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TRIASSIC MAGMATISM IN ALBANIDES: GEOCHEMICAL SIGNATURES.

Artan Tashko
Universiteti Politeknik,Tirane. tashkoar@gmail.com

ABSTRACT

Based on the REE and other trace elements abundances and Nd, Pb isotopic ratios we distinguish three phases on the development of the Triassic magmatism:

1. *Lower Triassic volcanism in a continental rifting environment. Volcanic rocks are significantly enriched, compare to MORB, on LREE and other trace elements typical for the continental crust. The negative value of εNd (-1,9)and Pb isotopic ratios indicate an enriched mantle magma source, close to EMI geochemical reservoir.*
2. *Middle Triassic volcanic and plutonic rocks formed in the continental extension conditions. Volcanic rocks are less enriched, compare to low Triassic volcanic rocks, on LREE and other trace elements typical for the continental crust. The low values of εNd and Pb isotopic ratios indicate a less enriched mantle magma source, but clearly different from the MORB. Middle Triassic plutonic massifs, mainly granitoides, are of the type A, A2.*
3. *Middle Triassic – Lower Jurassic volcanic rocks of the volcanic-sedimentary series formed in the spreading conditions, probably in a BAB. These rocks have the geochemical signatures close to MORB , but some high values of the trace elements typical for the continental crust may indicate probably the BABB's. The εNd and Pb isotopic ratios values are close to MORB.*

KEY WORDS

Magmatic rocks, Triassic,Geochemistry, U-Pb dating, Nd and Pb isotopic ratios, Albanides.

INTRODUCTION

The new data (Haklaj et al., 2011) showthe existence of the plutonic Triassic rocks, such as Trokuzi and Fierza massifs. So, differently from that is shown in the Geological map of Albania at scale 1:200 000, 2002 we have a very well developed Triassic magmatism. During more than 50 million years, from LowerTriassic to Lower Jurassic there are a big variety of the volcanic rocks from basalts to ryolites and at least to granitoid massifs including granites, granodiorites, gabbros etc..

The aim of this paper is to make a review of the analytical data that have been treated separately (Tashko etj., 2007, Tashko, Mascle, 2009, Haklaj, Tashko, 2012) to give a more complete vision about the geochemical developing of the Triassic magmatism in Albanides.

GEOLOGICAL SETTING

After Geological Survey of Abaniaet al., 2002 the Triassic basalts flow associated with sandstones, grauwake and sandy limestones lay above the P-T_1 verrucano terrigenic series and below verfenian limestones, mainly in western part of Korabi zone (Vanat-Tershane, Ujmisht-Ura e Dodes, Prat-Bllace, ect.). Sometimes trachytes and andesite-dacite are also found in this low Triassic formation.

In Middle Triassic formations, volcanic and volcanoclastic rocks are intercalated bylimestones and covered by cherts of Anisian age. As concern the Middle Triassic plutonic rocks, the Trokuzi massif, localized inthe central part of Gashi zone, is the biggest massif of Triasic (Anisian) age in the terrains of Albania. There are mainly granodiorites but also granites and gabbros.

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The most important occurrences of the Triassic volcanic (volcanic rocks?) are those of "volcano – sedimentary" series (Kodra et al., 1993) consisting of basalts intercalated with levels of cherts (signed as β T_2-J_1 in the Harta Gjeologjike e Shqiperise ne shkalle 1:200 000, 2002).

Finally, the Triassic volcanic??? are found as blocks in the supraophiolitic mélange.

METHODOLOGY

The analytical methods used to obtain these results are described in Tashko et al., 2007, Tashko & Mascle, 2009, Haklaj &Tashko,2012.

GEOCHEMICAL SIGNATURES OF THE TRIASSIC MAGMATISM IN ALBANIA.

The geochemical features of the LowerTriassic volcanismmay be illustrated by basalt- andesites found in Vanat, L.Lumes.

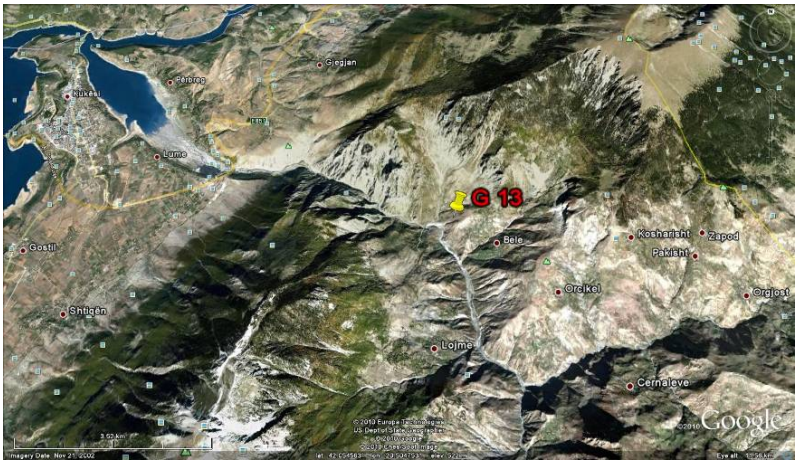


Figure 1 Localisation of low Triassic basalt andesites in Luma River (sample G13).

These rocks are unique as concern the trace elements content and the negative value of εNd. As seen from the Figure 2 they are enriched, compared to MORB, in REE and especially in LREE (up to 10 times) indicating a significant continental crust material assimilation by the magma. The value 0.8 of Eu/Eu* show that there is not a marked negative Eu anomalies to indicate an important previous plagioclase removal.

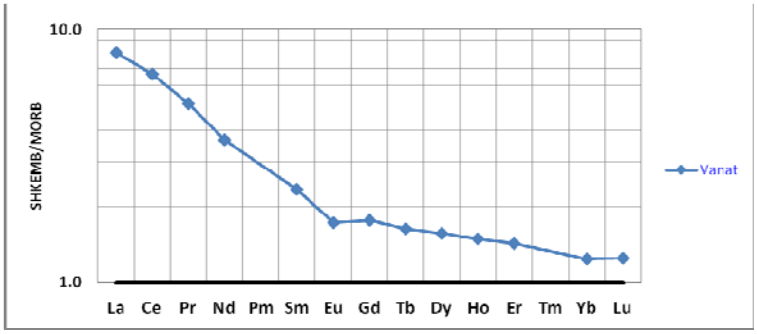


Figure 2 MORB-normalized REE compositions for low Triassic (Vanat, L.Lumes) volcanic rocks (normalization values after Sun and McDonough, 1989).

The extended multi-element variation plot (Figure 3) show also an enrichment (10 to 50 times) compared to MORB in the elements typical for the continental crust material and a characteristic Nb-Ta trough.

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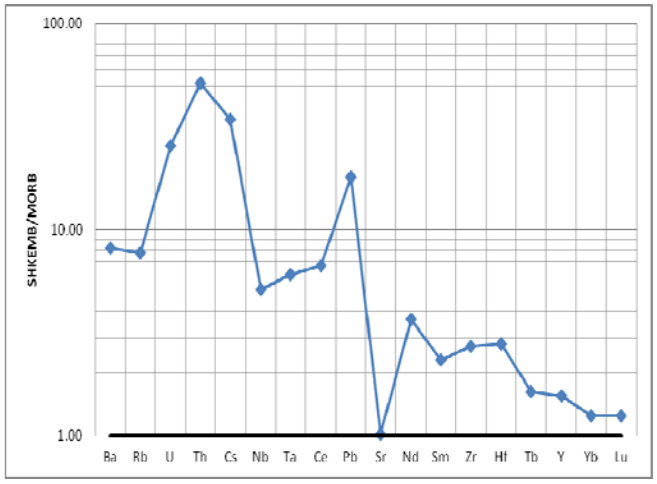


Figure 3 Extended multi-element variation plot for low Triassic (Vanaj, L.Lumes) volcanic rocks. Sample normalized to MORB (Salters, V. and Stracke, A. ,2004).

Nd and Pb isotopic ratios give more information about the magma source. In the εNd_i vs. $^{206}Pb/^{204}Pb_i$ plot (Figure 4) these rocks (sample G13) seems to be between BSE and EMI geochemical reservoirs. The negative value εNd = -1,9 is significant for an enrichment mantle source.

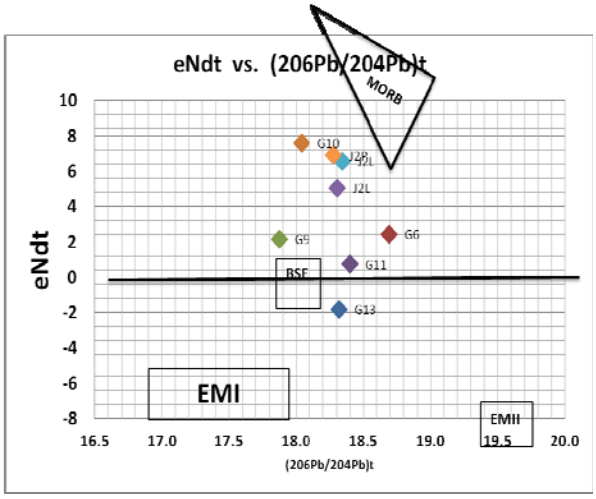


Figure 4 Plot of εNd_i vs. $^{206}Pb/^{204}Pb_i$ for low Triassic (Vanaj, L.Lumes) volcanic rocks. All corrected to 250 Ma. Isotopic reservoirs after Zindler and Hart (1986).

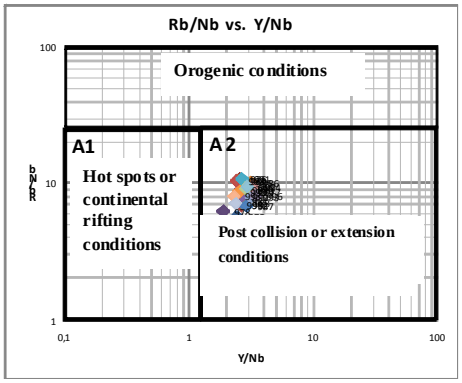
The geochemical features of the LowerTriasic volcanic rocks testimony that they are formed by the crystallization of a magma generated in mantle and enriched by the assimilation of the continental crust material. Normally, this assimilation may occur during a volcanism developed in continental rifting or continental volcanic arcs conditions.

The geochemical features of the MiddleTriassic volcanic rocks may be obtained from the Miraka basalts, but also from the basalts and ryolites found respectively in the Fush Arresi and Blinishti melange. The REE distribution in these rocks (Figure 5) is different from those of the LowerTriassic volcanic rocks. The REE content is similar to the MORB, but differs because of a light enrichment in LREE. The difference from MORB is clearer in the extended multi-element variation plot (Figure 6) showing a slight enrichment in the elements typical for the continental crust material. In the isotopic diagram (Figure 4) the position of these samples (G9, G11, G6) is between the MORB and EMI reservoir.

At the same time (Anisian), the plutonic granitoid massifs are formed. Geochemical features of these granitoids and the ryolite of Blinishti melange (Figure 7 and Figure 8) are typical for the granitoids

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formed by the magmas generated in mantle but that have assimilated the continental crust material. The



Trokuzi granitoids are of the A2 type (

Figure 9) formed in post collision – extension conditions.

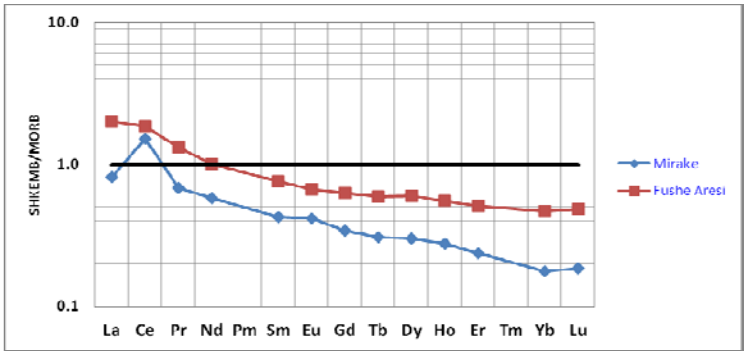


Figure 5 MORB-normalized REE compositions for middle Triassic volcanic rocks (normalization values after Sun and McDonough, 1989).

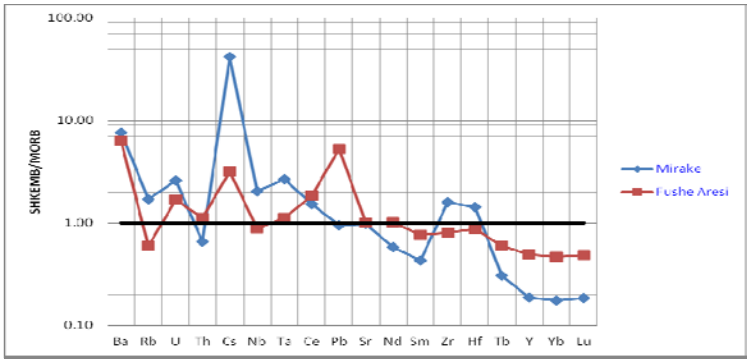


Figure 6 Extended multi-element variation plots for middle Triassic volcanic rocks. Samples normalized to MORB (Salters, V. and Stracke, A. ,2004).

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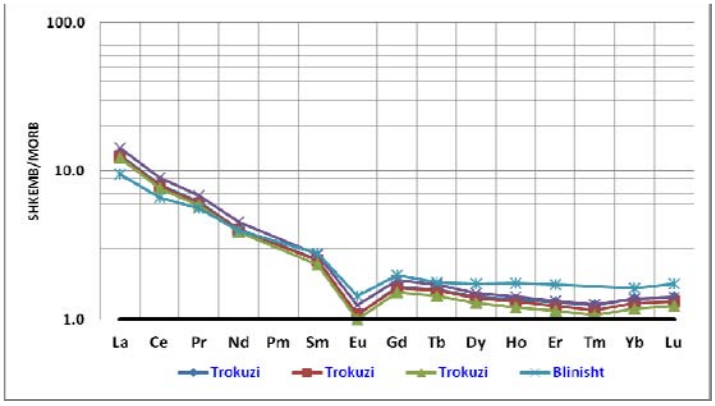


Figure 7 MORB-normalized REE compositions for Middle Triassic granitoid rocks (normalization values after Sun and McDonough, 1989). Blinisht sample is a ryolite.

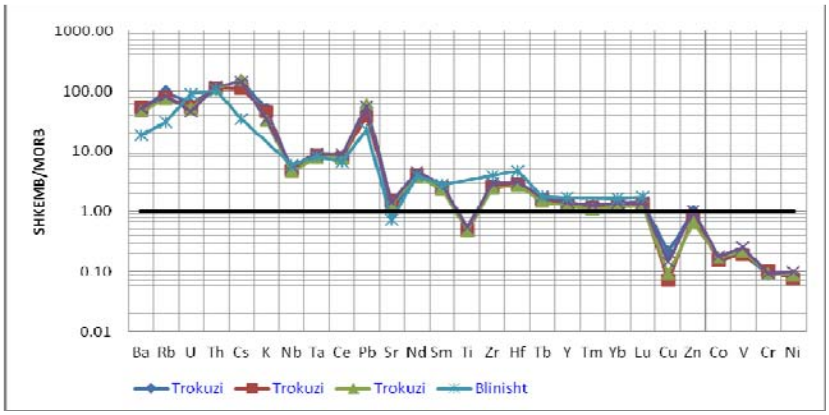


Figure 8 Extended multi-element variation plots for Middle Triassic granitoid rocks. Blinisht sample is a ryolite.

Samples normalized to MORB (Salters, V. and Stracke, A. ,2004).

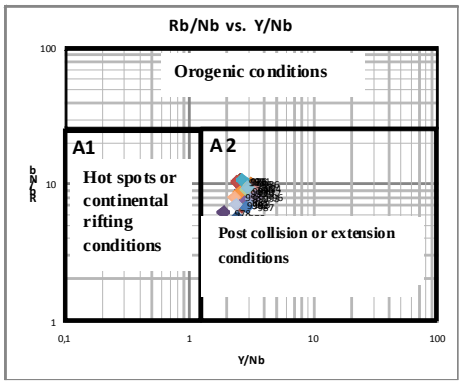


Figure 9. Classification of the Trokuzi granitoids as of type A, A2 (after Eby, 1990).

The geochemical features of the final stage of the Triassic magmatism are shown by the volcanic rocks of the volcanic sedimentary series, dated as T_2- J_1. These rocks, contrary from the Lowerand mMiddle Triassic magmatic rocks, show a clear similarity with MORB (Figure 10 and Figure 4 , sample G10). This is a testimony for a change in the geodynamic conditions with the opening of an oceanic basin. The magma source is close to a depleted mantle. But in the extended multi-element variation plot (Figure 11) we see some elements typical for the continental crust material to be higher than in MORB, what in the all context may be interpreted as an echo of some ancient developments that may be recorded only in small basins. That is why we may suppose a BAB as the environment of these rocks instead of a MOR.

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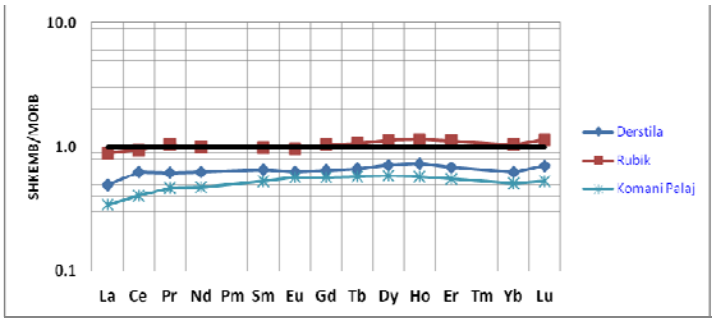


Figure 10 MORB-normalized REE compositions for T_2-J_1 volcanic rocks (normalization values after Sun and McDonough, 1989).

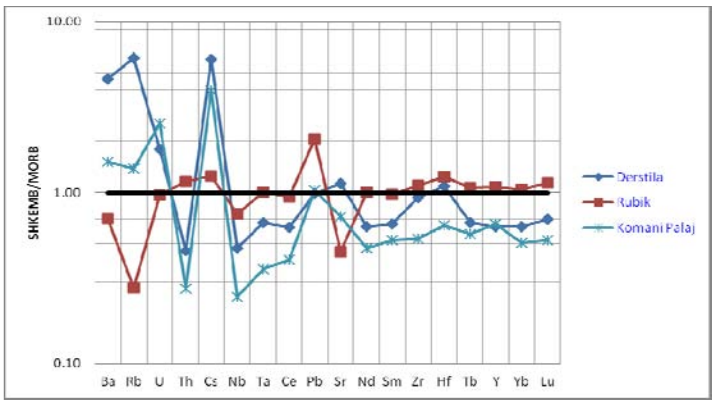


Figure 11 Extended multi-element variation plots for T_2-J_1 volcanic rocks . Samples normalized to MORB (Salters, V. and Stracke, A. ,2004).

That may be confirmed by the fact that this feature is absent in the Middle Jurassic basalts (samples G3 and G4 in Figure 12) although they plots in the same position in the isotopic plot (samples JL in Figure 4).

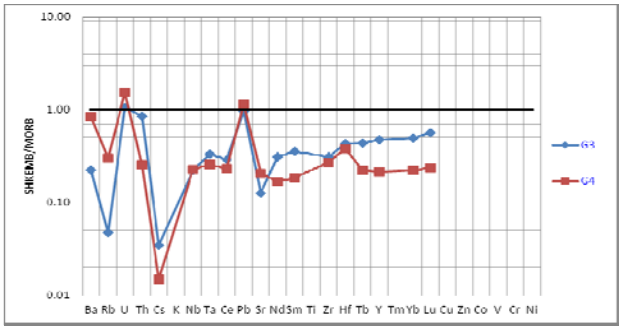


Figure 12 Extended multi-element variation plots for Jurassic volcanic rocks. Samples normalized to MORB (Salters, V. and Stracke, A., 2004).

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CONCLUSIONS

Based on the REE and other trace elements abundances and Nd, Pb isotopic ratios we distinguish three phases on the development of the Triassic magmatism:

1. Lower Triassic volcanism in a continental rifting environment. Volcanic rocks are significantly enriched, compare to MORB, on LREE and other trace elements typical for the continental crust. The negative value of εNd (-1,9) and Pb isotopic ratios indicate an enriched mantle magma source, close to EMI geochemical reservoir.
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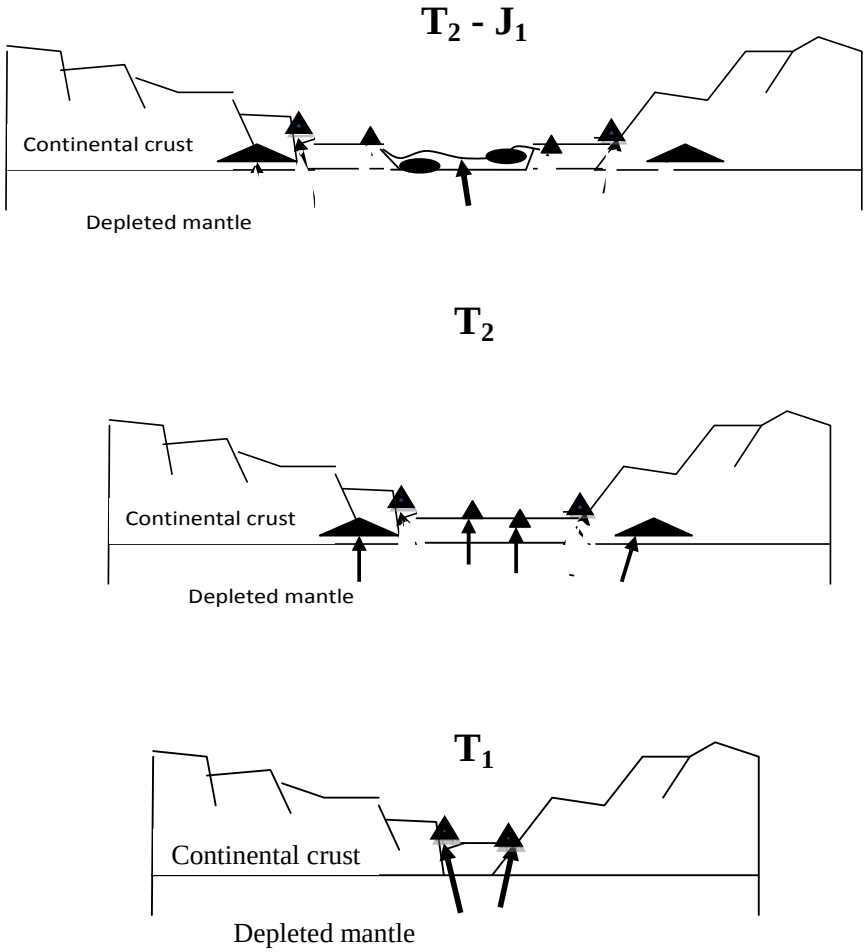


Figure13Schematic representantion of the Triassic magmatism development, based on the geochemical features.

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LITERATURE

A. Tashko, G.H.Mascle, B. Muceku, H. Lappierre 2007 Nd, Pb isotope and trace element signatures of the Triassic volcanism in Albania. The relationship to the NeoTethys opening. AJNTS, 2007, 1(21),3 – 23

Haklaj Isa, Tashko Artan 2012 Klasifikimi gjeokimik i granitoideve te masivit te Trokuzit. Buletini i Shkencave Gjeologjike, 2012, ne botim.

Haklaj Isa, Tashko Artan, Neziraj Adil, 2011**.** Isotopic dating (absolute age) for granitoides of Gashi zone. ***AJNTS***. In print.

Eby, G. N. 1990 The A-type granitoids: a review of their occurrence and chemical characteristics and speculations on their petrogenesis. Lithos 26, 115-134.

Kodra A., Vergely P., Gjata K., Bakalli F. & Godroli M. 1993. La formation volcano-sédimentaire du Jurassique supérieur: Témoin de l'ouverture du domaine ophiolitique dans les Albanides internes. Bulletin de la Societe Géologique de France 164, 61–7.

Salters, V. and Stracke, A. 2004. Composition of the depleted mantle. Geochemistry, Geophysics, Geosystems 5(5): doi: 10.1029/2003GC000597.

SH. GJ. SH. 2002. Harta Gjeologjike e Shqiperise ne shkalle 1:200 000.

Sherbimi Gjeologjik Shqiptar, Albpetroli, Universiteti Politeknik. 2002. GJEOLOGJIA E SHQIPERISE. Stratigrafia, Magmatizmi, Metamorfizmi, Tektonika, Neotektonika dhe Evolucioni Paleogjeografik dhe Gjeodinamik. Tirane 2002.

Sun, S.S. and McDonough, W.F. 1989. Chemical and isotopic systematics of ocean basalts: implications for the mantle composition and processes. In: Saunders, A.D., Norry, M.J. (Eds). Magmatism in the ocean basins. Geol. Soc. London Spec. Publ., 42, 313-345.

Tashko A., Georges H. Mascle 2009 Nd, Pb isotope ratios and trace element signatures of volcanic rocks in Albania: Magma source identification. AJNTS, 2009, 2, 3-23.

Zingler, A. and Hart, S.R., 1986. Chemical geodynamics. *Ann. Rev. Earth Planet. Sci.*, 14, 493-571.

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ORIGIN AND EVOLUTION OF THE TERTIARY EVROS VOLCANIC ROCKS, THRACE, NORTHEASTERN GREECE: MAJOR, TRACE AND Sr, Nd AND Pb GEOCHEMISTRY

G. CHRISTOFIDES[1], T. SOLDATOS[1], A. KORONEOS[1], C. PIPERA[1], L. PINARELLI[2] and Z. PECSKAY[3]

[1] Department of Mineralogy, Petrology and Economic Geology, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece, christof@geo.auth.gr
[2] CNR - Istituto di Geoscienze e Georisorse, Sezione di Firenze, Via La Pira, 4, 50121 Firenze, Italy lapina@igg.cnr.it
[3] ATOMKI Institute of Nuclear Research, Hungarian Academy of Sciences, Bem ter 18/C, 4026, Debrecen, Hungary pecskay@moon.atomki.hu

ABSTRACT

The Tertiary Evros volcanic rocks (EVR), which comprise one of the two widespread volcanic occurrences in northeastern Greece, crop out in Thrace, in close association with fault-controlled sedimentary basins, which developed synchronously with post-Cretaceous collision and subsequent Tertiary extension. Three volcanic areas, namely Loutros-Feres-Dadia, Kirki-Esimi and Mesti-Petrota, after the corresponding basins, are distinguished. Rock bulk chemistry and compositional variations show magmas with calc-alkaline to high-K calc-alkaline and, locally, shoshonitic features associated with magmatism at convergent margins. The EVR consists of pyroclastic flows interbedded with conglomerates at its base, consisting of volcanic layers locally associated with lahars. The upper part of the volcanic succession consists of lava flows, covering an ignimbrite sequence, domes and dykes. Their chemical composition ranges from basaltic andesite to rhyolite through andesite, trachyandesite, trachydacite and dacite. Basaltic andesites have two pyroxenes while andesites are either pyroxene andesites or biotite-hornblende andesites. Trachyandesites and trachydacites have pyroxenes and biotite. Dacites have mostly biotite and hornblende and locally pyroxene. Rhyolites have mainly biotite and rarely hornblende. All rocks are porphyritic with glassy, holocrystalline or semicrystalline textures. The K/Ar ages range from 33.4 to 19.5 Ma, establishing an Oligocene (33.4-25.4 Ma) and an Early Miocene (22.0-19.5 Ma) volcanic activity. Intercalations, however, of pyroclastic materials with Priabonian clastic sediments indicate that the volcanic activity started earlier than Oligocene. Two main groups of rocks have been distinguished, the PxBt group comprising basaltic andesites, pyroxene andesites, trachyandesites and trachydacites, and the HblBt group comprising hornblende-biotite andesites, dacites and rhyolites. Two, parallel, sub-parallel or cross-cutting geochemical trends are distinguished, indicating different evolutionary histories for the two groups. The isotopic composition of Sr, Nd and Pb differs in the two groups, with Sr I.R. ranging between 0.7074 and 0.7077 in the PxBt group, and between 0.7054 and 0.7085 in the HblBt group. Nd I.R. is 0.512447-0.512630 and 0.512352-0.512378 and $^{206}Pb/^{204}Pb$ is 18.745-19.898 and 18.228-18.963 in PxBt and HblBt, respectively.

The parental magmas of the PxBt group originate in an inhomogeneous and strongly metasomatized mantle through a slight modification of a primary basaltic melt. Isotope (Sr, Nd, Pb) correlation diagrams support a metasomatized (enriched) mantle as source region since the samples analyzed plot between EMI and EMII. The parental magma for the evolution of the HblBt group could be a hybrid magma of the PxBt group, which evolves, under different conditions, to give the HblBt group rocks. Although the involvement of a mantle component cannot be excluded for the origin of the rhyolitic melts, partial melting of crustal material (amphibolite, basalt, andesite, gneisses, pelites, greywackes), under various P-T conditions, is responsible for the genesis of melts similar to the less evolved rhyolites.

The PxBt group was evolved through an open system process (MFC) in which basaltic andesite and trachydacite represent the basic and the acid end-members respectively. Although AFC is not excluded, MFC between a basic end-member, similar to the HblBt andesites, and an acid end-member, having rhyolitic composition, is suggested as a possible process for the evolution of the HblBt group.

ACKNOWLEDGMENTS:

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ARSENOPYRITE-BEARING MINERALIZATION

Aleksander ÇINA[1]

Institute of Geosciences, Energy, Water and Environment, , Tirana, Albania.
E-mail: aleksandercina@gmail.com

ABSTRACT

In Albanides, despite various ore mineralizations, are found also mineralizations, distinguished for arsenopyrite, consequently for native gold-bearing. These mineralizations are located in both old Paleozoic and ophiolitic Jurassic formations. Some types of mineralizations as massive and vein polymetallic, massive arsenosulfides and veined quartz-sulfide have been encountered. As for geological setting and type of mineralization, arsenopyrite is part of several mineral assemblages, where in mutual relation with other minerals, results to belong of earlier age. Similarly, some features of its crystal structures can be clearly seen, as twinning and zonal structure. In its crystals are found also gold grains.
Chemical composition of arsenopyrite is represented by Fe, As, S and their associates, Sb, Co and Ni, that differ depending on geology and type of mineralization. In some places are also evidenced differences in composition and crystal growth zones.
It is possible that a part of gold-bearing of arsenopyrite can be as free state like inclusions of native gold, and partly like isomorphous mixture in its structural lattice.

KEYWORDS: arsenopyrite, mineralization, mineral assemblage, Albania.

INTRODUCTION

Ore mineralizations arsenopyrite-bearing are encountered from Gashi zone in the north, (Rupa, Mollavci, Lluzhnica occurrences); Korabi zone in northeast (Nimce, Lojme, Kallabaku occurrences); in central – north Mirdita zone (Dardha, Thirra, Dedaj, Lajthiza, Tureci, Gjazuj, Lak Roshi, Munella, Kurbneshi occurrences and deposits), as well as in southeast, in Librazhdi zone (Qafe Shuli, Babje and Babje 2 occurrences).
These mineralizations are situated in Paleozoic formations, at various sequences of Gashi and Korabi zones, from mantle-crust passage one, to volcanic – basaltic and intermediate – acidic zones of Jurassic ophiolitic formation.
They are represented by lens-like, massive arseno-sulfide, veined quartz sulfide, veined polymetallic and massive polymetallic types of mineralizations. Their ores are distinguished for a variety of mineral assemblages.
Arsenopyrite, which is their component, is distinguished for an apparent variation of chemical composition Fe, As, S, as well as Sb, Ni and Co, which is in correlation with geological setting and type of mineralization.
In euhedral prismatic, often twinned with zonal texture of arsenopyrite crystals, are found fine native gold inclusions. In addition, are also evidenced elevated gold values, which are likely related to its setting in structural lattice of arsenopyrite, by partly replacing its main components.

GEOLOGICAL SETTING OF MINERALIZATIONS.

Arsenopyrite bearing mineralizations in Albanides are setting in geological formations of different ages and lithotypes, belonging to Gashi, Korabi and Mirdita zones (Neziraj et al., 2007).
In fig. 1 are shown some of these mineralizations, of central area of Mirdita ophiolitic zone (Çina 1978, 2012, Shallo et al.1995). Such earlier mineralizations belong to polymetallic mineralizations, situated in Gashi zone, like Rrupa, Lluzhnica, Kreshta and Mollavca occurrences, situated in Paleozoic volcanics, probably of Silurian-Devonian, as well as in exocontacts of granitic massif of Trokuzi with volcanic and limestone wall rocks, and metamorphic shales of Silurian – Devonian.
To this early polymetallic type of mineralization belong mineralized occurrences of Korabi zone, related to quartz – shale series of Ordovician-Silurian, as well as in black shales of Silurian, which

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are thought to be related to monzonite – syenites. Arsenopyrite bearing mineralization of other types are related to different lithotypes of Jurassic – ophiolitic formation of Mirdita zone.

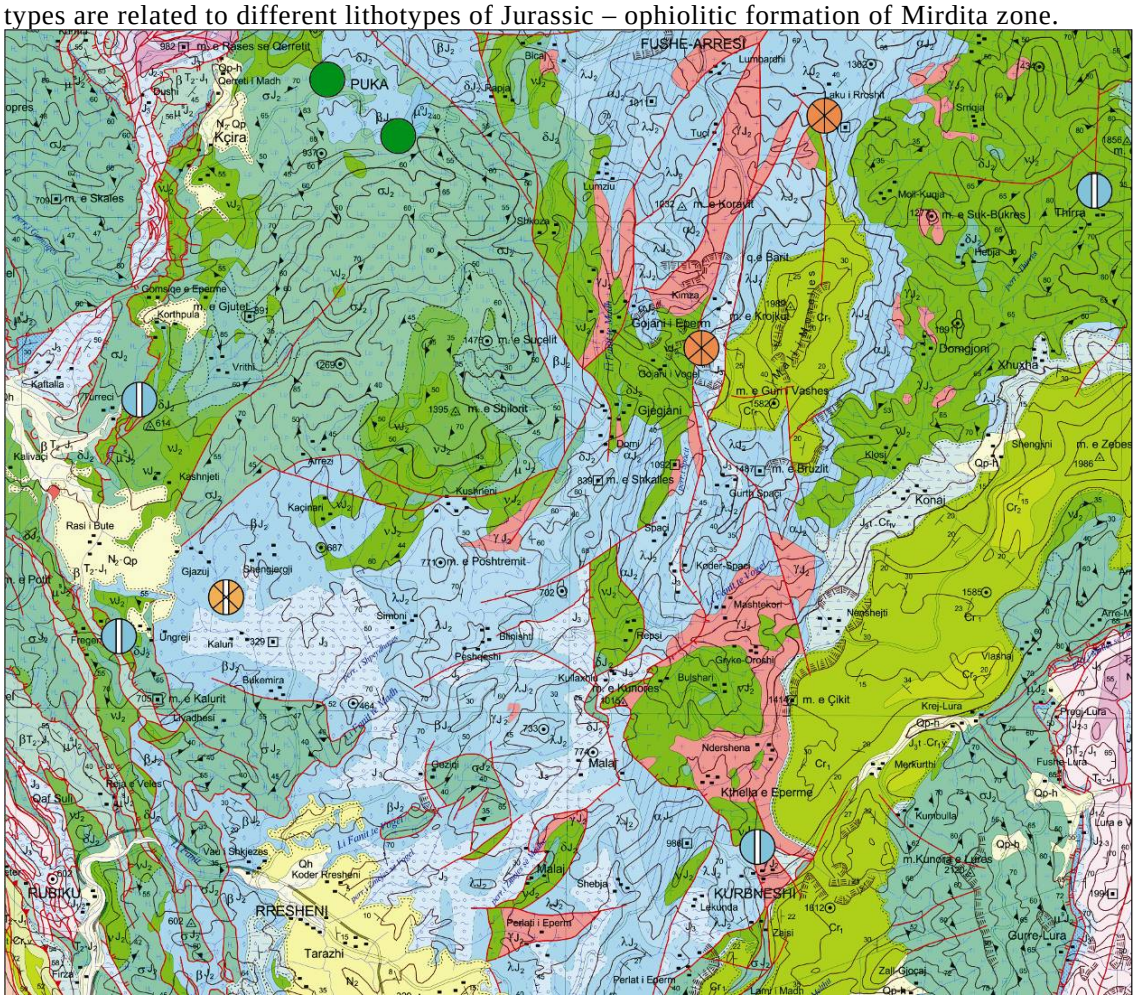


Fig.1 Geological map of central area, ophiolitic Mirdita Zone compiled with arsenopyrite-bearing mineralizations. (Xhomo et al., 2002, digitalized by L. Gurabardhi).

Legend
1- Pleistocene - Neogene sediments; 2- Late Cretaceous limestones; 3- Early Cretaceous limestones marl-limestones; 4- Early Cretaceous-Late Jurassic radiolarites, radiolarite limestones; 5- Late Jurassic, ophiolite breccia tuffogenous sandstones; 6- Middle Jurassic, metamorphic soil, amphibolite; 7- Middle Jurassic, ultramafic intrusions; 8- Andesite basalts boninites, riodacites, rhyolites; 9- Basaltic and basalt andesite pillow lava; 10- Volcanic rocks of basaltic series; 11-sheeted dyke complex; 12- Plagiogranites, quartz diorites; 13-Microdiorites; 14- Norites, gabbronorites, gabbro; 15- Troctolites; 16- Pyroxenites; 17- Dunites; 18- Plagioclase lherzolites; 19- Mantle harzburgite; 20- Mantle hartzburgite lherzolites.
1- polymetallic Mineralization related to basaltic sequence of Jurassic ophiolitic formation, MOR-type; 2- Massive polymetallic related to andesite, dacite and and rhyolite volcanic series, IAT-type; 3- Cu-(Au) quartz sulfide vein, related to cumulate layered gabbro-norite sequence;

Massive lens-like mineralization of arsenosulfides of Cu – As – Au type are situated in mantle – crust passage part?, associated with ultramaphic intrusions, or at lower part of layered gabbro – noritic cumulate sequence close to the ultramaphic rocks, like Qafë Shuli, Babje, Dedaj mineralized occurrences . In ophiolitic formation of gabbro – noritic sequence occur veined quartz sulfide, mainly Cu mineralization, associated by As, Co and Au, such as Kurbneshi,Thirra, Tureci dhe Fregeni deposites. Other mineralizations of ophiolitic formation, belong to Cu-Zn-Pb-As-Au-Ag massive and polymetallic ore, at volcano – exhalative or alternated origin, such as Munella and Gjazuj deposits (Sinojmeri 1990, Deda et al. 1995).

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Munella mineralization is related to upper levels of volcanic sequence, among andesites, dacites and rhyodacites, belonging to eastern ophiolitic belt of IAT type, while Gjazuj mineralization is related to basaltic pillow lavas, belonging to eastern ophiolitic belt of MORB type.

SAMPLING AND CONDITIONS OF ANALYSIS

Investigation of arsenopyrite as gold-bearing mineral, has been done based on selection of ore mineralizations of Albanides, where arsenopyrite has been found. At such ore occurrences are collected necessary samples, about 150, which underwent to the microscopic observations with reflection light, using Axionplan 2 imaging Carl Zeiss microscope, in order to evidence mineral assemblages and their textural features, mutual relationships of arsenopyrite with other ore-bearing minerals. It is also noted the presence of fine native gold grains in arsenopyrite crystals. Textural features are shown in microphoto, using MC 80 DX camera. The analyses of quantitative composition of arsenopyrite have been made by electronic microprobe of type CAMECA-BAX, BRGM, France and JOEL JXA-5 in the Salzburg University, Austria, with acceleration voltage 20 and 25 V, beam current 10 nA and with correcting program ZAF-4.

MINERAL COMPOSITION OF ARSENOPYRITE-BEARING ORES.

Arsenopyrite bearing mineralizations are distinguished from mineral assemblages and other various mineral constituents, because of their mutual relationships, textural features, and its geological setting.
In table No 1 are shown semiquantitative compositions of investigated minerals. At this table are seen differences in composition of arsenopyrite, from traces and limited amounts, to the main ore component, from polymetallic ones to quartz – sulfide, and up to massive arsenosulfide.
These mineralizations are composed by some mineral assemblages, belonging to polymetallic type: pyrite-chalcopyrite-sphalerite-galena-fahlerz-arsenopyrite-gold+ (barite), sulfide and arsenosulfide: pyrrhotite-cubanite-chalcopyrite-arsenopyrite-gold, and quartz sulfide: pyrite-phyrrotite-chalcopyrite-arsenopyrite-gold-cobaltite, and in some cases, calcite.

Table nr. 1 The mineral composition of arsenopyrite-bearing ores

	Minerals / Mineralization	Native gold	Pyrrhotite	Pyrite	Cubanite	Chalcopyrite	Galena	Sphalerite	Arsenopyrite	Cobaltite	Fahlerz	Goethite	Quartz	Epidote	Calcite	Barite
1	Munellë	…		xx		xx	x	xx	…		x	…		…		…
2	Gjazuj	…		x		x	x	x	x		…		x			
3	Babje 2	…	x	x		x		x	x		.					
4	Thirrë	.	x	xx		x		..	…				xx	…	x	
5	Dedaj	.				x			x				x			
6	Lajthizë	.	x			x			x				.			
7	Turec	..				x		.	…	..		…	x			
8	Fregen	..		x		x		.	x	..		…	x			
9	Kurbnesh	..	xx	xx	x	x		.	…	…		.	xx		x	
10	Qafë Shul	..	xx		x	…		.	x							
11	Babje	…			x	…			x							
12	Cërrujë	..							xx							
13	Rrupa	..		xx		x	…	x	…		…		…			
14	Nimçe	..		x		x	x	x	…		…		…			…

1 and 3: Massive polymetallic mineralizations, related to andesite, dacite and rhyodacite of Jurassic ophiolitic formation of IAT type;
2: Veined quartz-polymetallic mineralization, related to basaltic volcanics of Jurassic ophiolitic formation of MORB type;
4-9: Veined quartz-sulfide mineralizations of Cu (As+Au), located in layered gabbro-noritic cumulate sequence;

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10-11: Lens-like arsenosulfate mineralizations of Cu-As-Au, related to gabbro-norite, close to mantle ultramaphics.
12: Arsenosulfide mineralizations of As-Au, related to intrusive ultramaphics, close to gabbro-norites.
13-14: Veined–lens-like and polymetallic mineralizations,situated in early Ordovician – Silurian formations.

MINERAL ASSEMBLAGES AND TEXTURAL FEATURES.

Characteristics for arsenopyrite – bearing mineralizations are their various mineral assemblage and textural features of arsenopyrite in mutual relationship with other minerals.
In polymetallic ores are distinguished assemblages composed by: pyrite, marcasite, chalcopyrite, sphalerite, galena, fahlerz of Cu-As-Sb, arsenopyrite, native gold, and barite.
Quartz-sulfide ores are represented by the following assemblages: quartz, chlorite, calcite, pyrite, pyrrhotite, chalcopyrite, arsenopyrite, native gold, cobaltite.
Massive arsenosulfide ores are characteristic for the following assemblages: pyrrhotite, cubanite, chalcopyrite, arsenopyrite, native gold.
Finally, are found also quasi mono-mineral ore, composed by arsenopyrite.
At investigated mineralizations, mainly the arsenopyrite is the earlier mineral than other component ores. For this mineral, characteristic is its prismatic euhedral shape of crystals (photo 1) which are joined together as star-like twins. (photo 2, 3 and 4). Another characteristic of arsenopyrite crystals is their thin zonal internal structure. (photo 5, see also 4,10). Such structure is shown also by various elementary composition of specific zones (compare analyses 1 and 2 to those of 3 and 4, table 2).
In arsenopyrite crystals occur fine native gold inclusions (photo 6 and 7). In a case was observed the As bearing pyrite nucleus enveloped by an arsenopyrite shell of later generation (photo12).
Based on textural features, reflecting the mutual relationships among the minerals, arsenopyrite is earlier than pyrrhotite, pyrite, cubanite, chalcopyrite, sphalerite and fahlerz, which can be seen at photos: arsenopyrite is partly replaced by cubanite – chalcopyrite exsolution aggregate (photo 8), and cubanite (photo 9). Similarly, twined crystals with zonal structure are cut by pyrite (photo 10), or chalcopyrite veinlets (photo 11).

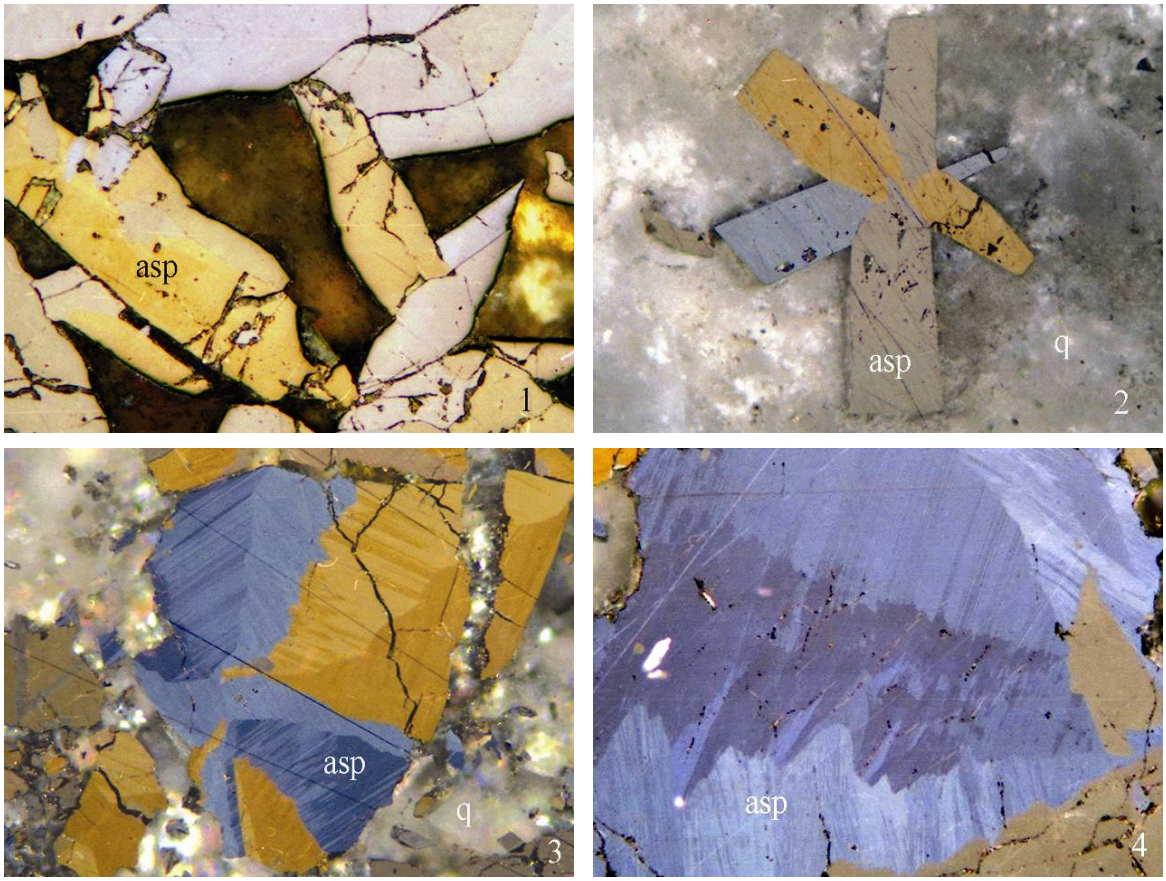


Fig. 1: Euhedral prismatic crystals of arsenopyrite (asp). Babje (Librazhd). Crossed nicols.

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Fig. 2: Star-like twins of arsenopyrite crystals (asp) in quartz matrix (9). Cërrujë (Klos). Crossed nicols.
Fig. 3: Thin zoned twins of arsenopyrite (asp). Gjazuj (Mirditë). Crossed nicols.
Fig. 4: Thin zoned twins of arsenopyrite (asp). Gjazuj (Mirditë). Crossed nicols.

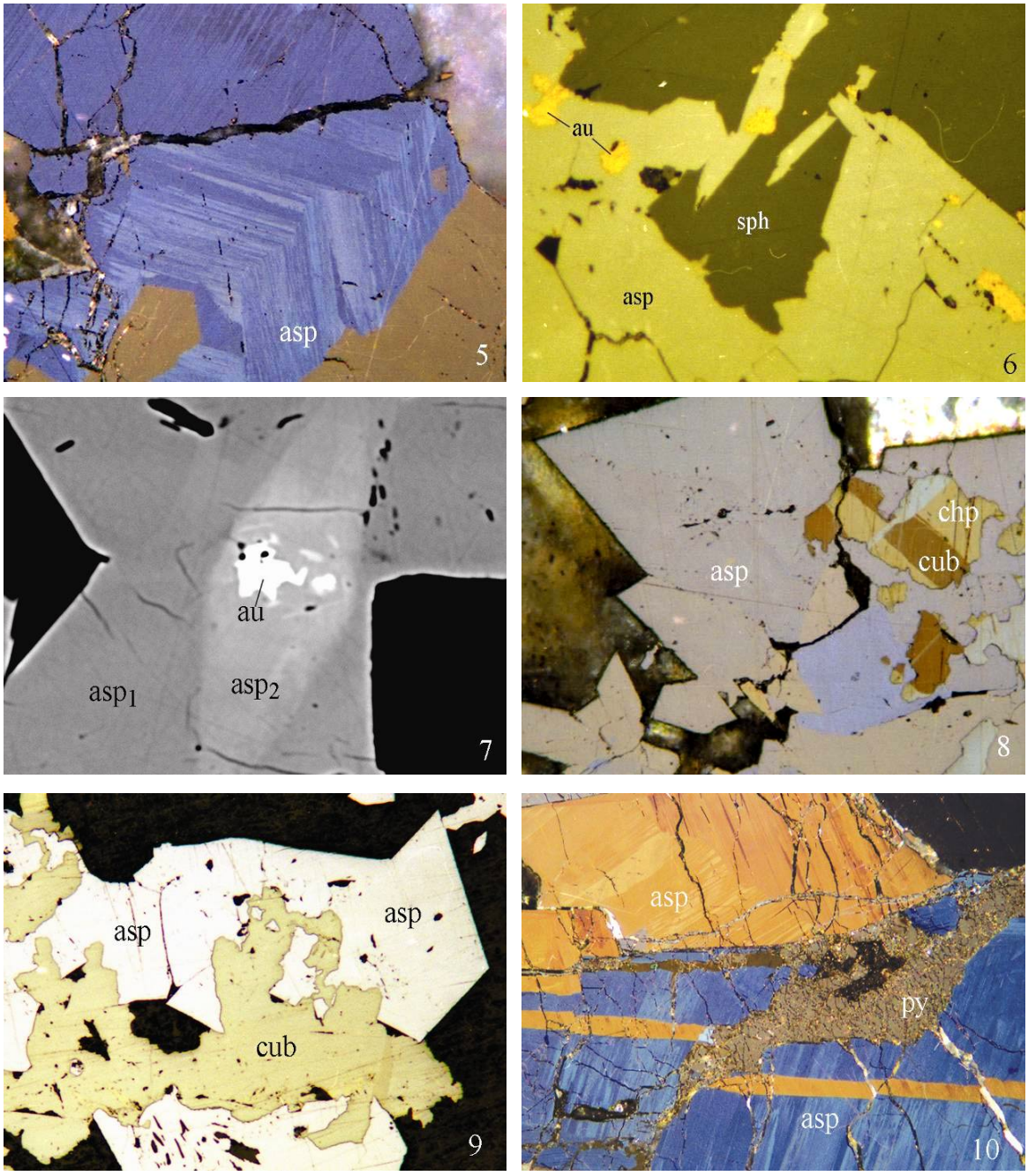


Fig. 5: Thin zoned twins of arsenopyrite (asp). Crossed nicols. Gjazuj (Mirditë). Crossed nicols.
Fig. 6: The fine native gold inclusions (au) within host arsenopyrite grains (asp) in mutual relationships with sphalerite (sph). Gjazuj (Mirditë).
Fig. 7: The fine native gold inclusions (au) within host prismatic crystal of arsenopyrite (asp_2), that is also included within another bigger arsenopyrite crystal (asp_1), distinguished by differ chemical composition. Babje (Librazhd). SEM.
Fig. 8: Replacement of arsenopyrite (asp) by parquet exsolution aggregate of chalcopyrite (chp) and cubanite (cub). Crossed nicols. Babje (Librazhd).
Fig. 9: Replacement of arsenopyrite (asp) by cubanite (cub). Babje (Librazhd).

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Fig. 10: Complicated twins of arsenopyrite crystals (asp) intersected by pyrite veinlet (py). Gjazuj (Mirditë). Crossed nicols.

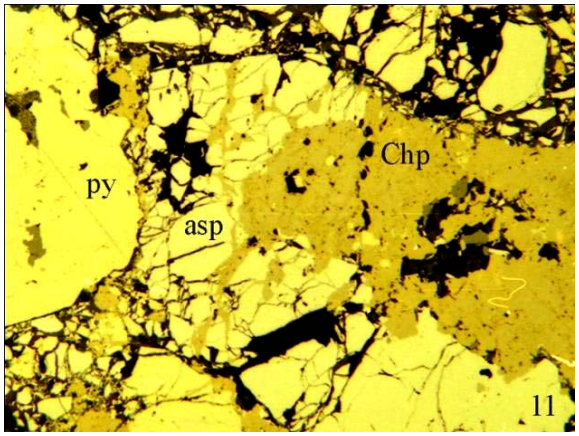




Fig. 11: Fractured arsenopyrite (asp) intersected by chalcopyrite veinlet (chp). Thirrë (Fan). Or replacement of arsenopyrite (asp) by sphalerite (sph). Babje (Librazhd).
Fig. 12: Pyrite nucleus (py) enveloped by arsenopyrite (asp). Gjazuj (Mirditë). SEM.

CHEMICAL COMPOSITION OF ARSENOPIRITE

Analysed arsenopyrite samples of mineralizations belonging to mineral assemblages and its separate parts of crystals, are distinguished for an apparent variation of chemical compositions, of the main ones Fe, As, S, and subordinated, represented by Sb, Co, Ni, Au, which are related to geological setting of mineralizations and their type.

As it is shown in Table no 2, S value ranges from 19 to 23.4 wt.%, As from 40.8% to 48 wt.%, Fe from 32.2 wt.% to 35 wt.% against its theoretical composition, respectively 19.69%, 46.0% and 34.3%. In accordance with composition of analysed arsenopyrites, ratio As/S is sometimes >1 and sometimes <1, which shows that ratios among them are variable, from about 0.75 to 1.16, while ratio of metals against the total of As+S is from 0.49 up to 0.51, which indicates the absence or surplus of an element against the other.

Greater variation have As and S values, in opposite ratios, arsenopyrite with S - 18.6 wt.%, where As - 47.6 wt.%, while when S - 23.4 wt.% As - 40.8 wt.% (see Table 2). Fe value has more limited variation, unlike As (compare samples 1 with 8).

As for subordinated elements, their values (Sb, Co, Ni) vary greatly. Sb value is very low, only 0.03 wt.%, to 0.17 , sometimes go to 0.99 wt.%.

Co and Ni values are also very variable, from 0.02 wt.% to 0.34 wt.%; and 0.03 wt.% to 0.92 wt.% respectively, even at maximum 1.85 wt.%, (compare analyses 1, 2, 3 and 4 with the rest, Table 2).

These features of chemical composition of analysed arsenopyrites, are related to geological location of arsenopyrite-bearing mineralizations, their types and mineral assemblages.

Arsenopyrite of the mineralizations is related to gabbro-noritic rocks, close to ultramaphic rocks, composed by the mineral assemblage of pyrrhotite-cubanite - chalcopyrite - arsenopyrite - gold, are distinguished for their low S content, consequently higher As content (samples 1, 2, 3; Table no 2). Similarly, this arsenopyrite is distinguished for higher Co and Ni content, which is consistent to the maphic - ultramaphic rock types and setting of mineralization.

Arsenopyrite of massive – lens-like mineralization, located in ultramaphic rocks, close to maphic cumulate crust, has similar composition to theoretical ones, and is characterized by very low content of Sb, Co and Ni (sample 5, Table 2).

Arsenopyrite of veined – polymetallic mineralization, related to Jurassic basaltic volcanics of MORB type, composed by mineral assemblage of quartz – pyrite – arsenopyrite – sphalerite – fahlerz – galena – native gold, is distinguished for high S content, and lower As values (samples 7 and 8) from one side, and the orther side (samples 6, 9, 10).

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Arsenopyrite of the other polymetallic mineralization, but of massive type, related to upper andesite, dacite and rhyodacite volcanic sequence of Jurassic ophiolitic formation of IAT type, is distinguished for elevated presence of Sb up 0.99 wt.% (sample 12), while other constituents (S, As) are similar to theoretical ones, meanwhile Fe value is low.
By using electron microprobe analysis has been evidenced the composition difference of generations and growth zones of arsenopyrite crystals.
In mineralization of Gjazuj, well grown crystals of early generation (sample 6) contain less S, therefore more As than small crystals of later generation (sample11). Among those, prominent distinction belongs also to higher Sb content.

Table nr. 2 Chemical composition of arsenopyrite

	Babje-Librazhd				Cerruj	Gjazuj-Mirdite						Munel
	1 C	2 C	3 C	4 C	5 K	6 C	7 C	8 C	9 C	10 C	11 C	12 S
S	17.7	18.2	19.0	18.6	20.92	19.8	22.8	23.4	19.5	19.1	23.1	20.6
As	48.0	47.8	47.0	47.6	45.10	46.4	41.1	40.8	46.4	47.0	40.8	44.6
Sb					0.03	0.17	0.98	0.49	0.49	0.34	0.39	0.99
Fe	32.20	33.50	33.50	33.60	34.28	34.3	34.8	35.3	33.6	33.6	35.0	34.7
Ni	1.85	0.92	0.17	0.07	0.02				0.03	0.03		
Co	0.34	0.32	0.24	0.19	0.05	0.03	0.04	0.04	0.04	0.04	0.02	
Cu	0.01	0.02	0.02	0.01					0.02			
Zn			0.03	0.01			0.03	0.03	0.01	0.02	0.02	
Tot.	100.04	100.76	99.97	100.07	100.39	100.67	99.71	100.06	100.04	99.93	99.37	100.89
S	0.918	0.933	0.975	0.957	1.047	0.999	1.127	1.146	0.996	0.978	1.143	1.032
As	1.065	1.047	1.029	1.047	0.966	1.002	0.870	0.855	1.011	1.029	0.860	0.957
Sb						0.002	0.013	0.006	0.007	0.004	0.005	0.030
Fe	0.957	0.987	0.984	0.990	0.985	0.996	0.990	0.993	0.984	0.987	0.992	0.999
Ni	0.052	0.026	0.005	0.002	0.001				0.001	0.001		
Co					0.002	0.001	0.001	0.001	0.001	0.001		
Cu												
Zn										0.001		
Tot.	3	3	3	3	3	3	3	3	3	3	3	3
As/S	1.160	1.122	1.055	1.094	0.923	1.005	0.783	0.751	1.022	1.056	0.757	0.956
Me/ AsS	0.507	0.510	0.492	0.496	0.489	0.498	0.493	0.496	0.490	0.492	0.495	0.499

C-Çina, 1978, 2012; K-Karaj, 1992; S-Sinojmeri, 1990.
The microprobe analysis are carried out by Dan Topa, Salzburg University, Austria and by Daniel Ohnenstetter, CRSCM, CNRS-BRGM,France.

At a zonal crystal, internal ones contain more S, therefore less As compared to external ones (compare samples 7 and 8, to those of 9 and 10). Similarly, a slightly higher Fe and Sb content, distinguish internal zones against external ones.
In mineralization of Babje, arsenopyrite bearing prismatic crystal of native Au grains, included within a large arsenopyrite crystal (see photo 7) contains slightly more S and less As, Co, and especially Ni. (compare samples 3 and 4 to 1 and 2), which fluctuate from 0.19 to 0.24 wt.% Co, and from 0.07 to 0.19 wt.% for native gold bearing crystal; and 0.32 to 0.34 wt.% Co and 0.92 to 1.85 wt.% Ni.
In arsenopyrite concentrates of some of its mineral bearing as Thirra, Dedaj, Dardha, Au value is from 10g/t to 26 g/t.
The gold-bearing of arsenopyrite is depend partly by presence of its inclusions but a part, as has suggested by Johan et alt. 1989. is as isomorphic in structure lattice.

CONCLUSIONS

Arsenopyrite bearing ore mineralizations belong to different formations, ages, mineral assemblages and structural features, which appear to have mutual relationships.

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Earlier Paleozoic mineralizations, located in Gashi and Korabi zones, belong to veined-polymetallic type, and are composed by the following mineral assemblage: pyrite, chalcopyrite, sphalerite, galena, fahlerz, arsenopyrite, ± barite.

Other mineralizations are related to Jurassic ophiolitic formation of Mirdita zone, and belong to different types: mineralization of mantle – crust transitional zone is massive – lens-like (Cu – As – Au); mineralization of layered gabbronoritic sequence of veined quartz – sulfide type of Cu-As-Au±Co, related to basaltic volcanic sequence, as well as the upper andesitic, dacitic, rhyolitic sequence of sulfide massive polymetallic type.

Arsenopyrite, in relation with other mineral constituents is earlier. Its crystal individuals are distinguished for twined euhedral shapes and internal zonal structure.

Main chemical constituents of arsenopyrite, as Fe, As, S, and associates as Sb, Co and Ni, in correlation with geological location and type of mineralization, are variable. Among these, As and Sb constituents have negative correlation.

Arsenopyrite of the mineralization, located in mantle – crust transitional zone, has higher As content, consequently lower S content. It is distinguished also for higher Ni and Co content, analysed in ultramaphic and maphic wallrocks; whereas there are only traces of Sb.

This arsenopyrite has hydrothermal origin of high temperature, which respond to the following mineral assemblage: arsenopyrite-pyrrhotite-cubanite-chalcopyrite (exsolution).

Arsenopyrite of polymetallic mineralizations, situated in Jurassic volcanics, is distinguished for higher S content, therefore lower As content, especially of Ni and Co, while Sb performs high values.

Apparent differences of chemical composition are evidenced at arsenopyrite crystal growth zones, as well as in its different generations.

In arsenopyrite bearing mineralizations, is evident presence of gold. It is microscopically observed like fine inclusions, native gold, not only in arsenopyrite, but also in chalcopyrite, sphalerite, fahlerz. But even in cases when it is not microscopically observed, arsenopyrite results to contain gold, which is supposed to be like a isomorphic mixture with its structural lattice.

REFERENCES

1. Çina, A., 1978 *Shoqërimet minerale paragjenetike të mineralizimeve hidrotermale damarore.* Tezë disertacioni. Universiteti Tiranës, pp. 210 (in Albanian).
2. Çina, A., 1990. *Sulphide and arsenide mineralization within the basic and ultrabasic rocks of Albania ophiolites.* Oceanic Crystals Analogues, Symposium "Trodoos 1957". Edited by J. Malpas, E.M. Moores, A. Panayiotou, C. Xenophontos. Nicosia, Cyprus, pp. 615-626.
3. Çina, A., 2012. *Mineralet xeherore të Shqipërisë.* (Ore minerals of Albania, Ore Microscopy and Electron Microprobe Analysis. Academy Sciences of Albania, pp. 296) (in Albanian and partly in English)
4. Deda, T., Sinojmeri, A., Leka, Gj., Pjetri, N., 1995. *Geological and mineralogical aspects of the Munella gold-bearing sulphide deposit*. Workshop on Albanian ophiolites and related mineralization. Documents du BRGM, nr. 244.
5. Johan, Z., Marcoux, E. et Bonnemaison, M., 1989. *Arsenopyrite aurifère: mode de substitution de Au dans la structure de FeAsS.* C.R. Acad. Sci. Paris, t. 308, Sèrie II, p. 185-191. (Abridged English version).
6. Karaj, N., 1992. *Repartition des platinoides, des chromites et sulfures dans le massif de Bulqiza, Albanie. Incidence sur les proccesus metallogeniques dans les ophiolites.* Thèse, Univ. d' Orlèans, pp. 400.
7. Kodra, A., Gjata, K. and Ballaki, F. 1995. *The Mirdita oceanic basin from rifting to the closure*. In: Workshop on Albanian ophiolites and related mineralizations. Documents du BRGM 244. Editions BRGM, France, pp.9-26.
8. Neziraj, A., Gjata, K., Çina, A. and Milushi, I., 2007. *Metalogjenia e Shqipërisë*. Shërbimi Gjeologjik Shqiptar, pp. 35 (in Albanian).
9. Shallo, M., Çina, A. and Turku, I., 1995. *Outline of metallogeny of the Albanian MOR and SSZ-type ophiolites.* In: Workshop on Albanian ophiolites and related mineralizations. Documents du BRGM 244. Editions BRGM, France, pp. 27-46.
10. Xhomo, A., Kodra, A., Shallo, M., Xhafa, Z., 2002. *Geology of Albania and Geological map (1:200000)*. Geological Survey of Albania. Arch. of Geology Tirana, pp. 320 (in Albanian).

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MAGMATISM IN THE WESTERN PANNONIAN BASIN (POHORJE, SLOVENIA) AS REFLECTED IN PALAEOMAGNETIC PARAMETERS

Mirka TRAJANOVA[1]

[1]*Geological Survey of Slovenia, Dimičeva ul. 14, 1000 Ljubljana, Slovenia*

EXTENDED ABSTRACT

The area of Pohorje Mountains in northern Slovenia represents southwesternmost outcrops of the Austroalpine units at the transition to the Pannonian basin. It consists of polymetamorphic rocks of southeastern prolongation of Koralpe and Saualpe and of Permo-Messozoic thrust units, all intruded by granodioritic batholith. The western part is transgressively covered by Miocene sedimentary rocks. The granodiorite body extends in the northwest-southeast direction. Eastern part represents somewhat deeper and coarser-grained part of the batholith. Reduction of grain size is observed toward the northwest from granodiorite, via porphyroid granodiorite to subvolcanic dacite. The central part of the pluton is crosscut by aplite-pegmatite veins. Lamprophyre dikes intrude the surrounding metamorphic rocks and sporadically and shallowly the pluton alone. An older gabbroid body named cizlakite is included in granodiorite at its southern margin near Cezlak. Simplified geological map of the Pohorje Mountains is shown in (Fig. 1).

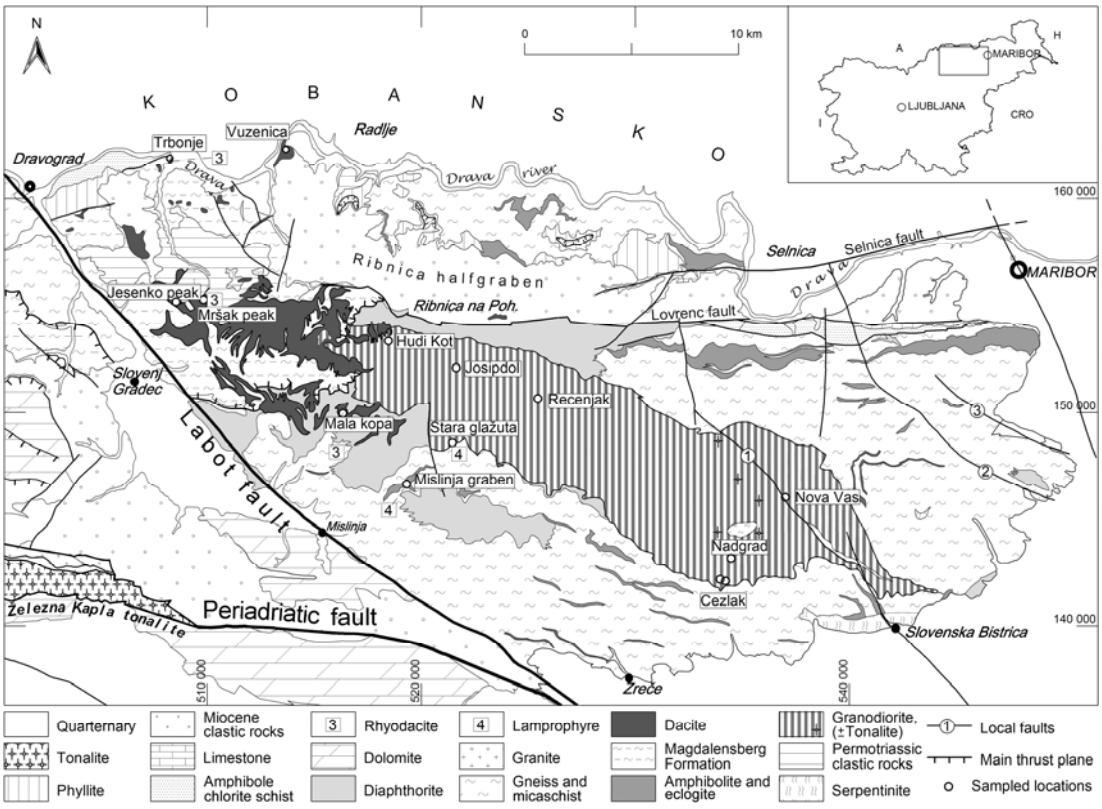


Fig. 1: Simplified geological map of the Pohorje Mountains (modified after Mioč & Žnidarčič, 1976; Žnidarčič & Mioč, 1988; Trajanova et al., 2008), showing the sampled localities.

From paleomagnetic point of view, the batholith represents very unique occurrence. The paleomagnetic measurements were made with the aim to determine rotations of separate parts of the investigated area and their regional and/or local significance. It was expected the results to support one of two different statements, namely, that the dacite is younger from granodiorite and that the magmatic activity is connected with Periadriatic lineament, which was valid up to now (e.g. Mioč, 1978; Mioč & Žnidarčič, 1989, Márton et al., 2006b), or that the intrusion is most probably peri-Pannonian (Trajanova et al. 2005,

2008, Trajanova & Pécskay 2006, Fodor et al. 2008), and granodiorite and dacite represent one common intrusion (Trajanova et al. 2005, 2008, Trajanova & Pécskay 2006). In this context, paleomagnetic results published by Márton et al. (2006b) are re-evaluated and reinterpreted.

Rotation as basic discrimination criteria for succession of the Pohorje Mountains magmatism is questionable. Therefore, magnetic polarity is used instead, representing regional parameter. This change enabled explanation of extremely inhomogeneous paleomagnetic results.

Paleomagnetic measurements were carried out on: granodiorite with transition to porphyroid granodiorite and dacite, co-genetic varieties lamprophyre and rhyodacite, on gabbroid inclusion in granodiorite named cizlakite and in the surrounding metamorphic rocks. Oriented samples were subjected to standard palaeomagnetic and magnetic susceptibility anisotropy processing.

In granodiorite body, paleomagnetic signal originate from ferromagnetic minerals, predominantly from magnetite. Paramagnetic minerals (mostly hornblende and biotite) are responsible for magnetic signal of cizlakite and surrounding metamorphic rocks. Relatively frequent secondary magnetite that formed on the account of paramagnetic minerals by deuteric processes also influenced the signal locally.

As shown by petrographic and structural data, magma crystallized in a dynamic conditions producing mushy flow of a partly crystallized magma. The influence of synmagmatic and postmagmatic ductile and brittle deformations in shallow parts of the crust influenced paleomagnetic record of the intrusion more than its direction of emplacement. Later reduction of grain size in mylonitized zones and reorientation of grains within shear zones affected stronger wider central and eastern part of the Pohorje Mountains, therefore the influence of emplacement direction on the paleomagnetic fabric was destroyed there.

There is extreme variation in susceptibility and in its anisotropy within the pluton. Lowest values are obtained in the mafic members (the cizlakite and in some lamprophyres), while the granodiorite exhibits extreme variation, far exceeding those observed for other Periadriatic plutons. The variations are attributed to the complex history that involves assimilation, fractional crystallization and stratification in the magma chamber, incorporation of wall rocks, and most of all tectonic processes. Besides, the pluton is locally affected by variable degree of K-metasomatism and hydrothermal alteration. The degree of susceptibility anisotropy of the pluton is often much higher than in the metamorphic rocks. It is on average higher in central to eastern part and weaker in western part of the massif. The dacite, part of the granodiorite and three metamorphic samples are characterized by counter-clockwise rotated declinations. Clockwise rotation affected only central southern to south-eastern part of the pluton. The palaeomagnetic directions for the dacite fit the regional pattern of counter-clockwise rotation observed in the Neogene sediments around the Pohorje pluton (Fodor et al. 1998; Márton et al. 2002; Márton et al. 2006a).

Polarity measurements indicate that magmatism of the Pohorje Mountains was active in the period of magnetic reversion. Such an example is known from western Antarctica (Behrendt et al. 2007). The time of eruption there is estimated to be older than 15 Ma and magnetic anomalies occur only in volcanic exposures older than 10 Ma, what in broad coincides with the time of emplacement and cooling of the Pohorje Mountains batholith (between around 18.7 to 15Ma). Both, granodiorite and dacite have normal polarity, which is in agreement with their common emplacement. Lamprophyre and rhyodacite, together with separate mafic inclusions in granodiorite have reverse polarity, confirming their younger age. The polarity results in combination with radiometric dating of the rocks (Trajanova et al., 2008, Fodor et al. 2008) show that pole reversal occurred after emplacement and cooling of the granodiorite body under the Currie point, but before lamprophyre (age around 16.7 Ma) was cooled under about 560^{o}C.

The magmatism of the Pohorje Mountains is younger than the Oligocene intrusions along the Periadriatic zone. Therefore, it probably originated as a response to deep transtensional rifting of the Pannonian basin, and development of the Labot fault, respectively in early Miocene. In this context, it represents one of the earliest and the westernmost peri-Pannonian intrusions.

REFERENCES:

Behrendt, J. C. Finn, C., Morse, D. L. & Blankenship, D. D. 2007. *One hundred negative magnetic anomalies over the West Antarctic Ice Sheet (WAIS), in particular Mt. Resnik, a subaerially erupted volcanic peak, indicate eruption through at least one field reversal*. U.S. Geological Survey and The National Academies; USGS OF-2007-1047.

Fodor, L., Gerdes, A., Dunkl, I., Koroknai, B., Pécskay, Z., Trajanova, M., Horváth, P., Vrabec, M., Jelen, B., Balogh, K. & Frisch, W. 2008. *Miocene emplacement and rapid cooling of the Pohorje pluton at the Alpine-Pannonian-Dinaridic junction, Slovenia*. Swiss J. Geosci., Birkhäuser Verlag, 255-271, Basel.

ISSN 2306-9600

Fodor, L., Jelen, B., Márton, E., Skaberne, D., Čar, J. & Vrabec, M. 1998. *Miocene - Pliocene tectonic evolution of the Slovenian Periadriatic fault: implications for Alpine - Carpathian extrusion models*. Tectonics, 17, 690-709.

Márton, E., Jelen, B., Tomljenović, B., Pavelić, D., Poljak, M., Márton, P., Avanić, R., Pamić, J. 2006a. *Late Neogene counterclockwise rotation in the SW part of the Pannonian Basin*. Geologica Carpathica 57, 41-46, Bratislava.

Márton, E., Trajanova, M., Zupančič, N. & Jelen, B. 2006b. *Formation, uplift and tectonic integration of a Periadriatic intrusive complex (Pohorje, Slovenia) as reflected in magnetic parameters and palaeomagnetic directions.* Geoph. J. Internat. 167/3, 1148-1159.

Mioč P. & Žnidarčič M. 1976. *Basic geological map of the SFRJ 1:100.000, sheet Slovenj Gradec.* Federal Geol. Survey, Belgrade.

Mioč P. & Žnidarčič M. 1978. *Explanatory notes for the sheet Slovenj Gradec. Basic geological map of the SFRJ 1:100.000*. Federal Geol. Survey, 74 pp., Beograd (in Slovenian).

Mioč, P. & Žnidarčič, M. 1989. *Explanatory notes for the sheet Maribor and Leibnitz. Basic geological map of the SFRJ 1:100.000*. Federal Geol. Survey, 60 pp, Beograd (in Slovenian).

Trajanova, M. & Pécskay Z. 2006. *Evolution of the calc-alkaline magmatism in the Pohorje Mt., Slovenia*. In: Sudar, M., Ercegovac, M., Grubić, A. (Eds.). Proceedings of the 18th Congress of the Carpathian-Balkan Geological Association, Serbian Geological Society, Belgrade, 632-635.

Trajanova M., Pécskay Z., & Itaya T. 2005. *Timing of Magmatism in the Pohorje Mts., Slovenia.* In: Tomljenović, B., Balen, D. & Vlahović, I.: 7th Workshop on Alpine Geological Studies. Abstract book, Zagreb, 97-98.

Trajanova, M., Pécskay, Z. & Itaya, T. 2008. *K-Ar geochronology and petrography of the Miocene Pohorje Mountains batholith, Slovenia.* Geol. Carpath. 59/3, 247-260, Bratislava.

Žnidarčič M. & Mioč P. 1988. *Basic geological map of the SFRJ 1:100.000, sheets Maribor and Leibnitz*. Federal Geol. Survey, Belgrade.

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LOW-GRADE METAMORPHIC ROCKS FROM THE PERIPHERY OF THE BULQIZA ULTRAMAFIC MASSIF

Arjan Beqiraj[1]

[1]*Faculty of Geology and Mining, Polytechnic University of Tirana (Albania) e-mail: ae_beqiraj@yahoo.com*

ABSTRACT

Major – and trace –element contents and initial Sr-isotope ratios of four amphibolites samples from the metamorphic sole of the ultramafic massif of Bulqiza in eastern Albania have been determined. The immobile –element plots show that the rocks derived by metamorphism of either within plate alkaline basalts and island-arc boninites. Metamorphisim ranged from greenschist to amphibolites facies (440-575 ^{O}C and 5 kbar), grading upwards from the bottom to the top of the metamorphic sole. Finally, the initial Sr-isotope ratios (0.70497- 0.70723) show that amphibolitization took place with addition of radiogenic Sr provided by sea-water-derived fluids, likely during subduction of an oceanic slab.

KEY WORD

Geochemistry, Amphibolites, Metamorphism, Bulqiza, Albania.

INTRODUCTION

Albania hosts major ophiolitic outcrops of Mesozoic age, that form two main alignments trending roughly NW-SE (fig.1). The Bulqiza massif, that occurs in the Mirdita zone, is the most important complex in the eastern alignment and, as well as other ophiolitic massifs from the Mediterranean area, is bordered by a narrow and discontinuous metamorphic belt. This later separates the ultramafic rocks from the Triassic-Jurassic volcano-sedimentary formations, that is probably an ocean-floor fragment of the Tethys (e.g. TURKU 1987). The amphibolites were selected among other rocks of the metamorphic sequence for this study aimed at defining the petrologic nature of the protolith(s), and, thus, highlighting the geodynamic significance of the rocks.

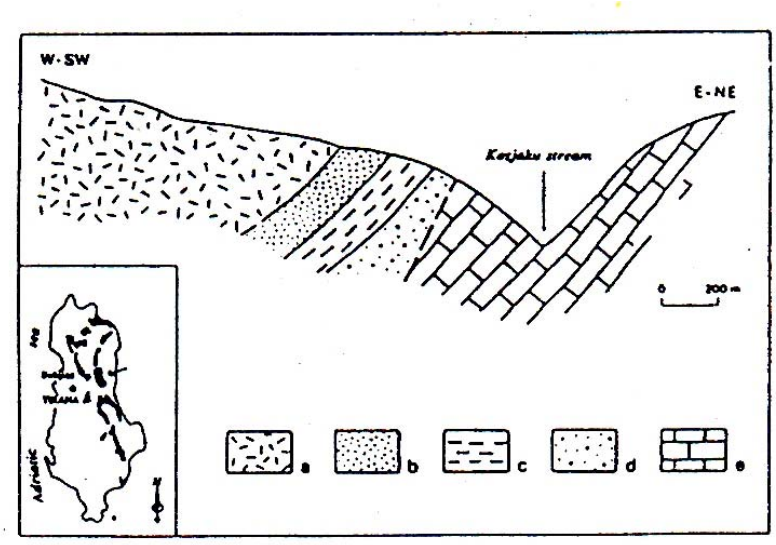


Fig. 1. Geologic sketch profile of the eastern flank of the Bulqiza ultramafic massif (modified from SHALLO et al. 1989).
a-tectonic harzburgites of the massif, b- Amphibolites, c-Tiassic-Jurassic volcano –sedimentary formation , d- Upper Jurassic- Lower Cretaceous flysch , e-Upper Triassic-Lower Jurassic neritic limestone.

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GEOLOGIC SETTING AND SAMPLING

The Bulqiza massif is bordered by a narrow belt of amphibolitic schist, amphibolites, greenschist and quartz-mica schist with garnet (KODRA et al.1989; SHALLO et al. 1989), that form limited outcrops due to both faults and younger sedimentary terrains, and show upwards grading metamorphism from the top of the underlying volcano–sedimentary formation to the bottom of the overlying ultramafic rocks (KODRA and GJATA 1989). ?In places either the amphibolites or the volcano-sedimentary rocks rest on the Triassic-Jurassic platform limestone. The ultramafic rocks at the contact with either the amphibolites or the volcano-sedimentary formations are represented by serpentinite or serpentinitic schist derived from harzburgite alteration. The metamorphic sole belongs to the volcano–sedimentary formation (SHALLO 1965, TURKU 1987, KODRA and GJATA 1989) or is closely related to the overlying ophiolites in both its formations and its emplacement as metamorphic analog of the ophiolite oceanic crust (MESHI 1995). The metamorphic sole is thought to be the product of: i) contact metamorphism (SHALLO 1965), ii) intraoceanic ophiolite obduction (KODRA et al. 1989), iii) initial ophiolite displacement during the late Jurassic prior to the Tithonian (SHALLO et al. 1995) or, finally, iiii) intraoceanic subduction of a pristine lithosphere BECCALUVA et al. 1994).
The studied samples were collected from the Kozjak stream valley in the southeastern corner of the Bulqiza massif moving from the contact (sample K-1) with the Triassic–Jurassic volcano-sedimentary formation through the metamorphic belt (samples K-2 and K-3) up to the contact (sample K-4) with the ultramafic massif. The samples show nematoblastic to granoblastic fabric, that along with the geochemical affinity suggest the rocks are metamorphosed basalts of the volcano-sedimentary formation (SHALLO et al. 1989). The mineralogical assemblage is composed of amphibole, ranging from green to common hornblende with variable hydration, saussuritized intermediate to basic plagioclase, minor epidote and accessory sphene.

ANALYTICAL PROCEDURE

Analysis of mineral phases was carried out by a CAMECA SX 50 electron microprobe with EDS Link and WDS (operation conditions: 15 kV, 15 nA and counting time 100 sec); at least 10 crystals of each mineral phase were analyzed for each sample. Chemical analysis of rocks was carried out by XRF except for Fe^{2+} (by tritimetric method) and Li and Cu (by anatomic absorption). Finally, the Sr- isotope ratios were measured by a VG-54 E Micromass spectrometer; details about procedure are reported by AKINCI et al. (1991). During the period of analysis the NBS-987 Sr-standart yielded $^{87}Sr/^{86}Sr=0.71024\pm2$.

EXPERIMENTAL RESULTS AND DISCUSSION

Table 1 shows average composition of both amphiboles and plagioclases, while Table 2 shows major-and trace-element contents, the initial Sr-isotope ratios of the studied rocks.

Mineralogy

According to LEAKE's (1978) and HAWTHRONE's (1983) nomenclature, the amphiboles belong to the calcic group ((Ca+Na)>1.34; Na<0.67) and are magnesio-hornblende, actinolitic hornblende, actinolite, edenitic hornblende and ferroan pargasitic hornblende. The samples exhibit rough zonation from K-1 to K-4 with respect to both mineral assemblage and composition. In fact, samples K-1 and K-2 are characterized by Al - poor actinolite + epidote + albite (An < 7%) + sphene, whereas samples K-3 and K-4 are characterized by Al-rich horneblende + oligoclase/labradorite + rutile/ilmenite + glaucophane(?); therefore, the two sample pairs are representatives of greenschist and amphobiolite facies, respectively (LEAKE 1965, TURNER 1968, SPEAR 1981, LIOU et al. 1974, SHALLO 1982 , SHALLO et al. 1989). In particular, the coexistence of both Al-poor actinolite and Al-rich hornblende in sample K-2, and of pure albite and An-rich plagioclase in samples K-3 and K-4 (Tab.1) shows the transition from greenchist to amphibolite facies (TURNER 1968). The transitional nature of the amphibolites is also shown by Fig 2, that depicts the relation between Al^{IV} and A-site occupancy, i.e. the cation substitutions coupled within the intermediate terms of hornblende and pargasite (Tschermakite (Al^{IV}) substitution - medium pressure; edenite ($Na^{(M4)}$ substitution-low pressure). Finally, as the samples contain abundant prehnite, there is evidence of retrograde metamorphism signature

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Geochemistry

Samples K-1 and K-4 distinguish from samples K-2 and K-3 due to higher contents of TiO_2 ,Al_2O_3, $Fe_2O_3^{tot}$, Na_2O, K_2O, P_2O_5, Rb, Sr, Ba, La, Ce, Y, Zr, and Nb and, conversely, lower MgO and Cr,
Assuming that metamorphism was isochemical and talking into account normative minerals, three samples are hawaites and sample K-4 is trachybasalt. Zr, Ti, Cr and Ni contents support an igneous origin of the rocks.

Tab. 1- Average composition of amphibole and plagioclase from the metamorphic sole of the Bulqiza massif.
bdl =below detection limit.

N° Sample		K1	K2/1	K2/2	K3	K4
Type of mineral		AMPHIBOLE				
SiO_2	%	42.33± 0.43	46.80 ±1.88	53.65 ± 0.35	47.94 ± 0.47	49.96 ± 1.14
TiO_2	%	0.79 ± 0.02	0.52 ± 0.23	0.68 ± 0.15	0.69 ± 0.13	0.27 ± 0.02
Al_2O_3	%	11.91± 0.48	10.34 ± 2.37	3.06 ± 0.70	9.38 ± 0.51	9.26 ± 1.46
FeO	%	18.48± 0.25	9.81 ± 0.61	11.52 ± 1.89	12.95 ± 0.15	6.76 ± 0.09
MnO	%	0.29 ± 0.04	0.28 ± 0.06	0.62 ± 0.33	0.33 ± 0.01	0.31 ± 0.01
MgO	%	9.29 ± 0.16	15.11 ± 0.64	15.49 ± 1.38	13.44 ± 0.30	17.00 ± 0.52
CaO	%	11.15 ± 0.14	11.60 ± 0.14	12.55 ± 0.15	11.07 ± 0.14	12.41 ± 0.09
K_2O	%	1.22 ± 0.21	0.11 ± 0.03	0.10 ± 0.02	0.29 ± 0.06	0.12 ± 0.03
Na_2O	%	1.93 ± 0.10	1.45 ± 0.37	0.50 ± 0.13	1.44 ± 0.02	1.39 ± 0.21
Formula						
Si	a.f.u	6.44 ± 0.06	6.93 ± 0.26	7.71 ± 0.02	6.92 ± 0.07	7.06 ± 0.15
Al^{IV}	a.f.u	1.56 ± 0.06	1.07 ± 0.26	0.29 ± 0.02	1.08 ± 0.07	0.95 ± 0.16
Al^{VI}	a.f.u	0.58 ± 0.03	0.68 ± 0.18	0.23 ± 0.14	0.52 ± 0.06	0.60 ± 0.09
Fe^{3+}	a.f.u				0.36 ± 0.12	
Ti	a.f.u	0.09 ± 0.01	0.06 ± 0.02	0.08 ± 0.02	0.07 ± 0.01	0.03 ± 0.01
Mg	a.f.u	2.11 ± 0.04	3.22 ± 0.13	3.32 ± 0.28	2.89 ± 0.07	3.58 ± 0.10
Fe^{2+}	a.f.u	2.35 ± 0.03	0.87 ± 0.08	1.15 ± 0.21	1.20 ± 0.31	0.81 ± 0.01
Mn	a.f.u	0.04 ± 0.01	0.03 ± 0.01	0.02 ± 0.01	0.04 ± 0.01	0.04 ± 0.01
Ca	a.f.u	1.82 ± 0.02	0.74 ± 0.07	1.84 ± 0.08	1.72 ± 0.02	1.88 ± 0.01
K	a.f.u	0.24 ± 0.04	0.02 ± 0.01	0.04 ± 0.02	0.05 ± 0.01	0.01 ± 0.01
Na	a.f.u	0.56 ± 0.03	0.11 ± 0.07	0.14 ± 0.08	0.40 ± 0.09	0.38 ± 0.05

No. Sample		K1	K1	K3	K3	K4	K4
No. analysis		1	2	1	2	1	2
Type of mineral		Plagioclase					
SiO2	%	66.99	60.70	65.07	63.67	68.92	49.70
Al2O3	%	20.00	24.71	21.74	22.79	19.36	27.94
FeO	%	0.14	0.35	0.56	0.27		0.25
MnO	%	0.00	0.20	0.00	0.00	0.00	0.05
MgO	%	0.00	0.19	0.00	0.00	0.00	0.15
CaO	%	0.81	0.43	0.69	2.79	0.08	15.24
K2O	%	0.11	3.60	1.55	0.60	0.07	0.07
Na2O	%	11.56	8.05	10.17	9.44	12.15	4.36
Formula							
Si	*a.f.u*	11.80	11.01	11.52	11.30	11.99	9.36
Al	*a.f.u*	4.15	5.28	4.54	4.77	3.97	6.20
Fe	*a.f.u*	0.02	0.05	0.08	0.04	0.00	0.04
Mn	*a.f.u*	0.00	0.00	0.00	0.00	0.00	0.02
Mg	*a.f.u*	0.00	0.05	0.00	0.00	0.00	0.04
Ca	*a.f.u*	0.15	0.08	0.13	0.53	0.01	3.07
K	*a.f.u*	0.03	0.83	0.35	0.14	0.02	0.02
Na	*a.f.u*	3.95	2.83	3.49	3.25	4.10	1.59
Mol %							
An	%	3.60	2.10	3.30	13.50	0.20	65.50
Ab	%	95.80	75.60	87.90	82.90	99.30	34.00
Or	%	0.60	22.30	8.80	3.60	0.50	0.40

Tab. 2-Major –(mass %) and trace - (ppm) element contents and Sr-isotope ratios (m=measured ,i=initial) of the amphibole from the metamorphic sole of the Bulqiza massif. bdl=below detection limit.

No. sample					
Rock type		Amphibolite			
SiO2	*%*	48.32	46.91	45.40	45.61
TiO2	*%*	2.49	0.26	0.42	3.12
Al2O3	*%*	15.87	13.84	12.67	14.27
Fe2O3	*%*	3.96	2.32	3.27	6.41
FeO	*%*	6.21	3.95	5.61	5.29
MnO	*%*	0.14	0.15	0.22	0.17
MgO	*%*	8.54	14.63	13.37	5.14
CaO	*%*	6.26	13.14	14.74	13.27
Na2O	*%*	3.66	1.00	0.77	3.48
K2O	*%*	0.96	0.41	0.17	0.48
P2O5	*%*	0.80	0.03	0.03	0.76
H2O	*%*	2.89	3.37	3.34	2.02
Total	*%*	100.10	100.01	100.01	100.02
Li	*ppm*	8	12	22	17
Rb	*ppm*	19	9	-	4
Sr	*ppm*	298	59	29	468
Ba	*ppm*	702	84	30	370
La	*ppm*	32	-	-	20
Ce	*ppm*	69	-	-	48
Y	*ppm*	28	-	-	24
Zr	*ppm*	299	12	10	264
Cu	*ppm*	23	31	37	63
Zn	*ppm*	108	168	62	151
Pb	*ppm*	7	-	11	19
Ni	*ppm*	191	276	149	144
Cr	*ppm*	124	789	291	77
V	*ppm*	177	136	202	204

No. sample	K1	K2	K3	K4
Rock type	Amphibolite			
$(^{87}Sr / ^{86}Sr)_m$	0.70542 ± 1	0.70790 ± 2	0.70623 ± 2	0.70729 ± 2
$(^{87}Sr / ^{86}Sr)_i$	0.70497	0.70667	0.70623	0.70723
$^{87}Rb / ^{86}Sr$	0.18	0.44	-	0.025

Geodynamic setting

As the amphiboles are likely metabasites, and disregarding the alkaline character shown by all rocks , that can be to some extent either a premetamorphic feature (e.g TURKU 1987) and/or an alteration feature connected with metamorphism, plotting immobile-element contents in discriminatory diagrams (e.g. PEARCE 1975; PEARCE and GALE 1977; SHERVAIS 1982) can provide information of protoliths. In this view, samples K-1 and K-4 show a signature of within-plate basalts due to their Ti/Zr and Zr/Zn+ Y ratios, whereas samples K-2 and K-3 fall in or near the field of arc-basin tholeiite basalts in the same diagrams and in the Cr/Ti plot . In particular, with respect to the different TiO_2 contents, samples K-1 and K-4 resemble closely high-Ti basalts and, thus, were likely derived from MORB-type magmas, whereas samples K-2 and K-3 look like very low-Ti basalts derived from boninitic magmas. These conclusions agree partially with the opinions of KODRA at al. (1995), who claim the metabasites are mostly of WPB and MORB composition, and only occasionally are akin? to IAT and boninites. Comparison of the studied rocks with other amphibolites from Bulqiza (TURKU 1987) shows that both high-and low-Ti amphibolites exist throughout the area considered and, thus, the existence of two types of magmatic protoliths may locally be generalized. Comparison with the un-metamorphosed Tirassic-Jurassic volcano-sedimentary rocks (TURKU 1987) from the peripherical sectors of ophiolites suggests that amphibolites K-1 and K-4 may represent the metamorphic equivalent of the MORB fraction of such rocks, in agreement with SHALLO et al. (1989), TURKU (1987) and KODRA and GJATA(1989); on the contrary, amphibolites K-2 and K-3 have no un-metamorphosed corresponding lithotypes. Finally, comparison of trace-element patterns normalized to an average MORB composition of the amphibolites and other Tethyan and modern equivalent volcanites (e.g. PEARCE 1979) shows that the

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samples K-1 and K-4 are similar to the Lower-Middle Mesozoic volcano-sedimentary lavas and modern alkaline basalts from Azores Islands, whereas samples K-2 and K-3 look like the upper lava units of the Upper Cretaceous from Troodos and Oman, the Middle Jurassic from Mirdita (SHALLO et al. 1987) and the modern lavas from the Tonga Islands; therefore, samples K-1 and K-4 likely represent ocean island or seamount created during the initial stage of rifting and sea–floor spreading, whereas sample K-2 and K-3 represent intraoceanic island arc tholeities (boninites) of high partial melting degree.

Sr-isotope ratios

The initial Sr-isotope ratios, calculated from the measured ratios taking into account the K/Ar radiometric ages, range from 0.70497 (sample K-1) to 0.70723 (sample K-4) therefore, the ratios are higher than those of typical boninitic and MORB rocks (FAURE and POWELL 1982), providing evidence of addition of radiogenic Sr to the rocks. ^{87}Sr addition likely took place during metamorphism that brought in hydration of protoliths. Moreover, as sample K-1, which is the least metamorphosed, is that showing the lowest Sr-isotope ratios, it is apparent that increase of the Sr-isotope ratios was favored by prograde metamorphism. During metamorphism either Rb and Sr can variably be released or introduced into amphibolites; however, as the K/Rb ratios of the samples increase with prograde metamorphism, there is evidence that remobilization and/or exchange processes were least, thus favoring infiltration of radiogenic Sr from a fluid phase. This later was likely represented by seawater, as the higher Sr-isotope ratios of the samples approach the isotopic composition of seawater in the Mesozoic (e.g. Dogger: $^{87}Sr/^{86}Sr$= 0.7068, BRUKE et al. 1982). Therefore, at least with respect to Sr, metamorphism was not isochemical.

T-P conditions of metamorphism

Variations of the amphibole composition may be used as indicators of thermodynamic conditions of metamorphism. In this view, as Al^{VI} contents are pressure dependent (LEAKE 1965, 1971), it is apparent from Fig.3 that pressure was about 5 kbar (RAASE 1974), as the samples fall astride of line 1, distinguishing between low- and high-pressure hornblendes. Temperature, calculated considering the hornblende-plagioclase pair (BLUNDY and HOLLANDA 1990), ranges from 440 to 575 ^{o}C, and is consistent with experimentally determined values of LIOU et al. (1974) and SPEAR (1981) for the upper (475 ^{o}C) and the lower (550 ^{o}C) boundary of greenchist and amphibolites facies, respectively. As a whole, T-P conditions, that are similar to those proposed by TURKU (1987) and SHALLO et al. (1989) for other metamorphic rocks from eastern Albania, may be compatible with regional metamorphism (TURKU 1987) or subduction of an oceanic slab (BECCALUVA et al. 1994). The involvement of seawater-derived fluids in amphibolitization of the protoliths is a fact in favor of the later hypothesis, as well as the increase of metamorphic degree through the metamorphic sole, observed in other sub-ophiolite metamorphic rocks. Finally, because the rocks are overprinted by significant retrogressive assemblage, there is evidence that exhumation took place slowly.

Fig.2- Plot showing relation between Al^{IV} and A-site occupancy for the Bulqiza amphibolites.

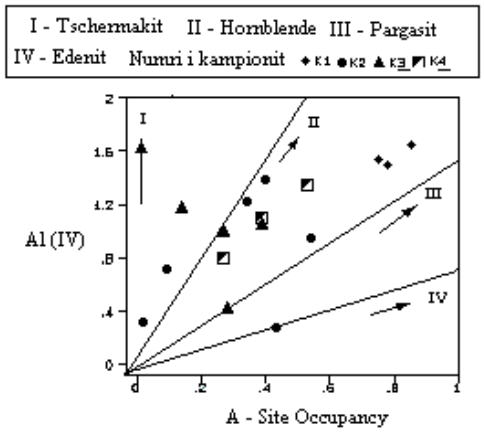
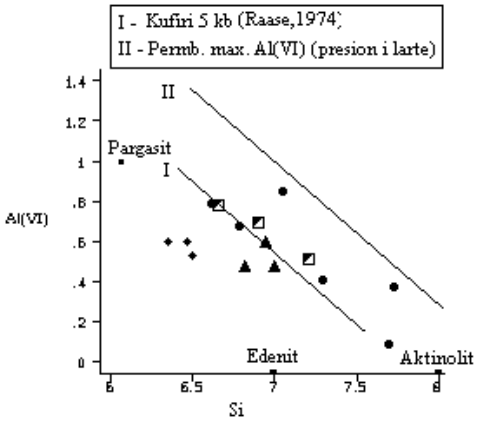


Fig.3- Plot of Si versus Al^{IV} content of the Bulqiza amphibolites.



CONCLUSIONS

Limited outcrops of amphibolitic schist, amphibolites, greenschist and quartz-mica schist with garnet are found in the periphery of the Bulqiza ultramafic massif.
The T-P conditions (440-575^{o}C and ≈ 5 kbar) of metamorphism are compatible with subduction of an oceanic slab. Exhumation of the amphibolites was slowly because the rocks are overprinted by significant retrograde metamorphism.
Discriminant plots of immobile elements show that the protoliths were either within-plate alkali basalts and boninitic basalts; these later are products of subduction magmatism, characteristic for the Albanian Eastern Ophiolitic Belt, whereas the within-plate alkali basalts are likely evidence of the pre-ophiolitic sea-floor magmatism.
The initial Sr-isotope ratios, ranging from 0.70497 to 0.70723, are higher than those of typical mantle-derived magmas, showing that radiogenic Sr was added to the rocks by fluids, basically represented by seawater, likely during amphibolitization. Therefore, metamorphism was not isochemical, at least with respect to Sr.

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REFERENCES

Akinci Ö. T., Barbieri M., Calderoni G., Ferrini V., Masi U., Petrucciani C. and Tolomeo L., 1991. *The geochemistry of hydrothermally altered rocks of the Lower Volcanic Cycle from the Eastern Pontides (Trabzon, NE Turkey)*. Chem. Erde 51, 173-186.

Beccaluva L, Coltorti M, Premti I, Saccani E, Sienna F, Zeda O, 1994. *Mid-ocean ridge and suprasubduction affinities in the ophiolitic belts from Albania. Ofioliti, 19(1), 77-96.*

Blundy J. D. and Holland T. J. B., 1990. *Calcic amphibole equilibria and new amphibole – plagioclase geothermometer.* Contr. Mineral. Petrol. 104. 208-224.

Burke W. H., Denison R. E., Hetherington E. A., Koepnick R. B., Nelson H. F. and Otto J. B.,1982. *Variation of 87Sr/86Sr throughout Phanerozoic time.* Geology, 10, 516-519.

Hawthorne F. c.,1983. *The crystal chemistry of the amphiboles.* Can. Mineral. 21, 173-480.

Hynes A.,1982. *A comparison of amphibolite from medium- and low-pressure metabasites.* Contr. Mineral. Petrol. 81, 119-125.

Kodra A, Gjata K,1989. *Mesozoic evolution of the Inner Albanides, rifting stages and the Mirdita's ocean spreading.* Bul.Shkenc.Gjeol. 4, 55-66 (in Albanian, abstract in English).

Kodra A., Gjata K. and Bakalli F., 1995. *The Mirdita oceanic basin from riftig to closure.* Documents du BRGM 244, 9-26.

Leak B. E.,1965. *The relationship between tetrahedral aluminium and the maximum possible octahedral aluminium in natural calciferous and sub-calciferous amphiboles.* Am. Mineral. 50, 843-851.

Leak B. E.,1971. *On aluminous and edenitic hornblendes.* Mineral. Mag. 38, 389-407.

Leak B. E.,1978. *Nomenclature of amphiboles.* Am. Mineral. 63, 1023-1053.

Liou J. G., Kuhiyoshi S. and Ito K.,1974. *Experimental studies of the phase relations between greenschist and amphibolite in a basaltic system.* Am. J. Sci. 274, 613-632.

Marcucci M,Kodra A,Pirdeni and Gjata T,1994. *Radiolarian assemblages in the Triassic and Jurassic cherts of Albania*.Ofioliti,19(1):105-114).

Meshi A, 1995. *Strukturat e mikrostrukturat e masivit ofiolitik te Bulqizes.* PhD Thesis, Tirane, Albania.

Pearce J. A.,1975. *Basalt geochemistry used to investigate post tectonic environments on Cyprus*. Tectonophysics, 25, 41-67.

Pearce J. A. and Gale G. H.,1977. *Identification of arc deposition environment from trace-element geochemistry of associated igneous host rocks. In : Jones M. J. (ed.) Volcanic processes in ore genesis.* Inst. Mining and Metallurgy and Geol. Soc. London Spec. Publ. 7, 14-24.

ISSN 2306-9600

Pearce J. A.,1979. *Geochemical evidence for the genesis and eruptive setting of lavas from Tethian ophiolites.* Ophiolites proceed. Intern. Ophiol. Symp. Cyprus, 261-272.

Raase P.,1974. *Al and Ti contents of hornblende, indicator of pressure and temperature of regional metamorphism. Contr. Mineral.Petrol.45,231-236.*

Shallo M., 1965. Mbi marrdheniet e kontaktit midis shkembinjve ultrabazike te masivit te Kukesit dhe formacioneve efuzivo – sedimentare te Triasikut te Poshtem – Mesem te rajonit Surroj. Permb. Stud. 1.

Shallo M., Kote Dh. and Vranai A.,1987. *Geochemistry of the volcanics from ophiolitic belts of Albanides.* Ofioliti 12, 126-136.

Shallo M,Cina A,Dobi A,Cili P,Premti I,1989. *Petrologjia e masivit ultrabazik te Bulqizes dhe mineralizimi kromitik i tij.*I.S.P:Gjeologjise. Tirane,193p.

Shallo M, Cina A, Turku I, 1995. *Outline of the metallogeny of the Albanian MOR- and SSZ-type ophiolites. Documents du BRGM 244, 27-46.*

Shervais J. W.,1982. *Ti-V plots and the petrogenesis of modern and ophiolitic lavas.* Earth Planet. Sci. Lett., 59, 101-118.

Spear F. S.,1981. *An experimental study of horneblende stability and compositional variability in amphibolite.* Am J. Sci. 281, 697-734.

Turku I.,1987. *Metamorphites from the Kukes ultramafic massif (Northeastern margin of the Mirdita ophiolitic zone, Albania).* Ofioliti,12(1),137-150.

Turner F. J.,1968. *Metamorphic petrology: Mineral Field and Tectonic Aspects. 1st ed.,* McGraw-Hill, New York 403 pp.

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CARBONIFEROUS AND MIDDLE TRIASSIC GRANITOIDES: THE ISOTOPIC DATINGS BY U-Pb IN ZIRCONS

Isa HAKLAJ[1], Artan TASHKO[2]

[1] *Albanian Geological Survey Tirana, Albania, (isahaklaj@yahoo.com)*
[2] *Polytechnic University Tirana, Albania, (tashkoar@gmail.com)*

ABSTRACT

Two samples of the granodiorites of the Gashi Zone, one sample from the Juniku(Kosovo) granite and one sample from the granitic massive of Fierza are dated by U-Pb method in zircons. The isotopic dating is realized in the Istem, CC 066 Laboratory of the Montpellie II University, France. Based on these data we conclude that there are two kinds of granitoide rocks. Juniku granite is dated 329.6±2.1 Ma (Carbon, Mississippian, Serpukhovian) and the grandiorites of the Trokuzi massive are dated 242.2± 1.5 and 244.5± 1.5 Ma (Middle Triassic, Anisian). The Fierza granite is dated 247.3 ± 3.1Ma, that is at the border of Low Triassic (Olenekian) and Middle Triassic (Anisian), but the ± 3.1Ma analytical error don't exclude the possibility that this massive is of the same age as the Trokuzi massive. On the Geologic Map of Albania, in scale 1:200 000 both the Trokuzi and Fierza massifs are dated J_{2-3}. Our new data confirm the formation of the plutonic rocks in Low-Middle Triassic as the known in Albania volcanic rocks. After the last geochemical studies, including isotopic one, these volcanics are formed initially in a rifting zone that is evolved to a spreading ridge. Both plutonic and volcanic rocks are known in Dinarides, formed in the same geodynamic conditions in the Low-Middle Triassic. All our data are out of the range of the Jurasic ophiolites and especially plagiogranites and microdiorites dated by the same U-Pb method in zircons (160-165,5 Ma, Middle Jurassic, according to Yildrim Dilek et al. 2008).

KEY WORDS

absolute geochronology, isotopic dating, granodiorite Gashi area, Junik granite, Fierze granite.

INTRODUCTION

Trokuzi Massif is located in Gashi zone and occupies a territory of 25,5km^2 extending from Markofça, Trokuzi to Doberdol and further to Kosovo. Its exposures have been encountered at the front of thrust as: in Javorr, Qafa e Livadhit, Presh, Pojane and in Kershat e Brevines.

Rock types (Hoxha et al., 1992, Haklaj and Tashko, 2010) from bottom up are as following: gabbro, gabrodiorite, diorite, granodiorite, plagiogranite and granite. Characteristic for these rocks is their great change. Beside graphitisation, which is strongly evidenced, is also encountered gneissation. This phenomenon appears to have been more developed in SW and marginal sectors of this formation. The age of Trokuzi massif has been widely discussed on the base of geological motives, being defined from Paleozoic to Miocene (Table 4).

At Durmitori zone, where parts of this massif are located (Kosovo), these rocks are called ''curious granite that can be considered as products of an "in situ" granitism (Fabian Trubelja, et al. 2004). Juniku granites (Fig.1) are situated here but some kilometers away from the Trokuzi massif and in a curious geological situation. The surrounding formations are considered as a melange (Dimitrijevic,1992) or the Middle Triassic- Lower Jurassic ophiolites (Zenun Elezaj, 2009)

In western Macedonia have been encountered granitoid intrusions, dated as Ordovician age (461-465 Ma) (Hrvatović and Jakob, 2005).

Fierza granitic massif, located in northern boundary of Mirdita zone, is dated J_{2-3} in Geological Map of Albania at scale 1:200 000 (SH. GJ. SH., 2002).

In this article, we present for first time information about isotopic dating (U-Pb method in Zircon) for granitoids of Gashi zone and Fierza massif.

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MATERIALS AND METHODS

Two samples were collected in the granitoids of Trokuzi massif, nr 202 in Deçan (Kosovo), and 204 in Maja e Trokuzit. Sample nr 201 is taken in Junik (Kosovo), where a special outcrop of granitic rock is evidenced. Finaly, sample 203 is taken in granites of Fierza massif, (Figure **1** and Figure **2**).

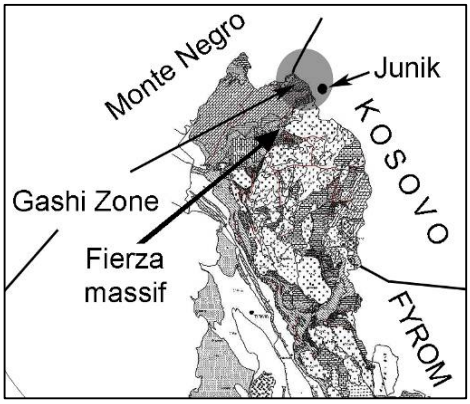


Figure 1. *Structural sketch with the position of the Gashi Zone*

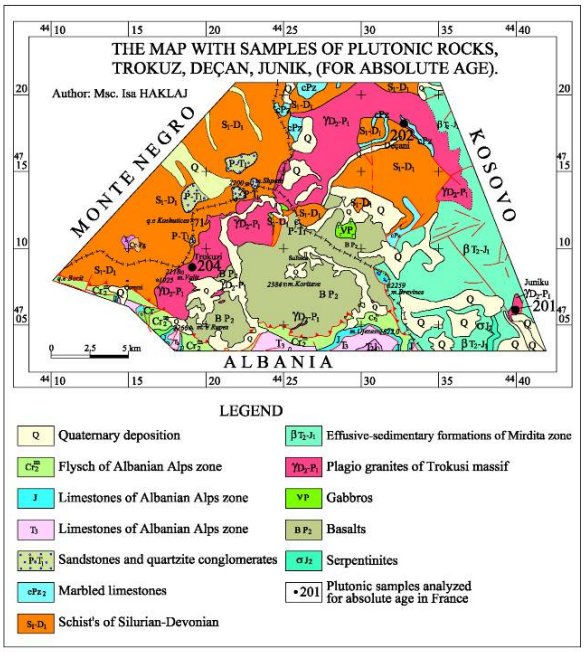


Figure 2. *Geological Map of the area { prepared by Haklaj I, based on Geological Map of Gashi zone at scale 1:10 000 by (Hoxha J, Haklaj I, et al. 1992) and Geological Map of Kosovo at scale 1:200 000, 2006 }, with sampling sites 201, 202 and 204.*

The coordinates of the sampled locations ar given in table 1. The photos no. 1, 2, 3, 4 illustrate the sampling for each of the granitoid massifs.

Table 1. *The data about samples, collected for isotopic dating.*

Sample n^0	Rock type	Sampling site	X	Y
201	Granite	Junik	47 06 680	44 39 405
202	Granodiorite	Deçan	47 17 515	44 32 775
203	Granite	Fierze	46 78 890	44 21 345
204	Granodiorite	Trokuz	47 08 715	44 19 265



Foto 1. *Granitoides in Maja e Trokuzit (18/08/2010);*



Foto 2. *Granitoides in Deçan (Kosovo-10/07/2010);*

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Foto 3. *Granites in Junik (Kosovo - 10/07/2010);*



Foto 4*. Granites in Fierza, (17/08/2010).*

Analyses have been carried out in Istem laboratory, CC 066 of Montpellie II University France. Isotopic dating has been done by U – Pb method in Zircons of these samples. Zircon was selected by hand in concentrates obtained after milling and separation of sample with heavy liquid and magnetic separation. Zircon grains of every sample, along with zircon grains of standard G91500 were analysed with Lambda Physik CompEx 102 excimer laser (AETE Plateform, University of Montpellier, France). To determine the age was used the program Isoplot/Ex, which, besides analysed isotopes of ^{202}Hg, ^{204}Pb+Hg, ^{206}Pb, ^{207}Pb, ^{208}Pb, ^{238}U and ^{232}Th, takes into consideration also the decay constants and actual values of the ^{238}U/^{235}U ratio.

Uranium-lead is one of the oldest and most refined of the radiometric dating schemes, with a routine age range of about 1 million years to over 4,5 billion years and with routine precisions in the 0,1-1 percent range. The method relies on two separate decay chains, the uranium series from ^{238}U to ^{206}Pb, with a half-life of 4,47 billion years and the actinium series from ^{235}U to ^{207}Pb, with a half-life of 704 million years. The term "U-Pb dating" normally implies the coupled use of both decay schemes in the 'Concordia diagram' (see below). However, use of a single decay scheme (usually ^{238}U to ^{206}Pb) leads to the U-Pb isochrones dating method, (Alan P. Dickin, 2005).

Although, different minerals as monazite, titanite, and baddeleyite can be used, zircon is preferred, because its chemical structure likes uranium and hates lead. Uranium easily substitutes for zirconium while lead is strongly excluded. On the other hand, zircon has a high (900°C) "trapping" temperature and is not easy influenced by subsequent geological events.

RESULTS AND DISCUTIONS

The results of the isotopic dating analyses are shown in Table 2. For two samples 204 and 204 of Trokuzi massif, isotopic dating can be closely fit (242.2 ± 1.5 and 244.5 ± 1.2 Ma), giving us the Triassic age and precisely Anisian (237 ± 2 up to about 245.9 Ma) (according to International Stratigraphic Chart, 2009).

Table 2. *The isotopic dating (U-Pb method in zircons) for samples 201, 202, 203 and 204.*

Sample n^0	(Ma) Concordia age	(Ma) Isochrones	Comments
201 Junik	329.6 ± 2.1	328.6 ± 2.3	378.8 ± 8 (2δ)
202 Deçan	242.2 ± 1.5	242.8 ± 1.1	
204 Trokuz	244.5 ± 1.2	244.3 ± 1.2	
203 Fierzë	247.3 ± 3.1	249.0 ± 1.1	

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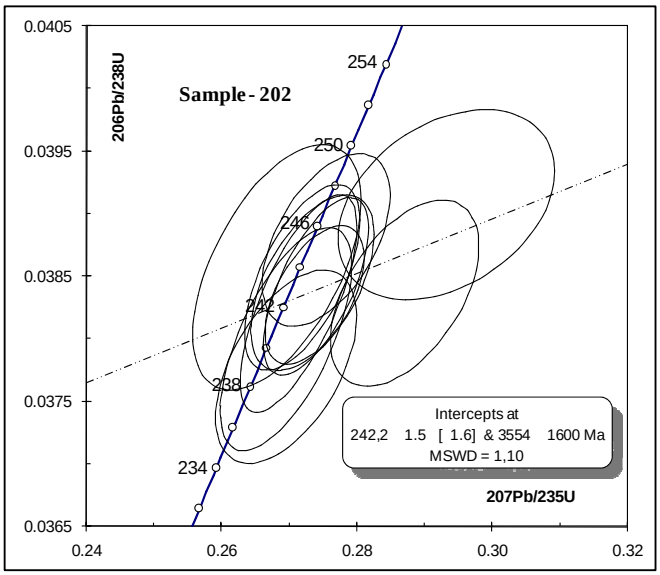


Figure 3. *Concordia Diagram for the sample 202 - Deçan. Absolute age: 242,2 ± 1,5 Ma.*

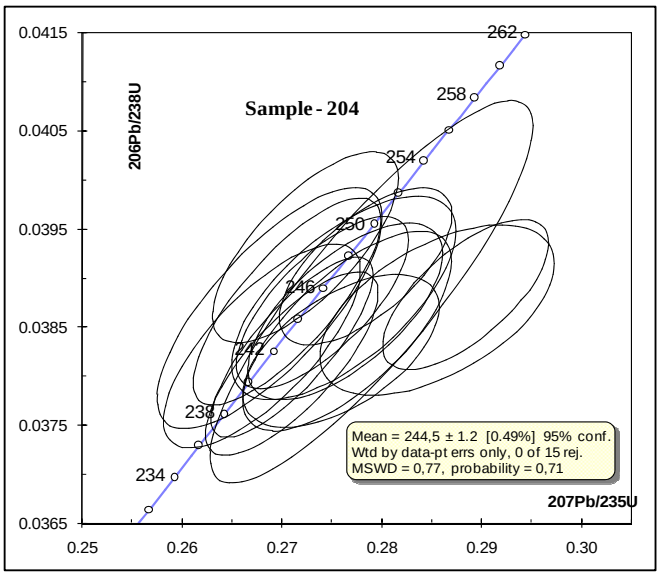


Figure 4. *Concordia Diagram for the sample 204 – Maja Trokuzit. Absolute age: 244,5 ± 1,2 Ma.*

For sample 201 (Juniku outcrop), isotopic dating gives an older age, 328.3 ± 1.6 Ma, concretely Carbonian, Mississippian, Serpukhovian, (International Stratigraphic Chart, 2009). The age 378.8±8 Ma, determined in some zircons of this sample, seems to be connected with a loss of Th, however going outside the limit(2δ). In this case the age would be D_3, (Frasnian 374-385 Ma, International Stratigraphic Chart, 2009).

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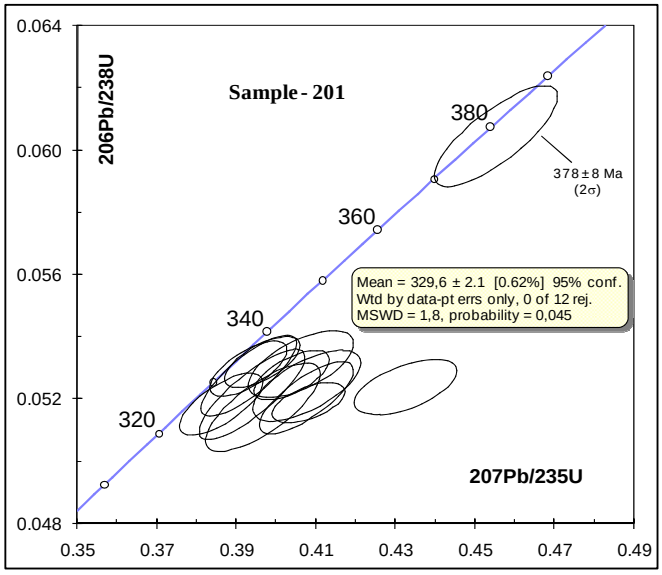


Figure 5. *Concordia Diagram for the sample 201 - Junik. Absolute age: 329,6 ± 2,1 Ma.*

These rocks are macroscopically and chemically distinguished by granitoides of Trokuzi massif.

Table 3. *Chemical composition of the Junikut and Trokuzi Massif granitoids.*

Nr	SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	NiO	CoO	LOI	H_2O	Total
201	69.51	13.80	3.09	0.03	2.83	1.22	3.72	3.25	0.50	0.25	0.01	0.002	1.32	0.20	99.73
202	66.43	14.60	5.76	0.07	2.22	1.96	2.14	3.81	0.72	0.25	0.003	0.002	1.82	0.07	99.86
204	68.52	14.23	4.94	0.07	1.68	2.01	2.57	3.32	0.46	0.23	0.002	0.002	1.71	0.05	99.79

Based on their mineral composition, the Juniku sample is determined as granite, while those of Trokuzi massif as granodiorites.
As for TR spectrum, normalized with hondrite (figure 6), granitoides of Juniku are clearly distinguished by depletion of heavy TR, and lacking of negative anomalies of Eu**.**

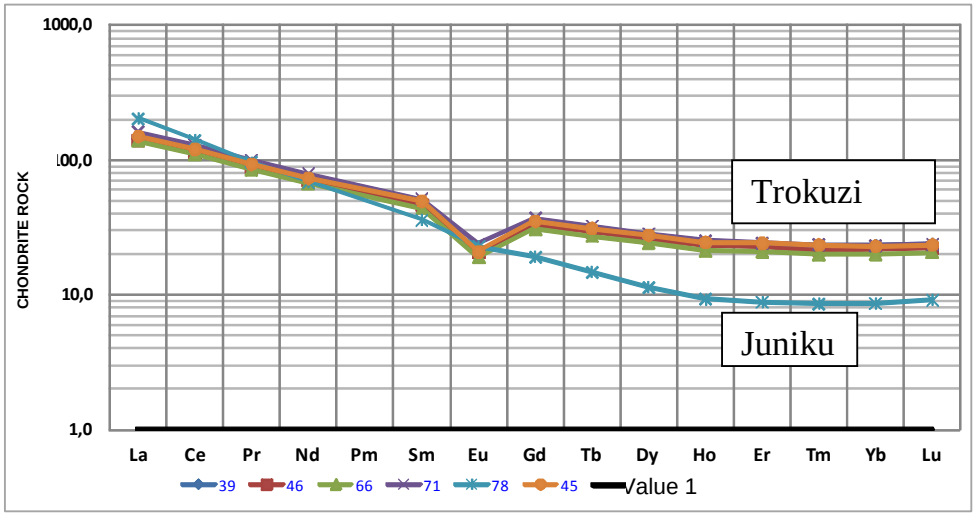


Figure 6. Spectrums of TR (normalization with hondrites) for Juniku (78) and Trokuzi massif granitoides

Geochemical differences among these rocks, and their incorporation in geological history of Gashi zone, will be treated in details in another article which is in the preparation.

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Here we can note that the age of the granitoides of Trokuzi massif is within the age interval, given by various authors (Table 4), but is finally determined as Middle Triassic, Anisian. The Juniku granite age as Carbonianian Serpukhovian, is a completely new data.

Table 4. *The age of Trokuzi massif according to various authors.*

Triassic (T)	1929 - **N**opca F, Novak E.
Lower - Upper Triassic (T_1 -T_2)	1961 - **D**obrecov N. L.
Upper Permian {Pz_3 (P_2)}	1968 - **G**eological Map of Albania
Miocene (N_1)	1972 - **G**jata K. et.al.
Upper Paleozoic (Pz_3)	1974 - **M**elo V. et. al.
Jurassic – Cretaceous (J – Cr)	1982 - **G**jata K, Kodra A.
Lower Cretaceous (Cr_1)	1983 - **G**eological Map of Albania
Paleozoic (Pz)	1986 - **X**homo A. et. al.
Middle Devonian – Lower Permian (D_2 – P_1)	1992 - **H**oxha J. Haklaj I. et. al.
Middle – Upper Jurassic (J_{2-3})	2002 - **G**eological Map of Albania
Middle – Triassic, Anisian (T_2^1)	2012 - **H**aklaj I. (Disertacion)

Fierza granites result to be of the same age with those of Trokuzi massif, since the age 247.3 determined with an error of ± 3.1Ma, can be considered tightly fit with ages 242.2-244.5, determined with an error of ± 1.5 Ma. We might say that these granites belong to Middle Triassic, Anisian or at most Lower Triassic, Olenekian. In Geological Map (SH. GJ. SH. 2002) these granites are dated as J_{2-3}, based on absolute age (method K/Ar and Rb/Sr in the rock) 165 ± 4 to 175± 6 Ma (Castorina F. et al. , 1995).

Table 5. *Chemical composition of Fierza granites.*

Nr	SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	NiO	CoO	LOI	Total
203	76.77	11.70	1.75	0.02	1.11	0.56	2.21	6.37	-	0.16	0.002	0.001	0.32	100.97

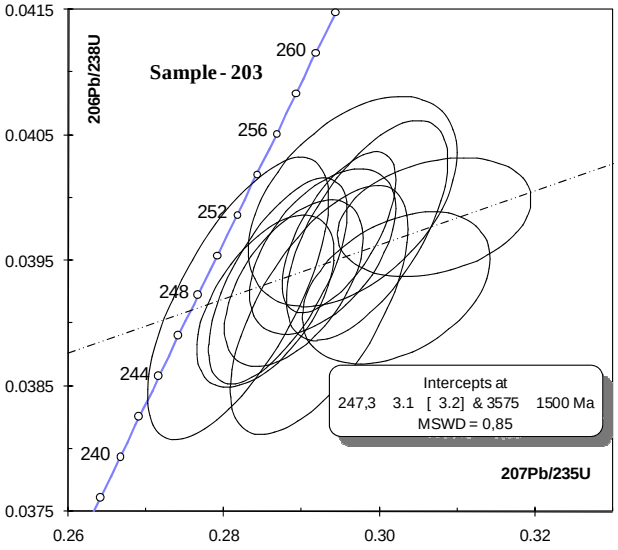


Figure 7. *Concordia Diagram for the sample 203 – Fierza granite. Absolute age: 247,3 ± 3,1 Ma.*

CONCLUSIONS

- Our data, based on isotopic dating (U-Pb method in zircons), reveal two magmatic events with formation of granitoid rocks at different times.
- Earliest event is that of Carbonian, Mississippian, Serpukhovian, evidenced in Juniku granites (329.6±2.1 Ma). It should be supposed that such rocks can be found also in other outcrops, separated from Trokuzi massif.

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- A later plutonic magmatism is evidenced in Middle Triassic, Anisian and is represented by granitoids of Trokuzi massif (242.2 - 244.5 ± 1.5 Ma). On the map (SH. GJ. SH,. 2002), this massif is dated as J_{2-3}.
- Fierza granites results to be of the same time with those of Trokuzi massif, dating as Middle Triassic, Anisian (247.3 with analytical error ± 3.1 Ma) or at most in boundary with Lower Triassic, Olenekian. In Geological Map (SH. GJ. SH., 2002), this massif is also dated as J_{2-3}.
- Triassic plutonic magmatism, evidenced with these isotopic datings, is fitted in time with volcanism which is encountered in territory of Albania, and based on recent geochemical studies (Tashko and Mascle, 2009), including isotopic ones, shows for a rifting stage in Lower Triassic to Middle Triassic, followed by an opening stage. Even in Dinaride is evidenced a volcanic and plutonic magmatism of Triassic, which is extended by an early regaining process up to the opening of Tethys (Hrvatović and Jakob, 2005).
- All datings presented in this article, go outside boundaries of ophiolite age of Mirdita zone, including datings with the same method (U-Pb in zircons) of plagiogranites and microdiorites. (160-165.5 Ma, according to Yildrim Dilek et. al., 2008).

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REFERENCES

Alan P. Dickin (2005). Radiogen Isotope Geology.Cambridge.University Press.2005. pp. 59-73.

Canko S., Haxhia P. (1985). Report of the complex geological investigation of the Lushica region (1982-1983) and in the Kreshta e Bollotergut region. (in Albanian). Tropoja Geological Enterprise.

Castorina F., Gabarino C., Masi U., Mignardi S., Nicoletti M., Beqiraj A. (1995)- The granite rocks from Fierza (North-Eastern Albania): Geochemical evidence of the Jurassic margin of the Balcan Continent. Geol. Soc.Greece, Sp. Publ. 4.

Dimitrijevic M.D. (1992)- GEOLOGICAL ATLAS OF SERBIA 1: 2.000.000. Published by: Republical Foundation for Geological Investigations and Geological Institute GEMINI.

Dobrecov N. L. (1961). Geologiceskoje strojenis i poleznie iskopajenie severo-Albanskih Alp. i Cukali. Nd. Gjeol. Tropojë.

Fabijan TRUBELJA, Klaus-Peter BURGATH and Vesna MARCHIG- Triassic Magmatism in the Area of the Central Dinarides (Bosnia and Herzegovina): Geochemical Resolving of Tectonic Setting. Geologia Croatica, 57/2, 159-170.

Gjata K., Elezi E. (1972). Report on the revision works and evaluation in the mineralized sectors of Gashi region 1970-1971. Tropoja Geological Enterprise.

Gjata K., Kodra A. (1982). Post-ophiolitic Jurassic-Cretaceous magmatism and the younger intermediate-acid magmatism in Albania. Bulletin of Geological Sciences.

I S P GJ (1983)- Geological Map of Albania, scale 1:200 000.

I S N I M (1968)- Geology of Albania.

Haklaj I., Tashko A. (2010)- Geochemical features of Gashi Zone palaeozoic magmatism. Journal of International Environmental Application & Science. V. 5, 4, pp.538-545.

Hrvatović Hazim, Pamić Jakob (2005)- Principal thrust-nappe structures of the Dinarides Acta Geologica Hungarica, Volume 48, number 2/June 2005.

Hoxha J. (1991) – Geology and metallogenic features of the Gashi region (disertacion).

Hoxha J., Haklaj I., Meço S., Lika O., Kospiri A. (1992)- Report on the complex geological-geochemical-geophysical investigations of the Gashi region 1986-1990, on scale 1:10 000. Central Archive of Geology.

International Stratigraphic Chart. (2009)- International Commission on Stratigraphy (ICS).

Pamić J. Jakob (1984)- Triassic magmatism of the Dinarides in Yugoslavia. Tectonophysics Volume 109, Issues 3-4, 10, November 1984, Pages 273-277.

Melo V. etj. (1974)- Problems of the geology of the northeast Albania. Permb. stud. nr. 2 Tiranë.

SH. GJ. SH. (2002)- Geological Map of Albania, scale 1:200 000.

Tashko A., Georges H. Mascle (2009)- Nd, Pb isotope ratios and trace element signatures of volcanic rocks in Albania: Magma source identification. AJNTS, 2009, 2, 3-23.

Zenun ELEZAJ (2009)- Geodynamic evolution of Kosovo during the Triassic and Jurassic, Journal of the Earth Sciences Application and Research Centre of Hacettepe University , 30 (2), 113–126.

Yildrim Dilek, Harald Furnes, Minella Shallo (2008)- Geochemistry of the Jurassic Mirdita Ophiolite (Albania) and the MORB to SSZ evolution of a marginal basin oceanic trust. Lithos 100 (2008), 174-209.

Xhomo A. et al. (1986)- Stratigraphy of the Paleozoic depozits of the Albanides and the potential of related mineralizations (in Albanian). Tropoja Geological Enterprise.

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BONINITES OF THE EASTERN OPHIOLITES IN ALBANIA (SSZ) RESEMBLE TO THOSE OF OTHER REGIONS OF THE WORLD BY

Kristina GJEÇI (Ndreca)
Institute of Geosciences, Energy, Water and Environment, Tirana, Albania

ABSTRACT

The boninites of Eastern (SSZ) - type ophiolites (BEO) in Albania, have wide facial representation (they are part of the volcanic sequence, and sheeted dike complex; in the plutonic gabbro–plagiogranitic sequence and very rare in ultramafic intrusions and in uppermost part of ultramafic sequence) compared with other ophiolites in different parts of the world where the boninites are met mainly in volcanic sequence. They are porphyric, microporphyric, vitroporphyric with CPx – endiopsid (aughite) chromitic with (Wo 38.5-43.58; en 50.98 – 53.37; fs 5.12 – 8.69); Cr_2O_3 > 0.15% and $_{OPx}$ - enstatite-bronzite (Wo - 18.12; en-80.61; fs-3.27), olivine phenocrysts and accessory cromspinelide. Absent plagioclase phenochrits. Microphenocrysts are Opx rare Cpx and chromshpinelid. The groundmass is small grain, microlitic (Opx, Cpx, and Pl), sometimes chlorite and obsidian (volcanic glass) with basic and average contain. They rare meet fresh, are partially or totally alterated.
Chemical composition of boninites shows very low (< 0.45%) TiO_2 content, low (average 0.5) CaO/Al_2O_3 ratio, high (> 7.5%) MgO content and low RLE content. Boninites of the Eastern (SSZ) – type ophiolite are mainly low – Ca boninites, rarely high - Ca boninites according to [2] classification.
Based in chemical data and petrographic characteristics boninites of Albania in Eastern ophiolites can be correlated with other boninites in theworld, Cape Vogel, Chichi Jima, Mariana Trench, Baja California and Cypros. BEO are mainly low - Ca boninites and rarely high – Ca boninites according to [2] classification, but those boninites are differently on contain mineral and petrographic characteristics, for example: BEO (low - Ca boninites) are more poor in SiO_2, Na_2O, K_2O and moor rich on Al_2O_3 as Cape Vogel, Chichi Jima, Mariana Trench, Baja California. BEO (high – Ca boninites) are richer on SiO_2, Na_2O, K_2O and moor poor in CaO as boninites Cyprus. In the bonites dyke's, sheeted dike complex and the dykes on the plutonic sequence gabro- plagiogranitic, the alternate is more intense and often the primary minerals change in the amphibole or chlorite, which is not observed in Chichi Jima or Tonga, and belong to the Tertiary age.
BEO can be correlated with boninite of Cape Vogel, Chichi Jima, Mariana Trench, Baja California and Cyprus in contain LREE and RLE. BEO and another boninites are porphyric with CPx, OPx and olivine phenocrysts, absent PLL phenocrysts it's microlitic in groundmass bat BEO are partly or totally hydrothermally alterated, (the boninitic dikes in the sheeted dike complex).

KEY WORDS: *Albanian Eastern ophiolites (SSZ), boninite, correlation.*

INTRODUCTION

The boninites as part of Albanian ophiolitic magmatism for the first time have been referred by [10] , later by [11], [8], [12], [1] , [5] , [6] , and continue to be studied for their geological settings, petrographic and geochemical characteristics, for their genesis and resemble to those of other regions of the world by.
The boninites have a special economic interest because of the largest ore deposits in the world for platinum group elements (Bushveld and Stillwoter) have parental magma with boninitic affinity [2].
The boninites have theorical interest. The most of the studies on boninites and ophiolites genesis are supposing that the boninites are formed under subduction conditions, considering them as

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subduction indicators.
Based on petrographic and geochimical characteristics, particularly the content of the indicator elements (SiO_2, TiO2, MgO, Na2O, K2O, CaO/Al_2O_3 ratio, rare earth elements), we try to correlate boninites of Eastern (SSZ) Albanian ophiolites with boninites of the other ophiolites in different parts of the world.

Petrographycal and geochemical characteristics of the boninites of Eastern (SSZ) Albanian ophiolite and resemble to those of other regions of the world by

Among Albanian ophiolites, boninites are found within Eastern (SSZ) type ophiolites as part of their volcanic sequence (Perlat - photo1, Rrenjolle, Reps, Spaç, Koderspaç, Gurthspaç, Munelle, Letiten, Gur i Zi etj Simon-Kaçinar, Paluce, Preçaj, Helshan), and sheeted dike complex (Reps, Spaç, Rrenjolle (microphoto 3), Lak Roshi(microphoto 2) -Qafe Mali-Lajthize (microphoto1), Vau Spas, Helshan); in the plutonic gabro–plagiogranitic sequence (in upper part of Kaptena gabbroic massif), Fan-Shemri,region, in gabroplagiogranitic massif Shemri and very rare in uppermost part of ultramafic intrusions (in Western part of Shebenik massif), ?in confrontation zone of the two ophiolitic belts (Gojan and Shkoze), Puke region. Boninites are found in the uppermost part of the mantelic sequence in ultrabazic massifs (Tropoje,Kuksi and Bulqiza). In ophiolites of other regions of the world,the boninites are found mainly in the volcanic sequence.
Boninites and high – Mg basalts in volcanic sequence are localized in the upper part as pillow lava, lava flows and volcanoclastites, interbedded with andesitebasalts, andesites, dacites and rhyodacites. The volcanic sequence:boninites, boninitic dikes of the sheeted dike complex, boninitic dikes of sequence plutonic gabbro – plagiogranitic, boninitic dikes in ultramafic intrusions are small grain rocks, have gray and dark gray color, with porphyric (microphoto1, microphoto 3) - micro porphyryc (microphoto 2),
vitroporphyric and vesicular texture. Phenocrysts are represented by clinopyroxene, rare ortopyroxene, olivine, ?cromshpinelid, absent plagioclase phenocrysts. ?Microphenocrists are represented by ?pyroxene rhombic and olivine, rare pyroxene monocline and cromshpinelid. The groundmass is small-grained, microlitic and represented by prisms of (Opx, Cpx, Pl) and chlorite.Sometimes groundmass represented by obsidian (volcanic glass) with basic and averagecontent, partially or completely alterated. The accessories minerals represented by small granules ?cromshpinelid (idiomorphic, poikiliticsometimes ?skeletal construction). As secondary minerals meet chlorite, carbonate, ceolit. Tonsils (vesicular) are filled with carbonate, chlorite or zeolite. They rare meet fresh, partially or totally alterated. Based on the petrographic characteristics, boninites of volcanic sequences are closest to Chichi Jima ?augitike boninites (Japan) [7]. Based on the chemical composition, clinopyroxen resulting endiopsid (Aughit) chromatic, with Wo (38.5 - 43.58), en (50.98 - 53.37), fs (5.12 - 8.69), Cr203> 0,5%; and ortopyroxen resulting enstatit-bronzit (Wo -18.12;En-80.61;fs-3.27). Chemical composition of boninites shows very low (< 0.45%) TiO_2 content, low (average 0.5) CaO/Al_2O_3 ratio, high (> 7.5%) MgO content and low RLE content. Boninites of the Eastern (SSZ) –type ophiolite are mainly low –Ca boninites, rarely high-Ca boninites according to Crawford et al. (1989) classification. Boninites are associated with high-MgO and low-TiO_2 basalts and with andesitedacites and rhyodacites with boninitic affinity, forming a Boninitic association, which together with predomination IAT basalt-andesite-rhyodacite constitute an association similar to the Western Pacific arc lavas generated at fore arc settings.Formation of the boninites of Eastern-type ophiolite is caused by partial melting processes of the refractary mantle peridotite and

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mantle-melt interaction. Boninitic dikes in ultramafic intrusions, which show extreme RLE depletion, are linked with mantle-melt interaction processes developed during final stages of magmatic activity of Eastern (SSZ) -type ophiolite.

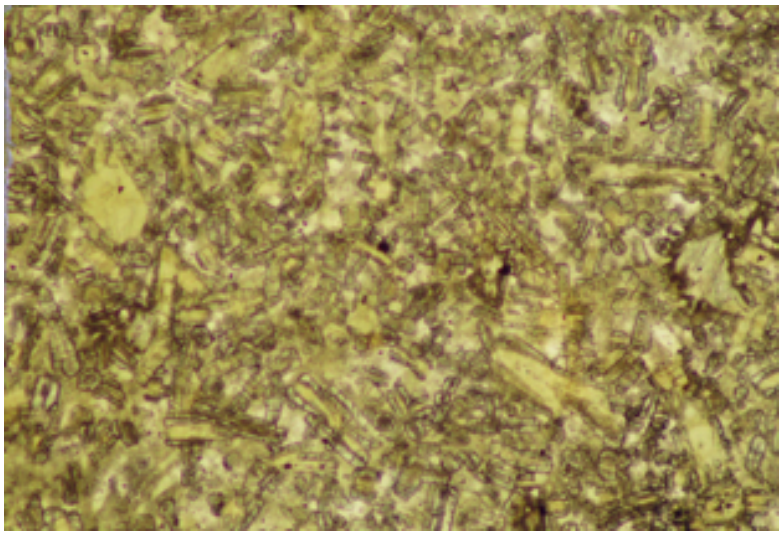


Photo 1. *Boninitic dike cutting the basaltic sequence from Perlat, Mirdita region.*

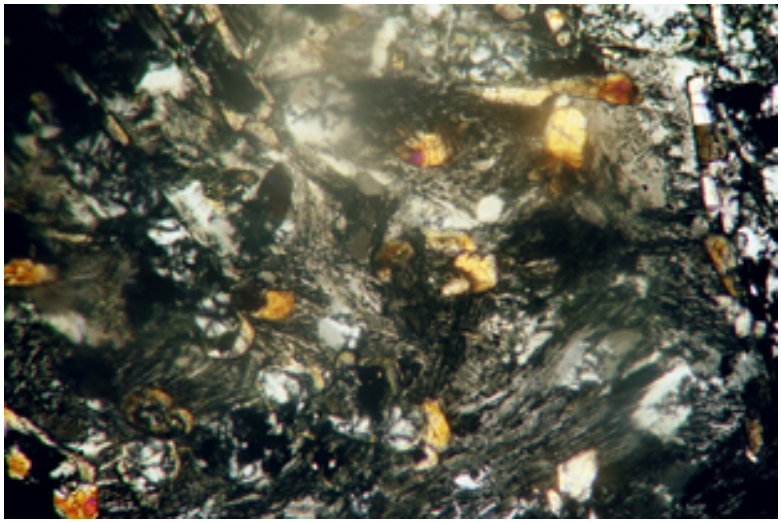


Microphoto1. *Boninite dike with porphyritic texture. Phenocrysts are represented by clinopyroxene partly replaced by chlorite or amphibole. Groundmass consists of small clinopyroxene prisms, rare plagioclase, and secondary chlorite. Thin section 94-31/a. Crossed polarizers. 25x. (Sheeted dike sequence of the SSZ-eastern-type ophiolite). Lajthize - Puke*

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***Microphoto 2**. Boninite dike with microporphyritic texture partly chloritized. Phenocrysts are clinopyroxene partly replaced by amphibole and chlorite thin section. Plane polarized light. 25x. (Sheeted dike sequence of the SSZ-eastern-type ophiolite). Lak Roshi, Puke.*



***Microphoto 3.** Boninite partly alterated, with porphyritic texture with acicular aggregates. Phenocrysts are clinopyroxene in elongated prisms; rare orthopyroxene partly replaced by chlorite. Glassy groundmass, partly recrystalized, contains small thin plagioclase prisms. Thin section 074b. Crossed polarizer's. 100x. (Volcanic sequence of the SSZ-eastern-type ophiolit). Rrenjolle, Mirdite.*

Based in chemical data and petrographic characteristic boninites of Albanian Eastern (SSZ) - type ophiolites correlation with another boninites ?suite by world, Cape Vogel, Chichi Jima, Mariana Trench, Baja California and Cyprus. Boninites
of Albanian Eastern (SSZ) - type ophiolites are mainly low - Ca boninites and rarely high – Ca boninites according to [2] classification, but these boninites are differently on mineral content and petrographic characteristics, for example, the boninites of Albanian Eastern (SSZ) - type ophiolites (low - Ca boninites) are more poor in SiO_2, Na_2O,K_2O and moor rich on Al_2O_3 as

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Cape Vogel,Chichi Jima, Mariana Trench, Baja California(fig.1). The boninites of Albanian Eastern (SSZ) - type ophiolites (high – Ca boninites) are richer on SiO2, Na2O.K2O and moor poor in CaO as boninites Cyprus (fig.1).The boninites of Albanian Eastern (SSZ) - type ophiolites correlation with boninite suites Cape Vogel, Chichi Jima, Mariana Trench, Baja California and Cyprus in contain LREE and RLE (figure 2) Boninites are associated with high-MgO and low-TiO_2 basalts, and with andesitedacites and rhyodacites with boninitic affinity, forming a boninitic association, which together with predominating IAT basalt-andesite-rhyodacite constitute an association similar to the Western Pacific ?arc lavas generated at fore arc settings. Formation of the boninites of Eastern-type ophiolite is caused by partial melting processes of the refractary mantle peridotite and mantle-melt interaction.

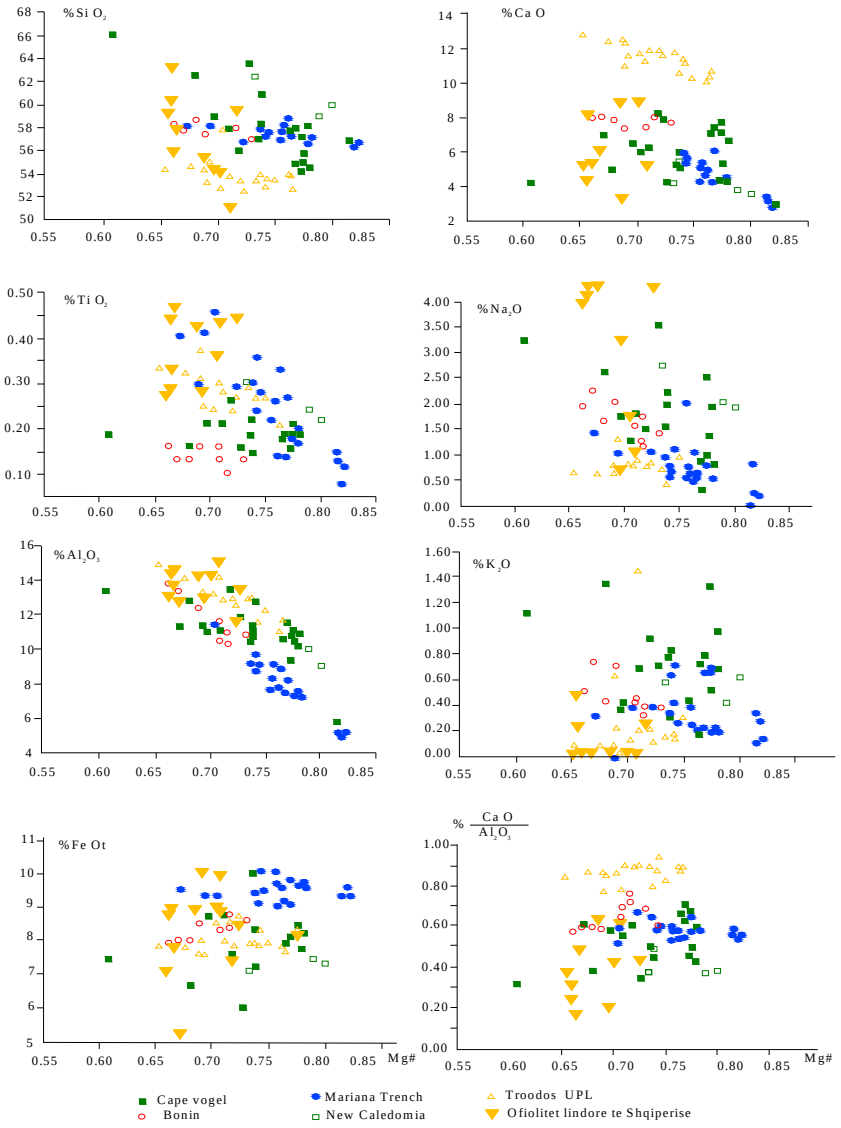


Figure 1. Diagram elements of the SiO2%, Al2O3%, FeO%, CaO%, Na2O%, K2O%, CaO/Al2O3%, versus Mg#, for the boninites from Eastern Albanian Ophiolites and from boninitic suites (CapeVogel,Bonin,Mariana Trench,New Caledonia,"Trodos UPL"),after [6] based on the [2] and [5] ; [11], [12] ; [1] , [9]; [8] .

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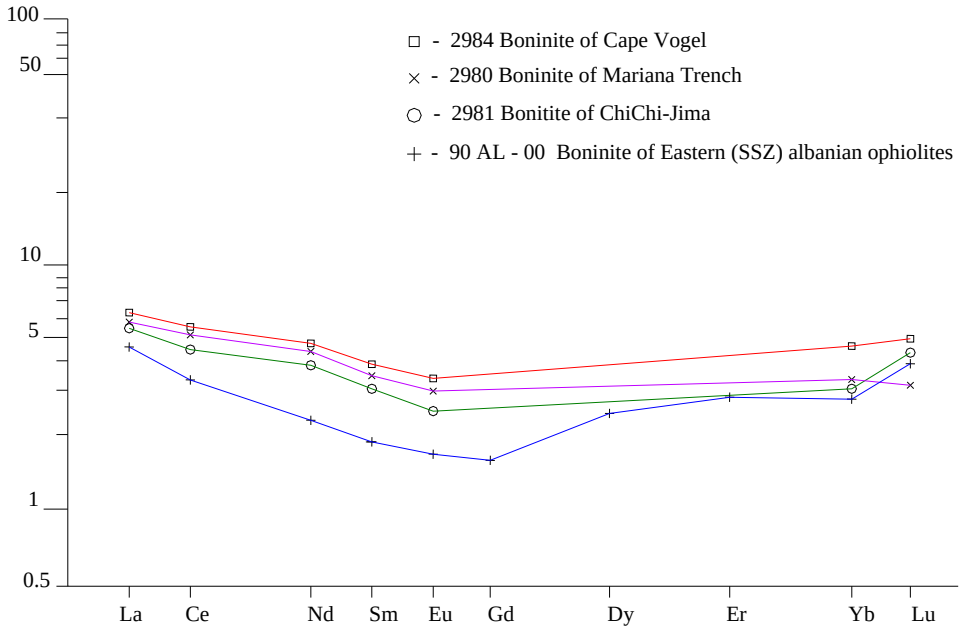


Figure 2. Diagram elements of the RLE versus chondrites (as Nakamura values, 1974), for boninites from central Mirdita (Albania) and from boninitic suites Chichi Jima, Mariana Trench, Cape Vogel, after [6], based on the [4] and [3]

CONCLUSIONS

Among Albanian ophiolites, boninites are found within Eastern (SSZ) type ophiolites (in the volcanic sequence and sheeted dike complex, in the plutonic gabbro–plagiogranitic sequence and very rare in ultramafic intrusions and in uppermost part of ultramafic sequence) compared with other ophiolites in different parts of the world, where the boninites are founded mainly in volcanic sequence.

Boninites of Albanian Eastern (SSZ) - type ophiolites are mainly low - Ca boninites and rarely high – Ca boninites according to [2] classification.

Based in chimichal dates and petrographic charachterstics boninites of Albanian Eastern type ophiolites (SSZ) corelation with other boninites ?suite by world, Cape Vogel, Chichi Jima, Mariana Trench, Baja California and Cypros

The boninites of Albanian Eastern type ophiolites (SSZ) are porphyric with CPx, OPx and olivine phenocrysts, absent PLL phenocrysts it's microlitic in groundmass but boninites of Albanian Eastern (SSZ) - type ophiolites are partly or totally hydrothermally alterated, (the boninitic dikes of the sheeted dike complex).

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REFERENCES:

[1] Beccaluva L. etc. Petrologjia e ofioliteve te Mirdites Qendrore dhe te brezit lindor ofiolitik te Shqiperise. Fondi I.K.GJ., Tirane, 1995.

[2] Crawford, A.J., Falloon, T.J., and Green, D.H., Classification, petrogenesis and tectonic setting of boninites, in Crawford, A.J., ed., Boninites and related rocks. London, Unwin Hyman,p. 1–49. 1989.

[3] Dilek Y., Furness H., Shallo M. Suprasubduction zone ophiolite formation along the periphery of Mesozoic Gondwana. Gondwana research, 2007.

[4] Hickey R., Frey F.A. Geochemical characteristisc of boninite series volcanic implications for their source. Geochim. Cosmochim., Acts 46, p. 2009 – 2115, 1982.

[5] GJeçi K., Shallo M., Vendosja gjeologjike e boniniteve ne ofiolitet e tipit lindor te Shqiperise dhe veçorite petrografike e gjeokimike te tyre. Buletini i shkencave gjeologjike, nr.1, p.3-16 Tirane 2006.

[6] Gjeçi K. - Petrologjia e boniniteve te ofioliteve lindore te Shqiperise (PhD material). Tirane, 2008.

[7] Kuroda N.,Shallo M.,Kiuchin.– Clinopiroxene composition in high – MgO volcanic rocks from north Albania ophiolites. Abstrct of 30th IGC,Bejing China, volume 2, p. 351,1996.

[8] Manika K. Petrologie des massif ophiolitiques de Shebenik. Universite de Paris Sud. 297P. 1994.

[9] Milushi I., etc. – Studimi strukturor i kompleksit te dajkave paralele. Fondi I.K.GJ. Tirane, 2002.

[10] Shallo M. Boninite ndermjet ofioliteve lindore te Shqiperise Buletini i shkencave Gjeologjike nr.4, Tirane, 1990.

[11] Shallo M. Studim petrografik i shkembinjve vullkanike e subvullkanite te rajoneve te Mirdites Qendrore dhe Vau Spas. Tirane, 1994.

[12] Shallo M.Volcanics and sheeted dykes of the Albanian SSZ ophiolite. Bul. Shk. Gjeol. Nr.1, 99 – 118. Tirane ,1995.

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PETROGENETICAL FEATURES OF PERIDOTITES FROM SKENDERBEU, ALBANIA

Agim SHENJATARI[1]

[1]*Geological Survey of Albania, Blloku 'Vasil Shanto', Tirana, Albania; Tirana, Albania*

ABSTRACT

This paper presents results of a study on the field relations, petrographic features, mineral and rock chemistry and petrology of peridotites from the Skenderbeu massif, which belongs to western belt of Jurassic Albanian ophiolites. As confirmed by petrological characteristics, the geological section of the Skenderbeu massif consists, from the bottom to the top, of a mostly harzburgite and diopside harzburgite tectonite sequence, plagioclase lherzolite transitional zone, magmatic gabbros and troctolites and basalts. Based on the bulk chemistry, mineral chemistry and modal composition, the peridotites of Skenderbeu massif have undergone a relatively low partial melting grade which increases from the centre of the massif towards its western sectors. The low partial melting grade was also supported by the very limited abundance of the dunites and chromite ore bodies which, in turn, are higher in Al. Both high-temperature asthenospheric fabrics and high-stress and relatively low temperatures lithospheric fabrics are oresent in the peridotites of the Skenderbeu massif.

KEY WORDS: *Ophiolite, Skenderbeu massif, ultramafic, tectonite, cumulate*

INTRODUCTION

The ultramafic massif of Skenderbeu, which belongs to the western ophiolitic belt of Albania (Figure 1), consists of a thick (3.5 km) rock sequence. Its generalized geological profile, from the bottom to the top, is composed from the follows rock sequences (Shenjatari & Jaurri, 2001): tectonite sequence composed of lherzolite, clinopyroxene (diopside) harzburgite and dunite; transitional zone composed mainly of plagioclase lherzolite; magmatic sequence composed of troctolite, gabbro and, finally, a volcanic sequence composed of basalts. Because this massif is scarce in chromium it has not been between the most studied ultrabasic massifs of Albanian ophiolites and, as a consequence, the petrological data on it are scarce. The first structural model of the Skanderbeu massif was firstly given by Meshi et al., 2009), based on the foliation and lineation measurements. Onuzi et al (2007) presented a petrological model based on a more completed geochemical database.

The geological observations and microscopic studies of the first author and geochemical data from other studies (Onuzi et al., 2007) in which the first author was involved, are used in order to light some petrogenetic aspects of the Skenderbeu ultramafic massif. The harzburgites and lherzolites contain metamorphic textures derived during the diapiric uplift of the massif. The lherzolite and clinopyroxene (diopside) harzburgite could represent a weakly depleted upper mantle (Nicolas and Dupuy, 1984) while the harzburgites and dunites are the most refractory residual rocks of the massif. On the other hand, plagioclase lherzolites were probably resulted from a plagioclase-clinopyroxene magmatic impregnation into formerly depleted harzburgites (Nicolas e Prinzhofer,1983; Benn et al., 1988; Cannat etj, 1990; Tartarotti e Vaggelli,1994). Finally, the lack of metallurgical chromium deposits along with the Al-rich accessory chromite, that contrast the high chromium potential and Cr-rich chromite of the Bulqiza ultramafic massif (Beqiraj, 2008), shows that Skenderbeu mantle section suffered a lower partial melting grade with respect to Bulqiza one. The presence of the clinopyroxene harzburgites and lherzolites, the scarce extent of dunites and harzburgites in this massif, the geochemical features of minerals and rocks and, finally, the scarce abundance of chromite ore bodies, which are mostly higher in Al, all favour the opinion that peridotites of the Skenderbeu massif fuffered a lower partial melting grade with respect to Bulqiza analogues (Beqiraj, 2008, Beqiraj and Masi, 2009).

GEOLOGICAL SETTING AND SAMPLING

The Skenderbeu massif that belongs to the Western belt of Albanian ophiolites covers more than 112 Km^2 in central Albania (Figure 1). It is overthrusted westward on the T_3-J_1 limestone and on the younger (Pg_1-

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$_2$) flysch formations. The early J_3^t-Cr_1 flysch or melange formations rest transgresively and/or tectonically on the massif. Finally, the mollasic formations of Burreli depression, that represent the youngest sedimentary cover, rest transgresively on the massif. As shown in Fig. 2, that gives a generalized stratigraphic log of the massif, its geological section, from the bottom to the top, consists of a thick tectonite section, a thin plutonic section and, finally, a reduced basaltic sequence. The thicker tectonite sequence is composed of lherzolite, clinopyroxene harzburgites, harzburgites and dunites. Lherzolites and diopside harzburgites, that represent the less depleted mantle section of the massif, crop out in the central sectors of the massif, while the harzburgites spread out in the western part. The cumulate sequence consists of troctolite and gabbros, whereas on the top of the massif section occurs a reduced volcanic section mostly composed of basalts. The plagioclase lherzolites with small and scarce dunite lenses that lay between the two above sequences represent the transitional zone, as usually observed in other ophiolitic complexes (Beqiraj, 2008). This unit may represent the lowermost part of the cumulate sequence (Pallister and Hopson, 1981; Elthon et al., 1982; Shallo et al., 1989) or it is residual (Nicolas and Prinzhofer, 1983; Benn et al., 1988; Tashko and Marto, 1990). Scarce pyroxenite and microgabbro dykes are present in the uppermost part of tectonite sequence and plagioclase lherzolites.
A representative number of almost all lithotypes was collected from the tectonite sequence, through two East-West extended profiles (Fig. 1). 9 samples of massif lithotypes were analysed for both mineral and whole-rock chemical composition at the Department of Geological Sciences, University of Vienna.

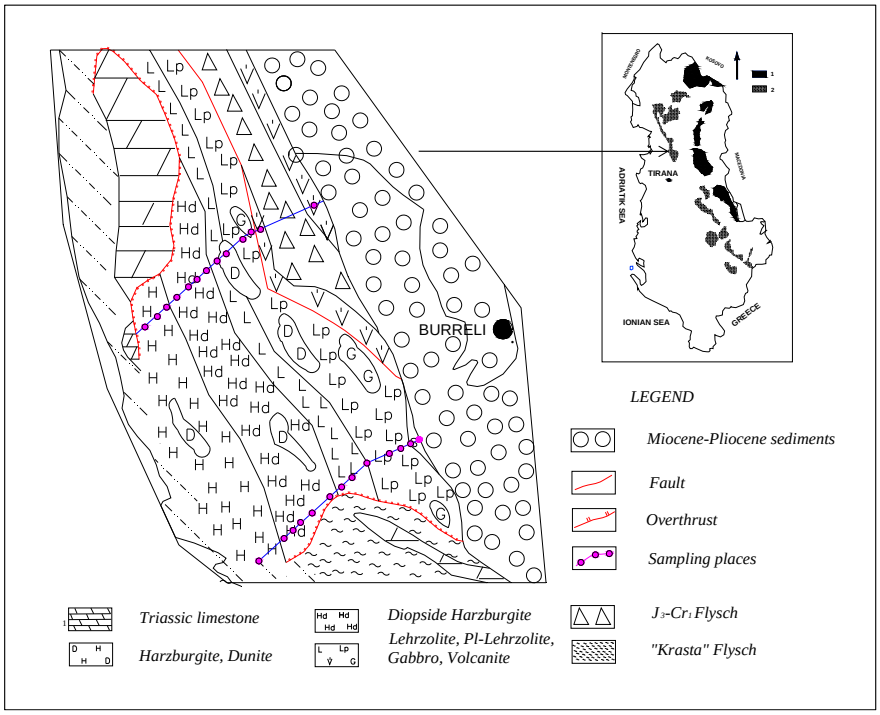


Fig.1. Schematic Geological Map of the ultramafic massif of Skenderbeu

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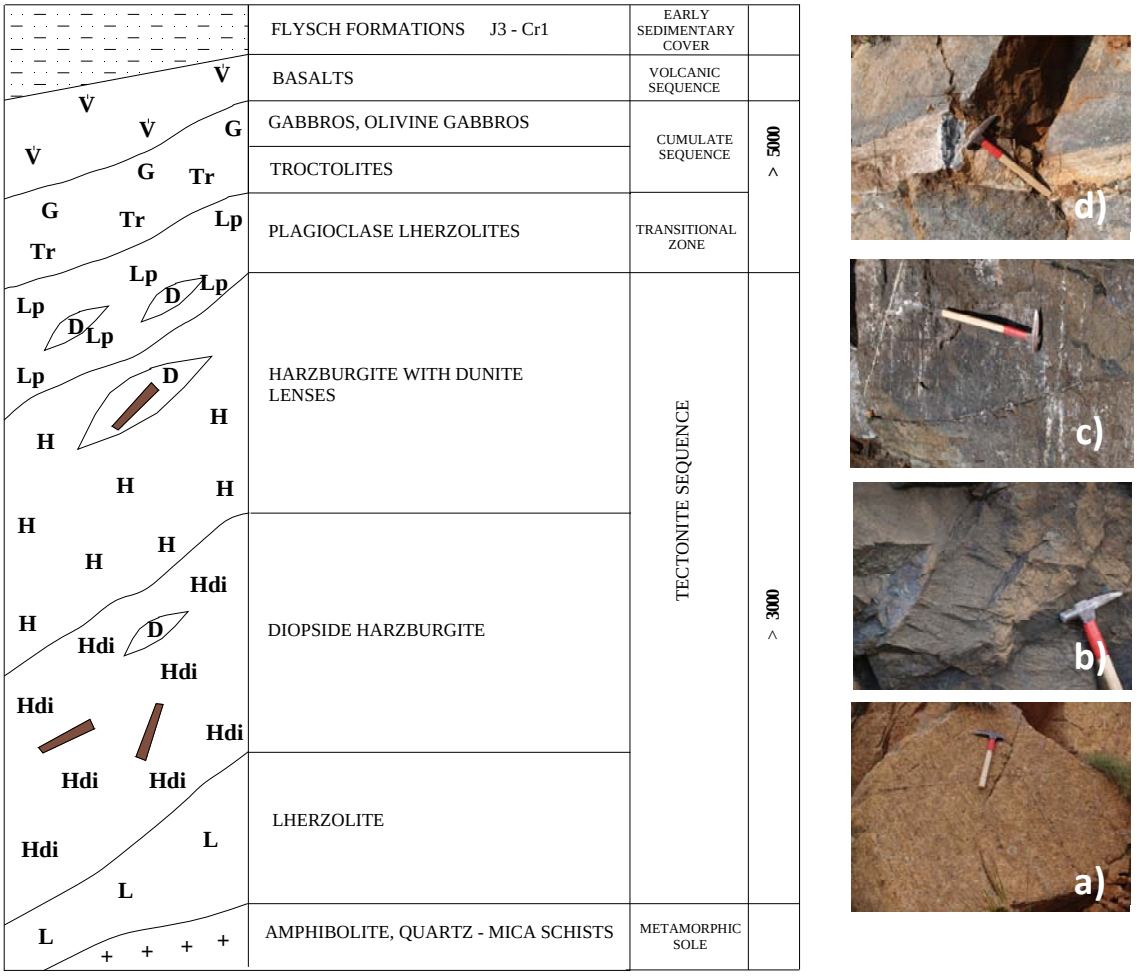


Fig. 2. Geological log of the Skanderbeu massif (on the righr some representative pictures of the tectonite rocks are presented: a = foliated harzburgite, b = dunite with disseminated accessory chromite, c = plagioclase lherzolite, d = troctolite dyke within plagioclase lherzolite)

ANALYTICAL PROCEDURE

All the samples were studied for petrography in thin section by optical microscope, while the electron microprobe analyses were carried out on polished thin sections coated with carbon, at 15 kV accelerating voltage, 40 nA beam current intensity and 5 μm electron beam diameter, with a Jeol XA 8600 (Salzburg University) equipped with four wavelength dispersive spectrometers (WDS) and a Si (Li) energy-dispersive spectrometer (EDS). Major and trace elements were analysed by X-ray fluorescence (XRF) using a Philips PW 2400 at the Department of Geological Sciences, University of Vienna (according the procedure described by Hoeck et al., (2002).

RESULTS AND DISCUSSION

The dunite, that represent the most refractory rock type of the upper part of the mantle sequence is very scarce in the Skenderbeu massif. The most abundant ultramafic rocks are harzburgites (olivine+orthopyroxene+chromite) followed by diopside-bearing harzburgites (olivine + orthopyroxene + clinopyroxene (3-5%) + chromite and lherzolites (olivine+orthopyroxene + clinopyroxene (>5%) + chromite) (Fig. 3). Olivine crystals in harzburgite range in size from 0.1 mm to a 6,0 mm and display both uniform and undulose extinction. The olivine from harzburgite displays shape preferred orientation formed either by ribbons of olivine porphyroclasts that are parallel to the foliation and define it in thin section or by imbricate elongate neoblasts. Orthopyroxenes grain size varies from approximately 0,5 mm to greater than 4 mm in thin section. Orthopyroxene grains show a variety of crystal morphology from interlobate to polygonal and they are commonly kinked or slightly bent and display clinopyroxene

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exsolution lamellae. In the samples with inequigranular textures the large orthopyroxene grains contain olivine inclusions. Chromite ranges in size from 0,1 mm to 1,0 mm and may be equant (subhedral to euhedral) or elongate. Chromite lineations, that is common observed, can be formed by an alignment of equant crystals or may be formed by anhedral elongate grains. Clinopyroxene is commonly observed as interstitial anhedral grains. Its crystals generally have exsolution lamellae and well developed cleavage that is often slightly bent.

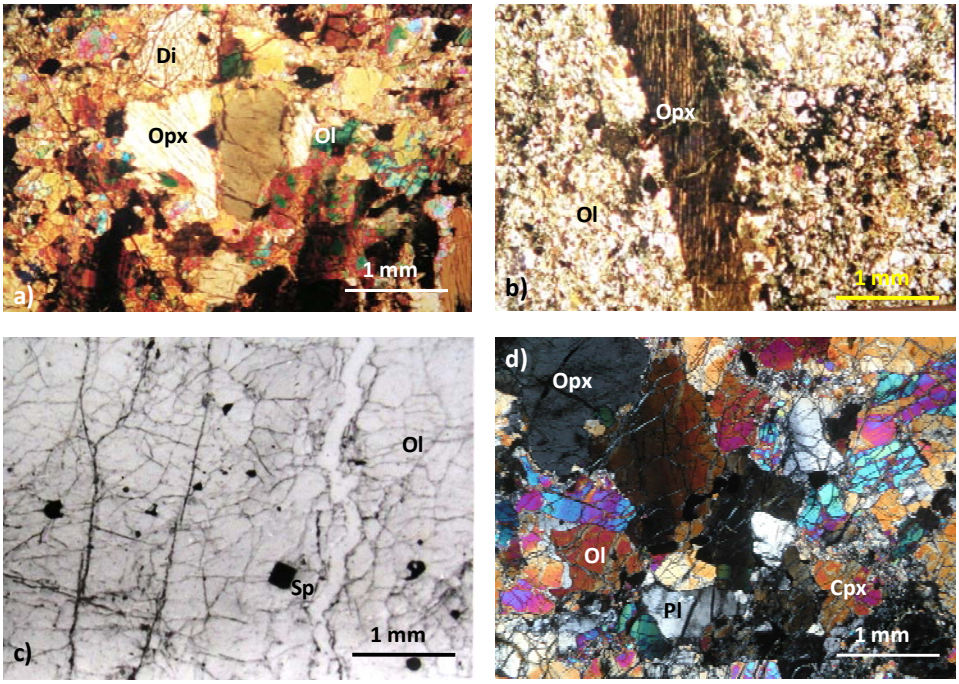


Fig.3. Photomigraphs of the main lithotypes (a = Diopside harzburgite; b = Milonitized harzburgite; c=dunite; d = Plagioclase lherzolite; Ol – olivine; Opx – orthopyroxene, Cpx – clinopyroxene; Pl – plagioclase; Sp – spinel.

Foliation and lineation, as macroscopically distinguishable penetrative structure, are often observed in the harzburgites, diopside harzburgites and lherzolites. These finite strain markers result from plastic flow, which causes shape and lattice fabric development representing a kinematic record (Nicolas and Poirier 1976). The mantle rocks contain metamorphic textures derived during the diapiric uplift of the massif. The low-T, high-P millonitic textures are found along the contact of the massif with limestones, while the high-T, high-P porphyroclastic and granoblastic textures are observed in the central sectors of the massif, respectively. Based on foliation by pyroxene, a symmetric anticline form can be inferred for the massif (Fig. 4), whereas the stereogram of lineation shows a north-western inclination of the massif (Fig. 5). With respect to modal variations, a gradual disappearance of mineral phases (ol+sp+opx+cpx - ol+sp+opx - ol+sp), from the bottom to the top of the tectonite sequence, was observed (Fig. 6). Such a modal variation correlates with the upward increase of partial melting (Dick et. al. 1984) that resulted in a gradual melt extraction from the mantle residual. The peridotite in the Skenderbeu massif, like other ophilites, has been subject to alteration by serpentinization, on a regional scale, either by on-axis processes active during spreading (Coulton et al,, 1995) or by processes that were active during emplacement and weathering (Coleman, 1977).

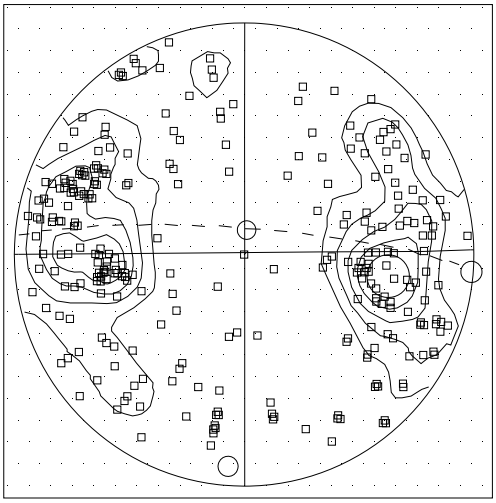


Figure 4. Stereonet of foliation after pyroxene

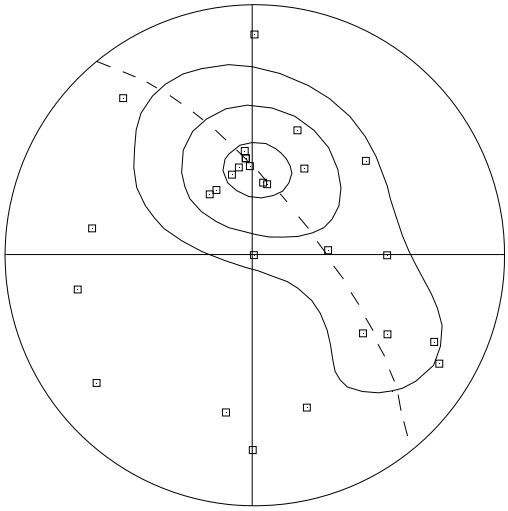


Figure 5. Stereonet of lineation

As shown by table 1, there is a apparent major element variation among the various petrographic mantle types. Al, Ca and Na increase from dunite, through harzburgite to diopside harzburgite and lherzolite, the highest values being encountered in plagioclase lherzolite, due to the impregnated clinopyroxene and plagioclase. The harzburgite tectonite has the characteristics of refractory residuum resulting from the extraction of a basaltic melt produced by partial melting of a lherzolite.

Table 1. Bulk composition of the ultramafic rocks from Skenderbeu massif (Oxides are given in wt%) (data from Onuzi et al, 2005-2007)

Sample	Rock type	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	Summe
SK540	Harzburgite	41.53626	0.01664	0.785796	7.968897	0.120181	39.36376	1.303497	0.065637	0.012943	0.011094	98.635
SK541	Harzburgite	44.66	0.019	0.79	8.78	0.13	43.06	1.47	0.01	0.008	0.013	98.94
SK542	Harzburgite	43.26	0.026	0.92	8.99	0.12	44.91	0.69	0.01	0.009	0.013	98.948
SK543	Dunite	38.82251	0.01338	0.162477	10.31253	0.124247	45.8377	0.286725	0.010513	0.007646	0.012425	100.016
SK550	Lherzolite	43.05207	0.041387	2.389169	8.220998	0.12228	36.66527	2.4362	0.006584	0.010347	0.012228	98.825
SK556	Pl-Lherzolite	39.93941	0.057261	2.23675	8.016513	0.116311	35.66275	2.800411	0.008947	0.008947	0.011631	99.317

Table 2. Composition of olivine (Oxides are given in wt%) (data from Onuzi et al, 2005-2007)

Sample	Rock type	SiO2	TiO2	Al2O3	Cr2O3	FeO	MnO	NiO	MgO	CaO	Na2O	K2O	Sum	XMg
SK551	Pl-lherzolite	40.85	0.00	0.02	0.03	8.48	0.14	0.40	50.43	0.03	0.00	0.00	100.37	0.91
SK541	Harzburgite	40.97	0.00	0.01	0.01	8.51	0.14	0.41	50.74	0.03	0.00	0.00	101.08	0.91
SK550	Pl-lherzolite	40.73	0.01	0.01	0.01	9.27	0.14	0.44	50.11	0.02	0.00	0.00	100.64	0.90
SK543	Dunite	40.51	0.01	0.01	0.01	9.24	0.13	0.33	49.75	0.02	0.00	0.00	99.84	0.90
SK542	Harzburgite	40.84	0.00	0.01	0.03	8.46	0.11	0.41	50.61	0.02	0.00	0.00	100.47	0.92

Table 3. Composition of accessory chromite (Oxides are given in wt%) (data from Onuzi et al, 2005-2007)

Sample	Rock type	SiO2	TiO2	Al2O3	Cr2O3	FeO	MnO	NiO	MgO	Total
SK551	Pl-lherzolite	0.026	0.04	51.91	14.556	12.694	0.102	0.271	18.868	98.469
SK550	Pl-lherzolite	0.133	0.02	52.01	13.846	14.196	0.118	0.263	17.891	98.468
SK543	Dunite	0.022	0.08	38.03	26.525	17.985	0.155	0.204	15.434	98.430
SK542	Harzburgite	0.022	0.09	38.26	27.836	16.256	0.158	0.155	15.687	98.455
SK731	Harzburgite	0.475	0.06	42.11	26.768	14.100	0.042	0.180	17.165	100.895
SK541	Harzburgite	0.020	0.03	31.23	35.750	17.170	0.189	0.134	14.266	98.788
SK734	Lherzolite	0.030	0.14	38.62	30.268	15.647	0.050	0.193	15.974	100.929
SK733	Lherzolite	0.011	0.08	43.45	24.911	15.662	0.051	0.203	16.437	100.801
SK730	Lherzolite	0.000	0.00	22.40	13.925	0.057	0.255	0.000	17.774	54.414
SK27	Harzburgite	0.019	0.13	30.02	38.223	17.772	0.062	0.122	14.037	100.388

Table 4. Composition of orthopyroxene (Oxides are given in wt%, cations as a.f.u) (data from Onuzi et al, 2005-2007)

No	**SK-541**	**SK550**	**SK731**	**SK734**	**SK730**	**SK733**	**SK727**
SiO_2	56.34	55.90	56.37	57.33	56.67	56.36	57.04
TiO_2	0.02	0.028	0.031	0.033	0.022	0.022	0.024
Al_2O_3	2.09	3.101	3.22	1.53	2.46	2.89	1.55

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Cr_2O_3	0.43	0.286	0.58	0.23	0.32	0.435	0.25
FeO	5.74	6.69	5.59	5.98	6.24	6.23	5.76
MnO	0.15	0.144	0.134	0.145	0.15	0.164	0.14
NiO	0.103	0.069	0.068	0.087	0.07	0.065	0.04
MgO	34.80	33.88	35.12	35.63	35.05	34.55	35.61
CaO	0.85	0.57	0.29	0.268	0.44	0.70	0.56
Na_2O	0.038	0.015	0.002	0.00	0.00	0.01	0.00
K_2O	0.02	0.001	0.00	0.00	0.00	0.00	0.00
BaO	0	0	0	0	0	0	0
Total	100.64	100.69	101.42	101.23	101.42	101.43	100.97
Si	1.93	1.92	1.91	1.95	1.93	1.92	1.94
AlIV	0.065	0.078	0.085	0.048	0.07	0.079	0.053
AlVI	0.019	0.046	0.043	0.013	0.028	0.037	0.009
Ti	0.001	0.001	0.001	0.0008	0.0006	0.001	0.0006
Cr	0.012	0.008	0.016	0.006	0.009	0.012	0.007
Fe^{3+}	0.008	0.009	0.008	0.009	0.009	0.009	0.008
Fe^{2+}	0.156	0.18	0.15	0.16	0.168	0.17	0.156
Mn	0.004	0.004	0.004	0.004	0.0045	0.005	0.004
Ni	0.003	0.002	0.002	0.002	0.0019	0.002	0.001
Mg	1.78	1.73	1.78	1.81	1.77	1.75	1.81
Ca	0.031	0.021	0.01	0.009	0.016	0.025	0.02
Na	0.003	0.001	0.0001	0.00	0.00	0.0007	0.00
K	0.001	0.00	0.00	0.00	0.00	0.00	0.00
Sum	4.018	4.011	4.012	4.014	4.016	4.015	4.018

Table 5.Composition of clinopyroxene (Oxides are given in wt%, cations as a.f.u) (data from Onuzi et al, 2005-2007)

No	**SK-541**	**SK550**	**SK731**	**SK734**	**SK730**	**SK733**	**SK727**
SiO_2	53.982	53.918	53.30	52.63	52.28	53.25	53.34
TiO_2	0.04	0.11	0.11	0.22	0.17	0.155	0.11
Al_2O_3	1.528	2.60	2.89	3.04	3.53	2.55	2.23
Cr_2O_3	0.298	0.41	0.63	0.76	0.86	0.45	0.63
FeO	1.933	2.60	2.05	1.93	2.22	2.20	1.99
MnO	0.091	0.09	0.08	0.065	0.07	0.08	0.075
NiO	0.085	0.064	0.029	0.043	0.036	0.038	0.02
MgO	18.347	17.765	17.73	17.33	18.00	17.81	17.87
CaO	24.19	23.13	24.54	24.52	24.20	24.14	24.40
Na_2O	0.04	0.40	0.087	0.13	0.06	0.091	0.08
K_2O	0	0.029	0	0	0	0	0
BaO	0	0	0	0	0	0	0
Total	100.532	101.11	101.45	100.67	101.42	100.76	100.74
Si	1.95	1.93	1.90	1.90	1.93	1.92	1.92
Al^{IV}	0.05	0.06	0.08	0.095	0.07	0.077	0.07
Al^{VI}	0.01	0.04	0.035	0.034	0.026	0.031	0.03
Ti	0.001	0.03	0.003	0.006	0.003	0.004	0.003
Cr	0.008	0.012	0.018	0.021	0.012	0.013	0.018
Fe^{3+}	0.003	0.004	0.003	0.003	0.003	0.003	0.003
Fe^{2+}	0.055	0.074	0.06	0.055	0.063	0.063	0.057
Mn	0.003	0.003	0.002	0.002	0.002	0.003	0.002
Ni	0.002	0.002	0.001	0.001	0.001	0.001	0.001
Mg	0.98	0.95	0.94	0.93	0.96	0.96	0.96
Ca	0.93	0.89	0.94	0.95	0.93	0.93	0.94
Na	0.003	0.03	0.006	0.009	0.005	0.006	0.005
K	0	0.001	0	0	0	0	0
Sum	4.014	4.014	4.01	4.01	4.014	4.016	4.017

The Skenderbeu massif is very scarce in chromium deposits and, on the other hand, the ore body chromite is higher in Al (Table 6), thus showing that the mantle rocks of this massif suffered a relatively low partial melting.

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Table 6. Composition of chromite ore bodies

No.	SiO_2	MgO	CaO	Cr_2O_3	Al_2O_3	TiO_2	FeO	Fe_2O_3	MnO	CoO	NiO	V_2O_5	P_2O_5	Na_2O	K_2O
82/2	2.20	16.4	0.1	34.4	29.3	0.21	11.4	2.3	0.2	0.01	0.2	0.1	0.01	0.56	0.12
202	2.79	17.3	0.1	33.4	30.0	0.21	7.1	6.0	0.2	0.01	0.2	0.1	0.01	0.62	0.12

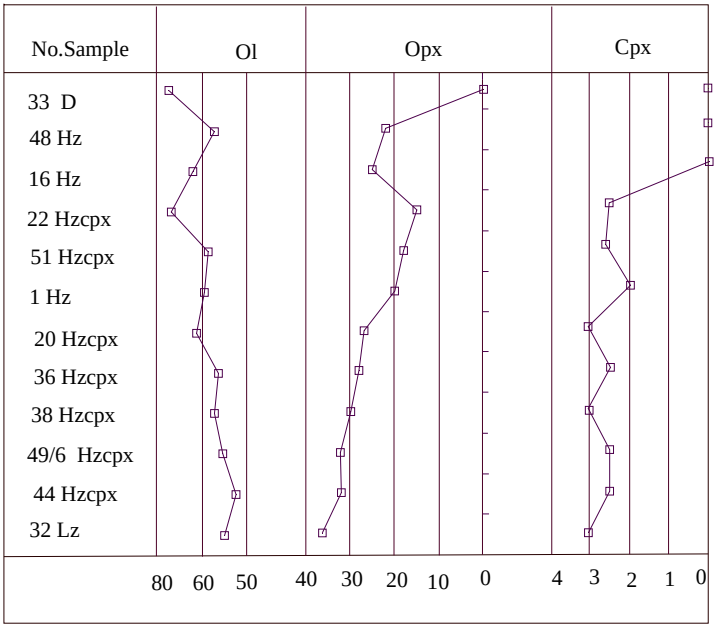


Fig. 6. Modal variation of the of Olivine, Orthopyroxene and Clinopyroxene in the Peridotites of Skenderbeu massif.

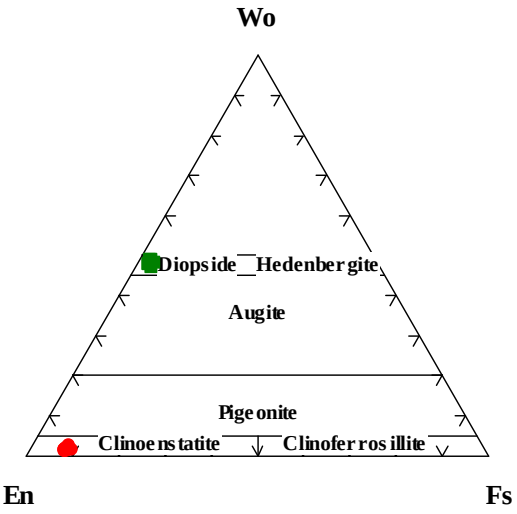


Fig. 7. Triangle diagram of the Pyroxene composition.

PETROGENETIC IMPLICATIONS

Peridotites of Skenderbeu massif contain penetrative structures, foliation and lineation, which result from plastic flow (Nicolas and Poirier 1976) showing a north-western inclination of a symmetric anticline of the massif. The high-temperature asthenospheric deformation fabrics are characteristic for the lower lherzolites and harzburgites while all the peridotites are affected by intense shear deformation developed in lithospheric conditions. The upper plagioclase peridotites of the Skenderbeu massif, as in most of the western ultramafic massifs, are interpreted as non primary mantle lherzolites, but an artifact of extreme deformation of dunites and harzburgites impregnated by basaltic liquids and intruded by gabbroic veins

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and sills (Meshi et al., 2009). The coarse-grained textures of harzburgites and dunites and porphyroclastic to submylonitic textures of plagioclase peridotites record asthenospheric deformation conditions at high temperatures (between 1000 and ,1200°C) and high-stress and relatively low temperatures lithospheric conditions (800 to 1000°C), respectively (Meshi et al., 2009).

The peridotites of the Skenderbeu massif have contents of magmatofile elements (Ca, Al, Na) similar with that of Ronda (Frey etj, 1985; Gervilla,1993), Lanzo (Bodinier etj, 1987) and Liguria (Beccaluva etj, 1984; Ottonello etj, 1984), thus being more fertile than the extremely refractory analogues rocks from Bulqiza (Beqiraj, 2008, 2009), New Caledonia (Prinzhofer & Allegre,1985), Troodos and Vourinos (Beccaluva etj, 1984). Based on the contents of the above elements three rock types are distinguished: i) the most depleted harzburgites of the western part of the massif, ii) clinopyroxene – harzburgites and lherzolites of the central part and, finally, plagioclase lherzolites of the transitional zone with impregnated clinopyroxene and plagioclase. The observed gradual disappearance of mineral phases (ol+sp+opx+cpx - ol+sp+opx - ol+sp), from the bottom to the top of the tectonite sequence, meet with the increasing of the partial melting grade in this direction. In the Fig. 8, where the composition of Skenderbeu peridotites is confronted with that of peridotites from other geodynamic settings, is shown that the peridotites from Skenderbeu massif have high (>1.5%) content of Al_2O_3 in orthopyroxene and low (<0.5) values of Cr/(Cr+Al, thus being similar with peridotites from the passive oceanic margins (Bonatti & Michael,1989).

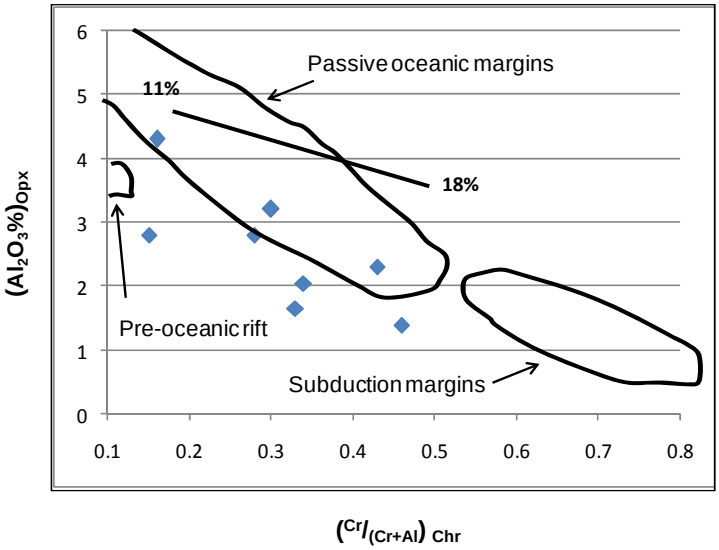


Fig. 8. Diagram of Al_2O_3 (in Orthopyroxene) versus $^{Cr}/_{(Cr+Al)}$ report (in Chromite) Fields of passive oceanic and subduction margins according to Bonatti e Michael,1989.

The chromite from Skenderbeu peridotites shows lower values (<0.6) of the $^{Cr}/_{(Cr+Al)}$ report and higher (0.16-0.89%) content of TiO_2 than the chromite from eastern analogues. Low Cr (high Al) chromites are probably precipitated from tholeiitic melts (Allan et. al. 1988; Kamenetsky et. al., 2001), favoring the opinion that the Skenderbeu peridotites are generated in a MORB-type geodynamic setting (Dick et. al. 1984; Allan et. al. 1988) (Figure. 9).

The bulk chemistry and mineral chemistry along with the lack or scarce abundance of dunites and Al-rich chromitites favor the opinion that the Skanderbeu massif belongs to the western lherzolite-harzburgite ophiolite belt that have suffered a relatively low partial melting grade.

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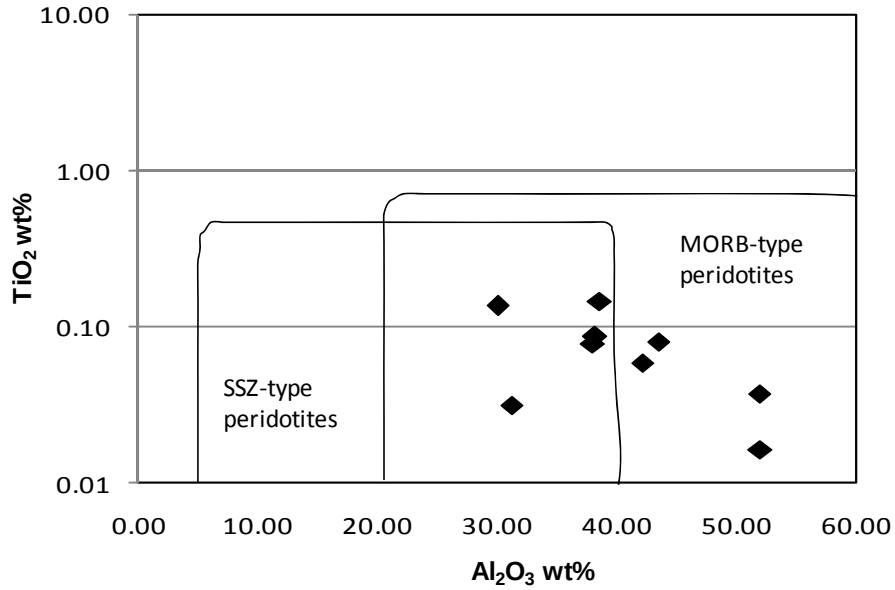


Fig. 9. TiO2 versus Al2O3 in Chromite from Skenderbeu peridotites (SSZ- and MORB-type peridotite fields according to Allan et al., 1988).

CONCLUSIONS

The Skenderbeu massif is a typically lherzolite-harzburgite massif of the western belt of the Albanian ophiolite complex. In contrast with eastern harzburgite-type ultrabasic massifs it is characterized by the lack or scarce abundance of dunites and Al-rich chromitites.

A gradual disappearance of mineral phases (ol+sp+opx+cpx - ol+sp+opx - ol+sp), from the bottom to the top of the tectonite sequence, was observed, which correlates with the upward increase of partial melting that resulted in a gradual melt extraction from the mantle residual.

Based on foliation and lineation, a symmetric anticline form can be inferred for the massif showing a north-western inclination. All the peridotites are affected by intense lithospheric shear deformation, while the lower lherzolites and harzburgites contain high-temperature asthenospheric deformation fabrics.

Both bulk and mineral chemistry show that peridotites of the Skanderbeu massif represent a mantle residual remained after the extraction of a basaltic melt during a relatively low partial melting of the mantle lherzolite.

The composition of orthopyroxene and chromite show that Skenderbeu peridotites are similar with those of passive oceanic margins favoring the opinion that they are generated in a MORB-type geodynamic setting.

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REFERENCES

Allan, JF, Sack R O, Batiza R, (1988) Cr-spinels as petrogenetic indicators: MORB-type lavas from the Lamount seamount chain, eastern Pacific. *Am. Mineral.*, **73**, 741–753.

Beccaluva L, Macciotta G, Piccardo G B, and Zeda O.,1984. Petrology of lherzolitic rocks from Northern Apennine ophiolites. *Lithos*, **17,** 299-316.

Beccaluva L, Ohnenstetter D, Ohnenstetter M, Paupy A, (1984) Two magmatic series with island arc affinities within the vourinos ophiolite. *Contr. Mineral. Petrol. 85, 253-271.*

Benn K., Nicolas A. and Reuber I., 1988. Mantle-crust transition zone and origin of wehrlitic magmas: Evidence from the Oman ophiolite. *Tectonophysics*, **151**, 75-85.

Beqiraj A, (2008) Petrogenesis of the Bulqiza ultramafic massif. *Monograph (in Albanian with abstract and conclusions in English)*. 155 p, National Library of Albania.

Beqiraj A, Masi U, (2009) Geochemistry and petrogenesis of Bulqiza peridotites, Hungary. *Mitteilungen der Österreichischen Mineralogischen Gesellschaft*, **155**, 31.

Bodinier JL, (1987) Geochemistry and petrogenesis of the Lanzo peridotite body, Western Alps. *Tectonophysics,* **149**, 67-88.

Bonatti E, Michael P, (1989) Mantle peridotites from continental rifts to ocean basins to subduction zones. *Earth Planet.* Sci. Lett., **91**, 297-311.

Cannat M, Bideau D, Hébert R, (1990) Plastic deformation and magmatic impregnation in serpentinized ultramafic rocks from the Garret transform fault (East Pacific Rise). *Earth Planet. Sci. Lett.*, **101**, 216-232.

Coleman, RG, (1977) Ophiolites: Ancient Oceanic Lithosphere, 229 pp.Springer Verlag, 236 Gray's Inn Road, Floor 6, London WC1X 8HB, United Kingdom.

Coulton, AJ, Harper, GD, O'Hanley DS, (1995) Oceanic versus emplacement age serpenfinizafion in the Josephine ophiolite: Implications for the nature of the Moho at intermediate and slow spreading ridges. *Journal of Geophysical Research,* 100, 22,245-22,260.

Dick HJB, Fisher RL, Bryan WB, (1984) Mineralogic variability of the uppermost mantle along mid-ocean ridges. *Earth Planet. Sc. Lett.*, **69**, 88-106.

Elthon D, Casey JF, Komor S, (1982) Mineral chemistry of ultramafic cumulates from the North Arm Mountain massif of the Bay of Islands ophiolite : Evidence for high-pressure crystal fractionation of oceanic basalts. *J. Geophys. Res.*, **87**, 8717-8734.

Frey F.A., Suen C.J. and Stockman H.W.,1985. The Ronda high temperature peridotite: Geochemistry and petrogenesis. *Geochi.Cosmochi. Acta, 49, 2469-2491.*

Gervilla F. and Remaidi M.,1993. Field trip to the Ronda ultramafic massif : an example of astenosphere-lithosphere interaction. *Ofioliti, 18(1), 21-35.*

HOECK, V., KOLLER, F., MEISEL, T., ONUZI, K. & KNERINGER, E. 2002. The Jurassic South Albanian ophiolites: MOR– vs. SSZ-type ophiolites. *Lithos*, **65**, 143–164.

Meshi A., Boudier F., Nicolas A, Milushi I., 2009. Structure and tectonics of lower crustal and upper mantle rocks in the Jurassic Mirdita ophiolites, Albania. International Geology Review, 1–25.

Nicolas A. and Dupuy C.,1984. Origin of ophiolitic and oceanic lherzolites. *Tectonophysics, 110, 177-187.*

Onuzi, K., Koller, F., Volker H., Shenjatari A. and Vukzaj N. 2007. Geology and Petrology of the Skenderbeu and Gomsiqe ophiolitic complexes. Archives of the Geological Survey of Albania.

Nicolas A. and Prinzhofer A,1983. Cumulative or residual origin for the transition zone in ophiolites: structural evidence. *J. Petrol., 24 (2), 188-206.*

Ottonello G. Joron J.L. and Piccardo B.,1984. Rare earth and 3d transition element geochemistry of peridotitic rocks : II. Ligurian peridotites and associated basalts. *J. petrology, 25 (2), 373-393.*

Prinzhofer A. and Allègre C.J.,1985. Residual peridotites and mechanisms of partial melting. *Earth Planet. Sci. Lett., 74, 251-265.*

Pallister J.S. and Hopson C.A.,1981. Semail ophiolite plutonic suite : Field relations, phase variation, cryptic variation and layering, and a model of a spreading ridge magma chamber. *J Geophys. Res., 86, 2593-2644.*

Shallo M,Cina A,Dobi A,Cili P,Premti I,1989. Petrology of ultrabasic massif of Bulqiza and its chromium – bearing potential. *Geological Survey of Albania (in Albanian). Tirana,193p.*

Tartarotti P. and Vaggelli G.,1994. Mantle peridotites and cumulates from the Elba Island ophiolites: fragments of the oceanic mantle-crust transition zone. Ofioliti, 19 (2), 319-325.

Tashko A.,Marto A.,1990. Kufiri midis ultrabazikeve tektonite dhe kumulate ne masivin e Bulqizes. Bul. Shk. Gjeol. No. 2, 67-81.

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LOW-TEMPERATURE THERMOCHRONOLOGY IN ALBANIDES: QUANTITATIVE CONSTRAINTS ON EXHUMATION RATE AND TECTONIC IMPLICATIONS.

Bardhyl MUCEKU[1]
[1]*Polytechnic University of Tirana, Rruga Elbasani, Tirana, Albania.*
e-mail: bardhyl.muceku@fgjm.edu.al

Albania occupies a central position within the Dinaro-Hellenic alpine mountain belt. This orogen is characterized by three fundamental components: a Western Fold-and-Thrust Belt (External Albanides), a Central Belt characterized by the occurrence of ophiolitic nappes, and an Eastern Complex (Internal Albanides). The internal Albanides were affected by pre-Tertiary tectonics, and in the external Albanides the deformation started during the Eocene. This deformation is related to subduction of the Apulian plate beneath the Eurasian plate.
Low-temperature thermochronology analysis permits to better constrain the thermal history of this mountain belt. Apatite (U-Th)/He ages in the western and northern Internal Albanides range from 55 Ma to 24-35 Ma, being in strong contrast with younger apatite (U-Th)/He ages of 4.5 to 9.3 Ma obtained for the eastern Internal Albanides. All of these results are in good agreement with apatite fission tracks (AFT) ages from the same areas. The observed east-west trend with older cooling ages in the west and younger cooling ages in the east across the Albanides is also reflected in zircon (U-Th)/He ages that range between 80-100 Ma in the north-western Internal Albanides, and 20-50 Ma in the eastern Internal Albanides. Only the higher-temperature zircon FT ages do not show any significant differences on both sides of this area. Thermal modeling based on the available low-temperature thermochronologic data, in particular the apatite (U-Th)/He ages, provide clear evidence for a phase of rapid exhumation of the eastern Internal Albanides around 3-6 Ma, reaching a rate of about 1.2 km/m.y., while the western Internal Albanides record much slower exhumation since the Eocene (< 0.1 km/m.y.).
The strong lateral gradient in rock uplift rates implied by the thermochronologic data suggests accommodation of this variation by faulting. The present-day structure of the Albanides, with major west-dipping faults forming the boundary between the Mirdita and Korabi zones and occurring within the Korabi zone constrains such faulting to be extensional on reactivated NE-SW trending former thrust fault systems.
We suggest that late Oligocene to early Miocene crustal thickening and shortening in the Albanides changed to an extensional regime in the eastern part of the orogen at about 6 Ma. Our thermochronological data indicate that rocks of the Korabi zone where exhumed from 2-3 km depth during this late extension phase. These results are in good agreement with regional structural and stratigraphic information.

INTRODUCTION

The eastern Mediterranean Dinarides-Albanides-Hellenides orogen (Fig. 1) formed by subduction of the Adriatic continental lithosphere beneath the Eurasian plate since Eocene-Oligocene times. Neogene extension has been extensively studied within this orogen and the Aegean region in general (e.g. Gautier and Brun, 1994; Jolivet and Patriat, 1999), and Neogene extensional basins have been described in Macedonia (e.g. Dumurdzanov et al., 2005) and southern Albania (e.g. Tagari et al., 1993). Extension has as yet not been characterized in detail further north, in the northern Albanides and Dinarides. Even though late orogenic extension is a widespread phenomenon in the Mediterranean convergence zone (e.g. Jolivet and Faccenna, 2000), the underlying processes are discussed controversially in the literature, and have been attributed to either extensional collapse (e.g. Dewey, 1988), slab roll-back (Royden, 1993; Jolivet and Faccenna, 2000) or slab detachment (Wortel and Spakman, 2000). Extensional faulting permits rapid tectonic exhumation that can be recorded with low-temperature thermochronology (e.g.

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Foster and John, 1999; Brichau et al., 2006). Here, we document late orogenic exhumation in the northern Albanides using (U–Th)/He and fission-track (FT) thermochronology, which allows establishing the timing and rate of extensional exhumation in the eastern Internal Albanides. We also discuss the tectonic implications of observed contrasting exhumation histories.

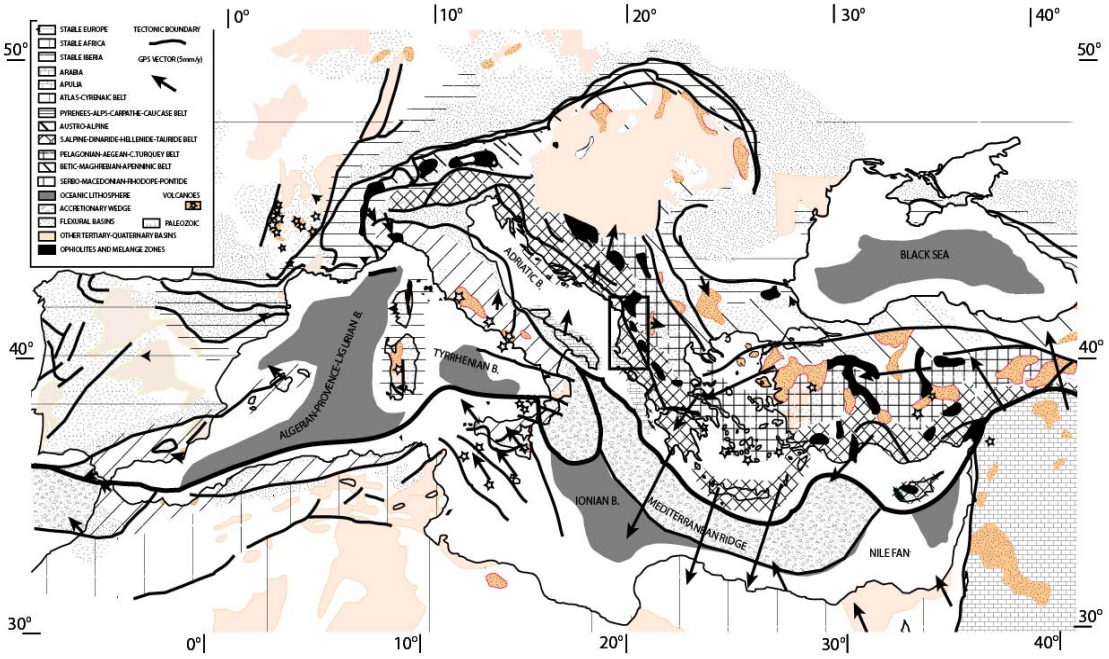


Figure 1: Situation of the Albanides in the Mediterranean

STRUCTURE AND DEFORMATION OF THE ALBANIDES

The Albanides form the central part of the Dinarides-Albanides-Hellenides orogen (Figs. 1 and 2) and are characterized by two fundamental components: i) External Albanides, a western fold-and-thrust and ii) Internal Albanides; a central Belt characterized by the occurrence of ophiolitic nappes (Mirdita or Pindos zone), and an eastern continental Internal Complex (Korabi, Gashi and Rubiku zones) (e.g., Robertson and Shallo, 2000; Cavazza et al., 2004). The ophiolitic nappes of the Central Belt were obducted onto the Internal Complex during the mid-Jurassic (Dimo-Lahitte et al., 2001), and the whole structure was thrust westwards over the External Albanides during Eocene–Oligocene times, when the Adriatic margin began subducting below the European margin (Fig. 3). The evolution of the fold-and-thrust belt in the external Albanides is well known, as it has been the target of extensive petroleum exploration (Robertson and Shallo, 2000; Cavazza et al., 2004; Roure et al., 2004). In contrast, the recent evolution of the Central Belt and the Internal Complex, together known as the Internal Albanides, has received much less attention.
Geological and geophysical data indicate eastward thickening of the Albanian crust from about 30 km in western Albania to 45–50 km near the Macedonian and Greek borders. Fault-kinematic and seismotectonic data suggest the existence of a compressional regime in the western belt, related to subduction of the Adriatic lithosphere, and a tensional regime in the eastern belt.

THERMOCHRONOLOGY DATA

Zircon and apatite (U-Th)/He (ZHe, AHe) and apatite fission-track (AFT) data are shown in Figs 2. AHe ages show a strong eastward decrease, from ~57 Ma in the Mirdita zone (sample AM4-02) to ~17 Ma in the Gashi zone (AM15-00) and ~5 Ma in the eastern Korabi zone (AM26-

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03, AM20-00). This eastward decrease also shows up in the ZHe ages, which are ~101 Ma in the Gashi zone (AM15-00) and ~50 to 20 Ma (AM08-00; AM26-03) in the eastern Korabi. These new data emphasize the significant differences in cooling histories between rocks of the Gashi zone in the north, the western part of the Mirdita zone, and the Korabi zone in the east of the Internal Albanides, as previously inferred (Muceku et al., 2006). In order to quantify the amount of exhumation associated with rapid cooling of the eastern Korabi zone, we use a transient 1D thermal model (Heat1D; Braun et al., 2006) to forward model the cooling paths, based on an undisturbed thermal gradient for this region of 25°C/km (Cermak et al., 1996). In figure 3 are presented four time-temperature histories of samples calculated by inversion of AFT, AHe and ZHe data using the HeFty code of Ketcham (2005), suggest slow exhumation rates ~0.1 mm/y for the western Internal Albanides, and ~0.16 mm/y for the eastern Internal Albanides, with a pulse of 1.2 mm/y between 6 and 4 Ma (Muceku et al., 2008). This pulse results in a transient increase in near-surface geothermal gradients of ~10%. Thus, final exhumation of the Korabi zone during the 6 - 4 Ma rapid cooling phase amounted to ~2.4 km.

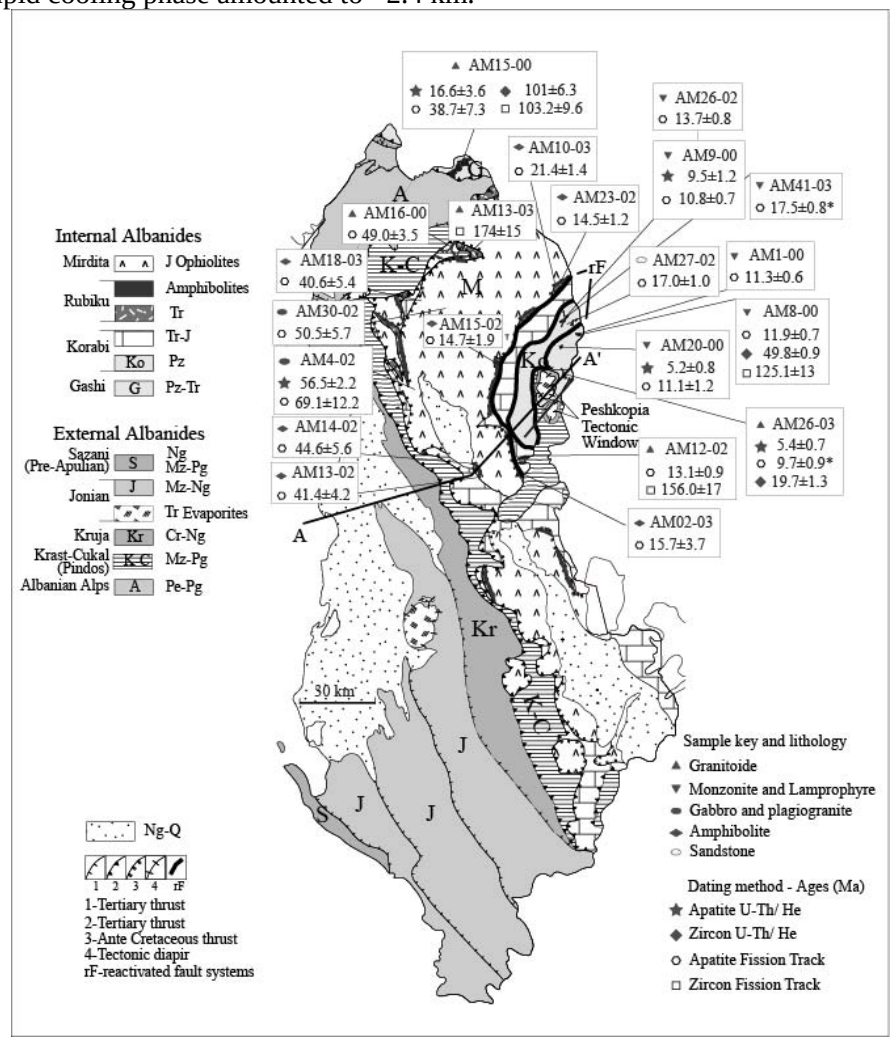


Fig. 2. Schematic geological map of the Albanides showing main structural provinces as well as thermochronological results (Muceku et al., 2006; 2008). Pz, Paleozoic; Pe, Permian; Mz, Mesozoic; Tr, Triassic; J, Jurassic; Cr, Cretaceous; Pg, Paleocene; Ng, Neocene; Q, Quaternary.

TECTONIC IMPLICATIONS

Rapid exhumation in the Korabi zone between 6 – 4 Ma contrasts strongly with continuous slow exhumation further west and north in the internal Albanides (Fig. 4). Such a localized phase of rapid exhumation can be explained by localized erosion, by tectonic exhumation, or by a

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combination of both. Discriminating between the two end-member scenarios (erosion vs. tectonic exhumation) requires comparing the calculated exhumation rates with sediment volumes derived from the internal Albanides (e.g., Kuhlemann et al., 2001). No detailed studies on the sediment budgets for these basins are currently available. However, the strong lateral gradient in rock uplift rates implied by the thermochronologic data suggests accommodation of this variation by faulting. The present-day structure of the Albanides, with major west-dipping faults forming the boundary between the Mirdita and Korabi zones and occurring within the Korabi zone constrains such faulting to be extensional on reactivated NE-SW trending former thrust fault systems (Fig. 4).

We thus suggest that late Oligocene to early Miocene crustal thickening and shortening in the Albanides changed to an extensional regime in the eastern part of the orogen at about 6 Ma. This extensional phase has been linked both to rollback of a continuous slab under the Albanides (Royden, 1993; Dumurdzanov et al., 2005) and to a southward propagating tear in the Adriatic subducting slab (Wortel and Spakman, 2000), leading to localized uplift and extension in the overriding plate (e.g., Buiter et al., 2002). Our thermochronological data do not allow discriminating between these competing hypotheses, but they indicate that rocks of the Korabi zone where exhumed from 2-3 km depth during this late extension phase.

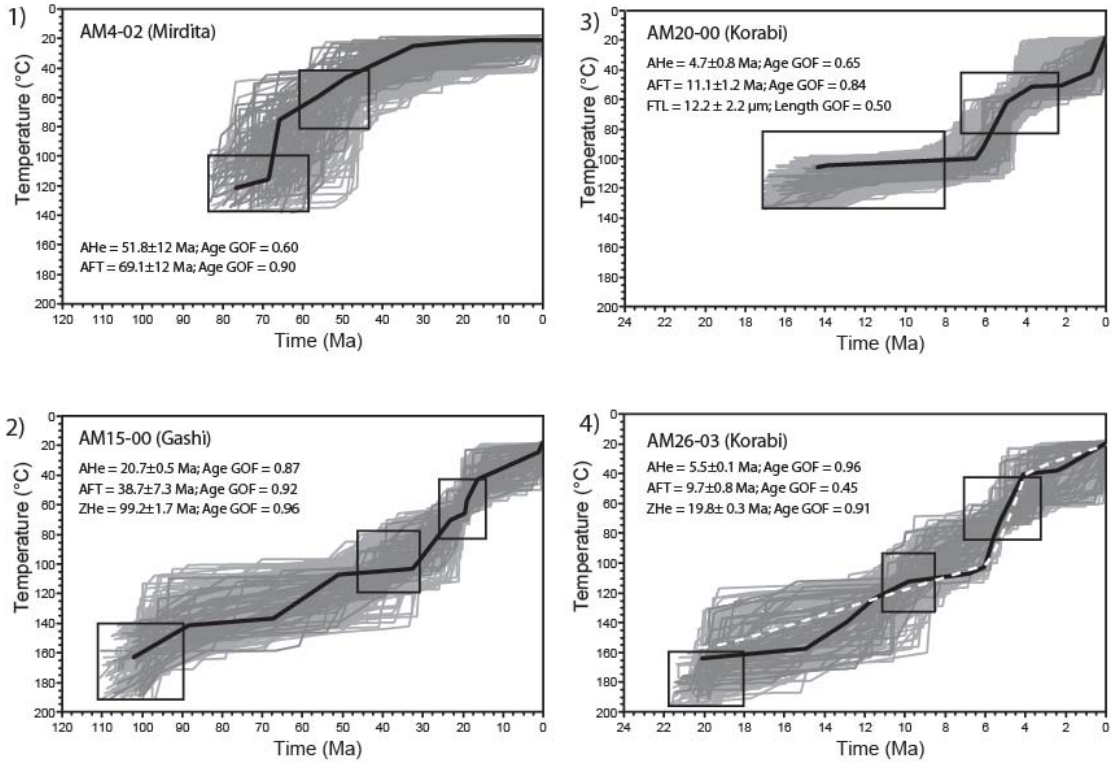


Fig. 3. Inferred time-temperature histories of samples calculated by inversion of apatite and zicon (U-Th)/He ages (AHe, ZHe), apatite fission-track ages (AFT) and fission-track length distributions (FTL) as indicated, using the HeFTy code of Ketcham (2005), for four representative samples from the Internal Albanides. "Age GOF" and "Length GOF" are the goodness-of-fit between the predicted and modelled ages and track-length distributions. Light shaded area in the time/temperature plots represent solutions that provide acceptable fits the observed data (overal GOF>0.05) whereas dark shaded area shows solutions with good fits (GOF>0.5) ; black line is overall "best fit" solution for the samples, for which GOF is reported. Boxes indicate imposed a-priori constraints on thermal history. Thick dashed white line in (d) is the predicted cooling history from a 1D transient thermal model for long-term exhumation of 0.16 mm/y punctuated by a pulse of rapid exhumation at 1.2 mm/y from 6-4 Ma. See text for discussion.

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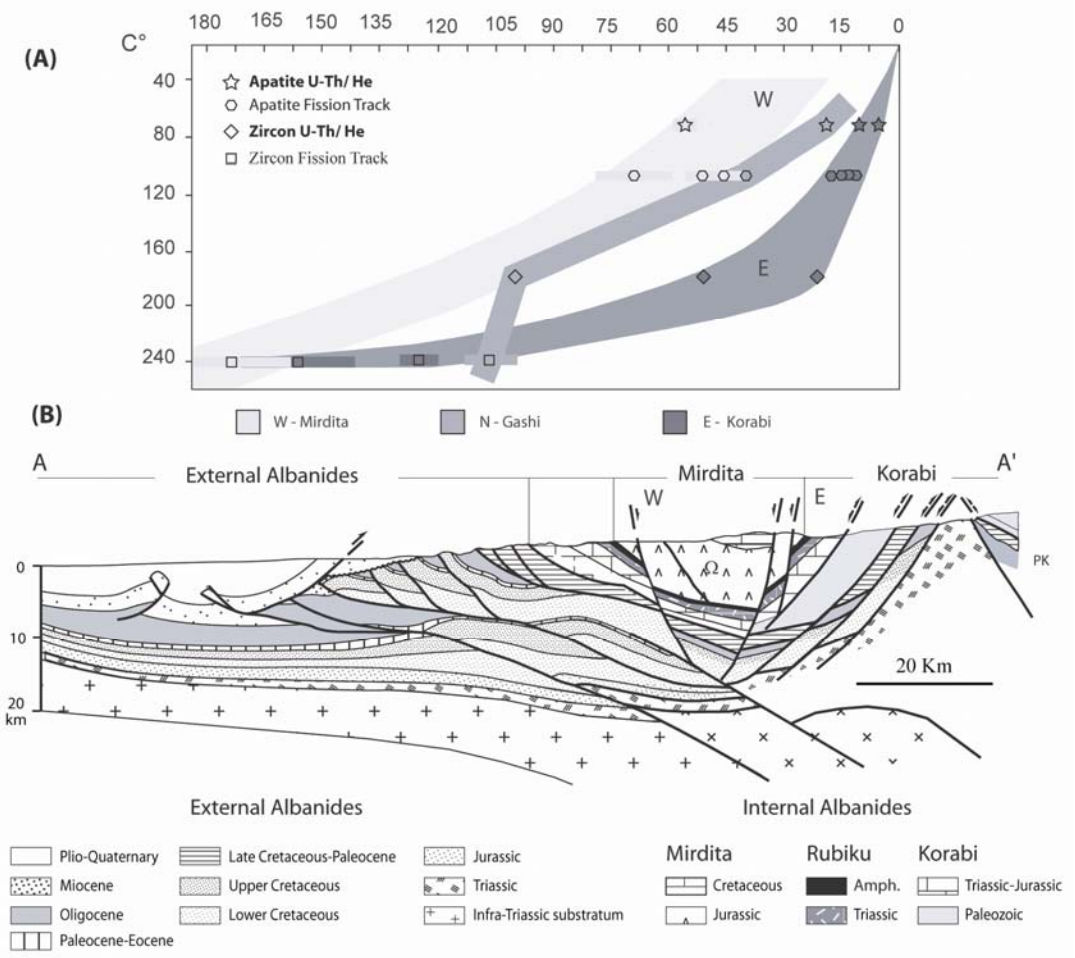


Fig. 4 A) Crustal cross-section of the Albanides (modified after Roure et al., 2004) and general cooling paths inferred from thermochronological data. Representative ages and closure temperatures are plotted for the different systems studied and three main regions; the Mirdita, Gashi and Korabi zones. Adopted closure temperatures are 240 °C for the ZFT system (Brandon et al., 1998), 180 °C for ZHe (Reiners et al., 2004), 120 °C for AFT (Gallagher et al., 1998) and 70 °C for AHe (Wolf et al., 1996; Farley, 2000). B) Lithosphere-scale cross-section of the Hellenic-Dinaric belt at the latitude of central Albania (modified after Cavazza et al., 2004). I, Ionian; KG, Kruja-Gavrovo; KP, Krasta-Pindos; PK, Korabi-Pelagonian; S, Sazani-Preapulian; V, Vardar; W, Mirdita.

CONCLUSIONS

The application of (U-Th)/He and AFT thermochronology helps to better understand the cooling and exhumation history of the Internal Albanides. Slow cooling and exhumation (<0.1 mm/y) of the northern and western Internal Albanides since Late Eocene-Early Oligocene times is likely a response to crustal thickening near the frontal thrust during tectonic emplacement of the internal units on top of the external fold-and-thrust belt. We propose that the present-day symmetric structure of the ophiolite units in the Internal Albanides is a result of Miocene-Pliocene extension on reactivated former thrust faults, affecting the eastern ophiolites and the Korabi zone. (U-Th)/He and AFT data allow determining the beginning of this extensional phase at less than 20 Ma. Exhumation of the Korabi zone rocks accelerated at 6-4 Ma, reaching a rate of about 1.2

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mm/y during this time. These results are in good agreement with regional structural and stratigraphic information.

REFERENCES

Braun, J., van der Beek, P. and Batt, G., 2006. Quantitative Thermochronology: Numerical Methods for the Interpretation of Thermochronological Data. Cambridge University Press, Cambridge, New York.

Brichau, S., Ring, U., Ketcham, R., Carter, A., Stockli, D. and Brunel, M., 2006. Constraining the long-term evolution of the slip rate for a major extensional fault system in central Aegean, Greece, using thermochronology. Earth Planet. Sci. Lett., 241, 293–306.

Buiter, S.J.H., Govers, R. and Wortel, M.J.R., 2002. Two-dimensional simulations of surface deformation caused by slab detachment. Tectonophysics, 354, 195-210.

Cavazza, W., Roure, F.M., Spakman, W., Stampfli, G.M. and Ziegler, P.A. (Eds.) 2004. The TRANSMED Atlas - The Mediterranean Region from Crust to Mantle. Springer, New York, 141 pp.

Cermak, V., Kresl, M., Kucerova, L., Safanda, J., Frasheri, A., Kapedani, N., Lico, R. and Cano, D., 1996. Heat flow in Albania. Geothermics, 25, 91-102.

Dewey, J.F., 1988. Extensional collapse of orogens. Tectonics, 7, 1123-1139.

Dimo-Lahitte, A., Monie, P. and Vergely, P., 2001. Metamorphic soles from the Albanian ophiolites : petrology, Ar- Ar geochronology, and geody-namic evolution. Tectonics, 20, 78-96.

Dumurdzanov, N., Serafimovski, B.T. and Burchfiel, C, 2005. Cenozoic tectonics of Macedonia and its relation to the South Balkan extensional regime. Geosphere, 1, 1-22, doi: 10.1130/GES00006.1.

Farley, K.A., 2000. Helium diffusion from apatite: general behavior as illustrated by Durango fluorapatite. J. Geophys. Res., 105, 2903-2914.

Foster, D.A. and John, B.E. 1999. Quantifying tectonic exhumation in an extensional orogen with thermochronology: examples from the southern Basin and Range Province. In: Exumation Processes: Normal Faulting, Ductile Flow and Erosion (U. Ring, M.T. Brandon, G.S. Lister and S.D. Willett, eds). Geol. Soc. London Spec. Publ., 154, 343-364.

Gallagher, K., Brown, R. and Johnson, C., 1998. Fission track analysis and its applications to geological problems. Annu. Rev. Earth Planet. Sci., 26, 519– 572.

Gautier P. and Brun J.P. 1994. Crustal-scale geometry and kinematics of late-orogenic extension in the central Aegean (Cyclades and Ewia Island), Tectonophysics, 238, 399-424.

Jolivet, L. and Patriat, M. 1999 Ductile extension and the formation of the Aegean Sea. In: The Mediterranean Basins: Tertiary Extension Within the Alpine Orogen (B. Durand, L. Jolivet, F. Horvath and M. Seranne, eds). Geol. Soc. London Spec. Publ., 156, 427–456.

Jolivet, L. and Faccenna, C., 2000. Mediterranean extension and the Africa-Eurasia collision. Tectonics, 19, 1095–1106.

Ketcham, R.A., 2005. Forward and inverse modeling of low-temperature therm-ochronometry data. In: Low-Tempera-ture Thermochronology: Techniques, Interpretations, and Applications (P.W. Reiners and T.A. Ehlers, eds). Rev. Mineral. Geochem., 58, 275–314.

Kuhlemann, J., Frisch, W., Dunkl, I. and Szekely, B., 2001. Quantifying tectonic versus erosive denudation by the sediment budget: the Miocene core complexes of the Alps. Tectonophysics, 330, 1–23.

Muceku, B., Mascle, G. and Tashko, A. 2006. First results of fission-track ther-mochronology in the Albanides. In: Tectonic Development of the Eastern Mediterranean Region (A.H.F. Robertson and D. Mountrakis, eds). Geol. Soc. London Spec. Publ., 260, 539–556.

Muceku, B., van der Beek, P., Bernet, M., Reiners, P.W., Mascle, G., and Tashko, A., 2008, Thermochronologic evidence for Mio-Pliocene late orogenic extension in the north-eastern Albanides (Albania). Terra Nova, v. 20, p. 180-187.

ISSN 2306-9600

Reiners, P.W., Spell, T.L., Nicolescu, S. and Zanetti, K.A., 2004. Zircon (U–Th)/ He thermochronometry: He diffusion and comparisons with 40Ar/39Ar dat-ing. Geochim. Cosmochim. Acta, 68, 1857–1887.

Robertson, A. and Shallo, M., 2000. Mesozoic-Tertiary evolution of Albania in its regional Eastern Mediterranean context. Tectonophysics, 316, 197–254.

Roure, F., Nazaj, Sh., Mushka, K., Fili, I., Cadet, J.-P. and Bonneau, M. 2004. Kinematic evolution and petroleum sys-tems – an appraisal of the Outer Alba-nides. In: Thrust Tectonics and Hydrocarbon Systems (K.R. McClay, ed.). AAPG Mem., 82, 474–493.

Royden, L.H., 1993. The tectonic expres-sion slab pull at continental convergent boundaries. Tectonics, 12, 303–325.

Tagari, D., Vergely, P. and Aliaj, S., 1993. Tectonique polyphasee plio-quaternaire en Albanie orientale (region de Korca-Progradeci). Bull. Soc. Geol. France, 164, 727–737.

Wolf, R.A., Farley, K.A. and Silver, L.T., 1996. Helium diffusion and low-temperature thermochronometry of apatite. Geochim. Cosmochim. Acta, 60, 4231– 4240.

Wortel, M.J.R. and Spakman, W., 2000. Subduction and slab detachment in the Mediterranean-Carpathian region. Sci-ence, 290, 1910–1917.

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ULTRAMAFIC, DIORIT-PLAGIOGRANIT INTRUSION AND QUARTZ - SULPHUR MINERALIZATION, IN HASI REGION.

Rakip HYSENAJ[1]

[1]*Albanian Geological Survey, Rruga e Kavajes, Tirane Albania*

ABSTRACT

The quartz-sulphur mineralization in the Hasi region is considerably wide-spread. In this region have been detected more 3 million tons of copper reserves. The main deposits are those of Golaj, Nikoliq 1, Nikoliq 2 and Kruma.

Until recently, these mineralization have been geneticallyrelated to the differentiated gabro-plagiogranitic complex only, and ultrabasic rocks into the gabbros have been considered as erosion revealing of the basement or blocks of tectonic nature, originating from the same base.

Since the existence of the ultramafic and diorit-plagiogranit intrusions in Hasi region and wider area, is undeniable, the presence of the quartz-sulphur mineralization in this setting and its association with an intense dike series, indicates a special and genetic relation between them.

Here is attempted to prove that they are the source of generation of hydrothermal solutions and quartz-sulphur mineralizations.

KEY WORDS: *Ultramaphic intrusions, quartz sulphur mineralization, ore deposits, ophiolites, gabro, plagiogranite,.*

INTRODUCTION

In this paper we modestly aim to list a few facts regarding the sequence of formation of the ultramafic, and diorit-plagiogranit intrusions, their dike series, and their quartz-sulphur mineralization, as a co-genetic intrusive complex found in the Hasi region and the entire gabbro-noritic masive of Kaptina, without pretending for definitive solution, which would require a reevaluation of the intrusions and the dike series, through analyses of absolute age (K-Ar), isotopes (S^{34}) and of quartz-sulphur mineral inclusions with isotopes S^{34} and K-Ar.

METODOLOGY

As to the methodological aspect, this study has not required a special methodology, but the following principles are followed: from known to unknown, and generalized estimating of the information of all the previous completed works, our personal experience and critical confrontation of earlier data with new ones.

Of course, the key methodology was that: the capture of the detail and graphic illustration of his.

GEOLOGICAL SETTING

Hasi region is located in the NE part of the eastern ophiolitic belt of Mirdita zone. The geology of the area consists of the mantel sequence, plutonic-intrusive sequence and extrusive sequence of Jurassic and sedimentary formations of the limestones and terrigenous facies.

At Hasi area, the most frequent rocks belong to the oceanic crust formations, transitions zone and less of the mantle harzburgites **(fig.1,2,3).**

The map of the area, scale 1:50000, shows the symmetric placements with the tectonites at the sides (western and eastern part) and the oceanic crust formations in the center (plutonic gabbros). The detailed ophiolite section is shown in the figure 2.

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All the plutonic sequence complex is interrupted from ultramafic and diorite-plagiogranite intrusions, their dike phase and the quartz-sulfur mineralization **(fig.1,2,3)**. The top of the section consists of sheeted dike complex and volcanites **(fig.2).**

DISCUSSION

Could it be that ultramafic intrusions serve as hidrothermal sources for the quartz-sulfur mineralizations ? In our opinion, idea that ultramafic intrusions are unsaturated with SiO_2 and could therefore not produce quartz hydrotherms, should not be absolutized, for the reasons mentioned in the material, but also due to the fact that scientific authorities with great expertise in the field of quartz-sulphur (Çina A. 1970, 1975, 1977, 1985, 1988), think that the role of the setting of depositing (circling rocks) is the most important in this process and that there is no reason for such a relation to be excluded. In direct or indirect ways, other authors have expressed likelihood of the relation of quartz-sulphur mineralization with ultramafic intrusions (Zaçaj M, Shallo M., 2001; Shehu B., etj. 1992; Kici V., 2003, 2006). Ultramafic intrusions, at least the first premise constitute structural and magmatic that paves the way for all other ongoing processes, until the formation of quartz-sulfur mineralization.

CONCLUSIONS

Considering the setting of the depositing of the mineralization, the dike series that accompanies it, and its co-genetic mineral associations, it can be concluded as follows:

1. The presence of the ultramafic intrusions in the Hasi region already is an undeniable fact (Manika K, 1994, 1997; Shallo M,1996, 1998; Hysenaj R, 2004). They have a considerable extension, composed from wehrlite, lherzolite-wehrlite, lherzolite-wehrlite-dunite, plagioclase types and to be concentrated on the border ultramafic sequences with that mafic crust (inside of the oceanic gabbros, fig.1,2,3.)

2. Regarding the relation of the ultramaphic intrusions with the diorit-plagiogranit ones in the Hasi region, we know that they generally share a common structural plan, with the same extension and dip. However, since the dike series of the diorit-plagiogranit intrusions intensively cuts the ultramafic intrusions, these laters are of an earlier age than the diorit-plagiogranit ones (fig.4,5,6).

3. The surface, only representative the magmatic source from which generated hydrothermal solutions are dike series (Spiro A,1976), quartz-sulphur mineralization and environment of their location.

4. Therefore, the close spatial association of the quartz-sulphur mineralization with ultramafic and diorit-plagiogranit intrusions and their dike series, comprises the first premise for the genetic relation between the two (Hysenaj R, 2008).

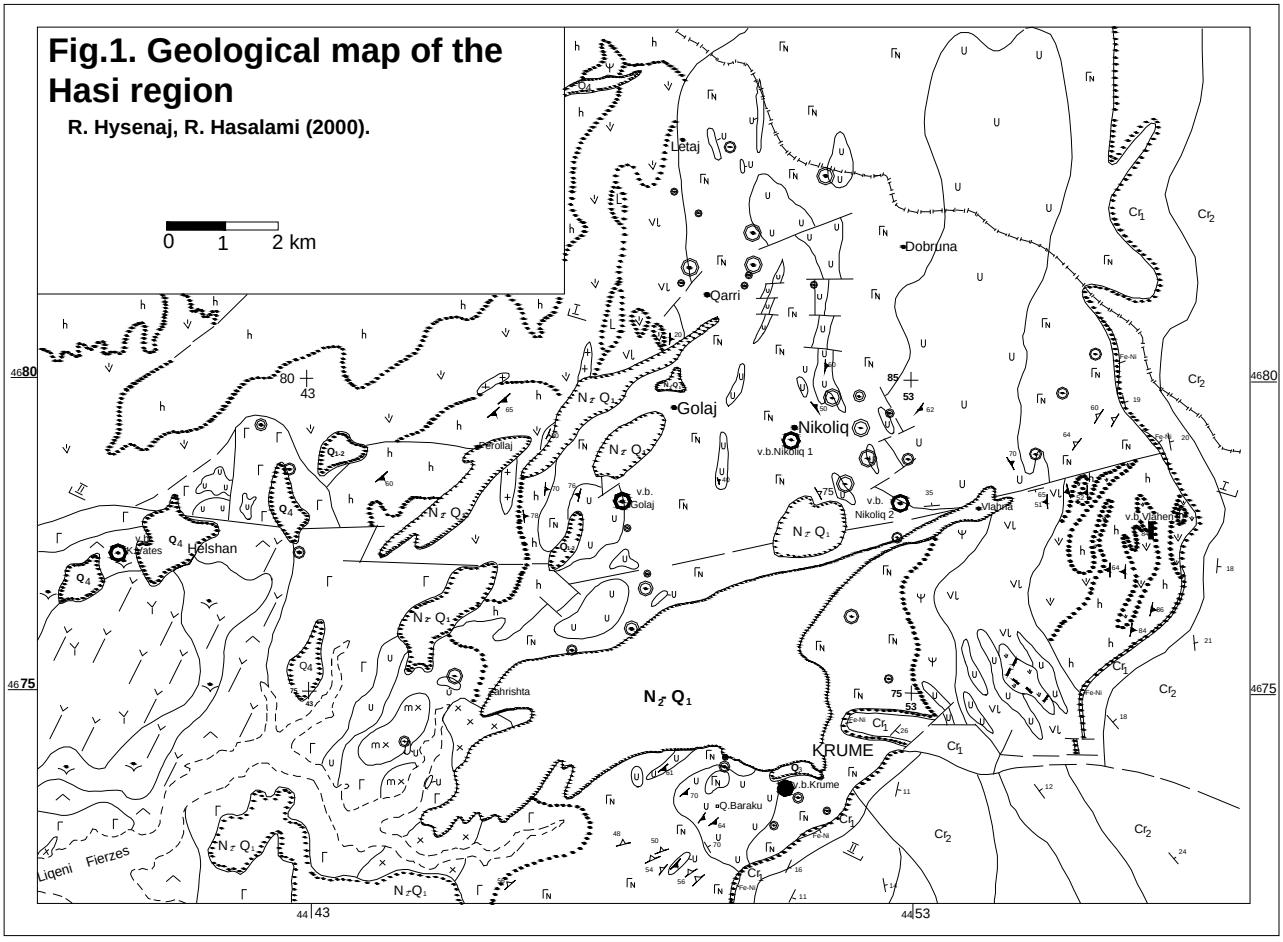
5. The presence of sulfur mineralization of vein-like nature within the ultramafic intrusions indicates a genetic relation between them. This is also indicated by the existence of quartz bodies within the ultramafic intrusions themselves (Mirun-Perroi Mrizit, Tobel).

6. The presence of important quartz-sulphur mineralizations (Golaj deposit) and many ore occurrences in contact with ultramaphic intrusions (fig.7,8,9,10) indicates a genetic relation between the two.
7. The presence of the intrusive bodies with a dike-nature of pyroxenes, that accompany the quartz-sulphur mineralization, in contact with the ultramafic intrusions, characteristic for many mineral deposits and occurrences, indicates not only spacial relation, but a genetic relation as well (fig.7,8,8/1,9,10).

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8. The fact that the quartz-sulphur mineralizations come after the ultramafic intrusions (in terms of formation sequence) means that they are not related to the differentiated plutonic gabro-plagiogranitic complex but to the ultramafic and diorit-plagiogranitic intrusions.

9. Two types of quartz-sulphur mineralization are noticed in the Hasi region. The first, major, dominating, and of an earlier age, which creates deposits, is accompanied and related to the ultramafic intrusions (fig.7,8,9,10). On the other hand, the second, secondary, of a later time, and generally poorer, is related to the diorit-plagiogranit intrusions (fig.11,12).



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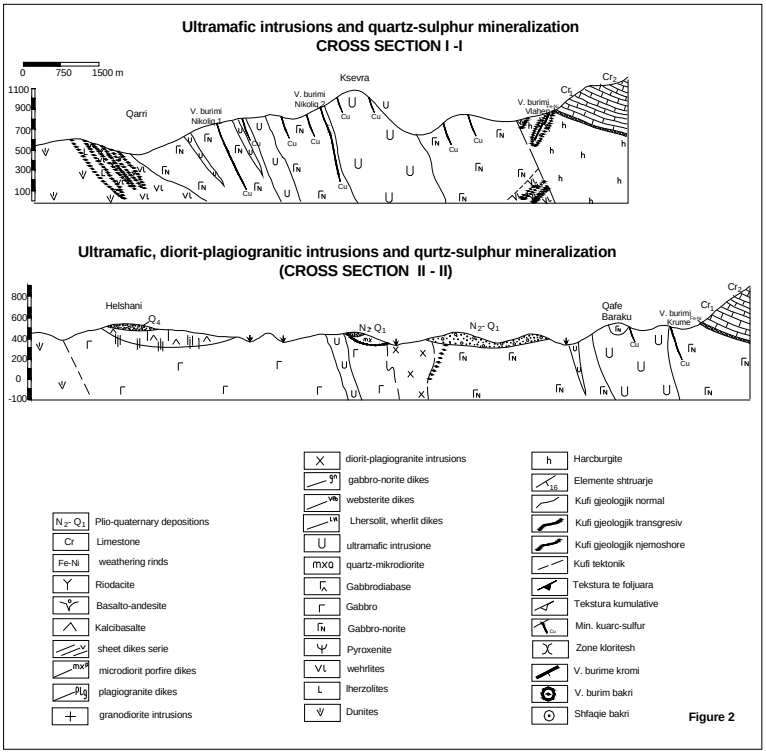
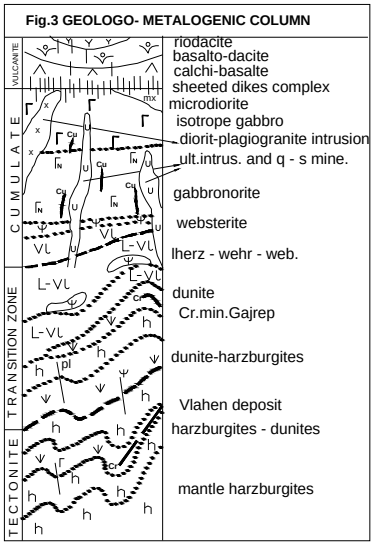
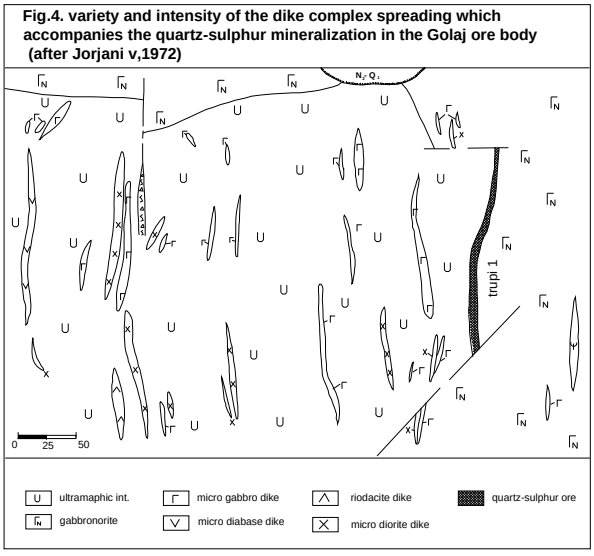
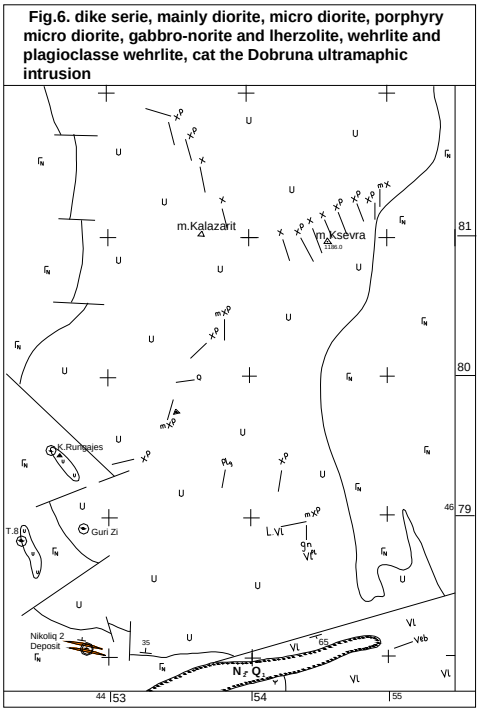


Figure 2







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Fig.5. A plagiogranitie dike which cat the ultramaphic intrusion. (Qafe Tobel)

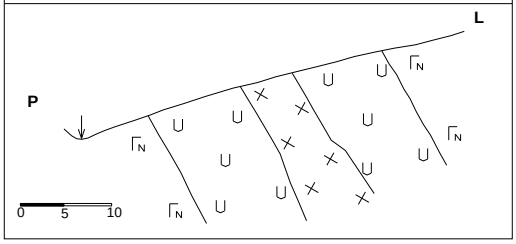
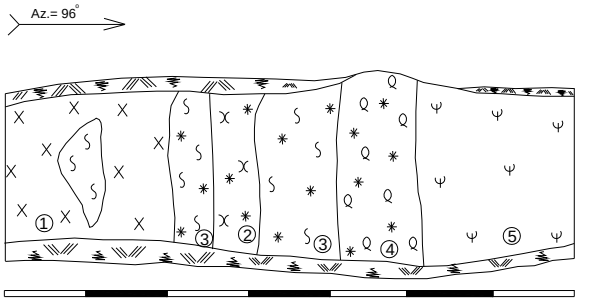


Fig.8.1. Quartz-sulphur mineralization in the Golaj deposit, accompained the floor with pyroxenite dike and in ceiling with microplagiogranite dike (Channel 9, 1970).



① Microplagiogranite dike
② Chlorite with poor mineralization
③ Serpentinites with poor mineralization
④ Quartz-sulphur mineralization
⑤ Pyroxenite dike

Fig.7. Dike pyroxenite and quartz-sulphur mineralization in the boundary between ultramafic intrusions and hosting gabbro. Zylfaj (Dobrune)

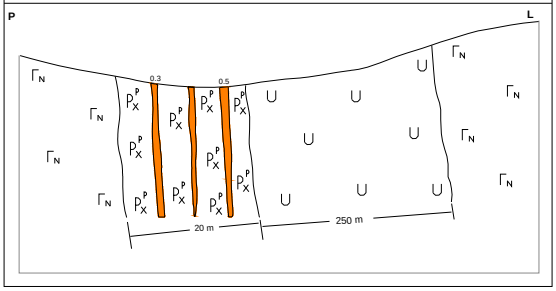
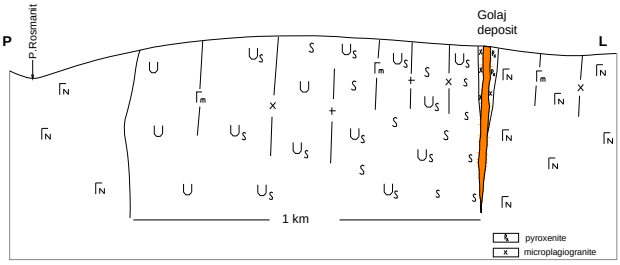


Fig. 8. Quartz-sulphur mineralization in the Golaj deposit, associations with pyroxenite, microplagiogranite, a powerful dike and located in the contact of the ultramafic intrusion with hosting gabbro.



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Fig.9. Quartz-sulphur mineralization contacts direct with ultramafic intrusion and associations a more small ultramafic intrusions (Nikoliq 2).

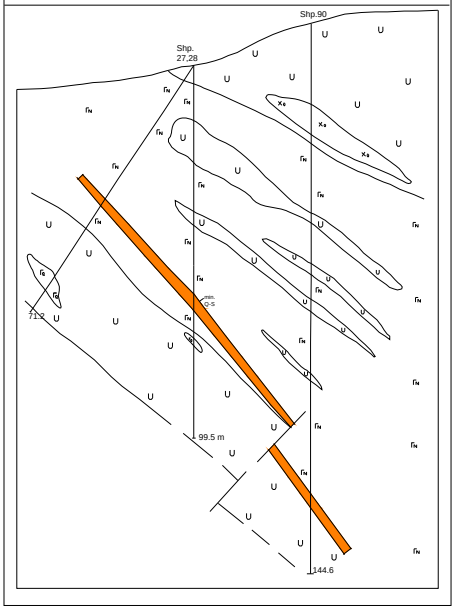


Fig.10. Quartz-sulphur mineralization located in the contact of the ultramafic intrusion with hosting gabbro (body 1, Zahrishte).

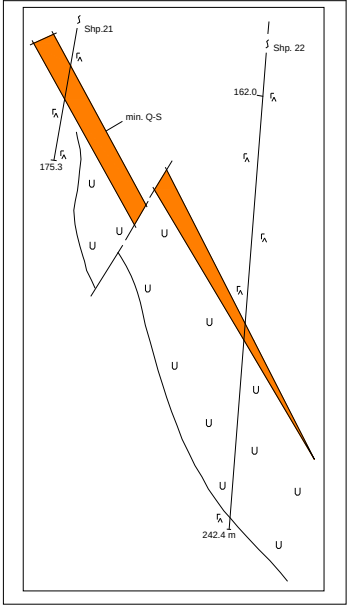


Fig.11. Sketch in plane of the geologic situation for the body 4, Qafe Tobel, where the quartz-sulphur mineralization is accompanied by a micro diorite porphyre warp, and is localized inside plagiogranite which cuts the gabbro-norite.In northeast of this body inide the gabbro-norite are encountered ultramaphic intrusions.

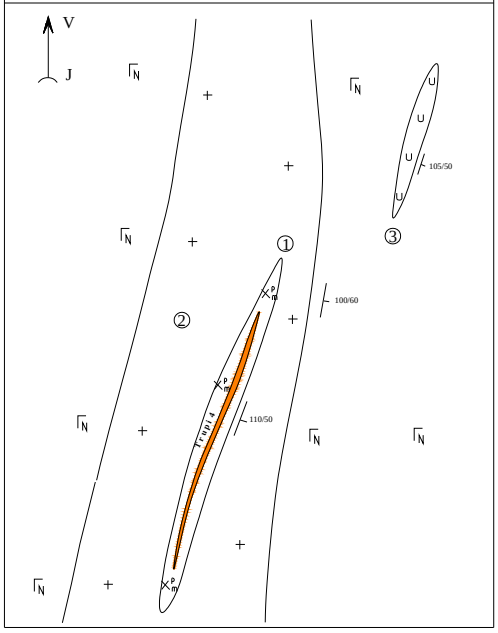
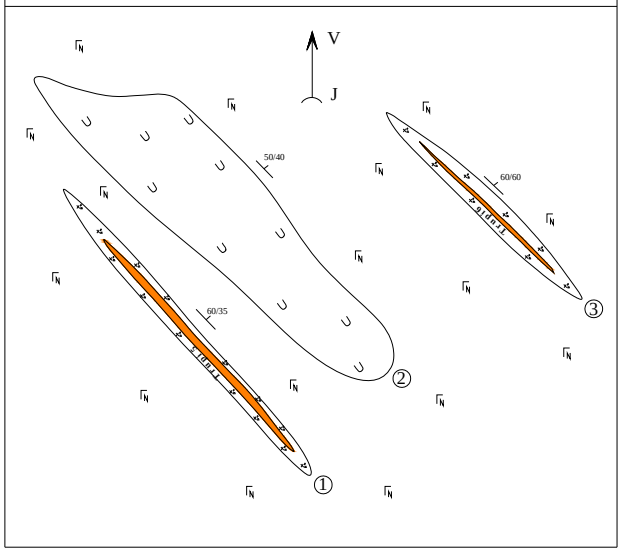


Fig. 12 Sketch in plane of the geologic situation for the bodies 5 and 6 Qafe Tobel, where the quartz-sulphure mineralization is accompanied by a micro diorites porphyry warp, and is localized inside the gabbro-norite, where are encountered ultramafic intrusions.



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On this occasion, i thank all the geologists of the former Kukes Enterprises Geological and the ones of the former of Geological Institute of Tirana, which have contributed to the prospecting and discovery of copper ore and geology of this area, because what has been achieved is contribution of all of them.

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REFERENCES

Çina A., 1977. Cogenetic hydrothermal associated of the veins hydrothermal mineralization the northern part of the Mirdita Zone. (Doctoral thesis)

Çina A., 1988. Arsenure and sulphure mineralization of basic and ultrabasic ophiolite. Geological Sciences Bulletin, Nr 1

Hysenaj R., 2008. Quartz-sulfur mineralization in the Hasi region is related to genetic and spatial with ultramafic and diorite-plagiogranit intrusions. Geological Science Bulletin Nr.2.

Hysenaj R., 2004. Ultramafic intrusions in the Hasi region (the north-eastern part of the Mirdita area) Geological Science Bulletin , Nr1

Hysenaj R, Hasalami R., 2001. Geoeological map and the mineral resource in the Hasi district. 1:50000 scale. Archive of Albanian Geological Service .

Hysenaj R, Elezi M, Gjeta H., 2000. Report of the geological mapping in the 1:25000 scale, for the Krumë-Vlahën-Dobrunë region.(Has). Archive of Albanian Geological Service .

Hysenaj R., 1982. Report of the geological mapping in the 1:10000 scale, for the Qarr-Perollaj and Fajza-Zahrishtë-Vranisht region (Hasi zone) . Kukes Geological Enterprise Archive.

Hysenaj R., 1983, 1984, 1985, 1986, 1987,1988, 1989, 1990. Project of research and discovery for the quartz-sulphur mineralization in the Hasi region. Kukes Geological Enterprise Archive.

Jorjani V., etj. 1972. Complex report of the Geologo-geophysic-geochemical in the 1:2000 scale for the Golaj-Bregu i Vlahnës. Region. Kukes Geological Enterprise Archive.

Jotopulli N., 1977. Geological report with reserves calculation of the quartz-sulphut mineralization in the Golaj deposit. Kukes Geological Enterprise Archive.

Lama B., 1988. Geological report with reserves calculation of the quartz-sulphut mineralization in the Kruma deposit (emergence report). Kukes Geological Enterprise Archive.

Manika K, Shallo M, Gega D., 1997. The plutonic sequence of the Shebenik ophiolite complex, Albania; Evidence for dual magmatisem. Ofioliti, 1997, 22 (1), 93-99.

Meshi Z., 1981. Geological report with reserves calculation of the quartz-sulphut mineralization in the Nikoliq 1 deposit. Kukes Geological Enterprise Archive.

Meshi Z., 1983. Geological report with reserves calculation of the quartz-sulphut mineralization in the Nikoliq 2 deposit . Kukes Geological Enterprise Archive.

Spiro A., 1975-1976. Geological mapping in the 1:2000 scale of the Miruni Zone. Kukes Geological Enterprise Archive

Shallo M, Spiro A, Çina A, Kote Dh, Konomi N, Çaushi R., 1970. "Results of the research work thematic in the 1:50000 scale, performed in the Kaptina gabbros massiv for prospects evaluation for the quartz-sulphur ore. Kukes Geological Enterprise Archive.

Shallo M, Çina A., 1975. Quartz-sulphur veins copper mineralizatin in the Kaptina gabbros massiv.Summary Studies Nr.3

Shallo M., 1998. Ultramafic intrusions in the Albanian ophiolite Geology Faculty Library.

Vllaho J, Haxhia Sh, Elezi E., 1962. Mapping report the scale 1: 10.000 in the Helshani region. Kukes Geological Enterprise Archive.

Zaçaj M, Çina A, Shallo M, Pulaj H, Hysenaj R., 1989. Copper vein mineralization, of the gabbro-plagiogranit sequence in the Albanian ophiolitic complex. Geological Science Bulletin, Nr.2.

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MINERALOGY AND CHEMISTRY OF BLACK CERAMICS

Volker HOECK[1], Corina IONESCU[2], Viorica SIMON[3]

[1]Dept. Geography & Geology, University of Salzburg, 34 Hellbrunner Str., A-5020 Salzburg, Austria,
[2]Dept. Geology, Babes-Bolyai University, 1 Kogalniceanu Str., RO-400084 Cluj-Napoca, Romania,
[2]Faculty of Physics &Institute of Interdisciplinary Research on Bio-Nano-Sciences, Babes Bolyai University, 1 Kogalniceanu Str., RO-400084 Cluj-Napoca, Romania,
e-mail: volker.hoeck@sbg.ac.at corina.ionescu@ubbcluj.ro viosimon@phys.ubbcluj.ro

ABSTRACT

A modern black ceramics produced recently at Marginea (NE Romania) was studied by means of optical microscopy, XRPD, EMPA, SEM and ICP-MS, in order to approach the problem of colouring. Additionally we looked also into the Miocene calcareous illitic clay used for producing the ceramics. Further on firing experiments on the raw clay, between 700 and 1200ºC, where carried out.
The ceramic wall generally has a zoned structure, with a grey core and thin black margins. Mineralogically, the ceramic body consists of a fine network of a vitreous groundmass (matrix) in which primary minerals such as quartz, K-feldspar, plagioclase, muscovite, biotite and Fe-rich grains are preserved. Newly-formed phases include wollastonite, clinopyroxene (fassaite?), feldspar, magnetite and maghemite. The black outer layers are more compact and have a higher content of Ca-rich plagioclase and Fe-rich phase.
The firing experiments on Miocene clays showed that the original greyish colour turns to brown after 2 hours of heating at 700°C. At T>900°C a vitreous phase (glass) appears. At 1100°C hematite, magnetite and also some maghemite form, whereas at 1200°C magnetite predominates. Thus, magnetite and maghemite are most likely responsible for the black colour. The results can be applied for compositional and technological studies on ancient black ceramics.

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APPLICATION OF GEOSCIENCES IN THE STUDY OF ARCHAEOCERAMICS

Corina IONESCU[1], Volker HOECK[2]

[1]Dept. Geology, Babes-Bolyai University, 1 Kogalniceanu Str., RO-400084 Cluj-Napoca, Romania,
corina.ionescu@ubbcluj.ro
[2]Dept. Geography & Geology, University of Salzburg, 34 Hellbrunner Str., A-5020 Salzburg, Austria,
volker.hoeck@sbg.ac.at

In the last 25-30 years many studies have worldwide concentrated on archaeological artifacts and in particular on ceramics, due to their importance for reconstruction the technological level of ancient societies. As the ceramic body is derived from minerals and rocks, in particular clays and sands, the scientific approach in terms of geosciences is necessary to obtain basic information on composition and fabric. On the other hand, they can be regarded as products of an "anthropogenic pyrometamorphism" and their study can help the understanding high T mineral reactions at 1 atm pressure.

Due to the wealth of such remnants in archaeological sites spanning from Early Neolithic to Medieval times, Romania represents an ideal domain for ancient ceramic studies. The investigations focus on the mineralogical composition and the fabric, as well as the chemistry of the ceramic body. Polarized light optical microscopy, electron microprobe analyses, X-ray diffraction, scanning electron microscopy, scanning electron microscopy and inductively coupled plasma mass spectrometry are the main analytical methods involved in studying pottery from Copper Age (Cucuteni site, NE Romania) and Bronze Age (Lapus site, NW Romania).

The archaeometric interpretation of the data regards: a) the identification of manufacturing techniques, b) the estimation of the firing temperature and atmosphere, and c) the identification of raw materials. The raw clayey material, the kind of temper, the grain-size, the modeling techniques, the firing temperature might be indicative of the technological "standard" but are most likely variable from site to site independent of time and cultural level.

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PRELIMINARY DATA ON PROVENANCE OF AN ANCHOR BELONING TO THE ARCHAIC PERIOD IN THE BAY OF DURRES

Adrian ANASTASI [1], Enkeleida GOGA BEQIRAJ [2], Adem HYSENI[2]

[1]*Center of Albanalogic Study, Bulevardi Deshmoret e Kombit, Tirane, adrian.anastasi@gmail.com*
[2]*Fakulteti i Gjeologjise e Minierave, Ruga e Elbasanit, Tirane, ea_beqiraj@yahoo.com*

ABSTRAKT

The study of archaeological materials is a multidisciplinary task that requires the contributions of different branches of scientific knowledge. The value of different scientific branches is underlined by the character of the objects, generally artefacts, ceramics, pottery, pieces or buildings that can be seen as materials developed by the older societies using the technology at their disposal.
This paper presents the preliminary data (optical microscopy) of the two stony parts of this anchor, and it aims to give a contribution on the characterisation of raw material and the provenance of the anchor.
Studying this anchor, the following questions raised:
Are these two stony parts from the same anchor? Where did the raw material come from?
Comparing the thin sections from the two stony parts of anchor, results that they belong to the same anchor. Based on the raw material study we can say that this anchor, can be a local one. Possibly the raw material was taken from the so-called "Shkembi i Kavajes - Kavaja stone" of the Durres region. The chemical analysis and X-ray diffraction analysis will complete the characterization of the stony parts of the anchor and will further clarify its provenience.

KEY WORDS

Archeometry, anchor, underwater archaeology, provenance, Durres.

I-INTRODUCTION

During the summer of 2005, the Underwater Archeology Department of the Institute of Archeology, studied the area between northern actual Port and Currila site, bay of Durres. A lot of archaeological materials were found and a wreck of I century, BC with amphorae Lamboglia 2 was identified in the western part of Batlla. Under the sandy sea bottom mixed with mud and scarce Posidonia (Angiosperm Monocotiledoni), in the depth of 4 m, two stony fragments of an anchore were found. Clear signs of the human interventions are observed on the surface of the archaic anchor.
In this paper, we will present the preliminary results about the characterisation of raw material and possible provenance of archaic anchora, using optical microscopic study. The final data, chemical analysis and X ray diffraction are in process and will publish soon.
The interdisciplinary work of mineralogists and archaeologists has lately proved to be of great help in understanding and often solving archaeological problems such as the provenance and characterization of archeological materials (Druc, 2001). In the study of archeological material, it is important to combine geological, laboratory and technological techniques to achieve good results.
Although in the past provenance studies have used traditional wet chemistry and gravimetric analyses, the field is now dominated by instrumental analysis. This is partly because of the large numbers of samples that need to be processed in order to account for the no-homogeneity and variability of much archaeological material. Optical microscopy has an important role in the characterization of the archeological material. Information about source(s) of raw materials or production centers, significant archaeologically as it may indicates strategies for the procurement of raw materials, technological advancement, mechanisms of distribution, exchange and trade, and contacts between different archaeological cultures (Griffits D., 1999).
So, the study on identification and the characterization of the materials of the wreck are of utmost importance to provide information about the possible origin of the raw materials utilized in the production and on the provenance of the rock materials constituting the ballast and the stowage. These findings might shed some lights on the trade routes followed by the ships (Pecchioni et.al, 2007).

II- MATERIALS AND METHODS

In this work, both archaeological finds and stone samples were analyzed. In the figure 1, is shown the area of archeological survey. In the depth of 4 m two stony fragments of an archaic anchor were found under the sandy sea bottom mixed with mud and scarce Posidonia (Angiosperm Monocotiledoni). The GPS position was 41° 18' 32.39" N and 19° 25' 52.37" E. (Fig. 2).

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Fig.1. The area of archeological survey



Fig.2. The exact location of the anchor

Two fragments of the stony anchor were examined (fig.3). A visual description and a careful stylistic analyze was carried on the two stony fragments. They are considered as separated samples, in manner to compare and to answer to the questions if they are parts of the same anchor. Both fragments were recovered, purified and treated for a period of one month with fresh water. After treatment they were documented in 1:1 scale and weighted. The first element has a length of 29cm, width 6.5cm, height 7.5cm and weighed 1.5kg. The two extremes along its length are rectangular and of blade edge forms, respectively. The second element had a length of 33cm, width 7cm, height of 7cm and weighed 2.3kg. The arched extreme bear witness of the human intervention, while the other extreme has a rectangle base. In one extreme was distinguished a clear human intervention, which was in the form of the arch, while the opposite extreme, terminated in a base in form of rectangle.



Fig. 3. Photos of the stony fragments of amphore

Care was taken to select samples of natural materials such as sandy rocks present around the region for the local provenance possibility. A geological survey was carried in all around the region. Two sandy rock samples are selected, one from the Kavaja Rock and two others from the sandstone layers of Pliocene that outcrop along the hills of Currila.

According to Crisci G.M. et al., 2010, in order to examine the characteristics of archeological material and its provenance, the degradation products and the relation between superficial patinas several types of analysis were carried out on archeological and rocks samples, as follows:

(i) The petrography description and mineralogical composition of the rocks and the stony fragments of anchor has been performed using Leitz (OM) polarized light microscope on a thin section.

(ii) X-ray diffraction analysis

(iii) The chemical composition of anchor's parts and of the stones has been determined by X-ray fluorescence (XRF)

X-ray diffraction and X-ray fluorescence (XRF) are still in process. In this paper we will present only the preliminary data, based only on the optical microscopy study.

III- ARCHEOLOGICAL DESCRIPTION

In the first centuries of the first millennium BC, before and after the establishment of the colony by the Corinthians and Corcyra's, Bay of Durres was an important part of commercial routes and different economic activities oriented toward fishing (Anastasi A. 2003, 2004, 2011). Ancient sources and

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archaeological excavations confirmed this thesis. The port Epidamne-Dyrrachium has played a very important role in the relation with the Western countries. In an assessment of underwater archaeological potentiality of the coast of southern Illyria, Bay of Durres in general, and the port of Durres, in particular, represent very high value and certainly their study constitutes one of the main objectives of scientific research projects (Anastasi A. 2001, 2002).

Wood anchors could be used for about 1000 years, from the VII century BC until c. III AD and in the course of time they have evolved from anchors designed entirely of wood, in those combined with arms initially of stone, and to terminate in those with leaden arms (Halden 1984, 1990, Kapitan G. 1982b, 1984, Benoit F. 1955, Purpura G. 2003). From a typological assessment as it was noted above, these elements belong to a stone arm of a wooden anchor of archaic period that probably belongs to a small commercial or fishing ship.

IV- GEOLOGICAL DESCRIPTION

The Durrësi Bay, around 20 km long, is situated between the Cape of Selitë (Lagji) in the South and the Cape of Durrësi in the north. The highest hills are the castle of Turra and that of Karpen (106 m and 147 m above sea level, respectively). The Durrësi Bay is new and it belongs to the late Holocene developments. The important geological developments occurred during the post-glacial period of Wurm and were linked with the glacial melting in the Northern Europe and Canada, more than 12.000 years ago. The second phase started 6.000 years ago and it was accompanied by filling of bay with river sediments. The beach area of the bay, especially the sector "Ura e Dajlanit – Golem", lived a dynamically stabilized phase during the last 100 years (Hyseni A., 1995).

The zone in study belongs to the Pre-adriatic depression. Its geology consists of Neogene (N_1^3-N_2) formations and Quaternary (Qh) sediments (Fig. 4). The Neogene formations crop out on the hilly terrains, whike those of the Quaternary fill the low plain reliefs. The Messinian (N_1^3) formations, that extend along the western flanks of the hills and under the sea water, consists mostly of soft to moderately hard sandstone, intercalated with clay layers. The Astian clay formations, known as "Helmasi suite", are placed transgressively on the Messionian formations. On the top of the Neogene section of the hills of Durresi bay occur the so called "Rrogozhina package", composed by intercalations of sandstone and conglomerates with clay. The compactness of the sandstone and conglomerates ranges from very soft (sand and gravel, respectively) up to hard rock (Shkembi i kavajes) (*Beqiraj A. et.al, 2006).*

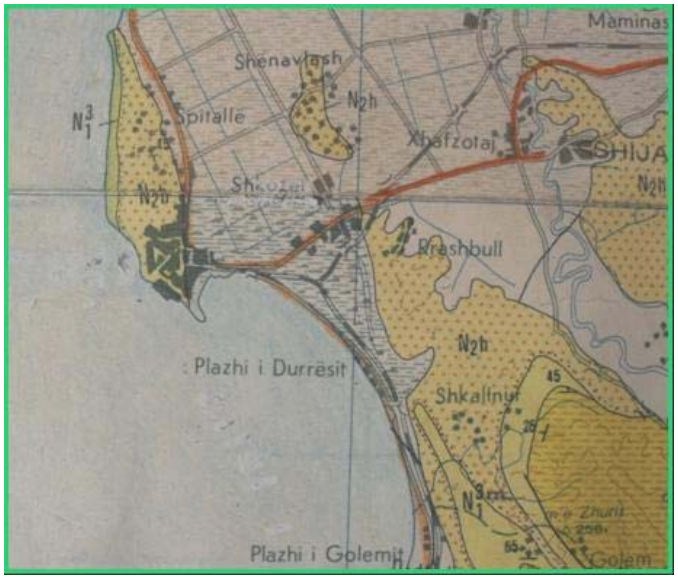
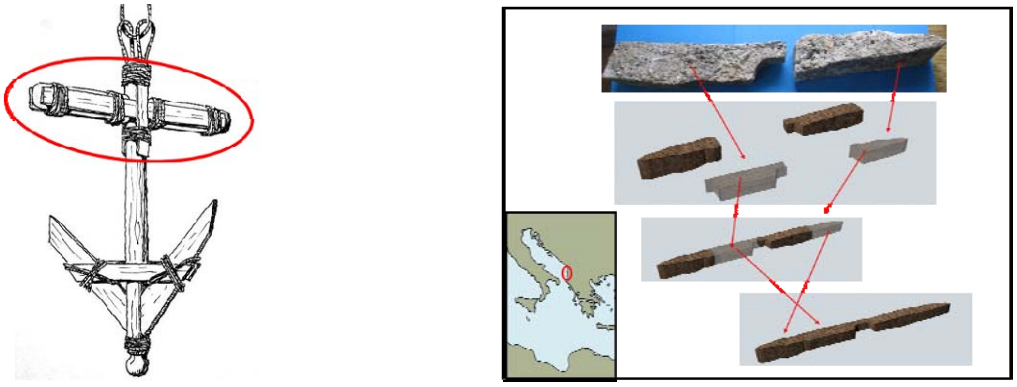


Fig. 4- Geological map of region, part of the Pre-Adriatic depression (N_1^3-Messinian molasses, N_2^h-Astian clayof Plicene molasses)

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III- RESULTS AND DISCUSSION

Based on e typological assessment we can affirm that both the stone elements corresponds the half of the stock, in our case a stone one of a wooden anchor. This type of anchors is used from VI to the half of the IV century b.C (Haldane 1984), although in terms of an accurate chronology there is disagreement between different researchers. In general, these stone stocks were of marble, but there are cases in different parts of the Mediterranean coast, that the local sailors also used the area stones (Haldane 1984, Purpura 2003, Kapitan 1984, Anastasi 2011). A common characteristic of stone stocks was that during the use they were broken in the middle, exactly where they join with the shank of the anchor (Kapitan 1984, Purpura 2003, Anastasi 2011). These fractures were more frequent when were used at rocky bottom, so in subsequent centuries the stone stocks were replaced with another typology that were the lead stocks (Haldane 1984, Kapitan 1984). Even in our case it seems very clear that the half of the stone stock is broken into two parts, as well as its own stone stock is broken exactly at the very weak peaks that corresponds with the half circle where it joined to the shank of the anchor. This has been the cause of the loss of the anchor by the boat. The finding of these elements of anchor in a sea-rocky bottom justify the reason of its loss (Anastasi 2011, 2012).



a) b)

Fig. 5 a,b-Reconstruction of the wooden anchor and the stone stock in 3D.

Thin section observation:

Currila 1. Microscopic examination reveals that this sample exhibits a moderate sorting and not oriented texture of a sub-mature maturity. It is comprised of sub-angular to rounded fine sand grains of quartz feldspars, micro-fauna, lithic fragments (included quartzite, cherts, pyroxene) and sericite, zircon, micas. The feldspar are strongly sericitized. The cement is consisted of carbonatic material (Fig.6a,b).

Currila 2. It seems to be mineralogically similar with sample Currila 1, but differs from it due to the grain size, which ranges from fine to coarse (Fig. 7a,b).

Kavaja Rock: This sample exhibits a well sorting and not oriented texture (Fig.8a,b). It is comprised of angular grains quartz, feldspars, mica, zircon, micro-fauna and carbonatic cement. It is a sub-mature texture of maturity with moderate sorting, very fine and sub angular grains.

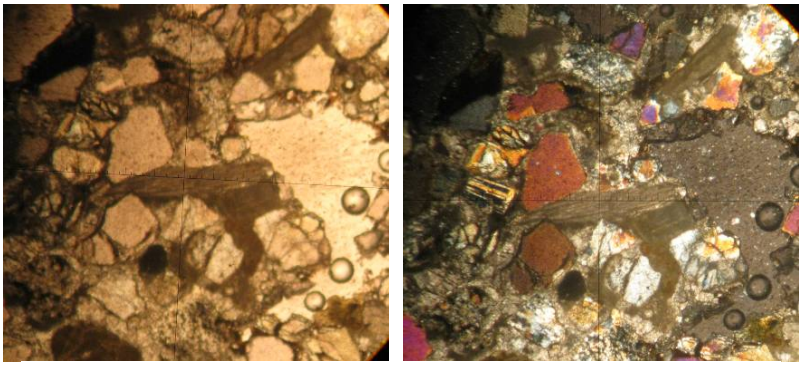


Fig. 6 a,b- Mikrophotos of the sample Currila 1. a)PPL, x100 b) XPL, x100

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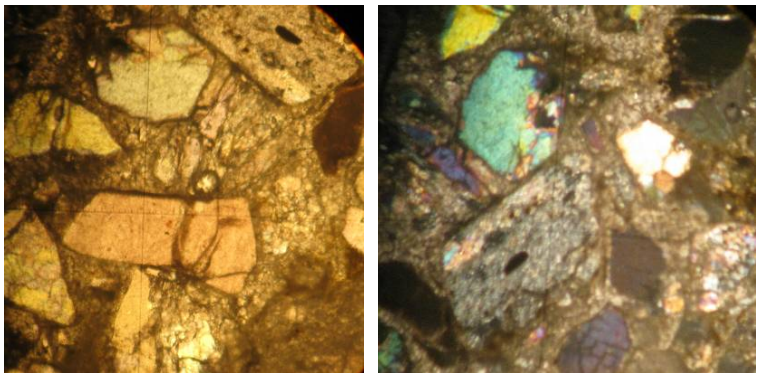


Fig. 7 a,b- Mikrophotos of the sample Currila 2. a)PPL, x100 b) XPL, x100

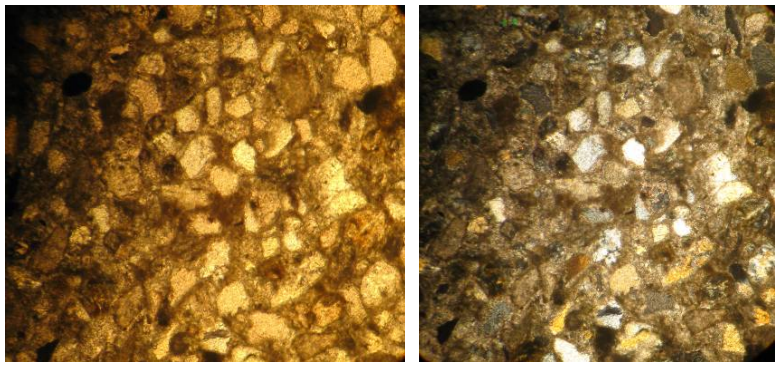


Fig. 7 a,b- Mikrophotos of the sample Kavaja rock. a)PPL, x100 b) XPL, x100

Fragments of anchore:
Both fragments exhibit a well sorting, not oriented texture and sub-angular feldspars grains. According to the USDA scale (Pettijohn *et al*., 1987), the grain size consists of fine sand. The mineralogical content is more than 25% feldspar, thus it can be defined as an arkose.
Comparing the mineralogical composition of two fragments, we can say that both of them are parts of the same anchore. Based in the texture and mineralogical composition, result that anchore's material is more close to the sample Kavaja rock (Fig. 8,9).
The chemical analysis and X-ray diffraction analysis will complete the characterization of the stony parts of the anchor and will further clarify its provenience.

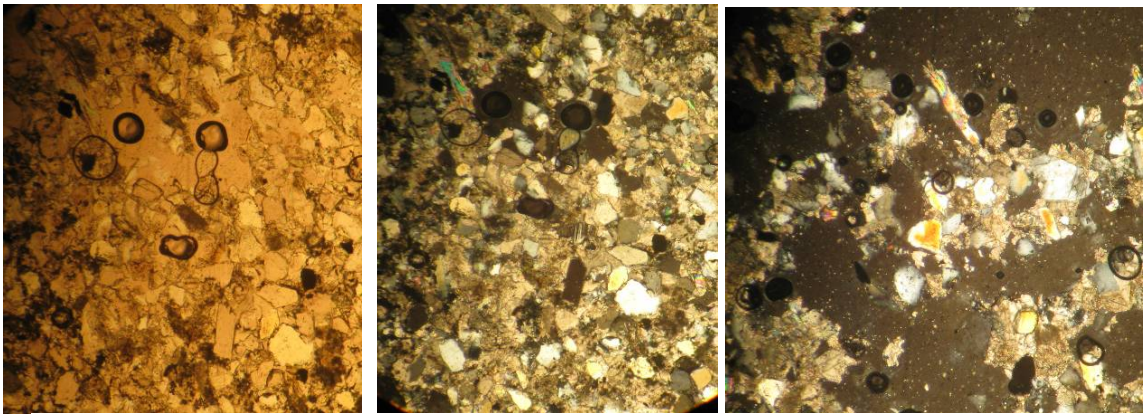


Fig. 8 a,b,c.- Mikrophotos of the Fragment 1 from anchore. a)PPL,x100 b) XPL, x100 c) Black area represents voids created by the erosion effects of the seawater, XPL , x100.

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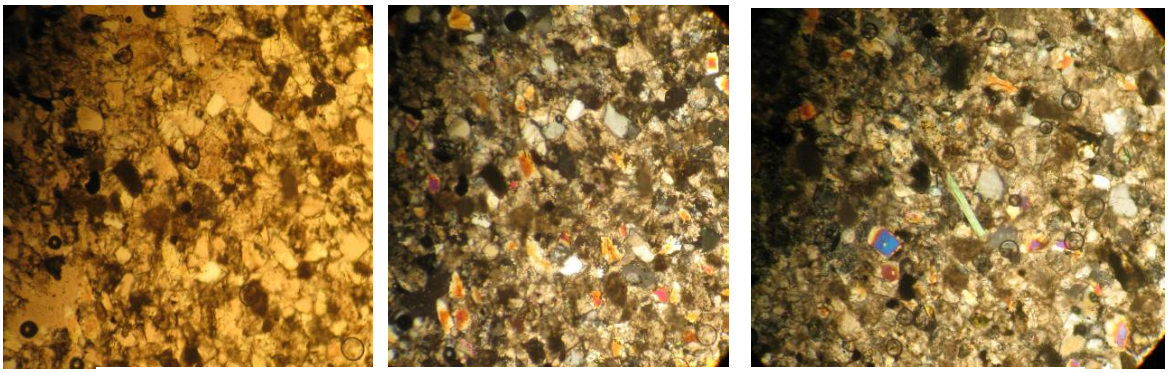


Fig. 9 a,b,c.- Mikrophotos of the frament 2 from anchore. a)PPL, x100 b) XPL, x100 c)XPL, x100.

CONCLUSION

Based on microscopic and stylistic study we can say that:

- Both stony fragments may be parts of the same anchor.
- Based on the textural and mineralogical similarity with Kavaja sandstone sample, the anchor is considered to be a local production.

Further analysis such as chemical tests and X-ray diffraction needs to be done in order to give a more complete characterisation of the stony fragments of the anchor.

LITERATURE

Anastasi A. 2001. "*Lembos.Elementi per una ricerca*". "*Il Secondo Convegno d'Archeologia Subacquea*". Castiglioncello, Rosignano Marittimo (Toscana), 7-9 September 2001, Italy. Edipuglia, Bari 2003, p 253-258.

Anastasi- A. 2002. "*Nautical Archaeology. New Prospects Research in Albania*", VIIIth International Symposium on Ship Construction in Antiquity.Hydra, 26-31 August 2002. Greace.

Anastasi A., Mustaka M 2003. "*ALBANIA. Preliminary Survey in the Bay of Durres, Adriatic Sea*", 8th International Symposium *THRACIA PONTICA* Sozopol, Bulgaria 13-19 September 2003.

Anastasi A. 2004, Albania. "*Epidamnos-Dyrracchion, a preliminary underwater survey to Batlla*". 9-10 Dicembre 2004, Genova, Italy, Convegno Internazionale "*AEQUORA, PONTOS, JAM, MARE…*", *Un viaggio nel Mediterraneo Antico partendo da Genova: percorsi economici e culturali di uomini e merci*". All'Insegna del Giglio S:A:S:, Firenze, Italia 2005, p 285-290.

Anastasi A. 2011. " *Rezultatet e kerkimeve per Harten Arkeologjike Nenujore te Bregdetit Shqiptar 2011"*, Simpozium i Institutit te Arkeologjise ne Akademine e Shkencave, Tirane, Dhjetor 2011.

Anastasi A. 2012. " *Tipologjia, Rindertimi dhe Interpretimi i spirancave te drurit te zbuluara ne bregdetin shqiptar"*, Revista ILIRIA, preparing in press.

Druc, I.C. (Ed.), 2001. *Achaeology and Clays.* British Archaeological Report International Series, Vol. 942, pp. iii– vi. Oxford.

Dafydd Griffiths, 1999. Institute of Archaeology, University College London, UK, Interdisiplinary science reviews, Vol. 24, No. 4.

E. Pecchioni, E. Cantisani, P. Pallecchi, F. Fratini, A. Buccianti, E. Pandeli, S. Rescic and S. Conticelli, 2007. *Characterization of the amphorae, stone ballast and stowage materials of the ships from the archarchaological site of Pisa-San Rossore, Italy: inferences on their provenance and possible trade route.* Archaeometry 49, 1 (2007) 1–22.

Beqiraj A. Hyseni A. Leka Gj, 2006. *Geology-structural aspects of "Rrogozhina" aquifer. International Scientific Sympozium on Geological Resources, Potencialet gjeominerare – Strategjia dhe zhvillimi i tyre*. p.52, Mitrovica, Kosova.

Benoit, F. 1955. "*Jas d'ancre et pieces d'outillage des èpaves de Provence"*. In Rivista di studi Liguri Nr. 21; p. 117-128.

Haldane, D.1984. "The wooden anchor" p. 3-4 e 39- 42, Texas A & M University.

Haldane, D. 1990. Anchors of antiquity in "Biblical archaeologiest 53, 1 (1990) p. 19-24.

ISSN 2306-9600

Hyseni A., 1995. *Struktura tektonike dhe evolucioni gjeodinamik i molassës Pliocenike të Ultësirës Pranë Adriatike (UPA).* PhD thesis.

G.M. Crisci, M.F. La Russa, M. Macchione, M. Malagodi, A.M. Palermo, S.A. Ruffolo, 2010. *Study of archaeological underwater finds: deterioration and conservation,* Applied Physics A , p. 855–863.

Kapitan G., 1982 b, "*On stone - stocked Greek anchors as found in Thrachia Pontica. Suggested reconstruction of their wooden parts"*. In Thracia Pontica I Premier Symposium International, Sozopol 1979. Sofia; p. 290-300.

Kapitan G. 1984. "*Acient Anchors- Tecnology and Classification*" in *The international Journal of Nautical Archaeology and Underwater Exploration,* 1984, Nr. 13,1; p. 33-44.

Purpura G. 2003. "*Le ancore"*, in Archaeogate, web pubblication.

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OPTICAL MICROSCOPY ANALYSIS OF MORTARS OF SKENDULAJ HOUSE, 18TH CENTURY, GJIROKASTRA, ALBANIA

Enkeleida GOGA BEQIRAJ[1], Lejla HADZIC[2]

[1]*Geology and Mining Faculty, Ruga e Elbasanit, Tirane, ea_beqiraj@yahoo.com*
[2]*CHwB Regional Office, Rruga "Ismail Qemali", Tirane, lejla.hadzic@chwb.org*

ABSTRACT

CHwB (Cultural Heritage without Borders) is working in Albania since 2009, where the activities in Albania focus on capacity building in education and training in a cooperation with national and local authorities, universities and owners of monuments as a way of stimulating socio-economic development and understanding of the value of cultural heritage. An important segment of these educational efforts is an assistance provided to residents of Gjirokastra.
One of those small interventions during the 9th regional restoration camp that took place from 1st to 15th of September was the plaster repair on a façade of Skenduli monument of 1st category. Skenduli monument is one of the best-preserved residential houses that date from the end of 18th century.
The composition of the plaster differs from the plaster applied on stone masonry to the plaster applied on the wooden catma.
Scientific analyses of historic mortars, plasters, and renders are widely used in studies concerning investigation and restoration of historic monuments. The results of such analyses are not only useful in the academic research, but they are essential in the right choice of compatible restoration materials, recipes, and techniques.
From geological point of view, mortars can be considered as complex systems or artificial rocks, consisting of natural and/or artificial minerals. Therefore, mineralogical and geochemical methods of study are very useful and successful in their characterization.
In this paper the attention will be focused on optical microscopy and granulometric results. Based on optical observations, the mortar consists of three layers, which from the outer side to inners one, are: layer1, layer 2 and layer 3. Generally, there is a cold contact between layers. The binder can be a natural hydraulic lime NHL1-2. The aggregate is composed from coarse sand, with weak to medium sorting, angular to slightly rounded. Chert and carbonates are the main mineral phases. The additive material consists of marl, wood coal pieces, straw and goat wool. The binder/aggregate ratio is from 2.5:1.

I-INTRODUCTION

The activities CHwB (Cultural Heritage without Borders) date in Albania since 2009, focused in the education and training of the students involved in the restoration of museal buildings for the preservation of the regional cultural heritage. As a part of educational efforts the CHwB is making in Gjirokstra small repair interventions conducted as a part of an overall training for young professionals provided through Regional Restoration Camps.
Gjirokastër, is a city in southern Albania. Its old town is inscribed on the World Heritage List as "a rare example of a well-preserved Ottoman town, built by farmers of large estate (Fig. 1).

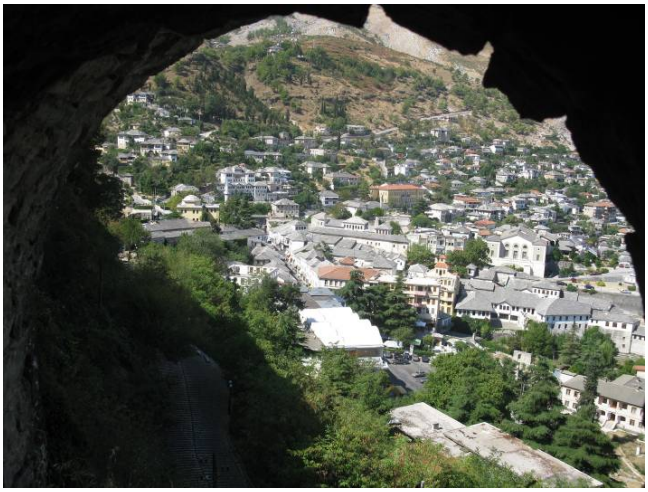


Fig.1. Photo of the historical city of Gjirokastra

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One of those small repair interventions during the 9th regional restoration camp that was held from 1st to 15th of September 2012, was a plaster repair of Skenduli Monument.
The compositional variations in historic mortars is surprisingly large, with great differences both geographically and different time periods. Mortars with different binder types have been used since ancient times for different applications; masonry mortars between bricks or stones, mortars as well finishing materials internally (plaster) or externally (render), mortars as foundations for flooring, decoration mortars, ect. (Elsen J., 2004). The study of old mortars combines historical, conservation and materials science research which enables the identification of the materials and available technologies during the several construction stages, the diagnosis of the state of conservation and in some cases the knowledge of the commercial routes in the society that built the monument. Underlined to any conservation intervention is the fact that all materials used must be compatible to the original ones and reversible (Adriano P. et. al., 2007).
However, as with many monuments of 1st category in Gjirokastra, the analytical study of cadastral units from XVIII and XIX century haven't yet been conducted, therefore we must rely to what is found on the building themselves, and yet to interpret the layers of different interventions. The aim of this paper is to present a scientific study of ancient mortar from Skenduli Monument.

II-SAMPLING AND METHODS

The sampling of the mortars is a crucial step that can influence the success of the characterization methodology, as has been pointed out by several studies. The size of each sample has to be carefully chosen to guarantee all the analyses and to allow confirmation or a "reserve" for future studies. The sampling is normally carried out using a hammer and a small chisel and the location is documented before and after removal of the sample (Estêvão Candeias A. 2004).
The mortar sample was taken from the Skendulaj Monument facade, just in the right side. The following criteria are respected during the sampling procedure:

- The less possible destructive procedure to be applied,
- The most representative sample to be taken,
- The size of each sample has to be carefully chosen to guarantee all the analyses and to allow confirmation or a "reserve" for future studies .

The mortars were thoroughly observed in laboratory using an Nicon stereo-zoom microscope and disaggregated with care so as to avoid breaking the existing aggregates. Thin sections and of the mortars were prepared by vacuum impregnation with an epoxy resin and were observed with a Leitz microscope .
The granulometric analysis was done after the sample was washed, dried, crushed and sieved under electric vibration for 15 min.

III- ARCHITECTURAL DESCRIPTION

The exact year of when the Skenduli monument was built is difficult to claim for certainty. According to one of the inscriptions found on this monument it dates back to 1765, while additional inscription claims the date of 1823. The Skenduli monument (Fig. 2) is a three floor dwelling with a robust stone walls in the construction of ground floor and first floor, while the second floor was constructed of elegant wooden structure, quite typical for Gjirokastra's examples of elaborate residential architecture, such as Zekate Monument or Babameto Monument.
- Found condition
The plaster in the lower zones was loosely connected to the wall construction, it was bulged and in some sections it has completely fell off the wall surface. The plaster in the lower zones was most probably changed in some of the later interventions, where the second layer of lime plaster wasn't enough reinforced with fibres, which caused its collapse not having enough of a grip with the first rough layer of plaster that was made of clay and straw. However, the layers that were still kept in situ were detached from the wall construction. This was due to penetration of the water through the exposed parts after the second layer of a plaster in some of the parts of the façade has fallen off, allowing for water to penetrate into all the neighbouring surfaces.The series of layers of lime wash that were the result of a regular maintenance were as well peeling off.
In the upper zones, on the wooden construction the plaster was in a critical condition. The layers of cement plaster added in later interventions have had a different aging dynamic, which caused the serious cracks in the contact with authentic plaster. The penetration of water and the effect of frost have caused the bulging and a complete detachment of the authentic plaster from the wooden construction threatening the loss of authentic painted layers.

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Fig. 2- Photo of Skendulaj Monument a) North-east facade b) South-east facade (by Frederica Pompejano, architect)

IV-GEOLOGICAL DESCRIPTION

The geology of the region consists of Eocene (Pg_2) limestone, Lower Oligocene (Pg_3^1) marble and flysch, Quaternary (Qp-h) sediments (Fig.3).

Eocene limestone (Pg_2)

They limestones constitute the eastern flank of the Mali i Gjere anticline. The limestone shows a perfect layering and varies from organic to biomicritic and terrigenous types.The limestone contains also brown chert inclusions with different forms. The thickness of the limestone arrives up to 120m. The limestone layers dip eastward with angle 16 - 22º.

Lower Oligocene marble and flysch (Pg_3^1)

They start with transitional marble pack and continue upward along the section with flysch formations. The transitional marble pack lies conformably on the layered limestone formations. The transition from limestone to marble is gradual, beginning with clayey limestone and continuing marble limestone up to the marble. In lower part the marble pack is represented by silty marble while in the upper part by the clayey siltstone.

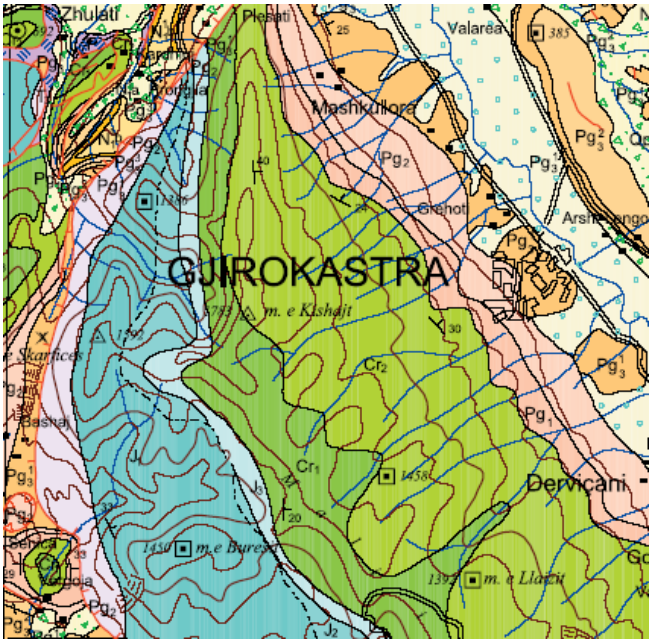


Fig.3.The geological map of the region (Pg1, Pg2, Pg3- flysch, Cr_1, Cr_2-limestones, J_1,J_3-limestones)

The flysch lies normally on the transitional marble pack and consists of three petrographic components: sand, silt, clay. The above components alternate between them forming so called cyclic flysch units of clay-silt-sand pack composition. This pack has thickness of 150 m.

Quaternary sediments (Qp-h)

They spread out over the plain zone of the town Gjirokastra, from quarter 18 Shtatori to Gerhot and industrial zone. They lie on the flysch formations and have a thickness up to 20 m. Delluviums are represented by brown clay and sandy clay containing gravel grains of limestone and more rarely sandstone composition.

V- RESULTS AND DISCUSSION

The mortar sample was 1.5cm thick and consists on three layers which from the outer side to inners one, are: render, plaster and filler (Fig. 4). The surface of the mortar was not homogenous on all the walls of house as shown by varying color. Generally it was smoky white, but there were parts in yellowish color (Fig. 5,a, b, c). The smoky color possibly is due to the dust.



Fig.4.View of mortars



Fig. 5. View of mortar's surface a), b) coarse and white c) more fine and smoky white.

The layer (1) is a lime crust of 1-2mm thick, formed by painting.
The layer (2) is a layer of 0.3-0.4 cm thick, white, pure lime without aggregate content. This layer has possibly played a double function, as decorative and for thermo-isolation. Based on its mechanical resistance during the crushing, this layer ranges from low to moderate hardness that shows for a NHL1-2 possible binder. Its hardness according to Mohs scale ranges from 2 to 3.
The layer (3) is about 1cm thick, beige, fine grained, moderately sorted and not well homogenized. In the fig. 6, there are shown the inclusions selected from sieving process.

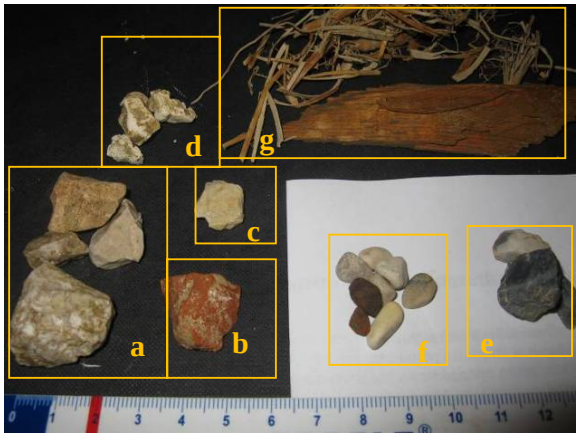


Fig.6- View of inclusions selected in the fraction >4mm. a) dolomite grains b)ceramic c) marl grains,d)lime fragments, e)cherts, f) mixture of carbonate grains g)bioinclusions:wood pieces, straw.

Based on its mechanical resistance during the crushing, this layer ranges from low to moderate hardness that shows for a NHL1-2 possible binder. Its hardness according to Mohs scale ranges from 2 to 3.

- *Optical observation:*

Thin section observation show that the contact between *layer 1* and *layer 2* is cold, while the contact between *layer 2* and *layer 3* there is a weak reaction, associated with fine chains of Ca-silicate re-crystallization materials (Fig.7). The matrix reveals a breccias texture, homogeneous brown color containing round nodules as a result of accumulations of lime binder (Fig.8). The presence of lime nodules is due to the un-slake lime, or weakly burned lime, or to a very short or incorrect slaking. The presence of lime lumps indicate also an incomplete calcinations, poor mixing or the practice of "hot lime mixing" converting all CaO into Ca(OH)2 (Schouenborg, 1993 ; Elsen, 2004). Natural cement can be considered as highly hydraulic natural lime, these cements are prepared by calcining naturally occurring rocks, containing a mixture of argillaceous or siliceous and calcareous components. The use of natural cement can be identified by the observation of anhydrate cement grains (belite=dicalcium silicate) shown in figure 9 of our sample also. The cloudy appearance of lime show for its hydraulic character (Elsen J., 2005).

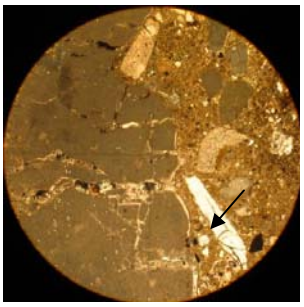


Fig.7. Weak reaction between plaster and filler (PPL, x5).

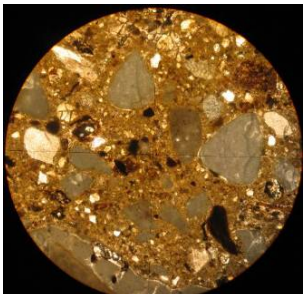


Fig.8. The breccias texture, homogeneous brown colour with lime nodules (PPL, x5).

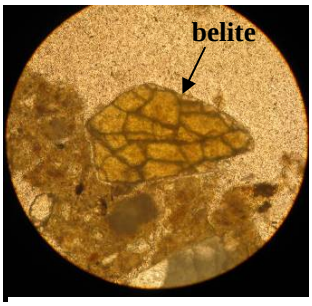


Fig.9. View of belite grain (dicalcium silicate) (PPL, x10).

Aggregate is represented by cherts (Fig. 10) and carbonatic rocks fragments. Additives are represented by mergele, ceramic fragments (Fig.12) to upgrade the natyral pozolanic and hydraulic features of binder; bioinclusions (straw, woods and goat fur) to upgrade the elasticity and clay material for both as natural hydraulic cement and better elasticity feature of mortar.

The mortar's aggregate mineralogical composition is compatible with the geological environment of this historic buildings (fig. 3).

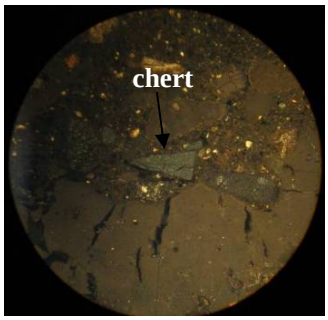


Fig.10. View of chert grain (PPL, x5).

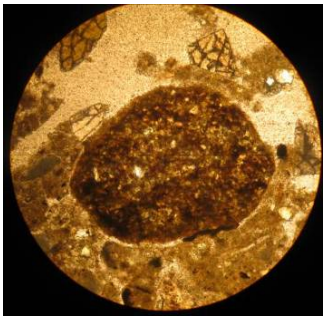


Fig.11. View of ceramic fragment (PPL, x5).

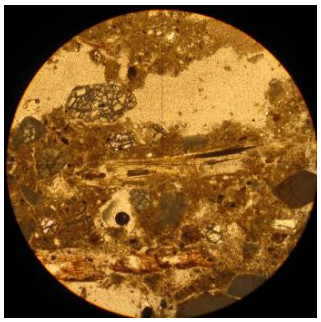


Fig.12. Weak reaction between plaster and filler (PPL, x5).

Mortar consists of a porous binder. The planar voids are coarse, irregular in shape and distribution (Fig.12), formed by the entrapment of the air during the mixing process. The capillary pores are found especially in the *layer 2*, are formed during the drying and hydration process and is influenced in a second phase by the carbonation processes.

The data of the granulometric analyses are shown in the Tab. 1

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Ø (μ)	<45	>45	>63	>90	>125	>180	>250	>355	>500	>710	>1000	>2000	>4000
Weight (g)	137,7	44,4	31,8	35	29	27,2	50	70	62,3	41,6	56,1	43,7	51,4
Cumulativ Weight (g)	137,7	182,1	213,9	248,9	277,9	305,1	355,1	425,1	487,4	529	585,1	628,8	680,2
Cumulativ Weight (%)	20,25	26,77	31,45	36,59	40,85	44,85	52,21	62,5	71,66	77,77	86,02	92,44	100

Tab.1. The granulometric data of the mortar

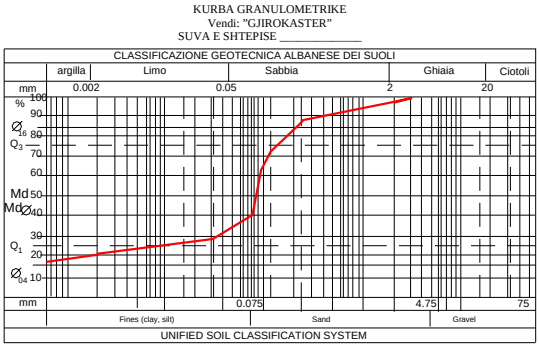


Fig.13. The granulometric curve of the mortar

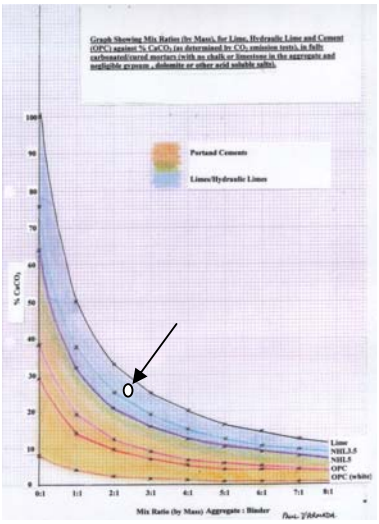


Fig.14. The graph showing the mix for ratio hydraulic lime against % $CaCO_3$

The granulometric curve of the mortar shows that the ratio aggregate/binder is aproximately 2.7:1. Correcting this value according to the dehydrated phase that was observed in thin section this ratio can be reduced up to 2.5:1. According to the grafic in the fig. 14 which classify the a variation between binder and the percent $CaCO_3$, this ratio belongs to the value of 25%-35% $CaCO_3$.

CONCLUSIONS

This study provided interesting information and allowed a further insight on the mortars materials and preparation techniques.
Based on physical properties, optical observation, and granulometric analyses results that:
The mortar sample from Skenduli Monument house, was 1.5cm thick and consists on three layers.
The presence of round lime lumps indicates that the lime was not well slaked.
The binder can be a natural hydraulic lime NHL 1-2. Agregate is represented by cherts and carbonatic fragments. Mortar consists of a porous binder. Additives are represented by mergele, ceramic fragments, bioinclusions (straw, woods and goat fur) and clay material upgrade the pozolanic, natural hydraulic elasticity feature of mortar. The ratio Aggregate/Binder reveals 2.5:1, and the content of CaCO3 is 25% up to 35%.

LITERATURE

Patrícia Adriano, Teresa Cruz, Antonio Santos Silva, Rosario Veiga, Antonio Candeias & José Mirao, 2007. *Mineralogical Comparison Study of Old Mortars from Southern Portugal Cathedrals (Evora e Elvas), MATERIAIS.*

Veiga M.R., Aguiar J., Silva A.S., Carvalho F., 2001. *Methodologies for characterisation and repair of mortars of ancient buildings* in Proceedings of the 3rd International Seminar Historical Constructions, Guimarães, 353-362.

M. Dupas 1982. *L'analyse des mortiers et enduits des the conversation of the build heritage.*ICCROM, Rome, 281-295.

Estêvão Candeias A., Nogueira P., Mirão J., Santos M., Silva A., Veiga R., Casal Gil, Ribeiro I., Seruya A.I., 2011. *Workshop on Chemistry in the conservation of Cultural Heritage: present and future perspective*

ISSN 2306-9600

Elsen J., 2005. *Microscopy of historical mortars – a review.*Cement and Concrete research, 36, p.1416-1424.

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MINERALOGICAL DIVERSITY IN OREBODIES WITHIN XTH HORIZON AT STAN TERG MINE, KOSOVO

Joana KOŁODZIEJCZYK[1],*, Jaroslav PRŠEK[1], HalilQELA[2]
[1]*AGH-University of Science and Technology, Department of Economic Geology, Kraków, Poland*
[2]*Trepça under AKP Administration, Kosovo*
e-mail:asia.office@wp.pl

INTRODUCTION

Stan Terg mine, located in northern Kosovo, is carrying out an underground extraction of lead and zinc ore and it is a leading producer of this metallic elements in Balkan Peninsula.
The 10th horizon in Stan Terg mine has been the leading extraction level for a few years. The extraction is carried out in different orebodies; each of them shows different ore mineral composition and element distribution. The main minerals of present economic interests are sphalerite and galena. The output of ore comes into Tunnel i Parë flotation station and is processing into zinc and lead concentrates.
The aim of this study is to characterize the changes of ore composition within Xth horizon and the relation between the values of the additional elements, such as Cu, Sb, Ag, Bi, and the position of the orebodies.

DEPOSIT GEOLOGY

The mineralization in the deposit was formed by two processes. Minute part of ore is metasomatic (skarn mineral paragenesis), and the main part of ore is an effect of precipitation from hydrothermal fluids, in wide range of temperatures. The main ore minerals are pyrite, pyrrhotite, sphalerite and galena. Gangue minerals are represented mainly by carbonate, less by quartz and silicates.
Orebodies are related to the structure and lithology of the regional geology of the deposit area. They lie at the contact between marbles and schists or dacite volcanites. They have mostly columnar-like and elongated lenticular morphologies, parallel to the hinge of the anticline, which is the main tectonic structure in the deposit.
There are distinguished eleven main orebodies; some of them reach surface, others are often splited or joined together. An effect of this is a huge "stockwork" form. The central orebody continues for more than 1500 m. Other smaller orebodies occur at various distances from the volcanic breccias pipe, at both north and south part of the deposit. Mineralization is not homogenous in vertical and horizontal plane. It also changes in size and thickness. The central ore body has average thickness of 78.5 m (Forgan 1950, Schumacher 1950, Smejkal 1960, Hyseni et al. 2010, Durmishaj et al. 2011).

METHODOLOGY

The samples have been picked up in August 2011 and March 2012 from 140, 148, 148a, 148-43, 149e and 149-C2 orebodies (Fig. 1) at the northern part of the mine. Macroscopic observations, microscopic investigation in reflected light and EDX-analysis were performed.

RESULTS

140 orebody

The samples from this orebody are fine-grained. The main ore minerals are arsenopyrite and pyrrhotite. Samples are often cut with younger carbonate veinlets. Dark gangue minerals are visible.
In the microscope pyrrhotite is coarse-grained and forms veinlets. It is often replaced by marcasite and pyrite. Sometimes, younger pyrrhotite is present in thin veinlets that cut

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chalcopyrite. Pyrite occurs often together with magnetite. Galena of this ore body is free of mineral inclusions or contains small aggregates of native bismuth and bismuthinite. They envelope galena. Arsenopyrite is present mainly as euhedral crystals. In the samples with garnets, the skarn ore is concentrate within these grains. Majority of the skarn ore is pyrrhotite which is replaced by magnetite. Sphalerite is rich in chalcopyrite-mackinawite inclusions.

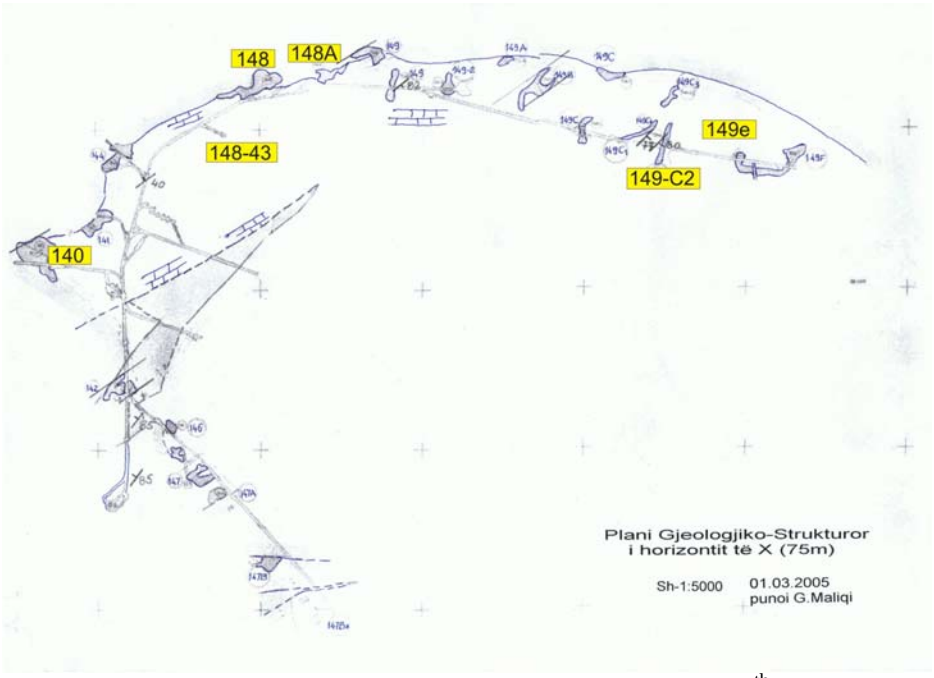


Fig.1 Localization of investigated orebodies (yellow highlighted) in Xth horizon in Stan Terg mine, materials from the mine, modified

148 orebody

It comprises skarn ore samples. Green hedenbergite, altered zone of gangue minerals and quartz are most common. Main ore minerals are fine-grained sphalerite and pyrrhotite. Thin veinlets of galena are visible.

In investigated microscopic samples the majority are pyrrhotite-magnetite assemblages. Pyrrhotite is the main ore mineral, it is coarse-grained; it occurs also as blebs within galena. Minute pyrrhotite veinlets cut sphalerite. Sphalerite contains many chalcopyrite-mackinawite inclusions. Within galena native bismuth and bismuthinite were recognized.

148A orebody

The collected samples from this orebody contain typical hydrothermal mineralization. The main ore minerals are pyrite, pyrrhotite and sphalerite. Samples are covered by carbonates, mostly siderite. The youngest mineral is boulangerite, filling all druses. Within calcite, some galena veinlets are visible. Sphalerite covered by siderite is very common. The most popular gangue mineral is rhodochrosite or similar carbonates. Different layers of carbonates from white to pink or gray have been noticed.

Under microscope pyrite, marcasite, sphalerite without inclusions, galena without any inclusions and pyrite with magnetite are most widespread. In less amounts, chalcopyrite with tetrahedrite are present. They occur near to the gangue rhodochrosite. Within carbonates, heteromorphite and boulangerite were recognized. Heteromorphite often replace older galena. Within carbonates, euhedral arsenopyrite grains occur.

148-43 orebody

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The ore from 148-43 ore body consists of hydrothermal ore, with sphalerite, pyrite and galena. Some younger pyrite veinlets cut some parts of ore. Gangue minerals are quartz and calcite. Layers of ore are often parallel to the marble lamination.
Under microscope, the main ore minerals are pyrite, galena and sphalerite. Marcasite and arsenopyrite occur as encrustations on pyrite or within it. Galena occurs like coarse-grained texture or crosscutting veinlets in the ore. Sphalerite is poor or rich in chalcopyrite--mackinawite inclusions. Chalcopyrite is present as xenomorphic grains as well. It is often accompanied by Ag-bearing tetrahedrite. Many star-like sphalerite inclusions are visible within chalcopyrite.

149-C2 orebody

Oligonite (Mn-rich siderite) ore samples have been picked up from this orebody. It contains low sphalerite and galena. Samples of massive ore at the contact with marbles were also examined. Such ore is composed by sphalerite, pyrite and arsenopyrite. Younger calcite forms veinlets or filled up vuggs.
In the microscope, sphalerite contains elongated boulangerite inclusions, or has many blebs of pyrrhotite or chalcopyrite and mackinawite. Euhedral pyrite and xenomorphic chalcopyrite are common. Galena is present in small amounts. Bournonite owergrowths pyrite and occurs together with Ag-bearing tetrahedrite, and less amounts of galena and chalcopyrite. Within tetrahedrite, fine veinlet of polybasite was noticed.

149e orebody

The samples consist mainly of massive galena ore but also contain pyrite-pyrrhotite ore as well. Galena is from fine to coarse-grained. Galena occurs in massive form as nets or forms small pieces or layers within rhodochrosite. Galena is younger than pyrite and pyrrhotite and replaces these minerals.
In the microscope, elongated boulangerite crystals are abundant within galena. Within cracks in galena, young generation of sphalerite is present. Vuggs are filled sometimes by Ag-rich tetrahedrite and heteromorphite. Tetrahedrite and chalcopyrite are replaced by silver minerals such as pyrargyrite, stephanite, pyrostilpnite. Freibergite has been noticed within tetrahedrite. Silver-bearing minerals are typical for fine-grained galena. In coarse-grained ones samples have not been noticed. Pyrite and pyrrhotite occur locally in these samples as remnants. In other parts of ore body pyrite, marcasite, arsenopyrite, and sphalerite with high content of chalcopyrite blebs predominate. Chalcopyrite occurs together with Ag-rich tetrahedrite and stannite with sphalerite or stannite fills up vuggs in chalcopyrite. Within rhodochrosite, euhedral arsenopyrite has been noticed.

SUMMARY

They orebodies 140 and 148 are composed mainly of skarn ore, with high amount of gangue minerals, such as pyroxene group minerals or garnets. The main ore mineral is pyrrhotite and magnetite, which has minor economical interest. Sphalerite and galena occur in fewer amounts. Bismuth bearing minerals are present in galena. Skarns occur in the central part of the deposit in the close relation to the volcanic breccias core.
The other orebodies are composed of hydrothermal mineral association, with the abundant ore minerals such as sphalerite and galena. 148-43 orebody contains ore minerals from the main stage (Pb-Zn) of precipitation, 148A has additionally large amount of younger lead-antimony sulphosalts, such as boulangerite and heteromorphite, whereas within 149e and 149-C2 orebodies silver minerals have been found. Identified Ag-bearing minerals belongs to the youngest precipitation stage in the deposit and they are concentrated at the external parts of

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the deposit. Following the lateral distribution at the 10th level we could see that bismuth is concentrated in the high temperature ore (skarn) whereas silver in the epithermal ore. The Pb and Zn are concentrated in the middle – mezothermal zone, which lies between skarns and epithermal ore.

REFERENCES

Durmishaj B., Hyseni S., Shala F., 2011. Trepça minerals atlas, Mitrovicë

Forgan C. B., 1950. Ore deposits at the Stan Terg lead-zinc mine International Geological Congress. Report of the eighteenth session Great Britain 1984. Part VII. Symposium and proceedings of section F. The Geology. paragenesis and reserves of the ores of lead and zinc, Yugoslavia

Hyseni S., Durmishaj B., Fetahaj B., Shala F., Berisha A., Large D., 2010. Trepça Ore Belt and Stan Terg mine – Geological overview and interpretation. Kosovo (SE Europe). Geologija, 53/1, 87-92

Schumacher F., 1950. Die Lagerst□tte der Trepca und ihre Umgebung. Izdvacko preduzece Saleta za energetyku i ekstraktivnu industriju vlade fnrj, Belgrad

Smejkal S., 1960. Strukture. mineralizacije. mineralne parageneze i geneza olovo cinkovih lezista kopaonicke oblasti. Doktorska disertacija. Rudrsko geoloski fakultet Univerziteta u Beogradu

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PETROGRAPHIC AND STRUCTURALCHARACTERISTICS OF THE EASTERN AND NORTHERN PARTS OF GJILANI REGION-KOSOVA

Festim KUTLLOVCI[1], Muceku BARDHYL[2], Islam FEJZA[1]

[1] *Faculty of Mining and Metalurgy, University of Prishtina, Kosova*
[2] *Faculty of Geology and Mining, Polytechnic University of Tirana, Albania*

ABSTRACT

The Serbian - Macedonian and Rhodope massifs are predominately composed of crystalline rocks and are regarded as a continental slope rising during Jurassic and Cretaceous time.
The evolution of the Alpine orogen is characterized by different orogenic cycles, each of them being accompanied by foldings, nappes transport and regional metamorphism. Geological explorations in Gjilani region (Vardar and Serbian-Macedonian zones) describe the essential problems concerning the geological -structural deformation, tectonics, magmatism and mineral resources.
The litostratigraphic units separated in the region are: Palaeozoic units (schists,micaschists, orthogneiss, amphibolites, marbles and quartzites); Jurassicophiolites units (harzburgites and serpentinites with granitic intrusions, gabbros, sheeted dike complex, pillow lava,supraophiolitic sedimentary melange and limestones); Cretaceous units (Albian-Cenomanian basal conglomerates and turbidites) and Neogene deposits (lacustre deposits, andesites - pyroclastic rocks and tuffs).
In this paper, we present the petrographic characteristics and geological-structural analyzes of Paleozoic crystalline rockswhich are (i) orthogenesis and paragniesis (ii)micaschistsand (iii) graniticrocks. Geological structural analyses show that the Paleozoic crystalline basement structured during the variscan and hercynianorogenesis it is not fully revealed because the post-hercynian deformations have been important and have modified the previous structures. Our structural analyses shows that at least two deformations phase are identified during Mesoizoic and Cenozoic.

KEYWORDS: *Paleozoic crystalline rocks, Gjilan region, structural analyzes and metamorphism*

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GOLD IN THE VOLCANOGENIC MASSIVE SULPHIDES OF THE OPHIOLITES OF EASTERN MIRDITA, ALBANIA

Ilir ALLIU[1] Martin LEGISI[1]

[1]Polytechnic University of Tirana, Faculty of Geology and Mines, Rruga e Elbasanit, Tirana, Albania
e-mail: alliuilir@yahoo.com
[1]Geological Survey of Albania, Rruga e Kavajes, Tirana, Albania

ABSTRACT

VMS related to the ophiolites of Eastern Mirdita represent one of the most striking metallogenic features of the terrains of Albania. More than 30 VMS ore deposits, ranging in their size from 1 million to 10 million tons ore, some 45 million tons in total, have been discovered so far in the ophiolites of Eastern Mirdita. Besides Cu and Zn, the VMS of this area contain high Au values, some ppm.
This paper aims the study of Au distribution in the VMS of Eastern Mirdita. The Au distribution in 5 VMS deposits known in the area, has been considered. The obtained data show that the Au values depend on the Cu and Zn values in the VMS. The VMS of the Eastern Mirdita represent potential resources not only for Cu and Zn , but also for their Au-bearing.

***KEY WORDS** : Gold, volcanogenic massive sulphides, ophiolites, Eastern Mirdita, Albania.*

1.INTRODUCTION

The Mirdita ophiolite in Albania represents a good example of almost complete and well-perserved ophiolite sequences exposed on land. Its northern half part, related to which the most important VMS ore deposits known so far in Albania are found, consists of a semicontinously elongated outcrop with NW-SE direction, some 80 km long, exhibiting roughly concentric zones of plutonic rocks, gabbros and ultramafic ones, and sheeted dike complex around an extrusive core consisting of extrusive rocks: basalts, andesites, rhyolites and dacites and less trondhjemites.
According to a modern reconstruction of the geological evolution of the Eastern Mediterranean, the Mirdita ophiolites are slices of oceanic lithosphere that derived from the Mesozoic Tethyan basin.
Petrological and geochemical data on the Mirdita ophiolites (Beccaluva et al.,1994; Shallo et al.,1996, 1999) have highlighted some slighty differences between their western part and eastern one and on this bases it is generally accepted the separation of their outcrop in two belts, the western and eastern ones.

2.GEOLOGY

VMS found in the area of Eastern Mirdita represent one of the main metallogenic feature of the ophiolites of Albania. The mineralized belt Qaf Mali – Munelle – Spaci – Perlati is 25 km long and 0.5 km – 2 km wide.
Geology of the area largely consists of extrusives and sheeted dykes and less of gabbros and plagiogranites. Typically, the sequence of the extrusive rocks consisting of andesite-basalts, andesites, andesite – dacites, dacites and rhyodacites, predominates. Specifically, the rhyodacites represent the main individuality of this area, because related to them and/ or close to them, the most important VMS deposits have been found. Along this, the high occurrence of sheeted dyke complex and plagiogranites is an another geological feature, typical for this area.
The area Qaf Mali – Munelle – Gurth Spaci – Perlati, is the most important one regarding the VMS in the ophiolite of Mirdita. The extrusive sequence of this area consists of 40% - 45% dacites (with 5% - 7% volcanic glass), 30% - 35% andesite and andesite – basalt agglomerates and the rest of andesite – basalt pillowlavas. The VMS occupy 10% - 15% of the area and they largely occur between the andesite and andesite-basalt agglomerates, at the hanging wall of the basalt and andesite – basalt pillowlavas and lava flows.

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The most important known VMS ore deposits such as Qaf Bari, Laku i Roshit, Munella, Gurth Spaci, Spaci, Perlati, belong to this area.

3. VMS MINERALIZATION

More than 30 deposits of cupriferous massive sulfides belonging to the Eastern Mirdita, have been discovered so far. All of them lie within or at the top of the uppermost part of the extrusive sequence up to 2000m thick. Generally, the biggest VMS deposits (> 1 million tons) are associated by several small ones (< 1 million tons), but in a number of instances, groups of smaller deposits (< 1 million tons) occur in relatively close proximity to each other. Among the known deposits, 14 of them exceed 1 million tons in size, 5 deposits exceed 5 million tons and only Munella deposit exceeds 10 million tons.
The VMS of the ophiolites of Eastern Mirdita occur within the volcanic rocks of Mirdita structural zone. The volcanics constitute a complete differentiated sequence that from the bottom to the top consists of vescicular basaltic to basaltic pillow lavas, finegrained to glassy vescicular andesite-basaltic and boninitic pillow lavas and lava flows, dacites and rhyodacite-rhyolite extrusives. Pyroclastic and andesite-dacite and boninitic glasses overlie andesite-basaltic lava sequence. Important volcanogenic sulphide mineralizations of massive and stockwork type occur in different parts of volcanic sequence. The most important lenticular to tabular volcanogenic sulphide concentrations lie in the transition between the lower unit of basaltic and basaltic-andesitic pillow lavas and the upper part of the andesite-basaltic, andesite-dacitic, boninitic and rhyodacitic volcanics of Eastern Mirdita. These VMS are associated with thick aureoles of hydrothermal metasomatites consisting of quartz-epidote, quartz-chlorite, quartz-sericite, smectite-zeolite and sulphide disseminations.
The main VMS lie in or near the transition between the two main facies: pillowlavas and piroclasts. The lithofacies of glassy composition is always present at their hanging wall. Generally, the hanging wall is more glassy (hyaloandesites, dacites), and only occasionally it changes and these changes are associated with changes in the mineralogy of the ore and consequently with qualitative and quantitative changes of the elementary ratios between Cu, S, Zn, Pb and Au. These changes belong to the entire vertical zonation of VMS.
The geochemical features of VMS of Eastern Mirdita are characterized largely by the association of the main elements that compose these mineralizations. They are mineralizations of simple elementary composition. Their typical elementary association is the one Fe – S – Cu – Zn- Au. Sometimes, this elementary association is completed by Pb, Ag, As, Sb, Ba, but these latters are not always present in them. The elementary association differs from one ore deposit to the other ones.
The association Cu – Zn + Pb -+ Au +-Ag _+ As _+ Ba is typical for the VMS related to the andesite-basalts and rhyodacites. The average values of these elements are: Cu 0.97% (0.n – 3%), Zn 0.70% (0.n – 15%), Pb 0.12%, Au 1ppm (0.n – 4ppm), Ag 15ppm (0.1 – 40ppm), As 0.15% (0.03 – 1%), and Ba 0.01 – 3% (ore deposits Munella, Qaf Bari, etc.).
The same elementary association is typical for the VMS related to the basalts and andesites, but Au values are lower, some 0.4ppm in average (Northern Qaf Bari ore deposit). Along, the transition from the host rocks affected by the secondary hydrothermal processes such as the argillization, kaolinization, sericitization, epidotization, towards the VMS orebodies, shows a gradual increase of the values of some elements: Cu and Zn range from 400 – 500ppm to 0.5-0.6% and up to 2-3% in the orebodies. Other elements such as Pb 10 – 300 - 1500ppm, Ag 1 –20ppm, Sb 700 – 1000ppm and As 300 – 4000ppm, are also present.

4. GOLD DISTRIBUTION IN THE MAIN VMS DEPOSITS OF THE AREA

Gold is always present in the VMS of the area. But its values change depending on the rock lithologies and related ore types. This represents a striking feature of the behavior of Au in the extrusives of the area, this confirmed by the available geological and analytical data on the known VMS (Alliu et al., 2001). Within the VMS, gold is present like associate element. The Au values in the VMS of the area differ in single ore deposits, but they are around the typical Au average for this mineralization type, some 1ppm. The study of

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the distribution of Au within the volcanic sequence of the ophiolites of the Eastern Mirdita area is completed based on the investigation of the behavior of Au and other main ore elements of VMS and of the relationships between them, that condition this distribution. A part of the available data on Cu, Zn, S, Au and Ag in five main deposits of the area: Perlati, Gurthi, Munella, Laku i Roshit and Qaf Mali, are considered for this purpose.

Perlati ore deposit

The VMS of this ore deposit lie between the andesite basalts – andesite pillow lavas and lava flows. The data on Au, Cu and S values belong to 120, 116 and 105 core samples, respectively, collected from the exploration boreholes performed in this ore deposit.

The frequency histograms for Au and Cu show a distribution with left skewness (Fig.1). Among the total number of the assayed samples, most of them belong to the lowest values of Au and Cu. The average Au value is 2.4 ppm and the one of Cu 2.4%. The Au values range from 0.n ppm to 3 ppm: in 25-30 samples Au varies 4 – 6 ppm and only in 4-5 samples Au is 8 – 14 ppm. The Cu values 0.n% – 2% predominate and only in 5-6 samples Cu is 10% to 14%. Based on the S values, the samples can be grouped in successive clusters with 10 or more samples and with 5% difference between them on the S value, within the whole range of S values from 0.n ppm to 50 % S.

The analysis of linear regression shows the presence of a positive linear relationship between Au and Cu in Perlati ore deposit (Fig.1). On the contrary, Au shows negative relationship with S.

The equations of regression are:

$$Au = 1.8310 + 0.3633\ Cu$$
$$Au = 3.8192 – 0.0382\ S$$

Gurthi ore deposit

This ore deposit lies within the uppermost volcanoclastic sequence consisting of andesites and dacites (rhyolites).

The data on the Au, Cu and Zn values in Gurthi ore deposit belong to 90 core samples which represent the sulphide mineralization explored in this deposit

The frequency histograms of Au, Cu and Zn show a left skewness (Fig.2). The highest number of samples belong to their lowest values. The average Au value is 3.7ppm, of Cu 2.7% and of Zn 9.8%.Their range varies from 0.n – 5ppm for 80 samples and only in 10 samples Au varies from 10-20ppm. For Cu, the values 0.5-1.5% predominate for half of the total sample number (50 samples), 2-8% for 35 samples and 10-11% for 5 samples. Some 38 sample contain 0.n-4% Zn, 20 samples contain 5-10% Zn and 20 other ones have Zn values higher then 12.5% Zn.

The analysis of linear regression between Au and Cu shows the positive linear relationship between them. The Au – Zn relation is also positive, while there is a weak negative relation between Au and S. So, the highest Au values correspond to the highest Cu and Zn values (Fig.2.). The respective equations of regression are:

$$Au = 2.5477 + 1.1340\ Cu$$
$$Au = 2.1992 + 0.4240\ Zn$$
$$Au = 5.4521 – 0.0053\ S$$

Munella ore deposit

Munella is the biggest VMS deposit found so far related to the ophiolites of Albania. It occurs in the pyroclastic sequence of andesite – dacite composition. The mineralization consists of chalcopyrite – pyrite – sphalerite and less of tenantite – tetrahedrite and traces of galenite.

The data on Au, Cu, Zn and S in Munella ore deposit belong to 51 core samples which represent the sulphide mineralization explored in this deposit.

The frequency histograms of Au, Cu, Zn and S show a left skewness, i.e. the highest number of the assayed samples belong to the lowest values of these elements. Their average values are: Au 2.3ppm, Cu 0.90%, Zn 1.10% and S 7.7%. Among the total samples, 33 of them have Au values between 0.n- 2.5ppm Au, and 15 samples have 3-5ppm Au. Cu in values 0.n-0.5%, Zn in values 0.n-1.5% and S in values 0.n-5% belong

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respectively to 42, 42 and 40 core samples. The analysis of linear regression shows a positive linear relationship between Au and Cu, Au – Zn and Au –S (Fig. 3). The equation of regression are:

Au = 1.7973+0.5866 Cu
Au = 1,9674+0.3167 Zn
Au = 2.1196+0.0271 S

Fig.1. Frequency histograms and regression analysis between the elements Cu, Au, S (Perlati ore deposit)

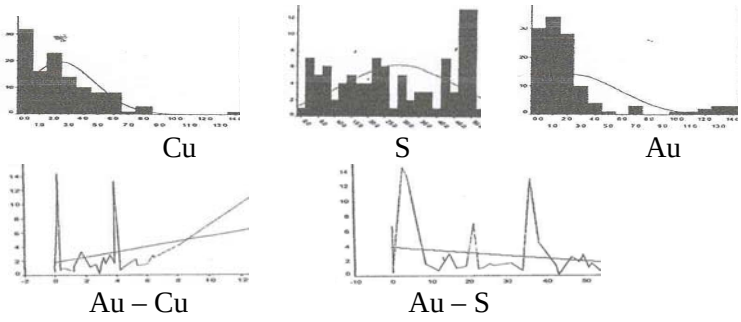


Fig.2. Frequency histograms and regression analysis between the elements Cu, Au, S (Gurthi ore deposit)

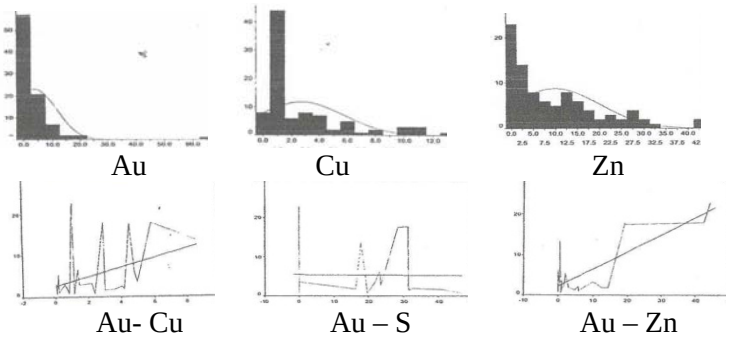


Fig.3. Frequency histograms and regression analysis between the elements Cu, Au, Zn, S (Munella ore deposit)

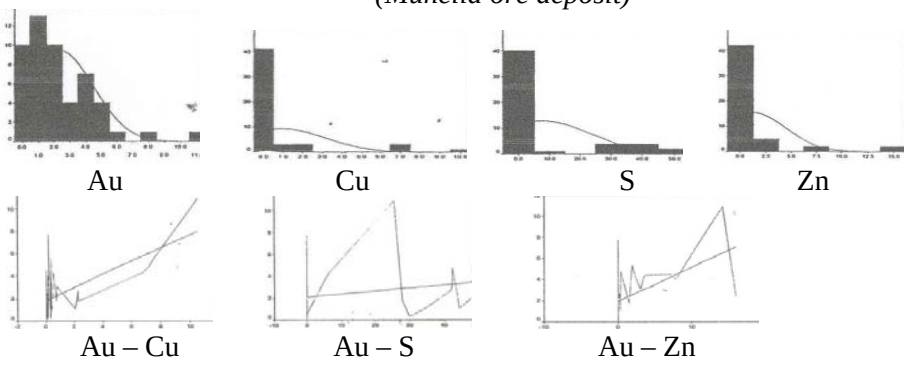
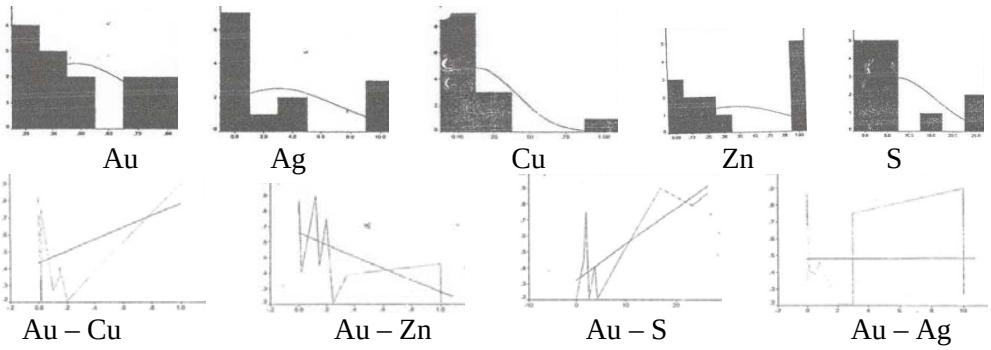


Fig.4. Frequency histograms and regression analysis between the elements Cu, Au, Zn, S (Qaf Bari ore deposit)

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Lak Roshi ore deposit

The data on the elements Au, Cu and S in the Laku i Roshit ore deposit belong to 15 samples that represent the sulphide mineralization explored in this deposit.

The frequency histograms of Au, Cu and S are different each from other. The Au histogram is with left skewness and the one of S, while Cu shows normal distribution. The average Au value is 2ppm and the ones of Cu 4.7% and S 29.6%.

The analysis of linear regression shows that Au has positive relation with Cu as well as with S (Fig…).

The equations of regression are:

$$Au = 1.4641 + 0.1172\ Cu$$
$$Au = 1.1441 + 0.0296\ S$$

Qaf Bari ore deposit

The data on Au, Cu, Zn, Ag and S in Qaf Bari ore deposit belong to 13 samples that represent the sulphur mineralization in this deposit.

The Au, Cu, Zn, Ag and S distribution histograms show that they have a distribution with left skewness. Their mean values are: Au 0.48ppm, Ag 3ppm, Cu 0.14%, Zn 0.47% and S 7.10%. Although, for all the elements, the histograms show that the considered samples belong to two groups. The biggest sample group has Au 0.25ppm-0.50ppm, Ag 0.n-4ppm, Cu 0.n-0.4%, Zn 0.n-0.4% and S 0.n-7.5%. The other group, with small sample number, has Au 0.75-0.90ppm, Ag 10ppm, Cu 1%, Zn 1% and S 25% (Fig.4).

The analysis of regression shows that Au has linear relationship with Cu and S, and negative relation with Zn. The Au-Ag relation is unconsidered (Fig.4). The equations of regression are:

$$Au = 0.4344 + 0.3469\ Cu$$
$$Au = 0.6602 – 0.3796\ Zn$$
$$Au = 0.3208 + 0.0227\ S$$
$$Au = 0.4808 + 0.0005\ Ag$$

5.CONCLUSIONS

The values of the assayed elements in the main VMS ore deposits of the area Perlati – Munella – Qaf Mali, decrease according to this order:

Au : Gurthi – Perlati – Munella – Lak Roshi – Qaf Bari;
Cu : Lak Roshi – Gurthi – Perlati – Munella – Qaf Bari;
Zn : Gurthi – Munella – Lak Roshi – Qaf Bari – Perlati;
S : Lak Roshi – Perlati – Munella – Qaf Bari.

It seems that Gurthi ore deposit represents an " inflexion point "for the known ore deposits of the area, this based on the values of the elements in consideration. The Au, Cu, Zn and S values decrease south of Gurthi ore deposit, in Perlati one, and decrease also north of Gurthi ore deposit according to the ranking Munella – Lak Roshi – Qaf Bari. Only Lak Roshi ore deposit avoids from this ranking.

The analysis of regression also shows that the affects of Cu, Zn and S values on the Au values in each ore deposit, in decreasing order are as follows:

Au – Cu : Gurthi – Munella – Perlati – Lak Roshi – Qaf Bari;

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Au – Zn : Gurthi –Munella – Qaf Bari;
Au – S : Gurthi – Perlati – Munella – Lak Roshi – Qaf Bari.

In this aspect also, Gurthi ore deposit represents an "inflexion point" between the Perlati ore deposit in south and the other ore deposits Munella, Lak Roshi and Qaf Bari, northwards.

The analysis of the Au behavior in these five copper ore deposits, selected as the representative of the known VMS belonging to different stratigraphic levels of the volcanic section of the area, shows that the Au distribution in the MSV of the area is in direct dependence from the values of Cu, Zn and S in these mineralization.

The Cu, Zn and S values reflect directly the presence of chalcopyrite, sphalerite and pyrite in the sulphide mineralization because this is the typical mineralogical association that predominates this mineralization. The presence of Cu and Zn, i.e. the mineralization type consisting substantially of chalcopyrite and sphalerite, conditions the presence of Au in high values. The lack of Cu or Zn, or their presence in low values, i. e. the lack or the low chalcopyrite and sphalerite in the sulphide mineralization, affects also the related Au values, because in this case, the contribution of Au related to chalcopyrite or Au related to sphalerite in the total Au, is lack.

The S values, that in these ore deposits have been used to characterize quantitatively mainly the presence of pyrite in the mineralogical association of their sulphide mineralization, do not affect or have a very small affect on the Au values in comparison with Cu and Zn.

The sulphide mineralization of Gurthi ore deposit represents the most important moment regarding the Au concentration among the entire metallogenic framework of the area Perlati – Munella – Qaf Mali. Based upon the fact that the MSV of the area belong to the same formation time as well as on the way of formation of the mineralization of this type, where their volcanic host rocks have an important contribution, it can be concluded that the MSV located in lithological environment similar to the one of Gurthi ore deposit should represent the most promising sectors for Au concentrations in the area Perlati – Gurthi – Munella – Qaf Mali.

REFERENCES

Alliu I., Legisi M., Aliaj P. 2001. *Quantitative – qualitative dependency of the precious metals on the acidity of the volcanic rocks of Qaf Mali – Munella –Spaci – Perlati area"*. Archives of Geological Survey of Albania (in Albanian).

Barrie C. T. et al.1999. *Classification of VMS deposits based on host rocks composition.* Reviews in Economic Geology, v.8, pp.1-9.

Beccaluva L., Coltorti M., Premti I., Saccani E., Siena F.and Zeda O.1994. *Ofioliti, Special issue on Albanian ophiolites: state of the art and perspectives.* Beccaluva Ed., 19(1), 77- 96.

Deda T., Daci A.,et al.. 2007. *Geological – economic assessment of copper and polymetalic ore in Albania. Compilation of data base for Spaci, Perlati, Palaj – Karme, Rehove, Lak Roshi, Fushe Arrez and Golaj – Nikoliq ore deposits.* Archives of Geological Survey of Albania (in Albanian).

Doda V. 1983. *Report on prospecting – exploration of Perlati ore deposit and calculation of ore reseves as at 1.01.1983.* Archives of Geological Survey of Albania (in Albanian).

Franklin J.M. 1996. *Volcanic- associated massive sulphide base metals.* In "Geology of Canadian Mineral Deposit Types", Ed.O.R.Eckstrand, Nr.8, pp.158 – 183.

Legisi M. 1996. *Report on explored ore reserves and perspective of sulphide mineralization at the areas of Perlati, Kullaxhi, Spaci, Gurthi, Letiten ore deposits.* Archives of Geological Survey of Albania.

Lleshi N., et al. 1988. *Report on prospecting – exploration of Munella ore deposit and ore reserves calculation as at 1.01.1988.* Archives of Geological Survey of Albania (in Albanian).

Poulsen K.H. et al. 1996. *Volcanic-associated massive sulphide gold.* In "Geology of Canadian Mineral Deposit Types", Ed. O.R.Ekstrand, nr.8, pp.183-196.

Shallo M. et al. 1996. *Genesis and tectonic setting of the ophiolites of Albania.* Library of the Faculty of Geology and Mines, Tirana, Albania.

Zacaj M., Shallo M., Deda T., Daci A., Cina A., Alliu I. 2001. *Gjeologjia dhe Metalogjenia e mineralizimeve sulfure te bakrit te Shqiperise.* Archives of Geological Survey of Albania (in Albanian).

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NEW MAP: MINERAL RESOURCES OF ALBANIA

Gjovalin LEKA[1], Adil NEZIRAJ[2], Afat SERJANI[3], Bislim BOSHNJAKU[4], Donald DEDA[5], Bilal KOÇI[6], Albert AVXHI[7],

[1]Geological Survey of Albania, Tirana. E-mail: lekagjovalin@yahoo.com
[2]Geological Survey of Albania, Tirana. E-mail: aneziraj@yahoo.com
[3]ProGEO-Albania, Tirana. E-mail: aserjani@yahoo.com
[4]Geological Survey of Albania, Tirana. E-mail: bboshnjaku@yahoo.com
[5]Geological Survey of Albania, Tirana. E-mail: doni_d81@yahoo.com
[6]Geological Survey of Albania, Tirana. E-mail koci.bila@yahoo.com
[7]Geological Survey of Albania, Tirana. E-mail: aavxhi@yahoo.com

ABSTRACT

The new Map of Mineral Resources of Albania in scale 1: 200,000 reflects the major deposits of metallic and non-metallic minerals, energy raw materials, and water resources. On the basis of Geological Map of Albania (2003), it was compiled the new genetic-formational map of Albania, on which were shown the mineral deposit according their genesis of formation. New genetical-formational criteria are used for compilation of this Map. Genetical affinities of group minerals and elements and some typically correlations of mineral ores and industrial minerals there are defined. The main ore fields in Albania are shown as well.
This Map represents the actual situation in the most complete form to date, marking an important point in discovering of Albanian mineral potential. Compilation for the first time of this digitalization Map of Mineral Resources of Albania is an important moment for getting very fast information about every deposit.
This map it is accompanied by explanatory text and catalog (database), which include in synthesized way the most important deposits and objects of mineral resources.
Albanian Geological Survey and Oil and Gas institutions have committed considerable geological, geophysical, geochemical and hydro-geological works, in whole territory of Albania. Numerous studies and summary-generalizations have established a solid scientific base for mineral potential resources of Albanian territory. In Albania there are found and explored about 56 types of different minerals and industrial rocks. Up to 1995, there were exploited of about 30 types of minerals, while recently their number decreased to 18 ones.
In the new map there are included 943 deposits and geological objects. Further evaluation and expansion of this great natural asset, and it is rational use by today's standards, offers great opportunities for sustainable, economic development of the country.

KEY WORDS

Mineral Resources Digitalized Map 1, genetical-formational affinities of mineral ores 2, typically correlations3, ore fields in Albania 4.

INTRODUCTION

The new Map of Mineral Resources of Albania in scale 1: 200,000 reflects the major deposits of metallic and non-metallic minerals, energy raw materials, and water resources. On the basis of Geological Map of Albania (2003), it was compiled the new genetic-formational map of Albania, where are shown the mineral deposits according their genesis of formation. It represents the actual situation in the most complete form to date, marking an important point in discovering of Albanian mineral potential.
This map is accompanied by explanatory text and catalog (database), which includes in synthesized way the most important deposits and objects of mineral resources.

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Compilation and publication of this new digitalized Map is a new achievement, and the great work of Albanian and foreign geologists, done during several decades, is included in numerous geological project, reports and studies.

Firstly, after liberation, geological survey and prospection of mineral deposits were lead by geologists from Soviet Union and ex-socialist countries. Later, since the fifteenth years of last century, Albanian Geological Survey and Oil and Gas institutions have committed considerable geological, geophysical, geochemical and hydro-geological works, in whole territory of Albania. Numerous studies and summary-generalizations have established a solid scientific base for mineral potential resources of Albanian territory.

In Albania there are found and explored about 56 types of different minerals and industrial rocks. In this Map, there are included 943 deposits and geological objects. Further evaluation and exploration of this great natural asset, and its rational use, offers a great opportunity for sustainable, economic development of Albania.

The accompanied text of this Map reflects the now days situation in geological prospecting and exploration activity, as result of licensing on the basis of the New Mining Law of Albania. This Map, amongst the scientific importance has the commercial value of mineral ores and raw materials of Albania.

As main source for compiling this digitalized Map of Mineral Resources of Albania have served the mineral maps of different regions in scale 1:50000, 1:25000, 1:10000, Metalogenic Map of Albania, geological reports of different deposits with calculated ore reserves and their graphics. Geological data of prospecting works from all ex-geological enterprises, publications in "Buletini i Shkencave Gjeologjike" (Geological Sciences Bulletin) and "Nafta dhe gazi" (Oil and Gas), were used as well.

The Criteria for Compilation of the Map

New Mineral Resources Map of Albania it is compiled on the basis of New Geological Map of Albania (Xhomo A. etj. 2002). This new Map is based on the formational-rocky criteria, compiling firstly the genetical-formational map in sc. 1: 200 000. The grouping of formations and rocks was done on the genetical features of their origin, and it is the same for all tectonic zones. In this Map there are presented some kind of rocks, which are of specific genetical, paleontological and geotectonical features. There are defined the following formational groups and rocks:

Carbonate facies divided in two main groups: platform shallow water algae carbonate and pelagic carbonate-siliceous basins of deep sea. Deposits of dolomites, bauxites, uranium-bearing phosphorites, are related to the shallow water carbonate formations while oil and gas, phosphorite and tripoli deposits are found related to the thick, deep sea limestone-chert sequences,.

Molasses formation of Pre Adriatic Depression (PAD), west of Albania, and Inner depressions, is a genetical formation of the mechanical character, related to which, coal, oil and gas, clay, gypsum and salt are, old placers and quartz sandstone, are explored.

Evaporites formation in Korabi and Ionian zones are separated in this map due to their genetical conditions of formation and the perspective for gypsum-anhydrite, salt and for the oil and gas-bearing traps. In Ionian zone, the evaporite formation of Permo-Triassic crops out like diapirs, linked with deep, regional, tectonic faults, while in Korabi zone, they occur like two large salt domes.

Metamorphic rocks of black shales and quartz-sandstone (O-S-D) are widespread in Korabi zone, in Peshkopi and Kuksi regions. In genetical aspect, this formation is typically metamorphic. The metamorphic deposits of quartzite, pyrophilite, radioactive element's deposits in Shistaveci region, while in Mirdita zone there are formed amphibolite, quartz-mica schists, metabasite, and serpentinites, belong to this formation.

Magmatic rocks are grouped on the basis of their genetical aspect and metallic ores.

Ultramafic complex is known as "Mirdita Ophiolites". In this Map there are grouped magmatic rocks of the depth and volcanic rocks. Ultramafic rocks (J_2) are located in Eastern belt (Tropojës, Kukësit, Lurës, Bulqizes, Shebenikut massif etc.). They consist of harzburgite, dunite, harcburgit-dunite, lercolite

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sequences. To the Eastern Ophiolite Belt there are genetically related chromite ore deposits (Bulqizë-Batër, Shkallë, Krastë, etc.), platinium linked with chromite, and nickel-sulphur mineralisation.
Basic rocks are represented by gabbros, gabbro-norite, gabbro-troctolites, troctolites, gabbro-diabase etc., like large massifs such as Kaptena, or small ones such as Bulshar, Kaçinar etc. In these rocks, there are concentrated titano-magnetite deposits, and quartz-sulfur veins with gold content.
In separate genetical form, are included in this Map pyroxenites, plagioclase lhercolite rocks, granite, plagiogranite, trahite rocks.
Volcanic rocks. Lower Triassic volcanic outcrops are located in western periphery of ophiolites and in small sizes in eastern periphery, while Middle Jurassic volcanic sequences are located in the central part of Mirdita zone. To the volcanic rocks of Central Mirdita (Jurassic SSZ type) belong the important copper sulphur, polymetallic, pyrite deposits, while to the volcanic rocks of western ophiolite belt (Jurassic MORB type) belong the copper sulfur deposits with zinc.
Sedimentary-volcanic formation it is located on both sides of Mirdita zone.
Volcano-sedimentary formation of T_2 in Mirdita zone and of Pz in Gashi zone it is shown in this Map as well. To this series are related the rich copper deposits of Gjegjan, Porave, Palaj, Rubik in Mirdita zone, while in Gashi zone there are explored some polymetallic occurrences.
In eastern belt, in tectonic and cumulate peridotite-dunite sequences there are explored large chromite, platinium deposits, and nickel-sulfur mineralizations. In Gabbroid there are explored titano-magnetite deposits, and quartz-sulfur veins with gold content. On their weathered crust there are formed kaolin deposits. Granite, plagiogranite, and trahite rocks located at the periphery of amphibolites there are a source for feldspathic and decorative stones.

Genetically Affinities of Group Minerals and Elements in Albania

In geological science there are known different genetically association, some of them are typically for Albania as well. The following main genetically groups of mineral resources are distinguished:
I. Ore deposit of Magmatic origin:
1. Deposits of plutogenic origin: Chromite, Platinum, Titan magnetite, Copper-Nickel, Magnesite ore deposits, and some industrial minerals and rocks such as: Olivine, Asbestos, Talk, Albitophyre, Volcanic glass, Tuffs.
2. Hydrothermal deposits: Polymetallic, Copper kolcedan, Quartz-Sulphide with content of gold.
3. Telethermal deposits: Copper, Gold, and Arsenic.
II. Deposits of sedimentary origin of formation:
1. **Deposits of chemical origin of formation**: salt, gypsum-anhydrite, dolomite.
2. Deposits of biochemical origin of formation: phosphorites, limestone, Tripoli, apoks, infiltration type of uranium-bearing Jurassic phosphorites.
3. Sedimentary mechanical deposits: clay, sandstone and quartz sandstone, bituminous sandstone deposits, river and seaside placers, fluvial sands (aggregates).
4. Weathered crust deposits: iron-nickel, nickel-silicate deposits, kaolin, bauxites.
III. Deposits of Metamorphic origin of formations: Quartzite, marble limestone, pyrophilite, graphite shale's.

Some Typical Correlations of Mineral Ores and Industrial Rocks in Albania.

Chromite ores are concentrated mainly in harzburgite-dunite sequences and less in cumulate sequences of the Eastern Ophiolite Belt.
Iron and Nickel have totally genetically relations with each other. They are concentrated in the weathering crust of the ultrabasic rocks of the Eastern Belt, beneath the carbonate formation of Upper Cretaceous and Eocene.
Nickel-Silicate ore is located in lower part of the section with nontronite mineral, while the iron ore is placed in upper part of the section, with a sharp contact.

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Typically paragenetical relation of the Nickel with Copper, and PGE elements in cumulative series.
PGE there are linked genetically with chromite ore bodies of the dunite-piroxenite transition zone in cumulate sequences.
Titan-magnetite deposits are formed in gabbroid rocks of the western Belt.
Gold is discovered as accompanying element in copper deposits of hydrothermal origin, and as metasomatic formations of high and medium temperatures. It is linked with volcanic formation and vein series of quartz-sulphides in intrusive and volcanic rocks of Mirdita Ophiolite.
Copper accompanied by Zn, Pb, Au, genetically is correlated with volcanic rocks of Central Mirdita. Genetically associations of **Fluor** in phosphorites are found.

Some Ore Fields in Albania
The main ore fields in Albania are the following ones:
Chromite field of eastern ophiolites Shebenik-Pogradec south up to Tropoja massif north and continues northeast to Kosovo.
Iron-Nickel and Nickel-Silicate ore field, of the eastern ophiolite Belt, beneath the carbonate formation from Bitincka southeast up to Kruma northwest.
Titan magnetite ore field linked with Kashnjeti gabbros massif in Western Ophiolite Belt. Copper ore field, associated with Zn, Pb, Au, in volcanic of Mirdita ophiolites.
Bauxite ore fields: a) In Valbona sub zone and b) In Kruja shallow water carbonate platform.
Phosphorite ore field, correlated almost with borders of Ionian zone in Albania and Greece.
Coal-bearing fields linked with molasses formation of Pre-Adriatic Depression and inner depressions, from Ptolemeas coal basin (Greece) southeast up to Central Kosovo north. Dolomite mineral fields in Ionian zone, in Kruja and Sazani platforms, and in Albanian Alps.
Salt and gypsum mineral fields: a) salt diapirs in Ionian zone; b) Dumrea salt field; c) Evaporite domes in Korabi zone; c) Miocene evaporite sequence in PAD. Clay fields

Mineral Resources of Albania (Reserves).

In this Map of Mineral Resources, there are shown with conventional signs all natural resources of Albania, grouped according different genetical-formational kinds, and according their classification concerning sizes. According using fields and their physic-chemical features resources are divided in four main groups: Metallic minerals (ores), non-metallic minerals and rocks, fuels, and mineral and thermal waters.
According to the inventory, attached to this Map, in total, there are included 1058 deposits and objects of different sizes, while in the Map there are included 943.
In mineral resources of magmatic origin there are included chromite, platinium, iron-titan (titano-magnetite), copper-nickel sulfur ore and industrial minerals such as olivinites, albitophire, volcanic glass, decorative stones etc.
In hydrothermal group there are included deposits of polymetallic, copper, and quartz-sulfur ores with gold content. To this group belong talc, asbestos and magnesite deposit. Teletelmal Cu, Au, As, Sb, S deposits are included here as well.
Prospected industrial and geological reserves included in this Map there are as following:
436 million ton oil, 13.76 milliard m^3 cub gas. 800 million ton coal, 158 million ton turf, 413 million ton bituminous sandstone, 57 million ton chromite ore, 70 million ton copper ore, 300 million ton iron-nickel ore, 111 million ton nickel-silicate ore, 133 million ton titan-magnetite, 2.5 million ton nickel-sulfur, 500 kg platinum. 3.7 million ton irons magnetite, 29.000 ton uranium, 3.6 million sulfur, 13 million ton bauxite, 309. 000 ton manganese, 1.1 million magnesite, 600 million ton salt, 108 million ton olivinites, 180 million ton dolomite, 54 million ton phosphorite, 23 million ton volcanic glass, 62 million ton quartz, quartzite and quartz sandstone, 3.4 million ton volcanic tuffs, 3.3 million ton Tripoli, 7 million ton Karoline, 76.000 ton fluorite, 60.000 ton barite, 168 million ton placers. There are prospected and

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accounted a lot of reserves of limestone, decorative stone, clays, travertine's, basalt, aggregates, gypsum, chalk, albitophire, dausonite, pirofylite, asbestos.

Digitalization of Data

After the filtration, all data there are organized in the database of the Map of Mineral Resources of Albania. This digital map is accompanied by data base, on which can get access in every moment. The accompanied forms of minerals are of commercial character. The compilation of the catalogue, data base forms it is done for separate group ores such as: Chromite, copper, iron-nickel, nickel-silicate, titan magnetite, polymetallic elements, bauxite, oil and gas, bitumen, coal, building materials etc.

Conclusions

- The new Map of Mineral Resources of Albania in scale 1: 200,000 reflects the major deposits of metallic and non-metallic minerals, energy raw materials, and water resources. On the basis of Geological Map of Albania (2003), it was compiled new genetic-formational map of Albania, on which were shown the mineral deposit according their genesis of formation.
- This Map represents the actual situation in the most complete form to date, marking an important point in discovering of Albanian mineral potential.
- This map it is accompanied by explanatory text and catalog (database), which include in synthesized way the most important deposits and objects of mineral resources.
- In the new map there are included 943 deposits and geological objects.
- Further evaluation and expansion of this great natural asset, and it is rational
use by today's standards, offers great opportunities for sustainable, economic development of the country.
- Prospecting geological works and capital studies on metallic ores in Albania have clarify their metallogenic perspective.
- There are defined genetical conditions of formation of mineral ores, and it is defined their prognosis.
- The perspective of metallic ores in our country, it is opened, especially in sectors next to prospected deposit on in parts between them.
- The exploration of mineral ore during Socialist Period, especially during 1960-1990, was mainly focused on the exploration of big deposits of chromium, copper, iron-nickel ore.
- During this period were exploited 25.5 million ton chromites ore, 21.8 million ton copper ore, and 56.7 million ton iron-nickel ore.
- Amongst the prospection works and research there are carried out a lot of capital studies of petrological, geochemical, mineralogical, geophysical, hydrogeological character, determining the genetical origin of formation of different minerals and their models.
- A lot of reserves of hydrocarbons, especially oil and gas and coal were explored in Ionian zone, in Pre Adriatic Depression (PAD) and in inner depressions.
- Resources of industrial minerals and rocks there are in huge quantities. The same it is for mineral and thermal waters.

REFERENCES

Geological Map of Albania in sc. 1:200 000. 1983, 2003. Tirana.
Metallogenic Map of Albania in ac. 1: 200 000. 1985, 2002. Tirana.
Biçoku T., Pumo E., Xhomo A., Papa A., Spiro A., Çili P., Dede S. (1967): *Gjeologjia e Shqipërisë.* Monografi. Shtëpia Botuese, 8 Nentori.

ISSN 2306-9600

Biçoku T., Arkaxhiu F. (1998); *Studiueshmeria e rilevimeve dhe hartografimeve gjeologjike në Shqipëri*. Arkivi Qendror i Gjeologjisë.
Çina A. (1987); *Kromitet në ofiolitet e Albanideve*. Bul.Shk.Gjeol. 4.
Dede S. (1988); *Pasuritë minerale të Shqipërisë*. Botim i ish shtypshkronjës "8 Nëntori", Tiranë. A.Q.Gj.

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IRON MINERALIZATIONS AT MUHURRI AREA AND PROBLEMS RELATED TO THEIR PROSPECTION

Vesel HOXHA[1], Alaudin KODRA[1], Ilir ALLIU[2], Pandeli PASHKO[1], Nezir MEKSHIQI[1], Ibrahim MILUSHI[1]

[1]Instituti i Gjeoshkencave, Energjisë, Ujit dhe Mjedisit, UPT, Rruga "Don Bosko", Nr. 60, Tiranë, Shqipëri..

[2]Fakulteti i Gjeologjisë dhe i Minierave, UPT, Rruga e Elbasanit, Tiranë, Shqipëri.

E-mail: veselhoxha52@yahoo.com, alaudinkodra@yahoo.it, alliuilir@yahoo.com, pandipashko@yahoo.com, nezirmekshiqi@yahoo.com, ibrahimmilushi@yahoo.com

ABSTRACT

This paper deals with the possibility on the search of the stratigraphic iron level known at Sorokoli and Kalabaku areas at Muhurri area as well, attempting the opening of the iron-bearing perspective in depth. The available results obtained by the iron occurrences of Muhurri area and the data obtained by the geological survey, scale 1:25 000, support the idea of the controlling of the expected iron ore structure more in depth than the iron showings known so far and these laters represent other iron levels, nevertheless their productivity or industrial interest.

KEY WORDS: *Iron silicates, palaeozoic, shales, cherts, graptolite, lithology.*

INTRODUCTION

The iron mineralizations are found at Muhurri area, Muhurri – Caja subzone of Korabi tectonic unit (Hoxha, 1979, 1981; Qirici, 1982; Xhomo, 1984, 1985). This subzone occurs like a belt, west of Kollovozi subzone. It represents a trench beginning from Silurian. Among the palaeozoic deposits, the black clayey and clayey – cherty shales with graptolites of Landoverianit, Wenlockian and Landlovianit are the most abundant ones (Xhomo, 1985; 1987; Qirici, 1982). The study of graptolites of last years has enabled the distinctions of several biozones (Pashko, 1987; 1988; 1989 dhe 2005). The Devonian deposits overly the Silurian ones and at Muhurri the bottom of these laters contains graptolites and belong to Lohkovian. Upwards, the limestone layers become frequent and the deposits consist of shales with limestones with tentaculites of Korabi (Pragian-Zlihovian). In this unit, the horizon of biomicritic limestones with Scyphocrinites p. belonging to Upper Silurian – Lower Devonian, occurs as well. The magmatism consists of basic volcanites with alkali affinity, with tuffs, tuffites, monzonites and minettes. The Muhurri subzone has represented a trench with scarse and quite sedimentation conditions in comparision with Kollovozi. It seems that this feature is repeated even after Permian – Lower Triass and especially during Ladinian and Upper Triass.

DATA ON THE GEOLOGY OF MUHURRI AREA

The study area consists of palaeozoic, mesozoic and pliocene – quaternary deposits (Fig. 1 dhe Fig. 2).

PALAEOZOIC DEPOSITS

These deposits are represented by three main series:

- *Series of palaeozoic shcists* $(S\text{-}D)_1$
- *Terrigenous series* $(S\text{-}D)_2$
- *Clastic – terrigenous series* $(P\text{-}T_1)$

SERIES OF PALAEOZOIC SCHISTS $(S\text{-}D)_1$.

Based on the lithologic – facial features and related bios, this series can be divided in two packages:

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a. Schists with Crinoidea, are the typical black shales that occur at the bottom of the palaeozoic deposits of this area. The bottom of the section consists of clayey – cherty – sericite graphitic black shales with graphite ***luspa*** and grains of authigene pyrite. Upwards, these shales are intercalated with clayey – sericite – cherty material of light grey color. Then they grade to clayey – silty – sandy graphitic black shales.

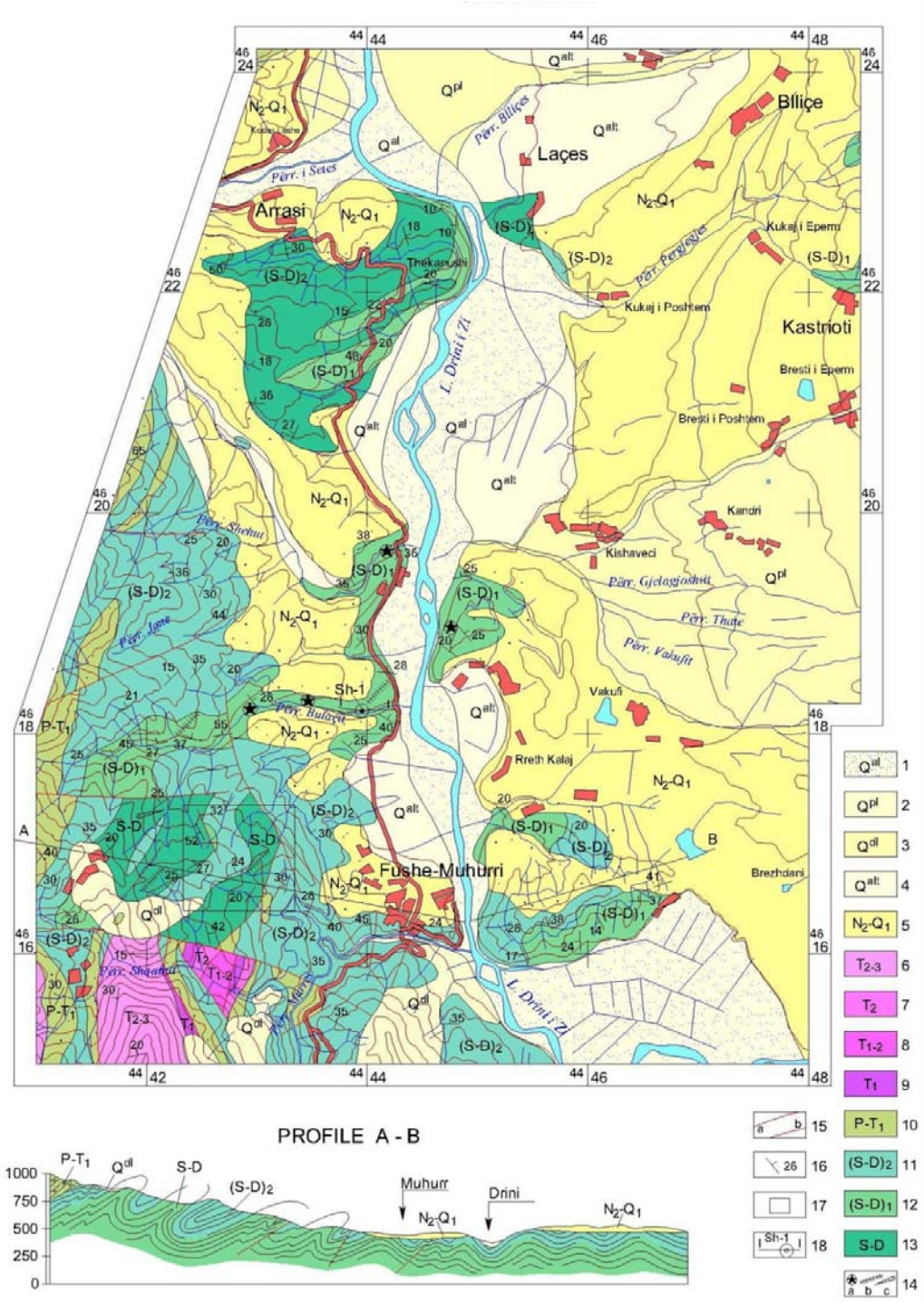


Fig. 1. Geological map of Muhurr zone. Scale; 1 : 25 000 (After Qirici V. et al. 1982)

EXPLANATIONS

1. Alluvial quaternary depositions of actual river beds (sands, gravels, etc). 2. Prolluvial quaternary depositions of actual streams beds and cone of flow. 3. Delluvial unseparated quaternary depositions. (clays, prolluvial breccias, vegetable earth). 4. Quaternary depositions of river terraces. 5. Fluvio – lacustrine depositions of Pliocene –

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Quaternary (gravels, conglomerates, sands, siltstones, clays). 6. Middle and Upper Triassic unseparated depositions (tabulated and massive limestones, radiolarites). 7. Middle Triassic depositions (red nodular limestones, dolomites, etc). 8. Lower and Middle Triassic depositions (thin tabulated limestone, sandstone limestones, rarely red nodular limestones, radiolarites, etc). 9. Lower Triassic depositions (sandstone, siltstone, clay schists, thin tabulated limestones, sandstone limestones, etc). 10. Lower Permo – Triassic depositions (arkosic and polymictic sandstones, gravelstones, red conglomerates of "Verrucano" facies. 11. Unseparated Silurian – Devonian depositions (Upper terrigenous series, etc). 12. Unseparated Silurian – Devonian depositions (Lower terrigenous of graptolite schists, etc).13. Unseparated Silurian – Devonian depositions (allochtonous subzone). Quartzites, sandstones, schists, etc. 14. Fosil-bearing site for paleozoic formations: a) Crinoidea b) Graptolite c) Corals. 15. Fault: a) confirmed b) supposed. 16. Layering elements of formations: normal strike . 17. Working area and iron ore showing in Muhurri area. 18. Prospecting line, with location of projected drill hole.

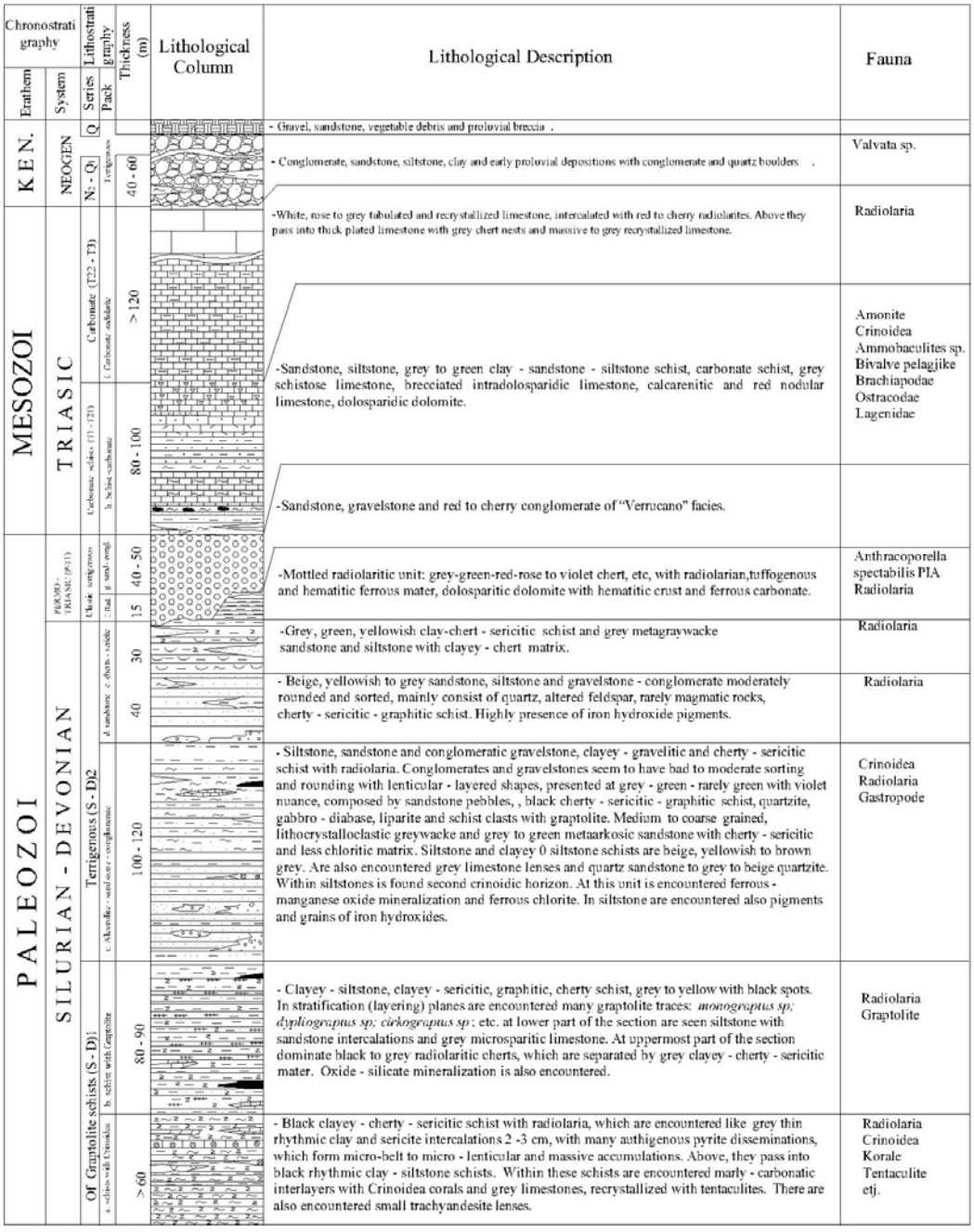


Fig. 2. Lithological and stratigraphical representing column. Scale 1: 2000 (After Xhomo A. et al. 1984, and Hoxha V. 2001)

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Within this package there are brown clayey – silty – carbonate schists and grey microsparitic limestones with frequent rests of Crinoideas. For the first time, a rich collection of tentaculites has been found in this package. This horizon is thought to be very close to the one of Crinoideas with a difference of 7 – 10 m. Radiolarians are present in all the deposits of this package. The package is 60 m thick.

b. Graptolitic shales overly normally the schists with Crinoideas

The bottom of this package consists of clayey – cherty – sericite graphitic black shales with radiolarians and thin lenses of grey limestones and grey – black silty sandstones as well as silty schists. The uppermost part consists of black cherty shales. Records of graptolites are found in their layering planes. The graptolites Pristiograptus (colonograptus) cf, romeri (bonande), Pirtiograptus et gr dubius (sues), Scatograptus ef, chimaero (Ba….), Mongraptus sp.nov.plectograptus sp., suggest the Uppermost Silurian age. Within the graptolitic shales, near their lowest part (between the silty – cherty – sericite graphitic shales and sandy – cherty – sericite shales) the iron – bearing horizon of type oxide – silicate of Muhurri, occurs. This package is 80 – 90 m thick.

TERRIGENOUS SERIES $(S\text{-}D)_2$

Based on the lithologic – facial criterion, three packages are distinguished:

a. Marly – sandy – conglomeratic package.

This package is wellspread and it overlies normally the graptolitic shales. It begins with grey marls and sandstones, argillaceous – marly – sericitic schists with beige – brown spots that contain at their upper part intercalations of grey – green sandstones that grade to coarse sandstones, gravels and conglomerates. Conglomerates are not well sorted and arounded. Their gravels are of size 10 – 35 cm and consist of grey – white quartzites, black cherts, argillaceous – sericite – cherty schists, grey limestones with radiolarias, liparites, nepheline syenites, gabbro – diabases, etc.The matrix is cherty – sericitic and less chloritic. They have green colour, while the sandstones are metagrauwacke and arkosic. Above them, marls and marly – argillaceous schists and cherts with beige –yellow-grey colour and flyschoidal structure, occur. In this series, within the argillaceous – marly schists, a second iron horizon consisting of iron – manganese oxide mineralization and of iron chlorites at its central part, occurs. The thickness of this package is 100 – 120 m.

b. Sandy package continues above the marly – sandy – conglomeratic one and at the eastern part it begins with beige – yellow gravelites and coarse sandstones with abundant iron pigments. At the western part, this package consists of yellow sandstones. There are intercalations of marly and argillaceous – cherty – sericitic schists inside them. The thickness is 40 m.

c. Cherty – sericitic – sandy package is represented by argillaceous – cherty – sericitic and cherty – sericitic schists with grey – green colour. There are also marls and grey metagrauwacke sandstones. The thickness is 30 m.

d. Multicoloured Cherty radiolarian package is typical and it always underlies the terrigenous – clastic facies "Verrucano". This package consists of radiolarian cherts of various colour, green cherts, reddish cherts.

TERRIGENOUS – CLASTIC SERIE $(P\text{-}T_1)$

This serie is known under the term "serie Verrucano". It generally overlies with unconformity several levels of the palaeozoic deposits. It consists of sandstones, gravels and conglomerates and less of argillaceous – sericite – haematitic schists with typical red colour and less reddish – green one. The gravels are mainly quartz, quartzites of different colour, schists, magmatic rocks and gabbrodiabases, liparites, quartz porphyry, granites and less of limestone clasts. The sorting is intermediate to low. Arounding is intermediate to good. The thickness varies 30 – 40 m.

MESOZOIC DEPOSITS

The mesozoic deposits overly normally the series "Verrucano" and they consist of two series:

1. Schistous – carbonatic series $(T_1\text{-}T_2^1)$, mainly represented by sandstones, marls, schists of yellow – grey color intercalated with argillaceous – carbonatic schists, laminated to schistous limestones, breccious

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limestones and at their upper part by sandy limestones and red sandstones as well as by red dolomitized limestones.

2. Carbonatic ***Series*** ***(T_2^2-T_3).*** This serie consists of white nodular limestones intercalated with red radiolarian cherts of Ladinian. This alternation grades normally to the grey – white massive limestones with scarse cherty lenses that perhaps belong to Karnian. The total thickness of the Mesozoic deposits is some 200 – 220 m.

KAINOZOIC DEPOSITS

These are deposits of N_2-Q_1 that fill the inner depression of Peshkopia and they have fluvial – lacustrine character. They consist of gravels and conglomerates weakly cemented by argillaceous–sandy and less by argillaceous–carbonatic material, sandstones and gravelites, marls and clays. The clastic material is heterogeneous and consists of quartzites, blocks of serie "Verrucano„, mesozoic limestones, etc. Their thickness varies 40–60 m. **MAGMATISM**

There are several small outcrops of magmatic rocks in the area. All of them are found within the palaeozoic deposits and belong to different lithologies. They are never found in relation to the series »Verrucano«.

Gabbrodiabases

Gabbrodiabases consist of small outcrops of size from some meters to 100 – 150 m long and 2-3 m to 70 – 80 m wide. Generally, they are elongated lenses and dikes, with NE extension (30-50^0) and western dipping (30-40^0). Gabbrodiabases are always with intersection contacts. They are rocks of green, dark green and grey–green colours. They are intermediate to coarse grained. Albitized gabbrodiabases and gabbrodiabases with titanaugite are distinguished under microscope.

Minettes

Minettes occur like elongated lenses (Fig. 8) without any single direction, of small size that varies from 2-3 ml to 50-60 ml in length and several centimeters to 2-3 ml wide. They are rocks with light brown colour and micrograined to medium grained. They are altered and with thin envelopes of iron oxides. They are generally chloritized and partly carbonatized and quartzized. In the field they can be confused with sandstones..

Porphyrites

These rocks are the extrusive representants of the palaeozoic magmatism in the area. They are similar to the chlorites with green–grey colour with frequent thin quartz veins. Their primary composition has been trachyte–basalt–andezite and later highly altered and changed to chlorite–carbonatic schists.

TECTONICS

In the tectonic regionalization of the country, the considered area is part of Korabi tectonic unit and it lies at its central – western part.
Two tectonic units has been distinguished:
a. the relative authoctone tectonic subzone, and,
b. the alloctone tectonic subzone**.**

The folding and faulting are well developed. The area consists of a series of synclines and anticlines. The folds are symetric and asymetric, with amplitude from several hundred meters to 50 m. At the western part, the folds tend to be overturned to east – southeast.

The disjunctive submeridional tectonic is of type normal/reverse with dip angles 15-30^0 to 50-80^0, with NW and SE dipping. It creates vertical and horizontal displacements up to 150 m and somewhere more than 750 m. The transversal and subtransversal tectonic is of the second order and it intersects the structures and separates them in blocks. They are normal and reverse faults with vertical and horizontal displacements from some ten meters to several hundred meters, in SE – NW and NE – SW directions.

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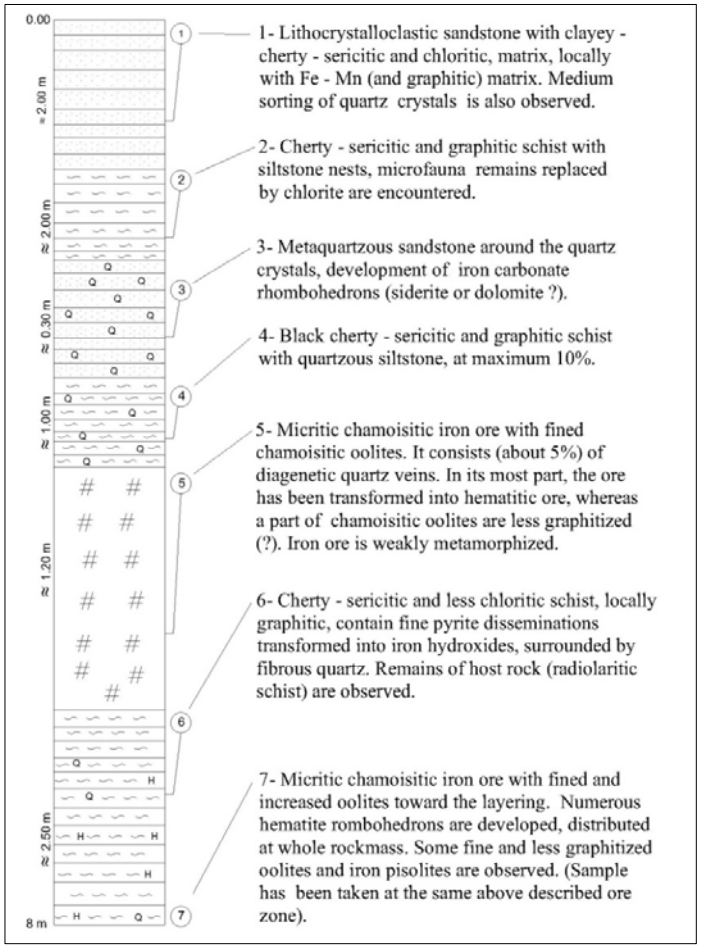


Fig. 7. Borehole nr. 3, Occurrence No. 1 of Muhurr
(Description based on this section taken on borehole No. 3)

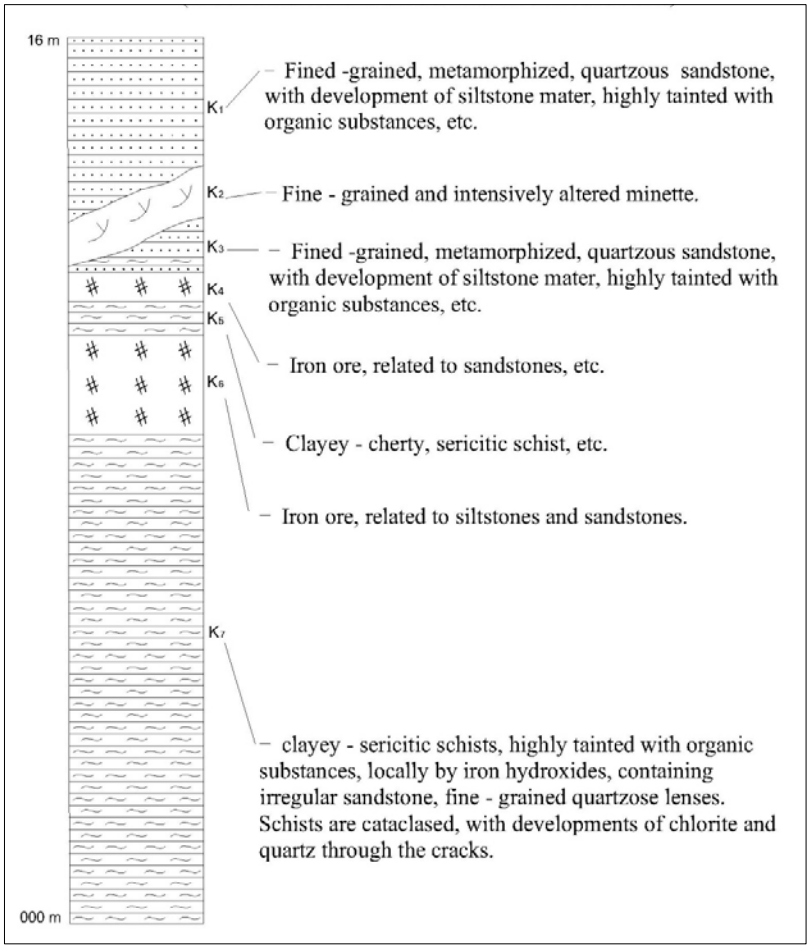


Fig. 8. Section of ore occurrence No. 6 of Muhurr
(Description based on collected thin section, Trench No. 28, Muhurr)

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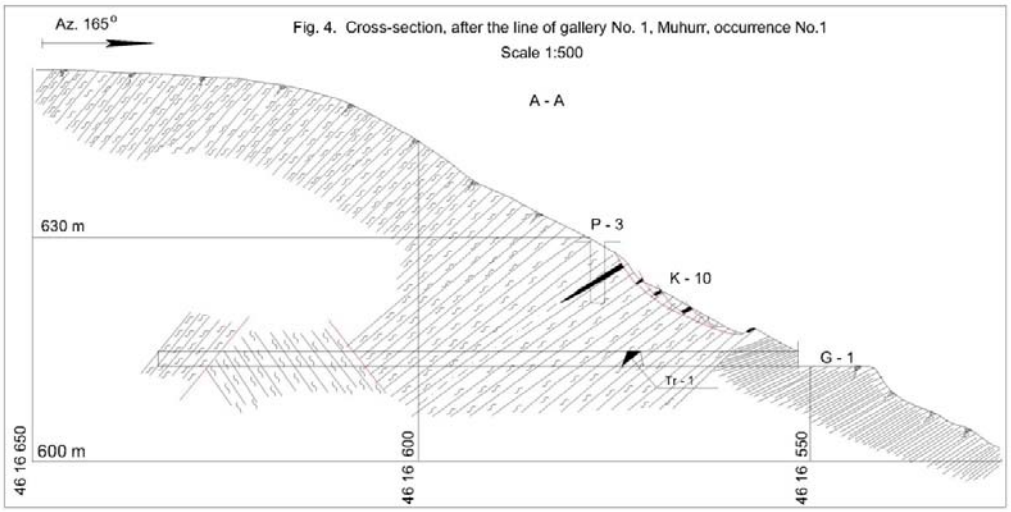


Fig. 4. Cross-section, after the line of gallery No. 1, Muhurr, occurrence No.1
Scale 1:500

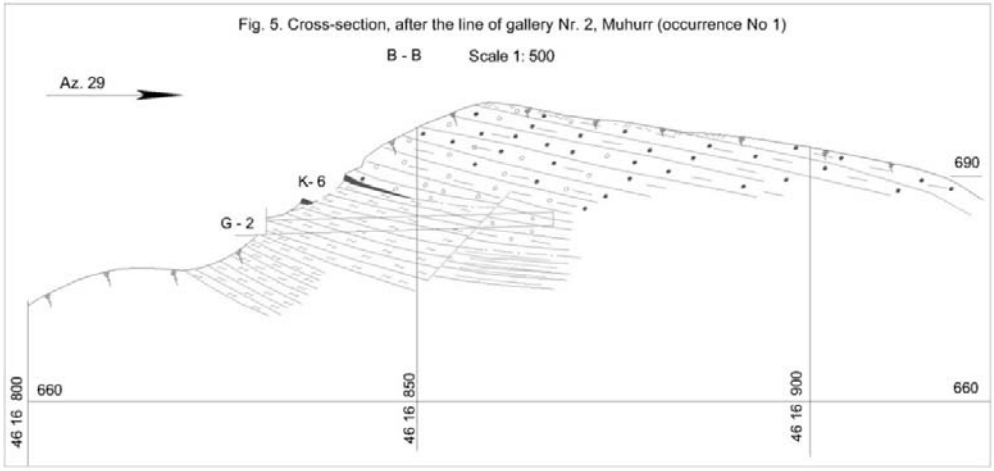


Fig. 5. Cross-section, after the line of gallery Nr. 2, Muhurr (occurrence No 1)
B - B Scale 1: 500

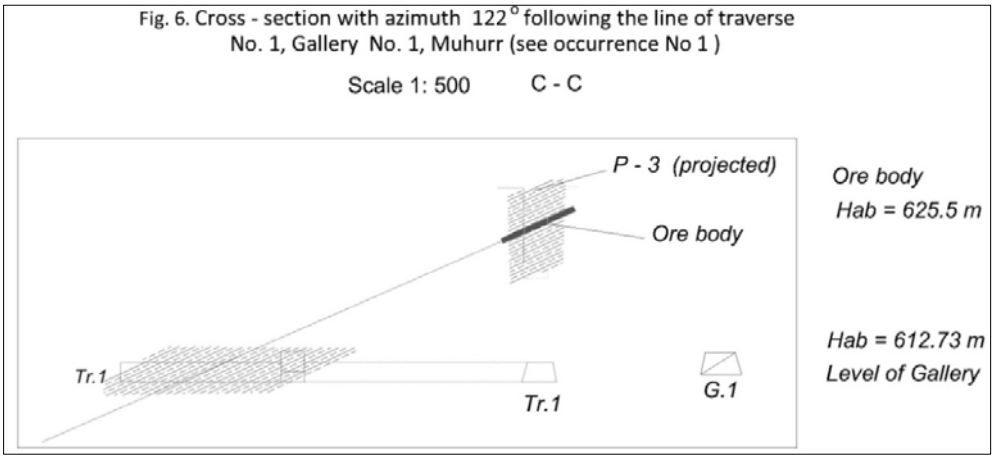


Fig. 6. Cross - section with azimuth 122° following the line of traverse
No. 1, Gallery No. 1, Muhurr (see occurrence No 1)
Scale 1: 500 C - C

ANALYSIS OF THE PERFORMED STUDIES

During the period 1979 – 1981, several geological – prospecting workings such as adits, pits, trenches, have been accomplished at the iron mineralization occurrences of Muhurri area (Fig. 3).
All the prospecting workings carried out so far in this area, at the ore occurrences No. 1, 2, 3, 4, 5 and 6, show that the found mineralization is of the iron ore of the **femicrite chamosite type** with enormous **ooliths** and 5-10 % diagenetic quartz veins. Most of the ore is changed in haematitic ore and most of the c**hamosite ooliths** are partly graphitised. The iron ore is weakly metamorphosed.

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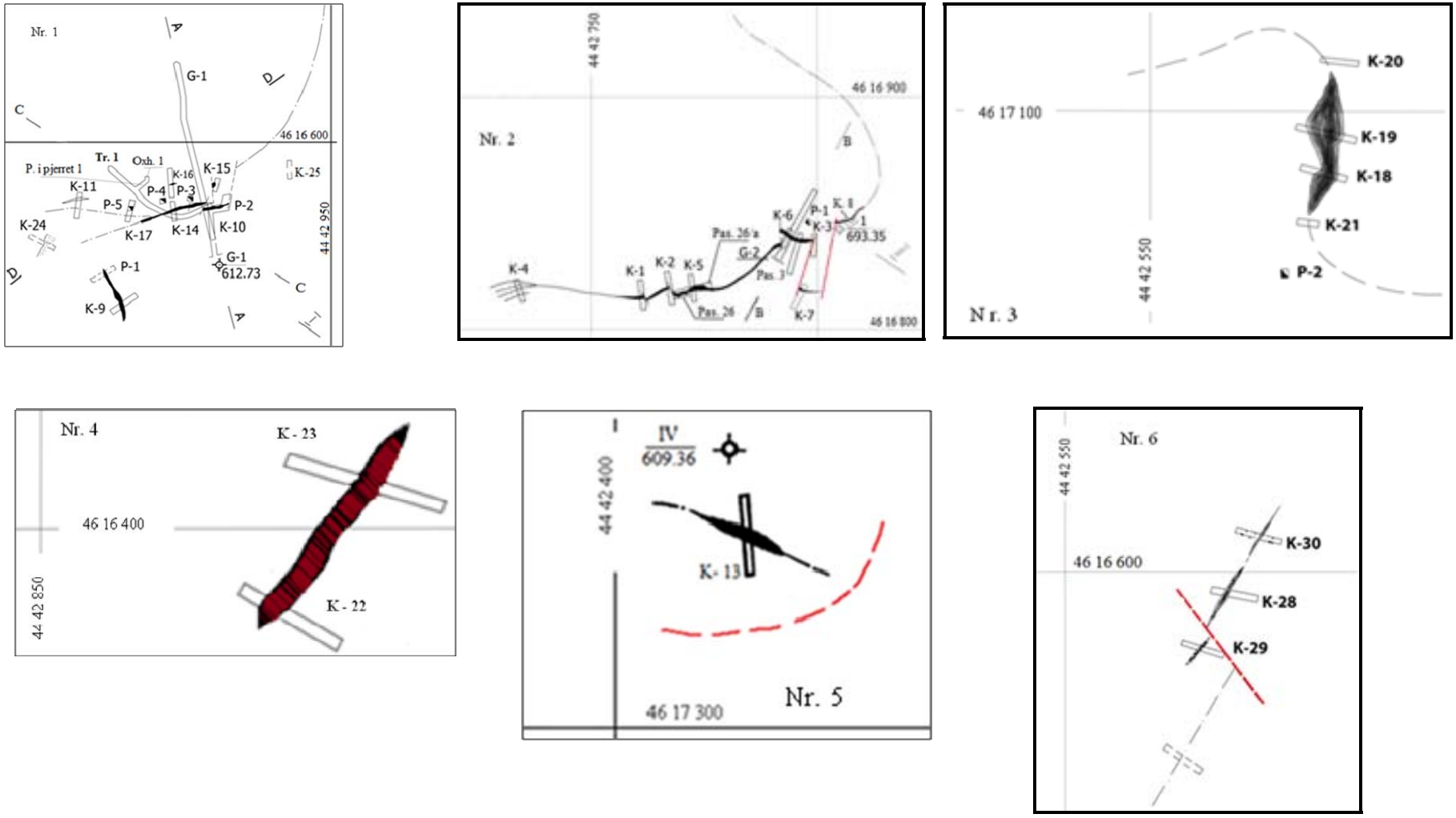


Fig. 3. The layers of iron ore bodies, ocurrences, No. 1, 2, 3, 4, 5 and 6 of Muhurri area, where exploration works have been carried out.

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The thickness of the ore horizon and the Fe oregrade values are not uniformlly distributed along the extension and dipping. The ore thickness varies from 20 cm to 1.5 m or more and the length is 10 m to 70-80 m. The Fe0 varies from 10 % to 34 and 35 % , some 32 % SiO_2 and MnO 0.50 %, (See Table 1).

Table 1. Analysis of some samples collected at three outcrops of the iron orebody.

Nr.	Nr. of sample	Length of sample	Outcrop number	Element values in %								Note
				Fe	$Si0_2$	Al_20_3	Mn0	Ca0	Mg0	$Ti0_2$	P_20_5	Sample belong to Outcrop near trench
1	1	1.00 m	Nr. 1	44.39	13.63	6.81	0.47	2.52	S'ka	0.26	2.67	K-10
2	2	0.80 m	Nr. 2	35.04	21.64	11.80	0.81	2.24	0.90	0.48	1.89	K-1
3	3	0.90 m	Nr. 3	36.02	22.20	9.71	1.35	3.22	0.80	0.33	2.22	K-1

The lenses morphology of the ore horizon along the extension is not excluded for the dipping as well.
The so far prospecting workings control the dipping for more than 20 m, but they do not found the ore horizon and suggest the lack of the mineralization.
The underground workings carried out at the showings Nr, 1 and Nr. 2 (Fig. 4 dhe Fig. 5) to control the ore continuation towards the depth, do not encountered the mineralization zone. Even the incline **adit** (Fig. 6), does not encountered the ore. At both its flanks, the orebody wedges and it is tectonically dismembered (Fig. 4). The same can be said for the ore showing Nr.2 (Fig. 5). The orebody found at the ore showing Nr.1 lies within the argillaceous – cherty – sericitic schists. (Fig. 7).
In this showing, the iron silicate ore predominates versus the oxide one and it appears like silts impregnated by iron mineralization. The orebody of the showing Nr. 2 lies between the argillaceous – cherty – sericitic schists and quartz – sericitic sandstones with argillaceous schists intercalations that represent the hanging wall. The ore itself is related to the platy cherts. The iron oxides predominate versus the iron silicate. Of the same nature are also the showings Nr. 4 and Nr. 6 (Fig. 8). Stratigraphically, considering the opresent level of knowledge, it can be stated that there are some iron levels of lense character along the strike and dipping. The geological survey, scale 1:25 000, of the area Zall Dardhë-Topojan, for the evaluation of the iron – bearing potential of this area, do not found other new iron ore occurrences.

Table 2. Chemical analysis of some samples collected at different prospecting workings at Muhurri area.

Nr.	Nr.of sample	Length of sample	Prospecting working	$Si0_2$ in %	Mn0 in %	Fe0 in %
1	1	1. 00 m	Trench Nr. 9	33. 08	0. 55	10. 14
2	2 - 5	0. 60 –2. 00 m	Trench Nr. 10	29. 96 – 32. 13	0. 41 – 0. 53	29. 88 - 30. 90
3	6	1. 00 m	Trench Nr. 11	66. 38	0. 35	1. 76
4	7	1. 00 m	Adit Nr. 1		0. 19	4. 57
5	8	0. 80 m	Trench Nr. 7	30. 18	0. 28	11. 97
6	9	0. 60 m	Trench Nr. 4	46. 90	0. 35	9. 15
7	10	1. 00 m	Trench Nr. 1	61. 74	0. 21	9. 37
8	11	0. 50 m	Trench Nr. 2	30. 80	0. 92	14. 90
9	12	1. 00 m	Trench Nr. 5	28. 82	0. 49	14. 45
10	13	0. 50 m	Stripping Nr. 2	32. 96	1. 34	16. 16
11	14	0. 50 m	Trench Nr. 13	23. 30	0. 35	17. 51
12	15	1. 40 m	Trench Nr. 6	29. 10	0. 42	27. 16
13	16	1. 00 m	Trench Nr. 14	32. 90	0. 42	29. 75
14	17	1. 20 m	Stripping Nr. 2	34. 02	0. 56	29. 06
15	18	0. 50 m	Trench Nr. 15	29. 86	0. 49	14. 18

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16	30 - 33	1. 50 - 2. 00 m	Trench	Nr. 19	27. 58 - 38. 50	0. 21 - 0. 35	31. 07 - 37. 71
17	34 - 38	1. 50 - 2. 00 m	Trench	Nr. 18	31. 32 - 40. 74	0. 21 - 0. 35	23. 74 - 34. 21
18	39	1. 10 m	Pit	Nr. 3	29. 62	0. 49	33. 98
19	40	0. 60 m	Pit	Nr. 4	29. 34	0. 77	34. 21
20	41 - 44	0. 60 -1. 95 m	Trench	Nr. 28	29. 34 - 32. 04	0. 77 - 0. 80	34. 21 - 37. 08

Similarly, some samples collected in the argillaceous – cherty – sericitic – graphitic schists with black colour encountered by the Adit Nr.1 (Fig. 4), show interest for their anomalous copper values. It deals for the sedimentary copper deposits of Mansfeld type.

The copper–bearing shales belong to the earler development stages of the folded belts and they are syngenetic marine deposits originated in an environment rich in H_2S and sapropelic mud. Their evaluation needs further specialized studies. Data on the presence of such a mineralization are also obtained for the grey – black shales of this tectonic unit (according to some samples collected by Hoxha V., 1980), at the sector in front of Vasiaj village till to Palushaj one (boundary zone between the districts Dibra and Kukesi). The section of these deposits can be observed at the northern slope of Veleshica Torrent, between Zall Kalisi village, Kukesi district, and Beshe quartier of Ploshtani village, Dibra district. Copper, lead, zinc and other elements show interest nevertheless their data belong to the spectrographic analyses. These mineralizations will be not subject of this paper.

Table 3. Data of the chemical analyses of the samples collected in the adit Nr. 1 Muhur, for sedimentary copper

Nr. of sample	19	20	21	22	23	24	25	26	27	28	29
Length of sample	1 m	1 m	1 m	1 m	1 m	2 m	2 m	2 m	2 m	2 m	2 m
Cu value in %	0.06	0.07	0.07	0.08	0.08	0.09	0.12	0.12	0.09	0.09	0.09

GEOLOGICAL DATA THAT SUPPORT THE PROSPECTION OF THE IRON MINERALIZATIONS IN DEPTH

The analysis of the performed prospecting workings shows that they have been sufficient for the knowledge of not only the morphology of the ore outcrops (orebodies) but also of their spatial dimensions. The available geological data obtained by these workings can serve like a basis for the projection of further prospecting working in these outcrops. Hence, in following, the idea on the prospecting of the iron ore in depth by drillings will be presented, based not only on the data of the ore outcrops, but also on the regional data provided by the geological survey, scale 1:25 000, of Zall Dardha – Topojani area, the prospecting – exploration workings of the oxide-silicate iron ore deposit of Sorokoli as well as by the geological mapping works on the perspective of the iron – bearing potential of Veleshica – Kalabaku area (Bushi etj. 1979). Some of these data will be presented here to justify and support better the idea of the localization of the iron mineralizations in depth and especially them that deal with the spatial lithostratigraphic position of the iron mineralization in Korabi zone, in general, and in Muhurri area, in particular, and with the marker lithostratigraphic horizons that condition the localization of the iron mineralization. At the central – eastern part of Korabi zone, i.e. Veleshica – Kalabaku area, so far, three iron ore types are found:

a. chlorite – haematite type

b. chlorite – magnetite type

c. quartz – haematite type *(less abundant).*

The first type occurs mainly at Sorokoli ore deposit and it is the best studied so far (Fig. 9). The representative section of the palaeozoic deposits that shows the spatial position of the two ore types, from the bottom to top, is as follows:

a. Sericitic sandy rocks, represented by thin intercalations of sandstones and marls with the cherty -sericitic and chloritic schists. Less frequent are the intercalations of conglomerates, orthoquartzite sandstones (with silicous –sericitic-chloritic cement with less shamozite), radiolarian limestones, extrusive basic and acide rocks. At the upper part of these deposits, between chloritic – sericitic and partly graphitic argillaceous – sericitic schists and platy grey limestones, the first iron ore horizon occurs.

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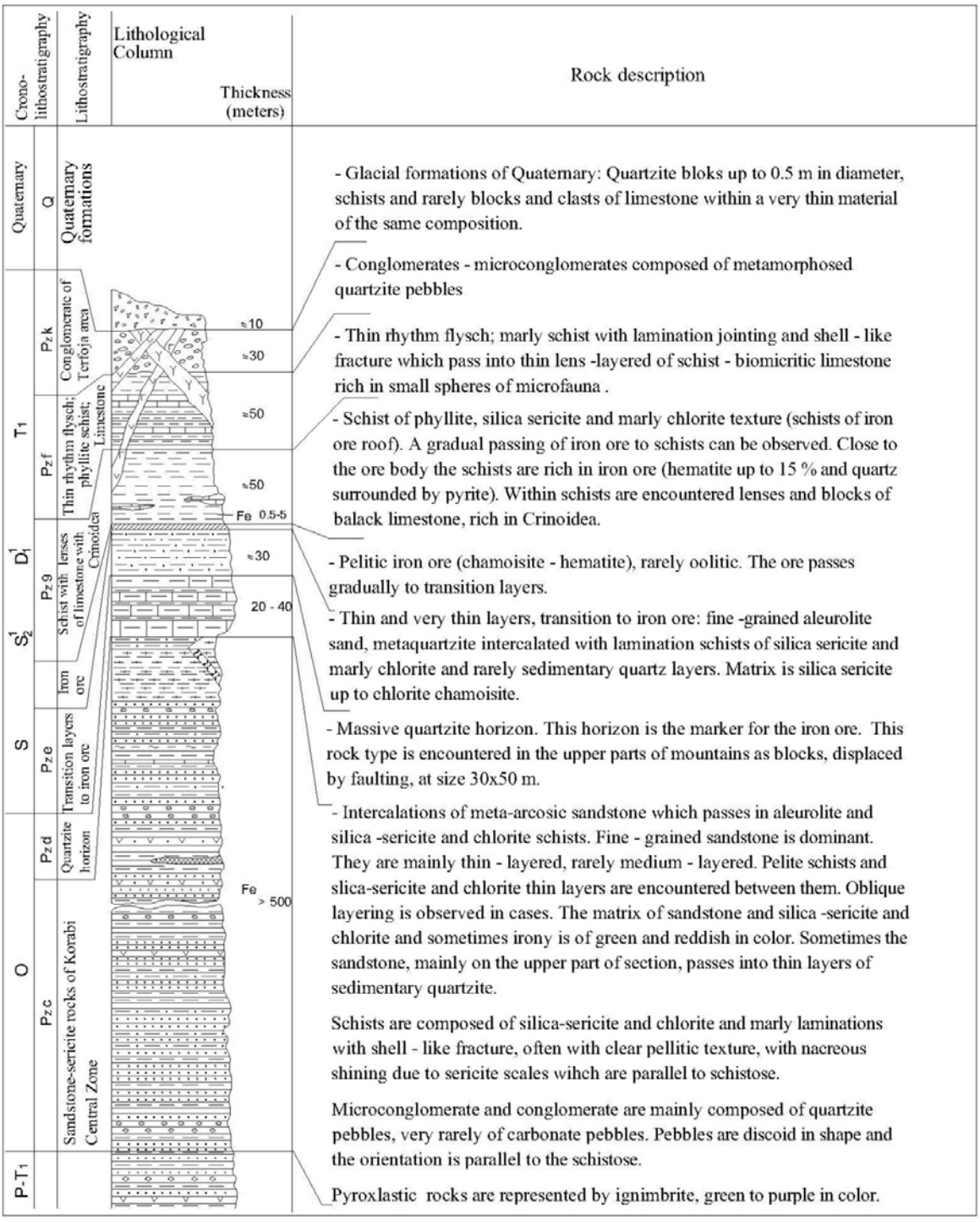


Fig. 9. Cross section of Kollovozi unit (After Xhomo A., et al. 1984 and Hoxha V. , 2001)

The ore is of the chlorite – magnetite type. It outcrops at Kepi i Zanit, Bjeshka e Kokajve and Kalabak. It seems that these outcrops correlate with each other along their extension and they represent the first iron horizon of Korabi zone. This ore type is represented by orebodies 1.00-1.50 m to 3.00 m thick and their oregrade is: FeO + Fe_2O_3 = 46. 53 %; P_2O_5 = 3.00 -5.00 %. Magnetite composes 20-30 % of the ore.

b. Horizon of quartzites**,** that serves like a marker horizon for the search of iron ore. This horizon is represented by metamorphic sandstones with scarse cement of cherty – sericitic and iron – chloritic composition. Their thickness varies 30 – 35 m.

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c. Sandy – marly rocks intercalated with cherty – sericitic schists, less partly shamositic. These layers so called like transitory layers to the second horizon of the iron ore are 15 – 20 m thick.

d. Second iron horizon, Sorokoli type, chlorite – haematite, represents a facial passage of the sandy – marly deposits with the increase of the iron material (shamosite – haematite) towards the occurrence of iron oolithes and pisolithes (some 20 % in volume). The thickness of this horizon is 0.50 – 5 m. The average haematite (iron oxide) is 30 – 40 %, and the iron chlorites compose 20 – 30 % of ore volume. The Fe values vary 20.90–35.60 % (average 25.00 %), $P_2 0_5$ = 0.80–3.70 % (average 2.40%).

e. Schists with lenses of limestones with Crinoidea, that overly the iron ore of Sorokoli. They are cherty – sericitic phyllitic schists (Fig. 10). Layers similar to grey limestones with Crinoidea occur within these schists. Their study at the Academy of Sciences of Prague by Prof. Dr. B. Boneck (Qirici V., 1971) found Scyphocrinites Zenker, 1883, that dates the uppermost Silurian or the lowermost Devonian (Gedinien). The thickness of these schists is some 50 m. Because these schists always directly overly the hanging wall of the orebody of Sorokoli, they can reasonably be considered like guide horizon that controls the possibility of the presence of the second ore horizon and hence it can serve like an important lithological element for the search of iron mineralization at Korabi zone.

f. Thin rhythmical flysch**,** that is represented by marly phyllitic schists, limestones, microconglomerates. It overlies with unconformity the other deposits and its thickness is 50 m.

k. Conglomerates of Terfoja, composed mainly by quartzite gravels and their thickness is 10 – 30 m.

The thematic and integrated geological surveys carried out at the area Zall Dardhe –Topojan during the years 1980 – 1981, show that the palaeozoic deposits have this lithological – facial representation, from the bottom to top:

a. Serie s of graptolitic shales, that consists of the package of the argillaceous–cherty–graphitic black shales with rhythmical intercalations of argillaceous–sericitic schists. Marly–carbonatic layers with Crinoidea corals? and grey recrystallized limestones with tentaculites with thickness 50–60 m occur within these schists. With normal continuation and gradual transition, the package of the graptolitic shales continues. It consists of argillaceous – marly, argillaceous – cherty–sericitic graphitic and cherty schists, of beige–yellow color and black spots that contain abundant graptolites. They are 80–90 m thick. Above the graptolitic shales at Muhurri area, two iron ore horizons occur. The lower horizon (Fig. 11) lies within the graptolite–bearing black shales. The orebody is 0.50-1.30 m thick and the oregrade is FeO = 31 %. The iron chlorites predominate versus the iron oxides. The uppermost outcrop (Fig. 12), lies at the uppermost part of the graptolitic shales, between the argillaceous–sericitic–cherty schists (footwall) and quartz – sericitic sandy schists (hanging wall). The orebody is 0.20–0.80 m thick and the oregrade is FeO = 25.00 %. The iron oxides predominate versus the irony chlorites.

b. Silty – sandy – conglomerate series that is represented by the package of the argillaceous – silty and cherty–sericitic schists, lenses of sandstones and conglomerates and lenses of limestones. Within dark green silts, the oxide iron–manganese ore and less the chlorite iron one of limited size, occur. The second horizon with Crinoidea occurs within silts of this serie. The package thickness is 100–120 m. Upwards, the sandy package and the one of argillaceous–cherty–sericitic one, some 70 m thick, continue. These series are considered to belong to Silurian–Devonian.

The terrigenous–clastic serie (series »Verrucano«) of Permian –Triass, overlies with unconformity these deposits. Above »Verrucano«, the triassic deposits (T_1-T_2 and T_3), represented by argillaceous–silty schists, basic extrusives, limestones and radiolarians, more than 200 m thick, continue with normal stratigraphy.

***

From all above mentioned, the lithological – stratgraphic section of the palaeozoic deposits of the eastern and western parts of Korabi zone has been described. The lithological – stratigraphic and spatial position of the iron mineralization known so far in Korabi zone is also clarified.

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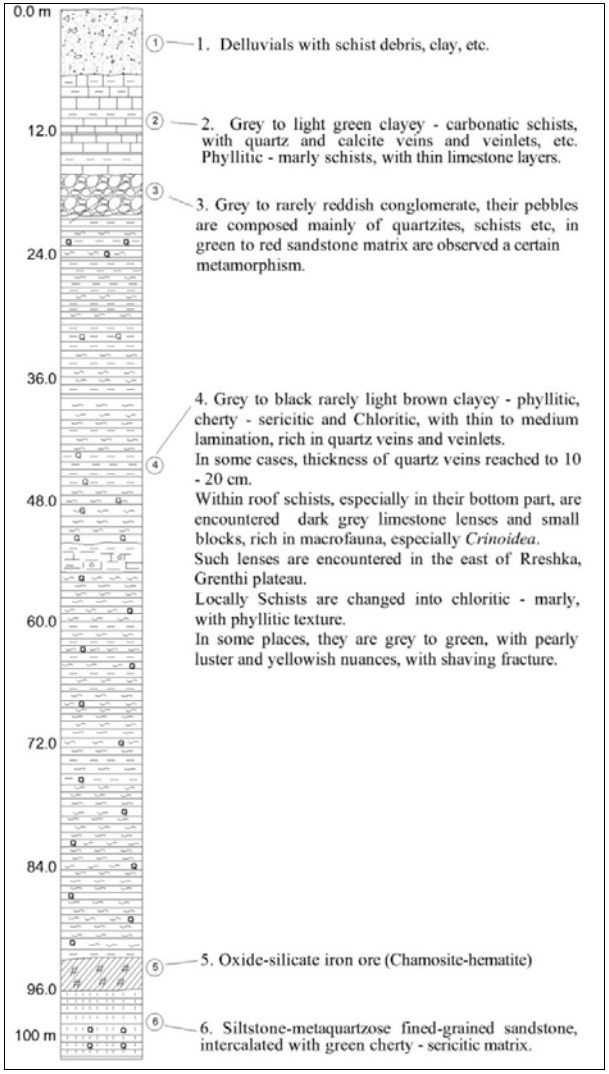


Fig. 10. Section of Borehole column No. 6/B, Guret e Kodres

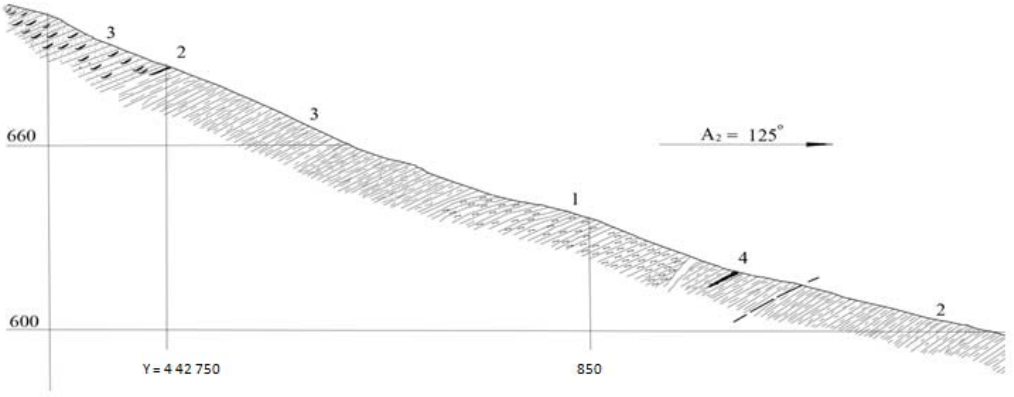


Fig. 11. Profile I-I Muhurr

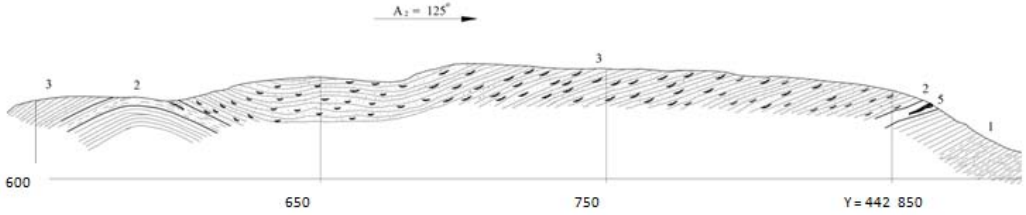


Fig. 12. Profile II-II Muhurr

Explanations of fig. 11 – and Fig. 12

1. Black schists with Graptolite 2. Aleurolite sandstone, grey to green in color 3. Sandstone and quartz –sericite schists 4. Iron ore, silicate type is dominant 5. Iron ore, oxide typo is predominant.

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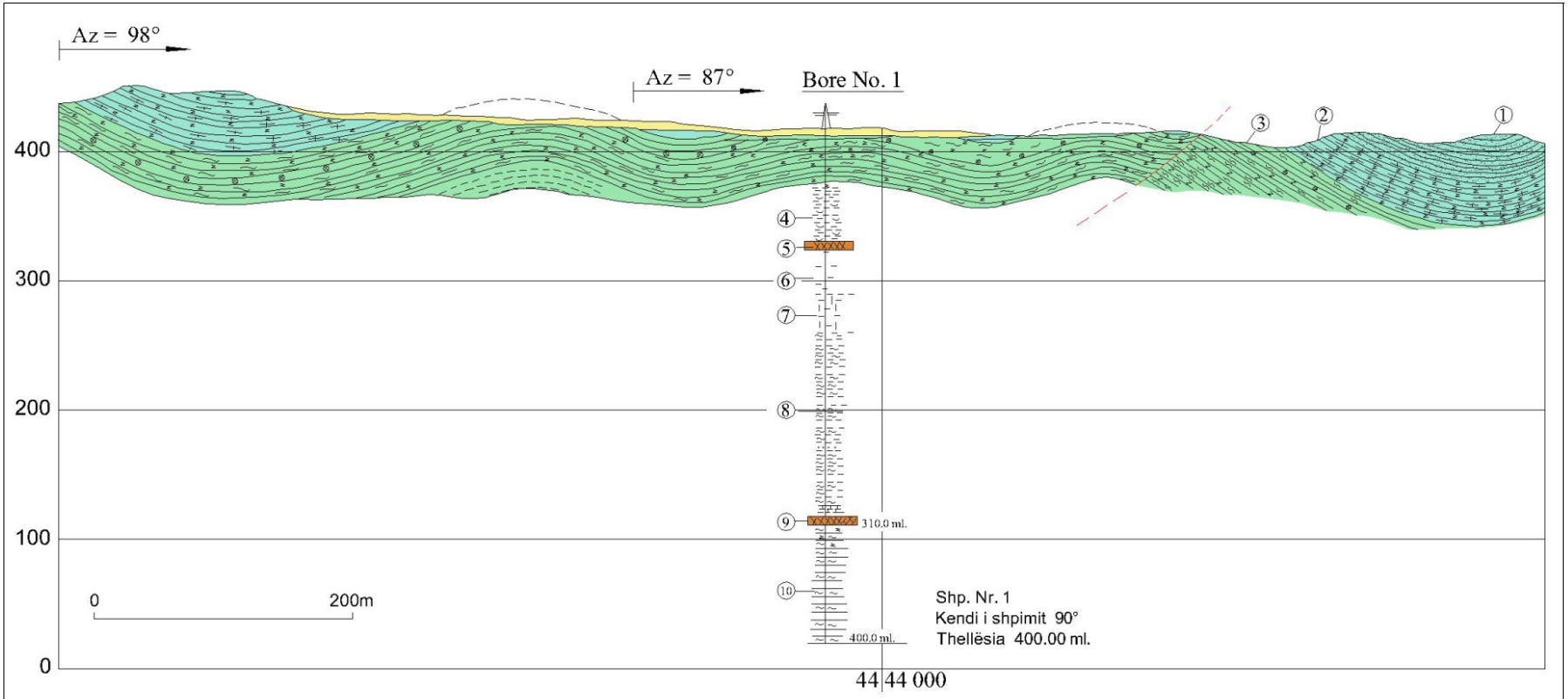


Fig. 13. Cross-section I - I of Bulaçi Stream (Scale 1 : 2 000)

Explanations:
1. Sandstones and grey quartz - sericitic schists. 2. Black graptolite schists. 3. Black clay -coal schists with Crinoidea. 4. Clay-cherty-sericitic schists. 5. Iron expected mineralization of chloritic-oxide type (with less oxide). 6. Sandstones and siltstones. 7. Quartzites. 8. Clay-sandstone-sericitic schists with conglomerate intercalations and rare limestones. 9. Iron expected mineralization of oxide type (hematite-magnetite). 10. Cherty-sericitic-chloritic and sandstone-siltstone schists.

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Considering these data, it is necessary to be also treated here, among others, the problem of comparison and correlation of the iron mineralizations found at the eastern zones (easten Palaeozoic), Sorokoli, Kalabaku, etc., as well as at the more western ones (western Palaeozoic) Muhurr, etc. At Sorokoli, where the first iron mineralization type occurs (chlorite – haematite type), its hanging wall consists of cherty – sericitic schists with lenses of limestones with Crinoidea (Fig. 10). The determination of these crinoides like ***Scyphocrinites Zenker, 1883***, suggests the age of Lowermost Devonian, Gedinien stage. While the section of the western Palaeozoic and especially the one of Perroi i Bulacit, at its beginnig, i.e. in the package of the schists with Crinoidea, the Scyphocrinites Zenker are determined again, but the author that determined them suggests the age of Middle Silurian (Reenllokiam stage), its uppermost part.

Upwards, at the same section, in the package of the graptolitic shales, are found and determined these species (Zhënevievë Termie-Universiteti "Pjer e Marie Kyri"-Paris): Pristiograptus (colonograptus) cf; romeri (Barrande), Pristiograptus ex gr dubius (Suess), Scatograptus cf. chimaera (Barrande), Monograptus sp. Nov, Plectograptus sp. that suggest the age of the Upper Silurian (Ludlovian stage), its lower part, and within this package the iron mineralization of Muhurri occurs.

It should be mentioned that in the serie «b» (schistous–silty) there are again Crinoidea that are not determined so far. The prospecting integrated geological studies of the years 1980–1981, in all the sections of Palaeozoic of entire the area Zall Dardhe – Topojan, the black shales are always at their bottom (Bulaci type) with Crinoidea (Veleshica, Lugjaj, Topuze, Kastriot, etc) and all the other series continue above them (Qirici etj. 1982) and in all other sites no other lithological package is found beneath this package, i.e. an another deeper one. We mention that structurally, the western Palaeozoic, nevertheless the meridional and transversal folding and faulting tectonics that intensively affects the Korabi zone, is more quite than the eastern Palaeozoic. These deposits continue normally along their extension and occupy a considerable area. By the comparison and correlation of the above mentioned sections, it can be deduced that the two Crinoid–bearing horizons are analogous in time and facias between them. The presence of graptolites in the sections of the western Palaeozoic above the package with Crinoideas, suggests conditions of dipper sedimentation than the ones of the eastern Palaeozoic, but nevertheless there have been local conditions suitable for iron depozitation like in the case of iron mineralization at Muhurri. Consequently, it should be thought that for equivalence with Sorokoli, even beneath the horizon with Crinoidea of Muhurri area and other sites, we should search again for iron mineralizations (Fig. 13). But it can be asked that which iron mineralization type should be expected beneath the Crinoid – bearing horizon of Muhurri? At the first glimpse, it could be thought that in depth it should be expected both the iron ore types, the first chlorite – haematite one (Sorokoli type) and beneath it , more dip, the second chlorite – magnetite type (Kallabaku type).

We think that the determination of the *Crinoideas of Bulaçi like Scyphocrinites Zenker of Middle Silurian might not be right, formore when it is known that thye belong to Lower Devonian and Uppermost Silurian, so they might belong to* Uenlokianit, but to an another species, because they follow the graptolites of Ludlovianit. The available data (stratgraphic and structural ones) do not suggest the possible presence of an overturned palaeostructure at least before Permian – Triass and if we consider that even at the more eastern margin of the area occupied by these deposits, such as at Kastrioti, the same sections with the one of Bulaci, are found. So, for this reason, it is more right to consider that the iron mineralization of Muhurri should be the timely and facial analogous of the one of Sorokoli. To resolve this very important question in the aspect of the geology and mineralbearing of this area, we are of the opinion to carry out some structural – prosecting works (idea for the prospecting in depth for the iron mineralizations is shown in the profile of the Fig. 13) that are based on the geological data and on the premises for iron – bearing, mentioned above.

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REFERENCES

1. Bushi E., Cakaj B., Hoxha V., Kodra A., etj. (1979)*: "Studim tematiko përgjithësues e rilevues kompleks për sqarimin e perspektivës hekurmbajtëse në pjesën qëndrore të zonës së Korabit dhe konkretizimi i një vendburimi hekuri pa nikël"* Tiranë.
2. Bushi E., Kodra A., Hoxha V., Cakaj B. (1982). *"Gjeologjia dhe hekurmbajtja e rajonit Bushtrice–Ploshtan»*. Buletini i Shkencave Gjeologjike Nr 1, Tirane.
3. Hoxha V., Alliu I. (1979). *"Mbi disa shfaqje të mineralizimit të Hekurit në rrethin e Dibrës"*. Përmbledhje Studimesh Nr.3. Tiranë.
4. Hoxha V. (1979). *"Projekt i punimeve kerkuese e vleresuese per disa shfaqje te hekurit silikato - oksid ne zonen e Sorokolit, Muhurit dhe Panairit ne rrethin e Dibres, per vitin 1980"*. Peshkopi - Bulqizë.
5. Hoxha V. (1981). *«Projekt i punimeve te kerkim-vleresimit te hekurit oksido- silikat per zonen Muhur-Kastriot."* Tirane-Peshkopi-Bulqizë.
6. Hoxha V. *(*2000). *Harta gjeologjike dhe e pasurive minerale te rrethit Diber ne shkallen 1:50 000 me tekstin shpjegues perkates.* Peshkopi.
7. Hoxha V. (2001). *Tiparet themelore te gjeologjise dhe perspektiva e kerkimeve ne rajonin Kerçisht-Sorokol*. Disertacion, Universiteti i Tiranes.
8. Kodra B., Alliu I., Hoxha V., etj. (1986): *"Studim tematiko-pergjithesues e rilevues kompleks per sqarimin e perspektives se hekurit dhe te mineralizimeve te tjera ne rajonin Radomire (per periudhen Qershor 1984 - Mars 1986"*. Tirane.
9. Qirici V., Kodra B., Manjani E., Hoxha V., etj. (1982)*: "Studim tematiko-pergjithsues e rilevues kompleks per sqarimin e perspektives hekurmbajtese te zones Zalle Dardhe-Topojan per vitet 1980–1981"*. Tirane.
10. Qirici V., Kodra A., Pashko P., Manjani E., Hoxha V. (1982). *"Ndertimi gjeologjik, mineralizimet e hekurit dhe perspektiva e kerkimit te tij ne rajonin e Peshkopise." Sesion shkencor i ISPGJM*, Tirane.
11. Xhomo A., Pashko P., Meço S., Hoxha V. (1984). *"Ndertimi gjeologjik dhe hekurmbajtia e Zones se Korabit." Sesion Shkencor i ISPGJM,* Tirane.
12. Xhomo A., Pashko P., Meço S., Hoxha V. (1984). *"Rreth vendit stratigrafik te hekurit ne rajonin e Sarakolit." Sesion Shkencor. Fakulteti i Gjeologjise dhe i Minierave.* Tirane.
13. Xhomo A., Pashko P., Meço S. (1985.) *"Stratigrafia e depozitimeve paleozoike te Albanideve dhe premisat e mineralizimeve qe lidhen me keto depozitime.* Studim.
14. Xhomo A., Pashko P., Meco S. (1991). *A view on Paleozoic sediments of Albanides. Colloque sur le geol. De l'Albanii. Soc. Geol. France.* Paris.
15. Xhomo A., Onuzi K., Pashko P., Pirdeni A. (2006). *A view on the Paleozoic sediments of Albania. Kolner Forum. Geol. Paleont. 15, f. 128-130,* Koln.

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Cu-Fe MINERALIZATON IN REZHANC, (HANI ELEZIT)

Lulzim ÇITAKU[1], Midin BOJAXHIU[2], Islam FEJZA[3]

[1]*Komisioni i pavarur për Miniera dhe Minerale, Prishtinë, Kosova, lcitaku@hotmail.com*
[2]*Komisioni i pavarur për Miniera dhe Minerale, Prishtinë, Kosova, midinbojaxhiu@yahoo.com,*
[3] *Fakulteti Xehetaro- Metalugjik, (Mitrovicë, Kosovë),islamfejza@gmail.com*

ABSTRAKT

The aim of this research is to provide data on the composition of the occurrences of Cu – Fe mineralization at Rezhanca, near Hani i Elezit. The collected samples are analyzed by the XRF portable analyser NITON. The prospecting works have found some occurrences of oxidized and altered mineralization. The samples belonging to these occurrences are analysed for several elements. This have enabled a more realistic recognition of this mineralization. Based on the obtained data, the accomplishment of more detailed exploration is recommended.

KEY WORDS *1Mineralization,* 2 *Rezhanca "Mixed Zone",3 Geological examinations, 4 Serpentine.*

INTRODUCTION

The explored area lies at the southern part of Kosova, or in SW of Elez Han. It is a mountainous terrain. The highest elevation in the area is 700m. Communication is very difficult because the roads of this region are in very bad condition. The area, during the rainfall period is not accessed by vehicle, but in normal conditions it can be reached from two directions: from Elez Hani, the Brezovica road – the border point with Tetova, and from Glloboqica in Goranc-Rozhanc village.
The sample analyses are done by portable analyzer NITON. NITON analyzer is a device that does the field analysis of the samples. It works by X-fluorescent rays. In order to have the most accurate results the sample which we analyze shall be drier fresh rock. The obtained results can be in percentage (%) and in ppm. In order to have the accurate reading in percentage (%) you should encounter the sample in the determinate part of NITON and to hold it 30 sec., whereas for reading in ppm 60 sec. NITON also has the possibility to save the gained results where afterwards these results can be transferred to any geological software for further processing. A total of 3000 readings can be saved in device.

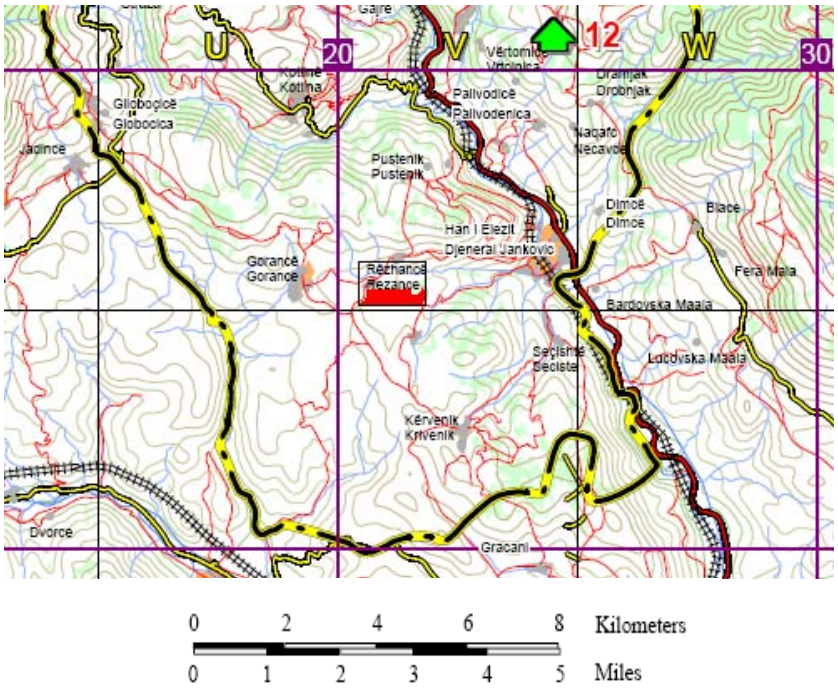


Fig.1. Topographic map of Elez Han with surroundings

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GEOLOGICAL DESCRIPTION OF THE AREA

There are not abondant geological data for the explored area. Some authors, that did the earlier geological researches, compiled a brief description on the geology of the area. Between the First and Second World War, there were only occasional explorations from Compagnie Francoise des Mines de Bor, in the mineralised occurrence. After the Second World War, this region has been explored by Geozavodi, and the conclusions are summarized in the related report "Studies on Shkup Karadak" (Studije Skopske Cerne Gore)

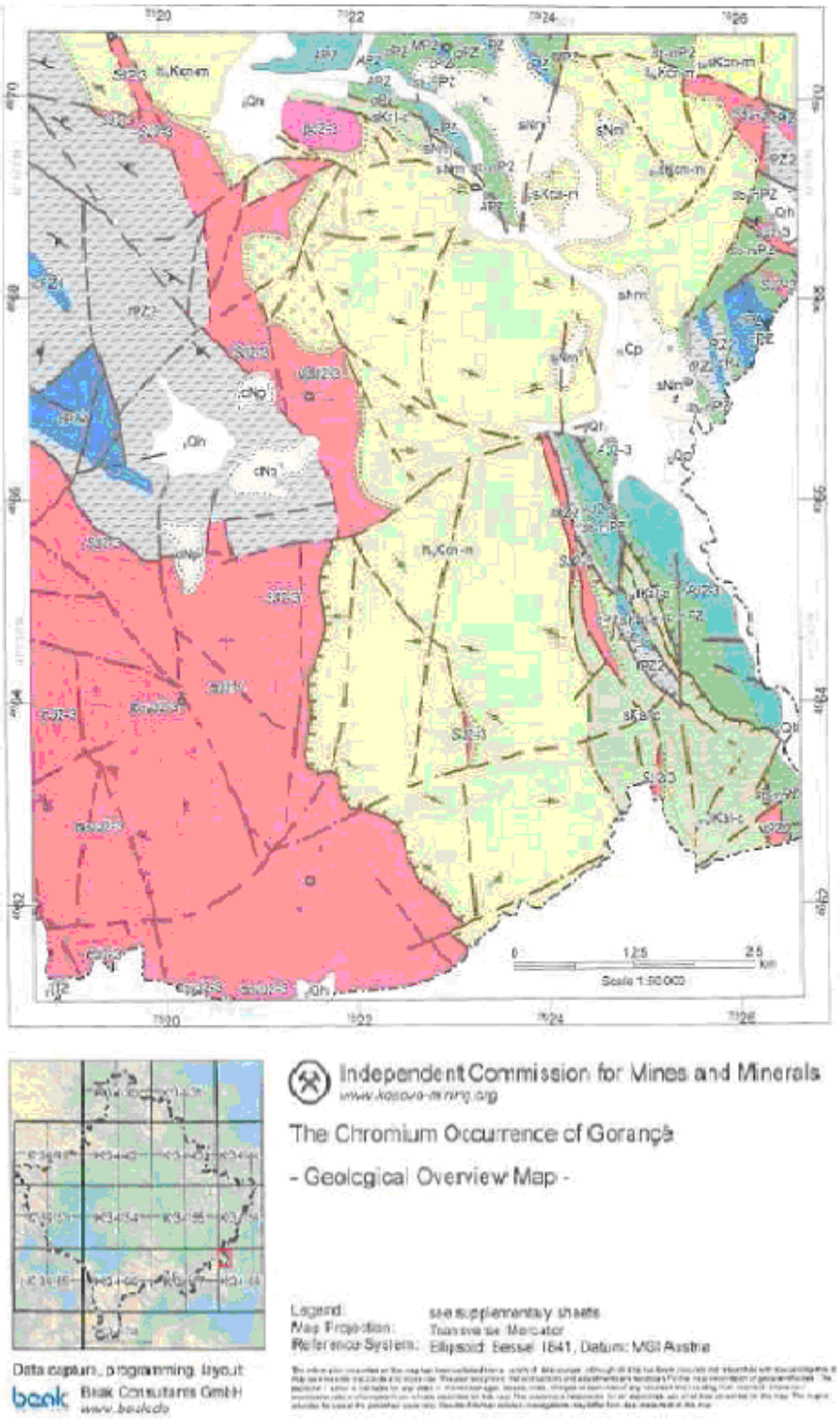


Fig.2. Geology *map of Elez Han with surroundings*

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Fig.3. Legend

Quaternary: Alluvium; proluvium; deluvium; glacial sediment.
Neogene: Clay; sand; gravel; marl, limestone; bentonite.
Cretaceous: Limestone; marl; conglomerate; sandstone (flysch series)
Jurassic: Dunite, serpentinite; hartzburgite; amphibolite and amphibole schist, ophiolitic melange with olistolith.
Palaeozoic: Biotite muscovite schist, amphibolite and amphibole schist; schist (phyllite, sericite schist, quartz schist).

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A BRIEF DESCRIPTION OF ROCKS LOCATED IN REZHANC VILLAGE

Dunite

Dunites occur like small and big bodies within harzburgites. They are with brown and green colour. They are altered in surface and brake in fine rhomboedric fragments. The contact with harzburgite is very clear. Chromite is always present like sparse disseminations.

Pyroxenites

Pyroxenites occur in vein shape in whole the massif with thickness from a few centimetres to a few meters. They are rocks with dark gray colour, composed totally by orthopyroxene and highly affected by serpentinization.

The structure of these rocks is allothriomorphic to idiomorphic. The upper part of Radushe massif is considered like a rock mixture (Dunite, hartzburgite, pyroxenite, serpentinite, gabbros, gabbro-pegmatite and rodingites).

"Mixed area"

This fastening in rocks described by K. Gerqev and P. Milinkoviq in 1962 is called "mixed zone". It can be traced from north-west of Safillari to Rezhanc village. The thickness of this zone is variable. The base of "mixed zone: consists of serpentinite, dunite, harzburgite, pyroxenite veins, gabbroid rocks and peridotite. Dunite, hartzburgite and pyroxenite are mainly serpentinized, ang gabbros are altered, with dark green colour.

Rodingites occur like dikes and they have light green colour.

Serpentinite

Serpentinite occurs in marginal parts of Radusha and Brezovica and along the fault of Vardari Zone, where it contacts with rocks of Palaeozoic, Permo-Triassic and upper Cretaceous. The serpentinized peridotite massifs of Radusha and Brezovica are characterized by a flat relief. The olivinite rocks are more serpentinized than pyroxenites. Serpentinites have grey to dark green color. They are schistous and highly fractured.

MINERALIZED OCCURRENCES

The area is rich with mineralized metal and non metal occurrences and mineralized water. These mineralizations occur in the ultramafic rocks (Ophiolite). These mineralizations are connected with Paleozoic complex, Mesozoic complex, with Jurassic formations, and sometimes also with Quaternary formations.

Cooper is connected with volcanogenic-sedimentary, volcanogenic, intrusive-gabbro-diabase rocks. The mineralization belong to different types: volcanogenic-sedimentary, volcanogenic, hydrothermal quartz-sulphur. Polymetals of lead-zinc are connected with these rocks and the ones of Palaeozoic. The mineralized occurrence of Cu is found at Rezhance area.

Sulphide occurrences of Cu, Pb and Zn are as secondary mineralizations, rarely they occur in quartz hydrothermal veins. Mineralization is of impregnated type of Cu sulphides in paragenesis with: Pyrite, marcasite, chalcopyrite, calcite, quartz, bornite, sphalerite and chalcocite. The most abundant mineral is pyrite.

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PHOTOS AND TABLES OF RESULTS

Sulphites mineralizations of Cu and other associated elements

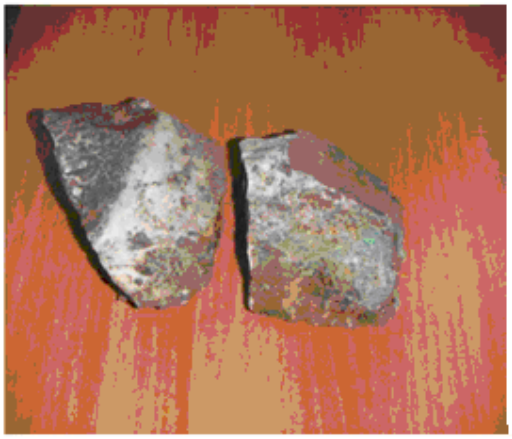


Photo No. 1 Coordinates X=7 521 746
Y=4 666 976
Z=680m



Photo No.2 Coordinates: X=7 521 336
Y=4 667 124
Z=726m

The analyses in taken samples are done by NITON (XRF) portable analyzer. The results of analysis are in ppm



Cu	Fe	Mn	Ni	Co	Cr	Au
4729.66	6770.16	163.2	26.96	-146.26	148.3	-12.24
4287.14	155344.42	2360.54	138.62	570.95	1050.08	-11.42
925.25	15842.13	108.38	151.83	-299.93	346.9	-12.47
48460.79	120459.7	575.83	303.92	-840.61	937.7	110.65
Pt	Ag	Zn	Pb	Cd	Sb	Sn
16.98	-6.49	-30.13	-4.92	21.74	133.91	96.6
-9.99	14.21	53.36	4.87	-7.65	-33.78	-129.84
12.78	-2.66	-15.6	-3.14	30.9	158.06	144.6
15.79	429.92	38.44	49.17	50.37	147.52	58.75

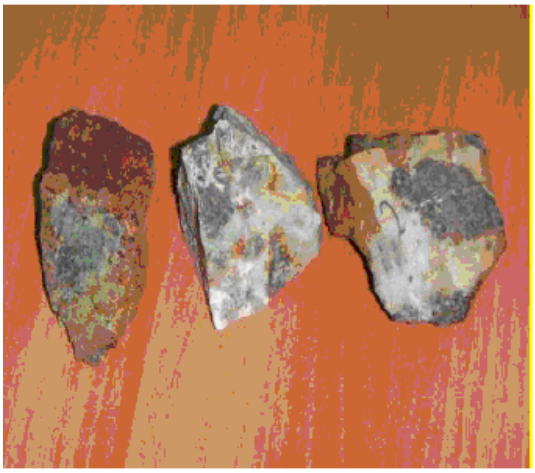
1) Analyses and photos: Sample 01 Coordinates: X=7 521 778; Y=4 666 612



Cu	Fe	Mn	Ni	Co	Cr	Au
22034.02	247633.6	92589.28	251.49	1007.95	811.71	57.34
419381.41	376981.97	845.2	-250.35	2070.22	-750.91	28.27
78804.86	426726.09	2784.73	841.31	-1884.53	-584.36	56.4
Pt	Ag	Zn	Pb	Cd	Sb	Sn
-16.93	-26.66	210.45	-12.15	36.85	-60.27	-340.86
16.74	1.23	119.54	13.03	15.92	21.52	-169.71
183.46	13.62	136.06	74.54	-18.77	177.52	-230.19

2) Analyses and photos: Sample 02 Coordinates: X=7 522 183; Y=4 666 471

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Cu	Fe	Mn	Ni	Co	Cr	Au
185018.02	312262.19	1305.25	128.72	1949.55	627.3	15.58
21111.17	453727.38	3760.35	738.83	973.52	2085.99	95.18
109788.68	294189.75	3336.99	279.64	102.47	448.88	55.38
541221	465207.2	22578.31	472.98	1491.76	1259.52	40.55
Pt	Ag	Zn	Pb	Cd	Sb	Sn
26.21	0.79	-74.16	39.34	6.52	-34.79	-237.71
94.35	19.06	1033.95	21.34	7.24	23.24	-308.84
89.25	-13.41	-13.14	-3.14	49.74	-1.36	125.92
-39.16	-15.97	1556.95	6.3	72.06	246.01	383.41

3) Analyses and photos: Sample 03 Coordinates: X=7 521 746; Y=4 666 976

COMMENT OF obtained RESULTS

As mentioned above, the samples analysis are done by NITON portable analyzer. The analyses results are expressed in ppm. From the table of results it can be seen that there is a high percentage of copper (Cu) in samples composition. The high percentage can be assessed also for the iron (Fe) in all samples. The highest result of Cu percentage has been read in sample 03 taken in point with coordinates (X=7 521 778, Y=4 666 612) and it was 541221 ppm. The maximum value of copper (Cu) percentage in samples 01 was 48460.79ppm. Whereas minimum value was 0. Average value of copper (Cu) percentage in these samples was 7304.8ppm. Also the iron (Fe) percentage in these samples had very high values. The maximum value of iron (Fe) was 155344.42ppm, minimum value was 0, whereas average value was 37356.42ppm, that it is a relatively high average.
In samples 02 taken in point with coordinates (X=7 522 183 Y=4 666 471), the maximum value of copper (Cu) was 419381.4ppm, the minimum ones was 0, and the average value of Cu percentage was 86733.93. In these samples, iron had the maximum value of 426726.1ppm. Minimum value was 0. Whereas average value was 175221.7ppm.
In samples 03 it is read the maximum value of copper (Cu) of 541221ppm, that it is the maximum value of all values read in these samples. The minimum value of copper (Cu) percentage in these samples was 0, whereas the average taken from reading of all values measured in these samples was 107163.7ppm.
Iron (Fe) in these samples had a maximum percentage of 465207.2ppm, minimum percentages was 0 whereas the average value of read percentages of iron (Fe) in these samples was 191547.1ppm. Except copper (Cu) and iron, it is seen from these tables that there are read also very high values of manganese (Mn), nickel (Ni), chrome (Cr), cobaltite (Co), gold (Au). But these values are not commented.

CONCLUSION

Based on results of earlier explorations, including also drillings done in some points of the area, it can be concluded that the detailed exploration works in Elez Han region, at Rezhanc village, must be intensified in the future. The analysis made by NITON portable analyzer show a significant iron mineralization in a very wide sector of this area. This can be taken as base to justify explorations with a relatively high cost in the future.

REFERENCES

[1] Report of works on prospection of the year 1959 (Rezhanc)
[2] Explanatory text KAQANIK

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PERSPECTIVE LATERITES OF NI- SILICATE MINERALIZATION IN KOSOVO

Shehribane ABAZI [1], Sylejman HYSENI[2], Bedri DURMISHAJ [2], Ramiz KRASNIQI[2]

[1] ICMM (Armend Daci nr1,Prishtinë, Kosovë,
[2] Faculty of Geosciences and Technology- FGT- Mitrovice, Kosova
e-mail: sabazi@kosovo- mining.org

ABSTRACT

The laterites of Ni – silicate are of great importance for Kosovo. The known Ni – silicate deposits and occurrences belong to Drenica area, such as "Gllavica", "Çikatova e Vjetër" and a number of occurrences Harilaçë, Sllatinë, Grablan, Baks - Kralicë, Galicë - Dubovc, Çirez, Krajkovë - Domanek, Llapushë, Krasmirovc, Nekovc, Trsenik, Carraleva and Kaçanik. The iron ore reserves discovered so far in Kosovo are 750.000 ton me 40% Fe and the ones of Fe – Ni in Shale,Terstenik – Carralevë – Ivajëare 2.500.000 ton with : Fe – 45 -53%, Cr – 0,4% and Ni – 0,6%.

KEY WORDS: *Perspective, ore deposit, Ni-silicate, Fe-Ni oolitic, ore reserves, Kosovo*

INTRODUCTION

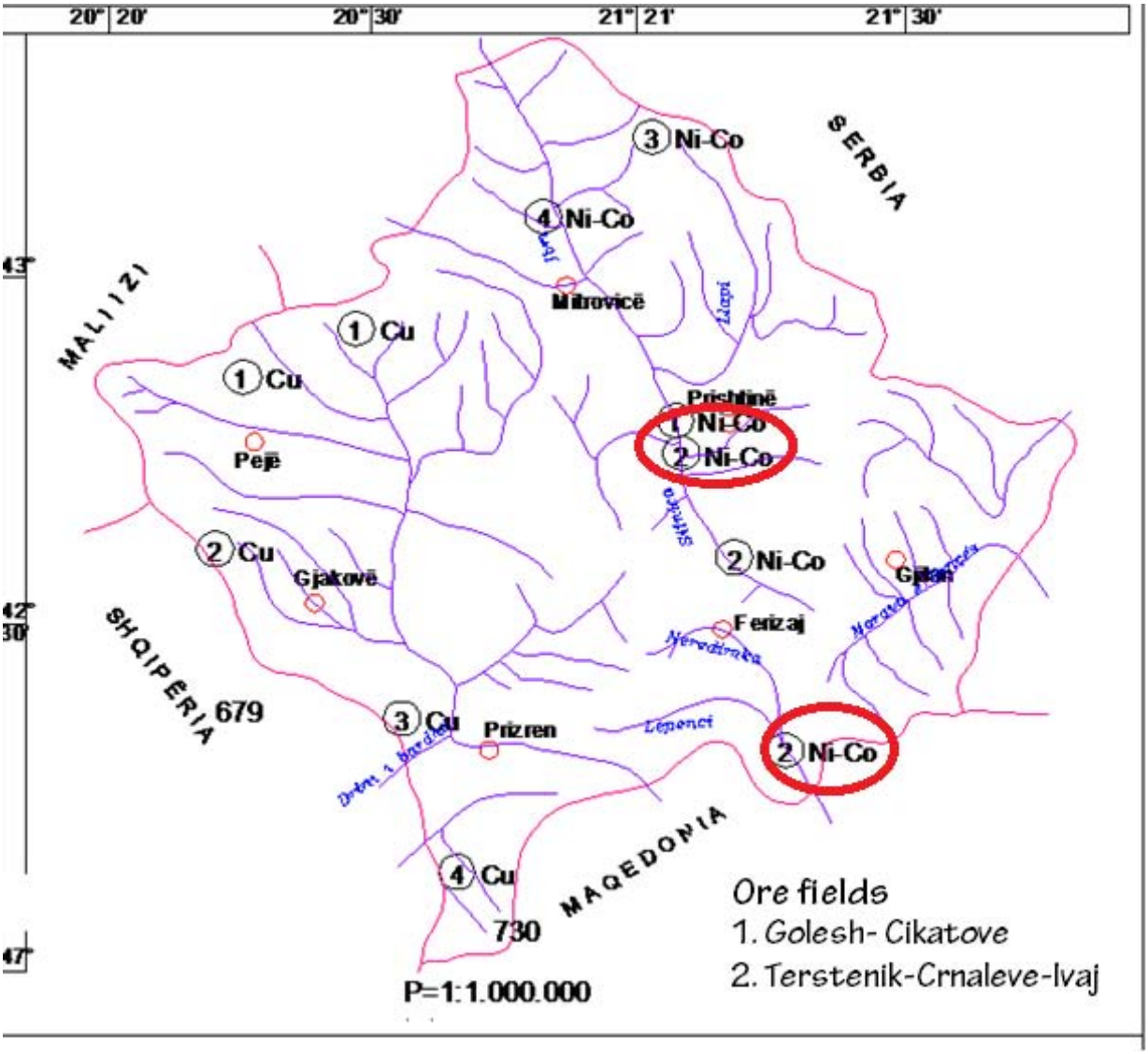
The known Ni- silicate deposits Çikatova, Drenas and Gllavica in Magura with their features in the morphology of the ore bodies, chemical composition and structural genetic characteristics and composition of the host rocks, have been of the first significance and economic interest for Ferronickel.
The exploration for Ni- silicate ore in the territory of Kosovo began in the year 1958, and the first occurrence of Ni – silicate mineralization is the one of Gllavica, near the magnesite mine in Magura.
In 1961, the detailed prospecting – exploration enabled the definition of Gllavica ore deposit.
The exploration of Gllavica Ni ore deposit was completed in two phases during the years 1961 - 1997 and 2006 – 2007..
The grid of the exploration drillings was 25 m x 25 m and 50 m x 50 m. The deposit thickness varies 2 – 32 m, in average some 11 m. Some 459 drillings were performed during the first phase and others 192 drillings during the second one.
Ni and other associating elements, important for the technological process, such as Fe2O3, SiO2, MgO and CaO, are analyzed.

NI – SILICATE MINERAL DEPOSITS AND OCCURRENCES IN KOSOVO

In Kosovo, these deposits belong to Drenica area: Ni-Co silicate deposits of Old Çikatova and Gllavica (Fig.1) and a number of occurrences of the same mineralization such as the ones of Harilaç, Slatina, Grablak, Baks-Kralicë, Galicia-Dubovc, Cirez, Krajkovë-Domeneck, Llapushnik, Krasmirovicë and Nekovc. Other known occurrences are the ones of Besiana area, Luzhan and Tërnavicë-Murgull.
Ni – Co silicate mineralization is also present at Bajska area, at western part of Mitrovica.
Other known deposits and occurrences of this mineralization are the ones found at Junik, Ponoshevc, Morin, Popovc and Bobaj Boka (near Gjakova), genetically related to the lacustrine deposits originated by the weathering crust of the ultramafic massif of Gjakova.

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Figure.1 Ni – Co mineral deposit and occurrences in Kosovo



Geology and mineralogy of the Ni silicate deposits

Primary weathering crust products and associated mineralization lie on the serpentinites (Old Çikatova deposit), or are transported in short distances by the surface water (deposit Gllavica) and in long distances far from the ultramafic massif (deposit Suka). Primary crust deposits show irregular isometric morphologies.

The profiles of the weathering crust are different. In Gllavica deposit, the nontronite-siliceous profile consists of the following geochemical zones, from the bottom to the top: peridotites, serpentinized peridotites and nontronites, clayey nontronites, mineral opal-quartz, clayey yellow – red goethite (Fig.2, 2a).

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Figure.2 Deposit of residual concentration Ni-silicate Gllavica
Figure 2a Serpentine Gllavica mine

Mineralogical analysis, although incomplete, shows that the main ore minerals of Fe-Ni-Co silicate are: nontronite, lizardite, serpentine, garnierite, chalcedony, kerolite, goethite, hydro goethite, haematite, magnetite, chromium, kaolin, limonite, etc. Besides the main minerals, chalcopyrite, galena, and sphalerite and less arsenic, occur in small quantities.
Fe-Ni-Co silicate ore also contains Mn oxides and hydroxides, which condition the presence of Co. The industrial Ni values are related to nontronite , which composes 75% of the ore. Quartz, opal, chalcedony, olivine, magnesite, are the gangue minerals.
Iron mines in Kosovo are known at Shala area (formerly Sedllar - Lipijan) and Trsteniku belt (Drenas) - Caralevë (Shtime) and Ivaja (Fig.3). Geological exploration at Shala defined some 750,000 tons of iron

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ore with40% Fe, while in the area Trstenik - Caralevë - Ivaja the explored Fe – Ni ore reserves are approximately 2,500,000 tons containing main components: Fe - 45 -53% Cr-0.4% Ni - 0.6%.

NI-SILICATE PROSPECTION PERSPECTIVE IN KOSOVO

Geological exploration for Ni – silicate should continue in the main known areas. The level of exploration is not the same for the different ore types known in Kosovo so far. Only the sedimentary ores related to the Pliocene conglomerates which build up the sides of Dukagjini valley namely locations Popoc, Ponoshevc, Junik, Morine, are mapped.
Geological explorations in these areas are at stage II, and them do not enable the distinction of the promising sectors and the estimation of the size, distribution, metal content and the importance of these mineralizations found in these areas.
The exploration for Ni – silicate at Trepça ore belt is not uniform and some sectors have exploration of the stage III (Bajskë, Lozna, and Jelakce).
Ni-Co-Cu sulphides are found at Rahaveci peridotite massif. The exploration galleries have found only few concentrations of limited sizes.
The exploration of the stage III should be developed in Pliocene conglomerates which build up the sides of Dukagjini valley, at the sectors Popoc, Ponoshevc, Junik, Morin, and at Rahaveci peridotites massif. The sediments with oolitic ore with nickel and iron from Gradicë and Trstenik through Petrashicë, Caralevë of up Kaçanik, should be explored as well.
The exploration of the stage IV should be carried out in known areas of this mineralization such as Goleshi massif, Dobroshec, Old Çikatovë Bakes, Likoshan, and Llapushnik (Fig 3). Prognosis assessment shows that the predicted ore reserves might be up to 3 million tones.

NI SILICATE AND GEOLOGICAL RESERVES IN KOSOVO

The Republic of Kosovo is one of the main suppliers of Ni ore in the area. In Kosovo there is also the Ni smelting industry and this makes convenient the exploration for new Fe – Ni ore deposits.
Ni in the geological reserves of and Çikatova and Gllavica), is quite high above 1.02%.
Statistical data for Ni and other components for mineral deposit Gllavica show that (tab.3) average distribution of Ni is very high 1.16%.

Table.1 Geological reserves in mineral deposit Çikatovë

Geological reserves		m3		Ton		Percentage (%)	
Ni	Si2O3		Fe2O3		MgO		CaO
Total	**4,368,904.50**	**7,868,396.9**	**1.04**	**40.94**	**18.43**	**6.87**	**0.78**

Conclusion

The concept of the development of the mineral resources exploration for Ni-Co, Fe-Ni is of importance for the assessment of the mineral – bearing potential and on this base for the development of plans and programs for continuing geological exploration for the increase of the known ore reserves and discovering of new ore deposits of Fe - Ni and Ni – Co.
Ni deposits in Kosovo are concentrated in the central part of Kosovo, near Çikatova village and Mount Gllavica, between villages Medvec and Magure.
Total known ore reserves 21.024 457 t (with Ni from 0.02-2.71%), and Fe-Ni reserves are 2.500 000 t (with Fe from 45 -53%, Cr-0.4% and Ni - 0.6%).

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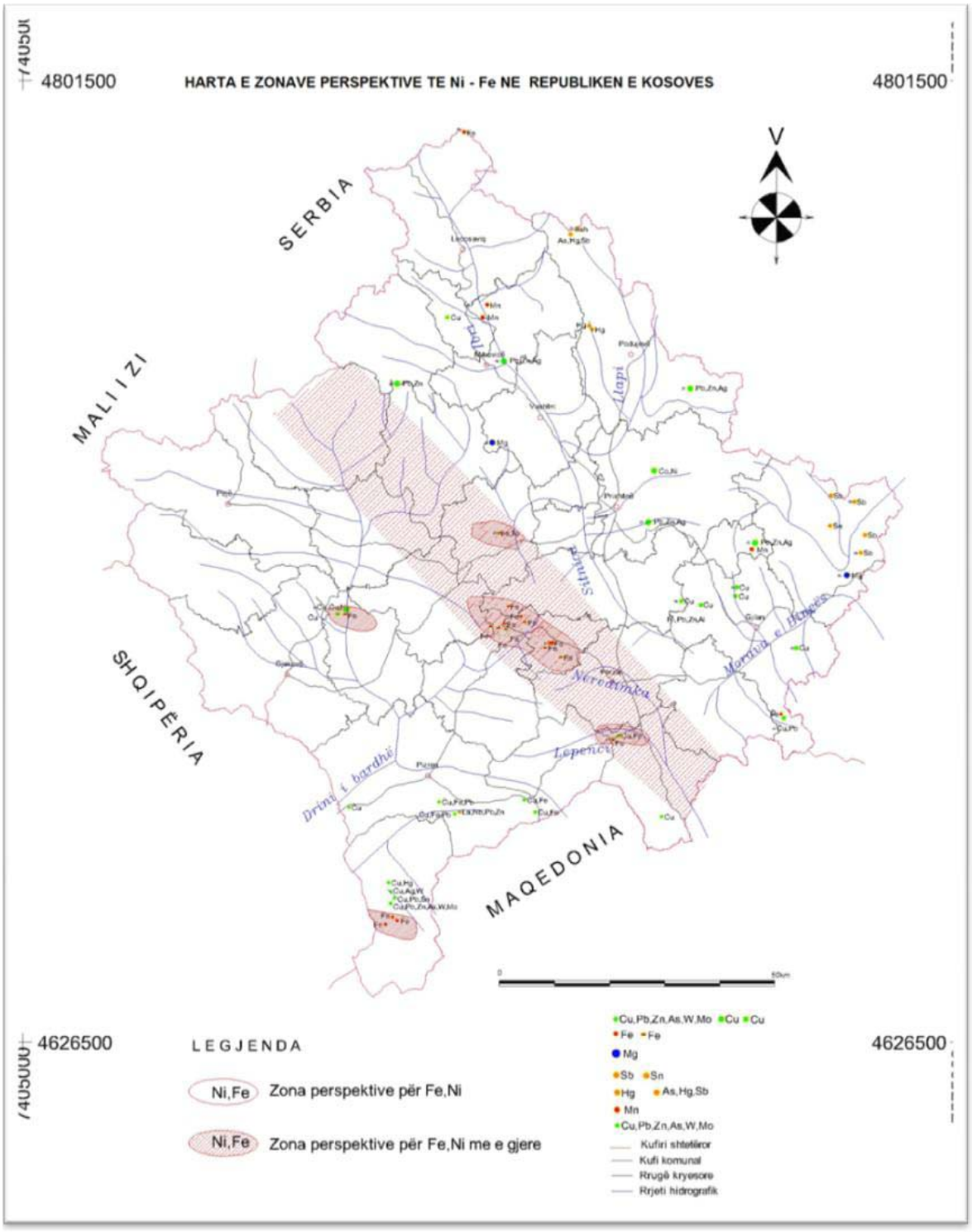


Figura.3 Map of promising Fe – Ni areas in Kosovo

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MINING RESOURCES IN KOSOVO AND ECONOMIC INTEREST OF MINING

Xhevdet Kastrati[1], Ramiz Krasniqi[1], Ahmet Tmava[1] , Shaip Latifi[1], Ibush Jonuzi[1]
[1] *Independent Commission for Mines and Minerals – **Kosovo***

ABSTRACT

The geology of Kosova consists of metamorphic rocks of basement, Mesozoic carbonates, basic and ultra basic rocks – Jurassic ophiolitic series, intrusions and intermediate – acid volcanic of Tertiary and upper Tertiary sediments. Complex tectonic structures are dominated by faults of NNW-SSE directions.
Metallogeny is characterized by favorable environment for:
Pb-Zn-Ag deposits as a result of Tertiary intrusions in Triassic and Cretaceous carbonatic rocks.
Nickel Ni and chromites Cr deposits are connected with Jurassic ophiolite series.
Epithermal mineralization connected with intrusion and volcanic of Tertiary.
Lignite in Miocene sedimentary basins and different industrial minerals deposits have the greater importance for economic development of Kosova.

KEYWORDS: Mines, mineral resources, Trepça, estimated reserves, coal

INTRODUCTION

Mineral recourses of Kosova

Kosova has a complicated geology that impacted in concentration of the considerable number of useful minerals. These minerals have supported the development of mining industry. The investments in mining and exploration of minerals in Kosova have been stuck for decades. Different investors are interested to start the investments on exploration and mining of minerals.

Lead -Zinc-Silver

Mining history

Exploration and mining of Pb-Zn mineralizations have a very long history. Traces of mineral operations are known since medieval. These are shown by the old mining operations. Exploration and mining are carried out in the beginning of XX century (1927-1941) from British company "Trepça mine Ltd". On a short period the company has commenced exploration, opening and mining. The mining infrastructure has been constructed in this period, including cable car and smelter in Zveçan. The use of mine during 1941-1944 is done by Germans. Mining activity has continued from 1949-2000. 32, 000, 000 tonnes ore have been extracted from Stanterg mine during mining history (1930-2000).

- Replacement and filling of gaps with mineralizations is done in Triassic and Cretaceous carbonatic rocks.
- Vein types of schist mineralizations, serpentinite
- Structural control (NNW-SSE)
- Association with Tertiary andesite -dacite industries.
- Metasomatic alteration of contact

Main Pb-Zn resources in Trepça complex

Stantërg- estimated reserves: 9.0 million tonnes 7.0% Pb, 4.3% Zn, 122 g/t Ag
Hajvali- estimated reserves: 2.9 million tonnes 9.2 % Pb, 16.9% Zn, 120 g/t Ag
Artanë- estimated reserves: 3.6 million tonnes 5.1 % Pb, 7.6% Zn, 142 g/t Ag
Belo Bërdo- estimated reserves: 3.7 million tonnes 8.7 % Pb, 7.8 %Zn, 120 g/t Ag
Cërnac- estimated reserves: 2.36 million tonnes 11.7 % Pb, 3.5 % Zn, 166 g/t Ag

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Airborne Geophysical Survey

- Magnetics
- Electro – Magnetics and
- Radiometrics (Potassium, Thorium, Uranium)

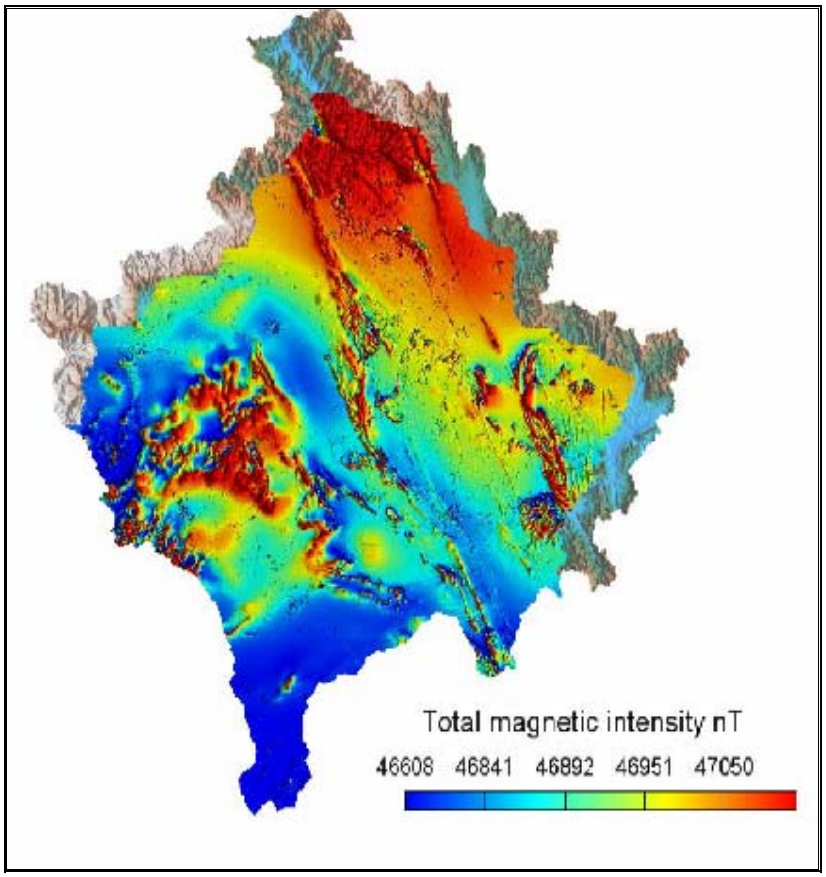


Fig 1. Airborne Geophysical Survey

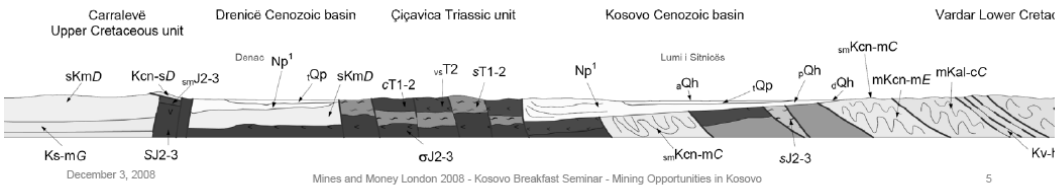


Fig 2. Profile from the Map

Bauxites

- Bauxite are located in the carstic area of Cretaceous limestone with an N-S extension around 6km
- Surface use of some ore bodies are done from 1966-1990
- Total reserves in 8 ore bodies are around: 1.7 Mt
- Additional resources: 4-5 Mt
- Content

Al_2O_3 45.0-51.0%
SiO_2 1.5-3.5.0%

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Fe_2O_3 30.0-38.0%
TiO_2 0.05-0.06%
CaO 0.05-0.06%

Laterite Nickel

- The average thickness and silicate ore (nontronite) is 10m and it is developed in Jurassic serpentinite in Ophiolitic Area
- Reserves about 14 million tonnes 1.3 % Ni and 0.07 % Co are in two mines.

These mines have a good potential of use with a good infrastructure including here also the Ferronikeli smelter.

Magnesites

Are occurred as:
Vein in serpentinite
(Goleshi- reserves of 1.7 Mt 46% MgO
Stratifications connected with dolomite
(Strezovci- reserves of 2.8 Mt 38-45% MgO)

Lignite

Main lignite deposits are located in Kosovo and Dukagjini basins of Miocene age.
The actual production is from two open pits that supply power plants with lignite.
Average thickness of coal layer is 56-70 m, whereas of cover 60-120m.
There are some 15.0 billion tonnes lignite resources in the Kosovo Basin, Dukagjini basin and Drenica basin.

Geochemical Survey

Stream sediment sampling for analyzing 53 elements including:

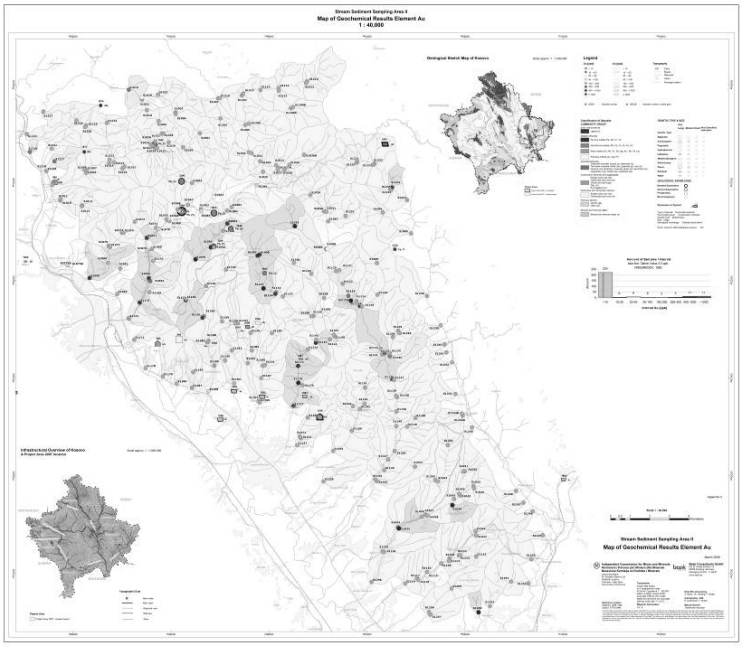


Fig 3. Geochemical Survey

Chromites

Podimorph mineralization of chromites in west of ophiolitic zone (in continuing of chromites deposits of Albania)

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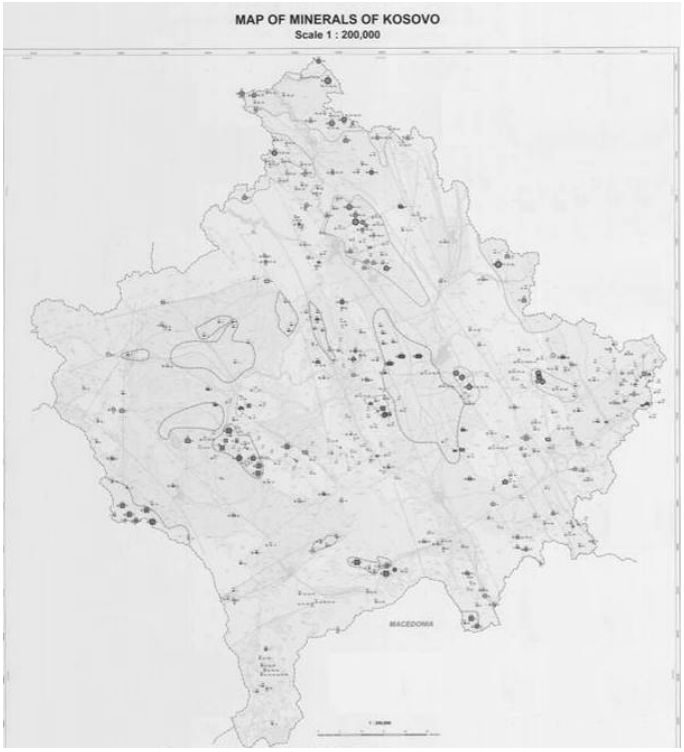


Fig 4. Kosovo map showing the main concentrations of Minerals and processing facilities

1. Kosovo is rich with mineral resources especially lead, zinc, lignite, iron - nickel, bauxite, etc.
2. Existing mining industry represents great potential for private investments. Mining industry is one of Kosovo traditions.
3. Kosovo is open to further exploration of its mineral resources.
4. Kosovo has a very Investor Friendly Mining Regulation.
5. Mining and mineral Sector of Kosovo is very attractive for private investors.
6. The Government of Kosovo is engaged to encourage private investors.

REFERENCES

[1] BLISS, J.D. (1998): Aggregate Modeling and Assessment. In BOBROWSKY, P.T. (ED.): Aggregate Resources. A Global Perspective. p. 255-274, 10 fig. Balkema, Rotterdam/Brookfield.
[2] Beak Consultants GmbH (2005): Kosovo Quarry Plan.
[3] Beak Consultants GmbH (2006): Compilation of Geoscientific Maps of Kosovo. Digital Geologica Map 1: 100,000 (DGM). Description of the Map Compilation, Report (187 p.) with 5 Appendices, (15 Maps).
[4] BRINGEZU S. (2002): Towards Sustainable Resource Management in the European Union, Wuppertal Papers, No. 121, January
[5] BRITISH GEOLOGICAL SURVEY: European Mineral Statistics 1999-2003, Keyworth, Nottingham 2005
[6] GEOSONDA BEOGRAD (1975): Elaborat o proracun rezervi i ispitivanju kvaliteta kamena lokalnost "GLAMA" Gjilan.
[7] GIOVANNANGELI, P.: Decorative and dimension stone development potential in Kosovo, USAID KOSOVO report, 15.November 20

ISSN 2306-9600

[8] HOUSEHOLD BUDGET SURVEY (2003): Housing in Kosovo, annual report.
[9] Elezaj&Kodra (2008): Geology of Kosova. University book, Prishtina.
[10] Official gazette of Republic of Kosova (27 August 2010): Law on Mines and Minerals, Law No. 03/L-163. Prishtina: Year V/No.80.
[11] Archive ICMM Prishtina

ISSN 2306-9600

SULFIDE MINERALIZATION AT THE STRUCTURE OF THE VOLCANIC ROCKS OF PERLATI AREA (CENTRAL MIRDITA) AND FURTHER EXPLORATION PERSPECTIVE

Asllan DACI

"Tirex Explorations", Rruga "Dëshmorët e 4 Shkurtit" Tiranë – Shqipëri,
e-mail: asllandaci@gmail.com

ABSTRACT

For more than 30 years, Perlati area, has been subject to numerous geological exploration studies. Many surveying, thematic – generalizing, prognosing studies, and tens of km^2 integrated geological – geophysical – geochemical, as well as thousands meters of drilling have been carried out, which were materialized in discovering the Perlati deposit with 4 million tons of copper reserves, and were evidenced some significant targets with future perspective around it. Result of this study and exploration in this area, is detailed geological and structural deciphering, the role of overthrust as controlling factor of sulfide mineralization, volcanic relationships with ophiolitic melange, laws of location of sulfide mineralization in the structure of volcanic section, mineral components, ore types, as well as defining the most perspective sectors, for increasing new polimetallic reserves in this area. Determination and exeptance now by many researchers of the fact that main productive level of copper sulfide mineralization and its associates in Perlati area and beyond is located in agglomerate and andesitic tuffagglomerate at contact with basaltic and basalt –andesitic lava, represents a significant guide for new discoveries. Development of sulfide mineralization according to an axis at NE – SW direction, and 200 m wide, can orientate correctly geological and exploration works. Overthrust is intensively developed in this area, which is apparent three times in volcanic section, being a controlling factor for sulfide mineralization. Analytic data of some foreign companies, as "NEBEX" (1995-1996), "Balkan Resources" (2008-2010), Tirex Explorations (2008-2011), which have carried out prospecting and exploration activities in this area, bring some important facts regarding the content of Au in potent sulfide alteration areas (hydrothermal metasomatites). These data have a special scientific and commercial importance, therefore, whole Perlati area, should be reassessed for probable potential of Au, Ag, Te, Se associates, etc.

KEY WORDS: *Formation, Structure, Mineralization, Prognose, Reserves.*

INTRODUCTION

Perlati area lies some 20 km east of Rresheni town, and it is part of the ophiolites of Central Mirdita. Geology of this area consists of a variety of volcanic and intrusive rocks and related copper sulfide mineralization and its associates. The first prospecting workings were accomplished by Russian and Albanian geologists in the early of the years '50^s. Then, after the discovery of Kurbneshi copper deposit related to gabbros, intense prospecting operations consisting of geological surveys, trenches, strippings, adits and drillings, step by step extended all over the area and their final results were the discovery of Rrenjolla and Perlati ore deposits related to the volcanic rocks. Later, other neighboring sectors of these deposits became important prospecting targets for copper mineralization. Presently, Kurbneshi and Rrenjolla deposits are already totally mined out, while Perlati deposit is partly mined. Up to the year 2000, integrated prospecting workings carried out by the Albanian Geological Survey and some foreign mining companies, have contributed on a better assesment of the copper – bearing potential of this area, defining significant promissing sectors for exploration of new mineral resourses.
This paper is a synthesis of the latest data obtained by the recent mineral exploration programs undertaken in this area and it aims to sensitize stakeholders for further explorations.

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GEOLOGY OF THE AREA

Perlati area is situated southeast of Central Mirdita, and is represented by rocks of eastern ophiolites of SSZ type, such as: basalt – dacitic formation, complex of intermediate – acid intrusive rocks, ultramafic rocks and sediments of ophiolitic melange (Fig. 1).

Basalt – andesitic – dacitic formation

Basalt – dacitic formation, is widely present in this area, striking from Buzeboja at southeastern edge of Perlati deposit, to northeast, at Shebe – Rrenjolla sector, Lumth - Shelbum, to Tuturiq in northeastern part of the area, at the tectonic contact with Kurbneshi gabbros massif. This formation consists of basalt-andesitic pillow lavas and agglomeratic andesites sequences.

Basalt and basalt- andesite sequence crops out at southwestern part of Perlati deposit, near to Livadhi i Turkut, but its best outcrop belongs to Rrenjolla and Lumth – Shelbum sector, up to Kthella e Eperme. It is represented by massive flows, as well as pillow and spherical lavas of different sizes, often intensively epidotized with pyroclast intercalations. Thickness of this sequence at Perlati area is limited, only 200 m, because it is intersected by plagiogranitic intrusions.

Andesites and basalt – andesite sequence occupies the central and most part of Perlat – Shebe – Tuturiq area, that, from bottom to the top consist of basalt – andesitic pillow lavas, aglomeratic – andesitic lavas, cemented by glassy and chloritic material, tuffs and tuffagglomerates containing high quantity of chloritic and hematitic matter and less dacite – rhyolites. Its normal section is less than 400 m (Drill nr. 600 – Shebe), (Daci A., 1994). According to Gjata K., et.al. (1995) and Shallo M., (1995), andesite is distinguished by its low grade of TiO2, and high grade of MgO, facts that suggests their clear boninitic composition. The top of the volcanic sequence is a cherty – radiolarian horizon 10 – 15 m thick, overlain by the ophiolitic melange. Heterogenous ophiolitic melange is represented by clayey – cherty – hematitic shales, cherts, limestones, sandstones and volcanic blocks. It is widespread at the central part of Perlat – Shebe – Tuturiq area. According to Prela M., (1996), Prela M., Xhomo A., (2000), its geological age is accepted to be of J_2 (Upper Bathonian – Callovian), and its thickness is already confirmed by the drillings. Sheeted dyke complex at Perlati area is weakly expressed. They are commonly encountered at Rrenjolla, Shebe e Siperme, Shenapremte and Lumth – Shelbum sectors. They are mainly diabasic and diabasic porphyrite dykes. Boninitic dykes occur at the uppermost part of the section. (Gjata K., et. al, 1995). Diabasic porphyritic dykes at Rrenjolle – Shenapremte sector intersect sulfide mineralization located in basalt – andesitic pillow lavas. They are mainly found in lower part of basalt and basaltandestic sequence. (Daci A., 1994, Daci A., et.al. 2003, Zaçaj M., et.al. 2001).

Plutonic rocks

In this area, the complex of basic and intermediate–acid intrusive rocks is represented by gabbro – plagiogranites and quartz diorites. In Perlati deposit, they are encountered at depths by drillings, whereas in surface they occur in west of Zalli i Dodajve, not far from Shebe e Poshtme, as well as in northestern part of the area, at Shenapremte – Qafë – Lak and Tuturiq sectors. In the section of Rrenjolle – Kurbnesh road (Sheneparemte – Qafe – Lak), the serrated and chloritized intrusive contact of plagiogranites with basalt–andesitic pillow lavas is clearly observed, whereas in front of Shebe, within plagiogranites, there are frequent xenoliths of volcanic rocks. (Daci A., 1994).

Ultramafic rocks

Ultramafic rocks are less present at the area. They are harzburgites and serpentinized harzburgites that crop out only at the southeastern part Perlati deposit (at Buzeboje) and also like a small fragment at Tuturiqi sector, close to the outcrops of the mineralized zones of this target area, having tectonic relationship with volcanics and ophiolitic melange.

Structure of Perlati area

Structure of Perlati-Shebe – Tuturiq area is characterized by development of folds and overthrusts. Volcanics of this area have been intensively subject to folds and faults, forming in plan some syncline and anticline-like structures, flanks of which are complicated by overthrust. Perlat – Shebe syncline structure has northeastern strike: its core consists of ophiolitic melange, 300 m thick, and the flanks are basalt – dacitic formations of both sequences, as well as plagiogranites and quartz diorites. The eastern part of this structure is complicated by the presence of overthrust. At Shebe sector (in front of the school), this

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structure tends to overturn towards the east. Just in its flanks, the sulfide mineralization of Perlati deposit and mineralized showings of Shebe, are located. Anticline structure of Lumth – Shelbum, extends from Shebe e Poshtme to the northeast, up to Kthella e Eperme, close to Tuturiq. At the core of this structure, massive lava flows and basalt pillow lava with dyke complex, as well as other pyrite sulfide mineralizations of Shelbumi, crop out. Its eastern flank is intersected by plagiogranite and quartz diorite intrusions, whereas in the west, the outcrops of agglomeratic and pillow lavas of andestic sequence of Shebe e Siperme, predominate (Fig. 1). Towards north, this structure gives way to syncline structure of Tuturiq (Fig. 1), which extends under the cover of the gabbroic massif of Kurbneshi. At the northeastern flank of this structure, composed by agglomeratic and andesitic lavas, the copper economic mineralizations, intersected by mine workings (trenches, adits) and drillings in Tuturiq target, are expected.

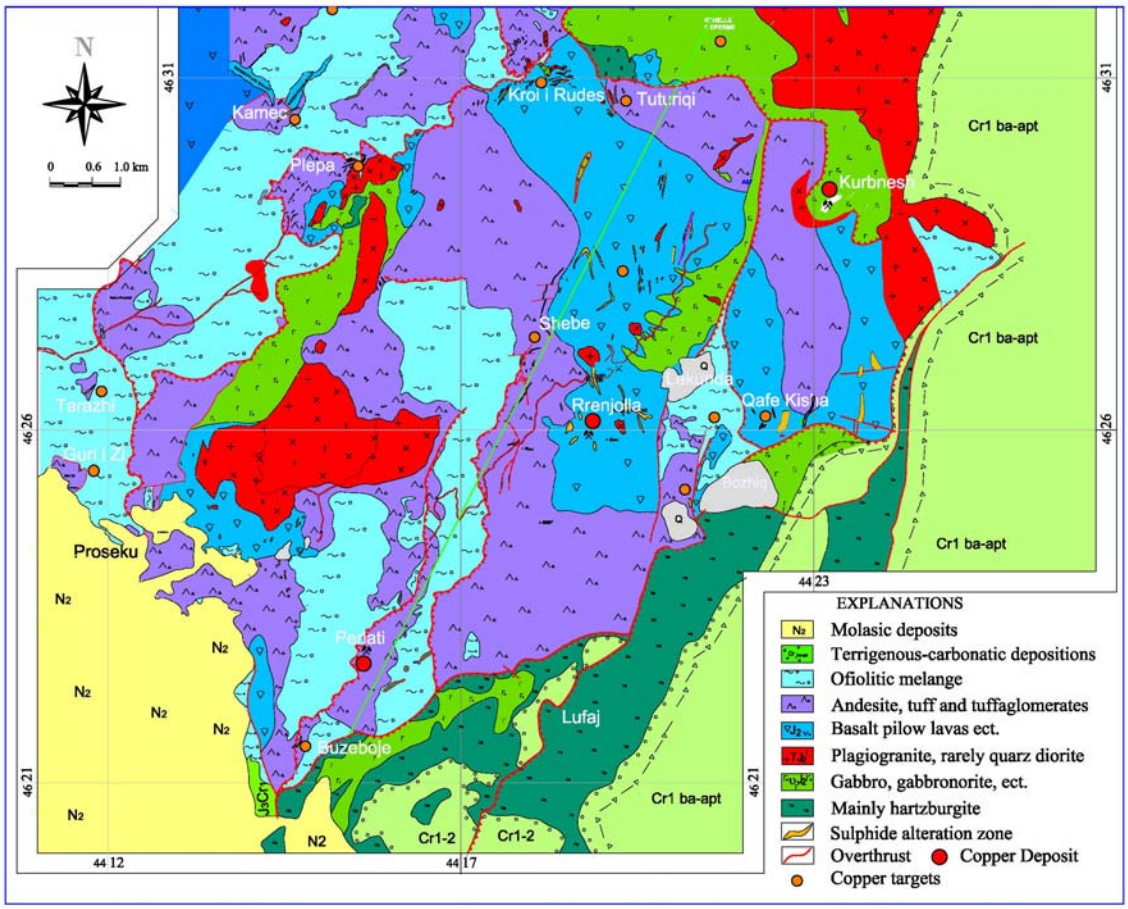


Fig. 1 *Geological map of Perlati area (Compiled Daci A., 2008)*

Overthrusting is the most distinctive feature in this area. Five main faults in Perlat – Shebe area are distinguished (Fig. 1). The first one starts in Southern edge of Perlati deposit, in Buzeboje, continues along the Zalli i Dodajve, and ends close to Shebe e Poshtme, putting into contact agglomeratic – andesitic lava with ophiolitic melange at angle 30 – 40^0. Apparently, its effects to the north gradually lose, weakly complicating western flank of Shebe syncline. In Perlati deposit, the volcanic section and related sulfide mineralization , is repeated 2 to 3 times by effects of the overthrust (Fig. 1,2). Second one starts east of Buzebojë and puts into contact the ultramafic rocks with andesitic volcanics and ophiolitic melange (clays – clastics); further north, at Tharri sector, agglomeratic – andesitic lave with ophiolitic melange are put into contact which continues up to Shebe e Poshtme (in front of school). The angle of dip is to the east at 35 – 40^0. Third fault is observed at northernmost edge of Perlat – Tuturiq area. It has longitudinal strike and northern dip at 30^0, and puts into contact gabbroic massif of Kurbneshi with agglomeratic – andesitic lava of Tuturiq, whereas overthrusts in Lufaj – Qafë – Kishë – Kurbnesh put into contact the ultramafic rocks with andesites and the basalt pillow lavas with ophiolitic melange (Fig. 1). Identification of these faults has a special significance for structural interpretation and correct orientation of prospecting works for sulfide mineralizations of this area.

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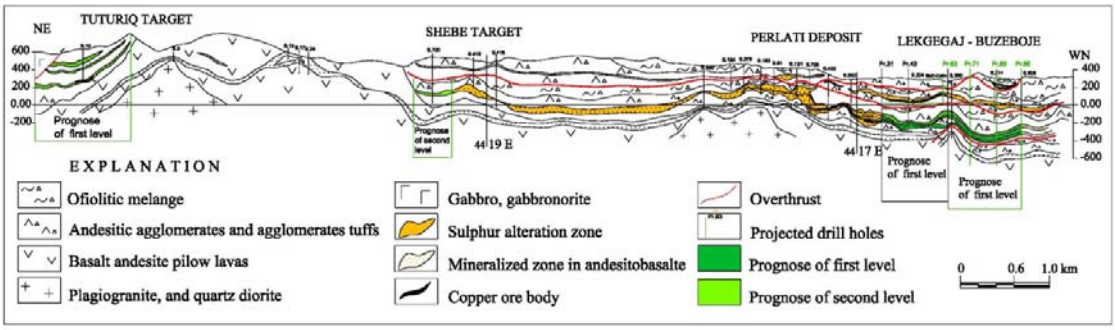


Fig. 2. Longitudinal geological section of Buzeboje-Perlat-Shebe-Tuturiq Area (Compiled Daci A., 2003 with additions 2012)

Sulfide mineralization in Perlat – Shebe – Tuturiq area additions

In Perlati area, sulfide copper-bearing mineralization, is encountered along entire volcanic section, forming economic concentrations at some of its certain levels. Perlati deposit has been discovered for e strikelength (NE – SW) of 2 km. In the surface, sulfide mineralization of this deposit is represented by two limited gossans - like exposures, one located at southwestern edge (In Buzeboje), and the other at former Perlati shop.

In this viewpoint, this is a typical covered deposit. For both zones, there are almost similar characteristics; are represented by strongly gossans, less chloritized and quartzised, with fine pyrite disseminations and any malachite stain. Based on many prospect and exploration works carried out since 1975 till 1993, have been discovered in total 4 million copper reserves at average Cu grade of 2.2%, whereas actually are remaining of 2.5 million of copper reserves at 2.5% Cu. Mineral composition is as following: pyrite, chalcopyrite ± sphalerite and disseminated type, beins and veinlets of pyrite - chalcopyrite. The shape of massive ore bodies is lenticular, pebble-like, lens-layered with dimensions 15 x 20 m, with sharp and apparent contacts with wall rocks, whereas veined – disseminated ore bodies are larger and have stability in strike and dip, as well as gradual contacts with wall rocks. Sulfide alteration zones (hydrothermal metasomatites), intersected by numerous explorating drillings, result at considerable thickness, ranging from 20 – 30 m to 50 – 60 m, and are followed in strike up to 200 – 250 m, serving as good prospecting guide for concentrations of copper economic mineralizations and its associates in this deposit and beyond. During 2008-2010 "Balkan Resources" Sh.p.k, has implemented an exploration drilling program in Perlati deposit. Based on analytic data, results that potent alteration zones, within of which are located sulfide ore bodies (massive and disseminated), have relatively high Au values, ranging from1 to more g/t, which constitute a considerable gold-bearing potential in this area (personal conversation). Such results for Au, are presented also by "NEBEX" (1995-1996) and Tirex Explorations (2008-2010), which have had mining prospect – exploration activity in this area. Based on the data obtained by numerous prospect and exploration works and our direct observations in this deposit, some important conclusions are outlined, as following:

1. In volcanic section of Perlati deposit, are distinguished 3 levels of sulfide mineralization:

a) Deepest level of disseminated, sulfide and low grade mineralization in economic components, intersected by drillings at central part of Perlati deposit, is located in pillow lava, as well as basalt and basalt – andesitic massive flow (Fig. 2).

b) Main level of productive sulfide mineralization of Perlati deposit (yellow color), is already confirmed at a general and stable length over 2 km, average thickness of mineralized zone 40 – 60 m, within of which are developed lens – layered, pebble – like and lenticular ore bodies of this deposit, is located in agglomeratic – andesitic lava, in vicinity of the contact with basalt and basalt – andesitic pillow lava. (Fig. 2,3).

c) The mineralization, located at contact between tuffs and tuffagglomerates, makes up uppermost level of volcanic section in this area. To this level belongs also mineralized showings of Buzëboja and Dyqani i Perlatit. This mineralization is less stable, mainly disseminated, with small potential reserves. (ore body no. 1, Perlat; and ore body no 85 Buzëbojë) (Fig. 2).

2. Sulfide mineralization of Perlati deposit seems to be quasi conformable with structure of wallrocks. Based on so far data of this deposit, no combined mineralization has been observed (Fig. 2). (?)

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3. Sulfide mineralization in Perlati deposit is developed along the the axis of ore structure at a direction NE – SW (30°-210°), is already confirmed with a strikelength about 2 km (Fig. 3). Width of economic mineral zone around the axis of this structure doesn't exceed 200 – 250 m, only in rare cases it reaches to 300 m. (Fig. 3). Later on sulfide mineralization becomes poorer, and gradually passes to altered volcanic rocks without mineralization. Concentration of copper sulfide mineralization along this defined direction, has a special importance not only for orientation and further exploration of copper sulfide mineralization in deposit and the area around it, but also for study and new genetic interpretations (Daci A., 2003, 2011).

4. Based on mine workings, was seen that massive pyrite and chalcopyrite ore bodies have not stability in strike and dip, have limited dimensions 15 x 20 m, rarely 30 m, their shape is pebble – like, irregular and with no relationship with each other, whereas veined – disseminated bodies have stability in strike and dip (Daci A., Bazhella F., 1989).

In genetic aspect, volcanic sulfide mineralization is related to Jurassic volcanism and subvolcanic facies. It is formed in medium to low temperature conditions, evidence of which are sulfide mineral associations, presence of relict marcasite, solid solutions of chalcopyrite – sphalerite, ferrous sphalerite, as well as mineral associations of hydrothermal metasomatites, belonging to sericitic and zeolitic facies. (Shallo M. 1980). Recent opinions of Hoxha L., et.al. (2000, 2002), about mineralization of Perlati deposit, say that it is related to "Black plumers", similar to deposits of "Cyprus" type. Time of volcanic sulfide mineralization formation is approximate with formation of volcanics.

Further north of Perlati deposit, are exposed mineralized showings of Shebe (Fig. 3), followed with interruptions for about 3 km from Tharri in South, to Ricaj in north. They are often represented by intensive gossans, with fine to medium pyrite disseminations, rarely are encountered chalcopyrite nests and malachite stains, with a general NE –SW strike, and northern dip at 40 – 45^0, and are located in agglomeratic pillow lava (hyalospilitic, tuff and tuffagglomeratic lava intercalations, etc). At the northernmost part of the area are exposed sulfide mineralized zones of Tuturiq (Fig. 3), located in agglomeratic – andesitic lava, and represented by intensive gossans, mainly chloritized with pyrite disseminations and chalcopyrite nests, reaching to economic values in the surface. Zones have northwest – southeast strike, different from other zones, perhaps this can be explained by the effect of overthrust, which is strongly developed in this sector.

PERSPECTIVE FOR EXPLORATION OF COPPER MINERALIZATION AND ITS ASSOCIATES IN PERLAT – SHEBE – TUTURIQ AREA

As we have mentioned above, sulfide mineralization of Perlati deposit, is located in syncline structure of the same name, at contact of agglomeratic – andesitic lava with basalt – andesitic pillow lava (Fig. 2). Andesitic sequence (agglomeratic, tuffagglomeratic, glassy and tuff sequence), which is main setting of location of sulfide mineralization, has a considerable distribution from Buzeboje in south and continuing to the north in Shebe and Tuturiq. This sulfide mineralization, regardless of repeated overthrust in volcanic section, performs a NE – SW linear continuity. By the late of 80s and early 90s in central and southern part of Perlati deposit, have been carried out some exploration drillings, in the function of the idea of ore structure axis. Some of these drillings (543, 390, 540, 573, 590), have intersected potent sulfide mineralized zones, and within them copper ore bodies at thickeness ranging from 0.5 to 15.8 m and copper grade from 3.41 – 9.40%, whereas Hole no – 608 in Buzeboje has confirmed the continuity of mineral zone at southernmost tip of this area (Fig. 2, 3). These drillings have already evidenced a certain mineralization level, which should be explored below discovered level of existing Perlati deposit (Daci A., 1987, 1994, 2003). Similarly, integrated geological and geophysical works carried ou in this sector, support the geological idea for such level of mineralization. (Hoxha L., et.al 1994, 2000, Leka P., et.al. 1988, Daci A., et.al. 1987, 1994). These facts once again tell about a clear perspective of Perlati deposit in its southwestern part, below the discovered level of this deposit in Lekgegaj to Buzeboje in its southernmost part.

Surface processes of mineralized zones of Shebe, which are exposed as gossans, integrated works and historic drillings carried out in this target around '70s, as well as debris containing massive sulfide mineralization found during field observations by "Tirex Exploration" in summer 2008, throw light on the possibility of ore structure continuation of Perlati deposit, toward Shebe and Tuturiq (Fig. 3). Performing of specialized geophysical works, and depending on results obtained by explorating drillings, will be evaluated the mineral-bearing potential of Shebe area.

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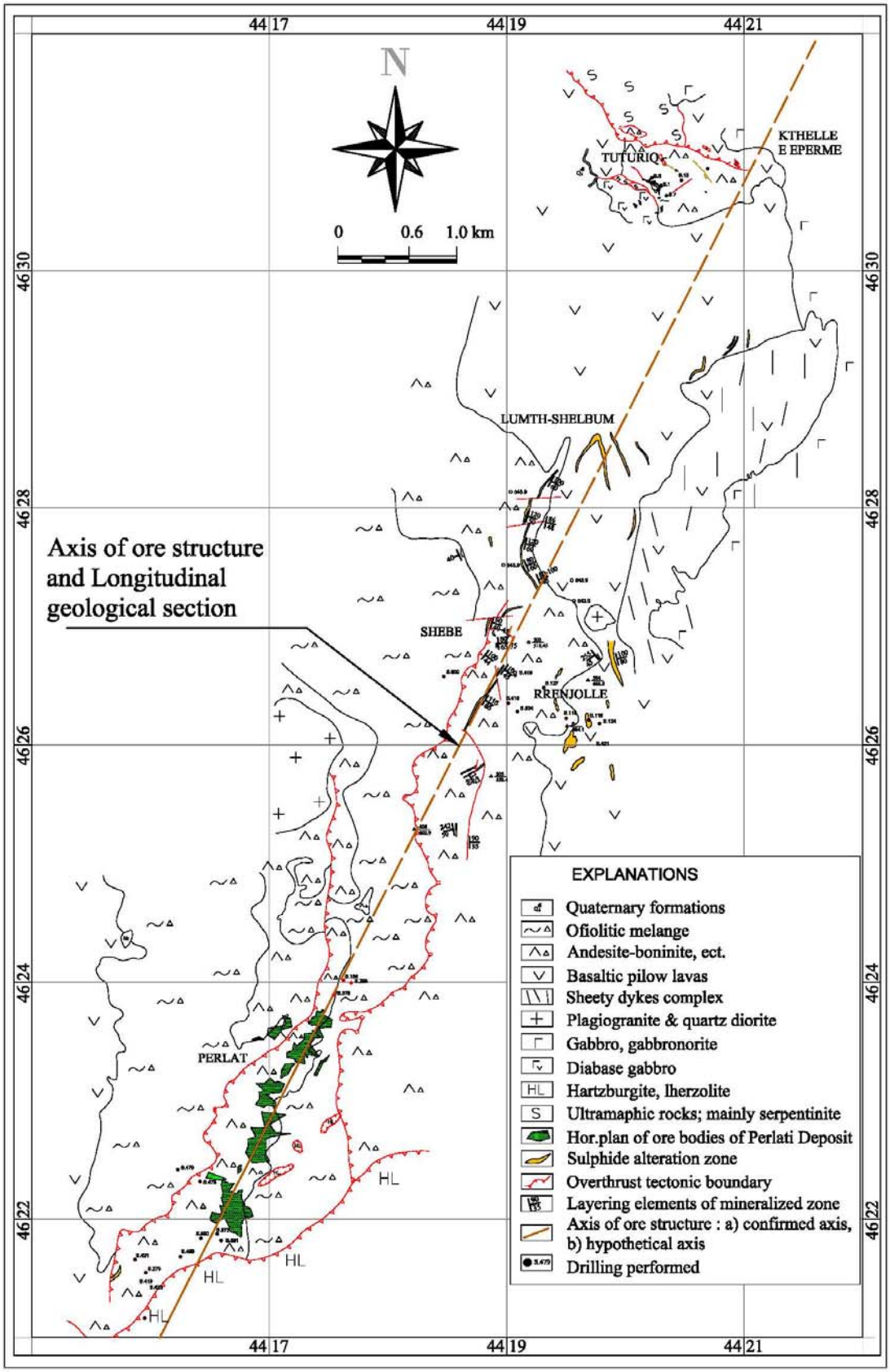


Fig. 3. Geological map of Perlati – Shebe – Tuturiq area with horizontal plan of ore bodies of Perlati deposit and axis of ore structure (Compiled Daci A., 2003)

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In Lumth – Shelbum, as shown at longitudinal geological section (Fig. 2), is a lifting of volcanic structure, showing in plan an anticline structure, in nucleus of which, are found basalt pillow lava, not favorable for massive sulfide mineralizations in this area. Further north, this anticline structure is replaced by a syncline structure, in center of which are located agglomeratic – andesitic fotmations, with affinity to contain copper sulfide mineralizations and its associates. This is evidenced by copper and gold mineralization in Tuturiqi sector. In works and drillings, accomplished during '80s (Legisi M., Shtjefanaku D., 2000), in Tuturiq target, have been intersected copper ore bodies at thickness 1-3 m, with Cu grade to 2%, whereas some gold assays, performed by "NEBEX" during 1995-1996, returned values to 3.75 g/t. These data present another possibility for discovering a new copper deposit in volcanic – andesitic rocks of this sector, which may continue below overthrust plane of gabbro massif of Bulshari.

METHODOLOGY OF STUDY

Several years of work experience as designer and implementer in prospect and exploration projects, of numerous field observations in whole area, compiling geological reports with calculation of reserves, participation in study and joint projects with other scientific institutions for 30 years on end, have been the main source of information, which served to interpretation and to present important conclusions regarding the geology and sulfide mineralization in Perlati area. Frequent observations carried out at depths of Perlati mine when it was in operation (1985-1989), helped me to see directly geological processes and to collect facts about morphology of ore bodies, their shape and size, relationships with wallrocks, mineral composition, ore type and strong alteration zones impregnated with sulfide mineralization. The integrated geological and geophysical works, accomplished for many years by Geophysical Center in this area, and cooperation with best specialists, were training and tremendous source of information that helped to crystallize many hipothetical ideas, to concrete definitions of perspective ore fields. Taking into consideration the views and interpretations of all researchers for Perlati area, as well as my long experience, was made possible to finalize this study.

CONCLUSIONS:

1. Perlati area is part of eastern ophiolitic belt of Albania, where predominate andesitic – dacitic – volcanic formation, containing copper sulfide mineralization and its associates.
2. Geology of this area is complicated by overthrust, which should be taken into consideration during orientation of further prospect and exploration works.
3. Sulfide mineralization is spread in whole volcanic section of the area, but the main productive sulfide mineralization is located between tuffagglomerate and basalt – andesite sequence.
4. This mineralization is developed along an ore structure at NE – SW direction, with productive width about 200 – 250 m. Based on what we discussed above, the following perspective sectors (as first instance prognosis) for increasing of copper reserves and its associates, have been defined:

a) Lekgegaj – Buzëbojë area (see longitudinal section, lines 31-95), below the level of discovered deposit, is defined as first instance prognosis with potential possibilities for increasing copper ore reserves and its associates. If exploration works (drillings), will be done starting from mine levels, at altitude 0.00 m, technological complications and drilling depths would be substantially reduced.

b) Shebe sector, as possible northern continuation of the axis of Perlati ore structure, is another place where exist possibilities for discovering a new copper deposit. Initially, in this sector, we recommend performing of some specialized geoelectric works (we suggest Real Section Method), and then drillings, especially at most intensive anomaly axes.

c) At northernmost part of the area, Tuturiqi target is perspective for exploration new polymetallic reserves of Cu, Au and other elements. Also in this sector, we initially recommend geoelectric works, and then drillings, to finalize the discovery of new ore bodies.

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REFERENCES:

Daci A., & "Tirex group", 2011. *Summary report of Geological – Exploration works, accomplished in Qafe Mali – Perlat area by Canadian Company "Tirex Explorations" during 2007 – 2011.* ("Tirex Exploration" Archives, Tirane).

Daci A., Deda T., Hoti S., 2003. *Perspective of copper mineralizations and its associates (Au, Zn, S), outside existing deposits boundary, in volcanic rocks of Mirdita zone (Qafe Mali – Munelle and Perlat – Shebe – Tuturiq area).* (Central Archives of Albanian Geologica Survey, Tirane).

Daci A., 1994. *Report "On Geological works accomplished in Tarazh – Prosek – Central Perlat – Western Perlat – Shebe – Rrenjolle, during 1983 – 1991.* (Archives of Rubiku Geological Center).

Daci A., 1994. *Report "On field works, accomplished during summer of 1994 in Tarazh – Shebe area.* (Archives of Rubiku Geological Center).

Daci A., Bazhella F., 1989. *Study "On the degree of accuracy of Perlati deposit reserves with remains of 1.10.1989.* (Archives of Rubiku Geological Center).

Daci A., Muça M., Kocani M., 1987. *Report "On results of Geological – Exploration works, and calculation of reserves for Perlati deposit, with remains of 1.01.1986".* (Central Archives of Albanian Geological Survey, Tirane).

Gjata K., Premti I., Milushi I., Beccaluva L., Coltorti M., Saccani E., Siena F., Zeda O, et.al, 1995. *Petrology of Central Mirdita ophiolites and of eastern ophiolitic belt of Albania.* (Archives of Institute of Geological Researches, pp 122, Tirane. Alb.ed.

Gjoni V., Daci A., 1995. *Report "On results of Geological – Exploration works and calculation of reserves in Perlati deposit, with remains of 1.01.1993.* (Central Archives of Albanian Geological Survey, Tirane).

Hoxha L., Çakalli P., Shtjefanaku D. (2002). *Re-assessment of geology of copper deposits in Central Mirdita ophiolites, prospection perspective and further prognosis.* (Central Archives of Albanian Geological Survey, Tirane).

Hoxha L., Prenga Ll., Imami S., Daci A., Leka P., 2000. *Generalization of the results of integrated works in Perlat – Shebe – Kullaxhi area.* (Central Archives of Albanian Geological Survey, Tirane

Hoxha L., Daci A., Leka P., 1994. *Additional project on electrometric works to be carried out with IPR – 10, southwest and northeast of Perlati deposit during 1994.* (Central Archives of Albanian Geological Survey, Tirane).

Hoxha L., Bërxhiku P., Daci A., 1988. *Overthrust effects on prospection of sulfide mineralizartion in Kurbnesh – Tarazh – Perlat area.* (Bulletin of Geological Sciences, no 3, pp 7 – 20, Tirane).

Legisi M., Shtjefanaku D., (2000). *Mineral Resources and Geological Map at scale 1:50000 of Mirdita district.* (Central Archives of Albanian Geological Survey, Tirane).

Leka P., Hoxha L., Daci A., 1988. *Project on prospection of copper sulfide mineralization, based on geologic and geophysic results for year 1989 in Perlati area*.(Central Archives of Albanian Geological Survey). Alb. Ed.

Prela M., 1996. *Stratigraphy of primary sedimentary cover of ophiolites in Mirdita zone based on radiolarites.* Dissertation. Library of Faculty of Geology and Mining, Tirane. Alb.ed.

Prela M. (2000). *Primary radiolarian cover of ophiolites of Albania in two ophiolitic belts, pp. 103.* Archives of Geological Study and Designing Institute, Tirane. Alb. ed.

Shallo M. (1980). *Petrology of magmatic rocks of Central Mirdita and sulfide mineralizations associated with them.* Dissertation. Archives of Geological Study and Designing Institute, Tirane. Alb. ed.

Shallo M., 1995. *Volcanics and sheeted dykes of the Albanian SSZ ophiolites.* Bul. Shk. Gjeol. Nr.1 99-118. Alb. ed.

Zaçaj M., Shallo M., Deda T., Daci T., Çina A., Alliu I., 2001. *(Monography) :"Geology and metallogeny of copper sulfide mineralization of Albania.* (Central Archives of Albanian Geological Survey). Alb.ed.

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THE QUARTZ SULPHUR MINERALIZATION FROM THE GABBROIC MASSIF OF KAPTENA (MIRDITA OPHIOLITIC COMPLEX OF ALBANIA)

Gjon KAZA[1], Vitore GJONAJ[2], Viktor DODA[1]

[1]*Institute of Geosciences, Energy, Water and Environment, Rruga Don Bosco, email: gjkaza@yahoo.com*
[2]*Geological Survey of Albania, Rruga e Kavajes*
[1] *Institute of Geosciences, Energy, Water and Environment, Rruga Don Bosco*

ABSTRACT:

This paper presents the results of the prospecting geological works on the copper –bearing capacity of the Kaptena gabbroic massif carried out for a period over 30 years. This massif belongs to the eastern belt of the Albanian ophiolite complex, which is considered as derived under the conditions of the Supra-subduction zone. The massif of Kaptena, which consists mostly of gabbros, norites and gabbro-norites, hosts a lot copper orebodies of quartz-sulphur mineralization. The copper orebodies show different morphological, textural and structural features. Their location is probably controlled by the percolation of the hydrothermal fluids and the successive deposition of the mineralization filling the votes of the gabbroic hosting rocks. A medium-low temperatures of the sulphur mineralization is considered based on the mineralogical paragenesis.

KEY WORDS:

Albania, Mirditaophiolites, Kaptena gabbroic massif,mineralogical association, sulphur ores.

INTRODUCTION

Different studies were carried out for the gabbroic massif of Kaptena which studied it from different point of views: Bajo and Konomi, 1967; Çaushi et al., 1968; Aleksi et al., 1969; Shallo et al., 1970; Çina., 1977; Imami and Pjetri, 1979; Kaza, 1992; Shallo et al., 1995). Most of the above studies were focused on the results of the prospecting geological works of the quartz-sulphur mineralization of copper. Thus, Thirra deposit was the first copper deposit found in the Kaptena gabbroic massif (Bajo and Konomi, 1967) that was followed by the prospecting works on the Gdhesht – Pist deposit (Çaushi et al., 1968). The study of Shallo et al., (1970) made the synthesis of the previous geological works and on this base gave the general lines for the further geological research of other quartz-sulphur mineralization of copper hosted by the gabbroic massif of Kaptena. The prospecting geological works that followed this study found other copper deposits like ShenMeria, Golaj, Nikoliq1, Nikoliq2, Krum, etc (Imami and Pjetri, 1979; Kaza, 1992).

Çina (1977) defined that the principal paragenetic mineral associations of veiny hydrothermal ores in the Kaptena gabbroic massif were represented by two mineralogical types: Quartz-sulfur type which consists of quartz, pyrite and chalcopyrite and Quartz – chlorite – sulfur type which consists of quartz, chlorite, pyrrhotite and pyrite. The mineralogical associations differ from one deposit to other as it could be seen in the case of the Piste – Gdheshte deposit where two mineralogical types are distinguished: a) Quartz – sulfur type, divided in two sub-types and b) Serpentine – sulfur type.

The immense quantities of the geological prospecting works (Imami and Pjetri, 1979; Kaza, 1992; Kaza and Kovaci, 2010, Kaza and Doda, 2011) characterized the copper ore bodies based mainly on their structural-textural features, as defined by Çina (1977). In fact, the copper ore bodies of the Kaptena massif are very complex but the most important ones are: veined textures, veined – lenticular textures, brecciated textures, disseminated textures, spotted – nodular texture.

Morphological – structural features, which are used as important prospecting premises by the geologist who guided the prospecting works, are vary variable not only in different deposits. But within the same deposit, too (Kaza, 1992; Kaza and Kovaci, 2010, Kaza and Doda, 2011). The prospecting geological works found that the main morphological forms of the quartz-sulfur ore bodies are represented by lenses and veins with subordinate layers.

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GEOLOGICAL SETTING

Gabbroic massif of Kaptena is situated in northern part of Mirditaophiolitic zone of Albania. Its geology is very complicated, either in rocks types, or in structure (Fig.1). Most of the lithotypes of the eastern belt of the ophiolitic complex are present in this massif, but gabbros and gabbro-norites dominate.

Above the Moho, they are represented by the layered gabbros while towards the top of the section, these gabbros grade into a relatively thick series (maximum 3 km) of heterogeneous upper gabbros, most of which are represented by foliated gabbronorites. These gabbronorites are locally pegmatitic (in texture), cut by diabase dikes, and intensely hydrothermalized (Meshi et al., 2009).

The extrusive and subvolcanic rocks are the main lithotypes and they are mainly represented by andesites, dacites, and rhyodacites and subordinate basalts, ultrabasic and basic plutonic and intermediate – acidic rocks.

Gabbros and gabbro-norites have irregular medium-grained, more rarely coarse-grained and fine-grained textures. In general, the most distributed medium-grained texture was found in the central parts of the massif, while in zones close to the contact of gabbros with volcanic rocks, are usually encountered fine–grained gabbroic rocks.

Gabbroid rocks are greenish to black coloured, according to the dominance of pyroxene or plagioclase and, in some cases, they present banded structure (mainly rhythmical banding), conditioned by alternation of mostly pyroxene – and/or plagioclase – bearing (0.5 cm to 5 – 6 cm thick)bands. Banded structures are more rarely conditioned by rhythmic alternation of finer grained with coarser grained bands.

In addition to banded structures, gneissic like structures are often observed in gabbro-norites, which are generally oriented in conformity with orientation of banded structures. Banded gabbros represent the deepest parts of gabbroid section.

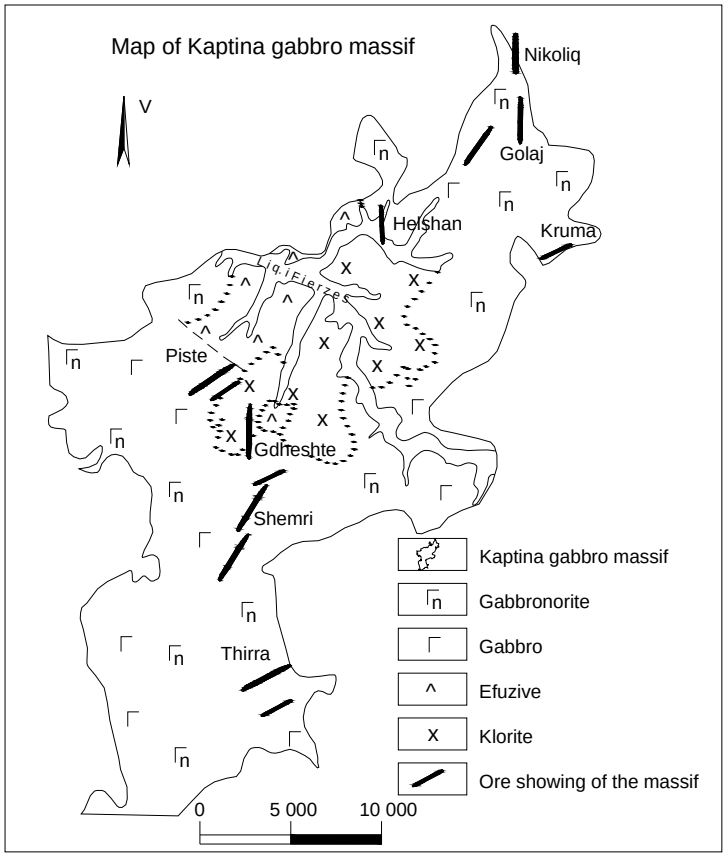


Fig. 1. Geological map of the gabbroic massif of Kaptena

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Gabbronorites, norites and gabbros have usually gabbroic-hypidiomorphic-granular texture, more rarely prismatic-granular, and rarely elements of sideronitic texture. They consist mostly of basic plagioclase (50 – 60 %), rhombic pyroxene (10 – 20%), monocline pyroxene (20 – 30%) and by accessory ilmenite.

Gabbro – pyroxenites and plagioclase bearing pyroxenites have limited distribution in eastern side of Kaptena gabbroic massif. These rocks are located close to outcrops of ultrabasic rocks, as it can be seen at Kumbulla – Ballna streams. Gabbro-pyroxenites and plagioclase bearing pyroxenites have coarse-grained, sometimes rhythmic-banded structure, conditioned by alternation of mostly pyroxene and/or plagioclase – bearing bands, or by alternation of coarser with finer-grained bands. Orientation of these structures is in conformity with orientation of banded structures of the above mentioned types of gabbro rocks.

Small irregular outcrops of amphibole gabbros (XhuxhëSanguiXhuxhës, Hebe) occupy uppermost parts of gabbro massif, often associated with quartz gabbros. Quartz gabbros, or quartz – gneiss – gabbros outcrop mainly in the south, south-east sectors of the gabbroic massif. They are located within gabbro-norites, having sharp contacts with them. Samll, irregular outcrops of metasomatic rocks are found at middle course of Breu stream, in sector between Uka and Hebe streams, close to the top mountain Megulla, etc.

SULPHUR MINERALIZATION

Factors controlling sulphur mineralization

Tectonic (structural) factor.The role of this factor is very important and it seems that sulfur mineralization is concentrated along the so-called weakened zones - tectonic faults which separate different rock types or run through them. This opinion was favored by the following findings: a) tectonic breccias of magmatic rocks are cemented by sulfur mineralization (Thirra, Patoci deposits, Fani area); b) small fissures and micro fissures are also filled with sulfur mineralization; c) partly schistouse zone are impregnated by sulfur mineralization; d) the hydrothermal alteration zones.

Magmatic factor.Most of geologists support the opinion that sulfur mineralization in the gabbroic massif of Kaptena, is genetically related to magmatic rocks. This opinion is favored by the occurrence of different sulfur mineralizations within the magmatic rocks (pyrite ores are mainly hosted by effusive rocks, pyrite - bearing ores by basic and ultrabasic rocks, presence of more intensive mineralization close to intrusive rocks, or vein series etc).

Lithological factor.The physical and chemical properties of host rocks played a significant role in controlling the mineral location. Thus, gabbros, gabbros, diabases, andesites, tuff-agglomeratic volcanic types and intermediate – acidic rocks played a screening role for post magmatic solutions. This role was conditioned by the presence of different fissure systems which served as favorable paths and traps for location of sulfur mineralization within the above rocks. In other cases the hydrothermal solutions reacted chemically with the host volcanic rocksgenerating mineralization zones like those found in Xhuxhe- Zall – Xhuxhe- Domgjon and Petoç, Ftere, eastern slope of Munella, Srriqe etc. They are represented by intensively mineralized zones, from several meters to tens of meters thick and 100 – 300 m long. Mineralization is presented by pyrite and rarely chalcopyrite disseminations, with irregular distribution. More rarely are observed pyrite-chalcopyrite nests and veins with limited sizes, less sphalerite, magnetite, chalcocite and iron hydroxides. Pyrite is principal mineral, and its content reaches up to 35 – 50 %.

Morphological – structural features of ore bodies

The morphology of the quartz-sulfur ore bodies changes from lenses and veins up to limited extension layers. Their thickness is extremely variable ranging from…… The ore bodies show significant structural variations in both strike and inclination which is reflected in the variation of the azimuth and dipping angle, respectively. For instance, at ore bodies of Thirra deposit, strike azimuth varies from 30 to 60 °, whereas dip angle goes to 80 – 90° at depths, sometimes is displayed their dip deviation in opposite direction. Both, in strike and dip, ore bodies inflate up to some meters, and narrow to some centimeters, forming veined-lenticular ore bodies with considerable size of lenses, which follow each other like chains, forming the so called veined textures in "curtain" shape. Lenses, as chain links, are connected between them through thin

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chloritic lines, which elongate from several meters to tens of meters, and serve as important prospecting premises.
It is also confirmed separation of ore body in two special branches, as well as their connection after e certain interval, both in surface, and depth. These branches make up apophyses of the same ore body.
We think that above mentioned features, related to morphology and location of ore bodies in Fani area, are conditioned by curved form of fissures, through which the hydrothermal mineralization has circulated.

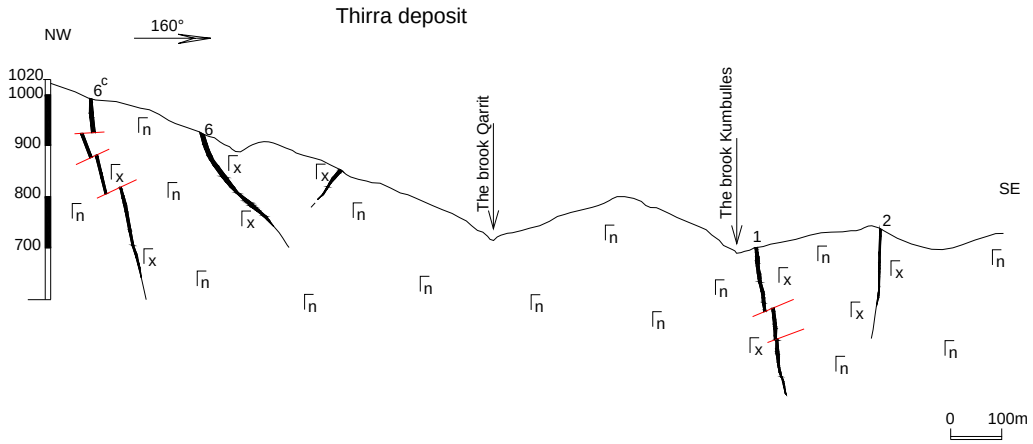


Figure2. Longitudinal section of the Thirra sulphur ore deposit

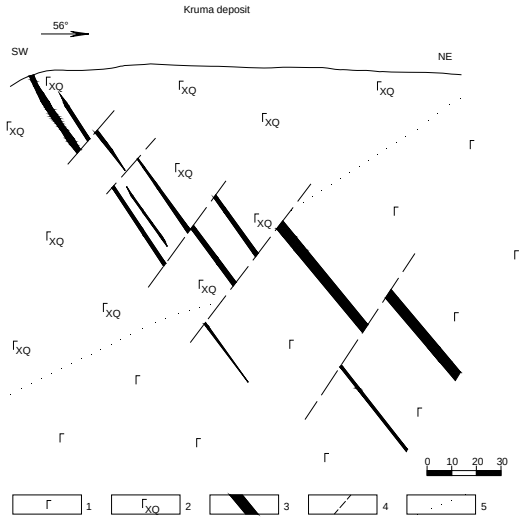


Fig. 3. Cross section of the Kruma sulphur ore deposit

MINERALOGICAL FEATURES OF SULPHUR ORE DEPOSITS

Sulfur mineralization shows a variable chemical composition which is reflected in a variable mineralogy of the ore types, where the quartz-sulfur mineralization dominates. Below are given different ore types of quartz-sulfur mineralization (Çina, 1977):
a – Quartz-sulfur type which consists of quartz, pyrite and chalcopyrite.
b – Quartz – chlorite – sulfur type which consists of quartz, chlorite, pyrrhotite and pyrite.
c – Chlorite – sulfure type where in the chloritic matrix, pyrite mineralization and, to a less extent, pyrrhotite and chalcopyrite (some ore bodies of Thirra deposit, Gdheshte, Shemri etc), are concentrated. Calcite and

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epidote are also present, while metallic minerals like hematite, magnetite, arsenopyrite, sphalerite occur in small contents. Finally, oxide minerals like Fe hydroxides, covellite, chalcocite, malachite, azurite represent secondary products.
However, the mineralogical association shows particularities in different places of the Kaptena gabbroic massif. Thus, in Piste – Gdheshte, the following mineralogical types are distinguished:

1. Quartz – sulfur type, divided in two sub-types:
   a. Quartz-chalcopyrite sub-type.
   b. Quartz – poly-metallic sub-type.
2. Serpentine – sulfur type.

A more detail view of the above mineralogical association is summarized in the table below:

Type of mineralization.		Principal ore minerals.	Veined minerals.	Maor elements.	Associate elements.	Main alteration processes of the host rocks	Morphology and structural features.
Quartz Sulfur	Quartz – chalcopyrite.	Chalcopyrite –Pyrrhotite.	Quartz Chlorite.	Cu	Co, Ag, Ga	Mainly chloritized gabro and gabbro-norites.	Veins and lenses in ramifications and closures. Steep dip >50°
	Polymetallic quartz	Chalcopyrite – sphalerite	Quartz	Cu Zn	Cd	Mainly partly chloritized pyroxene.	Veined. Steep dip.
Serpentine - sulfur		Pyrrhotite – chalcopyrite	Serpentine	Cu	Unclear	Serpentine peridotite	Unclear

In addition, in the Hasi area, the orebodies are generally composed of quartz, chlorite, and less pyrite, pyrrhotite, chalcopyrite, magnetite etc. Marcasite, arsenopyrite, ilmenite and pentlandite are encountered at very small amounts.
Chalcopyrite is found like stains and fine disseminations, representing up to 3 – 5 % of the ore bodies, while sphalerite is an associating mineral with limited distribution and lower content than chalcopyrite. Other ore minerals as magnetite, muscovite and chalcosite, are very rare.

Ore textures

The structures of the ores are conditioned by the deposition of the mineralization from hydrothermal solutions within gaps of different morphologies. In some places, the ore bodies have banded structure (Thirra and other deposit). Here, the lateral parts of the mineralization consist of symmetric belts (parallel quartz- chlorite-chalcopyrite veins), whereas central parts, which in some cases are very thick, are composed by milky quartz with rare chalcopyrite disseminations. Ore fragments (quartz – chalcopyrite) and chlorite xenoliths are intruded in this quartz matrix.
Within the ore bodies are observed also very large xenoliths, consisting of altered gabbros. In addition to the compact structure of quartz mass, some veinlets with denticular structure are observed. Within the quartz mass, which is the main component of different ores, the sulfur, chalcopyrite is often found as stains and nodular forms among very large quartz crystals. For the quartz-pyrite ores is very characteristic the cemented structure, where quartz fragments with chalcopyrite disseminations are cemented by nodular calcite formations. We can mention also the pyrrhotite – chalcopyrite ores with almost compact structure, where early oval quartz fragments are cemented. In some ore bodies of this massif, the disseminated structure is also observed.

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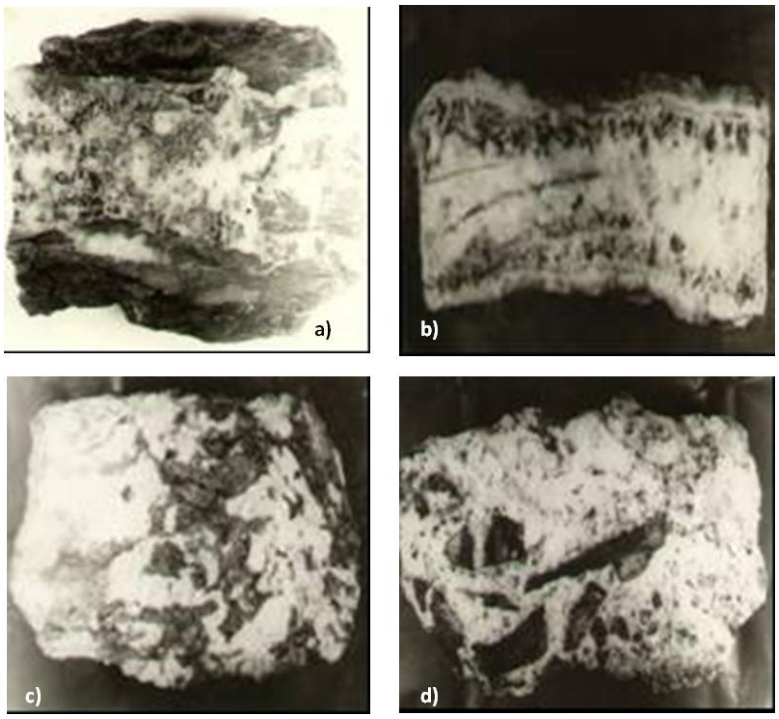


Figure4. Types of the sulphur mineralogical associations (a- Quartz - chalcopyrite - pyrrhotine; b - Quartz-chalcopyrite; c - Quartz – chalcopyrite – arsenopyrite; d - Quartz – chalcopyrite – sphalerite)

Within the chlorite – epidote mass, the pyrite disseminations are located, whereas the chalcopyrite disseminations are found within the quartz or calcite masses. All the above mentioned processes which formed the sulfur mineralization resulted in the following main textures:

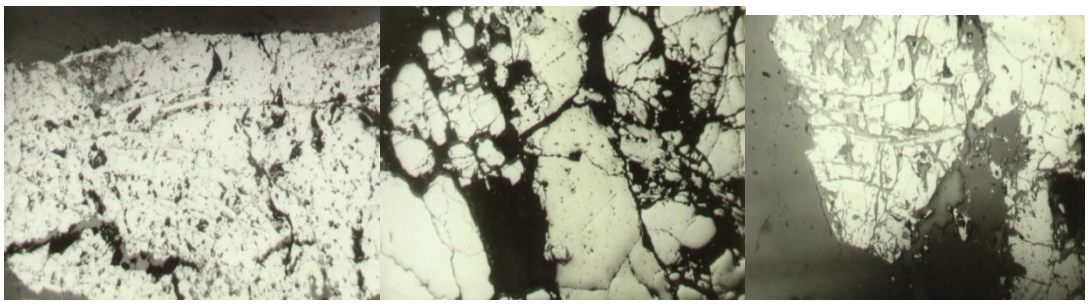
1. Veined textures. They are formed by filling of tectonic fissures of gabbroic rocks with ore-bearing solutions, deposited by hydrothermal solutions.
2. Veined – lenticular textures. Such structures are formed by depositions of minerals along some stages, or in some parallel fissures within gabbroic rocks.
3. Brecciated textures. These textures are characterized by cementing of the altered gabbroic fragments (xenoliths) by quartz – sulfur matter, at size from several cm to several meters. Characteristic are following structures.
4. Disseminated structures. Are characterized by distribution of sulfur mineralization like stains and grains in quartz mass.
5. Spotted – nodular structure. This structure is represented by stained and nodular chalcopyrite concentrations in quartz mass.

In elementary composition of these ores are present of Barium 0.002%, Manganese 0.004%,÷-0.5%, Galium 0.001%, Nickel 0.01÷0.02%, Ti 0.05÷0.5%, Vanadium 0.01÷0.1%, Zn ÷0.06% dhe Cobalt 0.001÷0.01%.
Total composition of Cu in the ores of this type, results 0.02% ÷0.47%.

GENETIC IMPLICATIONS OF MINERALIZATION

The genesis of the sulfur mineralization of the Kaptena gabbroic massif has been object of debate among the researcher that have studied it from different points of view. Thus, Aleksi V.1972, Shallo M. et. al 1970, Imami S. 1979, Daci A. 1984, KazaGj. 1992 consider that quartz – sulfur veins are formed as a result of the deposition of the minerals from the hydrothermal solutions which flowed through the cavities and fissures within the gabbros.

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Vein – like structure *Brecciated structure* *Narrow veins microstructure*

Fig. 5. Photos of selected microstructures of the sulfur ore bodies

Based on the mineralogical study of the sulfur ores, Çina A.1977 favored the opinion that minerals as quartz, pyrite etc, belong to two generations: grey quartz belongs to earlier generation and milky quartz of the second generation; the mineralization seems to be related to grey quartz (or as it is called "smoked quartz").
The zonal structure of ores (quartz – sulfur bands alternated with milky quartz bands without mineralization) testifies that depositions of mineralization by hydrothermal solutions, happened as a differentiated and pulsate character. Such a differentiation is also observed along the vertical direction as shown by the hypogene zone of mineralization.
Another possible way of quartz-sulfure formation, has been metasomatic replacement of wallrocks by gradual increasing of embrional fissures, suitable for circulation of hydrothermal solutions. This was testified by the character of quartz-sulfure ore relationships with wallrocks, the presence of intensive altered products (chloritization, silicification, epidotization etc), the presence of xenoliths of wallrocks within the mineralization, the presence in the ores of some chemical elements, such as Ti, V, Cr, which are characteristic for gabbro rocks, that in this case are metasomatically replaced by quartz-sulfure mineralization etc.
Based on the mineralogical associations and in analogy with data from literature, we suggest that quartz-sulfure ores, located in gabbro-norites of Kaptena massif, are formed in conditions of mean temperatures, however, we must accept that, during period of ore forming, temperature have had considerable fluctuations, and, as a consequence, may have co-existence of minerals or mineral associations formed at different temperatures.
According to the location of ore bodies at middle and lower levels of gabbro massif, (Shallo et.al, 1970) and the fact that the thickness of the gabbroic massif doesn't exceed 1-2 km, the depth of the formation of quartz-sulfur ores can be roughly estimated 1.5–2 km.
It is difficult to have a clear idea about relationship of quartz-sulphide mineralization with magmatic processes in the Mirdita ophiolites. There have been different opinions on this question. So, for Kurbneshi deposit, a genetic relationship with plagiogranites and quartz-diorites was accepted (Bjelostocki,1961, Zverjuga 1956). Other authors (Kollmak,etj.1959, Zhadan 1958), adhere to this idea for other quartz-sulfure ores of Kaptena massif. On the other side Shallo (1967), suggests genetic relationship of quartz-sulfure mineralization with magmatic center of Mirdita effusivo-intrusive comagmatic complex, i.e relationships with gabbro-plagiogranitic intrusive formation, perhaps with gabbroic rocks. For possible genetic relationships with gabbro rocks have been pronounced also other authors (Aleksi, Konomi, Çina, 1969). Based mainly on spatial location of quartz-sulfure mineralization, which occupies middle and lower parts in the gabbro massif section and taking into consideration the intersecting relationships of the quartz-sulfure ores with gabbros, we can accept that quartz-sulfure mineralization, on a large scale, may be related to hydrothermal activity of the Kaptena gabbro massif itself. Aleksi V. 1972.,Imami S. et.al 1979 considered that the mineralization was formed under the medium temperatures.

CONCLUSIONS

Gabbroic massif of Kaptena, which is the biggest one of the Albanian ophiolite complex, represents a noted importance for its copper-bearing potential. It consists mostly of gabbros and gabbro-norites with subordinate amphibole gabbros and quartz gabbros and very small outcrops of gabbro – pyroxenites and plagioclase bearing pyroxenites.

The quartz-sulfur ore bodies show variable morphological features changing from lenses and veins up to limited extension layers. Their extension and inclination change both in their azimuth and dipping angle.
The quartz-sulfur mineralization, that is the principal mineralogical type of the Kaptena massif, consists of two subtypes a) Quartz-sulfur type which consists of quartz, pyrite and chalcopyrite and b) Quartz – chlorite – sulfur type which consists of quartz, chlorite, pyrrhotite and pyrite.
The copper ore bodies of the Kaptena massif show variable textures where the most important are: veined and veined – lenticular texture, brecciated texture, disseminated and nodular texture.
Based on the mineralogical associations, textural and morphological features, a hydrothermal-metasomatic genesis of the medium-low temperatures was considered for the formation of the quartz-sulfur mineralization of the Kaptena gabbroic massif.

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REFERENCES:

Aleksi V. Konomi N. Çina A., **1969.** Morphological and mineralogical features of ore bodies in a copper deposit of Fani area. Përmbledhje studimesh (Monthly geological articles magazine), No. 12.1969.45p, Archives of Albanian Geological Survey. (in Albanian).
Bajo I. and Konomi N., 1967. Geological report on results of exploration works in Thirra deposit. Including estimation of reserves of 1.01.1967). 33p, Archives of Albanian Geological Survey. (in Albanian).
Çaushi R. Vllaho J. Çina A. Gjokuta D. Kotmillo Xh. 1968. "Geology of contact zone between basic and ultrabasic rocks in Helshani area, and relationship of copper sulphide mineralization with it." Përmbledhje studimesh Nr. 9-10. (in Albanian).
Çina A., 1977. Paragenetic mineral associations of veined hydrothermal ores (Mirdita area). 156p. Faculty of Geology and Mining. (in Albanian).
Imami S. and Pjetri F. 1979. Report on geology and estimation of reserves of Thirra deposit, including remained reserves of 1.01.1979. (in Albanian).
KazaGj., 1992. Report on results of exploration works and estimation of geological reserves of Thirra deposit of 1.09.1992. (in Albanian), 50p, Archives of Albanian Geological Survey.
KazaGj. and Kovaci S., 2010.Kaptena gabbroic massif of Mirdiraophiolite (Albania) and its relations with sulphidemineralizations.Proceedings of 7th International Symposium on Eastern Mediterranean Geology.P. 18. Adana, Turkey.
KazaGj. and Doda V., 2011. Geological – structural features of the sulphur mineralization of Thirra deposit and the surrounding area. Bul. Shk. Gjeol. Nr. 1/2011, p. 61-76. (in Albanian).
Meshi A., Boudier F., Nicolas A., Milushi I., (2009).Structure and tectonics of lower crustal and upper mantle rocks in the Jurassic Mirditaophiolites, Albania. International Geology Review V.52, no. 2-3, 117–141.
Shallo M., Cina A., Turku I. 1995. Outline of the metallogeny of the Albanian MOR and SSZ-Type ophiolites. The Mirdita oceanic basin from rifting to closure.Ëorkshop on albanianophiolites and related mineralization, IUGS/UNESCO Modeling Programme. p 27-46.
Shallo M..andDilek Y. (2003)- Development of the ideas on the origin of Albanian ophiolites . – In Dilek Y., and Newcomb S., eds., ophiolite concept and the evolution of geological thought. Bouldes' Colorado, Geological Society of America special Paper 373, p. 351-363.
Shallo M. Spiro (Qirinxhi) A. Çina A. Kote Dh. Konomi N. Çaushi R. 1970 Estimation of perspective about quartz-sulphide ore in Kaptena gabro massif" (Results of prospect – thematic works, carried out during 1968-1970 in Kaptena gabbro massif. 300p. (in Albanian).

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CALCULATION OF "RESERVES" IN CHROME MINING STOCKS OF BULQIZA

Ing. Ramiz BALLA[1], Dr.Gafur MUKA[1]
[1]*Faculty of Geology and Mining, Tirana, Albania*
ramizballa@yahoo.com, gmuka@yahoo.com

ABSTRACT

Sterile stocks of Bulqiza mine are created during a long time of underground exploitation (60-year) of chromium deposit in Bulqiza Mine.
About ready year 2007 they were regarded as sterile and are considered just as barren product on earth surface. Properly in year 2007, the world market was significantly increased demand for chrome ore. In these conditions, of course, began to focus particular attention on the use of remaining stocks (considered until then as loss) within the enclosed exploited area of the deposit.
But due to technology use until 2001, when the mine was used by state enterprise, known as chromium mine "Todo Manço" Bulqizë, mine specialists, but also its employees knew that a large amount of chrome mineral was cast in Sterile stocks.
Since that "mineral" was on the earth's surface, and can be assembled simply by selecting chrome sterile, private persons, also without any license, began to make this job, so it was create a "considerable amount" of chrome mineral, which it is ready for sale. At that time market conjuncture this kind of business was proved successful.
Certainly in these circumstances are displayed two problems. First, how much is the amount of general "reserves" in the territory of the former mine and secondly, how much is the amount of ore in them. In this writing we mainly will engaged with response to the first question, by using data on the topography of the area, carried out with the use of satellite images, in condition of absence of inventories and data on stock geometry.
Since this problem exists also for other regions of former mines, treating methods will also apply for all of them.

KEY WORDS: *stock, selection, map, image, calculation, method.*

1. THE ISSUE LAYOUT

Sterile stocks at Bulqiza mine had occupied an area about 1 km2. They are create from sterile material deposition, extracted mainly from the research and preparation works in all geographical sections units of the mine. Their name is referred to these units. So at Bulqiza mine we had already these major sterile stocks:

- the sterile stock area near the shaft nr. 2
- the sterile stock area near the shaft nr. 1
- the sterile stock area at the joined area
- the sterile stock area near D zone (D unit)

Regionalization of these stocks is shown in fig.1

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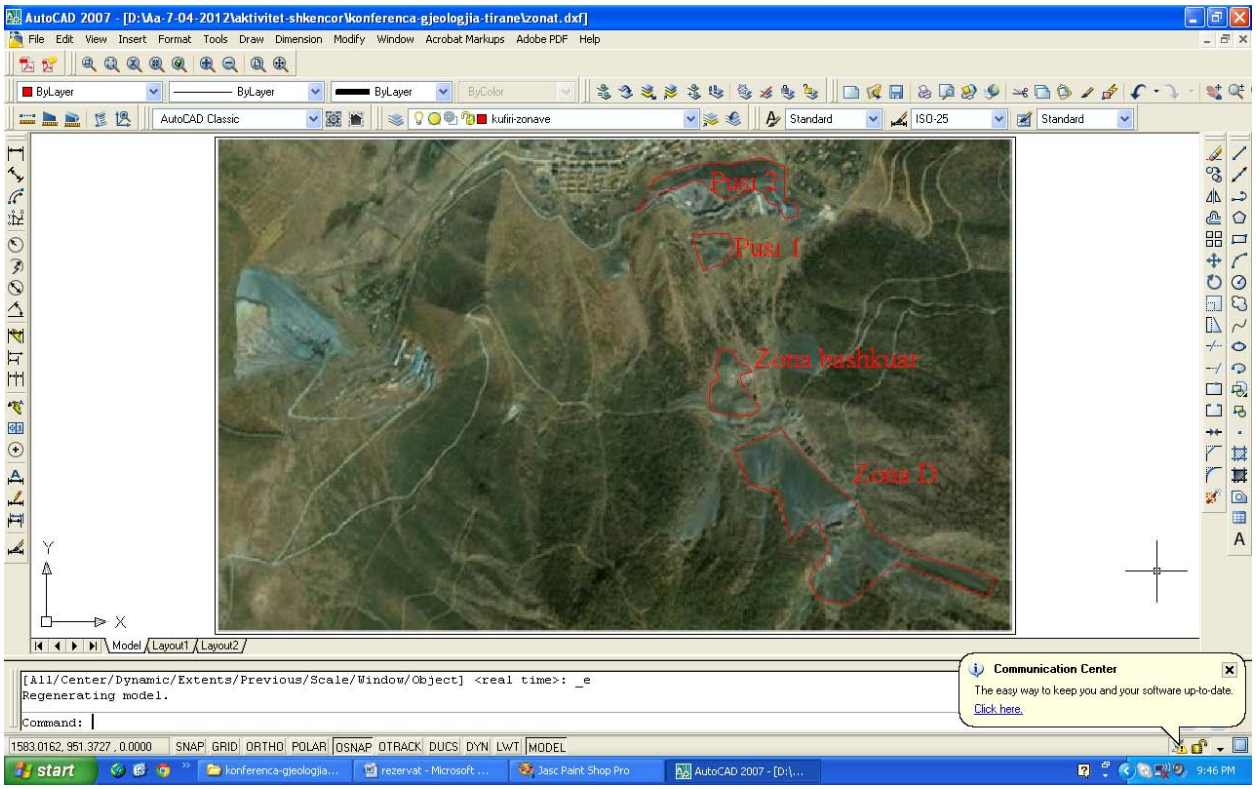


Fig. 1

Usually in these stocks thrown sterile rocks, but however in them were discharged mixed material. This was happened in cases where the composition of the rock in the wagon (railway carriage), it is considered unacceptable, from quality inspector, to be deposited in the stock of ore or when research works meets to the mineral. So, part of these stocks is also a quantity of mineral. In 2007, due to the increase of price conjuncture of chromium in the international market began issuing these sterile chrome stocks. This process was made by hand with simple surface selection. Initially there were inhabitants of the city, which because of huge unemployment, were engaged in a very private way to do this job, which were proved profitable. Then began a family organization, in which were included even women and children.

When the owners, who were licensed before that time, realized that this process was of particular interest, they requested that the administration of this process must be done by them.

In these circumstances was formalized the idea that these stocks had to be obligated to take a license, this kind of material was considered as "mineral reserves".

But how much is the quantity of these reserves?

To answer this question should be calculated first the stocks volume and then through chemical analysis is defined the average content of chrome on them.

In this paper it will only be explained the method of calculating reserves. Due to the lack of measurement throughout the mine it is only materialized by calculations of reserves for the sterile stock area near the shaft nr. 2

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Fig. 2 Sterile stock area near the shaft nr. 2, and the appearance of done measurements

2. THE CREATION OF THE DATABASE

- The topographic map (scale 1:5000) of Bulqiza mining region which contains situation and contours of this area before of creation of stocks.
- Measurements made out with the GPS in the stock area near the shafts nr.2, to build up surface of the stock in real situation.
- The availability of this data enables realization of cross sections and profiles on both surfaces, to obtain so cross-cutting of stock and terrain surfaces, based on this, we can realize the calculation of stocks volume. Consequently it's easy to make the calculation the quantity of reserves.

Since it was deemed to be used UTM coordinate system with reference datum WGS 84 to enable unification of data for all stocks located in the territory of mine, first was done the georeference of the existing topographic map. For that, were used the coordinates of existing objects which were measured with GPS.

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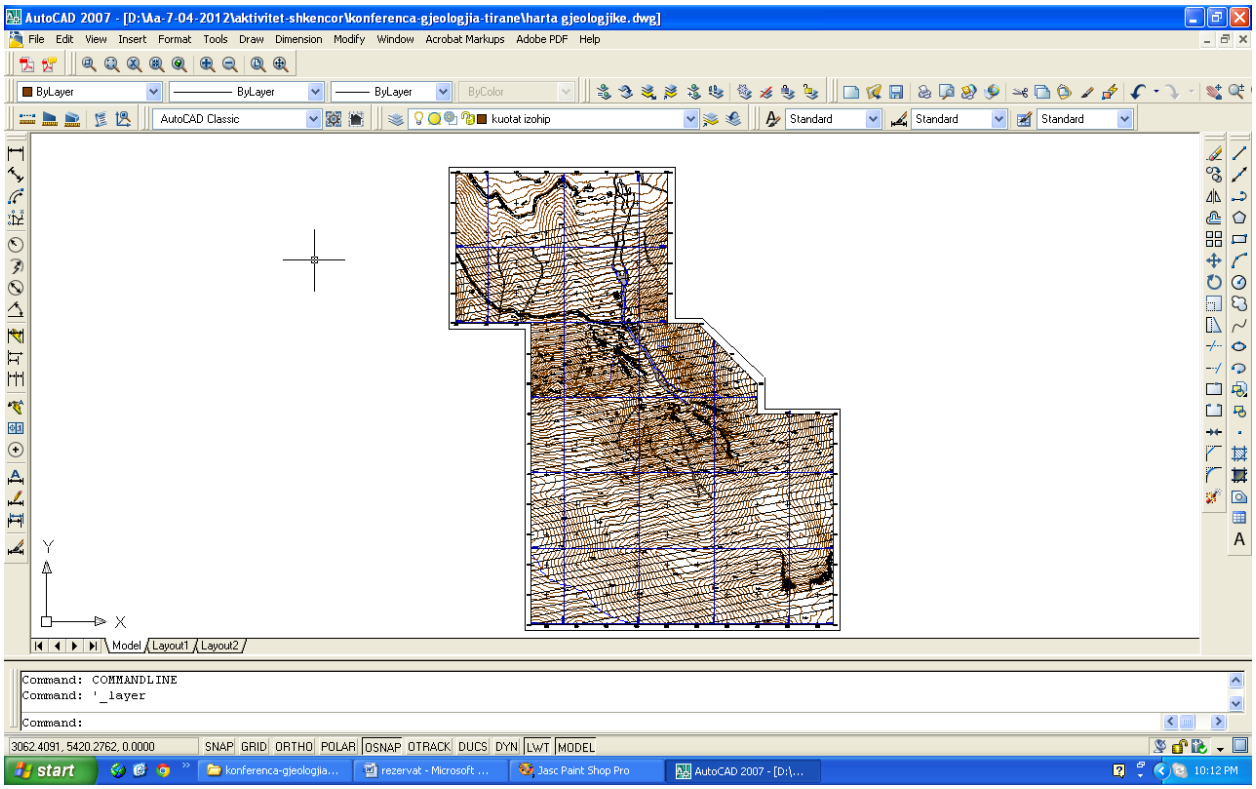


Fig. 3 Topografic map of Bulqiza mine area with contours and detailed situation

The data for creating the surfaces are arranged in the following tables:

Table no.1 (in the table are not presented all measured values)

Point No.	Y	X	Z	Name
1	434814.54	4593480.09	1052	1
2	434805.95	4593510.15	1043	2
3	434814.54	4593547.36	1042	3
4	434838.87	4593564.54	1037	4
5	434876.08	4593586.01	1038	5
6	434926.18	4593611.77	1039	6
7	434950.51	4593628.95	1037	7
8	434969.12	4593623.22	1040	8
9	435002.04	4593644.69	1037	9
10	435029.24	4593640.4	1039	10
11	435097.94	4593666.16	1036	11
12	435170.94	4593656.14	1039	12
13	435229.62	4593660.44	1038	13
14	435298.32	4593673.32	1037	14
15	435358.44	4593650.42	1044	15

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16	435395.65	4593618.93	1042	16
17	435407.1	4593567.4	1039	17
18	435399.95	4593533.05	1038	18
19	435404.24	4593504.42	1040	19
20	435435.73	4593507.29	1041	20
21	435485.83	4593468.64	1043	21
22	435514.45	4593465.78	1046	22
23	435545.94	4593480.09	1048	23
24	435547.37	4593452.9	1047	24
25	435523.04	4593435.72	1048	25
26	435491.55	4593442.88	1050	26
27	435430.01	4593484.38	1049	27
28	435395.65	4593472.93	1049	28
29	435349.85	4593528.76	1052	29
30	435352.71	4593557.38	1049	30
31	435292.6	4593557.38	1052	31
32	435262.54	4593565.97	1050	32
33	435182.39	4593514.44	1051	33
34	435153.23	4593545.55	1050	34
35	435134.2	4593571.22	1053	35
36	435069.31	4593558.81	1052	36
37	435038.78	4593586.49	1050	37
38	434983.43	4593573.13	1052	38
39	434966.26	4593573.13	1051	39
40	434941.45	4593558.81	1050	40
41	434889.92	4593550.23	1053	41
42	434873.7	4593534.96	1050	42
43	434867.44	4593544.5	1051	43
44	434839.88	4593513.54	150	44
45	434814.54	4593547.36	1043	"p1"
46	434825.15	4593534.74	1046	"p2"
47	434839.88	4593513.54	1050	"p3"
48	435029.24	4593640.4	1039	"p21"
49	435030.46	4593614.74	1043	"p22"
50	435033.48	4593601.16	1050	"p23"
51	435170.94	4593656.14	1038	"p31"
52	435170.85	4593627.58	1040	"p32"

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These data were used to construct the surface of the stock, which was superpose on surface of terrain. With the data of both surfaces were constructed, through AutoCad civil 3D, in total 40 profiles with 20 m distance from each other. In these profiles were identified the surfaces of cross cutting of stock. With these surfaces was calculate then the stock volume which was resulted around 605 000 m3.

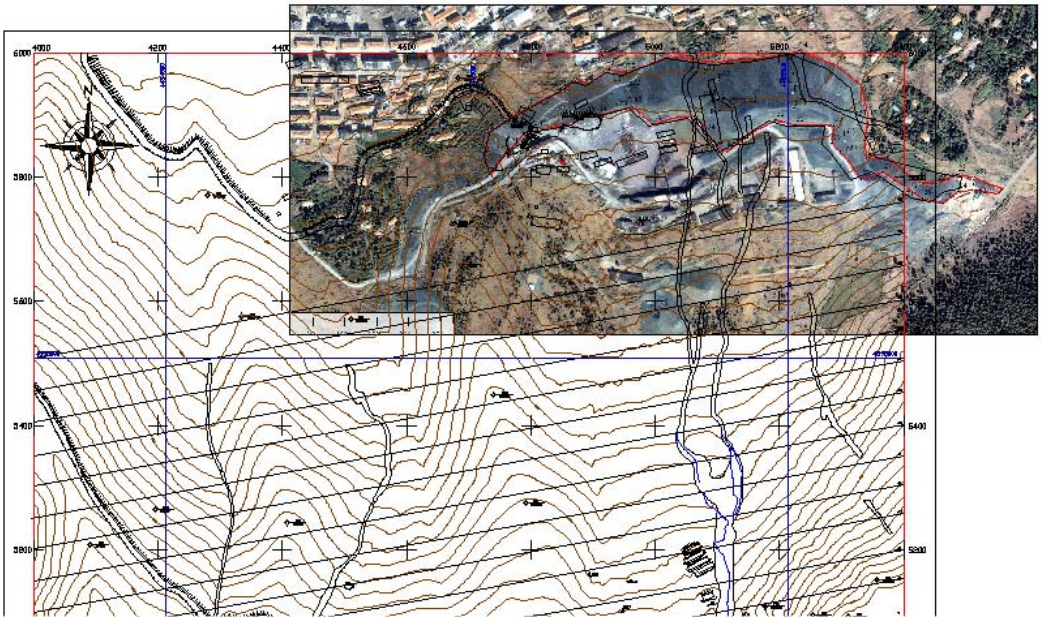


Fig.4 Superpose of surfaces to calculate the stock volume.

3. CONCLUSIONS

1. Sterile material Stocked in Bulqiza mine constitutes a "deposits", of which reserves should be calculated.
2. Superpose of the surface of the stock with surface of terrain, creates the base for determining the volume of the material stocked.
3. The given methodology in this paper, to calculate the volume of stocks, can be used throughout the mine.
4. The determination of quality mineral content in stocks should be studied by through chemical analysis with methodology of sampling. The methodology of sampling in this case it's specific and should be determined through a separate study.
5. The identification of the material stocked as mineral reserves requires the disciplined exploitation according with a project approved in advance.
6. The projection of sterile stocks exploitation in Bulqiza mine, should be consider for an optimum land use, because the entire area is under the influence of old time underground exploitation.

REFERENCES

1. Hennermann, K.: "Kartographie und GIS (Eine Einfuehrung)", 2006 by ËGR, Darmstadt
2. Grup autorësh,:Harta Gjeologjike e Bulqizës Sh.:1:5000, , 2009
3. Gurra, H,: Bulqiza, një minierë me histori, 2011
4. Muka, G., Korini,Th.:Hartografia dixhitale, 2010

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GEOLOGICAL MAPPING 1:50 000 SCALE IN ALBANIA AND CORRELATION WITH THE NEIGHBOURING AREAS

Kujtim ONUZI[1], Ndoc VUKZAJ[2], Gjergji STOJA[2]

[1]Institute of Geosciences, Energy, Water and Environment (IGEWE), address: Rruga Don Bosko, no.60, Tirane, Albania, e-mail: konuzi@yahoo.com
[2]Geological Survey of Albania (GSA), adress: Rruga Kavajes, no.152, Tirana, Albania, e-mail:ndocvukzaj@yahoo.com

ABSTRACT

The territory of Albania consists of 103 topographic sheets 1:50 000 scale prepared by the Geographic Institute of the Army (GIA) in the Gauss-Krüger projection. Thirty-eight topographic sheets occur along the boundary with the neighbouring countries. The Geological Survey of Albania is working since many years to cover the territory of Albania with geological maps 1:50 000 scale in digital format. Each of the geological maps is accompanied by an explanatory text.

During the recent years, the European countries have converted the geoplogical maps 1:50 000 scale into the Universal Transverse Mercator (UTM) projection. In 2010 by the IGEWE – GSA – GIA commenced a project to compile the geological maps 1:50 000 scale of Albania in the UTM projection based on the topographic sheets prepared by the Geographic Institute of the Army in ccoperation with NATO experts. The territory of Albania consists of 56 topographic sheets 1:50 000 scale in the UTM projection.

The correlation of the geology and the preparation of the geological maps 1:50 000 scale and of the explanatory texts for each of the sheets will be completed for all the territory of Albania in 2012. In this way, for the interested public and private institutions are available geological maps on scale 1:50 000 accompanied by the explanatory texts. These new geological maps 1:50 000 scale serve as a very good base for the interested public and private institutions as well as for other geoscientific studies in the field of hydrogeology, environment, geological-engineering, metallogeny, seismic etc.

For the preparation of the geological maps 1:50 000 scale that occur in the boundary areas with the neighbouring countries (Montenegro, Kosova, Macedonia, Greece) there have been carried out geological correlations in cooperation with geological mapping experts from the respective countries.

KEY WORDS *Geological Maps 1:50 000 scale, Albania, geological correlation, neighbouring countries*

INTRODUCTION

Every geoscientific activity is supported by geological maps. In this way it is a necessity the coverage of the territory of Albania with Geological Maps of quality that can be used by the interested public and private institutions. During 1993-2012 the Geological Survey of Albania has compiled 103 Geological Map sheets 1:50 000 scale covering all the teritory of Albania. These maps are compiled in digital format and are accompanied by an explanatory text for each of the sheets (fig. 1,2, Table 1).

This geological mapping activity on scale 1:50 000 included the systematization of all geological maps of various scales that had been compiled in the past, to bring them into the current geological thought. In this process there have been consulted previous geological maps 1:10 000, 1:25 000, 1:50 000 scale, thematic and regional studies.

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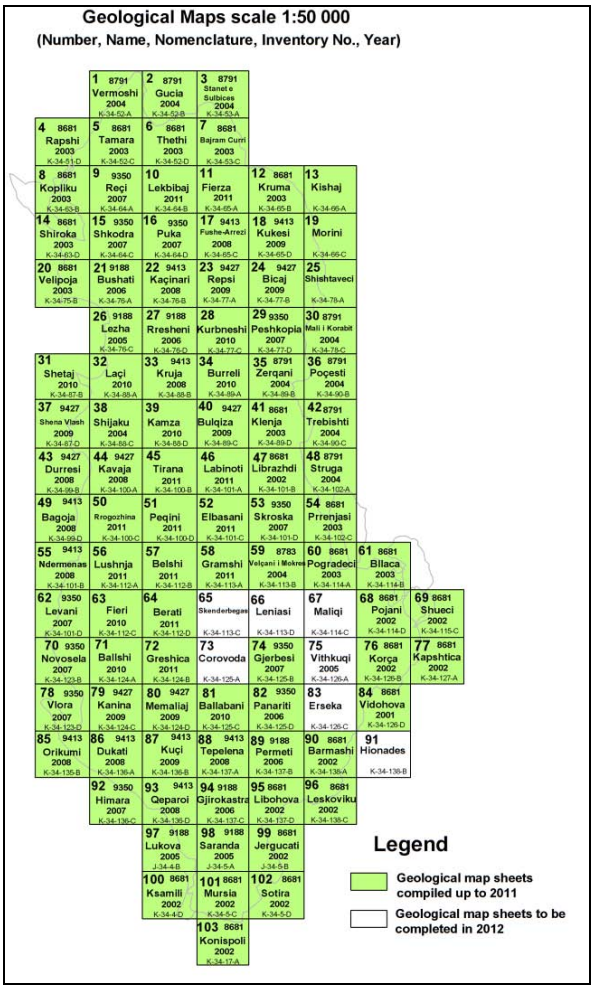


Fig.1 Nomenclature of the topographic sheets 1: 50 000 scale (Gauss – Krüger projection), showing also the sheets for which the geological maps have been compiled.

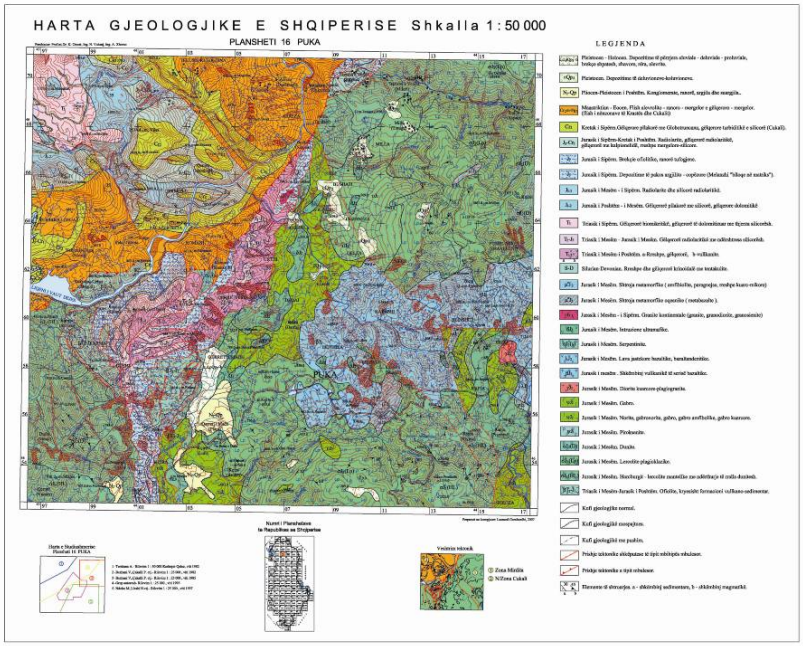


Fig.2 Geological Map 1: 50 000 scale of the sheet no. 16, Puka (Gauss-Krüger projection)

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Table 1. Compiled geological maps in 1: 50 000 scale.

No.of sheet	Name of the sheet	Nomenclature of the sheet	Authors of the geological map	Year	Director of study group, Inventory No.
1	Vermoshi	K-34-52-A	K. Onuzi, H. Pulaj, M. Pajoviç	2004	K.Onuzi. Inv8791
2	Gucia	K-34-52-B	K. Onuzi, H. Pulaj, M. Pajoviç	2004	K.Onuzi. Inv8791
3	Stanet e Sulbicës	K-34-53-A	K. Onuzi, H. Pulaj, M. Pajoviç	2004	K.Onuzi. Inv8791
4	Rapsh-Star, Podgorica	K-34-51-D	H.Pulaj, K.Onuzi, A.Pirdeni, S.Vukaj	2003	K.Onuzi. Inv8681
5	Tamara	K-34-52-C	K.Onuzi,H.Pulaj, M.Pajoviç	2003	K.Onuzi. Inv8681
6	Thethi	K-34-52-D	K.Onuzi,H.Pulaj,M.Pajoviç A.Pirdeni, S. Vukaj	2003	K.Onuzi Inv8681
7	Bajran Curri	K-34-53-C	N.Mekshiqi, K.Onuzi	2003	K.Onuzi. Inv8681
8	Kopliku	K-34-63-B	K.Onuzi,H.Pulaj, J.Hoxha M.Pajoviç, Ll.Dimo	2003	K.Onuzi Inv8681
9	Reçi	K-34-64-A	K.Onuzi, S.Vukaj, A.Xhomo	2007	K.Onuzi Inv 9350
10	Lekbibaj	K-34-64-B	N. Vukzaj.		N. Vukzaj
11	Fierza	K-34-65-A	N. Vukzaj.		N. Vukzaj
12	Kruma	K-34-65-B	R.Hyseni	2003	K.Onuzi. Inv8681
13	Kishaj	K-34-66-A			
14	Shiroka	K-34-63-D	K.Onuzi, H.Pulaj, A.Pirdeni, J.Hoxha	2003	K.Onuzi. Inv8681
15	Shkodra	K-34-64-B	K.Onuzi, S.Vukaj	2007	K.Onuzi.Inv 9350
16	Puka	K-34-64-D	N.Vukzaj, K.Onuzi	2007	K.Onuzi.Inv 9350
17	Fushe Arrezi	K-34-65-C	H.Beci, H.Hallaci	2008	H.Hallaci. Inv 9413
18	Kukesi	K-34-65-D	N. Hysa, H. Hallaci	2009	H. Halla.Inv 9413
19	Morini	K-34-66-C			
20	Velipoje	K-34-75-B	K.Onuzi, H.Pulaj, J.Hoxha, Ll.Dimo, M. Pajovic	2003	K.Onuzi Inv8681
21	Bushati	K-34-76-A	K.Onuzi, H.Pulaj, A.Xhomo, I. Prifti	2006	K.Onuzi.Inv 9188
22	Kaçinari	K-34-76-B	N.Vukzaj, H.Hallaci	2008	H.Hallaçi Inv 9413
23	Repsi	K-34-77-A	N.Vukzaj, H.Hallaci	2009	H.Hallaçi Inv 9427
24	Bicaj	K-34-77-B	N.Hysa, H.Hallaci	2009	H.Hallaçi Inv 9427
25	Shishtaveci	K-34-78-A			
26	Lezha	K-34-76-C	K.Onuzi, H.Pulaj, A.Xhomo, E. Bedini	2005	K.Onuzi. Inv 9188
27	Rresheni	K-34-76-D	K.Onuzi, H.Pulaj, A. Xhomo	2006	K.Onuzi Inv 9188
28	Kurbneshi	K-34-77-C	N.Vukzaj	2010	N.Vukzaj
29	Peshkopia	K-34-77-D	V.Hoxha, K.Onuzi	2007	K.Onuzi.Inv 9350
30	Mali i Korabit	K-34-78-C	V.Hoxha, K.Onuzi	2004	K.Onuzi. Inv8791
31	Shetaj	K-34-87-B	N.Karaj	2010	N.Vukzaj
32	Laçi	K-34-87-A	N.Karaj	2010	N.Vukzaj
33	Kruja	K-34-88-B	A.Shenjatari	2008	H.Hallaci
34	Burreli	K-34-89-A	N.Hysa	2010	N.Vukzaj
35	Zerqani	K-34-89-B	K. Onuzi, M. Spaho	2004	K.Onuzi. Inv8791
36	Pocesti	K-34-89-B	K. Onuzi, H. Pulaj.	2004	K.Onuzi. Inv8791
37	Shena Vlash	K-34-87-D	N Karaj	2009	H.Hallaçi Inv 9427
38	Shijaku	K-34-88-C	N. Karaj	2011	N. Vukzaj
39	Kamza	K-34-88-D	N.Hysa	2010	N.Vukzaj
40	Bulqiza	K-34-89-C	N Karaj	2009	H.Hallaçi Inv 9427
41	Klenja	K-34-89-D	K.Onuzi, H.Pulaj	2003	K.Onuzi.Inv 8681

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42	Trebishti	K-34-90-C	V.Hoxha, K.Onuzi	2004	K.Onuzi. Inv8791
43	Durresi	K-34-99-B	N.Hysa, H.Hallaci	2008	H.Hallaçi Inv 9427
44	Kavaja	K-34-100-A	N. Hysa, H.Hallaci	2008	H.Hallaçi Inv 9427
45	Tirana	K-34-100-B	N.Hysa	2011	N.Vukzaj
46	Labinoti	K-34-101-A	N.Hysa	2011	N.Vukzaj
47	Librazhdi	K-34-101-B	M.Spaho	2002	K.Onuzi.Inv 8681
48	Struga	K-34-102-A	K.Onuzi, H.Pulaj	2004	K.Onuzi Inv 8791
49	Bagoja	K-34-99-D	H,Hallaçi, A.Gucaj	2008	H.Hallaci
50	Rrogozhina	K-34-100-C	E. Malo	2011	N. Vukzaj
51	Peqini	K-34-100-D	V. Prifti, V Sylari.	2011	N. Vukzaj
52	Elbasani	K-34-101-C	N. Karaj.	2011	N. Vukzaj
53	Skroska	K-34-101-D	K.Onuzi, A.Xhomo	2007	K.Onuzi.Inv 9350
54	Prrenjasi	K-34-102-C	H.Pulaj, K.Onuzi	2003	K.Onuzi. Inv8681
55	Ndërmenas	K-34-101-B	H.Hallaci, A.Gucaj	2008	H.Hallaçi
56	Lushnja	K-34-112-A	Piro Dorre.	2011	N. Vukzaj
57	Belshi	K-34-112-B	Apostol Qirko.	2011	N. Vukzaj
58	Gramshi	K-34-113-A	V. Prifti.	2011	N. Vukzaj
59	Velcani i Mokres	K-34-113-B	R. Hyseni M. Spaho, J. Hoxha	2004	K. Onuzi. Inv 8783
60	Pogradeci	K-34-114-A	H.Pulaj, K.Onuzi	2003	K.Onuzi. Inv8681
61	Bllaca	K-34-114-B	H.Pulaj, K.Onuzi	2003	K.Onuzi Inv 8681
62	Levani	K-34-101-D	K.Onuzi,F.Lula,I.Prifti.	2007	K.Onuzi. Inv9350
63	Fieri	K-34-112-C	N.Vukzaj, A.Gucaj	2010	N.Vukzaj
64	Berati	K-34-112-D	V. Prifti, V Sylari.	2011	N. Vukzaj
65	Skenderbegas	K-34-113-C	K.Onuzi, H. Pulaj, A. Xhomo	2005	K.Onuzi,
66	Leniasi	K-34-113-D	K.Onuzi,S. Marishta, E. Bedini, H. Pulaj	2002	K.Onuzi,
67	Maliqi	K-34-114-C	K.Onuzi,	2000	K.Onuzi,
68	Pojani	K-34-114-D	K.Onuzi, P.Kita, F.Balli, A.Vranaj	2002	K Onuzi. Inv 8681
69	Shueci	K-34-115-C	K.Onuzi, P.Kita, A.Vranaj	2002	K Onuzi.Inv 8681
70	Novosela	K-34-123-B	K.Onuzi, F.Lula, I.Prifti, L.Hasani	2007	K.Onuzi. Inv 9350
71	Ballshi	K-34-112-B	A.Gucaj	2010	N. Vukzaj
72	Greshica	K-34-134-B	Agim Gucaj.	2011	N. Vukzaj
73	Çorovoda	K-34-125-A	Agim Gucaj	2012	N. Vukzaj
74	Gjerbesi	K-34-125-B	K.Onuzi	2007	K.Onuzi Inv 9350
75	Vithkuqi	K-34-126-A	K.Onuzi, F Koller, V. Hoeck, A. Palko	2012	K.Onuzi,
76	Korça	K-34-126-B	K.Onuzi, P.Kita, E.Bedini	2002	K.Onuzi Inv 8681
77	Kapshtica	K-34-127-A	K.Onuzi, P.Kita, A.Vranaj	2002	K.Onuzi Inv 8681
78	Vlora	K-34-123-D	K.Onuzi, I.Prifti, H.Hallaci, A.Qirko	2007	K.Onuzi Inv 9350
79	Kanina	K-34-124-C	A.Gucaj	2009	H.Hallaçi Inv 9427
80	Memaliaj	K-34-124-D	A.Gucaj	2009	H.Hallaçi Inv 9427
81	Ballabani	K-34-125-C	A.Gucaj	2010	N.Vukzaj
82	Panariti	K-34-125-D	K.Onuzi	2006	K.Onuzi.Inv 9350
83	Erseka	K-34-126-C	H. Pulaj	2000	K.Onuzi
84	Vidohova	K-34-126-D	K.Onuzi, H.Pulaj, A.Vranaj	2001	K.Onuzi. Inv 8681
85	Orikumi	K-34-135-B	H.Hallaci, A.Gucaj	2008	H. Hallaçi
86	Dukati	K-34-136-A	A.Gucaj, H.Hallaci	2008	H.Hallaçi
87	Kuçi	K-34-136-B	H.Hallaci, A.Gucaj	2009	H.Hallaçi

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88	Tepelena	K-34-137-A	H.Hallaci, A.Gucaj	2008	H.Hallaçi
89	Permeti	K-34-137-B	K.Onuzi	2006	K.Onuzi Inv 9188
90	Barmashi	K-34-135-A	H.Pulaj	2002	K.Onuzi Inv 8681
91	Hionades	K-34-138-B	K.Onuzi, V. Kici.	2001	K.Onuzi
92	Himara	K-34-136-C	K.Onuzi, I Prifti, H.Hallaci, A.Qirko, L.Hametaj	2007	K.Onuzi. Inv 9350
93.	Qeparoi	K-34-136-D	A.Gucaj, H.Hallaci	2008	H.Hallaçi
94	Gjirokastra	K-34-13-C	K.Onuzi, G.Gjivogli	2006	K.Onuzi Inv 9188
95	Libohova	K-34-137-D	A.Gucaj	2002	K.Onuzi Inv 8681
96	Leskoviku	K-34-138-C	H.Pulaj	2002	K.Onuzi Inv 9350
97	Lukova	J-34-4-B	K.Onuzi, H.Pulaj, A.Xhomo	2005	K.Onuzi Inv 9188
98	Saranda	J-34-5-A	K.Onuzi, I.Prifti, H.Pulaj, A.Xhomo	2005	K.Onuzi Inv 9188
99	Jergucati	J-34-5-B	A.Serjani	2002	K.Onuzi Inv 8681
100	Ksamil-Korfuz	J-34-4-D	A.Serjani, K.Onuzi, V.Qirici	2002	K.Onuzi Inv 8681
101	Mursia	J-34-5-C	K.Onuzi, D.Yzeiraj, V.Qirici	2002	K.Onuzi Inv 8681
102	Sotira	J-34-5-D	A.Serjani	2002	K.Onuzi Inv 8681
103	Konispoli	J-34-4-A	A.Serjani	2002	K.Onuzi Inv 8681

The Geological Maps and the accompanying texts have served as a base for the regulation and management activities in the territory of the country, exploration and exploitation of mineral resources, the use and protection of underground waters, for the selection of landfill sites, protection of geosites, for the study of natural hazards, the oil and gas drillings, and many other geoscientific studies.
During 2010 there have commenced geological correlations 1:50 000 scale for all the territory of Albania using as a base the topographic sheets in the UTM projection (Fig. 3). During this year was compiled the first geological map of the sheet 42, Maliqi (Fig. 4) as a cooperation of IGEWE – GSA – GIA - QUAMOD.DE. During 2011 was completed the Geological Map of the sheet 43, Korça and currently is being worked for the geological map of the sheet 48, Erseka.

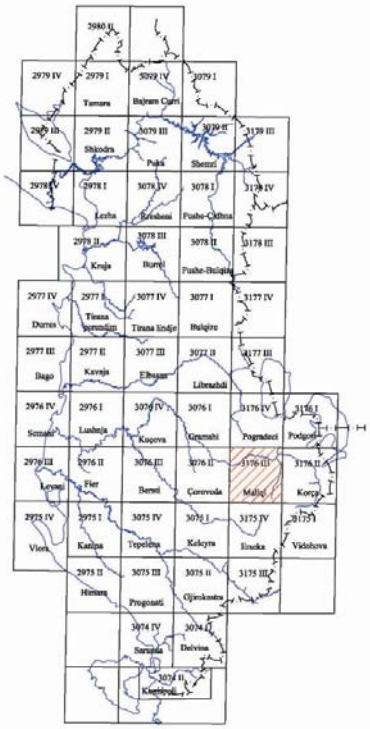


Fig. 3. The nomenclature of the topographic sheets of Albania on scale 1: 50 000 in the UTM projection.

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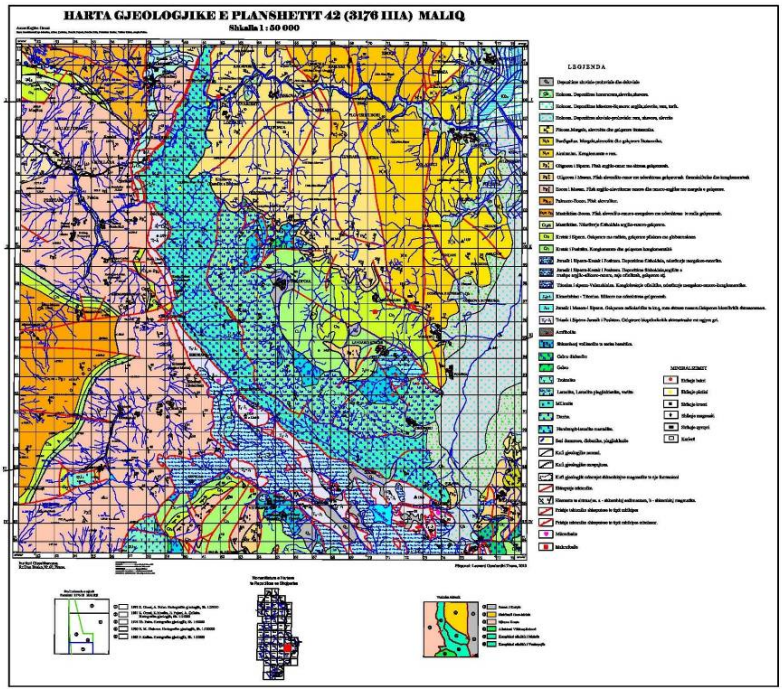


Fig.4. Geological Map 1:50 000 scale of sheet 42 Maliqi (UTM projection).

During these years (1993-2012) there have been carried out geological correlations with the neighbouring countries (Montenegro, Kosova. Macedonia, Greece) for the geology of the boundary areas in cooperation with geologists from Montenegro, Kosova, Macedonia, Greece, Germany and Italy. The final result is the publication of 38 geological sheets 1:50 000 scale and explanatory texts for each of them, for all the inter-boundary line between the countries. The following unified sheets 1:50 000 scales were published (Fig.5):

Albanian-Montenegro border area
1. Sheet 1 Vermoshi, 2. Sheet 2 Gucia, 3. Sheet 3 Stanet e Sublices., 4. Sheet 4 Rapsh-Starja, 5 Sheet 5 Tamara
6. Sheet 6 Thethi, 7. Sheet 8 Kopliku, 8. Sheet 14 Shiroka, 9. Sheet 20 Velipoja.

Albanian- Kosovo border area

1. Sheet 7 Bajram Curri,2. Sheet 12 Kruma,3. Sheet 13 Kishaj,4. Sheet 19 Morini

Albanian- Macedonia border area
1 Sheet 25 Shishtaveci,2. Sheet 30 Mali i Korabit,3. Sheet 35 Zerqani,4. Sheet 36 Poçesti,5. Sheet 41 Klenja
6. Sheet 42 Trebishti,7. Sheet 47 Librazhdi,8. Sheet 48 Struga,9 Sheet 54 Prrenjasi,10. Sheet 60 Pogradeci.
11. Sheet 61 Bllaca.

Albanian-Greece border area
1. Sheet 68 Pojani-Podgori Andartikon,2. Shee 69 Shueci –Andartikon,3. Sheet 76 Korca-Hionades Gramos

4. Sheet 77 Kapshtica- Korica Massapotamia,5. Sheet 84 Vidohova – Hionades Gramos,6. Sheet 90 Barmash-Hionades Gramos-Vassilikon Pogoniani,7. Sheet 91 Hionades Gramos-Vassilikon Pogoniani,8. Sheet 95 Libohova- Tsamantas,9. Sheet 96 Leskoviku-Hioandes Gramos- Vassilikon Pogoniani,10. Sheet 99 Jergucati-Tsamantas

11 Sheet 100 Ksamili-Ishulli i Korfuzit,12. Sheet 101 Mursia-Tsamantas,13. Sheet 102 Sotira-Tsamantas

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14. Sheet 103 Konispoli-Sagiadha-Filatai.

The geological maps 1:50 000 scale will be useful to various geo-scientific institutions (public and private) in both countries, in the Balkan region and in Europe.

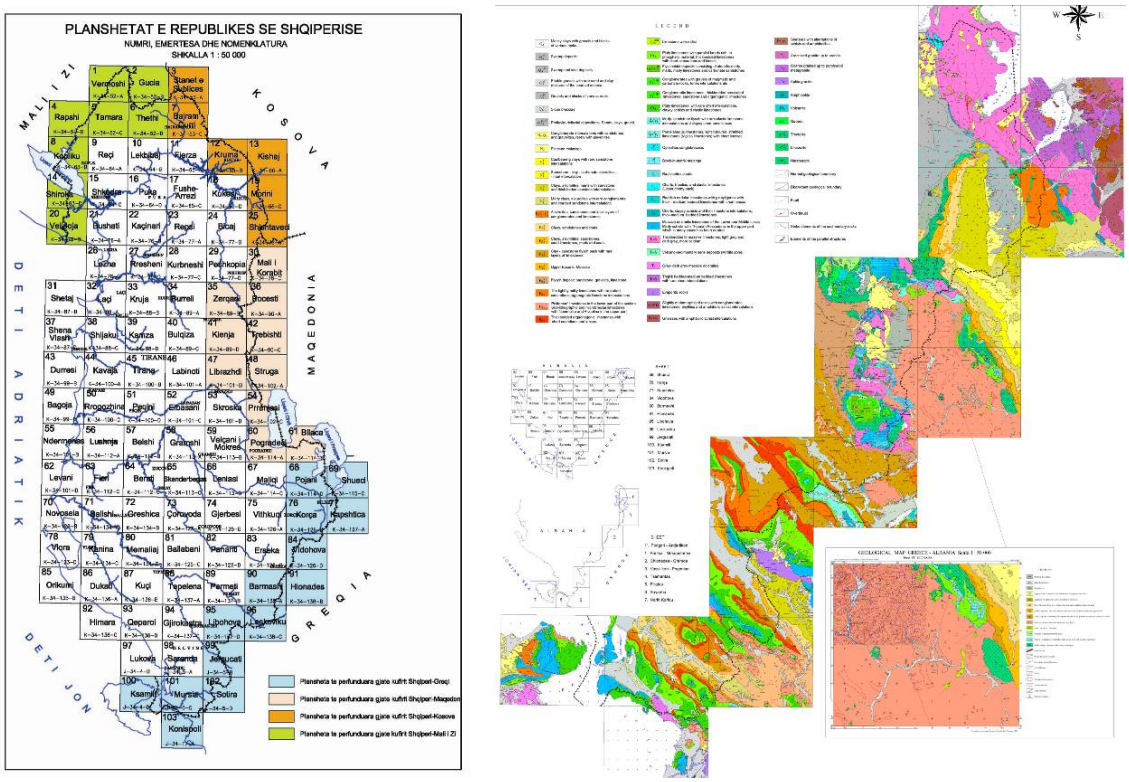


Fig. 5. Geological maps 1:50 000 scale of the Albanian - neighbouring countries border area (Albanian-Greece border area)

CONCLUSIONS

All the territory of Albania is covered by 103 geological map sheets 1:50 000 scale in the Gauss – Krüger projection system. Each of these geological maps is accompanied by an explanatory text. These maps are useful as a base for other geoscientific studies. Cooperation with geologists from neighbouring countries has led to the preparation of 38 correlated geological maps of the boundary areas with Montenegro, Kosova, Macedonia and Greece. A project has recently commnenced to prepare geological maps 1:50 000 scale based on the topographic sheets in the UTM projection compiled by the Geographic Institute of the Army.

REFERENCES

Kodra A.,Xhomo A.,Shallo M.,Xhafa Z., (2004). Geological Map of Albania 1:200 000. (SHGJSH)Tirana.

Matarangas D., Triandafilis E. (2000). Geological Map of Greece 1:1 000 000. IGME. Athens

Matarangas D., Androulakakis N. (2001). Geological Map of Greece 1:1 000 000.IGME. Athens.

Onuzi K, Metos A. (2003). Correlation of the geological maps 1:50 000 scale of the Albania-Greek border area.(4st European Congress on Regional Geological Cartography and Information Systems) (Vol.1,14-15.)

Onuzi K-(Bologna,2003)- Geological maps in Albania .(4st European Congress on Regional Geological Cartography and Information Systems) (Vol.1,43-45.)

ISSN 2306-9600

Onuzi K,.-(2004)Geologische Karten in Albanien(Deutsche Geologische Gesellschaft Tagung ,Geo Leipzig)

Onuzi K,Pajovic M,(2005)- Correlation of the geological maps 1:50 000 scale of the Albania-Montenegro border rea.(14st Serbian-Montenenegro Geological Congress ,f.123, Novi Sad)

Onuzi K.,Pulaj. (2000-2005) Geological correlations of the border area on scale 1:50 000). Archive of the Institute of Geological Research. Tirana.

Onuzi K,Koller F., Höck V.,Palko A.,Kosho P.,Ormeni R..-(2010) Harta Gjeologjike 1:50 000 dhe teksti spjegues i Planshetit 42 Maliq (UTM,IGJEUM)

Onuzi K,Koller F., Höck V.,Stoja Gj.,Kosho P.,Ormeni R..-(2011)Harta Gjeologjike 1:50 000 dhe teksti spjegues i Planshetit 43 Korça (UTM,IGJEUM)

Pentcherkovsky J.-Hatdjinutrova S (1975) Geological Map of R of Macedonia, 1:200 000, Skopje

Vukzaj N.,Onuzi K. (2007). Harta Gjeologjike 1:50 000 dhe teksti spjegues i Planshetit 14 PUKA (SHGJSH)

Vukzaj, N, Gucaj A, Karaj N, Hysa N, etj (2009, 2010, 2011) Korelime gjeologjike te planshetave ne shkalle 1:50.000 te Shqiperise. Fondi Qendror i Gjeologjise, Tirane.

Zivaljevic M., (1989) Explorationfor Geological Map of SR Montenegro, 1:200 000, Titograd.

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3D Structural Modeling and Organization of silicate deposit of Fe, Ni in Gllavica

Fidaim SAHIT[1]; Islam FEJZA[2]; Hazir ÇADRAKU[3];
[1]fidaimi04@hotmail.com: *MESP. Water Department. Government building*
[2]islamfejza@gmail.com *: University of Prishtina, Faculty of Mining and Metalurgy Mitrovica*
[1]haziri.Cadraku@hotmail.com*: MESP. Water Department. Government building*

ABSTRACT

Deposit of Fe, Ni-silicate in Gllavica in terms of geographical position is located 20 km south-west of Prishtina in the south east near Ultrabasic Massif of Golesh. The essence of the study is (3D) modeling of structures, textures of ore bodies and deposit in entirety by organizing database system during the research process on iron and nickel in Gllavica deposit in 2007. Potential of research is the geological system automation and organization of database of Fe, Ni deposit in Gllavica, through which 3D geological models are textured: litholo-strata-graphic structures deposit, ore bodies structures composed of ore bodies elements, the position of Ni distribution, in relation to spatial position of deposit, which in the end resulted in the conclusions on the factors that led to the formation of Ni-silicate deposit in Gllavica and other geological factors in the formation of the crust breaking. (3D) modeling structure in perspective of the field of research has shed light on the spatial position of the ore body on Fe and Ni, breaking crust spatial position in relation to the Golesh massif giving potential directions of continuity of the ore zone related to the breaking crust.

KEY WORDS

3D Modeling. Structure, texture, ore bodies

INTRODUCTION

Recently in the world it is the trend of sophisticated computer applications development of deposits geological data base system which enables designing of three-dimensional geological models in the intensified research areas for deposits of useful minerals and other geological issues. The development of such applications enables organization of geological data base which somehow facilitate: Quick access to information, development of plans, maps, 3D models, which allow analysis and fair judgment of professional and scientific opinion on the position and conditions of the geological formation.
Our research consist of such organization through computer applications, including 3D Geological mapping, cross sections, 3D block diagrams, and geostatistical analyses presented in diagrams that explain the natural pattern of the Ni distribution, define the textures, structures formation of ore bodies and designing 3D geological deposit of Fe, Ni in Gllavica.

GEOLOGY OF GOLESH AREA

Wide area of Golesh massif takes part in the geotectonic rock-forming area of Vardar which consists of peridotite and the remnant of the crust breaking peridotite with relatively small area. Peridotite of this area form the massif of "Golesh" and mineral composition consist of orthopyroxene and clinopyroxene, while the age of the peridotite is defined as Upper Jurassic [2]. Harzburgite and dunite cover central part of the massif.
Dunites- occur in the south-west of the massif, near the settlement of Medvec and Vrella and rock consist of hypidiomorphic granular texture. Serpentinite are found in suburb areas of the massif and the process of intensely serpentinization of peridotite is located near the floor of the massif. The serpentinization process represents more pervasive and fundamental process of auto-morph transformations and consist of serpentine mineral, iron oxides, silicate oxides, magnesium oxides, etc. The serpentinization process and breaking crust which appears mineral bodies Fe, Ni-Silicate, Cobalt have been developed in Gllavica locality.
Research has found crust breaking in a vertical line and other linear forms of alienation which go down to 200 m depth, up to 390 m quota. Three-dimensional relief model shows geological structure of Golesh region and spatial perspective of mineral areas of the crust breaking and other mineral bodies. Series of Paleozoic rocks which represent Golesh massif show that these rocks have fall under ultrabasic massif of Golesh.

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Massif does not reflect the movement in entirety, but cleavage towards the center of the massif is seen in the margins on the outskirts. From a regional perspective the massif represents a horst, which is due to deployments and deep tectonic break toward Risinoc-Poklek and Magura-Bardh i Madh. Fig 1.

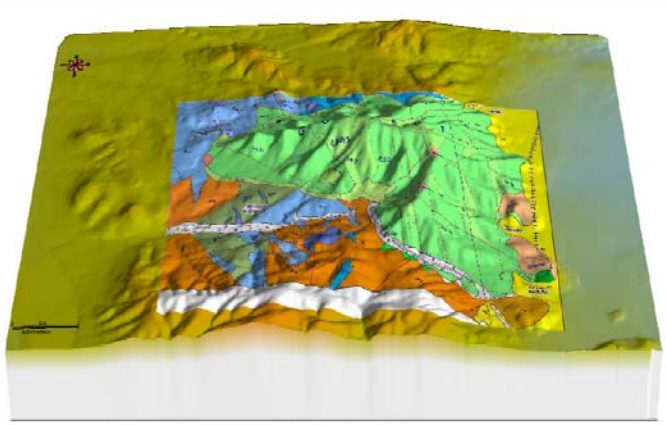


Fig 1: 3D relief model and geology of the massif of Golesh 1:25000.

The structural profile shows that Paleozoic formations in the northern and southern parts are inserted under massif of Golesh and Ni deposit in Gllavica. In this case, there are observed tectonic fractures expressed in deployments that have indirect directions from each other. Fig 2.

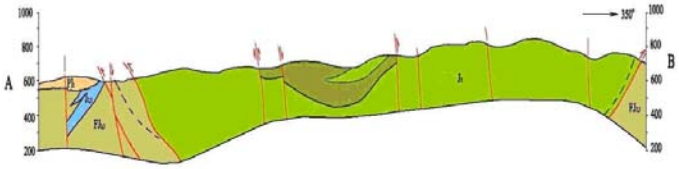


Fig.2: Structural profile of the massif of Golesh 1:25000

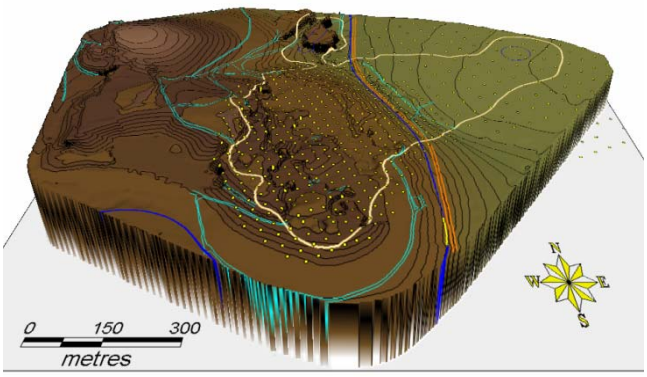
GEOLOGICAL STRUCTURE OF Fe, Ni-SILICATE DEPOSIT IN GLLAVICA

Research process on Fe, and Ni, in Gllavica location is intensified in 2007, and a total of 197 drillings of 50 x50 m density have been completed within an area of 100 ha. Research took place through core drilling. Results have shown that out of 197 drillings, 194 gave a positive result with Fe and Ni. Conducting the research by applying method of drilling, geodetic survey (record) of the area as well as other forms of research, it was organized data base system of Fe, Ni and silicate deposit of Gllavica.

3D model of deposit and geological texture of Fe and Ni deposit was designed by applying the methodology of integrated interpolation of data processing see. Fig 3. Database organization of Fe and Ni deposit and analysis of 3D model, starting from the top to the bottom of the deposit is composed by the following formations: Humus clay, Sandy and gravel clay, Sandy clay, Sand, Gravel, Iron nontronite hydroxide, Opal Zone, Iron hydroxide area, Nontronite area, Alternated serpentines area, Compact serpentines area, Schist area.Eastern and south-western part of the deposit is structured with Pliocene sediments and paleosoic formations that constitute basement of Fe and Ni deposit. Pliocene sediments are deposited in the Kosovo Basin and appear sandy-clay, clay, sandstone, gravel, sandstone terraces form. It is shown that the erosion of broken crust has occurred before tertiary sediment deposits. The time of the formation of floor by serpentinized magnesium breccia that are found in these sediments, has occurred after the deposition, or intensive erosion of tertiary sediment and rising of terrain. It is difficult to determine the age of this geological formation. It is certain that it is newer than the increase (or arrival) of peridotite on the surface, ie from the Jurassic and older than Miocene. We believe that the formation of the crust breaking belongs to the period between the Cretaceous and Pliocene.

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For the formation of these ores in the beginning has been serving the transportation of the crust breaking materials and their re-deposits not far from the dramatic cliffs. So full profile of ore body closes inside serpentinite and clay deposits which is defined lower limit of the alienation zone. Breaking crust formation is a consequence of regrouping of minerals from the rock mass chemically unstable in thermodynamic conditions of the earth surface.



Fi 3. Relief model of Fe and Ni deposit – Glavica

EXPERIMENTAL DATA AND METHODOLOGY OF STUDY

The database contains thousands data on the main base metal contents which are found to be present in the Ni deposit of Gllavica, ultrabasic massif of Goleshi. For the scope of this study, only data on Ni contents are considered and elaborated in order to determine the quality of the ore and assist in resolving issues of Fe and Ni distribution. Data processing methodology for the modeling of Ni rich areas is performed by using the Software Rock Ware which starting with the spatial database from the drillings and chemical analyses and applying integrated interpolation in nickel-rich areas gives the most rich areas in Ni. (Table 1).

Borehole Data Manager (194 boreholes)

Name	Location	Orientation	Lithology	Stratigraphy	Intervals (I-Data)	Points (P-Data)	Fractures	Water Levels	Symbol
SH-1111T									
SH-1111V									
SH-1111X									
SH-1111Z									
SH-1152D									
SH-1152F									
SH-1152H									
SH-1152J									
SH-1152L									
SH-1152N									
SH-1152P									
SH-1152R									
SH-1152T									
SH-1152V									
SH-1201									
SH-1203									

Depth to Top	Depth to Base	Ni	CaO	MgO	Fe2O3	SiO2
0.0	11.0	0.0	0.0	0.0	0.0	0.0
11.0	29.0	0.0	0.0	0.0	0.0	0.0
29.0	30.0	0.19	1.75	2.74	10.78	57.66
30.0	30.7	0.19	3.62	1.3	10.41	75.77
30.7	31.0	0.17	2.57	2.89	15.95	56.0
31.0	32.0	1.03	5.77	5.03	26.65	51.81
32.0	33.0	1.07	11.67	5.1	25.5	52.59
33.0	33.5	0.95	9.41	5.13	24.88	52.89
33.5	34.0	0.71	6.6	2.95	16.29	57.91
34.0	35.0	0.94	9.69	5.33	28.56	50.34
35.0	36.0	0.8	3.29	3.09	23.82	60.45
36.0	37.0	0.43	6.31	3.25	19.33	64.59
37.0	37.6	0.49	6.83	3.41	18.37	62.71

Table 1. Database system

In the Fig. 4 below, is shown the degree of concentration of Ni to nickel formations on the vertical column of the drilling which are then used for the construction of the qualitative model of the deposit as a whole..

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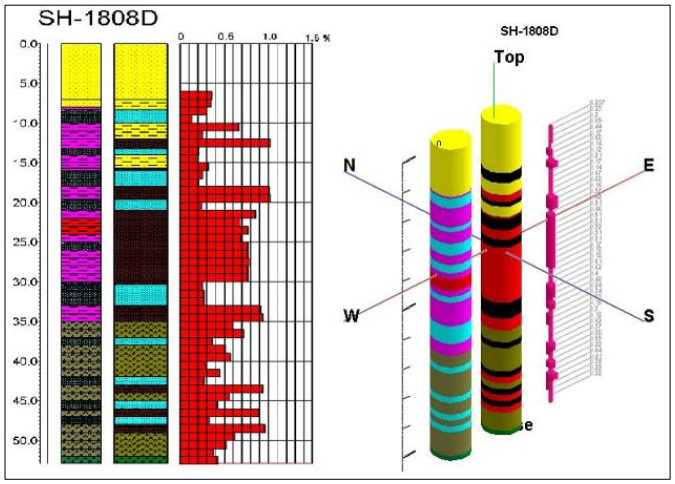


Fig 4. Modeling of research drilling

2-D AND 3-D SPATIAL MODELING OF THE QUALITATIVE DATA

Main parameter that affects categorization of useful mineral deposits is their qualitative composition and form of the distribution of useful component in ore body. In practice, changing the properties of the ore bodies is expressed by a variation coefficient. This coefficient expresses the ratio between average quadratic deviation of a property of an ore body and the arithmetic average of this property subject to the study. For distribution statistical process of variable is obtained parameter of Ni with 0.5% minimum coefficient. As the calculation of variation coefficient is based on 238 samples from 30 research drilling.

$$K_v = \frac{D_{(m)}}{M_{mes}} * 100 \quad \%$$

In the case of Fe and Ni deposit in Gllavica have been obtained evidence of medium weighted values and have resulted average composition of Ni (30 drilling).

$$M_{me} = \frac{\sum M}{n} = \frac{183.307}{238} = 0.77 \ \% \text{ Ni}$$

$$M_{mes} = 0.77 \ \% \text{ Ni}$$

Average quadratic deviation of Ni components is: $D_{(Ni)} = \sqrt{\frac{\sum (M - M_{mes})^2}{n-1}} = \sqrt{\frac{27.352}{237}} = 0.3397$ % Ni

Variation coefficient is expressed; $K_v = \frac{D_{(m)} * 100}{M_{mes}} = \frac{0.3397}{0.77} * 100 = 43.37\%$

Simple series variance is calculated according to the formula: $\delta^2 = \sum \frac{(M - M_{mes})^2}{n} = \frac{27.352}{238} = 0.1149$

Range width $Gj_v = = 1.76$

Median of series of numbers is 119-120

Median value is M_e=0.656-0.66 % Ni
Average content error.

$$G_{me} = \frac{D_{(mes)}}{n} * 100 = \frac{0.3397}{238} = 0.00142$$

These data are processed and indicated in cumulative histogram Fig 5.

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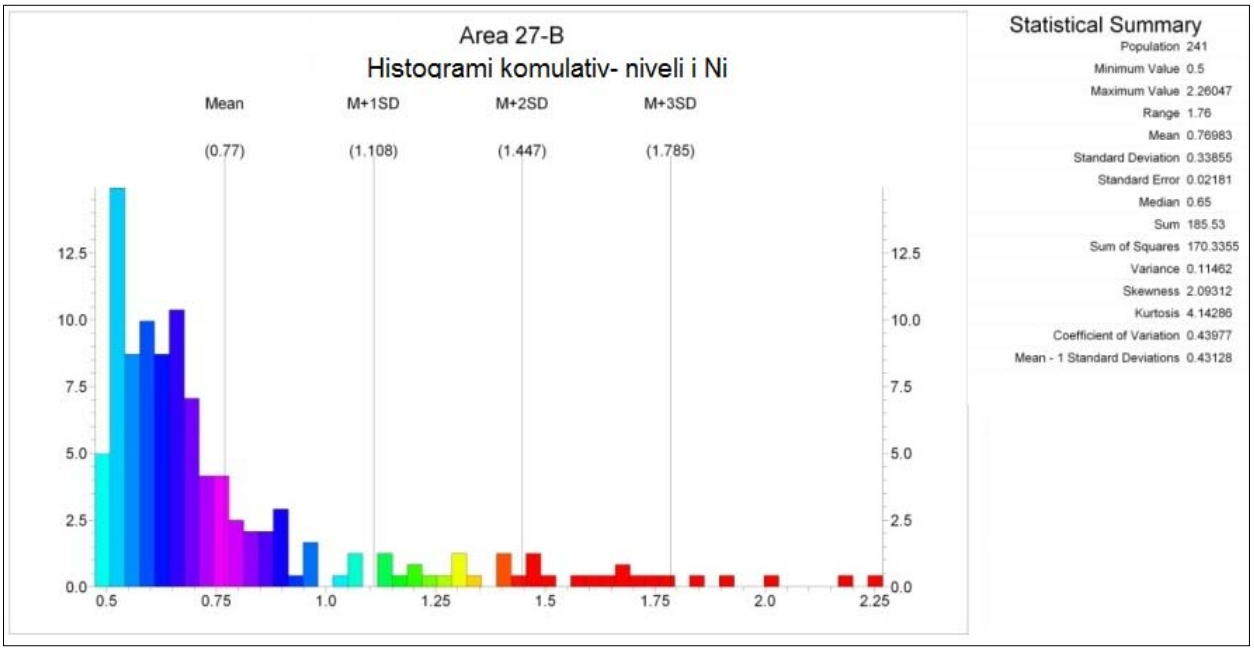


Fig 5. Cumulative histogram on nickel distribution in 30 drilling

Average content error is directly proportional to the average quadratic deviation while indirectly proportional to square root to the number of tests.

Based on this and the variation coefficient according to authors: Krasnjikov and Barishev, Ni deposits are categorized into five main groups.

Thus we conclude that the Ni component distribution with variation coefficient K_v=0.43 fall under the third group category with uneven distribution of Ni component. Ni average value was interpolated from average value of drilling researches see. fig 6

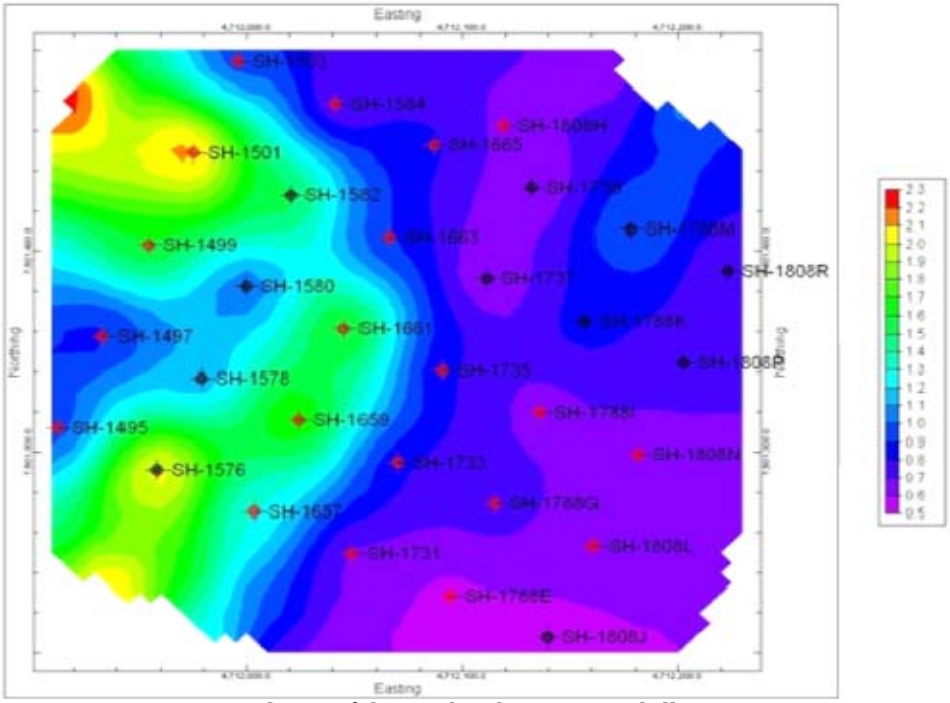


Fig 6.Interpolation of the N,i distribution in 30 drilling.

Cross profiles have been modeled in order to explain in detail the conclusion of zonality and properties of Ni distribution from the database system of deposit. The data have been processed in cross-profile by the method

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of interpolation, the approximate values of Ni, in an integrated way and thus is achieved the concentration level and other forms of Ni distribution. Fig 7.

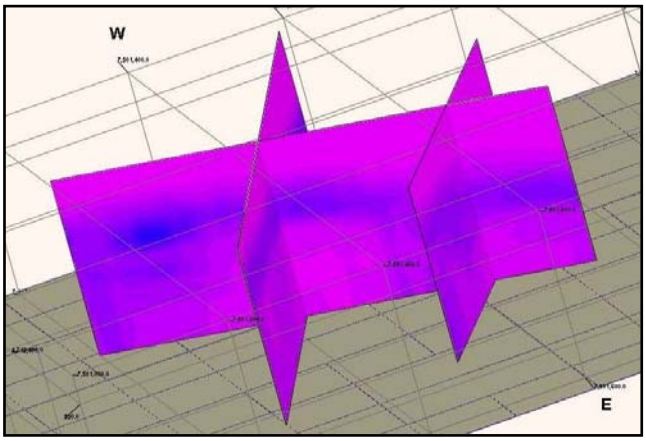


Fig 7. Cross profiles

In cross profiles, the conclusion is that the interpolation of the Ni concentration has uneven distribution and zonality of distribution varies depending on the formations that make up the ore body. Expounder of cross profiles shows Ni concentration level, while green color indicates the highest level of Ni concentration up to 2.78% Fig 8

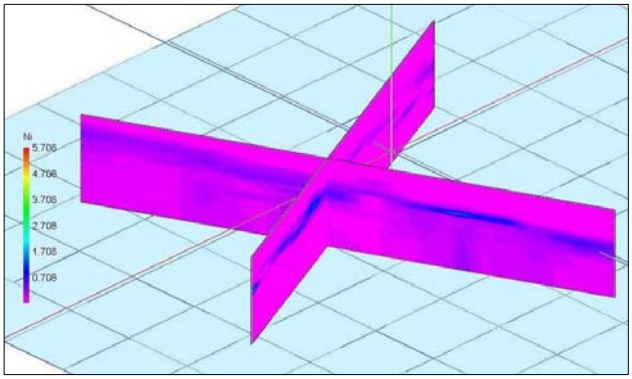


Fig 8. Cross profiles

For further clarification on the analysis of the deposit geologic texture, form and manner of the extent of formations in relation to ore bodies which constitute the deposit by organized system of the database applying the method of integrated processing, interpolation is gained (3D) model of the drilling and the (3D) model of the ore body.

This led to the conclusion of formations which constitute the ore body with Ni concentrations. So formations which constitute the ore body are: iron hydroxide with nontronite, iron hydroxide, nontronitized clay, nontronitized serpentinite which form horizontal and subhorizontale configuration to the lower limit of serpentinite alienation and Paleozoic schist Fig, 9 .

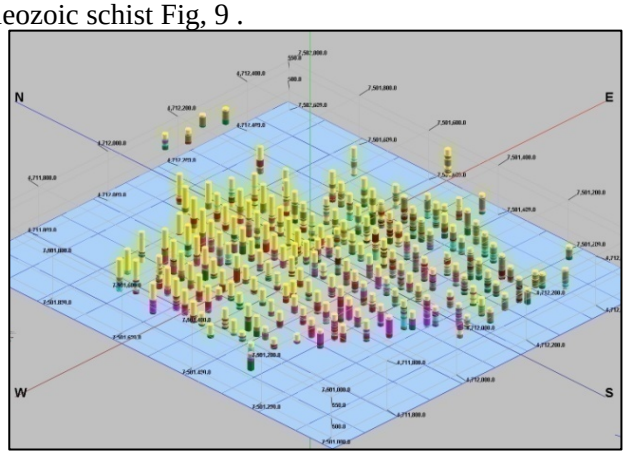


Fig 9. Three-dimensional (3D) drilling model.

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From the analysis of geological deposit formation factors, factors affecting the regrouping of Ni mineralization, form of configuration and composition of the formations which constitute the ore bodies, the shape of the distribution of Ni concentration, and other forms of linear expansion of the ore body in ratio to geological formations, we draw the conclusion that the ore body is formed in equilibrium conditions of calm waters in a colloidal environment isolated from the Pliocene formations after intensive erosion of breaking crust by chemically unstable rocks in the earth's surface thermodynamic conditions .

When analyzing Ni concentration areas and (3D) model, it is observed a zonal division into two parts, the southern and northern part of the deposit. In this we have judged that the main factor influencing zonal division of Ni concentration into two parts is that the water flowing through water flow of Medvec, crosses through the middle of the Ni deposit, which during high intensity water flow somehow has led to the disintegration of Ni element, and other supporting elements, or the displacement of useful elements in the rest of the basin. Fig 10

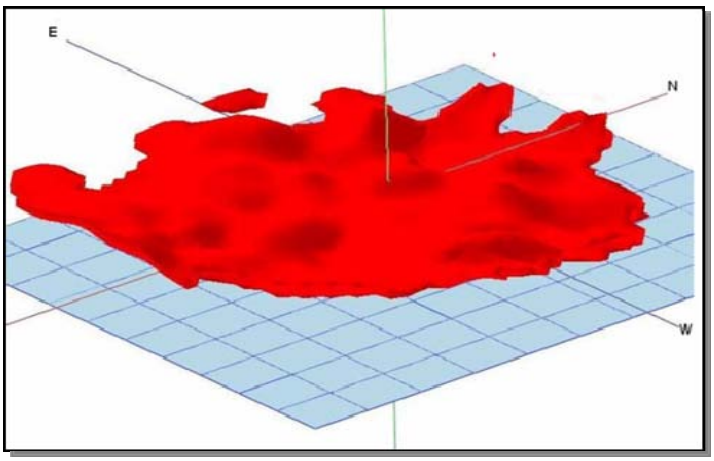


Fig 10. Three-dimensional (3D) model of the ore body

From (3D) model of block diagram of deposit in Gllavica, we conclude that the morphology of ore bodies is composite layered character with horizontal zonality. Figure 11

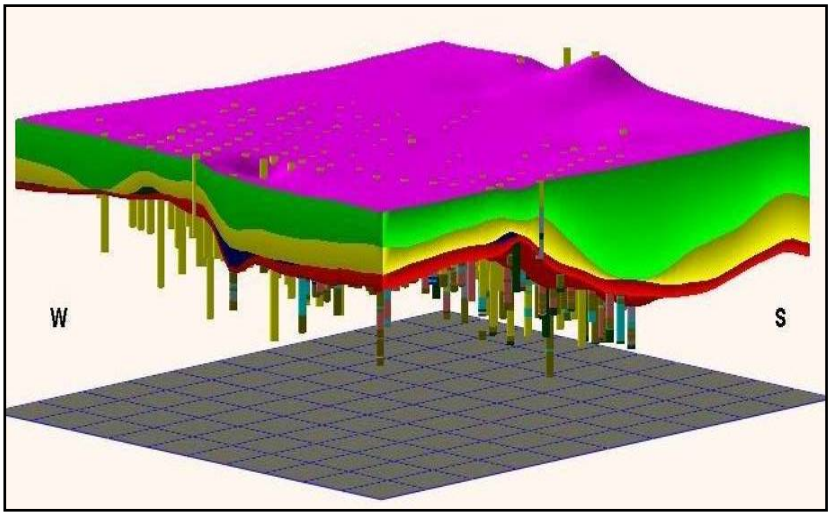


Fig 11. (3D) Block diagram of Ni deposit in Gllavica

CONCLUSION

- Nickel ore is formed under specific circumstances of chemical destruction processes of serpentinized peridotite which conditioned vertical zoning of nickel, iron and other supporting elements in deposit profile. In this field the Ni ore is concentrated in different conditions of concentration distribution.
- Factors that have contributed to the re-grouping of chemical elements and the formation of new minerals are chemically unstable rocks in the earth's surface thermodynamic conditions and Pliocene formations which have served as a shield in the preservation of the concentration of Ni and other supporting elements.
- Based on the distribution of Ni useful component with variation coefficient K_v=43, we conclude that the deposit is classified in the third group with uneven distribution.
- According to the (3D) model of the ore body and rich of minerals areas, ore bodies' morphology consists of layered composition character with horizontal zonality.
- Main factor that has led to the separation of Ni concentration in two parts is that the waters that flow through Medvec water flow, crosses through the middle of Ni deposit, which in the course with high intensity somehow has led to the disintegration of Ni element, and other supporting elements, or the displacement of useful elements in the rest of the basin.

LITERATURA

A. Meshi, Tiranë 2010. Gjeologjia Strukturore. 134
A. Meshi, I Hoxha,. Tiranë 2008. Gjeologjia dhe Origjina e Jetes. 230
B. Ostrosi, A. Peshkopia. Tiranë 1983. Gjeologjia e Vendburimeve të Mineraleve të Dobishme vëllimi 1. 220
B. Ostrosi, A. Peshkopia. Tiranë 1983. Gjeologjia e Vendburimeve të Mineraleve të Dobishme vëllimi 2. 220
A. Beqiraj. Tiranë 2008. Petrogjeneza e masivit ultrabazik të bulqizes (monografi).155
Elaborati për hulumtime gjeologjike të Ni-silikat 1983 Gllavicë 150
ELABORAT O PRORAQUNI REZERVENI DELO MANGENITCKOG LEZISTA "GOLESH" ISPOT XX KRALEVO JULA 1991. 120
DR Zenun Elezaj. Dr Alaudin Kodra. Prishtinë 2008 Gjeologjia e Kosovës. 293
D. Medak.Geodetsky fakultet Zagreb.33 Analiza prostornih podataka Predmetni nastavnik:.
D. K. Todd Larry W. Mays Arizona State Univerzity 2005. Graund Water Hydrology Therd Edition. 636
L Bariç Pr. Dr M Tajder . Zagreb 1972.Microfiziografija Petrogeni Minerali. 235
I. Fejza. Punim Dersitacioni Mitrovicë 2004. Tiparet petrologjike dhe strukturale të masivit të Goleshit dhe Rahovecit- Modelet të rrjedhjes mantelore. 200
M. Tajder. M. Herak. Zagreb 1972.Petrologija i Geologija. 355.
M Salloh. , K. Dhori , T. Ismail , M, Andrea. Tiranë 1990. Petrologjia e Magmatike dhe Metamofike
M. Shallo, Sh.Daja. Tiranë 2000. Gjeodinamika (Magmatizmi dhe tektonika Globale), 164
M. Iliç, S. Karamata. Beograd 197. Specijalna Mineralogija prvi deo.180
M. Iliç, S. Karamata. Beograd 1975. Specijalna Mineralogija drugi deo.184
M. D. Dimitrijeviç. Beograd 1978.Geoloska Kartiranja. 486
N. Pali.Sistemet Tiranë 2007 e informacionit Gjeografik ISBN 272.
N. Peci. Punim doktorate 2003. "Karakterizimi gjeologjik dhe vlerësimi gjeostatistik i vendburimit të nikelit silikat Çikatovë e Vjetër – Kosovë"
J. Kauani. Tiranë 1990. Petrologjia e Shkëmbinve Sedimentar. 321
S. Karamata. Beograd1967. Petrgeneza.323
Zbirka Savezni propisa iz geologije i rudorstva Beograd 1986. 459
Geting to Know Argis Desktop Second Edition 2008. Esri Press Redlends California. ISBN.568
S. Jankoviç.Beograd 1967.Lezista Metalicni Mineralenih Sirovina. 288
W. Schuman . Munchen 1990.Der neue BLV Steine Und Mineralien fuhrer. 383

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MAGNESITE MINERAL RESERVES IN DEPOSIT "DUBOVC"

Ramiz KRASNIQI[1], Alaudin KODRA[2], Sylejman HYSENI[3], Avni DIBRA[2], Jahir GSHI[1]

[1]Independent Commission for Mines and Minerals, (Armend Daci No.1, Prishtina, Republic of Kosova), rkrasniqi@kosovo-mining.org
[2]Albanian Geological Society, (Tirana, Albania), alaudinkodra@yahoo.it
[3] Faculty of Geosciences and Technology, (Mitrovica, Republic of Kosova), sylejmanhyseni3@hotmail.com

ABSTRACT

The magnesite deposit "Dubovc" is located in the area of the village with the same name, about 10 km in Southwest of Vushtrri in the north slopes of Çiçavicë mountain.

The deposit has been explored in the great mass with a relatively dense network of underground mining operations and drilling so today we can say that the exploration level of deposits is satisfactory. The deposit is represented by two great magnesite veins laying in the North west and South southeast direction, and according to the data of exploration operations it lays in the NE direction, except in the deeper parts dictated of surrounding rocks the vein will entirely change the angle and direction of dipping.

The done studies in the period from the mining interruption until now has denied the opinion of some previous researchers of this deposit, that calculate only for main veins of the deposit "Dubovc" , the deposit contains 1,5-2 million tons of reserves. The general final calculated reserves for all deposit "Dubovc" are 964 949 tons, from which the North part 409 898 ton, and South part 555 051 ton magnesite. Also two extensions in dipping of main magnesite strings that are about 55 000 tons have been added to this quantity of reserves.

The comparison of percentage of some determinate categories of mineral reserves in the deposit "Dubovc", leads to conclusion for a satisfactory level of the exploration of deposit and that it is a base for opening of mining operations of deposit.

KEY WORDS *Deposit, magnesite, Dubovc, Reserves, explorations.*

INTRODUCTION

Territorial area of Kosovo has considerable natural resources and within them the deposits of useful minerals, whether metal or non-metal minerals, have important place in national economy[5].

There exist documented research potentials for lignite, zinc, silver, nickel, chrome, bauxite, magnesite, and construction minerals (such as hard rock, sand, gravel, clay). According to explorations many geological premises have been met for precious metals (gold, platinum) where they are extinguished in rivers and as associated metals in other ores (chromite and base metals)[1].

Two active magnesite mines were present between two world wars: "Goleshi" and "Drenica" (Dubovci)[4].

The first interests for magnesite deposit "Dubovc" have started in 1929, whereas during the years 30' of the last century the mining operations have been carried out, a furnace have been placed in 1958 to profit caustic magnesite. The activity in this deposit ceased in the begging of the Second World War, to restart in 1953. In this year Qyteza (town) was built, three caustification furnaces, but because of non standardized production, so bringing of the raw material without quality conditions, the production was interrupted time by time until it was finally suspended in 1956. In 1958 revision operations took place in Northern and Southern sector of deposit, side to side with mapping, sampling, the gallery of new horizon 565 m was opened under the level of the existing mining operations that actually it is the deepest one in the deposit, but immediately after carrying out the operations of opening, it was abandoned after it was flooded by water. The operations were intensified n 1963-1965 in the Southern sector by carrying out the exploration operations by drillings, to verify the presence of magnesite under the horizon level 560m. The operations did not verify the presence of magnesite under this level (because of the wrong research orientation) and all operations were cancelled. Only after all these developments, the study of hydro-

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geological conditions of the deposit was carried out, in order to see the possibility of reopening the mine to use magnesite. Also during 1972-1973 in the Southern sector of deposit, the operations were carried out to control the presence of magnesite veins under the horizon 560m, but the done operations didn't catch the magnesite vein (because of the operations different of magnesite vein or wedging out) and for this new geological-geophysical operations were programmed.

The explorations carried out during 1975 and 1976 and 1978/1979 – are given in detail the development of the operations carried out in the respective years. The operations done during 1975/1976 did not give the expected results after they did not verify magnesite origin in the direction of depth under the level of horizon 565m. Later, the authors of explorations, did the exploration operations for the same reason in 1978/1979, mainly the drillings in Northern and Southern sectors of the deposit, in order to increase the reserves under the horizon 565m, which mostly are valued in re-categorization of mineral reserves in the highest level of mining operations than for perspective of magnesite deposit "Dubovc" in the direction of depth [2,3].

The general conclusive reserves calculated for the whole deposit "Dubovc" are 964 949 ton, from which Northern part 409 898 ton, and Southern part 555 051 ton magnesite. Also the reserves of two extension in dipping main magnesite origins have been added to this quantity of reserves, that are about 55 000 ton, are added to this quantity. The possibility of using these magnesite and some important geological explorations in the past and the state of mine today will be the study objective of this paper.

GEOLOGICAL CONSTRUCTION

In geological construction of magnesite deposit "Dubovc" take place:

- Serpentinite
- Sediments of Upper Cretaceous
- Carbonatic Series (Dolomite dhe Dolomitic breccias)
- Pliocene Sediments
- Quaternary Formations

Rocky representatives related to magnesite mineral in the deposit are brecciated serpentinite or serpentinite brecciated, but also representations of dolomite breccias where magnetized veins are located between them [1,8].

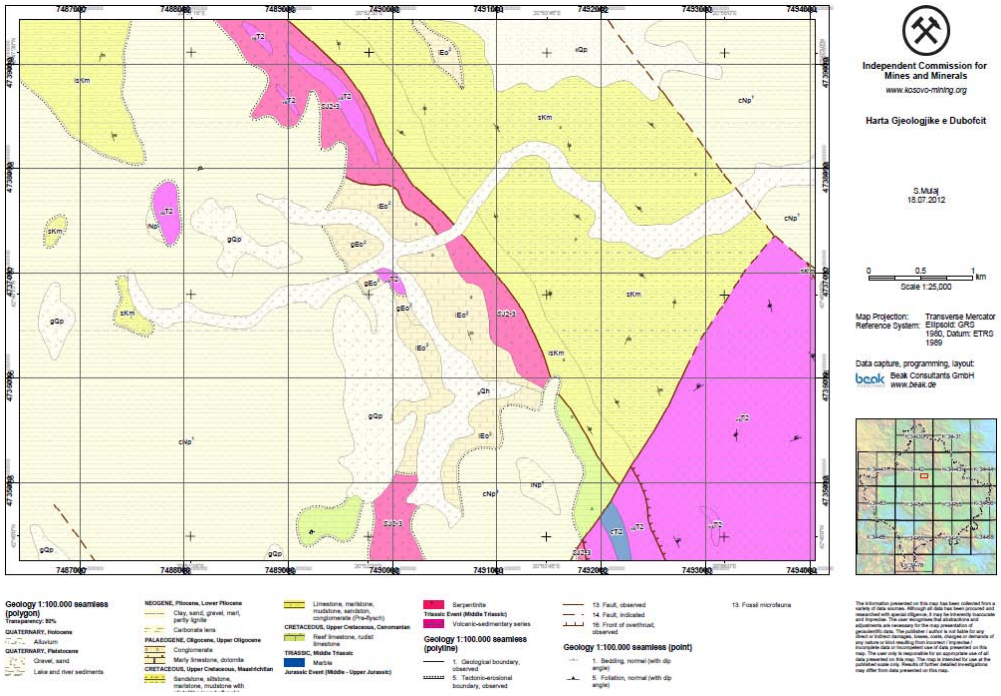


Fig.1. Geological Map of Dubovc

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Table1. Coordinates of mines field

Point	Y	X
1	7488710	4738100
2	7489422	4736982
3	7489555	4735450
4	7491527	4735665
5	7491402	4737421
6	7490000	4738100

METHODOLOGY

Firstly, it was stepped on field, it was analysed the geographic position and communication, there are evidenced all so far surface and underground operations, there are evidenced the outcrops of magnesite veins in surface etc.

Mainly, it is done the analysis of all geological explorations done in the past (1929-1979) which have been occurred in the different periods with interruption time to time. A primary importance during the study and the analysis of the literature which has been encountered for this deposit has been dedicated to the quality of magnesite of this deposit that was contested in the past. Anyhow in this direction there have not been underestimated the information related to the bringing of streams, the levels of surface water, of Brusniku stream and torrent created in the deposit surface or around it, which impact in the food and the levels of underground waters.

Hydro-geological observations are simple tasks in the geological practice during the explorations of a deposit, especially in bringing, debit and measurement of underground water level for different seasons of a year and for all territory of carrying out different operations, drillings, underground operations or simple observations of water spring in deposit or around it. We think that the methods which are used today in underground mines are very practical and Brusniku stream would not present a problem for example the insertion of this stream in wide profile pipes or building a wall of the river bed which would bring many positive environmental effects also for the inhabitants in surroundings [2,3].

CALCULATION OF MAGNESITE MINERAL RESERVES AND ITS QUALITY

Based on the collected data and the existing documentation, recalculation of mineral reserves have been done, that differs from some of previous ones, as in quantity and in the categories of reserves, because they have been re-categorised from the last exploration operations, in order that the most of the reserves of category C_1 and C_2 are of higher category, receptively B.

The methods with blocks have been used for calculation of reserves with limited configuration by density and the network of emplacing the done exploration operations and the forms that magnesite vein has.

According to the actual norms on classification and categorization of the reserves of magnesite deposits, magnesite deposit "Dubovc" is classified in II group, with partly irregular dispersion of harmful components, also this determines the deposit type according to reserves, so it means in large and medium deposits with partly irregular dispersion of harmful components.

Based on the network of exploration operations according to categories, placing the operations in extension for category A shall be 60 metres, for category B – 80 metres and for category C1 – 100. The distance of operation during the dipping of veins for all categories shall not exceed 30 metres [2,3,4].

Reserves are calculated according to formula:

Q = a x h x m x s = magnesite ton

a= the block's length in meters

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h = the block's height in meters

m= the block's width in meters

s = the specific weight of magnesite origin of the deposit 2,9 t/m^3

Table 2. Introduction of deposit reserves

Sector	category A	category B	category C	sum
Northern	92 885	161 88	155 195	409 898
Southern	78 300	192 995	266 756	555 051
total	171 185	361 813	421 951	964 959

Presence of reserves according to the report of special categories in % .

Category - A = 171 185 or 18%

Category - B = 361 813 or 37%

Category - C = 421 951 or 44%

QUALITY OF MAGNESITE IN THE DEPOSIT "DUBOVC"

The quality of magnesite is described in detail in the exploration carried out in the past. The used sampling with furrows is according to the methods and the manners of sampling for magnesite mineralisation. Furrows discontinue all the thickness of magnesite vein. Initially in the operations carried out during 1953, within the qualitative evaluation, also the selective sampling with furrows has been carried out only in those parts of thickness where magnesite with the best quality is determined macroscopically. Sampling with furrows has been practiced also in the following years as in the operations of opening the mine in 1956, also during 1958-1959 and 1965 and until the operations carried out during 1976 until 1979[3].

The average value of furrow's length of sampling and the average of length of selective sampling in furrow are given in the following tables.

Table 3. The data of quality, northern sector

Horizon	Number of taken samples	Length of sampling in furrow	Average content		
			MgO	SiO_2	CaO
I	2	1,15	44,56	0,94	1.21
II	18	1,11	44,74	3.35	0.48
III	12	1, 15	45,60	1.14	0,74
IV	12	0, 92	45,71	1.35	0,56
Average content.			45,40	1.69	0,74

Average content of magnesite oxide is gained by calculation of remains from normal samples.

Table 4. The data of quality, southern sector

Horizon	Number of taken samples	Average length of furrow	Average content		
			MgO	SiO_2	CaO
I	6	98	45,98	0,26	1.21
II	13	125	45,59	0,90	0.48
III	18	128	45,10	1.75	0,74
Average content.			45,64	0,79	0,74

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The qualitative characteristics of magnesite of the deposit "Dubovc" do not allow their use in the flame-resistant material industry without being enriched (purified), or processed, but it is very certain that after many experiments seen in the half industrial laboratory we can confirm that magnesite of deposit "Dubovc" can be concentrated with about 50% comparing with entrance and to be used for production of flame-resistant materials, that shows that 450 to 500.00 ton concentrate can be gained by this deposit, a quantity that in our situation it is a great quantity that in any way it can not be ignored.

DISCUSSIONS

Magnesites of Dubovci deposit have poor quality and do not meet the requirements of the industry to be used as natural raw material without being enriched.
Enrichment of magnesite can be achieved in acceptable borders only with the profit of concentrates by flotation method as researchers recommend only through a modern enrichment technology.
Deterioration in the quality of magnesite is from the siliceous presence as covering of clastic magnesite or network forms of siliceous veins within magnesite mineralization, separating them from the magnesite masses sorting by hand is almost impossible, we emphasize that the presence of free silica in crushed magnesite raw material is harmful.
In the deposit Dubovc, magnesites are outcropped, magnesite vein in the northern sector lies to a length of about 500 meters, with a thickness of 5-20m with northeast dipping with angle to average, while the southern sector origin lies about 550 meters, the thickness varies from a few meters to 15 meter with vertical dipping, magnesite is more qualitative in the southern sector by geological data. Magnesite in depth goes up to 80-90 meters from the surface (up to the quota 550m), but taking into consideration that the level of the stream Brusnik is over this level (about 30metra).
Reserves are calculated for both Northern and Southern sectors of the deposit, in the calculation of the reserves of magnesite deposit there are given in a total: 910 087 tones (A - 171 185 tones; B - 361 813 tones; C1 - 421 951 tones). But the calculations are carried out by geological material; - not taking into consideration the reserves used during 1953 -1956, - not taking into consideration the reserves calculated under the level of stream Brusnik (under the quota 590-600m)[2,3].
I think that using underground mining operations have not been a good choice, because the effects of this mining are reflected directly on the surface because of small depths, forming a furrow until the horizon of mining. Viewing current data on the state of the mine, we think that if it is foreseen a possible mining, outdoors mining shall be applied, otherwise it will encountered with the difficulties in operations focused on different levels as well as a huge expense to reopen mine. The level of mining in any case should not be below the level of the stream waters of Brusnik.



Fig.2. Old mining operation and magnesite ore, northern part (left) and southern part (right)

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CONCLUSIONS

The magnesite deposit in Dubovc is located about 10 km in southwest of Vuçitërn in the north slopes of Çiçavicë mountain. It is significantly connected with paved roads with Vuçitërn. The deposit of magnesite "Dubovc" is known for many years and in many cases production is suspended to finally be closed in 1958. In the deposit along with the mining and later geological - or mineral exploration operations have been carried out in a greater or lesser mass that lasted until they were ceased at the end of April in 1979 [1,8].

Throughout time of the research work deposit is greatly explored with a relatively dense network of underground mining and drilling operations, so that today we can say that the rate of exploring the deposit is satisfactory.

Deposits are represented by two large magnesite veins which lie in the North west and South-Southeast direction, and that according to data from exploration operation they fall in NE direction, except in the deepest parts dictated by the surrounding rocks the vein will completely change the angle and dipping direction.

Except these major veins in deposit and its surroundings a small number of veins are observed wider, leaving even stockwork form of magnesite. The subject of previous exploration was mainly two main magnesite veins, while less attention was given to the others.

The two major magnesite veins, in North and South, in general have been intensively subjected to post-mineralisation tectonics, so as magnesite veins from compacts transformed into the magnesite breccias area, which served as a genetic connection for the interposition of newest carbonates or siliceous substances, which reflected negatively on the quality and characteristics of magnesium. Cement, siliceous or carbonate composition, in such increase extent in the content of harmful components in magnesite made without a prior enrichment it can not be used in the production industry of flame-resistant items.

The done studies in the period from the mining interruption until now has denied the opinion of some previous researchers of this deposit, that calculate only for main veins of the deposit "Dubovc", the deposit contains 1,5-2 million tons of reserves. This denial comes from the fact that the magnesite veins to depth have more limited development, despite what we had foreseen, and only 30 meters dipping to depths below known horizon 565m as one and the other sector, Northern and Southern sector of the deposit.

The general final calculated reserves for all deposit "Dubovc" are 964 949 tons, from which the North part 409 898 ton, and South part 555 051 ton magnesite. Also two extensions in dipping of main magnesite strings that are about 55 000 tons have been added to this quantity of reserves.

The comparison of percentage of some determinate categories of mineral reserves in the deposit "Dubovc", leads to conclusion for a satisfactory level of the exploration of deposit and that it is a base for opening of mining operations of deposit.

The qualitative characteristics of magnesite of the deposit "Dubovc" do not allow their use in the flame-resistant material industry without being enriched (purified), or processed, but it is very certain that after many experiments seen in the half industrial laboratory we can confirm that magnesite of deposit "Dubovc" can be concentrated with about 50%comparing with entrance and to be used for production of flame-resistant materials, that shows that 450 to 500.00 ton concentrate can be gained by this deposit, a quantity that in our situation it is a great quantity that in any way it can not be ignored.

Based on all what it is said above, we believe that despite the unsatisfactory quality of the magnesite of deposit "Dubovc", by using mining, purification and concentration modern methods, the value of the deposit will be increased the with significant quantity of magnesite, ie, magnesite concentrate.

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REFERENCES

1.Archive of Independent Commission for Mines and Minerals (ICMM), Prishtina.
2.B. Milanoviq, Kraljevo, 1997, *Geološke karakteristike i ekonomski značaj magnezitskih leižišta Kosova* (Doktorska disertacija).
3.D., Jovanoviq, Beograd, 1979, *Elaborat mbi rezervat e mineralit te magnezitit ne vendburimin "Dobovc"*
4.Dushi M, Prishtinë, 2009, *Pasurit minerale të Kosovës.*
5.Elezaj Z. & Kodra A., Prishtinë 2008,*Gjeologjia e Kosovës*, Tekst Universitar.
6.Ostrosi B, Peshkopia A, Tiranë, 1983,*Gjeologjia e vendburimeve te mineraleve te dobishme.*
7.Prifti K, Bejta P, Tiranë, 1996, *Gjeologjia e Përgjithshme*, Shtepia botuese "Libri Universitar".
8.R. Krasniqi, Prishtinë 2010, Punim Master; *Karakteristikat Gjeologjike dhe vëlersimi ekonomik i magneziteve ne fushën mineral mbajtëse të Dritanit – Drenas.*
9.Tërshna A, Tiranë, 2000,Vendburimet e mineraleve jo metalore dhe kërkimi i tyre, shulu.

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IMPACT OF ALBANIAN OIL INDUSTRY ON POLLUTION OF GJANICA RIVER

Irakli PRIFTI[1], Suela DAUTI[2]
[1]*Polytechnic University of Tirana, Rruga e Elbasanit,Tirana, Albania, E-mail: irakliprifti@yahoo.com*
[2] *"Albstar" company, Patos, Albania, E-mail: sueladauti@yahoo.com*

ABSTRACT

Gjanica river is branch of Semani river in Albania. The environmental monitoring programs, pollution level and pollutant sources of the zone were evaluated. The pollution level of Gjanica river and its ecological impact are programmed in conformity of Albanian low.
River starts from the eastern side of petroleum refinery in Ballshi town. It continues through Visoka oilfield and then flows into the Seman river. Gjanica river transports two types of oils:
a. Large amounts of oil that floats on the surface of the water almost all along its flow. Moreover, thin oil sheets can be seen even at the Semani river water surface, causing big concern to the livings and humans.
b. Dissolved oil in water, for which are calculated total quantities.
The river accumulates the waste water of oil decantation stations of Usoja and Visoka, the waste water of petroleum refineries. In their flow towards the Seman river (northwards), pollutant values decrease as a result of freshwater input, while floating oil patches reach the Adriatic sea, causing its pollution.
The indicators for the pollution estimation are: the total quantity of technological waters discharging in the river; the oil content diluted in the discharging waters (taking into consideration the total quantity of discharging oil); phenols content; the chemical oxygen demand (COD); the biological oxygen demand (BOD_5);
Therefore, the treatment of the waters and the restoration of the whole zone are quite imperative. The life quality for the biota and humans in the zone will be improved and, moreover, its touristic values will be increased.

KEY WORDS *Refinery, decantation stations, oil content, pollution, phenols, Gjanica river`s, Adriatic Sea.*

INTRODUCTION

River of Gjanica has a length of 70 km and 234.07 km ² area of the watershed. The main source of the Gjanica river is Shpiragu mount. His feeds are characterized by major changes as the seasons of the year and in many periods of years. From the observations, the water capacity varies from 124 m³ / sec to 0.146m ³ / sec. This fluctuation is minimized by two lakes which are built in the mountainous area of Shpiragu. So water quantity is controlled by management discharges of lakes.
Gjanica river passing near the petroleum refinery of Ballsh town, acrosses northwards to Visoka oil field and continues towards the town of Fieri. In the north joins the Seman river. Having passed through the sectors of oil fields and petroleum refineries, the river is polluted by their technological discharges (Fig.1).

Potential pollutants of Gjanica river`s can be divided into four categories:

- Water discharged after decantation stations from Visoke and Usoje.
- Technological waters that flow from petroleum refineries.
- Uncontrolled water,
- Industrial discharges from food industries, hospitals and others from Fier and Ballsh towns. These waters are not treated before discharge (Prifti, I., 2004; Prifti, I., Bitri, A., 2010).

Amount of water discharge from decantation stations, after 2004, has grown for two reasons:

- The amount of oil production.
- High % of water content in crude oil production.

Fluid production comes in the form of water-oil emulsions (Prifti, I., 2011). For oil-water separation are established decantation stations of oil. Technology decantation in these plants is old. This increases the amount of oil discharged into the Gjanica river. Wastewater treatment process is performed only in the oil

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gravimetric separation through concrete horizontal separators. These separators have emerged from the technological scheme of the preparation of oil.

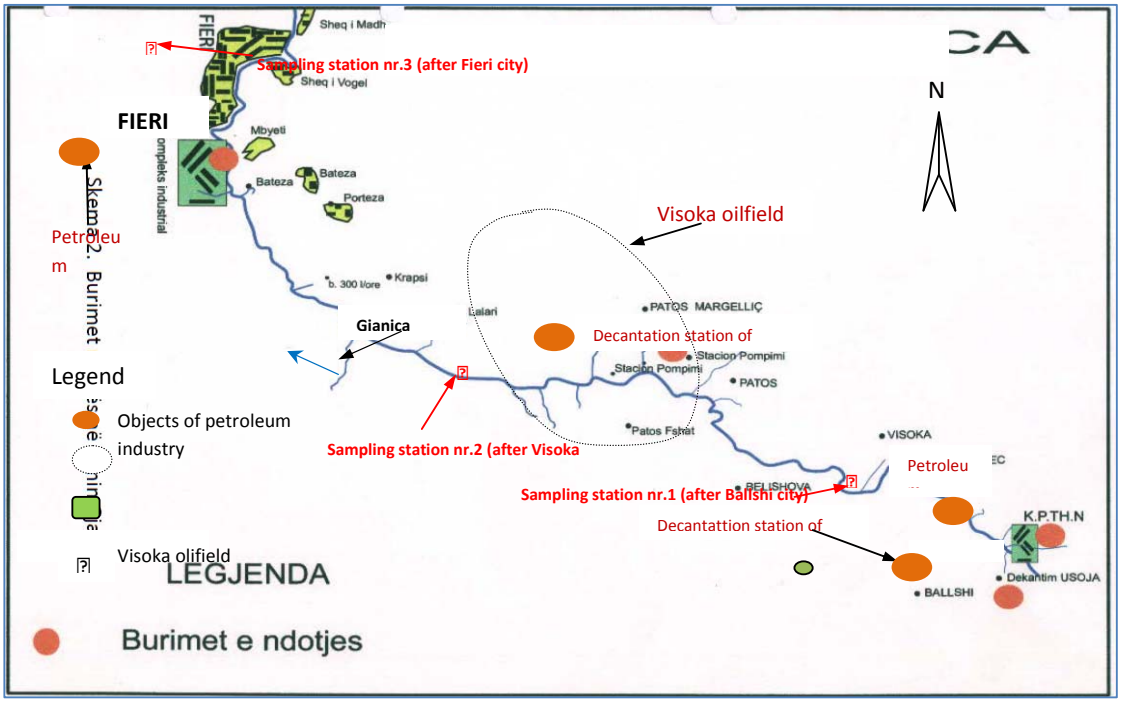


Fig. 1. Scheme of pollutant objects of Gjanica river

From the observations, it can be noted that Gjanica river is polluted significantly by the waters of the emissions of these plants.

MATERIALS AND METHODS

There are conducted in a systematic way a series of analyzes to assess the degree of water pollution in Gjanica river.
There are some objects of study to determine the contamination:

1. The amount of downloads technological decantation stations, petroleum refineries and chemical features of their own.
2. Waters of Gjanica river after discharge of the petroleum industry and urban areas.

Specifically defined Gjanica River for three sampling stations:

1. After discharges of Ballshi town (including petroleum refinery, Usoj decantation and urban emissions). This is the southernmost station (Fig. 2, 3, 4).
2. After unloading decantation station of Visoka (Fig. 5, 6).
3. After downloading the petroleum refinery and urban areas of the Fieri town. This is the most northern station (Fig. 7).

Sampling procedures is realized with the requirements of monitoring methodologies and environmental regulations. These methods are in accordance with Albanian state standards, based on the European standard (ISO) and the American one (ASTM).

Analytical determination of pollutant indicators are conducted by these institutions:

- National Scientific Centre of Hydrocarbons, Fier (closed operations in February 2007).
- Chemistry-Processing Centre, Kucova, part of "Armo" company.
- Institute of Public Health, Tirana.
- Institute of Veterinary Research, Tirana.
- Determinations by foreign companies operating in the prospection and production of oil in Albania.

The defined indicators are: The amount of water discharge, pH, suspended matter, oxygen, water quantity (m^3), oil dissolved, phenol, H_2S, nitrite, nitrate, phosphate, iron, COD, BOD_5, ammonium, aromatic

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hydrocarbons series of benzene (benzene-toluene, E.Benzene, P.Ksilene, M.Ksilene, O.Ksilene), (Prifti, I., Bitri, A., 2006; Prifti, I. , Bitri, A., 2010).



Fig.2. Old object in petroleum decantation station of Usoja



Fig.3. Gjanica river passing throw the petroleum refinery of Ballsh town



Fig.4. Petroleum decantation station of Visoka

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RESULTS AND DISCUSSION

In Gjanica River are discharged 437 517 m³/year from oil fields and 2,102,259 m3/year from petroleum refineries (Table 1). In periods of rainfall, the amount of oil discharged into the river increases as a result of the contaminated surfaces.

Table 1. Quantity discharge of technological and urban water during one year

Nr.	Pollutant objects	Quantity discharge (m³/year)
1	Petroleum refinery of Ballshi city	1 416 000
2	Power plant of petroleum refinery	189 800
3	Decantation station of Usoje	44 118
4	Decantation station of Visokë	112 495
5	Petroleum refinery of Fieri city	689 259
6	Urbane discharge of Ballshi city	1 152 000
7	Urbane discharge of Fieri city	8 030 000
	Total	**11 633 972**

Large amount of oil discharged technological waters as a result of outdated technology of the petroleum industry.
Currently, data on releases of oil with water are questionable (Table 2), because there are not including sailing chips, diving and sliding portions of oil in aquatic environments. Our opinion is that the total oil content in discharged water should be higher.

Table 2. Content of dissolved oil from discharging water of petroleum refineries and petroleum decantation stations

Nr	Discharging objects	2002 year	2003 year	2004 year
1	Decantation station of Usojë	76 mgr/l	70 mgr/l	50 mgr/l
2	Decantation station of Visokë	20.8 mgr/l	20.8 mgr/l	29 mgr/l
3	Petroleum refinery of Fieri city	90 mgr/l	90 mgr/l	96 mgr/l
4	Petroleum refinery of Ballsh city	60 mgr/l	0.06 mgr/l	153 mgr/l

Aggregated results of analysis of discharge waters from decantation plants are given in Table 3 (in mg / l). It can be seen clearly that waters discharged by decantation stations are very polluted. Their discharge causes pollution of Gjanica river.

Table 3. Chemical results of discharging water from petroleum decantation stations

Parameters	Usoja petroleum decantation stations	Visoka petroleum decantation stations
pH	6.35	6.55
Suspended matter	67.5 (mg/l)	76
Dissolved oxygen	2.1 (mg/l)	1.99
Ammonium	41 (mg/l)	32
Oils	165 (mg/l)	500
Phenols	96.5 (mg/l)	46
H_2S	6 (mg/l)	6.15
Nitrite	1.67 (mg/l)	0.36
Nitrate	2.6 (mg/l)	3.65
Phosphate	1.3 (mg/l)	1.12
Iron	0.21(mg/l)	0.16
COD	417 (mg/l)	750
BOD_5	68.25(mg/l)	64.15
Bor	78.7 (mg/l)	45

Ballshi petroleum refinery is located at the upper flow of Gjanica river. This refinery was built on alluvial deposits of the river. It has a 2 km stretch of the river. The technological refinery wastes discharged through two main channels. Besides them there are some others secondary ones.

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In the discharged waters, the content of oil dissolved during 5 years was analyzed and this index reaches up 96mgr / l (Table 4). So, for 5 years in the Gjanica river, 482.43 ton of oil are discharged. This amount of oil has gone into the Adriatic Sea (Bitri, A. et al., 2003; Irakli Prifti, Altin Karriqi, 2012).

Table 4. Quantity of oils in discharging water from petroleum refinery of Ballshi city

Nr.	Year	Quantity of discharging water (m^3/year)	Content of oils in discharging water (mg/l)	Quantity of oils in discharging water (ton/year)
1	2000	1 080 000	68	73.44
2	2001	1 116 000	72	80.35
3	2002	1 131 000	96	108.57
4	2003	1 305 000	84	109.62
5	2004	1 416 000	78	110.45
	Total	**6 048 000**		**482.43**

From the above estimates of refinery emissions, pollution of the Gjanica river allso affects the pollution of the Adriatic Sea coast line.

Water purification block of Ballshi refinery has not operated since the beginning and the efforts to restore the work of this block were not persistent and not effective. Thus, as seen from the table, in recent years, this refinery discharged into the Gjanica river not less than 100 ton of oil which ends at delta of Semani river.

High content of benzene and its homologues in Gjanica river originate by the emissions of different plants and uncontrolled water. Content of aromatic hydrocarbons is lower on Gjanica river as a result of natural flow (Table 5). However water of Gjanica river is polluted.

Table 5. Content of benzene hydrocarbons of discharging water from petroleum refinery of Ballshi and Gjanica river

Parameters	Ballshi petroleum refinery			Gjanica river`s		
	Lower value (mg/l)	Higher value (mg/l)	Average value (mg/l)	Lower value (mg/l)	Higher value (mg/l)	Average value (mg/l)
Benzene	0.85	9.052	4.951	0.11	1.39	0.75
Toluene	2.79	14.96	8.875	0.26	2.4	1.33
EthylBenzene	0.46	1.57	1.015	0.04	0.31	0.175
Penthylxylene	0.51	1.62	1.065	0.038	0.22	0.129
Methylxylene	1.06	3.57	2.315	0.092	0.61	0.351
Ortoxylene	0.94	2.57	1.755	0.09	0.59	0.34

Benzene reaches maximum value of 1.39 mg/l, toluene of 2.4 mg/l, while values of other counterparts come to landing. However, despite the results of the analysis, the presence of these hydrocarbons in the aquatic environment should always be taken under control because they are classified as carcinogenic material.

As a result of these discharges, Gjanica pollution is high enough to be considered dead and from the ecological point of view it can be classified as a dead river. In terms of fauna and flora, it can be said that they are reduced to a minimum or nonexistent.

The conducted tests show high levels of pollution throughout the period of the year and especially when the oil refineries and decantation stations are in operation. Water analysis are given in Tables 6, 7, 8 and fig. 5, 6, 7.

Based on the results of indicators (COD = 559mg/l and BOD5 = 102.5mg/l), we conclude that in this area there are no living beings.

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Fig.5. Sampling station number 1on Gjanica river (behind Ballshi town)

Table 6. Chemical results of water of Gjanica river in sampling station number 1 (behind Balshi town)

Parameters	Lower value (mg/l)	Higher value (mg/l)	Average value (mg/l)
pH	6.5	7.4	6.8
Phenols	2.62	3.64	3.60
COD	131	157	150
BOD_5	42.4	58.2	58
Ammonium	1.23	8.36	8.3
Nitrite	0.20	0.36	0.33
Nitrate	2.6	3.32	3.3
Phosphate	0.69	1.20	1.18
Iron	0.18	0.77	0.73
Suspended matter	71.0	110	108



Fig.6. Sampling station number 2on Gjanica river (after petroleum decantation station of Visoka)

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Fig.7. Sampling station number 3on Gjanica river (behind Fieri town)

Table 8. Chemical results of water of Gjanica river in sampling station number 3(behind Fieri town)

Parameters	Lower value (mg/l)	Higher value (mg/l)	Average value (mg/l)
pH	7.3	9	7.9
Nitrate	4.15	55	29.5
Dissolved oxygen	1.0	5.3	3.1
Ammonium	44.5	177	110.7
Phenols	1.44	3.0	2.22
Suspended matter	53	120	86.5
COD	204.5	914	559
BOD_5	55	150	102.5
H_{2S}	2.7	3.2	2.95
Dissolved oil	27	80	53.5

It is noted that after the industrial complex of Fieri there are increased values of COD and BOD5 respectively 2 and 3 over the allowed limit, while phenols, as a result of increasing the quantity of water discharged, decrease in their levels that are 2 times higher than the allowed ones (Fig.8, 9).
What is striking is the high level of oil content in the water which reaches the value 53.5 mg/ l.

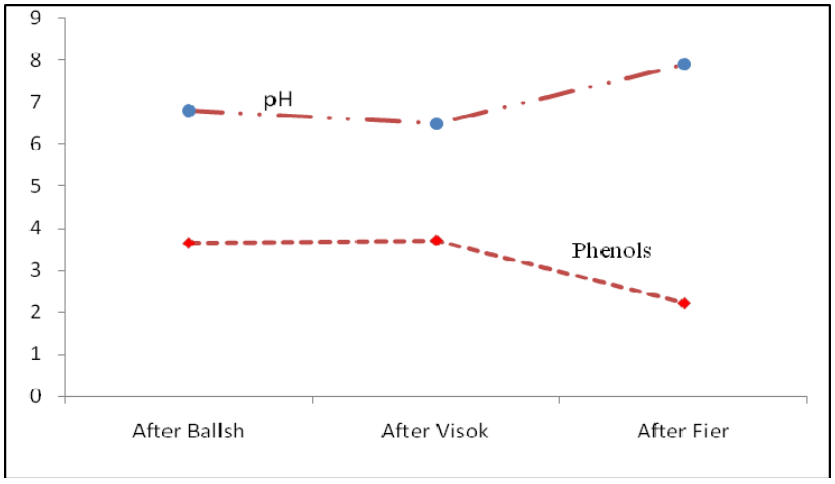


Fig.8. Fluctuations of content of pH and phenols during flow of Gjanica river`s

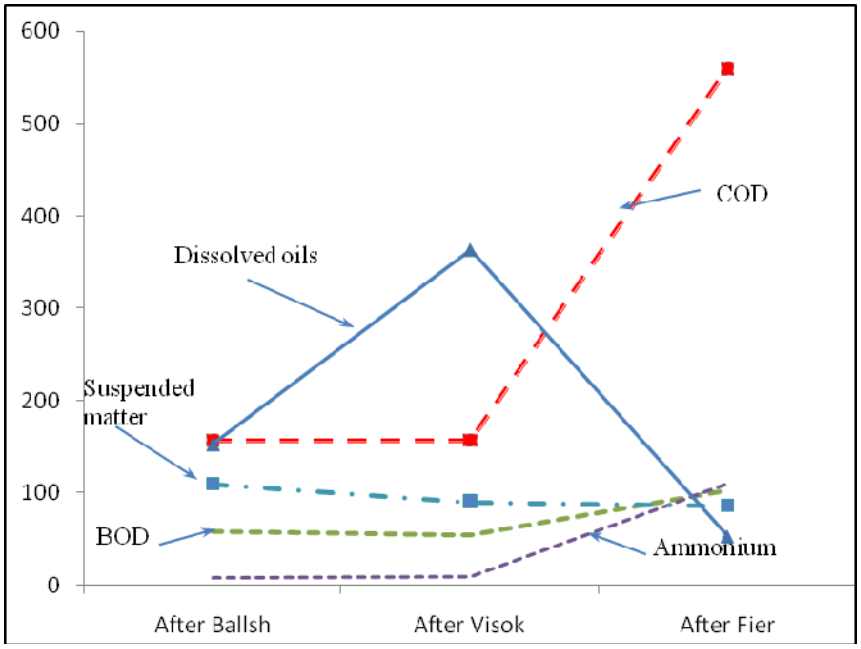


Fig.9. Fluctuations of content of COD, BOD, Ammonium, suspended matter and dissolved oils during flow of Gjanica river`s

CONCLUSIONS

The Gjanica river`s pollutants objects are: the uncontrolled oil discharges from Usoja and Visoka petroleum decantation stations , the oil wells, the polluted soil surfaces and the exposed land fields. The river polluted waters in the sector after Visoka petroleum decantation station are characterized by high values. Towards the north the values of the pollutant indicators (Phenol's, COD, BOD_5) decrease as a result both of the fresh waters flows into the river and of the natural self-cleaning.
The application of the return process into the pay bed of the accompanying oil waters after the separation of both the emulsion and that of the thin oil patches is the most rational and environmental way in order to eliminate the oil pollution in Gjanica river and in the zones around the installations.
In order to eliminate the oil discharges, it is imperative recommendation to make effective the renovation of the extraction technology as well as that of the oil preparation for transport and processing.
In order to realize the cleaning of the bed of Gjanica river`s from the solid oil bodies, it is necessary to ensure funds from the local government or from local or foreign donators, to sensitize the environmental associations in order to include them in this ecological activity.

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REFERENCES

Bitri, A., Prendi, M., Shkurti, B., Bonjaku M. (2003). *Studim për vlerësimin e ndotjes së mjedisit në zonën bregdetare midis grykëderdhjeve të lumenjve Seman e Vjosë*. Fier: Arshiva e Agjensisë Kombëtare të Burimeve Natyrore.

Irakli Prifti, Altin Karriqi. (2012). *Semani beach pollution from Roskoveci-Hoxhara drainage collector in Fieri region, Albania.*International Conference on Marine and Coastal Ecosystems. 25-28 April, Tirana, Albania.

ISSN 2306-9600

Prifti, I. (2004). *Monitorimi i hot spoteve (Patos-Marinza).* Referuar në "Konferencën Kombëtare për Monitorimin e Mjedisit. Tirana.

Prifti, I. , Bitri, A. (2006). *Monitorimi i mjedisit në industrinë e naftës dhe përpilimi i raportit vjetor mjedisor*. Fier: Arshiva e Agjensisë Kombëtare të Burimeve Natyrore.

Prifti, I. , Bitri, A. (2010). *Ndikimi i Shkarkimeve të Industrisë së Naftës në Ndotjen e Ujërave Sipërfaqësore (Monografi)*. Tiranë: 95-149

Prifti, I. (2011). *Oil Accumulations in Albanides*. In: Gjeoalb 2011, 27-30 September. Mitrovicë: 95-100

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HEAVY METAL TRANSPORT IN THE RIVER FANI AND RIVER MATI, ALBANIA

Xhume KUMANOVA[1], Gjovalin LEKA[1], Gunnar JACKS[2]

[1]Albanian Geological Survey, Rruga e Kavajes 153, Tirana, Albania;
[2]Dept. of Land and Water Resources Engineering, KTH, SE-100 44 Stockholm, Sweden

ABSTRACT

The heavy metal transport was investigated at 15 sites in the River Fani and River Mati in N. Albania. Upstream in the River Fani catchment there are numerous abandoned copper mine sites and one active mine. Upstream in the Mati catchment there is a large chromium smelter. Water samples and sediment samples were taken at each site. At a number of the sites the water samples were fractionated by filtering and by dialysis to assess in which form the metals were transported. There was a relative larger abundance of metals in the suspended (unfiltered water) and colloidal phase (filtered by 0.2 m filters). Concentrations in water and in sediments decreased rapidly downstream point sources for metals indicating that the larger fractions sedimented. The River Mati recharges a large coastal aquifer via an alluvial cone at the entrance into the coastal plain. There seems not to be any risk for the heavy metals to appear in the groundwater in view of the transport mode as largely suspended and colloidal. The bioavailability of the heavy metals is likely to be low except for just downstream of point sources. In view of the relatively large fractions of heavy metals found in the suspended and colloidal phases establishment of sedimentation dams downstream point sources would decrease the export to the rivers.

KEYWORDS:

Heavy metals, mining, river, transport, suspended, colloidal, fractionation, bioavailability

INTRODUCTION

This investigation was initiated after an investigation of the Mati Plain aquifers which were found to be almost entirely fed by the River Mati via an alluvial cone (Kumanova et al. 2010) in view of the risk for migration of heavy metals into the aquifers. Heavy metals are found in offshore areas (Rivaro et al. 2004).

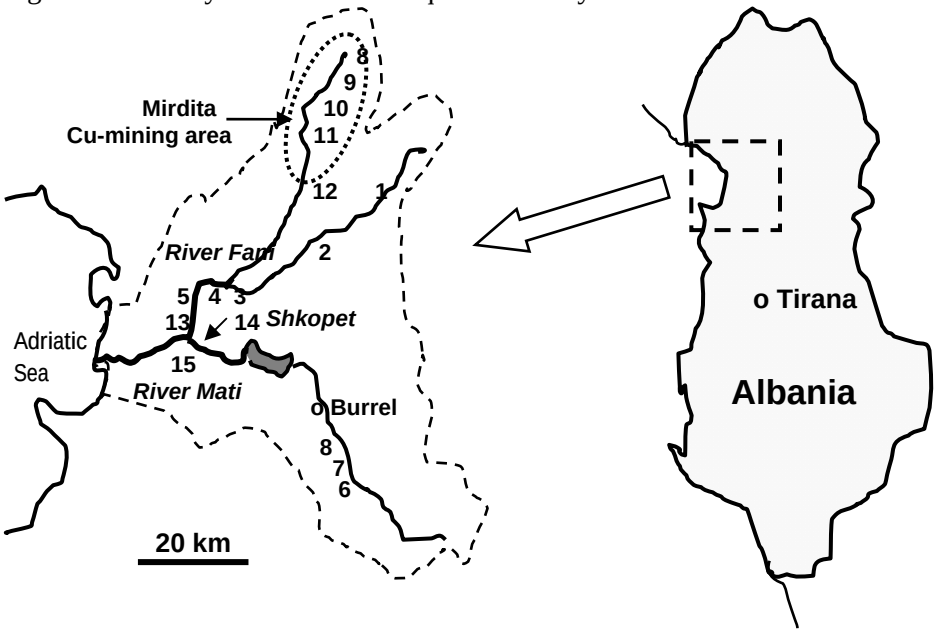


Fig. 1. The Mati and Fani catchment inNorthern Albania with major features. Numbers refer to Table 1.

Abandoned mines and copper smelters are present in the Fani catchment and an estimated 10 Mt of mining waste rock is left there (Demi 2003). The River Mati catchment hosts chromium mines and a large smelter

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facility for chromium in the Burrel town (Shtiza et al. 2005). The catchments are underlain by mafic rocks hosting the ore bodies (Economu-Eliopoulos et al. 2008) and carbonate rocks like limestone and dolomite while the buffering against acid mine drainage is good. There are as well other pollutants in rivers that may pollute the groundwater as pointed out by Cullaj et al. (2005).

A recent investigation has established the total concentrations of heavy metals in the sediments in River Fani and River Mati (Gjoka et al. 2010). The intention with this work was not only to measure the total concentrations in water at the time of sampling but also assess the mode of transportation, whether as suspended or colloidal matter and if more or less soluble in what molecular size class. This should give a better indication of the risk for migration of heavy metals into the groundwater and also an idea about the bioavailability of the heavy metals in the river water.

METHODS

The sampling was done at 15 sites along the River Fani and River Mati. At 15 sites sediments samples were taken while water was sampled at 14 sites as the first site in upstream Fani river was dry. The sediment samples were taken at the shore line at simple grab samples. The water was separated into four fractions: unfiltered, filtered via 0,2 m Sartorius millipore-filters, dialysed via two membranes with 10 respectively 1 kDa pore size, letting through roughly molecules having molecular weights of 10 000 respectively 1000. The dialysis was performed for a time period of 3 days to allow equilibration. pH was measured on the site. The samples intended for trace metal analysis were acidified to pH below 2 by 0,5 ml suprapure nitric acid diluted 1:1 to 50 ml of samples.

The sediment samples were air dried and sieved through a plastic 2 mm sieve and the fine fraction retained for analysis. pH was measured in distilled water with a soil/water ratio 1:2,5 after mixing and standing overnight. The sediments were digested by four acid digestion (nitric, perchloric, hydrofluoric, and hydrochloric acid). The digests were analysed by ICP-MS as were the water samples.

RESULTS

Selected heavy metals in the collected sediment samples are presented in Table 1. The values are of the same order as those presented by Gjoka et al. (2010).

Table 1. Selected metal contents in sediments in Fani and Mati rivers. Average crust from Alloway (1995).

Site	*Texture*	*pH*	*Cu mg/kg*	*Ni mg/kg*	*Zn mg/kg*	*Cr mg/kg*	*As mg/kg*
1.Klos-Fani	Silt	7,62	127	117	51	97	4
2.Fani	Silt	7,34	160	201	184	172	4
3.Small Fani	Silt	6,73	314	34	262	59	11
4.Big Fani	Sand	7,72	130	236	165	164	4
5.Main Fani	Silt	7,37	144	216	245	183	7
6.Mati	Silt	7,77	23	1268	39	264	3
7.Mati	Silt	8,37	33	693	67	226	4
8.Mati	Silt	8,24	27	92	62	46	5
9.Main Fani	Sand	7,43	84	322	101	194	3
10.Big Fani	Silt	7,63	39	389	68	141	5
11.Munelle*	Silt	5,35	3904	100	1568	98	304
12.Munelle*	Silt	7,16	1338	50	495	51	275
13.BigFani	Silt	6,24	200	108	168	135	10
14.Mati	Silt	6,48	775	232	906	172	22
15.Main Mati	Sand	7,90	84	336	81	161	4
Average Crust			50	80	75	100	4

Out of the 14 water samples collected 6 were subject to filtering and dialysis and analysis of the subsamples collected from these treatments. The rest of the samples were filtered by 0,2 m filters and analysed as such. In Table 2 is presented filtered and dialysed samples from two of the sites. The first site is in River Fani just

downstream a drainage from a copper mine tailings dam. The second site is in River Fani downstream the outlet from the tailings dam of the active Munelle copper mine.

Table 2. Metals in different fractions of the water.

Site	*Sample*	*Fe mg/l*	*Mn mg/l*	*Cu g/l*	*Ni g/l*	*Co g/l*	*Cr g/l*	*Zn g/l*	*Cd g/l*	*As g/l*
Fani river: talings dam pH=6,2	Unfilt.	36,0	1,10	103	9,1	44,3	3,1	283	0,64	<0,5
	Filt.	19,8	0,97	14,7	7,2	36,8	0,6	191	0,49	<0,5
	<10kDa	<0,01	0,69	5,8	5,8	26,8	<0,5	111	0,25	<0,5
	<1kDa	<0,01	0,33	5,9	3,6	14,3	0,5	63,6	0,17	<0,5
Munelle copper mine pH=5,4	Unfilt.	5,21	0,79	73,5	9,1	19,1	1,2	297	0,60	0,8
	Filt.	1,05	0,76	4,6	6,9	14,6	<0,5	111	0,08	<0,5
	<10Kda	<0,01	1,03	5,1	8,2	18,6	<0,5	122	0,26	<0,5
	<1kDa	<0,01	0,98	8,0	7,8	18,5	<0,5	117	0,26	0,5

Some results are contradictory, it has been found that the filtered fraction sometimes has a lower concentrations than the dialysed. It is especially remarkable for metals in lower concentrations. We do not have any straight explanation for this but it may have to do with adsorption onto the filters or rather on the matter, notably ferric hydroxides, accumulated on the filters.

DISCUSSION

The assumption that the buffering of the river water is good is verified as the pH of the sediments varied from 8,4 to 5,4. 5,4 was found just down stream the outlet from the tailings dam of the Munelle mine into the river (Table 1). A considerable amount of the acidity is likely to come from the oxidation of ferrous iron to ferric iron. Most of the iron was found in the suspended (unfiltered) fraction indicating that the iron was in the form of ferric hydroxides. Slightly acidic sediment with pH from 5,2 to 6,2 (Table 2) was also found at Rubik site where an abandoned copper smelter is situated. It is noteworthy that there are large variations along the rivers, indicating that point sources have made an imprint. The rather fast decrease in water concentrations downstream may to some extent be due to dilution by tributaries but is likely, in view of the sizeable suspended and colloidal fractions, mainly due to sedimentation..

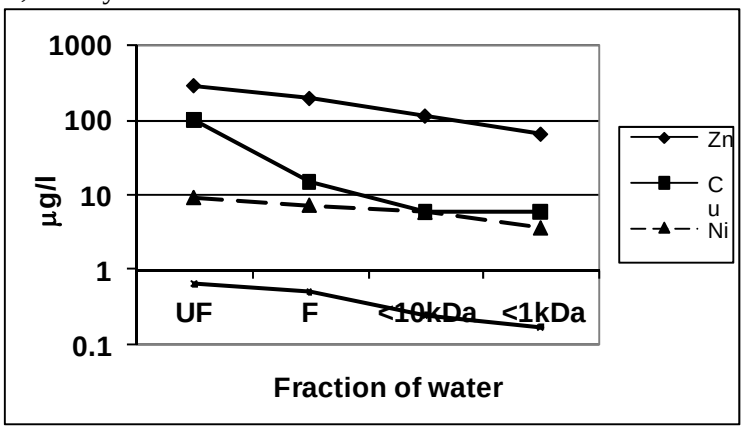


Fig. 1. Distribution of metals in the four fractions separated by filtering and dialysis for River Fani downstream tailings dam (Table 2).

The heavy metal concentrations in water were fairly low except just downstream point sources such as an old tailings dam in River Fani and Munelle mine (Table 2) in the Mirdita copper mining area (Fig. 1). Different metals were differently distributed in the different water fractions. Iron was predominantly found in the unfiltered water indicating that it was present as ferric-hydroxides. Manganese was also found in high

concentrations in the unfiltered and filtered samples but also to a considerable extent in the dialyzed water. Copper turned out to follow iron and is presumably adsorbed onto the ferric hydroxides to a large extent (Table 2 and Fig. 1). Copper has a considerable toxicity to the aquatic fauna. The toxicity limit for macroinvertebrates is in the order of 10 g/l (Bossuyt and Jansen 2004) which is exceeded only at some sites in the unfiltered and filtered fraction and thus not bioavailable. Other heavy metals such as zinc and cadmium were to a considerable extent found in the dialyzed fractions indicating a higher mobility and bioavailability. Nickel is the most mobile in the sense that it is found to a large extent in the <1kDa fraction (Table 2 and Fig. 1). In some cases the concentrations were lower in the filtered water than in the dialyzed water which is odd. This might be due to adsorption on the filter to the ferric hydroxides caught there while the adsorption was less efficient in the dialysis process. Arsenic is very low as compared to other investigations in Albania (Lazo et al. 2007).

The carbonate bedrock in the River Fani and River Mati catchments but also the ophiolitic rocks one, in which the copper ores are hosted, provide good buffering of the water which restricts the heavy metal transport and give rise to high sediment concentrations downstream point sources like the Fani river tailings dam, the Munelle mine in the Mirdita copper mining area (Fig. 1) and the former Rubik smelter. There seems to be little risk for the heavy metal invasion into the Mati plain aquifer and the aquatic toxicity of heavy metals, notably copper which is the most toxic metal to aquatic species is exceeded only downstream the point sources. The high alkalinity and hardness of the river water decreases the aquatic toxicity (Jin et al., 1991). In the sediments, copper, cobalt and lead should be related to Fe-hydroxides while Zn and cadmium are associated to carbonate phases (Moihuddin et al. 2012). The association of copper with Fe-hydroxides is evident from the filtering-dialysis results as there is a good correlation between iron and copper (Table 2). The River Mati has two large reservoirs, the Shkopet reservoir and Lake Ulëz, just downstream the Shkopet reservoir, in which a sizeable amount of precipitation and sedimentation should occur especially by suspended and colloidal matter. This is evident especially for nickel albeit it is considered to be quite mobile (Heikkinen and Räisänen, 2006). Points 6, 7 and 8 (Table 1) are upstream in River Mati and downstream the nickel and chromium mining areas and the Burrel smelter while point 15 is downstream the Shkopet reservoir (Fig. 1) and Lake Ulëz with considerably lower concentration of especially nickel. Thus even though nickel is quite mobile the reservoirs seem to be good sinks even for nickel.

CONCLUSIONS

A rather simple way to decrease the emission to the rivers would be to provide sedimentation dams downstream point sources. In view of the accumulation of copper in the suspended and colloidal fractions the copper export would be much lesser but even zinc and cadmium would decrease while the decrease in nickel would be smaller due to its high mobility. However, regarding nickel there seems to be a good retention in the Shkopet reservoir and Lake Ulëz downstream the source areas around the upper reaches of River Mati.

REFERENCES

Alloway BJ (1995) *Heavy metals in soils*. Springer Verlag. 371 pp.

Bossuyt BTA, Janssen CR (2004) *Copper* toxicity to different field collected Cladoceran spp in intra- and inter-species sensitivity. *Environ Poll* **36**:145-154.

Cullaj A, Hasko A, Miho A, Schanz F, Brandl H, Bachofen R (2005) The quality of Alabanian natural waters and the human impact. *Environ Int* **31**: 133-146.

Demi G (2003) *Waste assessment of copper mines and plants in Albania and their impact in surrounding areas.* Mining and Processing Technology Institute, Tirana, Albania. Report 10 pp.

Economu-Eliopoulos M, Eliopoulos D, Chryssoulis S (2008) A comparison of high-au massive sulphide ores hosted in ophiolite complex of the Balkan Peninsula with modern analogues: Genetic significance. *Ore Geol Rev* **33**: 81-100.

Gjoka F, Tabuku V, Salillari J, Henningson PF, Duering RA (2010) Heavy metals in the sediments from Fani and Mati rivers. *Carpath J Earth Env* **5**(2): 153-160.

ISSN 2306-9600

Heikkinen P, Räisänen ML (2006) Mineralogical and geochemical alteration of Hitura sulphide mine tailings with emphasis on nickel mobility. *J Geochem Explor* **97**(1): 1-20.

Jin H, Zhang Y, Yang R (1991) Toxicity of copper in an aquatic microcosm under different alkalinity and hardness. *Chemosphere* **22**(5,6): 577-596.

Kumanova Xh, Marku S, Fröjdö S, Jacks G (2010) Threats to a coastal aquifer in Albania. *XXXVII IAH Congress*, Krakow, Poland,12-17 Sept. 2010.

Lazo P, Cullaj A, Arapi A, Deda T (2007) An evaluation of arsenic in some Albanian rivers. *J Environ Protection and Ecology* **8**(1): 237-256.

Moihuddin KM, Otomo K, Ogawa Y, Shikanzono N (2012) Seasonal and spatial distribution of trace elements in the water and sediments of the Tsurumi River in Japan. *Environ Monit Assess* **184**: 265-279.

Rivaro P, Ianni C, Massolo S, Ruggeri N, Frache R (2004) Heavy metals in the Albanian coastal sediments. *Toxicol and Environ Chem* **86**:85-97.

Shtiza A, Swennen R, Tashko A (2005) Chromium and nickel distribution in soils, active river, overbank sediments and dust around the Burrel chromium smelter (Albania). *J Geochem Explor* **87**: 92-108.

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THE REDUCTION OF SOIL EROSION BY IMPROVING THE FORESTRY SPACE IN ALBANIA

Sazan GURI[1], NEHAT COLLAKU[2], Sherif LUSHAJ[3], Aulent GURI[1]

[1]G&G group Institute, Tirana, Albania
[2] Ministry of Environment, Forest & Water Administration, Tirana, Albania
[3]Soil erosion expert, free lender Tirana, Albania
e-mail: info@gggroup-al.com nehatcollaku@gmail.com shlushaj@tring.al aguri@gmail.com

ABSTRACT

Many studies have been carried out in the region of Albania on soils, but only few of them have measured the real erosion and the sedimentation scale throughout Albania during this last 20 years. They hardly have offered databases on soil erosion and sedimentation both in depth and surface. However, they have laid down the foundations for the evaluation and conservation of natural systems from landcovering, landusing and environmental point of view. The actual features of Albanian watersheds shows their degraded state and strong erosion indicating simultaniesly the economical and environmental consequences. In the period of 2006-2010, an enormous work have been done by the government implementing new forests spaces, forest improvement, pasture enhancement, forage cultivation, establishment of plantations with fruit trees, vineyards and olive groves in order to have the minimum scale of erosion in a near future and after. The methodology consists in the calculation of actual erosion scale before afforestration and after the forestry improving (new forest spaces, forest systematization, built mountainous dams, etc). In order to calculate the soil erosion reduction, the group is based on measurements of the new trees crown in years, as well as in accumulated sediments per year by dams.

KEY WORDS *erosion, watersheds, land loss, soil, environmental consequences, overgrazing.*

1. INTRODUCTION

In Albania, land (soil) loss through erosion is a widespread phenomenon in the whole territory of the country, in fields, hills, mountainous terrains and it covers all land resources, such as: agricultural land, woodland, pastures, river, non-productive surfaces. Based on field trip and a great deal of measurements as well as in our calculations applying the erosion equation, we draw out some results and here they are shown as erosion examples in order to calibrate the model. In Albania, land loss due to erosion is 2-3 times higher compared to other Mediterranean countries. Following the regional studies, which have been carried out in Albania, the level of erosion varies through average limits of 25-40ton/hectare/year. Nevertheless, on highly inclined and bare areas, under the impact of intensive rainfall, it reaches 180ton/hectare/year (Fig.-1). In approximately 25% of the territory, the potential risk of erosion is high, reaching the limits of 60-180ton/hectares/year.

At the beginning, the group was consulted with different maps and profiles for the study area in different scales, such as: topographic map in scale 1:10,000; Albania geologic map in scale 1:200,000; Albania geohazard map; The Albania climatic zonation; Morphostructure map of the area; Albania hydrogeological map in scale 1:200,000; Albania soil map; Albania soil texture map; Erosion case study map and Soil depth map; by means of which, the database concerning with the soil texture parameters have been obtained [1]. As to soil erosion reduction, the geologic, pedologic and erosion observations have been accomplished in all area. During the survey in terrain, a special attention has been paid to the river load and hydrologic situation around the study area, especially to the pedological conditions of the soils and geohazards one. To fulfil the objectives of this study, there have been taken photos of the relevant territory; meetings have taken place with local experts and community; measures have been taken for the dam's dimension. To give a sounder argumentation of the zone, hydrological and climatological parameters have been evaluated; The main specific task of the group is the calculation of the soil erosion reduction after new forestation spaces in Albania (forest systematization, new wood planting, building dam, agriculture improving). After a great deal of simulated calculations on computer

based on a typical module for erosion and after too many measurements in the trees crown and dam's sedimentation, the group concludes both for the actual erosion scale and for the reduction of it in a near future and in years. It is for the first time that Albania posses the real cipher of actual erosion and the possible rhythm of its reduction.

2. MATERIALS AND METHODS

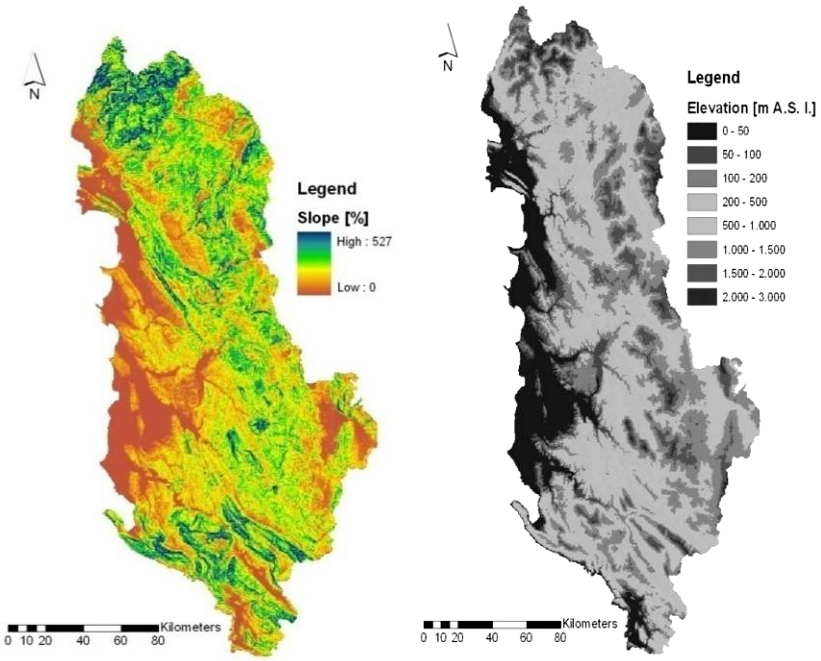


Fig. - 1 The physical features of Albania

According to the data on the map of erosion's intensity in our country it results that non-degraded or no-erosion territories cover approximately 48% of the country; territories with small amounts of degradation (erosion intensity up to 300ton/km^2/year) cover 16% of its suface; territories with average amounts of degradation (300 - 1200ton/km^2/year) cover 12%; territories with great amounts of degradation (erosion 1200-6000ton/km^2/year) include 14% of the country and territories with extensive amounts of degradation up to desertion (6000 - 18000ton/km^2/year) cover 10% of our territory. Among the most degraded and deserted regions are the following: Krraba hills, Tomorrica valley, highlands of Dangllia, Cermanika, *etc.*, where such territories cover almost half surface. Moreover, observations show that this surface is expanding quickly. The reasons of erosion and intensive degradation are linked with
optimal natural conditions and particularly with the continuous stimulation from the long activity of human society on our environment. Among the most significant, we highlight the geology composition of non-resistent rocks towards erosion (58 % of the country); mainly hilly-mountainous relief (80% of its surface); typical Mediterranean climate, assessed as one of the most aggressive ones for erosion (heavy rainfall and with a much regular regimen, drought as a permanent phenomenon, etc); heavy hydrographic network; prevalence of lands non-resistent to erosion (58.5% of the country) and limited expansion of the surface with land cover, woodland and pasture vegetation (51% of the country) etc. Erosion disperses Albanian land each year with about 3mm (if distributed in uniformity all over country). Before the forests of Bulqiza, Zerqani, Selishta, Lura, Arni, Gjallica and Puka were cut, not the woodland cover of Albanian Alps, it had been calculated that Drini brought to Adriatic sea about 250,000 ton inerts per year or exchanged in volume, about 180,000m^3. At irrigation reservoirs, the specialists calculated the fill-ups on average 1,5-2% annually. Now they are calculated to be up to 4% annually. Another resource for erosion states that each year, in national level, Albanian agricultural land loses up to 40ton/ha ground layer and in some areas, which are sensible to erosion up to 100ton/ha. I.e: in the surface of 1.182.900 ha, which is the surface of Fierza basin, it results that 40 -100 million tons fill up the lake

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each year, which, after 30 years of lake seem that have exceeded the quantity of 1 billion m^3, submerged in the lake and normal-level-water has less than half of lake volume to fill up.

2.1 Description of the problem

Control and management of soil erosion

Control and management of soil erosion and the related water quantity/quality and economic problems has become a serious cornerstone of watershed management strategies. Intensively used agricultural fields, on steep slopes and highly erodible areas, logging and deforestation, cultivation of riparian zones as well as floodplains and intensive building works in urban areas led to increased soil erosion rates throughout the world, in Albania as well. Inappropriate management practices on the agricultural lands additionally elevate the soil loss values, like intensive ploughing, cultivation on long hill slopes without terraces or other management facilities to reduce the energy of the surface runoff, leaving the soil surface bare for long time between the growing seasons, sparsely planted cereals with higher uncovered soil surfaces, clear-cutting of woodlands or overgrazing of shoreline pastures. The quantitative impact of the intensive agricultural activity and the mismanagement of soil cultivation is an increase of soil erosion by more orders of magnitude compared to the natural background values. Besides the evident ecological and agricultural damage at the spot of elevated erosion, related environmental and economic problems also arise in downstream recipient water bodies. Eroded soil particles are transported via surface runoff in the catchments towards the surface waters and despite of significant retention of sediment by settling in flat regions, buffer zones, floodplains, vegetated channels and reservoirs, still high amount of sediment can reach the water bodies. Deterioration of aquatic habitats (fish spawning areas, bottom fauna) and shoreline vegetation, rapid loss of storage capacity of reservoirs and decrease their life-span, transport of particle-bounded nutrients and dangerous substances inducing eutrophication and toxicity, turbidity of water column and limited photosynthesis are the main problems facing to soil erosion and sediment transport. (Fig.-2)

2.2 Screening – Scoping

There are well known the factors that cause the soil erodibility such as climate condition, vegetation cover, building activity, industrial activity of soil and forestry sources, and application of agricultural practices. Regarding the soil erosion, the group will be focused at any single measurement of erosion rates in affected by numerous variables, of which rock type, climate, vegetation and drainage-basin characteristics (such as area, steepness of slope, drainage density, relief, and length of slope) have been found to be the most important **[2]**. The group will make attempts in order to determine the pattern of country erosion rates using sediment-yield data and taking into account some or all of these variables, perhaps by following the empirical equation to predict sediment yield from the knowledge of relief and climate: $\log E = 2{\cdot}65 \log(p^2/P) + 0{\cdot}46 \log H. \tan \phi - 1{\cdot}56$

where

- E=suspended sediment yield (tons/km^2/p.a)
- P= rainfall in the month with the greatest precipitation (mm)
- H=mean height of basin (m)
- ϕ = mean slope in a basin:
- And p^2/P is used as a measure of precipitation seasonality, or the incidence of rainfall concentration.

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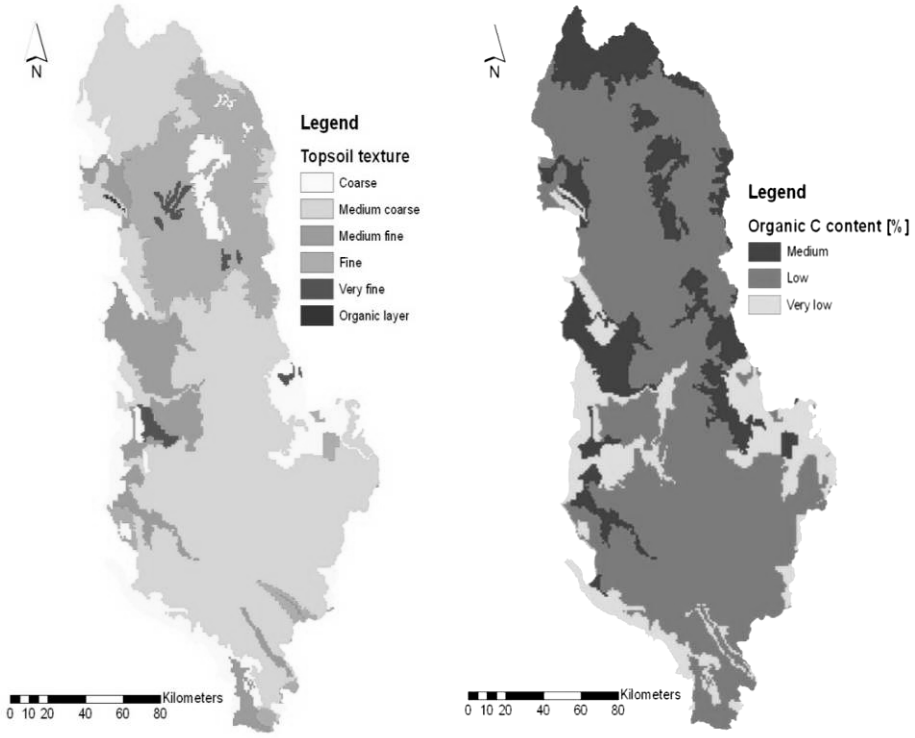


Fig. - 2 *Topsoil texture and humus content map of Albania (grid size: 1x1 km, source: European Soil Database v2 Raster version, Institute for Environment and Sustainability).*

Classification of the drainage basins according to relief and climate

Of course, this equation will require the calculation of both mean slopes of a drainage basin. Based on suspended sediment yield data, the group will provide constructing maps showing the country distribution of erosion rates. So, the group can classify the drainage basins according to relief and climate into several categories such as:

- Ia Low relief, temperate climate;
- Ib Low relief, subtropical, semi arid climate.
- II High relief, humid climate;
- III High relief, semi arid climate.

According to damage, the forms of soil erosion are:

1. Natural or geological erosion;
2. Surface erosion;
3. Deeper erosion;
4. Soil erosion in the shores of rivers and streams;
5. Massive slippers and movement of soil;
6. Desertification of soil as result of over population, over grazing and performing of building and industrial activity;

Our study will further analyze, in details, the protected measures with biologic, hydro-technique, and agriculture character, the priority of their application in:

- Tillage soils;
- In forestry and pastures;
- In unused soils;
- In soils that are near the shores of rivers and streams;
- In the protection of peat soils;

For the above mentioned processes, there will be taken into account the soil degradation processes, such as:
(1) soil erosion by water or wind;

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(2) soil acidification;
(3) salinization and/or alkalization;
(4) physical dégradation (structure destruction, compaction);
(5) biological degradation.

Hydrophysical properties of soils

The moisture regimen, the non-uniform rainfall distribution, the heterogeneous micro relief of the "mountain" Albanian Plain, and the unfavourable hydrophysical properties of soils are the many reason of the simultaneous hazard of waterlogging or over-moistening and drought-sensitivity in extensive areas. In order to predict the sediment yield, the p2/P is required to be calculated using empirically derived regression equations:

Ia $Y= 6{\cdot}14X - 49{\cdot}78$
Ib $Y=27{\cdot}12X - 475{\cdot}4$
II $Y=52{\cdot}49X - 513{\cdot}21$
III $Y=91{\cdot}78X - 735{\cdot}62$

Where, Y=sediment yield (tons/km^2/p.a.) and $X = p^2/p$.
It will be also calculated the erosive influence of precipitation which increases with the amount. These factors can be summarized in an equation which is solved empirically and converted to metric units:

$$E = \frac{1{\cdot}631\,(0{\cdot}03937\,P)^{2{\cdot}3}}{1+0{\cdot}0007\,(0{\cdot}03937\,P)^{3{\cdot}3}}$$

where

- E = suspended sediment yield in m^3/km^2/.p.a,
- P= effective precipitation (mm), and where the numerator represents the erosive influence and the denominator, the vegetation-protection factor.

Another item in our survey, as to the soil erosion will be:

- *the raindrop erosion* - *w*hich involves the detachment of particles from soil clods by impact and their movement by splashing.
- *runoff erosion* largely concerns the transportation water flowing in sheets, rills, or gullies, although some detachment of particles can occur in runoff erosion.

Each of these two types of erosion comprises its own forces and resistances: some forces tend to promote particle detachment, for instance, and others tend to resist to it. Put slightly differently, the nature of soil erosion depends on the relationship between erosive raindrops and running water on the one hand and the erodibility of soil material on the other. The median size of raindrops increases with rainfall intensity for low and medium-intensity falls in the form:

$$D_{50} = aI^b$$

where

- D_{50} = median size of raindrops (mm);
- I = intensity (e.g. mm per hour);
- a,b = constants.

Having established the nature of raindrop impact, the next step will be how to determine the relations between rainfall and soil detachment and transportation. Free (1960) found that splash erosion of sand was proportional to kinetic energy such as: $G= KDV^{1{\cdot}4}$
where

- G= weight of soil splashed (gm) ;
- K= a constant for soil type;
- D= drop diameter (mm);
- V=impact velocity (m/sec).

Generally, the runoff does not occur immediately after rain falls on a bare soil surface. If the soil is unsaturated, water will infiltrate into the ground at a rate determined by soil structure, soil texture, and vegetation cover, biological structures in the soil, soil-moisture content, and condition of the surface. If the rate of precipitation

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exceeds this value on infiltration capacity, water will begin to accumulate in and on the soil and runoff may result. If the rain continues for a period tR then we shall expect as follows:

$$f_p = f_c+(f_o-f_c)e^{-ktR}$$

Soil characteristics

Based on actual situation and world experience, it is apparent that soil erosion is largely controlled by variables which relate to climate, topography, soil characteristics, vegetation, and land-use practices. The climate variables can be summarized by the rainfall index (EI_{30}). The role of soil characteristics, the effect of vegetation, and topographic variables will be examined in a little more detail before comprehensive relations between soil loss and explanatory variables can be presented. (Fig.3)

Soil erodibility will be main object by calculating the erodibility of soils by water, which depends on several properties, notably those that affect detachment and transportability by rain splash and runoff, and those that influence infiltration capacity.

Index of erodibility = (mean shearing resistance x permeability)$^{-1}$ will be another work measurement related to soil density, range of grains size, and soil-moisture content.

The role of vegetation will also be another focus, because the vegetation cover will be perhaps the greatest deterrent to soil erosion for it tends to protect the surface from raindrop impact, reduce the amount of water available for runoff by consuming it and by improving infiltration capacity, and (by increasing surface roughness) decrease the velocity of runoff.

The effect of topography will be another focus of the group, by applying the universal equation **[3]**

A=R K L S C P

where

- A = average annual soil loss (tons/acre);
- R = rainfall factor;
- K = soil-erodibility factor;
- LS = slope length-steepness factor;
- C = cropping and management factor;
- P = conservation practice.

Estimation of erosion reduction

To estimate the reduction of erosion as a result of works carried out, measurements and observations were made on the area, climate and also the soil data (depth, structure, content of stones), slope, vegetation cover and practices management using restricted area were used to

- Universal soil Loss Equation (USLE) and CORINE model.
- The crown-density assessment of new forest plantings and its conversion to the extent of vegetation cover based on years of planting in afforestration and orchard.
- Measurements of sediment deposited in dams
- Use of experimental data obtained from monitoring the effectiveness of vegetation cover from different plants, particularly for alpha-alpha, which is proven in all experimental points in some regions of the country.
- Number of seedlings for orchard, olive and vineyard is converted to hectares, based on the number of the plants: 4000 plants vineyard, fruit trees, 625 plan/ha and 333 olive plants/ha.
- Conversion of crown-density of the forests into plots of carbon, where the number of plants is scheduled to move to 250-500 seedlings/ha, while the occupation of the seedlings is 40-60%. Consequently, land cover within 3 years results in crown-density 0.1-0.3. This is not enough to soil erosion protection.
- It is estimated the effect of the ban on grazing based on plant growth for each year and the impact on erosion reduction.

3. RESULTS AND DISCUSSION

3.1 Added issues of erosion

Forestry - Forests in Albania cover 0,45% of GDP, which constitutes one of the lowest figures in investment and benefits from them. Albania is still using them in considerable proportions, especially in rural areas, wood for fire (burning), while 40% of the matter goes in vain or is left adrift (at loose ends).

Cuttings constitute 2-3 times more than development of forests, which have generated a regrettable situation nowadays, apart from some protected areas such as: Dajti, Llogara, Frashëri, Vithkuqi, all over the country the highest woods are not more than 2-3m.

Greenhouse gases - Actually, in Albania there are approximately 1,000,000 m^3 wood growing annaually, which means that not more than 6 tons CO_2/hectares are acquired.

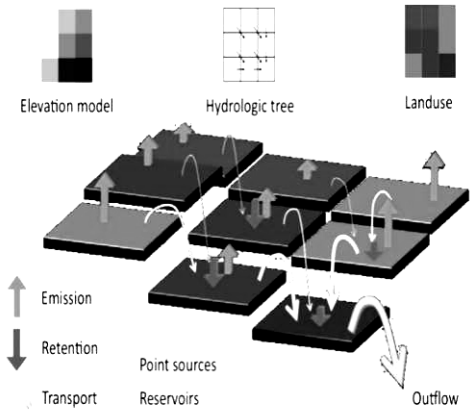


Fig. - 3*: Scheme of the transport sub-model*

Land loss is also different between the spots under the conditions of the same land cover (vegetation). While within the same experimental spot, depending on land cover, the land loss varies in the ranges of 1:2 up to 1:2.5. In the parcels covered with Vetiver and alfalfa, the land loss is 2 times smaller than in a portion of land planted with corn. In inclined surfaces, the streams transport 70-100 Ton/hectare/year. The consequences of such intensive erosion are numerous and sensible because ground profile has been heavily damaged and cultivable land has been diminished and drained, as each year 1,2 million ton of humus are removed from erosion, as well as about 170,000 tons of saline with high content of nutrient elements, such as: nitrogen, phosphorous, therefore the efficiency of agricultural plants has been reduced, at least 20-30%; water reservoirs are untimely filled-up, *etc.* **[4]**

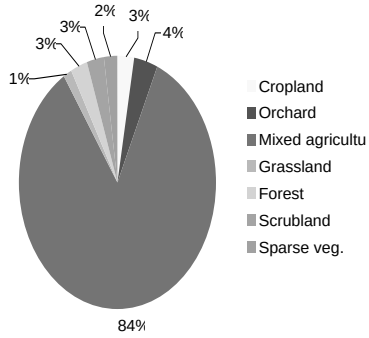


Fig.-4 *Share of the main landuse classes from the total soil loss*

3.2 Why does such a high rate of erosion occur in Albania?

As we have previously stated Albanian erosion rates are 2-3 times higher compared to other Mediterranean countries, which is 10 to 100 times greater than in many other European countries **[5]**. In Albania, there are many factors which generate erosion acceleration and they can be classified as natural factors and human factors, as follows hereunder:

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Climatic conditions. The amount of annual rainfall changes from one area to another at the level of 900-2200 mm/year, which provokes land loss due to erosion **[7]**.
High inclination of terrain and length of slopes. About 84% of territory surface lies in a height of more than 100 m above sea level.
Soil indicators Variations and varieties of land types, physical and chemical characteristics, in particular land type, profile depth, texture are with differences. Following the soil types in Albania, about 24% of them are assessed as high erosion soils, 59% predisposed to average erosion and the remainder with low predisposition to erosion.
Soil Texture Distribution: sandy and silt soil occupy more than 60% of the all soil which is predisposed to erosion.
Geological content in 55% of country's area makes the land unsteady to erosion **[8]**.
Soil Humus Content. Until 1990, soil fertility was monitored throughout agricultural land every 4-5 year. And the soil samples were taken for every 10 ha in the flat areas and for every 3-5 ha in the hilly and mountainous regions.
Data show that: 44.6 % of soils are classified as low in humus content located mainly in the hilly and mountainous area and partly in the western flat areas. But after 1990 (monitoring 2000-2002), the soil humus content is decreased in comparison with the year 1990.
Tight network of main rivers, which flow through the whole territory of the country up to the outflow at the Adriatic Sea **[6]**.
Land Cover (Vegetation) Limited expansion of surface area covered with woodland and pasture vegetation (51% of country's surface) make the land more exposed to erosion. Study data show that in many experimental spots on site, in the conditions of land without land cover (vegetation), the loss of land is up to 4 times higher compared to the land with vegetation **[9]**.
Extensive grazing. Erosion is intensified from extensive grazing in more than 40% of woodland surface.
(Lack of) Investments for erosion protection. During transition years, the infrastructure for the protection from erosion, floods, embankments, river protection not only have been heavily damaged, but investments for new buildings have been almost minimal.
Agricultural practices. The project has intervened into agricultural surfaces as well, in particular with planting of fruit trees. The typical Mediterranean climate, evaluated as one of the most aggressive ones for erosion *(heavy rainfall and with much regular regimen, drought as a permanent phenomenon, etc.);* The aim of our Assigment is to evaluate all those Economical Activities/ Human factors, which has been done to reduce the erosion rate of Albania during the last 5 years. During the Economical Analysis also the added side effects (externalities) should be considered, such as CO_2 reduction, Community improvements, water retention, biodiversity etc.

3.3 Lesson learnt / suggestions

For the long-term benefit of the project it is inevitable to orient the communities towards a more sustainable land use management practice and to increase the awareness of the importance of erosion. The amount of activities in each community could be weighed by the relative potential of the community in terms of erosion and siltation. Modeling results can help to establish such ranking as they provide a country-wide estimate of erosion potential with high spatial resolution and can help to develop a system for better funding penetrations/absorption with higher results. Besides the implementation of long-term measures (as planting trees on bare ground), state of the art BMPs (mulching, strip-cropping, etc.) could be also applied and more rapidly reduce erosion on agricultural areas. The effectiveness and impacts of the applied interventions could be more precisely assessed with a detailed and spatially referenced inventory and control measurements carried out in selected pilot catchments. The necessity of control measurements roots in the data coverage of the project. It must be emphasized, that according to the literature, even the baseline scenario carries the burden of a huge uncertainty originating from the lack of systematic measurement campaigns in the country. It would be extremely helpful to start measurements (either on land or in the streams) in selected places before an intervention is actually done.

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The soil loss in the area protected by dams (Tab. -1)

N_0	*Reg. Circle*	*Commune*	*Country/ place*	*N_0 of dams*	*Watershed- ha*	*The filling time with sediments/year*	*The filling in %*	*The vol. of sediments/ filling time m^3*	*Volume M^3/year*	*The year of construction*	*Ton/ ha / year*
1	Tirane	Preze	Ahmetaj	1	3.5	½	100	30	60	2009	27.4
2	Tirane	Preze	Ahmetaq	2	4	½	100	26	52	2009	20.8
3	Berat	Roshnik	Bogdan	9	2,5	1	100	162	162	2009	103.7
4	Lezhe		Plan	2	1600	20	100	160000	8000	1965-85	8
5	Lezhe		Plan	9	11	1.3	100	450	346	2006-2007	50.3
6	Elbasan	Qender	Spathare mal	5	5	½	100	60	120	2009	38.4
7	Elbasan	Hotolisht	Dardhe mal	12	250	1	100	110	110	2009	0.7
8	Diber	Sllove	Dipjake	13	30	2	100	800	800	Sept-nov 2007	42.7
9	Shkoder	Vau-Dejes	Gomsiqe	8	4	4	90-100	160	40	2006	16
10	Berat	Skrapar	Kakruk	2							

4. CONCLUSIONS

By all estimates through measurements and observations and models of computation, compared to USLE calculations, it follows that the influence of the works completed by the end of the performance of works (2010) in reducing erosion is low for several reasons.

New forests plantings for the period 2007-2010 are aged 1-4 years, which means that their crown-density provides from 0 to 40% ground cover.

Percentage of grown seedlings of the forest in the municipalities it results 65-68% on average (Kallmet, Kolsh, Blinisht, Tom, Kastriot, Muhur, Bushtricë, Xibër, Shishtavec, Shupenze, Zerqan, Lekbibaj) and Barmash in some cases as 40%, 50-55% in Qafëthanë.

Lack of monitoring of erosion indicator at the beginning of the project

The database is not complete for indicators of soil loss calculation from erosion and also for the reduction of erosion rate from the implementation of works.

The works will be more effective by implementing complex measures in the area as (dams, afforestation, couple fences etc.)

Implementation projects do not contain data to predict the effectiveness of measures in the areas of watersheds.

In many cases works have not started up, because of the slope and it has caused in many cases the decrease of effectiveness of their work and the damage of the investment. In this case the dams are filled with sediment within a year or are damaged.

Project development has not taken into account the reduction and monitoring of erosion. In view of improving and monitoring of erosion indicators, the project references must be developed differently. This can be applied at least in case of a new project. In this case the concept, the focus, the planning, the extension and the monitoring needs a radically change.

Overgrazing is one of the factors with a significant negative effect in raising the level of erosion as a result of natural grazing and young forests.
The number of small livestock of about 772 thousand heads of sheep and 1.3 million of goats maintain the forest and the pastures in pressure, more so in some areas of livestock the number is high. In the south of the country the overgrazing pressure of the livestock is high. From a risk assessment of erosion in Albania, from the low to the extreme levels, more than 40% of the surface is estimated threatened by overgrazing (Zdruli .P, Lushaj. Sh)
The pasture lands have shallow and skeletal horizon in more than 60% of the area. Therefore the overgrazing constitutes a negative factor for the erosion level.
In these circumstances, it is important not only the treatment to improve the pastures, but also to stop grazing for a certain period.
Overgrazing reduces the ground until the complete loss of one year pasture cover. It is therefore necessary to allow the overgrazing under a load chart and predicting the number of cattle for every season (John B.Thrones,A.Yoans,I.L.Fonseca., 2008).
Dense forests are not suitable for grazing (high forests of fir of streams and rivers). A sheep with its lamb consume 60kg of dry matter per month. Charge in livestock (sheep and goats) is 87% higher than the grazing capacity.
By rough estimates of sediment detention from dams it results 12000-18000 tons and 5000-6000 tons from the couple fencing in every 2 years. However, the dams and also the couple fences do not stop erosion of land surface, but restrict their transport from the plot where they are built.
Reduction in the level of erosion in areas where the project operated (for the project implementation period 2006-march 2010, the effectiveness of measures for implemented work are as follows:Prohibition of grazing; Improved pasture; Forage cultivation, Alpha-alpha; Afforestration and In micro basins –Vineyard establishment, while in the coming years, the crown forming of the forest trees, the role of forests in reducing erosion will increase in comparison with other measurements.
Soil protection measures are implemented in 239 communities spreading over the whole country. The implemented measures directly reduce erosion or prevent the transport of the eroded material in the stream network.
The involvement of communities successfully increases the awareness of local inhabitants of the importance of erosion and the critical nature of the current situation. According to both international experience and an adapted model application, the erosion potential is highly variable in Albania, too. Hotspots that contribute most to the soil loss and the siltation of streams are frequently separately positioned small areas.

ACKNOWLEDGMENTS

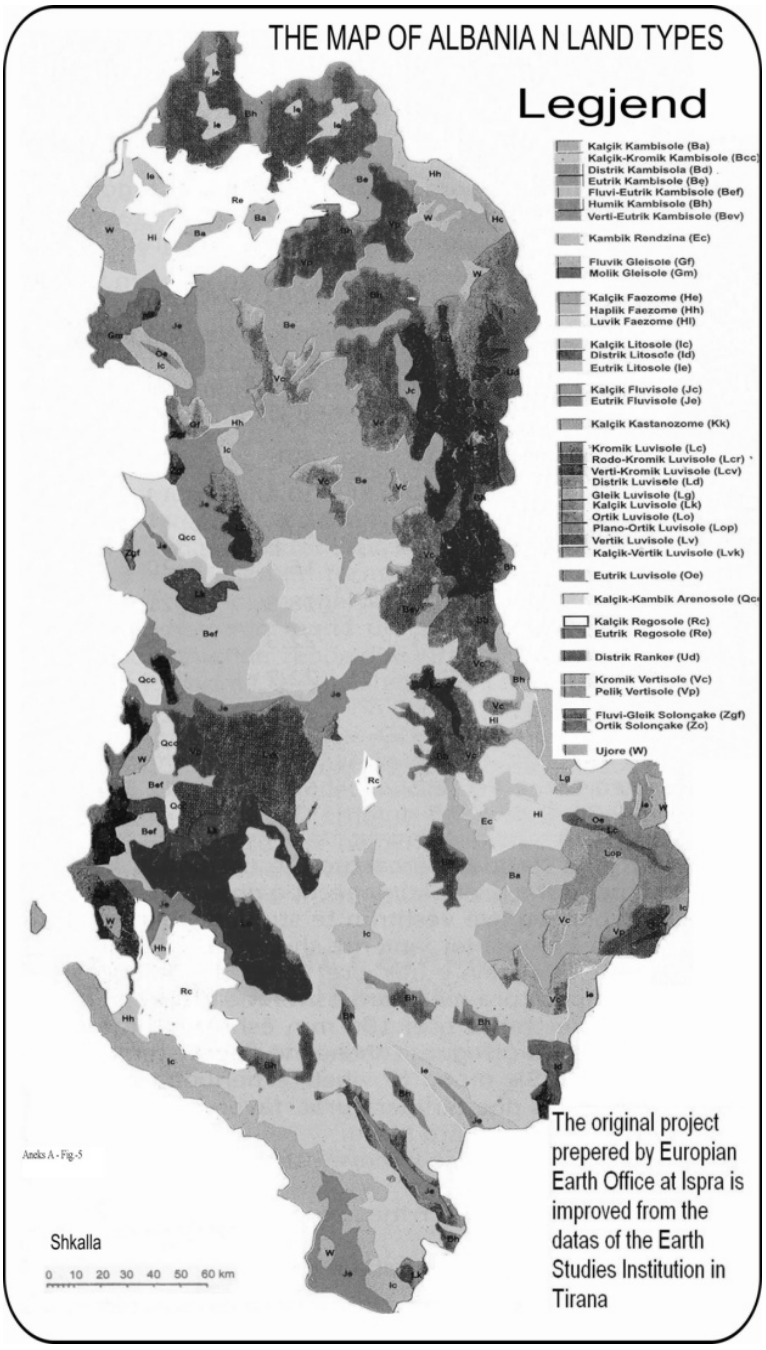
At first, we wish to thank the Albanian Communes, for the facilities that they offered to us collaborating with the local experts, to fulfill the research report "On the extent of soil erosion and sediment runoff resulting from land-use practices such a forest, shrub land, rangeland, and pasture management and mismanagement, and the quantifiable impacts of mitigation measurements". We wish to thank the specialists of the Directorate of Forest and Pastures Policies - DFPP, at the Ministry of Environment, Forests and Water Administration - MOEFWA, who in conformity with legal rules, contributed on realizing the jurisdictional operations. We also wish to thank the Natural Resources Development Project leading staff, Mr. Sami CENKO and Mrs. Fiorentina JORGJI for their collaboration with the database and procuring parameters in the compilation of this study.

REFERENCES

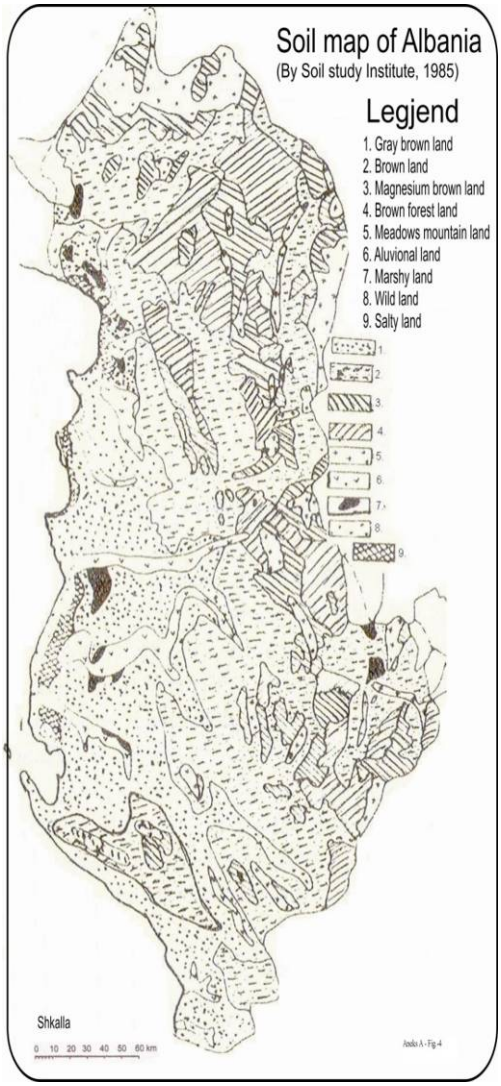
[1] Kovaci, Vangjo et al. Aspektet mjedisore dhe efektet në erozionin e tokës. Burimet e tokës ne Shqipëri, 1996, fq. 65-66.
[2] Kovács, Á., Honti, M. And Clement, A. Design of best management practice applications for diffuse phosphorus pollution 10sinë interactive GIS. *Water Science & Technology*, Vol. 57.11, pp. 1727-1733. 2008
[3] Liu, Y. B. And De Smedt, F. WetSpa Extension: A GIS-based Hydrologic Model for Flood Prediction and Watershed Management. User Manual, Vrije Universiteit Brussel, Brussels. 2004
[4] Lushaj, Sherif, etj. Dinamika e deltave te lumenjve Shkumbin e Vjose. 2000.

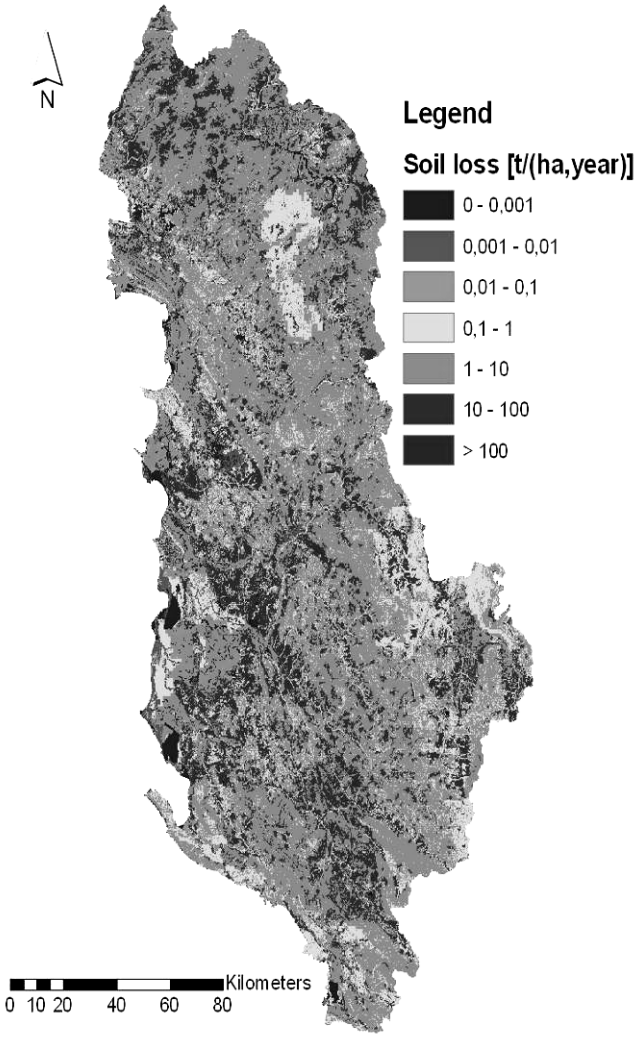
ISSN 2306-9600

[5] Lushaj.Sh,Kovaci V,Dedaj,k Soil Degradation in Albania"Preserving the Mediterranean Soils in the third Millennium:l 2001
[6] Matcom, Albania, Zhvillimi i menaxhimit të integruar të ujëmbledhësit, fq.12. 1998
[7] Pano Niko, Ujerat. Gjeografia fizike e Shqipërisë, f. 219-230, 1990.
[8] S. Guri, S. Bonjaku Studimi Tërësor i Ultësirës Pranë Adriatikut Përfshirë Pjesën Detare të saj deri tek Mesorja e Adriatikut. 2002
[9] Sh. Lushaj, V. Kovaci, P. Laze, S.Belalla Programi **"Monitorimi ndotjes se tokës, ujit për ujitje , erozionit dhe pjellorisë se tokës ne te gjithë vendin,** 1998-2005
[10] Shehu B. Luhatjet kronologjike shumëvjeçare të rrjedhjes dhe të reshjeve vjetore në territorin e vendit. Buletini Teknik i Shkencave, nr. 4. UT Tiranë. 1990



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COMPARISON OF RADON LEVEL CONCENTRATION IN SOILS WITH THE NATURAL RADIONUCLIDES CONTENT

Safet DOGJANI[1] Hamza RECI[1]

Institute of Geosciences, Energy, Water and Environment
e-mail: sdogjani@yahoo.com, reci.jack@gmail.com

ABSTRACT

Since 1996 until now, in Albania, measurements of radon level concentration in soil has been carried out. In this study we present the results taken in the south-eastern part of the country, in the Ionian coastal area mainly in the town of Ksamili, which in the view point of geological formation shows a tendency of high level of Radon concentration in soils. In an area with 3.5 km^2, at 30 sites in soil radon measurements have been carried out. The level of Radon concentration in soil has values from 10kBq/m^3 up to100kBq/m^3. From the interpretation of radon level according to Czech Classification together with permeability of the soils, it results that 50% of the studied area present a high risk of radon concentration.

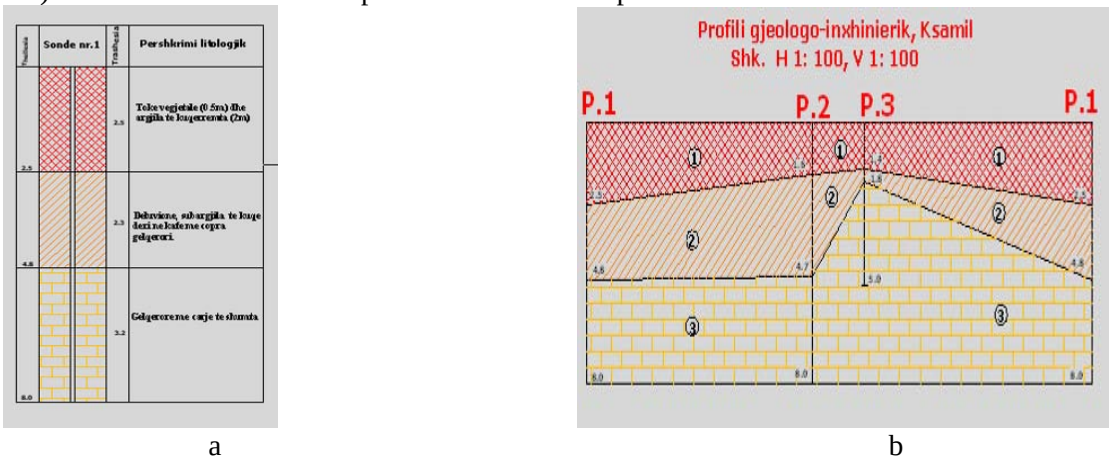
KEY WORDS *permeability-radon-soil gas-red clay*

INTRODUCTION

Everyone is exsposed to natural radiation.The natural sources of radiation are cosmic rays and naturally occurring radioactive substances existing in the Earth itself and inside the human body. A significant contribution to natural exsposure of humans is due to radon gas,wich emanates from soil and many concentrate in dwellings.Radiation exsposure has been associated with most forms of leukemia and with cancers of many organs,such as lung etc.

GEOLOGICAL SETTINGS

The Ksamili area and the wider belong to the Ionian tectonic zone, and is composed from carbonatic formation of Lower Jurassic (J_1), represented mainly from limestone with thin up to middle interlayer thicknesses, and rarely from conglomerate interlayers. All those geological formations belong to the eastern part of the Butrinti anticline. The Plio-quaternary deposits on the studied area are represented from clays (terrarosa formations) and vegetables soils of Quaternary. The Plio-quaternary deposits are mainly situated inside the town area and belong the lacustrine type or intermediate deposits (lacustrine-alluvium-lacustrine - prolluvium). The thickness of these deposits is from 0.5 m up to 6-8m.



a b

Figure 1: *The lithology of the Ksamili region. A) The lithological column of the Ksamili region. B) Geological cross section from engineering geology works carried out 1) Terrarosa; 2) clayey soils, limestone boulders; 3) Limestone.*

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The determination of the thickness of terrarossa deposits is somehow difficult in that area, that can be studied with engineering geological-geophysical works. In many cases they are covered from alluvium cones and as a consequence they cannot be seen in the surface. In figure 1, we see the thickness of the terrarosa given by geophysical and geotechnical studies in the area which is 0-2.5 m (Photo 1).



Photo 1: *View of a building above thick terrarosa formation*

METHODOLOGY

In every place, 12-15 test site measurements of the volumetric activity level of Radon concentration in soils (A_vRn) (Matolin, M., 1996), together with permeability(K) measurements has been carried out.
Measurement time for the determination of a_vRn is realized 6 minutes after the sample was taken, or after taking the sample from the soil throughout Janet Syringe using Lukas camera of the Instrument Luk-4.
The air samples are taken in depth 80-85 cm from the earth surface, according to the well-kown Luka-s methodology (Matolin, M., 1994).
The measurement of the soil permeability of the soils was done with the Instrument RADON-JOK (Neznal et al., 1996).
Assurance quality of the data
The used instruments on this study has been calibrated periodically in the National Metrological Center of Czech Republic in Pribram.



Figure 2: Transfer data from Equipment to p.c

RESULTS

In soil Radon measurements
In the Ksamili town is studied an area with 3.34 km2, with 30 places, in which are determined 430 values of volume Radon activity (a_vRn) and 90 values of permeability coefficient. From the interpretation of results we conclude that there are 5 level groups of a_vRn: there are not low levels smaller than 10kBq/m^3; middle levels from 10 up to 20kBq/m^3, belong to 3 places; increased levels from 20.01 up to 30kBq/m^3, are taken in 5 places; high levels from 30.01 up to 50kBq/m^3 are taken in 5 places; very high levels from 50.01 up to 70kBq/m^3 belong to 9 places; extremely high levels from 70.01 up to 100 kBq/m^3 are taken in 7 places.
The nature of radioactive emanation field
The study of natural radionuclides and that of the nature of radioactive emanation field in Ksamili area, has shown that it is complex and composed with ((Rn-222dhe Rn-220) and in any case it is only clean field of

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Rn-222 as consequence of Thorium concentration predominance. The typical cases of the field nature are shown in (Figure 2).

a b

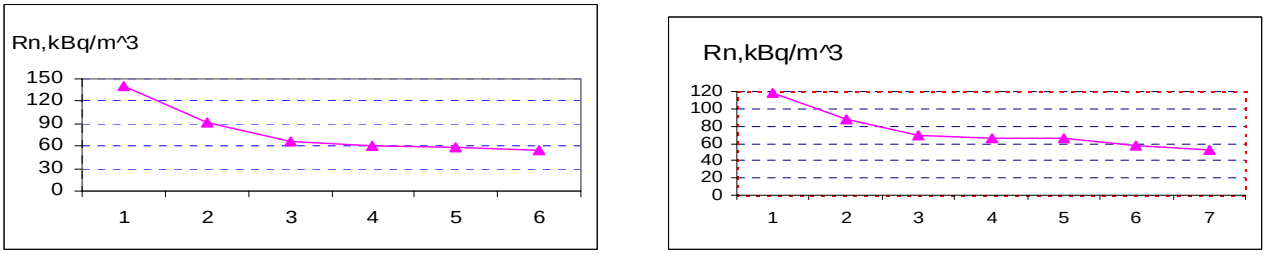


Figure 3: *Study of Radioactive field. a) place 5, K = 0.7%; eU-238 = 8,4ppm; Th-232 = 14.7ppm. b) place 14, K =1.1%; eU-238 = 7.5ppm; Th-232 = 17ppm.*

Determination of permeability

The processing of the data according to group levels of permeability are presented in figure 3. So, 50 % of the measurements belong to the group with high permeability smaller than 23s, the other part belongs to the group with middle up to high permeability (23.1 up to 36s) or 26.7% of the measurements, and in 10 places that make 33.3 % of the studied area belong to the group with middle permeability from 36.1 up to 200sek.

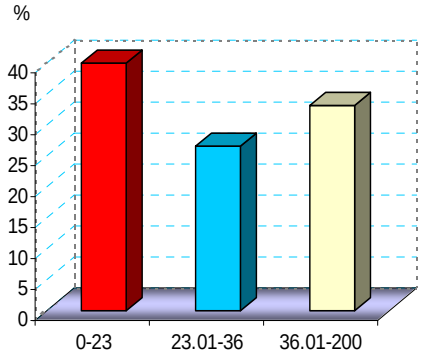


Figure 4: *Histogram of Radon distribution*

The classification of in-soil Radon risk

In the map of Radon risk on the Ksamili town are present three categories of Radon risk. In figure 5 are presented the results of Radon risk for this town. Only in one place there is low Radon risk, 14 places are of middle risk and 50% of the area or 15 places show high risk. We point out that in the places with high Radon risk, the level of Radon concentration goes up to 100kBq/m^3.

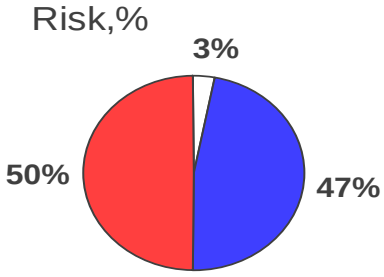
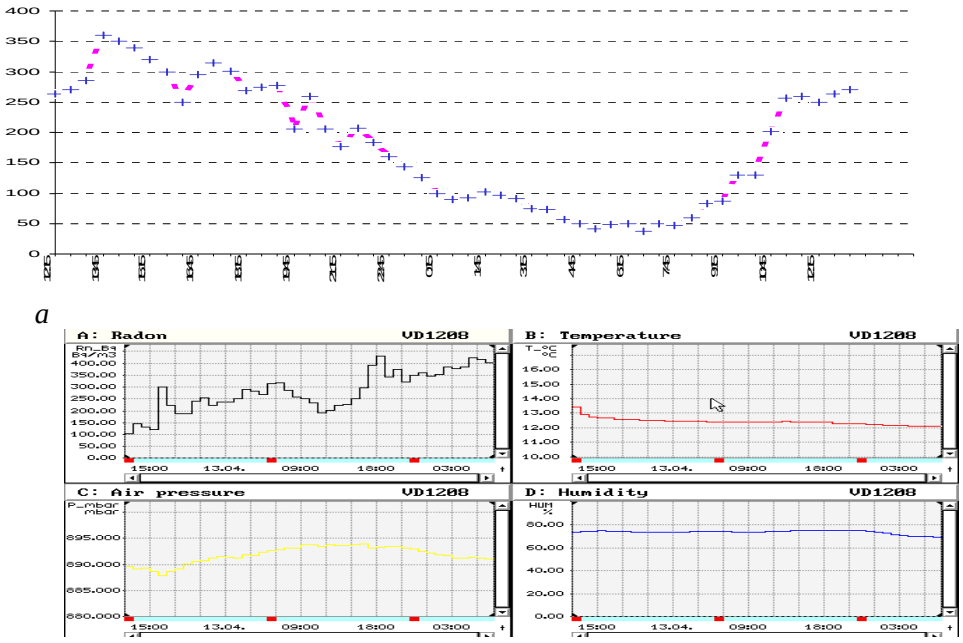


Figure 5: *Histogram distribution of in soil Radon risk in Ksamili area.*

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The level of indoor radon concentration

Indoor radon measurements are realized in 2 places, with the short term methodology using active detectors Fritra-2. Indoor monitoring is realized during 24 hours with a continuous cycle of measurements. In figure 5 are shown the graphical presentation of indoor radon concentration in two places. As seen from graphs, high level of radon are met which is above the norm. But, the levels of indoor radon concentration on those places should have been much more higher, taking into account the high in soil Radon concentration. This is explained from known different factors that affect the behavior of Radon gas.



a

b

Figure 6: Monitoring of indoor Radon concentration inside two houses, a,b.

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RADON RISK MAP
Area KSAMIL
Sc.1:10 000

Author: Prof.as S.DOGJANI

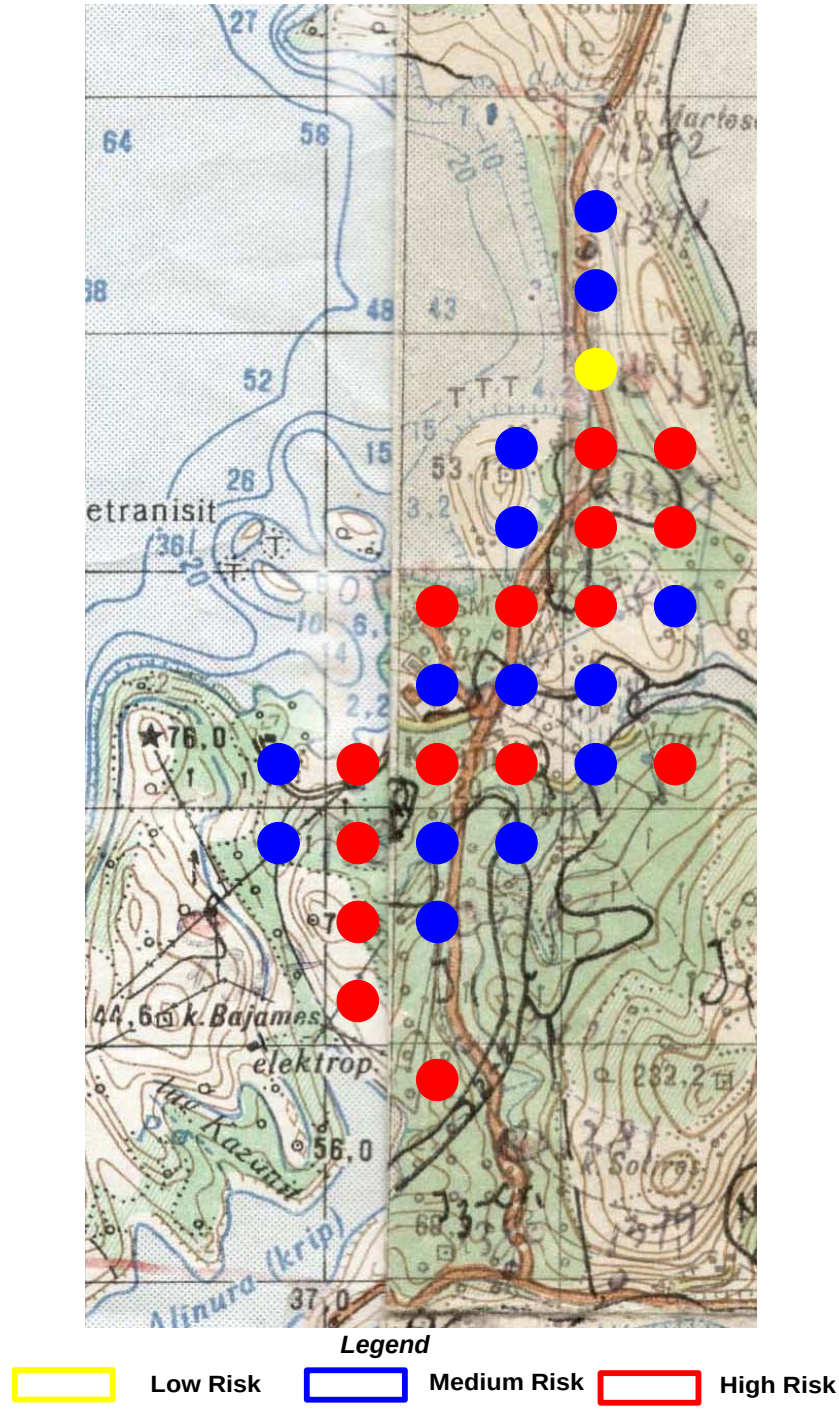


Fig.7 Radon Risk Map, area Ksamil

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DISCUSSION

We think that in the studied area, in some places of measurements, due to different spatial extension of terrarosa, there are low values of Radon concentration. This phenomenon is shown in figure 6, where there is an unconformity of radon level concentration, with the level of Radon from eU-238, measured with the instrument NaITl,Kristal3x3Inc, (Figure 6).

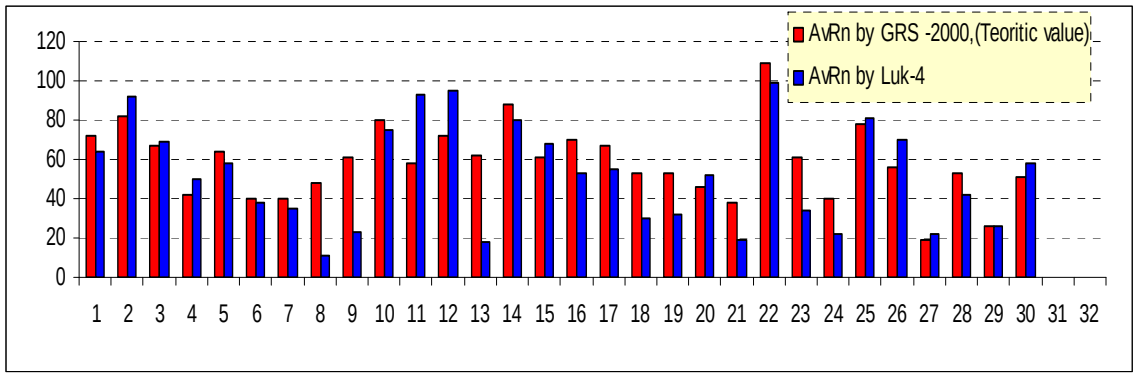


Figure 8: *The distribution of Radon level and the natural radionuclides in the places of measurements*

CONCLUSIONS

The presence of terrarosa in several parts of coastal Ionian area in Ksamili town as well, provokes high levels of in soil radon concentration.
In cases where the thickness of clayey cover is above 1m, high levels of radon concentration are met.
We recommend that the constructions have to be build taking into account the anti-radon measures.
Terrarosa should not be used as a filling material of building basement.

ACKNOWLEDGMENT

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REFERENCES

Barnet, I., 1994. Radon risk classification in Czech Republic. The activities of the Czech Geological Survey. Prague 1994.
Dogjani, S., 2007. Level of radon concentration in town Ksamil (in Albanian). Report of the Albanian Geological Survey (AGS), archive of AGS, Tirane, Albania.
Matolin, M., 1994. Intercomparison measurement of radon volume activity in soil air in Czech republic. Printed in the Czech Geological survey, Prague 1994.
Matolin, M., 1996. Reference test sites for measurement of radon volume activity in soil in the Czech Republic, Published by the Czech Geological survey, Prague 1996.
Neznal, Matej., Neznal, Martin., Smarda, J., 1996. Radon Risk Clasification of Foundation Soil. Published by the Czech Geological survey, Prague 1996.
UNSCEAR, Sources and effects of Ionizing Radiation, United Nations, New York, 2000

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ALBANIDES IN THE ASPECT OF THE ENVIRONMENTAL - GEOLOGICAL MAPS

Jakup HOXHAJ, Fatbardha CARA
Institute of Geosciences, Energy, Water and Environment, Rruga "Don Bosko" 60 Tiranë,
Jakuph2001@yahoo.com

ABSTRACT

The major objectives of geological research in the Albanian Geology have been revised in 1992. Accordingly improvement of the geological knowledge of the country, continuation of the compilation and edition of comprehensive and detailed geological maps, recovery of geological natural resources for the purposes of engineering and urban development, agriculture, water-management and environmental protection as well as a further development of geological application for practical utilization have been specified as pivotal issues. Explanations to each map variant should contain the following: introduction, research history, geography of the survey area, a review of geology, stratigraphy, tectogeneses and evolution, geohydrology, engineering geology, economic geology and list of references.
Today, Albanian Geology has a good experience on the environmental-geological mappings, scale 1:25000 and 1:5000 and actually for all Albanides in scale 1: 200 000.
The environmental-geological maps include: geological maps (layout map of geological observation sites, surface geological map, thickness of the quaternary deposits, position of the basement of quaternary deposits, occurrences of mineral raw material), geomorphological map (general geomorphological map), hydrogeological maps (hydrogeological map, map of hydrostatic levels of underground water, map of chemical composition of the underground water), engineering-geological maps (lithological logs of shallow boreholes, construction suitability map) and environmental-geological map.
The compilation of the above map series will be supported by the field work and studies carried out during a long period (1994-2011) in the western part of Albania (lowland of Adriatic Sea).

KEY WORDS *Geoenvironment, mapping, map series, geological potential, geological risk, etc.*

INTRODUCTION

Until the '90 years, in Albania was done only geological mapping, without environmental-geological consequences. Albanian Geology was organized for the prospection of known and new mineral deposits also the reconnaissance and detailed geological mapping of different areas of the country was its main activity. This work contributed on the knowledge of the geology of Albania and helped the land use planning for public activity. The earth's hydrogeological, geological, geological-engineering, tectonical and metallogenical maps as well as the maps of the natural space potential, pale-geographic, facial bottom sea and like sediments, geo-environmental, geophysical, geochemical and other maps, serves as products of the geological maps, for the explanation of different life phenomena. The major objectives of geological research in the Albanian Geology have been revised in 1992.
For the first time, environmental-geological mapping in Albania have started after 1992 year. The first project was the joint activity between Institute of Geological Research of Albania and Geological Institute of Hungary (1994-1998) in northwestern part of Albania, Shkodra-Lezha Region. Analogues works were done for the Laçi region, Tirane-Durres-Kavaja Region, etc.These studies will serve as the methodical base and a positive experience in forthcoming analogues geological works in other areas and marked the starting of the complex geological mapping in conformity with the modern standards. Accordingly improvement of the geological knowledge of the country, continuation of the compilation and edition of comprehensive and detailed geological maps, recovery of geological natural resources for the purposes of engineering and urban development, agriculture, water-management and environmental protection as well as a further development of geological application for practical utilization have been specified as pivotal issues.
They will resolve different complex problems of urban and public service and will be especially useful in the infrastructure, industry, agriculture, industrial pollution, water supply domains. The program of the work had been discussed and approved by Hungarian side in the first half of 1994.

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This geological complex mapping can be regarded as multidisciplinary work, with the most important objectives as follows: 1. the study of Quaternary deposits, serving as a base for the compilation of surface geological map. At the same time it aims to define the thickness of the Quaternary deposits and the character of their basement. 2. Geomorphological study to determinate the relief types. 3. Prospecting and evaluation of economic mineral and raw materials. 4. Hydrogeological studies to elucidate the hydrostatical level of ground water table below the surface, hydro chemical determinations, the precision of deep aquifers, natural water budget, etc. 5. The engineering-geological study in order to clarify the region construction suitability. 6. The agrogeological study to determinate the genetic types of soils, soil-fertility reducing factors, and erosion and accumulation process. 7. The study of physical feature of surface formations, serving as a base for the compilation of geological environmental protection map.

RESEARCH HISTORY

In Albania, only in these 10-15 last years is given attention to the environmental problems, which every day are getting more and sharper pointed. The fact is that the lowland and in the shoreline of Albania, the population is foreseen to be increased about twice in the end of this century and this without doubt will create ecological problems. To precede these problems we have undertaken some geoenvironmental studies mostly in the low part of Albania offering useful information of land use and infrastructure development. The environments as a dynamic system must be understand and regulate by the human being. Meantime that the human being understands the changes in the biological system, he has difficulties to see the progressive changes of the physical system. Precisely to study these changes a particular contribution gives the earth' sciences and among them geology helps in the solution of the environmental problems with the data derived from the following maps:

The environmental-geological map series is a member of the big family of maps widely used in geology. The head of the family is the geographical map which is the picture of the earth surface, or of a part of that. No geographical map can depict all details, which are present on the ground surface, even if it is made to a large scale. In this manner there are geographical maps representing the orographical conditions, the river net, the topography of the towns, villages, routes, etc. There are also maps, which illustrate the morphological structure of the land surface, the erosion form, places and forms of the accumulation, the type of the slopes and the summits, the form and genesis of the basins. There are maps giving details of the vegetation, the variety of the plants covering the surface.

Results of the mapping will be instrumental in the gradual development of a computerized data bank to embrace the following subjects; digitized topographic base maps with reference system, written references, data stored in data base, remote sensing data, field survey data, derived results, and maps. According to these project and others one the geological complex's mapping can be regarded as a multidisciplinary work, which aims to resolve environmental, hydrogeological, agrogeological, engineering and urban problems. The main topics as these projects are as follows: Environmental geological map series as the base of the solution of various problems such as the more right orientation of the prospecting-exploitation of different minerals, hydrogeological, geological, geomorphologic, geotectonic science and mainly of the studies about the environment protection. Final product of environmental-geological complex mapping is a collection of maps on relevant subjects or an atlas. The preparation of the underlined maps and written documents is compulsory: observation map and map of technical conditions, geological maps (surface and subsurface maps), geological sections, idealized columnar section, tectonic map, geophysical map, geo-morphological map, hydrogeological maps (relative and absolute depth of ground-water table, hydro-chemical maps, map of permeability), engineering geological maps (foundation conditions), agrogeological map, environmental-geological map, explanations to maps. Within the general frame of environmental study (series of geological-environmental maps), the geology, especially environmental geology is presented as an expression of scientific examinations of national natural resources. Environmental geology gives crucial contribution in protection of lithosphere as an integral element in the body of the natural concept. To complete the environmental control, the geology uses mapping as an appropriate form of presentation and as working basis to achieve the entire complex of elements. As study object of these types of studies, are quaternary deposits, their basement and quaternary–basement relations. The explanatory text should organically complement the map itself. It must not repeat the information shown the letter. On the other hand, methodology difficulties of

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map plotting as well as its degree of accuracy, i.e. reliability and way of utilization should thoroughly be elucidated. It should contain every datum not shown on map but with any importance from the engineering-geological angle. Explanatory to each map variant should contain the following items.

FUNDAMENTAL PRINCIPLES

The environmental-geological mapping and environmental-geological map series constitutes a geological bases. It relies crucially on measurable, calculable and experimentally verifiable facts. Environmental-geological tests are to forecast the potential behavior of rocks, examining these with regard to their genesis, historical past and present-day condition, and drawing conclusions. The aim of environmental-geological mapping is to provide foundations for the understanding of the surface and subsurface geology and environment of the area. It will provide here by the general planning of building developments with every geological details necessary for breaking down the large-scale plan and for making decision in the question of the need for complementary works that may emerge there from. It will also constitute the background of expert opinions in soil mechanics. An environmental-geological map series is supposed to give a uniform spatial representation of the available information on geomorphology, geology, tectonic, hydrogeology, hydrochemistry, petrophysics and economic geology of the respective area and should be indicative of a depth range determined previously by the needs for housing and engineering structures.
On the other hand environmental-geological map series are in the first place, for the purposes of regional and urban planning. They may be, however, informative for investment estimates of the planning of industrial or housing estates, etc., as well as for any other purpose whatever requiring from the planner to have a synoptic portrayal of a given area. They may be used as a reference of the information for the availability of local mineral deposits and water resources which can be exploited. They must not be used, however, for particular design works, in place of specific soil-mechanical case studied that may be required on the spot.

METODOLOGY

Previous collecting and ordering of date.
All valuable documents concerning the survey region will be gathered in the following order: a. Topographic maps of 1:25000 and 1:50000 scale for all the regions. b. Subject maps that drafted should be collected indipedently of their informative value. The relevant subjects are: geomorphology, geology, hydrogeology, geophysics etc. c. Documentation or dates of rocks recovered artificially or available in outcrops in the survey area, in the dates of laboratory tests made on them. d. It is recommanded together for all official reports and declarations on the area, which may be informative for the mapping planned. e. National and municipal development policy and relevant programs as well as land use planning, housing etc., projects set up for this region. f. Publications and manuscripts concerning the survey region. g. The sporadic date of every kind of information of a wide-range orientation, which might be of importance for the solution of the task.
Preliminary processing and valuation of date.
The processing and evaluation of the collected date should be carried out before the beginning of field work as stipulated by the instruction for observation maps. The documentation and topographic maps containing the collected date provide such working facilities (auxiliary material), which guarantee to achieve the optimum in drafting the plan of the field survey, including the recovery and laboratory testing programs. Most important items of these facilities are: preliminary geological map, preliminary geological legend, geological and stratigraphic column with date of thickness, preliminary geomorfological map, hidrogeological sketch map, map of technical objects, key map showing survey traverses. In the last phase of preliminary works it is desirable to drown up the scope of problems. This will encircle the following subjects: stratigraphy, lithology, minor and major tectonics, hydrology and engineering geology.
Previous reconnaissance in the field.
This is the previous work all over the survey region with the goal in situ checking and complementing the date that had previously been recorded and for gaining a preliminary on the spot understanding of the region. Special attention is to be paid to the condition of the road arteries in general and access roads in particular, to

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the scope for additional explorations in situ tests and for placing stations for continuous observation. The reconnaissance traverses should corresponds to the physical characteristics and problems offered by the region. The results of reconnaissance are to be recorded on the observation map and in the field notebook.

Operating strategy.

The required density of recovery points will depend on by the scale of mapping, the nature of the survey region and the complexity of its geological setting. The relevant norms wail is in dependence on the geology and the number of outcrops and artificial recovery points varies 1-8 per km^2. Number of observation points (observation point, outcrop, borehole) taken from literature and reports varies 3-6 per km^2. Number of boreholes varies 0-1 per km^2. Borehole metrage 5-8 m per km^2. Number of pits and trenches 0-1 per km^2. Spacing of observation points 1-1.5 km. The depth, type and site on recovery should be specified for each quadrangle in dependence on the geological background. The type and number of new recoveries, field and laboratory tests and various field stations of continuous observation should be defined after the completion of the preparatory work phase discussed previously. The plan of exploration and investigation of each quadrangle (operating strategy) is to be drafted, This should have the following content: *boreholes* (site, number, type, finally, expenditure, sampling methods), *surface recovery points* (extent of pitting and trenching, removing of overburden, cuts for canal sampling, cost), *laboratory tests and analyses* (code, price, cost), *test and measurements on the spot* (water level, points for measuring spring field, hidrometeorological stations, hidrochemical analyses, geophysical stations etc.), *data collecting* (surveying of excavation pits, trenches, drainages, foundations etc.).

Detailed mapping in the field.

Purpose is to checking up all outcrops and artificial recovery points and collecting all kind of data that may be of use in plotting the maps (natural recovery points, artificial recovery points). Scope of representation outcrops of more than 100 m in size (2 mm on the map) are plotted to scale as truly outlined. Smaller ones are shown as uniformly marked observation points. Artificial recovery points are marked by signs of a standard size. Accuracy of representation outcrops should be recorded with an accuracy of + - 50 m in line. Sites of recovery and observation points are to be put on map in the following way: directly on the map, by plane table, by compass traverses line and by geodetic surveying. The following data are to be recorded in the field notebook in case of direct marking on the map description of the location of the point, in case plane-table respecting, the two reference points each with azimuth should be recorded, in the case on compass traverses, the initial datum starting point, directions determined, distances in m, slope angles, number intermediate and the final points of the traverse.

The principles and data of observation proposed for recording in the field book are: *For geological observation:* lithology, color, texture, grain size, sorting, origin, type of cement, porosity, hardness, fracture or cleavage, preservation, state of rocks, bedding, preservation of fossils, facialogical and genetic features, age and chronostratigraphic position of rocks, geomorphological feature etc. *For structure geological observation*: strike and dip reading, strike and dip of joints, strike, and dip and off set of faults etc. *For engineering observation*: valuation of fracturing and fissuring, features, forms and intensity of weathering, face and boundaries of environmental pollution. *For hidrogeological observation*: valuation of aquifers, dag wells, karstik phenomena, data of surface waters, data of water level. *For geomorphological observation*: types of erosion, slope conditions, size and morphology of valley incisions, number, location, thickness and grade of exposure of terrace, etc. Other possibility kinds of observation: pedological observation (within the uppermost 1.5 m: subsoil and topsoil), reading of geophysical instruments, measurements of radioactivity, reading of meteorological instruments, area of permanent lowering of the ground water table, protection zones and their boundaries.

Sampling.

Every rock type observed either on surface or in boreholes, or in other objects of recovery should be sampled according to the following aims: a documentary rock collection has to be disposal, the characterization and classification of the rocks available must be based on due laboratory to sits and analyze.

Drilling.

Borehole setting in the field is performed by mapped himself. Drilling is done in all of the cases with full care sampling aimed at a widespread observation. After being recovered, cores will be put in standardized boxed cases in left to right order according to their succession in depth. Depth intervals (sampling boundaries) must be indicated by small attacks to be nailed inside the case. The cases containing the samples

must be stared so as to protect them against impurities and other affecting influences. The sequences of strata intersected by drilling are to be recorded in a standard notebook bound in a hard cover, the field notebook already referred to.

Handwork recovery in general.

Hard work recovery is for following purpose: preparation of outcrops for sampling, ensuring the possibilities for channel sampling, peeling off key section (stratigraphics sections), and recording the first layer of bedrock under soil cover, detecting strata boundaries and structural elements. Environmental-geological supplies the geological data the information in a suitable way for purpose of civil geology projects thus making it possible to be used in caring out construction works. Exploration is the bases of environmental-geological investigation. The most important fields of environmental-geological observation are as follows: construction materials investigation, geological survey, soil-mechanical examination of construction work, utilization of water resources (water supply dams, irrigation canals, and flood control), tunnel construction and underground excavations, stability examinations of surface movement, embankments, cuts. There are two main groups to determine the method of exploration direct and indirect exploration.

Examination and measurement in the field.

They are: water output determination, observation well network, geophysical observation and other special field examinations. At the completion of field work the observation should have the following documents at disposal: field notebooks, drilling notebooks, list of collected samples (samples for documentation), detailed plan of testing and analyses, observation map in draft manuscript, list of water samples, photographic documentation of observation points, and total documentation of examinations, measurements and observations undertaken in the field. The documentation to rule of geological field surveying its modern data processing and retrieval for scientific and practical purpose is such a task that its improvement should not be delayed any longer. Preparation of geological documentation: documentation stored in data bank, preparation of geological report, exploration and coloring of drawings, completion of geological sections, sketch of outcrops, photographs, documentations for uniform writings.

Laboratory testing and its documentation

In the consolidate rocks:

Complete or partial chemical analyses, specific and volume weights, hardness and resistance to rupture, spectral analyses, polished rock section, thin section, mineralogical determination in general, determination of mineral components, microstructural evaluations, macrofauna and microfauna, macroflora and microflora, statistical evaluation on paleontological features.

In the unconsolidate, loose sediments:

Granulometry, specific weight, volume weighty, yield point, twisting limit, plasticity index, shrink age limit, porosity, water satyration, organic materials content, calcium carbonate content, mikrominaralogy (heavy and light minerals), identification of clay minerals, petrochemistry, grain roundness of clasts rocks, permeability, pH measurements, macrofauna and microfauna, macroflora and microflora, statistical evaluation on paleontological features, shearing experiment, tree axial test, resistance to unilateral stress, hydrochemical analyses.

REALYZED VARIANTS

The environmental-geological complex maps are as following: *geological map, hydrogeological map, soil map, soil interpretation map, map of engineering-geological zoning, map of surface water geochemistry, map of geochemical reactivity of rocks, map of mineral deposits, map of protected areas, map of geophysical indications and interpretations, map of environmental geofactors, map of conflicting interests, map of important landscape phenomena.*

Observation Map

Observation map should carry outside the quadrangle frame the following informatios: plotters name, dates (start and completion) of surveying, legend to map, and date of completion in manuscript of the map. The observation map should be informative all date acquired prior to and during field survey, namely: results of observations, outcrops, exploratory shafts, pits and trenches, boreholes, geostructural elements observed, survey traverses with points of measuring, economic geological data, locations of serial measurements and

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observations, locations of random observations. This map shows the technical state of the area ready for environmental-geological mapping.

Variants of the gemorfological maps

Geomorphological observations includes compilation of a map, which for the specifications, it can be called a geomorphological general map, that reflects the landscape, factors that influenced in its formation and an actual dynamic of some factors that influence in the studies for a planning and development of the site.

Variants of the geological maps

Geological observation as main complexity, is based on: Map of observation places, which demonstrates all the work types that are given with symbols and with unrepeated numbers, surface geological map, which clearly shows geological formations in the lithologic, genetic and ages aspect, thickness of quaternary deposits come as a result of observations and more from the completed works, position of the quaternary basement deposits, which together with the thickness enable the state and contact character and mineral occurrences and raw materials from which dominate sand, gravel, clay and less other minerals and drinking water resources.

Variants of the hydrogeological maps

Hydrogeological observations, adding to those hydro-meteorological observations (annual hydrological and meteorological data published and edited by HIDMET), together with the surface geological map brought up the compilation of hydro-geological map and its variants. This variant based on: hydro-geological map, that was compiled being supported by data from all water points, natural sources of underground water, natural wells (holes and karst caves), excavated wells and drill holes, which were treated in general and dynamic manner and with a basic principle, geological-lithological division of formations in the function of their water-carrier capacity, characterizing them according to lithological and petrography content, structural and tectonic construction, cracking and cementing scale, and intensity of karst activities.

Variants of the engineering-geological maps

Geological-engineering observation has to deal with creation of a complete view for geological-engineering constructions and conditions in order to facilitate selection of potential areas for construction and more detailed studies in future. Among the many field goals and scope of environmental-geological mapping for engineers foundation of structures is one of the most important fields of application. In the whole process of mapping, requirements of users, like demands of foundation design engineers, always must to be fixed in mind. And at the same time, cartographers, being any kind of specialist may be familiar with the knowledge of map users.

Table 1. Characteristics and factors of district classifications

Numri rendor	Characteristics Factors of the classification of districts	Of 1	the 2	districts 3
1	Slope angle, geomorphological-geological processes	$0 - 5^0$ Not endangered by geological processes	$5 - 15^0$ Not endangered by geological processes	$> 15^0$ Or characterized, or endangered by geological processes
2	Ground-water level below the surface, hydrogeological aggressiveness of ground-water	> 2 m and not aggressive	> 2 m not aggressive, or < 2 m and aggressive	> 2 m aggressive
3	Geological, engineering-geological, bearing capacity	High $\sigma_{a > 300 kPa}$	Medium or low $\sigma_{a = 100-300 kPa}$	Very low $\sigma_{a < 100 kPa}$

Table 2. Regional suitability for surface waste deposition

The group of the phenomena	Completely unsuitable	Unsuitable	Rather Unsuitable	Poorly suitable	Suitable	Perfectly suitable
Geomorphological conditions	Slopes $>12^0$ anthropogenic replenishment	$10-12^0$ alluvial accumulation	$8-12^0$ deluvial accumulation	$5-8^0$ consolidated quaternary terrain	$3-4^0$ consolidated later tertiary terrain	$3-4^0$ consolidated early tertiary or older terrain
Vertical and horizontal homogeneity of the rock body	Thickness 10 m lenticular development lithological composition	10-15 m lenticular development slightly inhomogeneous lith.composition	15-20 m lenticular development subconstant lithology	15-20 m stratified or unstratified subconstant lithology	> 20 m laterally steady and consistent stratification subconstant lithology	> 30 m laterally and vertically homogeneous lithology

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Mineralogical and petrographic composition	Lack of clay minerals, gravel, breccias, sand, sandstone unconsolidated	fine sand, unconsolidated sandstone appearance of clay minerals	fine sand, salty 10-15% clay minerals	high content of clay minerals, salty, fine sandy, argils coarse rocks	High clay mineral-contents, salty clay, marl, tuff	clay, claymarl, bentonite, kaolinite
Granulometric and soil mechanical characteristics	Ø > 0.6 mm K > 0.002 m/s	Ø > 0.6-0.1mm K > $0.002\text{-}10^{-3}$ m/s	Ø > 0.1-0.02 mm K > $10^{-3}\text{-}10^{-4}$ m/s	Ø > 0.02-0.002 mm K > $10^{-4}\text{-}10^{-6}$ m/s	Ø > 0.02-0.001 mm K > $10^{-6}\text{-}10^{-8}$ m/s	Ø < 0.01 mm K < 10^{-8} m/s
Macrostructural parameters	Porous	fractured	Cavernous	karsted or	mylonitized	macrostructure
	At least 2 of the above mentioned features are present in a high abundance	one of them	At least 2 of the macrost. features are present in a comparatively high abundance	one of them	one or two of them are sporadically present	at least one of them is very rarely present
Tectonic conditions	Formations affected by a wide fault zone, dip steep > 20^0	Formations affected by a narrow fault zone, dip steep $10\text{-}20^0$	Formations dissected into tectonic units of varying height of throw $10\text{-}15^0$	Formations affected by one or two minor faults or flexing $5\text{-}10^0$	Formations affected by some slide flexing $10\text{-}20^0$	Formations not affected by tectonic deformation horizontal stratification
Surface stability	Unconsolidated	slightly consolidated	Consolidated but threatened by potential surface movements	Consolidated slightly threatened	Consolidated with infinitesimal surface movement hazards	Consolidated without surface movement
Mineral deposits	Well-know deposits in the subsoil	well-know deposits in the subsoil or in its neighbor hood	Reserves in its neighbor hood	know only in the vicinity of the study area	Hypothetical reserves in large distance from the area	No predictable mineral reserve
Hidrogeological conditions	Ls = 0-10 m, water content > 30 %	Ls =1 0-20 m, water content > 30 %	Ls = 20-50 m, water content 20-25 %	Ls < 25 m, water content 20-25 %	Ls = 20-25 m, water content 20-25 %	Ls = 25 m, water content 10-20 %

Variants of the agrogeological maps

Agro-geological observation is directly connected with the surface geological map, geo-morphological map and with one of new processes and based on: map of geological factors that reduce the land fertility, which include: erosion and accumulation processes, disfavor mechanical content of the land, impact of negative water effects and extreme chemical reactions, erosion and accumulation processes depend on slope inclination, lithologic content of formations and their consolidation, consolidation of land and characteristics of consolidated materials.

Variants of the geophysical maps

The main important place in these study have electrometric surveys (electrical Soundings Schlumberger study) in the little scale to determinate thickness and kinds of Quaternary depositions, particularly for the coarse strata (sands and gravels) and the depth of the basement of new depositions. Geophysical investigation methods examine, however, only physical parameters. Samples are needed in order to learn the chemical composition of the sediments and perform paleontological and technological tests. They can be obtained only from boreholes. Although very costly, it is the only feasible method.

Variants of the environmental-geological maps

Environmental observation demonstrates the above efforts in order to determine sensitivity and suitability of geological formations to different polluters and the possibility for their collection, gathering and burial in those that are most suitable, that based in some conditions. One of them is hydro-geological condition with areas influenced; by water sustainable surface power, summary of freatic water from 0-10 m, side observatory power, there is hydro-geological communication with deeper layers, content of natural water in rock layers > 30 %., by unsustainable surface water powers, summary of freatic waters from 10-20 m, side non-observatory powers, hydro-geological communication with deeper layers is somehow weak, content of

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natural water in rocky layers > 30 %), by surface water powers, summary of freatic waters from 20-25 m, no vertical and side water powers are noted, no communication exists with deeper layers, content of natural water in rocky layers 30 %, by surface water powers, summary of freatic water <25 m, there are no vertical and side water powers, content of natural water in rocky layers between 20-25 %, by surface water powers, summary of freatic water between 20-25 m, by surface water powers, freatic water 25 m, there are no horizontal and side water powers, content of natural water in rocks between 10-20 %.

EXPLONATORY BROCHURE

Final product of environmental-geological complex mapping is a collection of maps on relevant subjects or an atlas. The explanatory text should organically complement the map itself. It must not repeat the information shown the letter.
The preparation of the underlined maps and written documents is compulsory: observation map and map of technical conditions, geological maps (surface and subsurface maps), geological sections, idealized columnar section, tectonic map, geophysical map, geo-morphological map, hydrogeological maps (relative and absolute depth of ground-water table, hydro-chemical maps, map of permeability), engineering geological maps (foundation conditions), agrogeological map, environmental-geological map, explanations to maps. Within the general frame of environmental study (series of geological-environmental maps), the geology, especially environmental geology is presented as an expression of scientific examinations of national natural resources. Environmental geology gives crucial contribution in protection of lithosphere as an integral element in the body of the natural concept. To complete the environmental control, the geology uses mapping as an appropriate form of presentation and as working basis to achieve the entire complex of elements. As study object of these types of studies, are quaternary deposits, their basement and quaternary–basement relations.

REFERENCES

Cara F., Hoxhaj J., Leka P., Kalaja F. 2001. Complex Environmental Geological Mapping in the scale 1:50 000 of sheet 88-A (a, b,c,d) Laç. Geological report. Department of Hydrogeology and Engineering Geology and Environment, Geological Survey of Albania. Tirana, Albania (in Albanian and English)

Cara F, Dimo Ll, Hoxhaj J, Kalaja F., Scharek P. 2001. Geological-environmental mappings in Albania (Kopliku-Shkodra Region). Technical Sciences Bulletin, Technical University of Tirana, Albania. 5 pages (82-87). (In Albanian, abstract in English).

Hoxhaj J., Cara F. 1997. Environmental control by the geological-environmental aspect in the Kopliku square, 7 pages (59-65), in English, abstract in Italian. Proceedings of the Second National Conference organized by the Albanian group of IAEG. Historical Museum 17-18 November 1997, Tirana Geohazards and the Environment. Universita Degli Studi di Bari.

Hoxhaj J., Cara F., Dimo LL., Kalaja F., Kuka N. 1998. The series of the environmental-geological maps and its explanatory brochure of the Kopliku sheet in the scale 1:50 000. (Albanian-Hungarian joint project) Duration 1994-1998, page 53, dt. 22.10.1998. Geological report. Institute of Geological Research Tirane, Albania (in Albanian and English).

Hoxhaj J., Kuliçi H., Cara F. 2009. Geological -Environmental Mapping, Geosciences Institute, Polytechnical University of Tirana,

Locsmandi G. 1979. Urban development and planning. Geological Institute of Hungary.

Vegh S. 1972. Foundamental regularies for geological field documentations. Geological Institute of Hungary.

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GEOCHEMICAL PARAMETERS OF SELECTED ELEMENTS: Au, Ag, Cu, Pb, Zn, As and Sb IN RIVERS AND STREAM SEDIMENTS WITHIN TREPÇA METALLOGENIC BELT

Sali MULAJ[1], Naser PECI[2], Gani HOXHA[3]
[1]*Komisioni i Pavarur për miniera dhe Minerale (KPMM), Adresa (Armend Daci Nr.1, Prishtinë, Kosovë),* smulaj@kosovo-mining.org
[2]*Fakulteti i Gjeoshkencave dhe Teknologjisë, Mitrovicë, adresa (Zona Industriale 40000 Mitrovice, Kosovë),* naser_peci@hotmail.com
[3]*Esan Kosova Sh.pk, adresa (Bajram Kelmendi Nr.37, Prishtine, Kosovë),* gani_hoxha@hotmail.com

ABSTRACT

The most important polymetallic mineral deposits particularly lead and zinc mineralization are found in the northern and eastern part of Kosovo. They belong to the so-called Trepça metallogenic Belt of lead-zinc mineralization, which extends linear for over 80 km in northern and north-eastern Kosovo and include numerous mines and mineral occurrences.
The Trepça metalogenic Belt is located within the NNW-SSE striking Vardar zone and belongs to the Dardania (Serbo-Macedonian Metallogenetic Province).
Most studies describes that the mineralization are as replacement deposit of lead and zinc sulphides (Galena and sphalerite) in carbonate rocks, sometimes as skarn, as veins and veinlets, as palaeokarst fillings, massive, compact, lens-like, disseminated etc. However, the structural complexity of the district results in very variable morphology and architecture of the mineralized envelope for each deposit.
In detail, the genesis of deposit is different as: deposits in scarns contact-metasomatic-hydrothermal par ageneses (Stanterg, Belo Berdo dhe Artana), other deposits hydrothermal par ageneses (Hajvalia, Kishnica, Badovci, Cernaci, Plakaonica, Koporiçi, Zhuta Perlina, Jelakce).
Metal content (Au, Ag, Cu, Pb, Zn, As and Sb) and the relations between metals are very different too. From the genetic point of view, the mineralization is Neogene in age and hydrothermal in fluids. Uncertain is the origin of the metals, Pb, Zn and Ag could be derived from deep sources of mantel processes.
The possibility of the origin of near, metal sources (from older host rocks: Triassic orJurassic) is in discussion.
For further detailed verification of the polymetallic stream sediment contain, in all territory of Kosova was realized a project in three phases 2006, 2007 and 2010-2011.
In addition this work analyses geochemical parameters of selected elements: Au, Ag, Cu, Pb, Zn, As and Sb in river and stream sediments within Trepça metallogenic belt. In total 870 samples are subject of this study from which were considered only samples with values above Clarke value (VINOGRADOV, 1962 /6/) average of the Earth crust) in total 442 samples.

KEY WORDS *Geochemical, Polymetals , River-stream sediments, Trepça metalogenic Belt.*

1. INTRODUCTION

In the area of the Dardana Massif/Serbo-Macedonian Massif and Vardar zone (VZ), there are numerous ore deposits. These deposits were formed during various metallogenetic epochs and environments and belong to Dardania (Serbo-Macedonian) metallogenetic province.
The Dardania metallogenetic province is of main importance for Kosovo especially for tertiary mineral deposits of lead and zinc. The ore deposits are commonly associated with Oligocene-Miocene volcano-intrusive complexes of calc-alkaline series.
Within Serbo-Macedonian metallogenic province in territory of Kosova on the, Metallogenic Map of Serbia [MetM 2000 – SRB1, DIMITRIJEVIC M. D. et al.] the following metallogenic units have been

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delineated; Merdar metallogenic zone (north part of the Lece-Halkidik zone), Kapaonik metallogenic zone, Drenica District, Trepça metalogenic Belt (is the south continuation of Kapaonik metallogenic zone) and includes numerous mines and mineral occurrences.
The most significant polymetallic sulphide deposits are (Stantërg, Belo Bërdë, Crnac, Hajvali, Kishnicë etc.), containing lead and zinc, to some extent copper and antimony, and are accompanied by gold, silver, arsenic, thallium, bismuth and iron fig.1

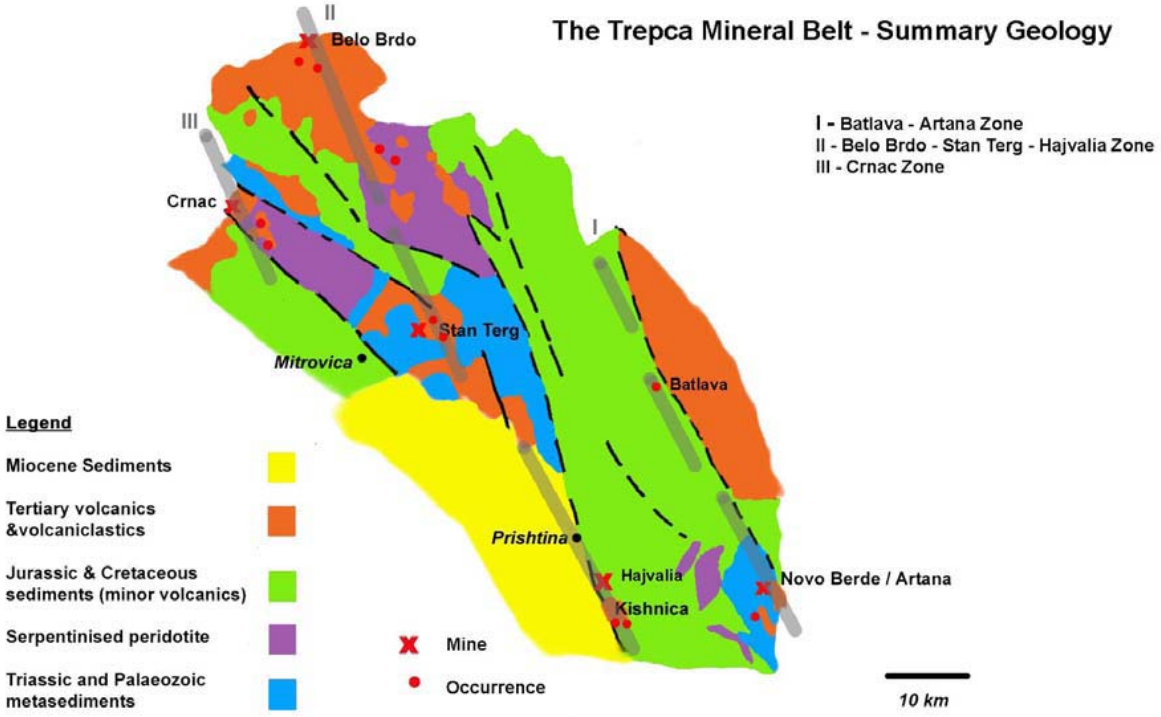


Fig.1 Trepça metalogenic Belt, Summary Description of Trepça 2005

2. STUDIED AREA

The studied area is amongst the major lead, zinc, silver and gold producers in the region.
For further detailed verification of the polymetallic stream sediment contain, in all territory of Kosova was realized a project in three phases 2006, 2007 and 22010-2011. For 2006 – 2007 the samples were processed to the *ACME Analytical Laboratories Ltd.Canada* analysing 53 elements and for period 2010 – 2011 the samples were processed in *SGS laboratory in Chelopech, Bulgaria* and were analysed for 51 elements.

In addition this work analyses geochemical parameters of selected elements: Au, Ag, Cu, Pb, Zn, As and Sb in river and stream sediments within Trepça metallogenic belt.

Location of the Stream Sediment Sampling Points
Sample locations have been selected considering (in most cases) the following conditions:
- Above the inflow of a subsidiary stream
- One sample of each stream
- Along the main stream sample distance was approximately 2 km
- Catchments area size was approximately 1 - 3 km^2

Quality control of the geochemical data was conducted on several levels:
- Internal QC of the SGS Laboratory
- Analyses of sample replicates and duplicates, and
- Repeated analyses of certified reference materials.

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3. RESULTS AND DISCUSSION

For preparation of this study we considered the data of 870 samples taken in Trepça metallogenic belt, see fig.1, for above mentioned metals. In addition based on Metallogenic Map of Serbia, samples were split in to groups:

- **Trepça metalogenic Belt,** which is south continuation of Kopaonik metallogenic zone in Kosova territory, with main mineral deposits (Belo Bërdë, Crnac, Stanterg to Hajvali Kishniçë and on the south east direction to the border with Macedonia) and
- **Merdare – Artana metallogenic zone** which is north part of the Lece-Halkidik metallogenic zone, with main mineral deposits (Çuka e Batllaves and Artana depozit with continuation on the south east to the border with Macedonia). See fig.2.

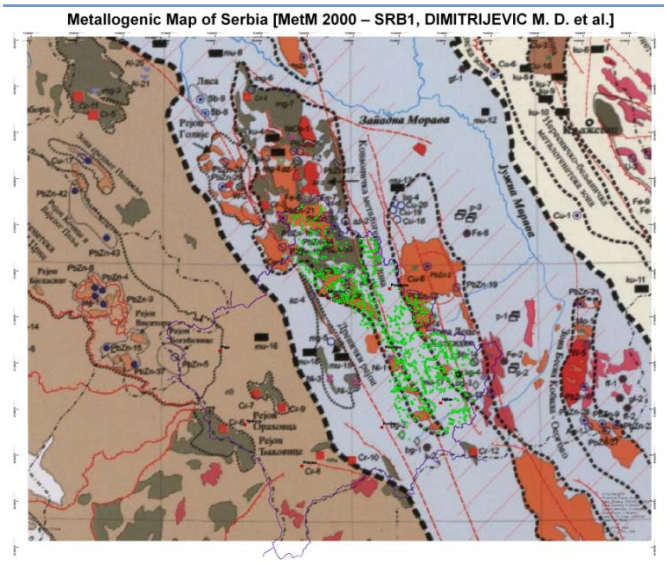


Fig.2 Metallogenic map of Serbia, Dimitrijevic M.

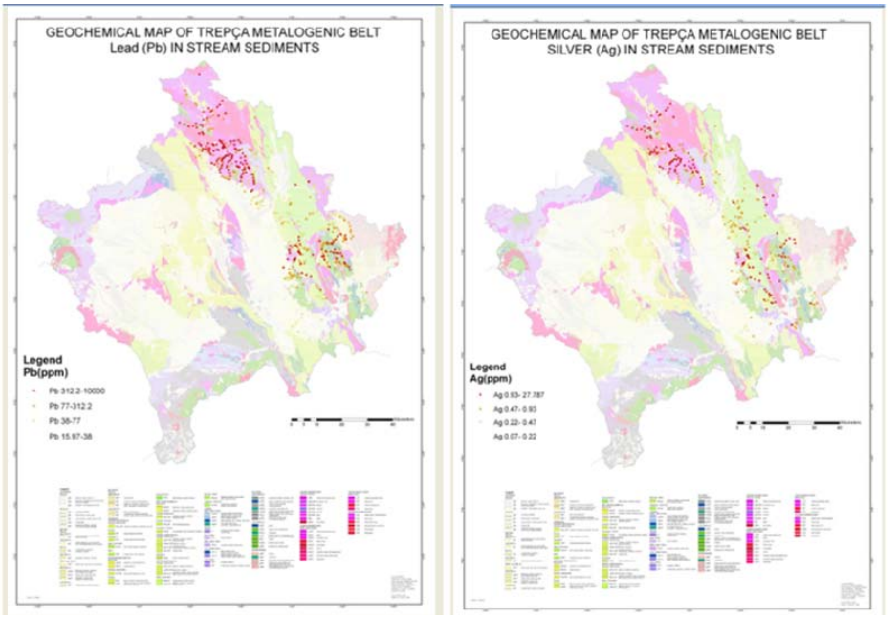


Fig.3 Geochemical map of Trepça metalogenic Belt lead and silver in stream sediments.

In addition from split samples for this study were considered only those that have values above *Clark value (VINOGRADOV, 1962 /6/ - average of the Earth crust*) of elements Au, Ag, Cu, Pb, Zn, As and Sb as for, from total 870 samples in additional work were taken:

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- Trepça metallogenic Belt 377 samples
- Merdare - Artana metallogenic zone 65 samples

For each chemical element we created separate maps, see example for lead and silver distribution (fig.3), zinc and arsenic distribution (fig.4).

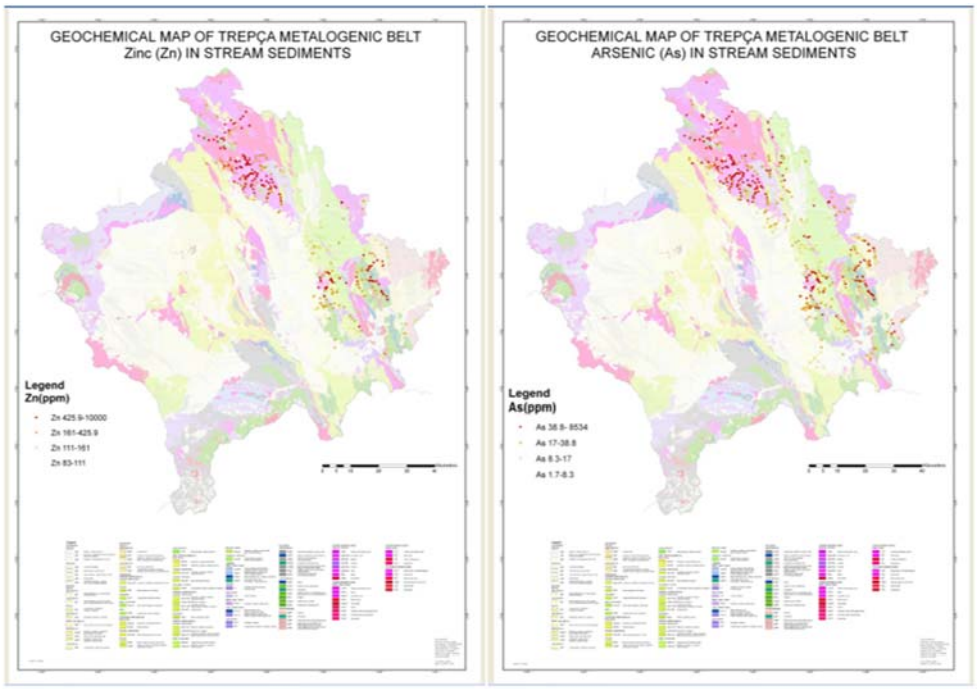


Fig.4 Geochemical map of Trepça metalogenic Belt zinc and arsenic in stream sediments.

3.1 Correlation coefficient of samples taken in the river sediments

For Trepça metallogenic Belt and Merdare - Artana metallogenic zone for each elements were defined the Univariate Statistics, see table 1.

Table 1. Univariate Statistics

Trepça metalogenic Belt Univariate Statistics			
Gold (Au)	ppb	Zinc (Zn)	ppm
Minimum:	4	Minimum:	83
25%-tile:	5.6	25%-tile:	111
Median:	8.8	Median:	161
75%-tile:	25	75%-tile:	425.9
Maximum:	10169	Maximum:	10000
Silver (Ag)	ppm	Arsenic (As)	ppm
Minimum:	0.07	Minimum:	1.7
25%-tile:	0.22	25%-tile:	8.3
Median:	0.47	Median:	17
75%-tile:	0.93	75%-tile:	38.8
Maximum:	27.787	Maximum:	8534
Copper (Cu)	ppm	Antimony (Sb)	ppm
Minimum:	47	Minimum:	0.5
25%-tile:	54.5	25%-tile:	1.6
Median:	63	Median:	2.5
75%-tile:	80.4	75%-tile:	5.2
Maximum:	2762	Maximum:	1543
Leaad (Pb)	ppm		
Minimum:	15.97		
25%-tile:	38		
Median:	77		
75%-tile:	312.2		
Maximum:	10000		

Artana-Merdare metallogenic zone Univariate Statistics			
Gold (Au)	ppb	Zinc (Zn)	ppm
Minimum:	4	Minimum:	83
25%-tile:	5.8	25%-tile:	99.8
Median:	10.4	Median:	143.6
75%-tile:	29.2	75%-tile:	404
Maximum:	1300	Maximum:	10000
Silver (Ag)	ppm	Arsenic (As)	ppm
Minimum:	0.07	Minimum:	1.7
25%-tile:	0.179	25%-tile:	6.5
Median:	0.29	Median:	11.7
75%-tile:	0.565	75%-tile:	23.5
Maximum:	8.478	Maximum:	2391
Copper (Cu)	ppm	Antimony (Sb)	ppm
Minimum:	48.6	Minimum:	0.51
25%-tile:	52.44	25%-tile:	1.08
Median:	61	Median:	2.5
75%-tile:	70.05	75%-tile:	3.15
Maximum:	189	Maximum:	51.2
Leaad (Pb)	ppm		
Minimum:	15.97		
25%-tile:	30.24		
Median:	52.75		
75%-tile:	164.6		
Maximum:	4731		

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From the above table, comparing each element in both zones shows that there are differences in Median and Maximum; for zinc, values of maximum and median are almost similar.

Comparison of the matrix of correlation coefficient (r) for selected elements (tab.2) shows that there is different correlation of same elements for both zones.

Table.2 Matrix of Correlation coefficient for selected elements

Trepça metalogenic Belt Correlation Coefficient							
	Au	Ag	Cu	Pb	Zn	As	Sb
Au	1						
Ag	0.5	1					
Cu	0.3	0.7	1				
Pb	0.5	1.0	0.7	1			
Zn	0.3	0.6	0.6	0.6	1		
As	0.7	0.8	0.5	0.8	0.4	1	
Sb	0.3	0.7	0.7	0.7	0.5	0.5	1

Artana-Merdare metallogenic zone Correlation Coefficient							
	Au	Ag	Cu	Pb	Zn	As	Sb
Au	1						
Ag	0.3	1					
Cu	0.5	0.5	1				
Pb	0.2	0.8	0.3	1			
Zn	0.1	0.5	0.2	0.7	1		
As	0.3	0.5	0.4	0.5	0.6	1	
Sb	0.0	0.6	0.1	0.3	0.2	0.2	1

There is a positive correlation between some elements within two zones. Moderate correlation is noted in Trepça metallogenic Belt between elements Pb-As and Ag-As (r=0.8). Correlation between other elements is low (r=0.5 – 0.7) or is very low (r = ≤ 0.5).
At Merdare - Artana metallogenic zone there is a moderate correlation only between Ag and Pb (r = 0.8), there is low correlation between Pb - Zn (r = 0.7) and elements Zn-As, Ag-Sb (r = 0.6).
Very low correlation is between other elements.
Based on the prepared maps for each element, it is possible to define different distribution and different metal values in stream sediments, that is also seen by grouping them in Univariate Statistics.
The highest values of metals taken in this study belong to the areas close to the active mines and their surrounding areas mostly south of Stanterg Terg, Kishinca and Artana mines, that could considered as perspective ones.
As is well seen in fig.3 and table 2, there are similarities in the distribution of high values of Pb and Ag and very good positive correlation.
The highest values of some elements found in river and stream sediments of the survey area are obviously partly caused by the contamination of stream sediments from mining activities as damps and ore waste and contain with metallic minerals from surrounding mineral occurrences and geological settings.
The comparison of the maximum values, arithmetic mean and median values with the Clarke values shows that the survey area is specific for such elements as Pb, Zn and as possible promising for the prospection for Au, Ag. The results don't show any broad distribution and high Cu values in the considered area.

4. CONCLUSION AND RECOMMENDATIONS

- Analysis of collected river and stream sediment samples indicates that the river sediments in the surrounded areas of mine activities are contaminated with heavy metals (Pb, Zn, As, Ag, Au and Sb).
- There are good indications for perspective areas and in zones where there was not any mining activity; stream sediments are enriched with metallic minerals several times over background values.
- There is a good positive correlation of some elements, which could be used as good parameter for special treatment of them.
- Based on the presented data, it can be concluded that there is a promising area for further prospection – exploration at the NNW and SSI sectors of the active mines.

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- The distribution of some elements in Trepça metallogenic Belt and Merdare - Artana metallogenic zone allows us to suggest that Artana –Batllava area should not be included in Trepça metallogenic Belt, as it is named in the map, see fig.1.
- Trepça metalogenic Belt to be named zone that is as a continuation of Kopaonik metallogenic zone that starts from Beloberdo and Cernac mine though Stanterg mine, Hajvalia, Badovc and Kishnica mine with continuation towards south east to the border with Macedonia.
- Merdare metallogenic zone to be named north part of the Lece-Halkidik zone within known Trepça metalogenic Belt.

REFERENCES

A.Pavič, L.Menkovič & M.Koščal, Beograd 1983 *Osnovna Geološka karta 1:100 000 Tumač za list UROŠEVAC K 34-35*

DIMITRIJEVIC M. D. et al.Ministry for Mining and Energetics Republic of Serbia, 2000 Beograd, *Metallogenic Map of Serbia* [MetM 2000 – SRB1] (scaned copy)

DIMITRIJEVIC M. D. et al.Ministry for Mining and Energetics Republic of Serbia, 2000 Beograd, *Map of Ore Formations of Serbia* [MetM 2000 – SRB2] (scaned copy).

LEGLER C. ET AL, Andreas K, Axel R. Prishtinë 2006, *The Compilation of Geoscientific maps of Kosovo – The Digital Geological Map 1 : 100,000: BEK Consultants reports, GeoMaps Kosovo,* project No. 20050136

Legler C, Andreas K 2008 Kosova, *Metallogenic / Minerogenic Map (1 : 200,000) – MetM 200,* Project no. 20070072.

Lehne R, Nitzsche, Deissmann, Krotz, 2010-2011 Kosova: *Support to ICMM to develop the Geochemical Survey in KosovoEU GEOS,* EuropeAid/128027/D/SER/KOS

Mueller. F & Dr. A. Barth February 2007 Kosova: *Stream Sediment Sampling Area I : Kizhniçë / Kišnica - Artanë /Novo Brdo,* Project no. 20060179.ber.doc.v.06

Mueller. F, Matthias K, Andreas B, 2008 Kosova: *Stream Sediment Sampling Kosova Area II Volcanic comlex Mitrovice-Samadrexh,* Project no. 20070088.ber.doc.v.1.0

N. Peci, Z.Elezaj, H. Hajra, S.Mulaj, 2012. Revistë shkencore e Institutit Alb-Shkenca, *Spatial analysis of stream sediment sampling geochemical data for selected elements, volcanic complex Mitrovicë-Samadrexhë,* Akted V, 2: 16-166, 2012.

Naser Peci, Ismail Hoxha: Analiza statistike dhe variografike e pjesës së shfrytëzuar të vendburimit të Nikelit silikat "Çikatove e Vjetër". Simpoziumi Ndërkombëtar "Potencialet Gjeominerare – strategjia dhe menaxhimi i tyre". Mitrovicë, 27 – 30 Shtator 2006.

Reimann Clemens, Filzmoser Peter, Garret Robert, Dutter Rudolf : Statistical Data Analyzis Exploined – Applied Environmental Statistics with R, Wiley, England, 2008

S.Mulaj, N.Peci, S.Avdullahu, Xh.Raci 2009 Bullgari, International Multidisciplinary Scientific Geo-Conference & EXPO – SGEM 2009: Impact *of Artana mine on pollution of "Kriva Reka" river sediments with heavy metals.*

VINOGRADOV, A.P.: Average contents of chemical elements in the principal types of ingneous rocks of the Earth crust. – in: Geochemistry 7, pp. 641-664, 1962

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METHODS USED IN SURFACE REHABILITATION IN THE EX-PETROLEUM REFINARY IN KUÇOVA

Nensi Mehmeti[1], Irakli Prifti [1]
[1]*Polytechnic University of Tirana, Rruga e Elbasanit,Tirana, Albania,*
E-mail: irakliprifti@yahoo.com

ABSTRACT

The Town of Kuçovë lies in central Albania in the District of Kuçove, which is part of a higher administrative unit, Berat.
The premises of the former refinery are located in the industrial zone at the north- western margin of the municipality on a total area of about 25 ha. The premises measure about 450 m from E to W, and about 550 m from N to S. The average altitude of the premises is about 40 m. They are delimited by a residential zone in the north, west and east; the southern edge is formed by the premises of a former wastewater treatment plant and a petrochemical processing plant. In premises of the former refinery and outside of it, especially in the proximity of the northern and eastern margin, there are a few working oil wells with operating facilities. Old petroleum refinery lies on Quaternary and Pliocene (suite of Helmasi) sediments.
Our objects are the methods and parameters to evaluate pollution of petroleum refinery area. Samples are taken from soil or sediments, while surface-water samples were taken from two profiles from a channel running through area (above and below the area of interest), especially from wells, lagoons and channels.
Regarding the recharge of contaminants into the unsaturated and saturated zones, the sources must be divided into two groups:

1. *The technological part of the refinery;*
2. *The lagoons.*

Physical-chemical and geophysical methods are in conformity with EU standards. Old petroleum refinery area (soil and water) is contaminated by petroleum substances.

KEY WORDS: *Old refinery plant in Kuçove, petroleum substances, petroleum hydrocarbons, polyaromatic hydrocarbons, heavy metals.*

INTRODUCTION

This paper has been prepared within a project of foreign development cooperation of the Czech Republic entitled "Implementation of New Environmental Technology for Oil Industry, Kuçove Region, Albania" and based on a contract on the implementation of a development cooperation project, concluded between the Czech Republic and Albanian Republic (Mgr. Jan Bartoň, Mgr. Boris Urbánek, 2009).
Based on the current survey, it can be stated that the presence of pollution by **petroleum substances**, **methylene blue active substances** (anionic tensides) and **heavy metals,** is the consequence of old ecological load caused by the operation of the refinery during a period of about 70 years. The recharge of risk substances into the rock environment and groundwater, which resulted from technological indiscipline, diverse accidents, fires and production organizations inconsiderate to the environment, is the main cause of the present detrimental situation.
Premises of the former refinery can be divided from the point of view of operation and technology into the area of old operation (Fig.1), which lies on the eastern slope of an elevation jutting out in the western part of the premises, and the area of new operation, which occupies the remaining tract (Fig.1).
Petroleum substances (Total Petroleum Hydrocarbons), polycyclic aromatic hydrocarbons, sulfur and its compounds, ionic tensides and heavy metals are the main compounds of soil pollution.

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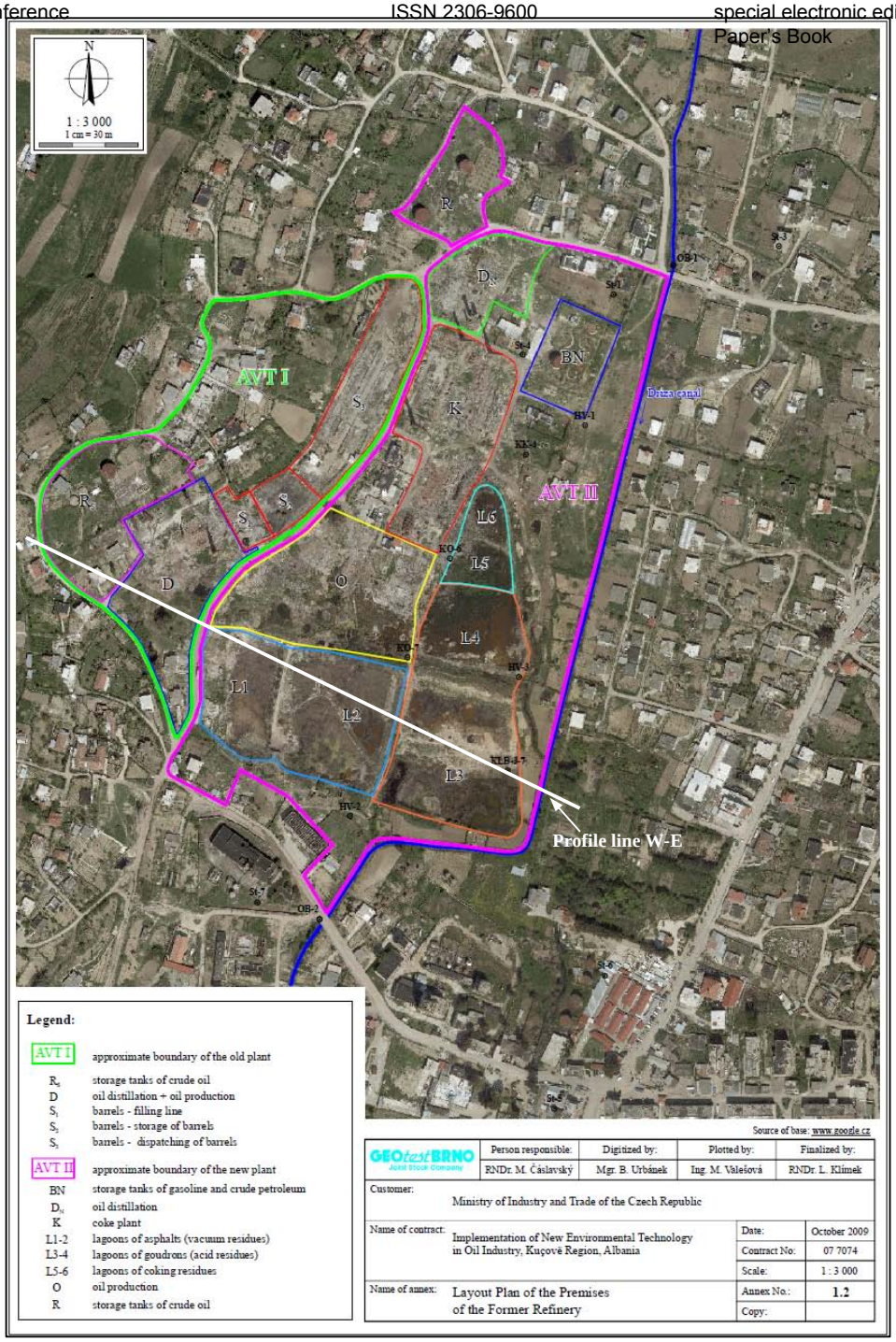


Fig.1. Scheme of old petroleum refinery in Kuçova (source: GEOtest Brno, a.s.)

The following parameters were determined in groundwater and surface water samples:
Physical-chemical analysis (PCA); **Total petroleum hydrocarbons** (TPH); **Total content of hydrocarbons** from the group $C_{10} - C_{40}$ in selected samples; **Group of substances** such as benzene, toluene, ethylbenzene, xylenes (BTEX) in selected samples; **Chlorinated hydrocarbons** such as cis-1,2-dichloroethene, trichloroethene, tetrachloroethene and 1,2-dichloroethane in selected samples; **BTEX and CHC** were determined as volatile organic compounds (VOC); **Polyaromatic hydrocarbons (PAH)** such as naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene in selected samples; **Heavy metals such** as Cd, Pb, Cu, Zn, Cr, Co, V, and Ni (HM) in selected samples; **Monohydric phenols** in selected

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samples; **Anionic tensides** (MBAS) in selected samples; **Microbiological screening** focused on the quantitative determination of microorganisms degrading petroleum hydrocarbons (Microb.) in selected samples.

The results of analyses of samples of water, soils and wastes were compared to the limits or criteria binding in terms of Czech legislation which is in full compliance with EU legislation in the field of the environment.

GEOLOGICAL SETTING

Geologically, the studied site lies in the Adriatic Depression, which belongs to the Outer Albanides. This zone is formed by marlstones, claystones, sandstones and lithotamnion and organogenic limestones of Miocene age. It is the filling of the Adriatic Depression, 1,000 m thick, which is formed upward by the Polovina, Kuçovë and Driza Units (Fig.2). The overlying Pliocene sediments consist especially of claystones and sands to sandstones of the Helmsi Unit, which outcrop at the site in question in the form of a moderate elevation at the western margin of the premises (Albanian Geological Survey (AGS), 2002). The Miocene and Pliocene sediments were eroded during the Quaternary.

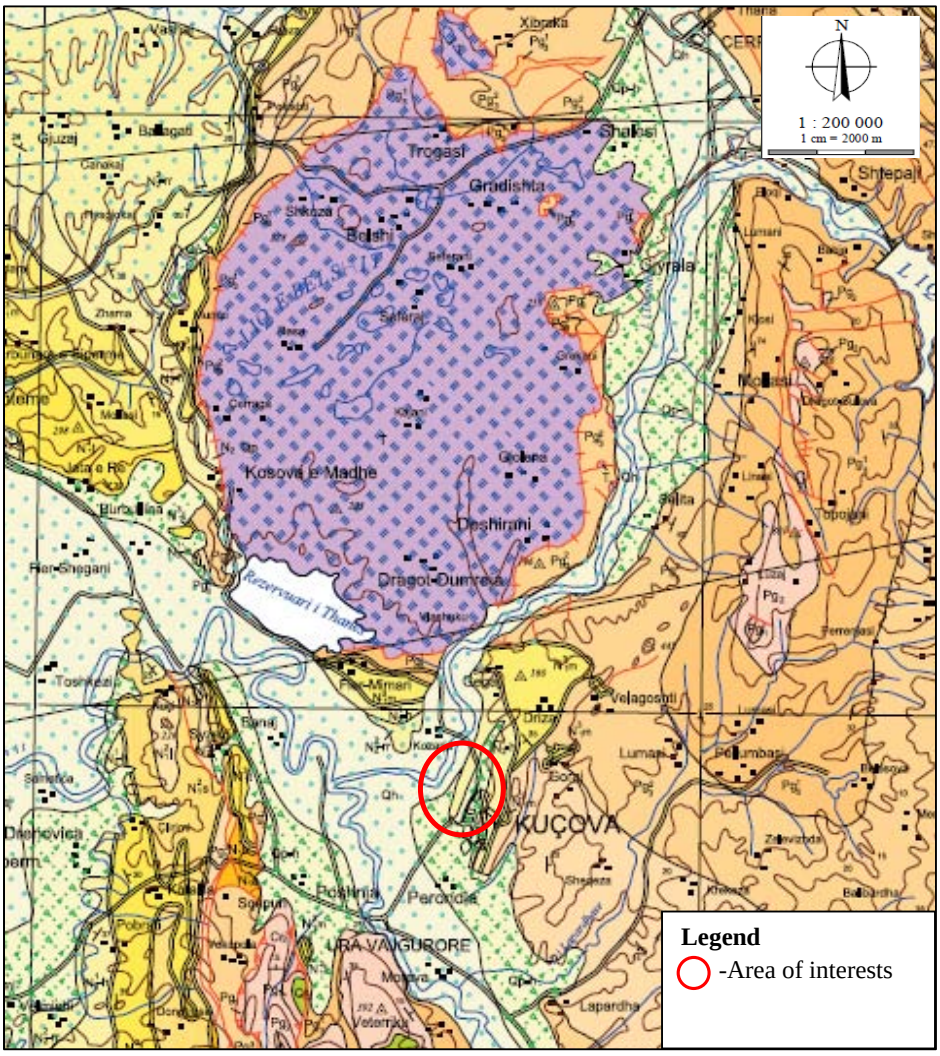


Fig.2. Area of interests on geological map of Kuçova region (source: AGS)

The Quaternary cover at the site is particularly of alluvial, eluvial and deluvial origin (Fig-3). The most significant alluvial accumulation at the site is a river terrace, which was created by a watercourse in the past, now regulated into several artificial canals. The Driza channel flows along the eastern edge of area. In the lower part of the floodplain profile, there are fluvial gravels probably

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in a continuous layer of about 2-5 m in thickness, depending on the position in the cross section of the valley. The overlying sediments are represented predominantly by sandy clays and clayey sands of about 20 m in thickness. A layer of flood loams (2-5 m) is deposited a t the uppermost part. A layer of anthropogeneous fills (lagoon dykes) locally occurs on the ground surface, not exceeding 5 m in thickness, and is represented especially by the rock material from the surroundings and by remnants of building materials.

The eluvial sediments were formed by the weathering of pre-Quaternary claystones. They have a form of angular fragments (Irakli Prifti et al., 2007). The thickness of this zone can be estimated at about 5 m. The deluvial sediments were formed by the displacement and settlement of eluvial products of weathering. In the area of concern, they form rainwash or solifluction sediments.

The total maximum thickness of the Quaternary sediments is 25 – 35 m, depending on the position in the cross section through the valley.

From the structural point of view, the presence of faults, which could affect the stability of the area and any potential spreading of contamination, has not been proved in the vicinity of the site.

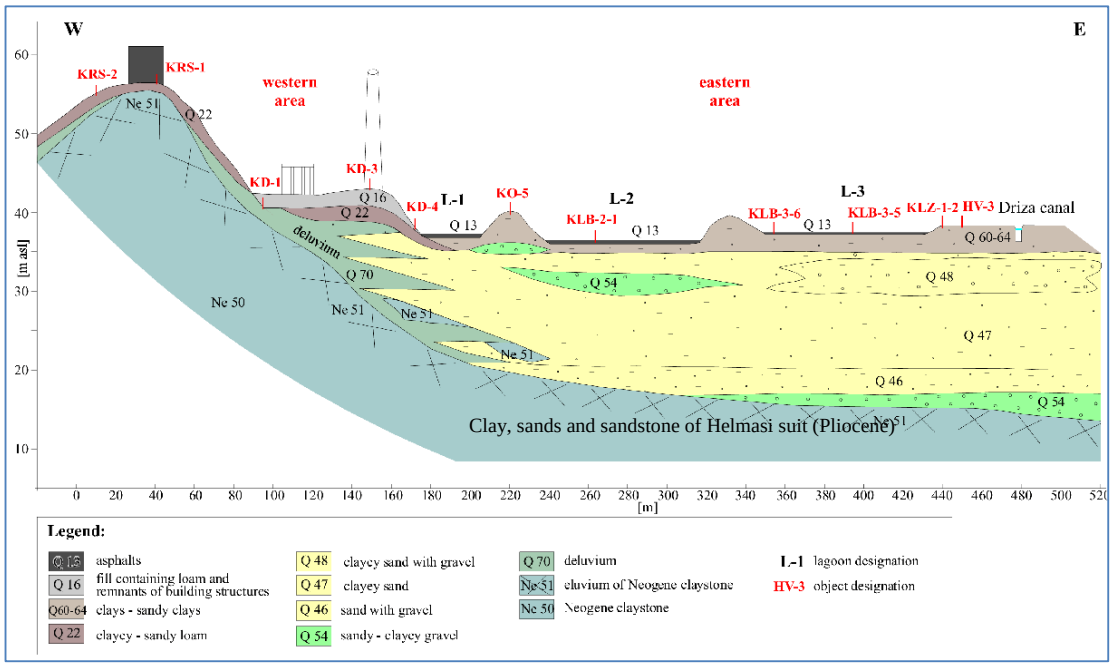


Fig.3. Profile of Quaternary sediments on area of old petroleum refinery in Kuçova (source: GEOtest Brno, a.s.)

METHODOLOGY

The methodology carried out was implemented in compliance with EU standards. But the methodology was modified as needed according to the current situation arisen during the solution of the practical problems (Mgr. Jan Bartoň, Mgr. Boris Urbánek, 2009).

Within the survey of the site for the needs of the study, the following work was carried out:

1. Review of archive materials and documentation of the site;
2. Subsurface exploration work;
3. Drilling work;
4. Sampling work:
   Soils; Wastes;
   Groundwater and surface water;
5. Regime measurements of groundwater and surface-water levels;
6. Hydrodynamic tests;
7. Geodetic work.

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1. Review of Archive Materials, Documentation of the Site. Before the start of field and preparatory work, available map bases were gathered, mainly geological, hydrogeological, topographic and special maps, and geological profiles of oil wells and project documentation of buildings and their foundation settings.

Besides technological units at the site and in its vicinity, the existing hydrogeological objects (wells) were verified from the point of view of their exploitability during the site survey. Also, the passportization of local sources of contamination was made in the vicinity of the refinery.

2. Subsurface Exploration Work. During the subsurface exploration work, complete primary documentation was made, comprising the following documents:

Petrographic, including information on water saturation and the orientation depth of the detected groundwater level;

Photographic;

Organoleptic (sensorial verification of the presence and assessment of the degree of contamination);

Soil sampling;

Waste sampling.

After the completion of subsurface exploration work and the making of primary documentation, the excavation pit was destroyed by compacted backfill; in case of the hydrogeological exploratory holes, the pit before being backfilled was fitted with a 6-m-long perforated PVC tube without a gravel pack and with slots of 2 mm in diameter. The location of the holes was horizontally as well as vertically surveyed.

The petrographic profiles of the holes are prepared (Fig-3). The complete photographic documentation is stored in the archives of the company GEOtest Brno.

3. Drilling Work. Within the solution of the survey for the needs of study, a total of 3 hydrogeological boreholes (wells) profiles were installed in area of old petroleum refinery. The boreholes served for the orientation documentation of geological conditions at the site, the verification of the depth range of the Quaternary groundwater body (gravels), groundwater sampling and the making of hydrodynamic tests. These objects will further serve for monitoring the groundwater level and also, if possible, for the control of the quality of groundwater.

During drilling work, proper primary documentation was made, consisting of the following documentation:

Petrographic; Photographic;
Organoleptic; Soil sampling.

4. Sampling and Analytical Work. Sampling was made in compliance with the guideline of standards of the company GEOtest Brno, a.s. Before the start of sampling work, a sampling plan was developed for the site, which is stored in the archives of the company GEOtest Brno, a.s.

Collection and analyses of waste samples. A total of 8 partial composite samples of waste (or with an admixture of soil) was collected from the available parts of asphalt lagoons number 1 and 2 and lagoons of goudrons number 3 and 4 using a dredger and a manual sampling device. Always one composite sample was created for each lagoon from selected samples in order to determine selected parameters in dry matter by homogenization in the laboratories. In case of waste samples analyzed in leachate, partial samples were used.

The following parameters were determined in waste samples:

- Physical parameters: heat of combustion, calorific value, dry matter at 105 °C, moisture at 105°C;
- Aggregate parameters: phenols volatilizing with water vapor;
- Inorganic parameters: total Cl, total CN, and S;
- Sensorial parameters: water content;
- Total petroleum hydrocarbons (TPH);
- Polychlorinated biphenyls – seven congomers: PCB 28, 52, 101, 118, 138, 153 and 180;

In selected samples: polyaromatic hydrocarbons (PAH) according to EPA 610: monohydric phenols, naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene;

- Soluble metals: Cr;

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- Extractible metals: As, Ba, Be, Cd, Co, Cr, Cu, Hg, Mo, Ni, Pb, Sb, Sn, V and Zn;
- Parameters according to the provision of Regulation No. 294/2005 Coll.: pH, DOC, chlorides, fluorides, sulfates, dried petroleum substances (105° C), Hg, Ni,Zn, As, Cd, Ba, Co, Cr, Cu, Pb, Mo, Se and Sb;

Chemical analyses of wastes were made by the company ALS Czech Republic, s.r.o., the laboratory of which is accredited by the Czech Accreditation Institute (CAI).

Collection and analyses of samples of free phase of petroleum substances (PS) are taken in compliance of EUstandards. Samples of phase of PS were collected for qualitative determination from the groundwater table from holes.

Collection and analyses of soil samples. Soil samples for analyses were collected during subsurface exploration and drilling work from the dug holes and one hydrogeological borehole (well). Samples were taken at one to three depth levels according to preliminary visual and sensorial evaluation. The designation of samples was chosen according to the name of the respective hole, behind which the depth interval of sampling was assigned in round brackets.

Samples were taken by the method "with a judgment" as:

- Zonal point samples for delineation of the extent of contamination;
- Composite samples for determination of qualitative and quantitative parameters of contamination or for determination of mechanical properties of rocks.

The level of sampling was determined on site by a judgment formed on the basis of:

- Sensorial evaluation;
- Assessment of lithological conditions;

Collection and analyses of groundwater and surface water samples. Groundwater samples were collected from a total of 14 hydrogeological objects. Both the existing hydrogeological objects (wells) inside as well as outside and the newly installed hydrogeological objects and hydrogeological holes were used for groundwater sampling.

2 samples of surface water from the Driza channel running through area of old petroleum refinery were taken from newly established sampling points.

The following parameters were determined in groundwater and surface water samples:

- Physical-chemical analysis (PCA);
- Total petroleum hydrocarbons (TPH);
- Total content of hydrocarbons from the group $C_{10} - C_{40}$ in selected samples;
- Group of substances such as benzene, toluene, ethylbenzene, xylenes (BTEX) in selected samples;
- Chlorinated hydrocarbons such as cis-1, 2-dichloroethene, trichloroethene, tetrachloroethene and 1, 2-dichloroethane in selected samples.

Note: BTEX and CHC were determined as volatile organic compounds (VOC).

- Polyaromatic hydrocarbons (PAH) such as naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene in selected samples;
- Heavy metals such as Cd, Pb, Cu, Zn, Cr, Co, V, and Ni (HM) in selected samples;
- Monohydric phenols in selected samples;
- Anionic tensides (MBAS) in selected samples;
- Microbiological screening focused on the quantitative determination of microorganisms degrading petroleum hydrocarbons (Microb.) in selected samples.

Chemical analyses of groundwater and surface water samples were made in the laboratories of the company GEOtest Brno, a.s., which are accredited by the CAI.

A total of 91 groundwater and surface water samples were collected for analytical determination. Groundwater samples were taken in dynamic state at the end of short-term pumping, by which 3 to 4 times the volume of the well (the tube and the pack) was pumped out and when the physical-chemical parameters of the pumping water were stabilized, i.e., that the measured values (mainly pH and conductivity) would not change by more than 10% by pumping out another volume of the well. A submersible pump GIGANT, with an output of 12 W, was used for dynamic sampling. In the event that dynamic sampling could not be made for technical reasons, the sample was collected statically by a sampling cylinder of 1 l in volume.

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Dynamic groundwater sampling was conducted at the outlet from the hole discharge into prescribed sample tubes. Before sampling, the pumping amount was reduced to eliminate aeration. Groundwater sampling for the determination of the content of total petroleum hydrocarbons (TPH) were made from a depth of about 0.5 m below the lowered groundwater level in the sampled object. For collections of samples for the other required analyses, the sampling was made from a depth of 1.0 m or less above the bottom of the hole.

Surface water samples were taken by direct drawing, using a sample cylinder of 1 l in volume, into prescribed sample tubes. The measurement of parameters such as temperature and pH was made by a field analyzer GMH 3530 and conductivity by an instrument GMH 3410.

Mandatory primary documentation of all collections of samples was kept. It is stored in the archives of Department 3311 of the company GEOtest Brno, a.s.

5. Regime Measurements. Within regime measurements of groundwater- and surface-water-level depths below benchmark, two cycles were carried out. These measurements were made in the existing accessible hydrogeological objects inside the area and outside it in the newly installed hydrogeological objects and holes. Two sampling points on surface stream – Driza canal, altogether in 15 objects. The results of regime measurements, together with the data on the tapped groundwater level in the holes and wells, need to summer to one Table.

The results of regime measurements served for the construction of maps of hydroisohypses to determine the direction of groundwater flow and the possible continuities of groundwater with surface streams. The measurement of the groundwater level was made by using a conductivity cable level gauge G10.

Based on the measurement and the above-given bases, the directions of groundwater flow, the relation between groundwater and surface water, the slope of the groundwater level, and the real velocities of groundwater in the aquifer were subsequently determined. They are necessary for determining the matter flow of contaminants.

6. Hydrodynamic Tests. For the orientation identification of hydraulic parameters of the aquifer, short-term hydrodynamic tests were conducted in the newly installed hydrogeological and hydrogeological hole. The pump was connected to a car battery and groundwater was conveyed from the well through waste piping and discharged onto the ground. The yield was measured by means of calibrated. After the end of pumping, a recovery test was made. The groundwater level was moderately confined.

The primary technical documentation of tests and analytical reports with the graphs of courses of hydrodynamic tests are stored in the archives of the implementer.

During the hydrodynamic tests, selected physical parameters of groundwater were measured on site. The samples for measuring temperature and pH parameters were taken in the dynamic way and measured on site by an instrument of the type GMH 3530, conductivity by an instrument GMH 3410.

7. Geodetic Work. Geodetic surveying at the site took place in two phases. In the first phase, the lagoons were surveyed in order to obtain partial input data needed for the calculation of the volume of dumped waste (Fig.4). Furthermore, the bodies of fills of municipal waste in the lagoons were surveyed. In the second phase, the vertical and horizontal surveying of the existing hydrogeological objects, dug holes, hydrogeological holes, newly installed hydrogeological boreholes and measuring points was made in area of study and its vicinity in order to subsequently evaluate the exploratory work, e.g., the constructions of hydroisohypses.

Overall, the horizontal and vertical surveying was made in the following objects: holes, wells, hydrogeological boreholes and documentation points on surface streams.

Moreover, are surveyed the areas and levels of the surface of the lagoons to calculate the cubic capacity of Waste contained in the lagoon and the bodies of fills (municipal waste) present in the lagoons.

The results of geodetic work were plotted into map bases and a digitized computer construction. These materials served as a basis for the areal evaluation of the area (the map of hydroisohypses, of the balance of wastes deposited in the lagoons, of the extent of pollution, etc.

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Fig. 4. View of coke-oven batteries (1965) and view of coke-oven batteries (2009) from SE

CONCLUSION

Area of study (25 000 m^2) presents the site of the old petroleum refinery in Kuçova town. The region is composed by Pliocene (Helmasi suit) and Quaternary sediments.
The methodology carried out was implemented in compliance with EU atandards.
Within the survey of the site for the needs of the study, the following work was carried out:

1. Review of archive materials and documentation of the site;
2. Subsurface exploration work;
3. Drilling work;
4. Sampling work:
   Soils; Wastes;
   Groundwater and surface water;
5. Regime measurements of groundwater and surface-water levels;
6. Hydrodynamic tests;
7. Geodetic work.

Analitical methods were carried out in conformity with type of samples such as waste samples, soil samples, groundwater and surface water samples and in compliance of EU standards.
Based on parameters area is contaminated. The origin of this contamination relates to the historical industrial use of the premises.

ACKNOWLEDGES

Thanks are due to GEOtest Brno, a.s. company from Czech Republic for realising of the study: ***"Implementation of New Environmental Technology in Oil Industry, Kuçovë Region, Albania"***.

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Authors wishe to thank particularly the Mayor of the Municipality of Kuçova town, for the smooth course of field survey work and a review of archive materials at the site of Kuçova.
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REFERENCES

Albanian Geological Survey (AGS), 2002. *Geological map of Albania, sc. 1:200 000*. Archive of AGS (in Albanian).

Irakli Prifti, Vangjel Prifti, Apostol Qirko, 2007. *Ndërtimi i hartave gjeologjike dhe të pasurive minerale shk: 1:25 000 të planshetave k-34-111-d-a (Kutallia) dhe k-34-111-d-b (Kuçovë)*. Archive of AGS (in Albanian).

Mgr. Jan Bartoň, Mgr. Boris Urbánek, 2009. *Implementation of New Environmental Technology in Oil Industry, Kuçovë Region, Albania***.** Archive of GEOtest Brno, a.s.Czech Republic

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ENVIROMENTAL PROJECT, AS INTEGRAL PART OF MINING PROJECT

Skender LIPO[1], Edmond HOXHA[1],

[1]Faculty of Geology and Mine. Rruga "Labinoti, Tirana – Albania;
e-mail: lipo54@yahoo.com

ABSTRACT

In addition of increasing technical difficulties, with the introduction of mining more and more deeper, to the management of a mining activity, for extraction and processing of mineral raw materials, today are added the challenge of environment protection and society values increasing. Assessment of the expected environmental impacts of a mining activity is today a challenge for environmental specialists. Based on the best experience of the world and our country, we bring on this paper the expected impacts on the environment by mining activities. Seeing the environmental project, as an integral part in three phases of the mining project: the stage of project preparation; during the mining activities for the exploitation of mineral deposit; and after closing the mining activity, emphasize the need for a continuous cooperation between mine owners, the community living and working in the area mining, and environmental protection institution.

KEY WORDS *1, Mining and Environment 2, Mining and Environmental project 3, Environmental impact*

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GEOLOGICAL EXPLORATION AND 3D MODELLING OF EPITHERMAL GOLD MINERALIZATION, LIVADHEZA-SHTUF, ALBANIA

Resmi KAMBERAJ[1]

[1]*MAusIMM, JAB Resources Ltd, Australia; reso.kamberaj@gmail.com Golden Touch Resources Corporation, Canada, , resmi@goldentouchresources.com*

ABSTRACT

The mineral bearing rock units within and outside the project area have been subjected to extensive geological and geochemical prospecting works (from previous and from most recent works) as: surface mapping, trenches sampling, stream sampling, core drilling, underground, and some metallurgical preliminary studies.
Unification of the historical and recent data and using them as the base for the preliminary resource modelling , interpretation the applicability of these results to exploration in other part of geological terrains, in combining them with geophysics survey, suggest clues to distinguishing first and second priority of drilling campaign.

KEY WORDS: *Resource modelling, Geostatistics, Gold, Copper, Porphyry, epithermal.*

1.Introduction

This project is located on the northern part of Albania, a hilly mountainous terrain area, elevation lower than 700m, good access roads and a typical Mediterranean climate. (Fig1. Fig2)



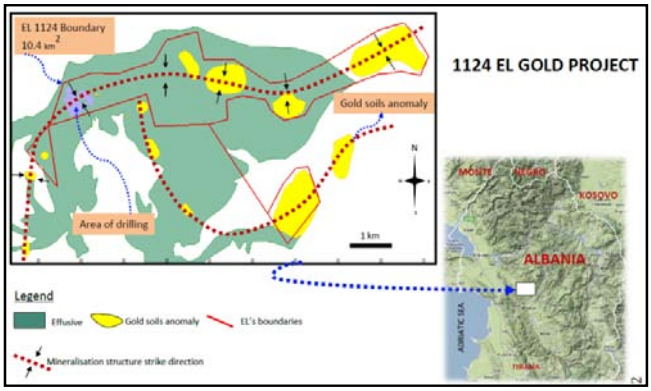


FIG 1- JAB-GOT Albanian project location *FIG 2-Simplified geology of the area*

Mineral exploration data of this project represent a vast source of information collected from different explore campaigns and completed on a wide period on time. The Albanian Geological Survey ("AGS") has been working till the end of 1990 and at the beginning of 2006 JAB Resources Ltd ("JAB"), Australian Company, got tenements (5,6) and started prospecting and exploration geological works followed latter on by Golden Touch Resources Corporation ("GOT"), Canadian-Australian Company.
In the Mirdita tectonic zone, where Exploration license ("EL") Liadheza Shtuf is located, most of gold ore deposits occur in a wide range of tectonic settings, and are highly variable in their local characteristics. In this paper, we focus on the gold deposit in the Livadheza- Shuf area, investigating geological controls on the distribution and characteristics of this epithermal gold deposit and present preliminary resources modelling as a guide for the next exploration works (Fig.3).

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2.Regional setting

The Project area lays between the Western Ophiolite Belt ("WOB") which is extensively faulted and Eastern Ophiolite Belt ("EOB"). In most areas AGS and other geological works from Tirana, Rubik and Puke Geological Enterprises have mapped surface geology and numerous north to north-west striking faults approximately parallel to the former frontal margin of the Mirdita tectonic zone. These tectonics are well evidenced on the western boundary of ophiolites (Fig.4).

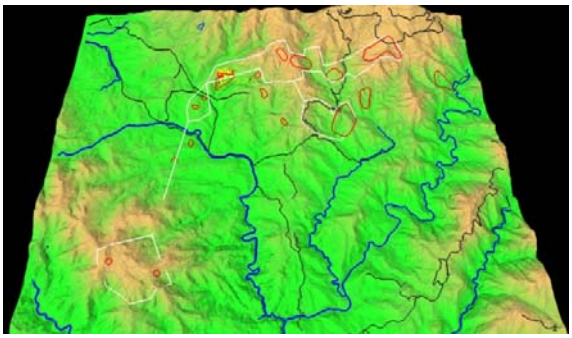


FIG 3 - EL 1124 (white) and gold anomalies (red)

The Mirditë Zone constituted a pelagic (deep) oceanic basin, with ophiolites in the Middle and later Jurassic, and later a neritic (relatively shallow) ocean with Upper Triassic to Lower Liassic (lowermost Jurassic) limestone. Volcano sedimentary and sedimentary strata in the Mirditë Zone include limestone, radiolarites, conglomerate, sandstone and basalt.

The area of Lezhe Rreshen, (as a part of the Ophiolitic Zone) of the Internal Albanides is an essential element in most of Albania's base metals deposits, including volcanogenic massive sulphide ("VMS").

The main lithological rocks on the area of study,(from the bottom) are:
1. Pelagic carbonate chert formation: Middle Triassic
2. Pre ophiolitic volcano sedimentary formation –late Triassic Middle Jurassic, basalts, radiolarites, schist with blocks,
3. Vulcanite of J_{2-3} (lower sequence of basalt-diabasics),
4. $J_3 Cr_2$ melange (blocks in matrix melange)which cover the litho units
5. Pre molasses formation of the inner zones: sandstones, siltstones, mud rocks, conglomerates, marls and limestone, which cover here and there all four formations.
5. Quaternary deposits.

Most lithological contacts in this zone are faulted contacts (Fig 4).

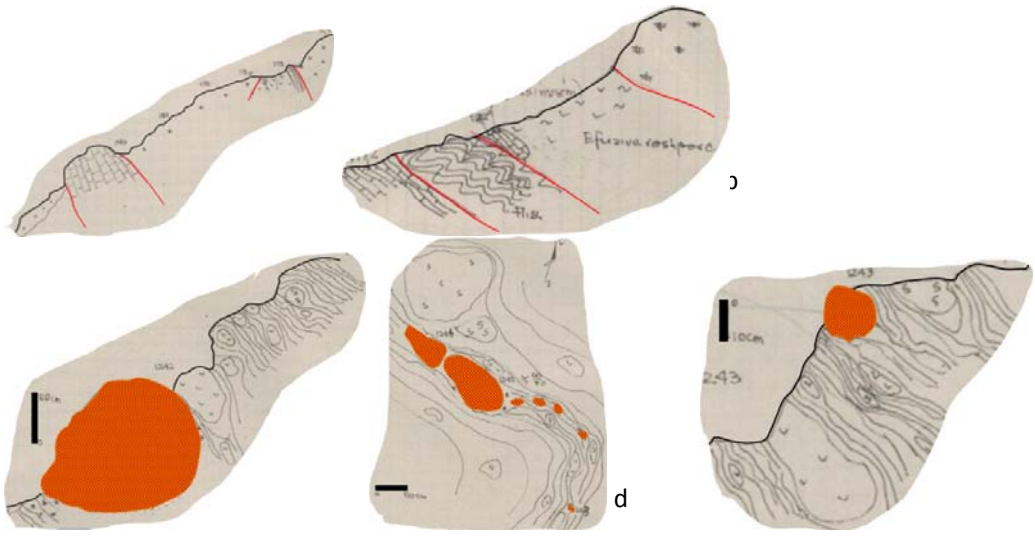


FIG 4 (a, b, c, d, e) - Schema, faulted contacts between the litho units on the WOB, *(R.Kamberaj field works 1978-1983)*

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The various units of the ophiolites, sedimentary and the metamorphic sole rocks, younger melange and flysch have a north to north-west strike, dipping east to north east which coincide with the faults direction.

Year	Ore mining Ton
1979	976

Units from different levels in the ophiolites can be repeated, overturned and juxtaposed against younger or older rocks.
Two distinctive ophiolite sequences have been recognised within the area:

a. At the western part of the WOB, radiolarian ages around the Rubik massive sulphide deposit demonstrate a Late Triassic age for chert layers immediately above the sulphide deposit; at the top and within the volcano-sedimentary sequence; and within the underlying pillow lavas. Similar rocks outcrop around Palaj in the north and along the eastern part of the WOB.

b. Around Kacinar, Lumth and Livadheza-Shtuf the WOB is Middle Jurassic in age. Here the lower pillow basalts are overlain by basaltic pyroclastics, predominantly agglomerates.

Ultramafic rocks, predominantly serpentinised lherzolites, and gabbros underlie both the Triassic and Jurassic basaltic rocks. The ultramafic rocks frequently occur as fault slices, injections or wedges within the stratigraphically overlying gabbros and basaltic rocks. No distinctive zones of sheeted diabase dykes have been mapped. Minor diabase dykes and intrusives are distributed throughout the basaltic rocks and may represent remnants of a fault disrupted sheeted dyke zone. Younger rocks mapped as flysch and melange are closely associated with the ophiolite. These are of Late Jurassic to Early Cretaceous age and crop out inside and outside the ophiolites. Around Rubik the flysch comprises a tightly folded north-west trending formation of thin bedded marl, limestone and sandstone. The melange at Rubik is a spectacular block in matrix type melange with blocks and clasts of Triassic limestone, ultramafics, metamorphosed ultramafics, basaltic rocks, massive and disseminated sulphides and flysch in an argillite matrix. Blocks range from metre size to hundreds of metres

3.Mineralisation

In the Rubik area, which is most western part of WOB, previous geological works were focused on the copper testing but most resent works also tested for gold and from samples on one limonite outcrops we have promising results for gold (Fig.5)

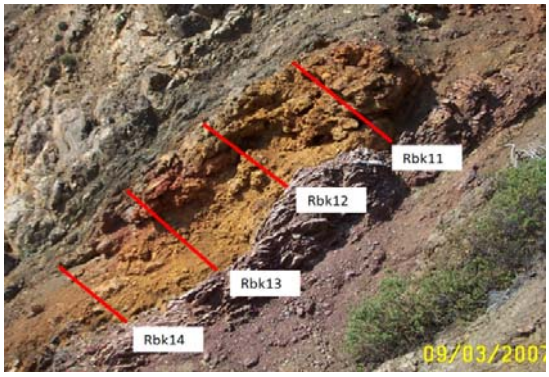


FIG 5- Gold positive results on Rubik outcrop

Sample	Weight kg	Au, ppm
RBK 11	4.18	2.62
RBK 12	3.88	2.87
RBK 13	5.2	3.04
RBK 14	3.02	2.16

From historical data, some mines were developed in past on this region as Rubik (for copper- high grade, Derven (copper- low grade), and Gjazuj (gold).
Mining in the Livadheza Shtuf EL has been very rudimentary and mostly to test metallurgical behaviour of mixed feed of smelter. This mixed feed of smelter in Rubik city was composed mostly from minerals of Rubik mine itself, Derven, Kacinar and mineral from Livadheza Shtuf deposit. Mining production form gold deposits has been very small started on 1979 and finished on 1988.

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1980	1921
1981	2580
1982	3024
1983	3663
1984	5492
1985	4924
1986	3685
1987	4809
1988	281

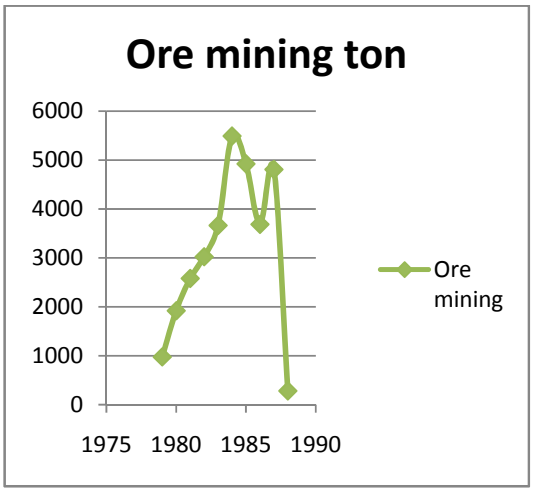
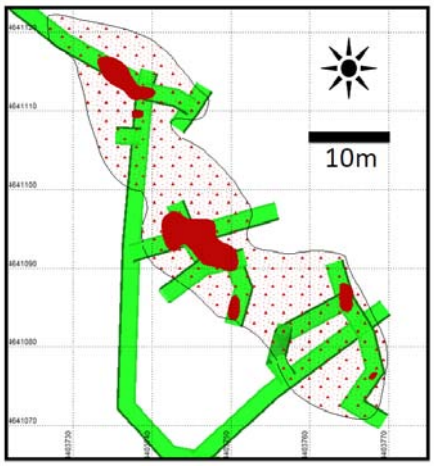


FIG 6- Mining production (ton) on the Livadheza-Shtuf deposit

The historical resource estimates of Livadheza Shtuf (EL 1124) were calculated but drilling cores from previous works, neither duplicate form lab, are saved and JAB was not able to check the accuracy of assay (1). This is one more reasons that drilling campaign planed to be achieved from JAB is going to test also previous results.
The gold mineralisation is in meso ?- epithermal gold-quartz veins hosted within layered fine grained Jurassic effusive age. While the quartz-gold veins are generally bedded and laminated in nature the mineralisation can form lenses of sheeted veins up to 20 metres in width. Main minerals are sulphides as arsenopyrite, sphalerite, pyrite mostly inside the quartz lenses and this is a characteristic for this deposit compare to other ore deposits known in Mirdita tectonic zone where main minerals are pyrite, chaclopyrite, sphalerite with gold as accessory element (2).
In Livadheza-Shtuf area a high volume of dholes and underground workings are completed and it is evident that gold is associated with lenses of quartz and sulphides within carbonate altered basaltic host rocks (1).
Irregular zones within these lenses carry 2-12g/t Au with a maximum of 15g/t. These zones can be distinguished from the rest of the quartz in the lenses by assay only. There is no obvious change in sulphide content with increased gold.



Trench	Sampl	from	To	Au gr/t
Prova56	58	2	3	10.55
Prova56	59	3	4	8.94
Prova56	60	4	5	7.7
Prova56	61	5	6	5.37
Prova56	62	6	7	5.14

FIG 7- Shapes and size of gold veins of underground workings (adit-green, metasomatose zone-doted and gold ore lenses-red colour) and on the table left are shown the JAB surface sampling results.

It is more likely that high grade gold mineralisation can be found also outside quartz zone which is substantiated by some surface sampling with good gold grade (till 7 gr/ton). Some trenches samples assayed from JAB indicating that gold is present in bear rock where sulphides are missing or hardly seen on it.

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Morphology and spread of quartz-sulphides lenses is very sporadic and they have quit a wide range of thickness from 2 -3 to 20m or more (Fig.7). Some underground working has contoured in details some of the gold lenses and surrounding zones with hydrothermal metasomatose (chlorite, carbonate, zeolite, clay, etc).

It looks that perspective zone for gold occurrences is wide 300m by 200m and in vertical direction 200m. Exploration works completed so far have discovered disseminated quartz sulphide mineralization with elevated gold values at Livadheza-Shtuf. During previous mining, silica flux was needed for the Rubik copper smelters with any associated copper and gold seen as potential credits. The area of disseminated mineralization was mapped and sampled in detail and subjected to closely spaced drilling. Density of drilled out the main Livadheza-Shtuf mineralized zone was a 20m x 25m grid. Other similar quartz sulphide vein systems with minor patchy gold occur around Livadheza-Shtuf.

At Livadheza-Shtuf several lenses of quartz sulphide mineralization occur within a 50m wide mineralized zone of carbonate-sulphide altered basaltic rocks. Lenses are 10 to 20m thick and up to 60m long and wide. Typical mineralization contains approximately 0.3g/t Au, 3g/t Ag, 0.2% Zn, 0.5% Cu and 0.2% As (1). Sulphides are predominantly pyrite (and marcasite), chalcopyrite, sphalerite and arsenopyrite.

JAB sampling on the trenches is done continuous and each sample was 1 m long (Fig 8).

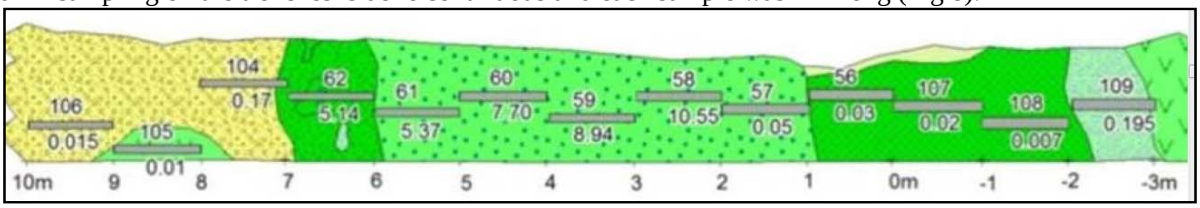


FIG 8- JAB Trench sampling

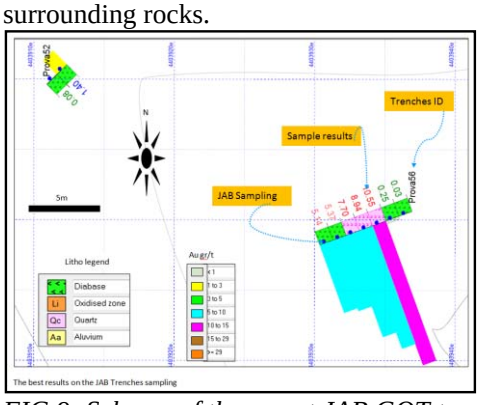
There are other outcrops identified, where mineralisation occurs on upper course of Livadhaza steam, mineralization is composed of phyrrotite-sphalerite and is located in serpentinite. Assay return Au values above 2g/t.

The other outcrops have mineralization of phyrrotite- sphalerite- chalcopyrite type and are located in serpentinites which are carbonatised and intensively sericitised. Limonitisation is clearly distinct. Assays return 0.25g/t Au, whereas in massive concentrations of ore body the gold value is up to 3 g/t.

Fregen area (far north) which has increased value of gold content and what is more interesting some of them are located in most western part of WOB and close to massive copper lenses. These small massive copper lenses are evident from Rubik in the bottom south to Qafe Kingjel and continues to Dush and Palaj very northen top part of area.

Some small area around EL 1124, which we need to review data and reinterpret are Q Kingjel, Fregen, Erza, Vele (Rrenja e Veles, Vela e Bardhe and Vele), Munaz, which are located west of EL 1124 and exhibit similar VMS style mineralization to Rubik. No large body of mineralization has yet been delineated.

Presence of these massive lenses a long wester border and close to the faults lets to think they are part of some ore body deeper, much bigger but as the result of the tectonic activity, part of it are pushed toward surface in the shape of lenses or round shapes (Fig 4) which have a clear cut "cold", contact with surrounding rocks.



Samp.	from	to	Thick, m	Au, gr/t	Weight, kg
102	2	3.3	1.3	16.5	6.66
58	2	3	1	10.55	4.08
59	3	4	1	8.94	6.68
60	4	5	1	7.7	6.16
61	5	6	1	5.37	4.24
62	6	7	1	5.14	5.46
53	1	2	1	1.4	3.52
46	1	2	1	1.28	6.24
45	0	1	1	0.95	4.16

FIG 9 -Schema of the resent JAB GOT trench results

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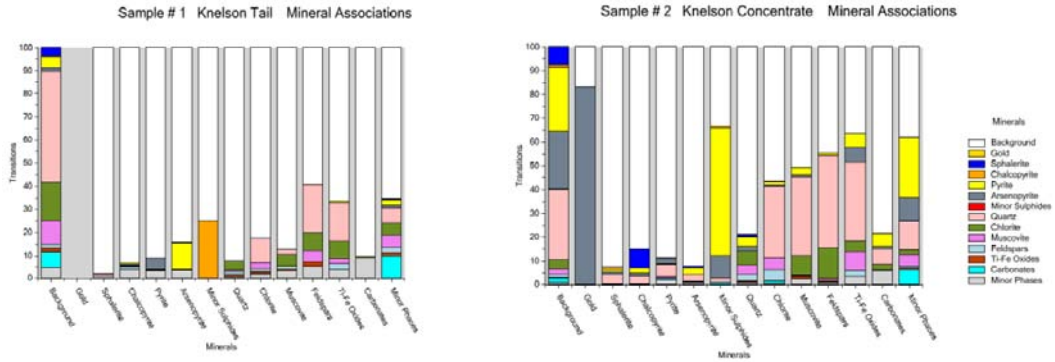
JAB trench samples which have the highest grade content are listed above

Trench	Thick, m	Au, gr/t
ZonaX4	1.3	16.5
Prova56	1	10.55
Prova56	1	8.94
Prova56	1	7.7
Prova56	1	5.37
Prova56	1	5.14
Prova52	1	1.4
Prova45	1	1.28



FIG 10 - Outcrop shape and micro tectonic and some of JAB GOT surface sampling

From mineralogical study of two samples(tail and concentrate) it is clear the relationship between different minerals (see diagrams below).



As a summary the characteristics of mineralisation on Livadheza-Shuf area are:

- ✓ *Main minerals are pyrite, arseno pyrite, sphalerite*
- ✓ *There two type gold: within sulphides (arsenopyrite and sphalerite) and free(fine inclusions 20-40 microns)*
- ✓ *It is a strong correlation Au- As*
- ✓ *The mineralization is located within basalts of the WOB ophiolites and is quartz sulphide type*
- ✓ *Mineralization zones are followed in strike 900 m, in dip direction 500 m, the thickness varies 10 – 120 m.*
- ✓ *Several lens-shaped ore bodies are delineated and have different sizes*
- ✓ *The gold content varies from 0.1 – 27g/t., average 3.4 gr/t*
- ✓ *Mineralisation is different from the other gold deposits known on the region.*
- ✓ *Main hydrothermal metasomatose is potential for mineralization(quartz, carbonate, pyrite, chlorite, epidote)*
- ✓ *Chlorites are common on the foot wall of ore bodies.*
- ✓ *Au Grade increases from west to east of EL 1124*

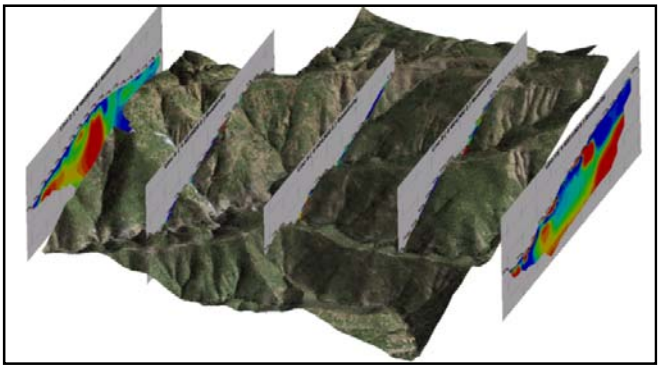
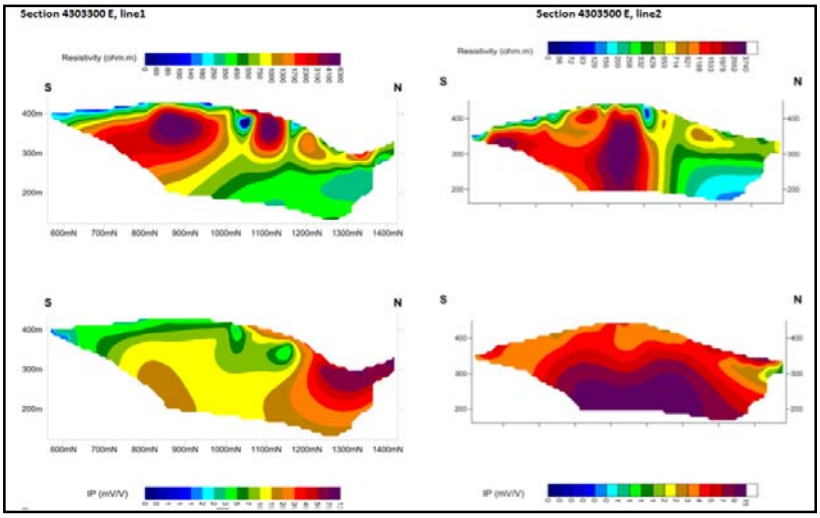


FIG 11- Geophysics section orientation on the Livadhez Stuf area

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4.Geophysics IP and magnetic survey

Geophysics: IP, resistivity and magnetometric survey is completed and results shown for a great development of mineralisation to ward depth and toward east.

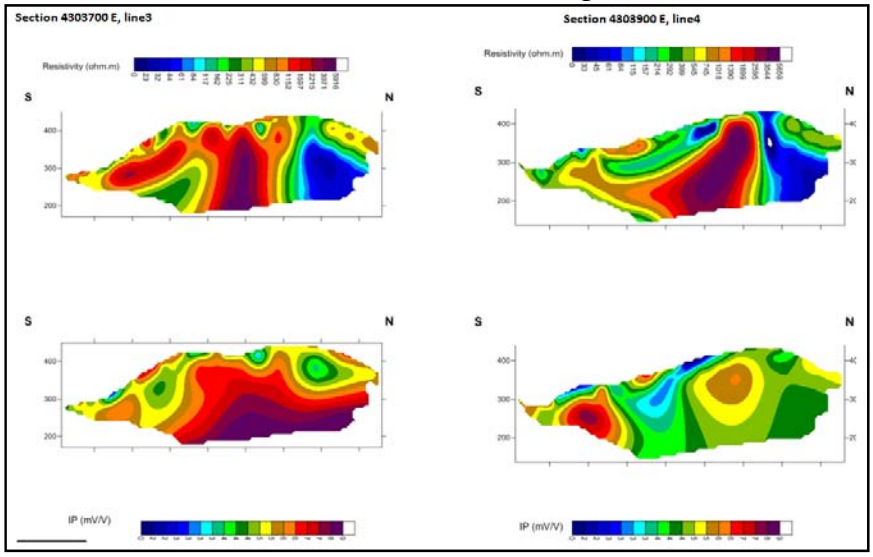


IP interpretation shows presence of ore body with distinguishing resistivity and IP as following on these demo sections, for more information regarding IP survey see the respective reports *(R.Kamberaj IP Old results compare, January 2012; and CTF Engineering Co, Ltd, internal report).*

The geophysics survey sections displayed, accentuate the presence on mineralisation toward depth.

This geophysical survey has indicted that the shearing occurs within greenstones located adjacent to major possible igneous intrusion like anomalies. The survey has identifies numerous resistivity and induced polarization chargeability highs for drill testing. Such anomalies may reflect areas of locally more abundant quartz and sulphides mineralization.

According to dipole positions of some structures and magnetized mineral concentration contents can cause abnormal magnetic value increasement and decreasement while measurement to get rid of these kinds of effects and daily differentiation effects total magnetic area values were convuluted. External high and/or low amplitudes were cleaned from data by convulution.

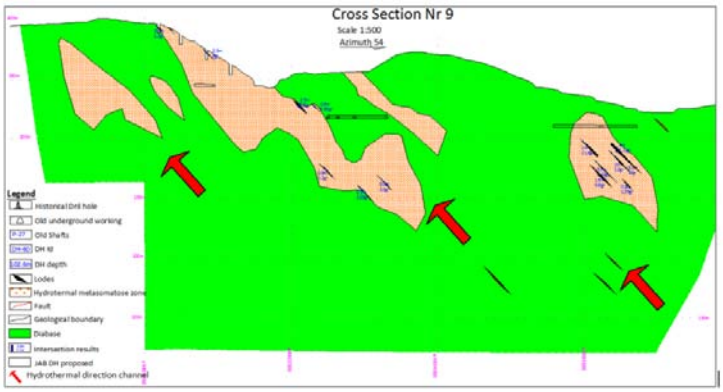


The total magnetic area anomaly and/or magnetic area that reduced to pole for both sector; SW – NE anomaly trend was observed in the first sector. Also high and low magnetic area boundaries or split anomaly zones could be characterized as possible fault zones. These low and high anomaly boundaries can be also explained as lithological contacts. As a different thought, areas that has low magnetic effect, can contains partially fractured and alterated and water-saturated material. Average and high magnetic area boundaries can be located at possible blocks structure, dikes and/or pyrrhotite, magnetite, rich in ilmenite zones. Based on surface map data magnetic effect differentiation in this sector can be explained as magnetized differentiation effects which were changed according to basalts structural positions, various fault zones and mineral groups that enter into rock

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The survey has also located very large intrusion like geophysical anomalies bodies with very high induced polarization chargeability responses. These targets have never been tested and they should be drilled with a high priory.

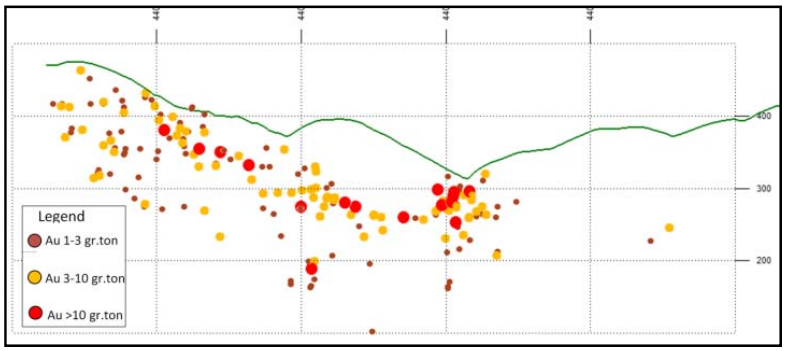
5.Resource modelling



Database has included a very big data from drilling and assay from surface and represents an unification of historical and resent data from JAB - GOT. Faults and litho geological units were taken from the drilling logs and mapping.

Database was organised as a relational database with four main tables (collar, survey, litho, and assay) and the main key field were drill hole number, sample number. Also the other data as sample interval, sample values and other additional characteristics of the sample such as sample weights (as determined in the field), and dry weight (measured in the lab) or core recovery in the case of diamond core drilling, diameter of core drilling, dry bulk density (SG) were incorporated in the data base.

Because our data base was built based on two types of data from historical and newly collected information it was difficult to include together other data as for example geotechnical logs or digital geophysics some were present on new data collected but were missing in the historical data.
Disadvantages of this data base were:
a- The incompleteness of the QA-QC data of historical information and lack of core and duplicates of old drilling on the Livadheza Shtuf gold project.
b- Some of info as litho unit were taken from old geological graphics.
From the experience of author other data auxiliary information such as: drilling company, rig type, drilling date, drill bit diameter, the name of the driller etc, is better to be saved on the separated tables of the same relational database. Key fields should be drill hole name and sample id which realises the link to other tables on the relational database.
As parameter for semi variogram and universal kriging was used *meter- gram* product. A west-east projection (Fig.13) and a plan display of all intersections exhibit a syncline 900 by 500m and 200m in depth direction. This volume is the target of drilling campaign to test for the economical gold mineralisation. Independent geologist reports and due diligence conclusions (JAB internal use report) are supporting this idea.



Preliminary resource model (Fig. 16) based on all data available to this moment and first priority drilling is shown on the central, east and west targets. From the resource model looks we have three areas (fig.14, 15) with high Au grade, first priority is the east target, second is central target. Interpretation of data collected so far suggest an increase of grade from west to east direction which we think is linked to the distance from the hydrothermal channel.

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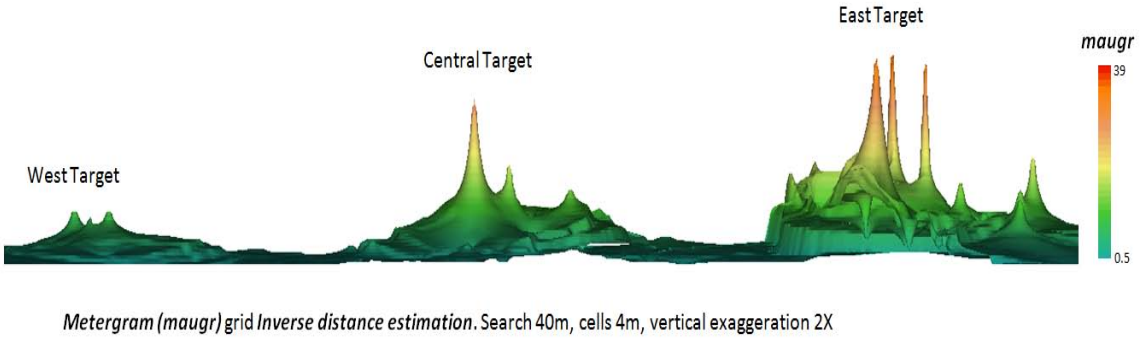


FIG 14 -Looking west east

6.Conclusions

Gold mineralisation of Livadheza Shtuf area has different characteristics compare to the other gold and copper gold deposits on the region therefore the exploration should not be driven by the analogy with known geological models.

Building, validation and maintaining database should be done with caution because it is composed from historical and recent data. Resource modelling should be dynamic as new data comes and should take in consideration all other interdisciplinary information. Gold mineralisation is expected in the quartz veins and also inside the metasomatoze hydrothermal zone.

Hydrothermal gold mineralization in the Livadheza Shtuf area is closely related to the volcanic sub volcanic activity and controlled by structure. The deposit might be formed by co action of lasting sub volcanic magmatic activity, hydrothermal circulation, fluid mixing and favored structural setting.

The controlling fault zone within the volcanic rocks, resulted from shear stress, and formed at the late stage of the crust thinning. Deep sources hot fluids associated with sub volcanic activity ascend along faults up to shallow depth, where fluid nixing between the deep hot fluid and the cool water as well as water rock reaction took place, The fluid mixing caused a rapid temperature change at the same time the pressure of the ascending fluid dropped down too. These factor changes cause the gold mineralisation deposition in favored structural setting.

Mineralisation is closely associated with intense hydrothermal alteration mainly controlled by faults with a typical alteration assemblage of quartz sericite chlorite calcite. These veins were formed at temperatures from 80^{o}C to 360^{o}C.

Many studies show that fluid mixing is the important factor that could cause the physical chemical condition change of the ore forming hydrothermal fluid system such as temperature Ph and Eh which we think on our case has caused gold precipitation.

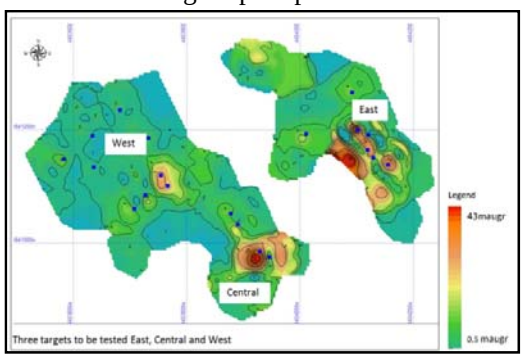


Fig 15. Meter gram model and the exploration drilling program

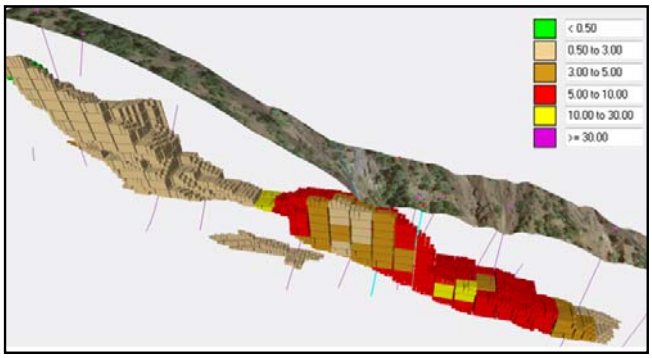


Fig 16.Cross section WE and block modeling of the results of drilling campaign of JAB GOT company

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7.REFERENCES

1. Paparisto, Dh, Ostrosi, B, Sokoli, M and Hashari, S, 1980. Raport mbi punimet e kerkim zbulimit dhe te studimeve te kryera ne vendburimin rrenjesor te Arit ne Gjazuj gjateviteve 1967-1978 (ne llogaritjen e rezervave me gjendjen 1 Janar 1979).*Tirane*

2. R.Kamberaj**,** The Comparison of IP, Resistivity, historical and GOT results,, January 2012, JAB GOT *Company internal report*

3. R.Kamberaj, N.Bardhoshi, 1984, Raport mbi punimet gjeologjike te kerkim-zbulimit ne vendburimin Munelle. *Fondi I Nder. Gjeol. Puke*

4. R.Kamberaj, *Field works, 1978-1983*

5. R.Kamberaj, Exploration License. Livadheze-Shtuf, EL 1124, *Ministry of Economy Trade and Energy, Tirana, Albania, 2008*

6. R.Kamberaj, Prospecting License, Palaj Karme, PL 995, *Ministry of Economy Trade and Energy, Tirana, Albania, 2007*

7. CTF Engineering Co, Ltd, Ip/Resistivity & Ground Magnetic Project, *Draft Report November 2011 – January 2012, JAB GOT company internal report.*

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DIGITAL MAPPING OF TIRANA THROUGH GEOMATICS METHODS

Arbi SHEHU[1]
[1]*ALUIZNI-Drejtoria Qendrore, Rr. Skënder Kosturi, Tirana, Albania, arbishehu@gmail.com*

ABSTRACT

Nowadays information technologies development has risen in every field of work, especially engineering. Thus processing of digital data in these areas is today a necessity for their further development. Cartography and digital processing methods mainly refer to geomatics knowledge. These methods include various disciplines such as photogrammetry, geodesy, GIS, remote sensing, etc.
This article presents the achievements and the latest technology use in digital mapping related mainly to Albania and Tirana area, accessed from ALUIZNI since 2007. The digital Mapping of Tirana represents an expanded engineering work according to geomatics methods. For this purpose were used aerial photo techniques, computer softwares for data processing (MicroStation, ArcGIS, AutoCAD, etc.), mapping professionals teams, etc. Consequently, the results are clear and very helpful, bringing a complete digital product multi-usefull in different fields as property registration, Territorial Planning, Surveying, Geoenvironmental Studies, Socio-Economic Analysis, etc.
The paper at hand analyzes a long and constructive process of further data processing in Albania. The desing of the topographic map in small and large scale, aerial photo creating, creation of databases for real estate, identifying the parts of the public areas, identifying urban areas, etc. through geomatics methods, open the way to further knowledge in the field of digital cartography. This knowledge brings the necessary development for engineers and they can be useful in many GIS projects that are being actualized in our country nowadays.

KEY WORDS: *Digital Mapping, Geomatics, GIS, Photogrammetry, Tirana.*

INTRODUCTION

Studies and applicable digital models are used today throughout the world as one of the main tools that guide and assist in various economic activities, socio-cultural and many other aspects related to the design of policies for the development of a country.
Digital models are used in real estate registration system, topographic maps and overall urban planning in cities and in rural areas. Their applications are required and are used to manage various activities in industry and agriculture, transport, geography, natural resources, in the design and use of marine maps, land surveying techniques and many other fields of study. Increasingly, collecting and analyzing digital data is being used in new areas. At the same time is required to ensure complete and accurate data in a low cost as well.
During economy transformation process in Albanian, the return of land ownership has enabled the creation of a registration system for land and real estate. The real estate registration system is essential for national economic growth and it has led to the increase of the investments made in updating and maintenance of its data, which have always been higher.
In the recent years, the growth of changes in the ownership of real estate at the public area in Albania, and their adaptation to ownership changes occurrence, demanded the creation of a national digital cartographic product with high engineering standards.
For this reason since 2007, the Albanian government has been contributed with specific funds for creating aerial images of Albania and the creation of digital mapping.
The methodology and techniques used are focused on the task of designing Tirana digital map in order to reflect modern technology techniques available for the application and to achieve the optimal cost-quality duty. Our attention is focused on other areas of use too by providing opportunities for other sectors to use this technique of digital technology and geomatics methods. The activity of various scientific disciplines

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especially the use of digital technologies has focused on techniques already showing an increase over time.

DIGITAL CARTOGRAPHY

The development of Albanian society and the increase of public areas, bring in the 21st century adaptation to international conditions in geomatics systems. This process was initiated by ALUIZNI (Agency for Legalization, Urbanization and Integration of Informal Areas / Constructions), this agency was primarily created for the identification of informal settlements, the administration of these zones and the creation of a national system of cartographic digital products of high engineering standards.

1. The Project

In terms of an existing situation rather outdated and incorrect, often with varying degrees of formats where missing information was obvious, it was requested an efficient solution for the objectives required by the government. The realization of this project needed a range of services which are carried out by the public administration. Among these services were:

- Determining the exact geographic position (UTM/WGS84 projection System)
- Geo Studies (Urban, Environment, Geology, etc.)
- GIS system creation in different administrative areas (Address System, Cadastral System, Registration Property System, Etc.)

From this point of view the main issues and objectives for ALUIZNI were:

- Aerial Images Production for all Albania territory
- Creating digital map (Topographic, Urban areas, Natural resources, etc.)
- Legalize informal object and areas.
- Etc.

2. Techniques and technologies used

The updated and georeferenced under international UTM projection system National digital map creation, went through several stages. The starting point of this process was to realize the aerial photos in digital format, made from the Croatian "GeoFoto" ompany. This company specializes in these processes, made the aerial photographs in three stages, which were completed respectively in March 2007, September 2007 and October 2007.

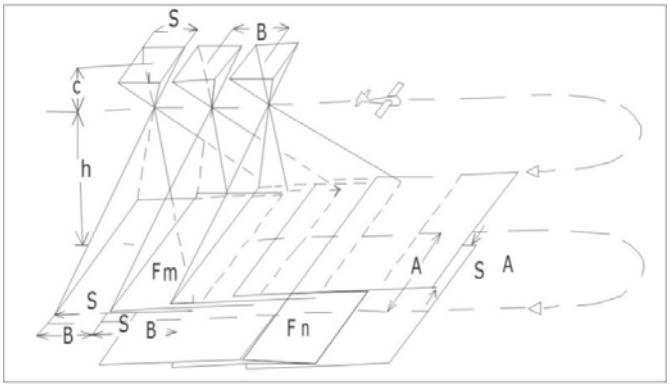


Fig. 1. Aerial Image Fly Process, by Geofoto.

Geofoto is the largest company in the Eastern Europe, and one of the largest companies in Europe. The main activities for the company are specialized studies, Air Photogrammetry, Digital Cadastral Surveys, Cadastral Database Production, Digital Topographic Mapping and creating and implementing Geoinformation Systems (GIS). This company was responsible for the planning and execution of photogrammetric campaign for producing aerial images.

3. Project Implementation

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The techniques which would represent the realization for creating digital maps is the photogrammetric method. This technique consists in creating aerial photographs for territorial areas, from a digital photographic device installed on board an aircraft. This process is performed at a low altitude and constant flight, to enable the affectivity and uniformity.

Photographs made by "GEOFOTO", were carried out according to a predetermined sequence based on the density of informality and priorities, being separated to LOTs:

- **LOT 1**: Photographing the LOT was carried out with a 8cm precision and had as its objectives the country's main cities like Tirana, Durrës, Vlora, etc.
- **LOT 2**: Photographing the LOT was carried out with an accuracy of 20cm and had as its objective the majority of the surface of the Republic of Albania, thus providing a further update for LOT 1 photos.
- **LOT 3**: Photographing the LOT was carried out with an accuracy of 30cm in rural and mountainous parts of the Republic of Albania.



Fig. 2. Aerial Image Map

METHODOLOGY

1. Digitizing Techniques

The development of the digital maps consists in processing and identification of the primary material, which was Orthophoto. This material previously produced in a high quality digital format was the basis of the project.

Once realized, the orthophoto was processed according to the predetermined standards and was made available for its digitalization in vector format. Spatial principles are based on the photo interpretation of the orthophotos, but with the feature that this process is done on computer and analog conditions.


Fig. 3. Digitizing Process with Stereo Glasses and topomouse

Photo interpretation refers to the identification of all objects on the surface of the land cover. These items may vary and are classified according to predetermined standards. The identification is carried out for the types of soils, hydrology parts, as well etc. A specific part of the digitizing process by ALUIZNI was to identify informal area passing through digitizing apart of the public territory areas, private parcels, rivers, lakes, etc..

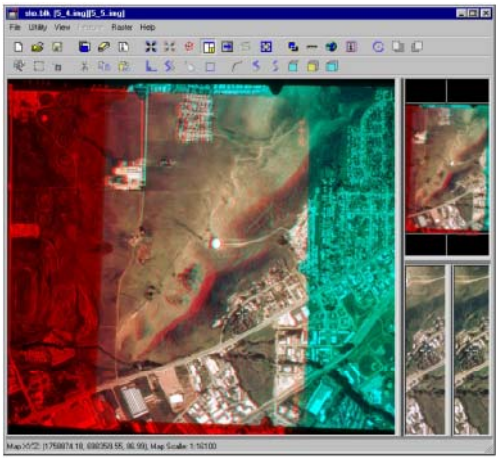
The identification and the later implementation of the vector maps, is performed in computer programs with high standards Workstation (whose parameters are very good). The programs for this process are numerous and all carry the same manner of digitalization. All of them are based on the principles of interpreting and converting it into an analog format.

Carrying of digitizing in all the kinds of programs is defined in such a way that areas identified uniquely struck by specific layer. The carried out digitizing will be of a higher quality if the quality of the orthophotos (their resolution) is high.

The delineation of buildings, roads, or land presses is performed in the format polyline, which is standard for any digitizing software. Also Layers were created, Topology, Identification of surfaces, etc. The digitalization of orthophotos meets all the requirements for a high-level mapping system and created the possibility of the use of materials derived from the digitalization in other areas.

2. Used Software

Using mapping software is the only way to create a digital material. Classification of these digital materials is based on the specifications of the software used. Sophisticated programs will provide high quality products.



The Project undertaken by ALUIZNI, focused on the use of several different softwares to its stage. These softwares include, ERDAS Image, Stereo Analyst, MicroStation, AutoCAD MAP 3D, ArcMAP, etc..

a. ERDAS Image allows the use of ESRI Shapefile formats and using geo databases. The use of this software is suitable for importing and exporting vector data and topology construction in a format compatible with ESRI. ERDAS program is divided into several modules of specified work.

b. Stereo Analyst is a Windows solution for the creation, interpretation and visualization of 3D images. Using Stereo Analyst will create an overlap versus GIS systems which ignore 2D models. The outcome will be the creation of a 3D stereo model in which we may have information processing under their real positioning. This overlap of data can be created during the process of their implementation.
Stereo Analyst is an alternative to 3D GIS data collection accurate and timely shots. If in the past we have spent a lot of time to gather information for the GIS or if the work was performed by a service office of photogrammetrical, now data collection can already be carried out and updating them quickly and easily.

c. PRO - MicroStation GeoGraphics, is a powerful program package, ,versatile to collect and process data with photogrammetric features in MicroStation GeoGraphics CAD space by Bentley Systems. The program is intended to generate an efficient and attractive presentation of information obtained from the images, in analog order, analytically and digital. This includes a wide range of functions for capturing, reporting, processing and cartographic increase two and three dimensional data.

d. Leica Photogrammetry Suite (LPS) is a summary of specific photogrammetric softwares mainly oriented to the creation and implementation of geospatial images. Within this program, there are several modules that enable the realization of the project and its requirements at all possible points. LPS consists precisely in the fact that this program allows you to refine the information being passed at all stages of its production. Depending on the flow of work is entirely possible to create and analyze all stages simultaneously.
The first phase of information processing in LPS, is the realization of photogrammetric images from air, adapting them to the desired coordinate systems. LPS allows both to be processed with a high-precision positioning, data acquisition, and automated measurement. Using LPS solution is well suited for mapping for engineering purposes.

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e. AutoCAD MAP-3D: provides a professional service in the implementation of digitizing the photo grammetrical data. Autodesk is a set of programs designed for pre-engineering purposes, which in their complexity reach higher goals.

f. ArcMAP-ESRI: is designed to create different actions in GIS field (Geographic Information System). This program will provide information link vector (derived from Autodesk Map 3D) and geo databases that will be created during the data collection.

ANALYTICAL RESULTS

1. Orthophoto

In the absence of significant cartographic information, orthophoto is the input to the generation of vector map. This is of great importance after mapping information returned in vector form and will be processed and returned in the form of typological accurate and will enable connection through different databases.
This mapping information produced by photogrammetric methods represents technical perspective, the transformation of aerial photographs taken from the plane, according to determine scientific methodology. Aerial photographs after undergoing a transformation process of slope in horizontal plan and the introduction of correction Projection transformation central to the orthogonal and Transformation for relief, these files transformed can easily be distributed along the covered area.
This advantage gives us the possibility to perform a correct digitalization, quickly and at low cost. Also, the accuracy of the information that we generate from it meets all technical parameters for topographic mapping scale required (1:2000).



Fig. 4. Digitized Ortophoto, Tirana area.

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The first part of Orthophoto format (.jpg / .TIF) consists of the image produced by aerial photography. In case on orthophoto work required geographic coordinates which are specified on the basis of a geo referencing system. It is these coordinates are located in file-t associated File-images; these are respectively formats (.TIFW / .JPGW)

The content of these formats consist of coordinates X, Y, Z which are processed according to the UTM projection, which is currently the most widely used worldwide. As part of the material Orthophoto file is automatically checked by the program in which we introduce Image.

2. Digital Map

The product is a derivative of authentic digital works carried on Orthophoto. Digitizing of all facilities, territorial parts, fields, forests, etc., found on the land cover consists in the fact the delineation and identification of them.

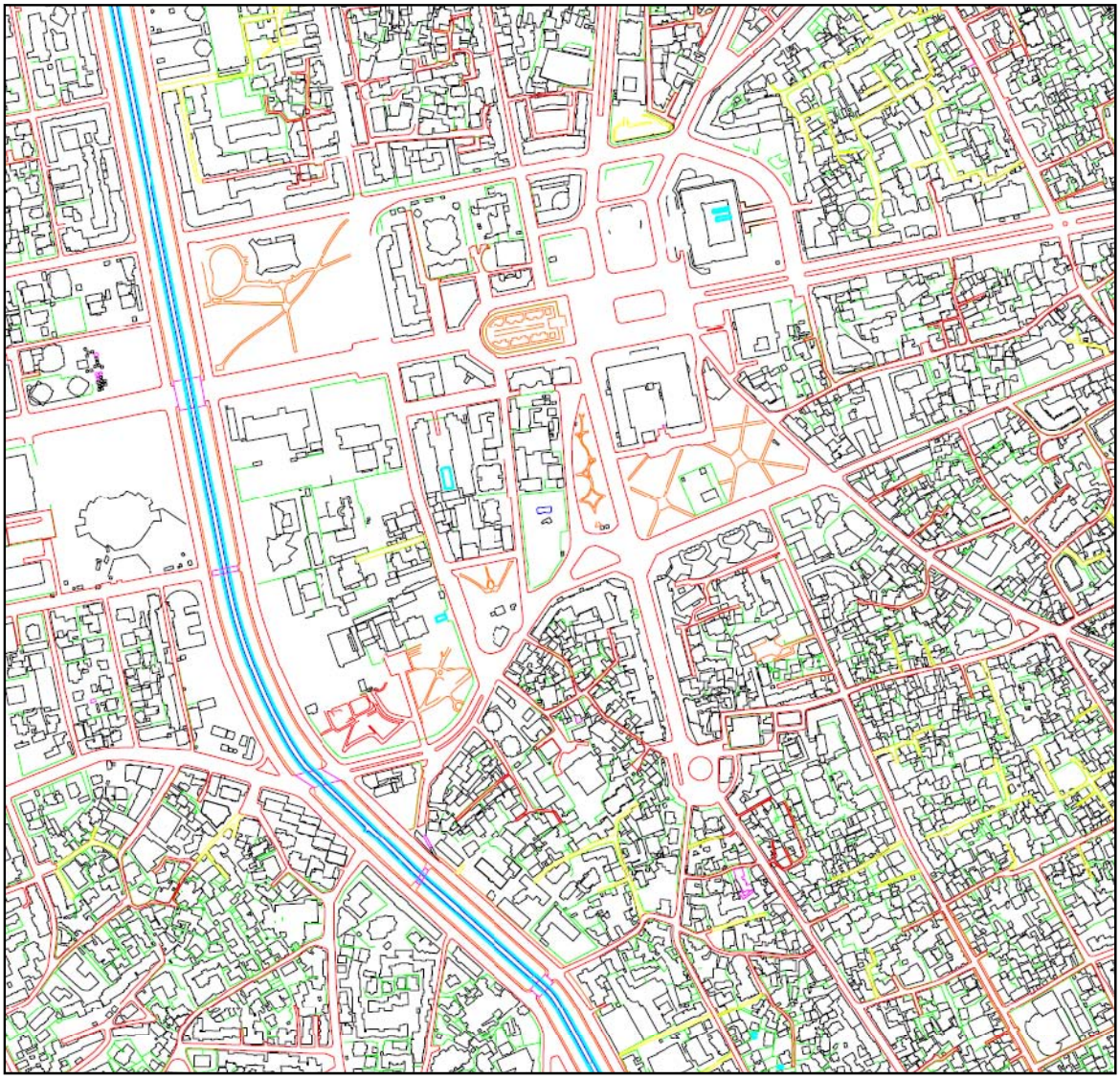


Fig. 5. Digitized Map of Tirana

Orthophoto digitalization is based on some specifications which are determined by the purpose of digitizing (Geological, Topographic, Military, Engineering, Urban, etc.), which are defined layers and accuracy required for digitalization. Digitizing at the core of which have a process of creating successive points depending on observed objects. From this point of view each area observed on the orthophoto will

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digitized in such a way as to have closed polygons and therefore an accurate topology. Digitizing than in polygons performed with polyline, which enables the creation of axes or territorial parts discontinued. Also another part of the digital product is the naming of buildings, roads, etc..

As a result of conducting the entire process of digitalization has achieved only conclusion which will unify digital aerial images with graphical interpretation, which would further be classified on the basis of predetermined layer geo referenced an international UTM projection system and ellipsoid WGS84.

CONCLUSIONS

- To create the map of Tirana we used techniques and technologies with the highest stage of geomatics methods.
- The techniques and the technologies used by this process give the possibility for engineers to apply them in other projects, such as mine, surveying, urban studies, etc.
- Resolution of images based on the requirements established, implemented the solution without problems as identifying the property as well as that of urban planning.
- The vector product implemented for Tirana, constitutes the digital model for the situation and the height as well.
- The final product can be disrupted for completion by increasing its use areas
- Keeping in mind the accuracy of 8 cm it is possible to realize urban planning and projects which do not affect the authenticity of the application avoiding overlaps.

ACKNOWLEDGEMENT

I would like to express my gratitude to all those who gave me the possibility to complete this article. I want to thank the Agency for Legalization, Urbanization and Integration of Informal Areas / Constructions – ALUIZNI, and my colleagues, Mr. Kristaq Qirko, Mr. Dritan Prifti, Mr. Klaudio Çollaku.

REFERENCES

ALUIZNI, Tirana, 2012, *Maps and Orthophoto*.

Leica Geosystems GIS & Mapping Division , 2008, *Erdas Imagine System Specifications*, www.erdas.com

Leica Geosystems GIS & Mapping Division, 2008, *Erdas Stereo Analyst*, www.erdas.com.

Leica Geosystems Geospatial Imaging, LLC, 2008, *Imagine Essentials Description*, www.erdas.com.

Leica Geosystems Geospatial Imaging, LLC, 2008, *Imagine Professional Description*, www.erdas.com.

Leica Geosystems Geospatial Imaging, LLC, 2008, *Imagine Advantage Description*, www.erdas.com.

Leica Geosystems Geospatial Imaging, LLC, 2008, *Leica Photogrammetry Suite Description*, www.leica-geosystems.com.

Leica Geosystems Geospatial Imaging, LLC, 2008, *Leica Photogrammetry Suite Specifications*, www.leica-geosystems.com.

Leica Geosystems Geospatial Imaging, LLC, 2008, *Leica Photogrammetry Suite System Specifications*, www.leica-geosystems.com.

Leica Geosystems Geospatial Imaging, LLC, 2008, Pro600 Product Description, www.leica-geosystems.com.

Sherko. R., Tiranë, Korrik ,2012, *Raport mbi Dixhitalizimin e Sistemit te Kadastral*.

Sherko. R., at al., Tiranë, Shtator – 2005, *Studimi i Sistemit të Regjistrimit të Pasurive të Paluajtshme (SRPP)*.

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ESTIMATING 3D BLOCK SIZE DISTRIBUTION OF BLOCK IN MATRIX ROCKS - DOBËRÇAN

Megi RUSI[1], Përparim HOXHA[2]

[1]*LIM-EM Construction l.t.d, Tirana, Albania, megi.rusi@yahoo.com*
[2]*Department of Applied Geology, Geoinformatics and Environment, Faculty of Geology and Mining, Politechnic University of Tirana, Albania, p_hoxha@yahoo.com*

ABSTRACT

Block-in-matrix rocks (BiM rocks) are mixtures of hard blocks embedded in weaker and finer matrix that are very difficult to characterize. Engineering geologists and the geotechnical engineers are frequently challenged by the characterization, design and construction problems associated with these heterogeneous geological mixtures.
The Moglicë- Grabovë headrace tunnel in the Devoll Hydropower Project will go throw these type of Rock. Evaluating Block Size Distribution in the BiM rock zone of this project area is only the firts step in characterizing all the geological and geotechnical parameters of the rock mass wich will influence a decision that has major economic consequences.
1D Borings and 2D outcrop and maps of melanges and BiM rocks produce distributions that differ considerably from the 3D block size distributions, but there is promise that rules may yet be devised to estimate reliable block size distributions of melanges from chord length and surface distributions.
Estimation of 3D particle size distributions from measurements in 1D and 2D are considered by stereology, a discipline blended from geometrical statistics, mathematics, microscopy, image analysis and empirical research.
The papper at hand is an attempt to show why there is currently little reliable procedures for evaluating spatial distribution of block size, which are these methods and how can they be applied in the engineering practice.

KEY WORDS *Block in Matrix, Stereology, Block Size Distribution.*

INTRODUCTION

For the headrace Moglice-Graboves (Devoll Hydropower Project) two different techniques of tunnelling are planned:

- DS TBM for the Flysch series starting in Moglicë and
- Drill & Blast for the Ophiolite section, starting in Grabovës

A major question concerning the tunnelling the Moglicë headrace seems to find the point where DS-TBM excavation from the Moglicë side should stop to "wait" for the Drill&Blast excavation from the Shemsit access tunnel side. We assume that the so called "block in matrix" rockmass is very unfavourable, respectively disqualifying for TBM excavation. The hard/brittle blocks of residual ophiolite rocks in the serpentinized matix (in other sections limestone, probably sandstone blocks in crushed siltstone matrix) are unpredictable concerning dimensions and spatial occurrence. Principially the Ophiolitic breccia is such a "block in matrix" rock-mass, but also the mélanges with limestone and the reworked hard components of Flysch series (sandstone) are. Hence Block in Matrix" is a term that has nothing to do with the rocktypes involved, but describes a behaviour when excavated.
The blocks are varying in dimensions from boulders to houses and have the rock properties close to sound ophiolitic rocks, that means, they represent "hard rock" with high abrasion. The Matrix is finegrained primary rock-mass that has been deformed, crushed, milled, recristallized, altered etc. and fills all crotches between the blocks. The properties are sometimes close to "weak rock"/loose rock, but sometimes (if recristallized) quite close to the primary rock-mass.
When the large blocks are encountered during TBM tunnel excacvation in the floor or the lower abutment of the tunnel profile it may be handled as long as the difference in rock properties are not too differential

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and cause a tilting or canting of the TBM. If a huge block is cut in the upper abutment or roof of the tunnel things may turn worse, because it might slide out of the rock-mass compound and put its whole load on the cutter head blocking it.
For these reason the BiM rocks have been mapped in detail with special on the size and distribution of the blocks.

GENERAL DATA

Grabova Hydropower

The Grabovë Hydroelectric Project will utilize a head of 300 m along an about 22 km long stretch of Devoll River between 650 m a.s.l. and 350 m a.s.l.. The intake is situated upstream the 140 m high rock fill dam planned at Moglicë. The powerhouse is located in an underground cavern on the east bank of Devoll River and has two Francis units with total capacity of 165 MW. Transmission voltage is 220 kV and estimated average annual energy production is 452 GWh . The tailrace outlet is at the upper end of the reservoir created by a 50 m high dam planned at Kokël. Approximately 11.7 km of tunnels with a diameter of 5.4m will be excavated in different rock masses and 700m of which will go throw BiM rocks and mélanges.

Geology and Tectonics

Grabovë hydropower project is part of two major tectonic zones. The eastern most part lies within the Mirdita zone which consists of aloctone Jurassic Ophiolithic massifs of Vallamara, Voskopoja and Devoll. The last one is placed isolated in the west and it is separated from the other ophiolithic massifs throw a corridor which belongs to the Krasta tectonic zone.

The Grabove-Moglice tunnel system will be excavated throw the Devoll ophiolithic massif of Mirdita zone as well as throw the flysch series of sandstones, clays, siltstones, conglomerates and limestone rocks of ages Crete-Eocene which belong to the Krasta zone. The lithological unit that will be studied in this paper represents the transitional area between the flysch series and ophiolitic body which consists of reprocessed material originating from the ophiolits as well as the flysch. The part of the Mélange which covers the ophiolitic complex is also part of Mirdita tectonic zone.

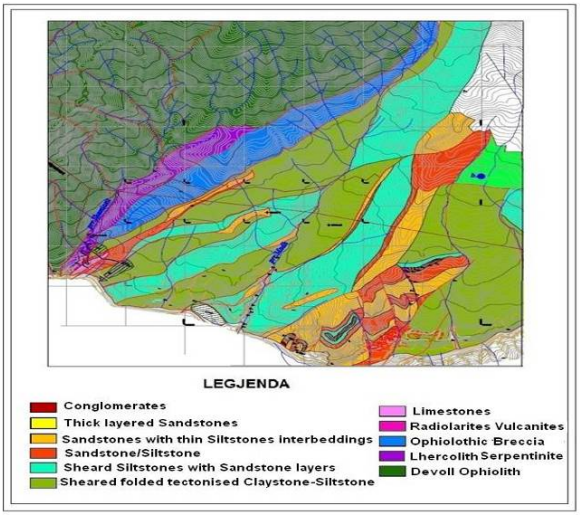


Fig. 1. Detailed Geological Map of the Mirdita melangé zone

We can distinguish four rock types within the area of the Mirdita heterogeneous melange. According to the principle used in this paper regarding their mechanical behavior during excavation, all these rocks nevertheless the type, strength, the cementation degree etc. belong to the Block in Matrix rock type. But

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according to a genetic and lithological characterization, the encountered rock types in this area are more than one. After the complete of the detailed mapping campaign in 2011 it was concluded that the rock types are lercolites / serpentinites, ophiolitic tectonic breccias, vulcanites, radiolarites and limestones. One of the results of this geological mapping phase was the preparation of the detailed longitudinal profiles and cross sections over the tunnel axis.

The main rock lithologies that are found along the tunnel axes in the melange zone include sheared serpentinites, ophiolithic breccias, flysch formations of folded limestones, radiolarites, vulcanites etc.

The tunnel sections that will be excavatet in the BiM rocks

The alignment of the headrace tunnel was divided in sections referring to the present lithology and rock conditions. In total 28 tunnel-sections were defined along the overall length of 11.775 meters. Five of these sections which consist of approximately 700m of tunnel alignment run throw the mélange zone.

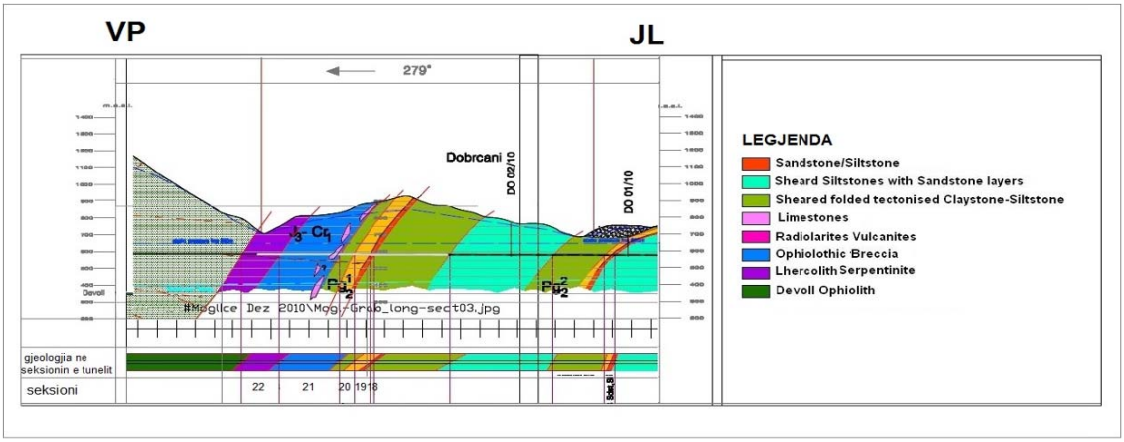


Fig.2 Geological longitudinal section along tunnel axes in the Melange zone

Section 18 and 19 – Station 7.450 m to 7.550 m

From station 7450 m to approx. station 7550 m the tunnel alignment crosses section 18 and 19 and is expected to run through medium to thick bedded interbeddings of sandstone and siltstone layers with intercalations of silty shale layers over a length of approx. 100 m. The strata dips moderately steep between 45 and 65° to the NW to NNW. The borders of this section are not known very well.

Section 20 – Station 7.550 m to 7.630 m

From station 7.550 m to approx. station 7.630 m the tunnel alignment is expected to run through thin to medium bedded interbeddings of clayey shale and siltstone layers with intercalations of sandstone layers and randomly occurring lenticular lenses of conglomerates over a length of approx. 80 m. The strata dips moderately steep between 45 and 65° to NW to NNW.

Seksioni 21– Station 7.630m to 7.950m

From station 7.630 m to approx. station 7.950 m the tunnel alignment is expected to run through the rim related ophiolitic fault conglobreccias of the Devoll ophiolite over a length of approx. 320 m. This rock can be named a real tectonic mélange. The strata dips moderately steep between 35 and 50° to the NNW.

Sectioni 22– Station 7.950m to 8.150m

From station 7.950 m until ca. station 8.150 n the tunnel alignment is expected to run through intensely tectonised and highly weathered lherzolites that are already part of the Devoll ophiolith massif along a distance of approx. 200 m.

THE METHOD

Data Collection

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The transition zone affected by the ophiolithic thrusting is the project area to which a special atentian has been given during all the stages. Ophiolithic breccias and different melange zones, BIM rocks, together with intensively folded flysch formations and complex tectonic history were the object of the detailed mapping for this study. More than 100 outcrops have been documented in this area which is 700 m along the tunnel axes. The outcrops have been randomly selected throw scanlines. These outcrops have been photographed with high resolution cameras, and the pictures have been reworked afterwards.

Stereology Considerations

The stimation of 3D particle size distributions from the 2D photographs are considered by **stereology**, a discipline blended from geometrical statistics, mathematics, microscopy, image analysis and empirical research. Stereology was originally defined as "the spatial interpretation of sections". It is an interdisciplinary field that is largely concerned with the three-dimensional interpretation of planar sections of materials or tissues. It provides practical techniques for extracting quantitative information about a three-dimensional material from measurements made on two-dimensional planar sections of the material . Stereology is a method that utilizes random, systematic sampling to provide unbiased and quantitative data. It is a developing science with many important innovations being developed mainly in Europe. New innovations such as the proportionator continue to make important improvements in the efficiency of stereological procedures.
In addition to two-dimensional plane sections, stereology also applies to three-dimensional slabs (e.g. 3D microscope images), one-dimensional probes (e.g. needle biopsy), projected images, and other kinds of 'sampling'. It is especially useful when the sample has a lower spatial dimension than the original material. Hence, stereology is often defined as the science of estimating higher dimensional information from lower dimensional samples.
Stereology is based on fundamental principles of geometry (e.g. Cavalieri's principle) and statistics (mainly survey sampling inference). *It is a completely different approach from computed tomography*.
The *maximum observed dimension* (dmod) characterizes block sizes measured from 2D maps, photographs and outcrops . In 1D drilling exploration, the chord length of intersection between the drill core and the block characterizes the size of blocks. Chords and dmod will generally be shorter than the maximum dimensions of blocks. Hence,1D chord length distributions underestimate the
actual 3D block size distributions.
CSDCorrections 1.39 is the program used for converting two dimensional intersection data gathered from photograps, thin sections, outcrops, etc. to true three dimensional crystal size distributions (CSD). Corrections are made for the intersection probability effect and partial corrections for the cut section effect. The approximate particle shape and rock fabric must be known to make these corrections.

Guide to Digitalisation

Before using the photograph for CSD it needs to be properly digitalised with image treatment programs and graphic programs (Adobe Photoshop, Adobe Illustrator, ImageJ ect). Every block has to be outlined and layered separately. After outlining all the blocks, and turning off the picture layer it is needed to export the black and white image as an uncompressed tif. file to the ImageJ .This program makes possible the scale, measurement, particle analyses.

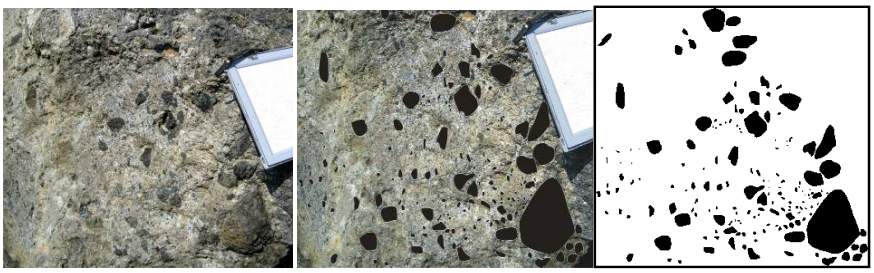


Fig.3 Digitalising method

CSD Correction Utilization

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CSD Corrections 1.39 is a program for converting two dimensional intersection data gathered from thin sections, outcrops, photographs etc. to true three dimensional crystal size distributions (CSD).The program constructs a solid of the dimensions indicated by the *Short*, *Intermediate* and *Long* dimensions. The orientation of the solid is constrained by the nature of the fabric (massive or foliated or lineated), the quality of the foliation (weak to strong) and the orientation of the desired section (parallel or normal to the fabric). This is sectioned by a plane placed a random distance from the centre of the solid. The outline of the intersection of the solid with the plane is determined and the length and width calculated. The distribution of these lengths and widths is used to correct the two dimensional for the cut section effect. The most likely intersection length (or width) is used to correct for tailing to smaller intersections. There is no tailing correction for intersections larger than the most likely intersection. This is rarely a problem if wide bins are used for the frequency distribution. After these tailing corrections have been made then corrections for the intersection probability effect are applied.

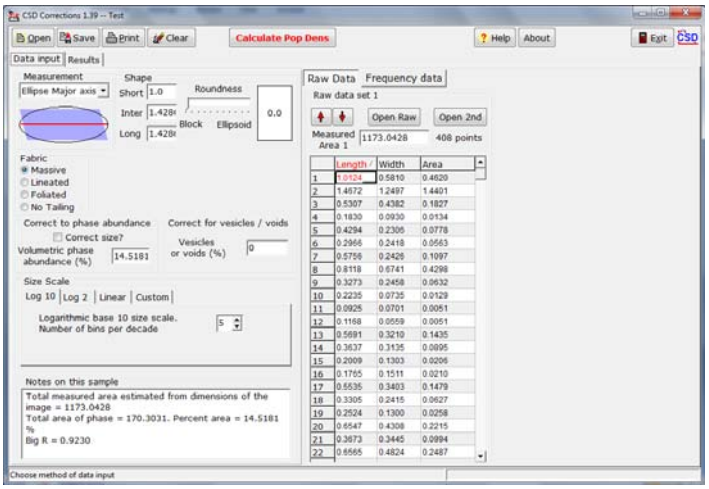


Fig.4 CSD Correction program preview

Data entry

Data can be entered as a list of *Lengths*, *Widths* and/or *Areas*. They can be typed directly into the grid or loaded from a simple file of data, with one measurement on each line. They can also be pasted from the clipboard if the cell has a dotted line around it (push the up and down arrows to get this). A maximum of ten thousand points can be measured. Rows can be deleted (with Del) or inserted (with Ins) if the cell has a dotted line around it. Data can be transferred directly from the ImageJ image processing program. It is possible to load two separate data sets. These will be summed. This may arise if data is measured at two different scales on the same rock. Data can also be loaded as a series of bins (size intervals) and number of measurements in each bin. The upper limit of the bin is put in the left column, with the number opposite in the right column. The last line must be the lower limit of smallest bin size and the number zero in the adjacent column. Bin sizes must decrease downwards. Rows, and hence bins, can be deleted (with Del) or inserted (with Ins) if the cell has a dotted line around it.

The scale

Log 10 based scales are calculated on the basis of a fixed number of intervals per decade. Five logarithmic bins per decade is the recommended maximum. In this case each bin is 1.6 times the next smallest bin (1, 1.6, 2.5, 4.0, 6.3, 10.0 mm …).**Log 2 based scales** are calculated on the basis of the phi scale -- 0, 1, 2, 4 mm etc. **Linear scales** have the same size interval. **Custom scales** can have any values. But they must be in order. They can be modified from other scales. The scales are for the original intersection sizes. The intervals are corrected when the conversion to three dimensions is done. This is because the most likely length intersection is equal to the intermediate dimension of a block, etc.

Corrections

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It is possible to correct the CSD so that the volume calculated from the CSD, V_{CSD}, matches the measured phase volume, $V_{M.}$ This process is closely resembles normalizing major element analyses to 100%, and similarly must be used with caution. We assume that error in V_{CSD} arises from a systematic error in the relationship between the crystal size used in the CSD and its dimensions. For instance the crystals may be partly convex, hence the simple ellipsoid or parallelepiped models cannot be applied. These errors can be corrected if the true size of each crystal is multiplied by a correction factor. This correction factor is the cube root of the ratio of V_{CSD} / V_M.

RESULTS AND THEIR INTERPRETATION

Rezalts are shown in tabels and diagrams. The table coloms show the following data. Column 1: Corrected Size of the middle of the interval. The size is long dimension of parallelepipeds, the major axis of ellipsoids, or the diameter of spheres. Errors are calculated using only the counting statistics. No error has been accorded to the tailing corrections, because it is not clear how to do this. Hence the error bars should be regarded as minimum values. Column 2: The natural logarithm of the population density. Column 3, 4: The error limits of the population density. They are calculated from the square root of the number of intersections in each bin. This is propagated to the other bins. The error calculations do not take into account any error in the correction factors, and hence should be viewed as minimum errors. Column 5: Numbers of crystals per unit volume in the interval. This can be used to make other kinds of CSD diagram. Column 6: Per cent volume of crystals in each interval. The error in the larger size intervals can be significant.

The diagrams in show the crystal size distributions throw the a) CSD in semi logarithmic diagram, b) Cumulative Distribution Function diagram, c) Fractal Dimension diagram and d) Population Density diagram.

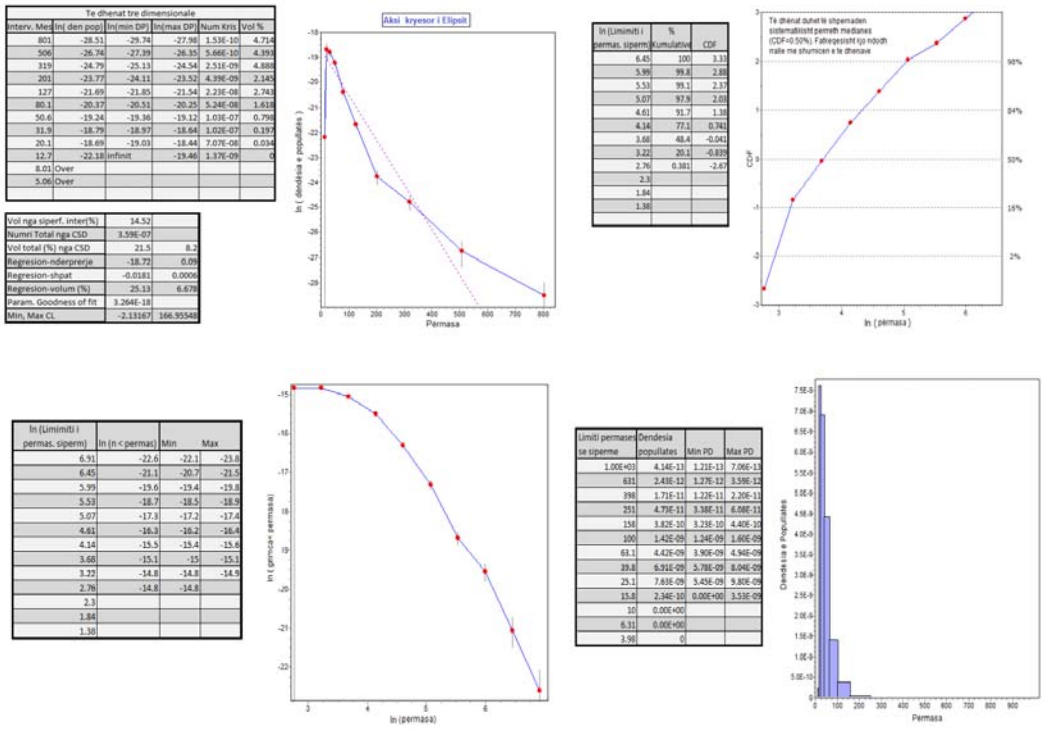


Fig.4 Graphical display of the Cristal Size Distribution results

The semi-log graph or semi-log plot shows the visualizing data that are changing with an exponential relationship. If CSD is linear in this diagram it matches with the regression line and slope angle can be defined. It is obvious that the size distribution in this case at some point do not align very well with the

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law and the log shape makes the match impossible. Possible errors correspond to the statistical counting. The refraction of CSD-curve comes from mixed population (blocks of various proportions), but the proportions of the blocks are reasonable. It is noted that the overall low is that by increasing the size of the blocks their density decreases. But there is also a decrease in population density for blocks of smaller size, which is actually normal for natural samples. Such a reversal in small sizes in natural rocks may come as a result of many reasons, one of which may be inadequate spatial resolution.

Log-normal distribution is a continuous probability distribution of a random variable whose logarithm is normally distributed. Cumulative data are transferred by using the normal standard cumulative distribution function inverse. In this diagram the log normal distribution appears as a straight line. Mixtures of log normal distributions are identified as two or more straight segments of the graphic. In our case, we can see four such distributions.

In the third plot, the steepness of the line can be used to determine the Fractal dimension distribution. In the cases where the line has more than one visible slopes, the distribution can be described as multi Fractal. In our chart although the curve does not match 100% the straight line, it can be determined only one Fractal dimension with a value of approximately 1.45.

The histogram is a graphical representation showing a visual impression of the distribution of data. It is an estimate of the probability distribution of a continuous variable. It proves the first statement that the overall low is that by increasing the size of the blocks their density decreases.

CONCLUSIONS

- Mélanges and BiM rocks are very coman in nature and a lot of engineering projects are obligated to be constructed in these chaotic rocks. Excavating tunnels in BiM rocks can result highly problematic for a number of different reasons, one of which is the fact that in these types of rocks the blocks vary in size.
- Knowledge of the size distribution of blocks is a key parameter that should be evaluated in these studies. Between the maximum and minimum block size, in the scale range, it is important that the blocks are characterized by their respective volumes. The methods presentet in this paper intend to help geologists and engineers in the characterization of melange blocks.
- Melanges, ophiolithic breccias etc are part of a family of geological materials defined as *bimrocks* (block in-matrix rocks) a non-genetic term that can be used for many rocks, and defined as:
  a mixture of rocks, composed of geotechnically significant *blocks, within a bonded matrix o.ffiner texture.*
- The geotechnically significant blocks in a bimrock satisfy the following criteria:
  a) There is a significant mechanical contrast between the blocks and the matrix, measured as a ratio between friction angles, stiffness, or other properties.
  b) There is a significant ratio between the limiting sizes of the blocks and the *characteristic engineering dimension.*
  c) The volumetric proportion of the blocks is between 25 percent and 75 percent; above 75 percent the rock mass is *blocky rock.*
- The block size distributions of some melanges at a particular scale can be plotted as *log-histograms,* which are block size frequency histograms plotted against logarithmic axes. Melange block size distributions invariably plotted as hyperbolas on log-histograms. The right limb, or *descent limb,* was generally linear with a slope (termed the fractal dimension, D), of between 1.0 and 1.6.
- *Scanlines,* or measurement traverses, were used to estimate block volumetric proportions and the block size distribution. And it appears to be the best technique for randomly choosing the outcrops
- It should be emphasized that the block size distribution is not the only parameter for the characterization of these rock types and that its should always be associated to other parameters.

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- Stereology is a powerful tool in this field of study when it is used properly. It is important to know the circumstances under which stereology will perform analysis, and its limits. Analysis requires substantial statistical knowledge of individual blocks sections.

REFERENCES

Alastair Robertson, Minella Shallo, Mesozoic-Tertiary tectonic evolution of Albania in its regional Eastern Meditettanean contex. 1999

Carrie R. Brugger, Julia E. Hammer, Crystal size distribution analysis of plagioclase in experimentally decompressed hydrous rhyodacite magma. 2010

Edmund W. Medley, Estimating Block Size Distributions of Melanges and Similar Block- in-Matrix Rocks (Bimrocks)

Edmund William Medley, Glossary of Geology, 3 rd Edition; American Geological Institute, The engineering characterization of Melanges and similar Block in Matrix Rocks, PhD Dissertation 1994.

Laznicka, P, Breccias and Coarse Fragmentites: Petrology, Environments, Associations, Ores, 25 of Developments in Economic Geology: New York,1988

Lindquist, Eric Stewart The strength and deformation properties of Melange, PhD Dissertation, 1994

Lindquist, E. S., and Goodman, R.E, The Strength and Deformation Properties of a Physical Model Melange, in Proceedings of First North American Rock Mechanics Symposium, Austin, Texas (June 13,1994): Rotterdam, Netherlands, AT.Balkema; 1994

Marinos P., Hoek E. Estimating the geothechnical properties of the heterogeneous rock masses such as flysch. 2001

Marsh, B. D., Crystal size distribution (CSD) in rocks and the kinetics and dynamics of crystallization I. Theory. Contributions to Mineralogy and Petrology, 1988b

Michael D. Higgins, Closure in crystal size distributions (CSD), verifications of CSD calculations, and the significance of CSD fans. 2002

Michael D. Higgins. Quantitative textural measurements in igneous and metamorphic petrology'. Cambridge University Press – August 2006,

Milushi I., Meshi A., Kaza Gj, Triassic-Jurassic Volcani-Sedimentary Formations in Albania and its relation with the middle Jurassuc Mirdita Ophiolite,.

Perfect, E , Fractal models for the fragmentation of rocks and soils: a review, 1997.

Raymond, L.A. Classification of Melanges. In Melanges: Their nature, origin and significance;1984.

Rob Jagnow, Julie Dorsey, Holly Rushmeier, Stereological Techniques for solid textures, 2004

Russ, J.C. and R.T. Dehoff, Practical Stereology. Second Edition. New York. 2000

Sahagian, D.L. and A.A. Proussevitch 3D particle size distributions from 2D observations: stereology for natural applications. J. Volcanology and Geothermal Research.. 1998.

Selam Meco, S. Aliaj, Gjeologjia e Shqipërisë, kontributet në gjeologjinë rajonale te Tokës, Vëllimi 28, vëllezërit Borntraeger, Berlin 2000

SJac, SJ, MR, NB Devoll_20110408_Moglice-Headrace-Geol-Longsection-A0_10000. Geolological Report. HPP Moglica

SJac, MR, NB, SJ Harnessing of Hydropower Potential of Devoll River. Geological Report. Part III-HPP Moglica. Chapter 7. Waterway Moglicë-Grabovë. 7.4 Headrace tunnel Dobercan-Shemsit: Mirdita Melange.

Shallo M., Ophiolithic melange and flyschoidal sediments of the Tithonian-Lower Cretaceous in Albania. Terra Nova 2. 1990

Tiago Ferreira, Wayne Rasband, ImageJ User Guide, ImageJ/Fiju1.46, 2012

Tremblay A., Meshi A., Bedard J. H, Oceanic core complex and ancient oceanic lithosphere: Insights from Iapetan and Tethyan ophiolithes (Canada and Albania.2009)

Turcotte, D. L.,Fractals and Chaos in Geology and Geophysics., 1992

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GIS - BASED EVALUATION OF GROUNDWATER VULNERABILITY, (ERZENI BASIN, ALBANIA)

Flora PROGNI[1], Arjan BEQIRAJ[1], Majlinda CENAMERI[1]

[1]Faculty of Geology and Mining, Tirana, Albania,
e-mail: progniflora@yahoo.com ae_beqiraj@yahoo.com m_cenameri@yahoo.com.

ABSTRACT

Groundwater quality has been recently deteriorating in different alluvial aquifers of Albania due to industrialization expansion, waste disposal, and agriculture activity. A preliminary assessment of vulnerability to groundwater contamination in Erzeni watershed area was undertaken because of enormous mining activities of river bed alluviums, the presence of the largest urban solid waste disposal site of Tirana and intensive agricultural and industrial activities at the plane part of the river course. The major geological and hydrogeological factors that affect and control groundwater contamination were incorporated into the DRASTIC model. Moreover, a Geographical Information System (Arc Gis 9.2 INFO) was used to create a groundwater vulnerability map of Erzeni river basin. Aquifer vulnerability assessment aims at predicting areas, which are more likely than others to become contaminated as a result of human activities at the land surface. As a result of the vulnerability assessment, 20% of the Erzeni basin was classified as being very highly vulnerable, 5% highly vulnerable, 15% vulnerable at moderate to low levels and, finally, around 60% of the basin has very low vulnerability.

KEYWORDS: *Albania, 2009, GIS-based evaluation, alluvial aquifer, groundwater, vulnerability.*

INTRODUCTION

Groundwater, that represents a major source of water for domestic, industrial and agricultural uses in Albania, is recently suffering a deterioration of its quality especially in the regions with extensive demographic and industrial development, due to excessive groundwater withdrawal and introduction of different contaminants from the surface The concept of groundwater vulnerability is based on the assumption that the physical environment may provide some degree of protection to groundwater against natural impacts, especially with regard to contaminants entering the subsurface environment (Napolitano, 1995). Consequently, some land areas are more vulnerable to groundwater contamination than others. Over the past 30 years, groundwater vulnerability maps have been developed in many countries as a basis for developing land use strategies that take into consideration aspects of protection of groundwater from pollution (Fritch, 2001; Naqa et al., 2006). The final goal of vulnerability maps is the subdivision of the area into several hydrogeological units with different levels of vulnerability. These maps show the distribution of highly vulnerable areas, in which pollution is very common because contaminants can reach the groundwater within a very short time. However, such maps do not replace more detailed studies of the geological and hydrogeological conditions of particular sites for the envisaged use. The aim of this study is to assess the vulnerability of groundwater to contamination for the basin of Erzeni river which flows through Tirana and Durresi regions (Fig. 1). Groundwater vulnerability assessment was done by using a DRASTIC model (Aller *et al.*, 1987) combined with a Geographic Information System (Arc Gis 9.2 INFO). This model has been widely used in many countries because the inputs required for its application are generally available or easy to obtain.

The Erzeni Basin (Fig. 1), which is one of the most important alluvial groundwater basins in Albania (Eftimi et al., 1989; Dhima et al., 2000), consists mainly of Quaternary alluvial gravels that are 2-7.0 m thick (Puca, 2005). The groundwater flow is influenced by the recharge/discharge areas, the topography and the internal characteristics of the aquifer medium. The main recharge occurs from the south-eastern side of the area and groundwater flows to the north-western part of the basin where the groundwater is under pressure due to the impermeable clay cover layer. The yield for the most of the groundwater wells ranges from 2.0 to 5.0 l/s. The general groundwater mined from this aquifer is around 2000 l/s (Puca, 2005). From the hydrochemical point of view, the groundwater belongs to calcium – magnesium – bicarbonate type having pH, general hardness and general mineralization values of 7.3, 27.9°Gj and 850mg/L, respectively.

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MATERIALS AND METHODS

For the assessment of the Erzeni groundwater vulnerability to contamination the DRASTIC (Aller *et al.*, 1987) model and a geographic information system (ArcGIS) (Napolitano, 1995) were used to produce the vulnerability map for groundwater contamination. This involved: (i) data (hydrogeological, geological and pedological) collection, (ii) scanning of toposheets and digitizing (raster to vector) source data, (iii) creating the attribute table, (iiii) analyzing the DRASTIC factors for evaluation of Drastic Index, (iiiii) rating these areas as to their vulnerability to contamination and deriving a Graduated Map.
(i) The seven parameters that are involved in arriving at the Drastic Index have been collected from the following sources: Geological Survey of Albania, Institute of Soils and Institute of Topography for the Depth to water, Aquifer media, Hydraulic conductivity and Net recharge, Soil media, Impact of Vadose Zone and Topography, respectively.
(ii)The toposheets were scanned for generating raster images TIF format (Tagged image file) which are then exported to CADD for converting them into a vector format through the digitization process; finally the topographic map was georeferenced. (iii) the attribute table, that was created in Excel, contains the following data: number and X, Y coordinates of the hydrogeological well, weights and ratings of Drastic parameters, values of Drastic Index. The data of attribute table were imported from Exel to GIS 9.2. (iiii) Drastic Index formula DR*DW +RR*RW + AR*AW + SR*SW + TR*TW + IR*IW + CR*CW was entered in the calculator (Excel) table where product of ranks and weights of each parameter was summed up and the final output (Drastic Index), as a whole number which assigns the vulnerability, was calculated. (iiiii) The Graduated Map for each parameter and for the Drastic Index (vulnerability map) was created in Arc Gis 9.2 INFO by using Spatial Analyses.

RESULTS AND DISCUSSION

Vulnerability refers to the sensitivity of groundwater to contamination, and is determined by intrinsic characteristics of the aquifer. It is distinct from pollution risk, which depends not only on vulnerability but also on the existence of significant pollutant loading. In this study, the DRASTIC model and a geographic information system (Arc Gis 9.2 INFO) were used to produce the vulnerability map for groundwater contamination in the Erzeni basin. Different models can be applied to mapping of groundwater vulnerability, but the most commonly used model in assessing groundwater vulnerability in porous aquifers seems to be the DRASTIC model (Aller *et al.* 1985; Aller *et al.*, 1987; Deichert and Hamlet, 1992,).
DRASTIC, that is a methodology for identifying vulnerability to groundwater pollution, was originally developed by the U.S. Environmental Protection Agency. The DRASTIC acronym stands for the seven hydrogeological parameters: Depth to water, net Recharge, Aquifer media, Soil media, Topography (slope), Impact on the vadose zone media, and hydraulic Conductivity of the aquifer. The DRASTIC model has four assumptions (Aller *et al.* 1985; Aller *et al.*, 1987): 1) the contaminant is present on the ground surface; 2) the contaminant is flushed into the groundwater by precipitation; 3) the contaminant has the mobility of water; 4) the area being evaluated by DRASTIC is 0.4 km^2 or larger. For the determination of the DRASTIC index number (pollution potential) each factor rating was multiplied by its weight and the resulting values were added together:
DRASTIC Index = DrDw + RrRw + ArAw + SrSw + TrTw + IrIw + CrCw (*)
where r = rating for area being evaluated (1–10), and w = importance weight for the factor (1–5). Importance weights are found in a generic DRASTIC table (Table 1) that lists weights for factors having greater applicability (Aller *et al.*, 1987) while factor ratings are derived from data on each factor (Table 2-8). Finally, the Drastic Index values are calculated by using the above (*) equation (Table 9). Higher sum values, i.e. higher DRASTIC index, represent a greater potential for pollution or a greater vulnerability of the aquifer to contamination. The DRASTIC index was further divided into five categories: very low, low, moderate, high, and very high. The sites with high and very high categories are more vulnerable to contamination.

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Table 1. Assigned weights for DRASTIC parameters

Parameters	Weights
Depth to Water	5
Net Recharge	4
Aquifer Media	3
Soil Media	2
Topography	1
Impact of Vadose Zone	5
Hydraulic Conductivity	3

Table 2. Ranges and rating for the depth to water

Depth to water (m)	
Range	Rating
0-2.0	10
2.0-5.0	9
5.0-10.0	7
10.0-15.0	5
15.0-30.0	3

Table 3. Ranges and rating for the net recharge

Net recharge (mm/Year)	
Range	Rating
0-5.0	1
6.0-10.0	3
10.1-16.0	6
16.1-25.0	8
>25.0	9

Table 4. Ranges and rating for the aquifer media

Aquifer Media	
Range	Rating
Coarse-grain gravel	8
Medium-grain gravel	7
Fine-grain gravel	6
Medium-grain sand	5
Fine-grain sand	4

Table 5. Ranges and ratings for soil media

Soil Media	
Range	Rating
Silty clay	3
Silty sand	4
Loam	5
Sandy loam	6
Sand	9
Gravel	10

Table 6. Range and rating for topography

Topography (Percentage slope)	
Range	Rating
0-2.0	10
2.0-4.0	9
4.0-6.0	5
6.0-8.0	3
>8.0	1

Table 7. Ranges and ratings for impact of the vadose zone media

Vadose Zone Media	
Range	Rating
Sandy gravel	8
Silty sand	6
Silt	4
Sandy silt	3
Sandy clay	2
Clay	1

Table 8. Ranges and ratings for hydraulic conductivity

Hydraulic Conductivity (m/day)	
Range	Rating
0-5.0	1
5.0-10.0	2
15.0-25.0	3
25.0-50.0	6
50.0-100.0	8
>100.0	10

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Table 9. Calculation of Drastic Index values

No.Well	D factor	R factor	A factor	S factor	T factor	I factor	C factor	DI number
	DrDw	RrRw	ArAw	SrSw	TrTw	IrIw	CrCw	ID
1	45	36	27	20	3	40	27	199
2	45	36	27	20	3	40	27	200
3	45	36	27	20	3	40	27	198
4	45	36	27	20	3	40	27	198
5	45	36	27	20	3	40	27	198
8	45	36	27	20	3	40	27	198
10	45	36	27	20	3	40	27	198
13	45	36	27	20	3	40	27	198
81	10	8	15	6	10	15	12	76
77	10	8	15	8	10	15	12	78
73	10	8	15	6	10	15	12	76
33	50	28	24	10	5	30	24	171
19	50	28	24	10	5	30	24	171
186	50	28	24	10	5	30	24	171
35	50	28	24	10	5	30	24	171
34	50	28	24	10	5	30	24	171
36/C	50	28	24	10	5	30	24	171
Ro	50	32	21	18	5	40	24	190
30/9	50	28	21	12	5	40	24	180
31	50	36	21	12	5	40	24	188
18	50	36	21	12	5	40	27	191
187	25	28	21	10	5	30	27	146
16	35	24	24	12	5	30	27	157
15	25	20	21	12	5	30	27	140
14	25	20	21	12	5	30	27	140
181	25	20	21	12	5	30	27	140
13/1	15	20	21	12	5	25	27	125
13/7	15	20	21	12	5	25	27	125
13/2	15	20	21	12	5	25	27	125
4/2	15	20	21	12	5	25	27	125
180	15	20	21	12	5	25	27	125
24	15	20	21	12	5	25	27	125
200	15	12	18	12	6	15	15	93
224	15	12	18	12	6	15	15	93
30	15	12	18	12	6	15	15	93
169	15	12	18	12	6	15	15	93
2/2	15	12	18	12	7	15	15	94
3/2	15	12	18	12	7	15	15	94
11/2	10	12	15	6	7	15	15	80
1/93	10	12	15	6	7	15	12	77
2/93	10	12	15	6	7	15	12	77
197	10	12	15	6	7	15	12	77
3/93	10	12	15	6	7	15	12	77
P5	10	12	15	6	7	15	15	80
P6	10	12	15	6	7	15	15	80
P7	10	12	15	6	7	15	15	80
1/2	5	8	15	8	9	10	12	67
1/3	5	8	15	8	9	10	12	67
1/1	5	8	15	8	9	10	12	67
1/4	5	8	15	6	9	10	12	65
1/5	5	8	15	6	9	10	12	65
7	5	8	15	6	9	10	12	65
6	5	8	15	6	9	10	12	65
P/3	5	8	15	6	9	10	12	65
11	15	8	15	8	10	15	12	83
10	15	8	15	8	10	15	12	83
13	15	8	15	6	10	15	12	81

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Table 10. Indicative values of hydraulic conductivity and vadose zone thickness

Well No.	10	19	14	2-Feb	2-Jan
Drastic index	198	171	140	94	67
K (m/day)	110	75	15.5	12.3	8.5
Thickness of Vadose zone (m)	1	4	18	20	36

Table 11. Representative data of qualitative monitoring

Well No.	10	19	14	2-Feb	2-Jan
Drastic index	198	171	140	94	67
NO_3 (mg/l)	2.8	1.8	1.3	1	0
PO_4 (mg/l)	1.8	1.1	0.8	0.5	0.1
NH_4 (mg/l)	0.1	0.05	Trace	0	0

The Arc Gis 9.2 INFO was used to compile the geospatial data and to generate the final vulnerability maps. The DRASTIC index map (Fig.2) was prepared to determine the vulnerability to groundwater contamination (*i.e.*, pollution potential). This map shows that the vulnerability of the Erzeni alluvial aquifer to contamination ranges from very low (DI=65) to very high (DI=200). The most vulnerable areas of the aquifer to groundwater contamination – showed by the highest DRASTIC indexes – are located in the southeast area of the basin where the soil cover and/or vadose zone are absent or very thin and aquifer media consists mainly of gravel and pebbles (Table 10).

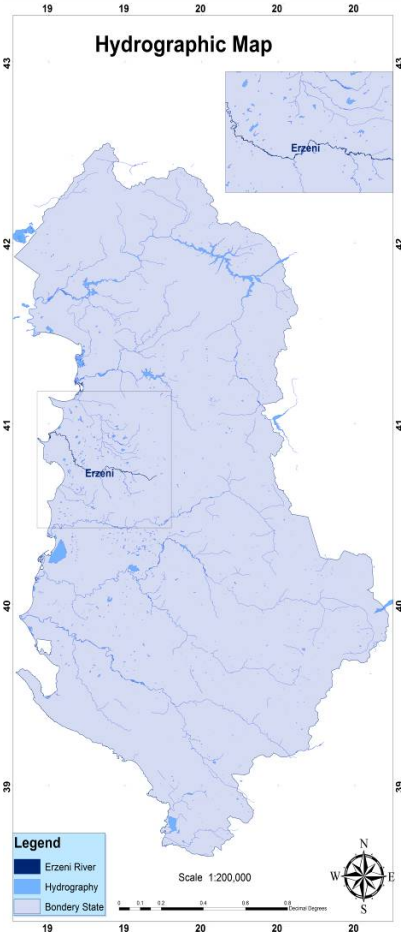


Fig. 1. Hydrographic map of Albania (Erzeni basin is shown on the right)

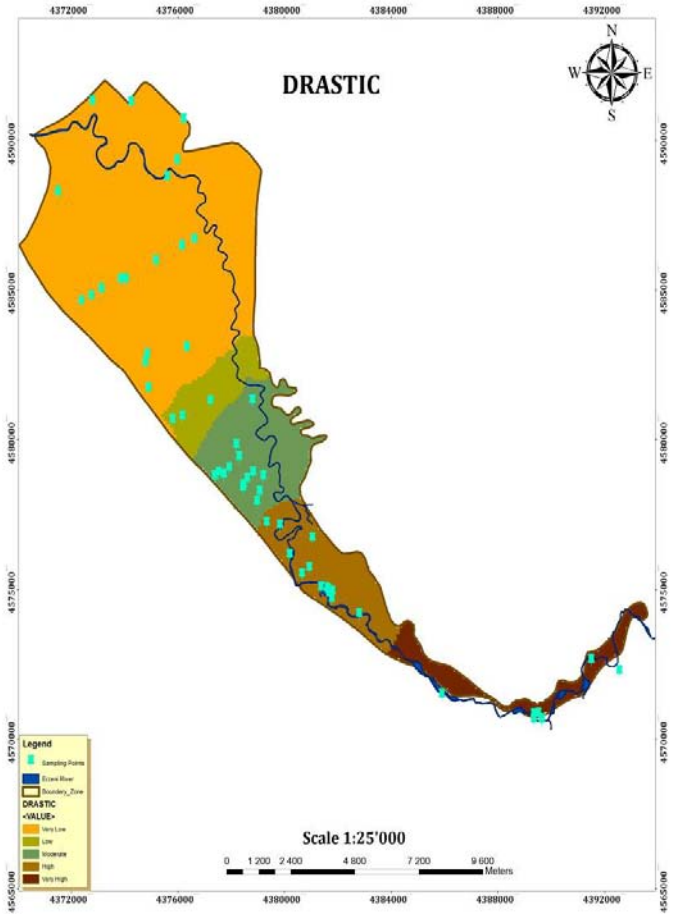


Fig. 2. Vulnerability map based on DRASTIC Index

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On the contrary, along the northwestern sectors of the Erzeni basin, where a thick (20-30m) vadose zone with a well developed soil cover are present, the lowest vulnerable areas of the aquifer to groundwater contamination are located. Even the very high vulnerable area represents only 20% of the basin, it has a strong impact on aquifer vulnerability because it represents the recharge area of the basin. After entering the aquifer in this area the contaminant can be distributed in other parts downward the aquifer flow.
The above configuration of the vulnerability to groundwater contamination fit very well with the data of the qualitative monitoring. This later has detected different levels of ammonium ions, nitrites, nitrates, phosphates, etc, in the groundwater of the southeastern sectors (Table 11) of the aquifer as it could be expected from the vulnerability map.

CONCLUSIONS

The DRASTIC model and a geographic information system (Arc Gis 9.2 INFO) were used for the assessment of the groundwater vulnerability to contamination in the Erzeni basin. This assessment along with a continuous qualitative monitoring are indispensable for this aquifer because its groundwater represents an important water source for potable, industrial and agricultural needs of the Tirana – Durresi region where Erzeni river flows. According to values of the DRASTIC index, five categories of aquifer vulnerability to contamination are distinguished: very low, low, moderate, high, and very high which fit very well with the data of the qualitative monitoring. The areas with high and very high categories, i.e. the more vulnerable areas to contamination are located in the southeastern part of the basin, whereas the lowest vulnerable areas of the aquifer to groundwater contamination are located along its northwestern sectors.

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REFERENCES

Aller, L., Bennett, T., Lehr, J.H., Petty, R.J., 1985, DRASTIC; A standardized system for evaluating groundwater pollution potential using hydrogeologic settings: Ada, OK, United States Environmental Protection Agency, Robert S. Kerr Environmental Research Laboratory, EPA/600/2-85/0108, 163 p.

Aller L., Bennet T., Lehr J. H., Petty R. J. and Hackett G., 1987. DRASTIC; A standardized system for evaluating groundwater pollution potential using hydrogeologic settings: EPA-600/2- 87-035, 622 p.

Deichert, L.A., Hamlet, J.M., 1992, Non-point groundwater pollution potential in Pennsylvania, *in* American Society of Agricultural Engineers (ASAE) International Winter Meeting, Nashville, Tennessee, 15-18 December, 1992: Paper No. 922531.

Dhima K., Kalaja F., Saraci. 2000. Hydrogeological Resources in Albania: State of their Administration. Italian – Albanian Symposium: Administration of Georesources, 64-71, (in Albanian-Italian).

Eftimi. R., Tafilaj I., Bisha G. 1989. Hydrogeological characterization of Albania. Bulletin of the Geological Sciences, 4, 303-316 (in Albanian with English abstract).

Fritch, T.G., Mcknight, C.L., Yelderman, Jr. J.C., Arnold, J.G., 2000a, An aquifer vulnerability assessment of the Paluxy Aquifer, central Texas, USA, using GIS and a modified DRASTIC approach: Environment Management, 25(3), 337–345.

Napolitano, P., 1995, GIS for aquifer vulnerability assessment in the Piana Campana, southern Italy, using the DRASTIC and SINTACS methods: Enschede, The Netherlands, International Institute for Geo-Information Science and Earth Observation (ITC), unpublished M.Sc. Thesis, 172 p.

Naqa A. E., Hammouri N. and Kuisi M., 2006. GIS-based evaluation of groundwater vulnerability in the Russeifa area, Jordan. Revista Mexicana de Ciencias Geológicas, 23/3, 277-287.

Puca N., 2005. Scientific report: Monitoring of groundwater in the main aquifers of Albania- Erzeni – Ishmi aquifer. 45p. Archives of Geological Survey of Albania (in Albanian).

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LANDSLIDE MAP OF TIRANA REGION AT SCALE 1:50 000

Mimoza JUSUFATI[1], Mentor LAMAJ[1], Musli DARDHA[1], Edlira PLAKU[1], Olgert JAUPAJ[1]

[1]*Albania Geological Survey, Tirana, Albania,*
e-mail: jusufati2000@yahoo.com lamajmentor@yahoo.com dardha2006@yahoo.com ediplaku@gmail.com

INTRODUCTION

Landslides are a big problem in Tirana region due to the relief conditions, causing a negative impact in terms of cost and level of inhabitants' life. For this reason Albanian Geological Survey (AGS) compiled the Landslides map of Tirana Region at scale 1:50,000 and landslide data-base, as needed information for decision-makers to decrease risks in their communities and for land use planning

The Landslide map has been compiled, during this year,by the Engineering - Geology Department and GIS Department.

KEY WORDS: Landslide map, lithological map, data base

THE METODOLOGY

The Tirana region is located in western Albania. It covers about 1,640 km^2. The methodology applied to build up the Tirana landslide map is based on: Archive data and field surveys.
Archive data: Gathering all information from Central Archive of AGS (Geological map of Tirana 1:50,000, The studies in the geodynamic phenomena's),from TA of the Ministry of Construction (The map of administrative countries, geological-engineering studies) and Road Directory (technical report for landslides in infrastructure).
Archive of AGS contain 90 studies from 1994 until 2010. This studies were carry out for emergency, with the request of Municipality, in order to assessment the danger and to give up recommendations to decrease risks in their communities. TA of the Ministry of Construction had 33 studies from the years 1970-1990.

Field surveys: to evaluate the landslide evolution, present state and activity.
For each landslide, evaluated by field surveys is filled out data sheet. It is organized in five information levels of increasing detail:

1st level contains General information (region, municipality, topographic map and geographical coordinates X, Y.
2nd level contains data for the Geology of the body to move, the plan of slide and the basement without moving.
3rd level provide data on Morphology (lithology, land-use, erosion, cause of activation).
4th level contains Hydrogeology data (ground water, underground water level, and springs).
5th level contains Geological Engineering data (type of movement, state activity, humidity).

From Central Archive of AGS,TA of the Ministry of Construction, and Field surveys are identified 174 landslide in Tirana Region, The MS Access database built for this purpose, contains 174 landslide.

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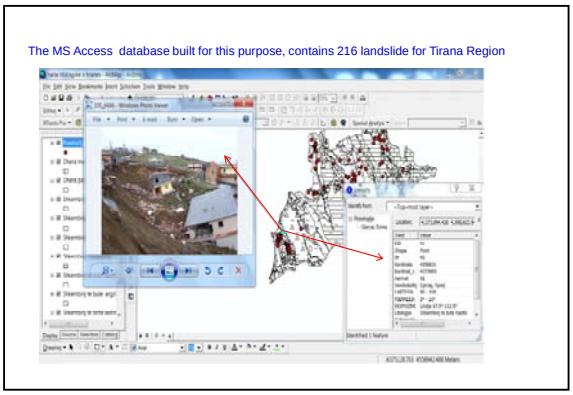


Figure 1 – Data base

CRITERIA FOR BUILD UP THE LANDSLIDE MAP

The criteria on which based to build up the landslide map was: lithological criteria and slope angle.
On the basis the Geological map of Tirana region at scale 1:50,000 and engineering geological field survey, carry out during this year, the lithological map was compiled. The classification of formation has been made on the basis the landslide susceptibility.
Ten groups of lithological/engineering geological unit were defined for the all region: 1-Hard limestone rock (11 %); 2-Average of stratified rocks (34%); 3-Sandy rocks (6%); 4-Average clay rock (17%); 5-Soft clay rock (6 %) ; 6-Conglomeratic rock (1%); 7-Chaotic rock (4%); 8-Soil with cohesion(3%); 9-Soil without cohesion(3%); 10-Soil stratification with and without cohesions.(17%)
In this map are marked 174 landslides, according to coordinates and azimuth of the direction of slides.
Landslide distribution according to lithological class are : Hard limestone rock - 5 ,Average of stratified rocks- 23 , Sandy rocks -12, Average clay rock -49, Soft clay rock -52, Conglomeratic rock 1,Chaotic rock -21, Soil with cohesion-3, Soil without cohesion-2,Soil stratification with and without cohesions- 6.
The slope angle is easily relatable to the slope movement, because it is strongly linked to the forces involved. High slope anglesites have more susceptibility to landslides.
Slope angle map is building in nine groups: Areas with slopes 0-5, 5-10, 10-15,15-20°,20-25 25-30°,30-40°,40-65 and areas with slopes > 65°.
From previous studies and surveys is emerged that the phenomenon of sliding occurs in most cases in slopes with inclination from 10° to 30° In slopes with an inclination greater than 30 ° occur phenomena of topples and falls. This is related mainly to the lithology and to physical – mechanical characteristics of rocks and grounds situated on the slopes
The data collected from archive and fields as well are entered as inputs in a database that serves to build the map of landslides in the GIS mapping.

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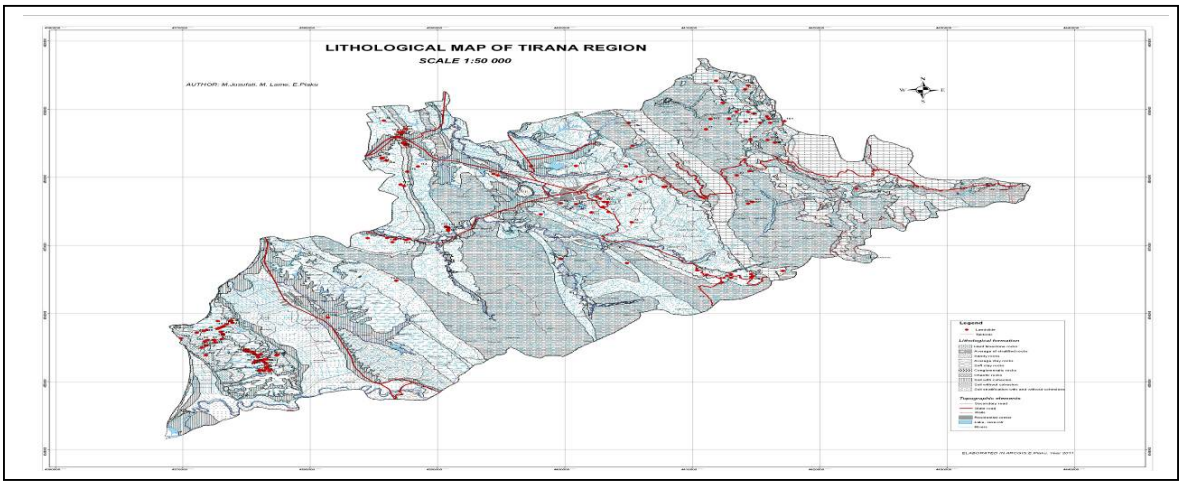


Figure 2 – Lithological map of Tirana Region at scale 1:50,000

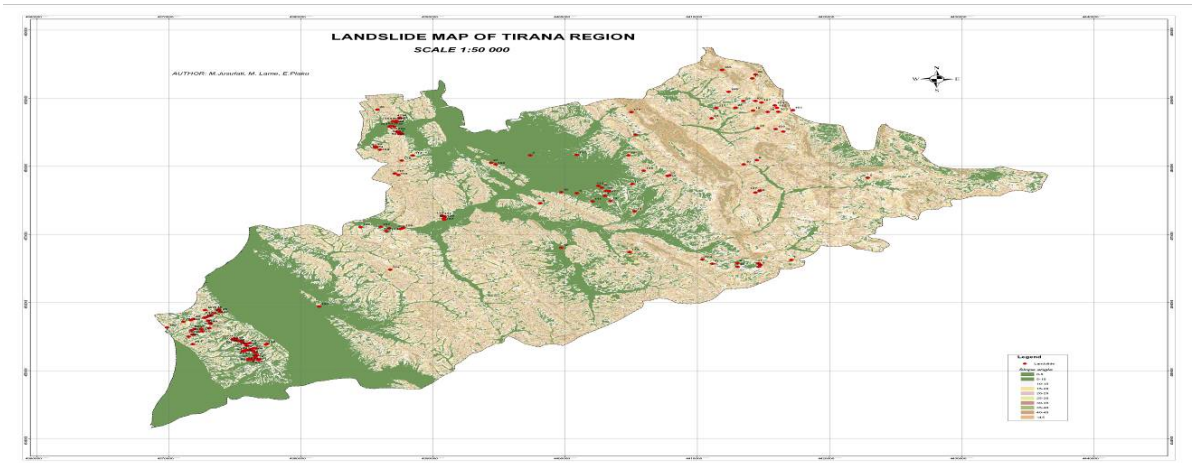


Figure 3 – Landslide map of Tirana Region at scale 1:50,000

CONCLUSION

The Tirana region covers about 1,640 km$^{2.}$ Through a field work and archive data are identified 174 landslide. Clay rock was found as the most susceptibly lithological complex

From previous studies and field surveys it is emerged that the phenomenon of sliding occurs in most cases in slopes with inclination from 10° to 30°. In slopes with an inclination greater than 30° phenomena of topple and falls occur.

A big role, during last years, in the activation of slides phenomena, has played the human factor, which with its interventions on slopes, often not well studied, has caused the acceleration of these phenomena and made them appearing more dangerous, due to the fact they affect engineering works also.

Based in this map and analyses of landslide spatial occurrence, coming year will be proceeded in derivation of the Landslides Susceptibility map of Tirana at scale 1:50,000

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REFERENCES

KOMAC, M., RIBI,M. 2006. Landslide susceptibility map of Slovenia at scale 1:250,000

CANIANI, D.,PASKALE, S.,SDAO, F., SOLE, A., 2007. Neural networks and landslide susceptibility of the urban area of Potenza.

GUERRIERI, L.,TRIGLIA, A.,& LADANZA, C., 2007. The IFFI project (Italian landslide inventory): Methodology and results

VARNES,D.,1996 Landslide types and processes, in Turner.

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STATUS AND PROSPECTS OF GEORISK MAPS IN ALBANIA

Gafur MUKA[1], Ramiz BALLA[1]

[1]*Faculty of Geology and Mining, Tirana Albania*
e-mail: gmuka@yahoo.com, ramizballa@yahoo.com

ABSTRACT

I
n our country have been conducted numerous studies on physico-mechanical properties of rocks, their lithology, the tectonics, the stratum nature, the inclined slopes, the regional vegetation and the level of the erosion, but even today lacks GeoRisk maps. Moreover lacks a clear definition of GeoRisk.
In these circumstances, in this article, we are trying first to give a formulation of GeoRisk, aiming at following to enable the presentation of GeoRisk mapping condition and the need for creating GeoRisk maps in perspective.
Development of GIS technology has created the conditions for structuring existing data, collecting new data in mapping function, their processing and visualization in view of user requirements. But where do we feel the need to create these kind of maps? In response to this question should be considered a number of factors related to the economic and the social development of our country.
Infrastructure development, demographic movements, design and construction of touristic resorts, especially in mountainous areas, the exploitation of raw materials , environmental protection, etc. are some of the factors that should be considered as priorities for building GeoRisk maps in Albania.
Considering the GeoRisk as movement of rocky masses compelled from the exploitation of raw materials, in condition of possession of the data, in this article we are attending especially in creating of maps of zones impacted from exploitation of raw materials in some regions of our country.

KEYWORDS: *GeoRisk, Mass Movement, GIS, Geological Features, Rocks, Infrastructure, Tourism*

1.THE ORETICAL CONSIDERATIONS

Design GeoRisk maps, such as the compilation of all other graphical materials eligible to be called maps, related to cartographic surveying, which is the process of creating, processing and evaluation of the database referring on methodological criteria established in view of the purpose of using maps. [Muka G., Korini Th.: Hartografia Dixhitale (Digital Cartography),2010].
Referring to maps based classification (Hake et al., 2002) [Hake Guenter., Gruenreich Dietmar., Meng Liqiu.: Kartographie,2002], GeoRisk maps are thematic maps. They are based on topographic maps on which are designed then the GeoRisk values.

But, what is GeoRisk? In the literature there are different definitions which often lead to misunderstandings. In an effort to have a more unified definition of this concept, we are referring to the instructions of the International Union of Geological Sciences (IUGS 1997), carried over and into the study GIS-support for landslides and risk analysis in the eastern Felsstuerze Alps. [Ruff Michael.: GIS-gestuetzte Risikoanalyse fuer Rutschungen und Felsstuerze in den Ostalpen (Voralberg, Oesterreich), 2005].
We emphasize that these concepts are used in the European Union.Their appearance is given in Tab. 1-1

Tab.1-1 Definition of concepts related to GeoRisk

Concept (Albanian)	Concept (English)	Specifying
Rrezik	Danger	The concept lends itself phenomenon (event) so the physical and mechanical properties
Rrezikim	Hazard, Susceptibility	The probability of appearance of a potential risk (when?-Hazard and where?-Susceptibility)
Probabilitet	Probabillity	The probability of occurrence within a specified period of time.

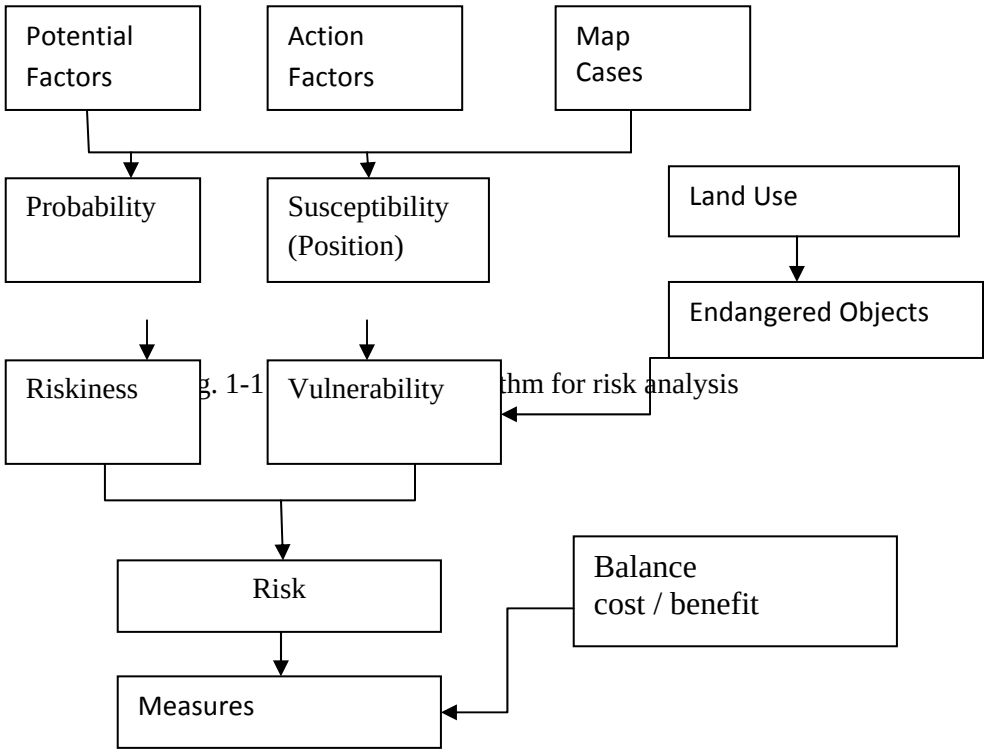
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Intensitet	Intensity	Strength and extent of the phenomenon (event)
Objekte të rrezikuara	Elements of risk	All objects (buildings, roads, agricultural areas, etc.) or persons who are threatened by a danger
Vulnerabilitet	Vulnerability	The rate of damage to an object, namely the expected damages depending on the intensity.
Rrisk	Risk	Consider the possibilities and consequences of a disaster on human lives, health, property or the environment

All the above concepts are used in the evaluation of landslides and fall pieces of rock on inclined

slopes. In risk analysis are considered together spatial and time components of danger. The factors that determine mass movements (landslides and rock pieces decreases) are divided into two groups: potential factors (e.g. lithology etcetera) and operational factors (e.g. rain etcetera). By mapping all cases of GeoRisk issued two types of information: the geographic location of cases (Where?-susceptibility) and their frequency in a certain time (probability).
Analysis of these two information leads to the definition of risk. Of course, information related to the frequency in time should be extended over a much longer period of time, so in the current level of studies, comprise a deficiency, therefore most of the studies are limited mostly in determining of the susceptibility. Analysis of land use is related to the number and value of objects that are in risk, but also from the number of persons, that is human lives.
Based on information obtained from the analysis of land use, concludes on vulnerability. Comparison of riskiness and vulnerability leads to risk assessment.
Depending on risk and balance cost / benefit must be plan and implement individual engineering measures (civil engineering) or/ and administrative measures to avert or reduce the harmful impacts. So through the analysis of risk for each case concludes: first - in anticipation of the occurrence of riskiness, second - in anticipation of the expected level of the damage.

In the below figure (fig. 1-1) it is given flowchart of algorithm for risk analysis examining the influencing factors to the measures to be taken to avoid or reduce the harmful impacts.



g. 1-1 thm for risk analysis

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1.1. NECESSITY OF ECONOMIC ANALYSIS OF GEORISK

In our country are known many cases of damages caused by natural geological factors or by human intervention, such as exploitation of minerals, forests or rivers. So are known cases of landslides in several villages in the area of districts Elbasan, Gramsh, Tepelena Korca, etc., cases of subsidence autoroutes such as the National Road Burrel-Bulqize (especially sector from exit of Burrel city to Bridge of Mati river) massive rocks slide during construction of Kalimashi tunnel or a road segment slide at highway Rrëshen-Kalimash etc.
In this group includes also falling of the land area during exploitation of chrome mine in Bulqiza Ultrabasic massif area, Mirdita and Puke area during exploitation of copper mines. There are some slides of rock pieces in some other roads of our country such as national roads Elbasan-Librazhd, Milot-Burrel etc. There are also known slides of massive rocks during the exploitation of quarries. Naturally due to the fact that lack of an intensive land use, lack of areas with high population density and lack of developed infrastructure, the damages there are not done still extremely problematic.
However, the lack of estimated preventive of risk during the opening work of the Kalimashi tunnel had increased in a sensitive mass costs to restore proper cribs (underpin) to cope rock massive pressures.
The following images (Fig 1,2,3,4) indicate that the effects of damages from factors that, notwithstanding not completely eliminated, as for natural factors, as for whereat of high costs that may be causing, can be taken into consideration regarding the impact on property and people (estimate of risk). Under these conditions, evidenced the necessity of economic risk analysis to avoid or reduce the quantity of damage, that naturally tends to reduce spending, but in most cases to prevent the loss of human lives.



Fig.1 Rocky crash in Berat

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Fig. 2 Landslide in Gjirokastër



Fig 3 Landslide and rocky crash in Tirana-Kukes road

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Fig 4 Landslide and rocky crash in Burrel- Bulqiza road

1.2. CAN THE GEORISK TO BE COMPUTE?

In the analysis of the influencing factors that mostly are influencing at the consequences of GeoRisk, it is concluded that predominant there are the natural factors. The difficulty in comprehensive modeling of these factors is known (Ruff, 2005) wherefore the computation starts based on hypotheses (Hutschinson 1995). Some of these hypotheses there are:

- ✓ Massive landslides that are occurred under the same conditions (geological, geomorphological, climatic and hydrological), there are qualify as iterant phenomena (the principle of actuality).
- ✓ The most important factors that cause massive landslide there are modeled by physical laws.
- ✓ Exist the possibility to determinate the riskiness scale.
- ✓ All types of massive landslides can be recognized, therefore they can be qualified.

Using these hypotheses in reality rarely it is performed, because the cause-aftereffect link itself, to massive landslides it's not a direct link. Might be that conditions of geological construction of the rocks to be identical, but because, as saying the unequal intensity of rain, in a inclined terrain (slope) sliding occurs while in the other straight terrain it's not. Here arises the idea of examining not only the all spatial conditions but also their time examination. In our country the time chronology of GeoRisks is somewhat poor, this causes difficulties in their computation.

In this paper we will concentrate mainly on positional review of GeoRisk at some old mines territory of our country. The mapmaking of GeoRisks creates a database that will serve to build documentation in function of the requirements of users to compute GeoRisk.

2. Creation and utilize of a database

Mining in our country has been a activity that was characterized by expansivity and intensity. As a result, there are a large number of mines that are considered abandoned exploitation, spread throughout the country. Disorder of equilibrium due to the creation of underground spaces, has made to slide of massif on them associated with the appearance on surface subsidence's muldes, holes from rock demolition, cleavage of terrain etc. (G.Muka, 1989).

These occurrences have brought damage to agricultural land (Valiasi mine), got out of function industrial facilities (enrichment plant Bulqiza mine, at the first zone), landslides and damage to residential buildings (Memaliaj, Tepelena), change the track of auto roads (remade) (Bulqiza mine) etc.

Identification of the location of these phenomena it's not relate only with visualizing in function of cartographic data, but also with the creation of a database for physico-mechanical properties, geological,

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geomorphological, hydrological and climate conditions, the extent of the earth's surface, damaged objects, the scale of their damage, etc.
The creation of this database and its processing through GIS technology (Ruff, 2005, Henermann, 2006) provides a complete analysis of the risk, extending the done generalizations and/or for other sectors where it's necessary computation of GeoRisk.
Specifically are created feature class (Esri shapefile) for the area where the old mines are located, within their exploited mineral areas, and areas where deformation, cleavage or collapse of terrain had occurred.

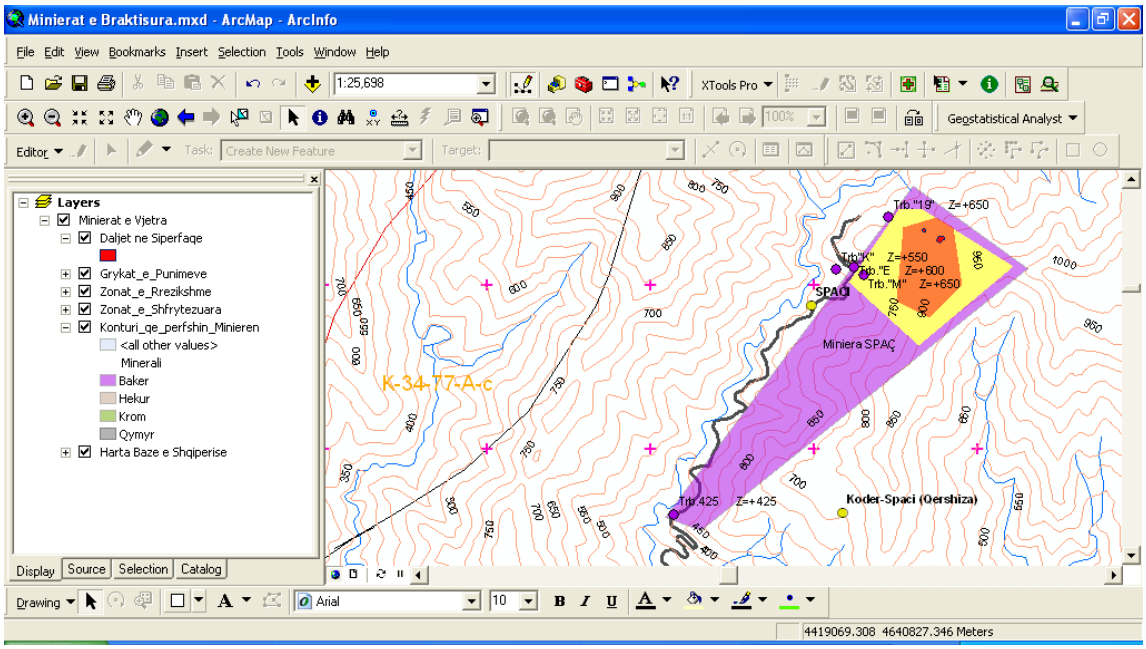


Fig 5 Feature classes for Spaçi copper mine

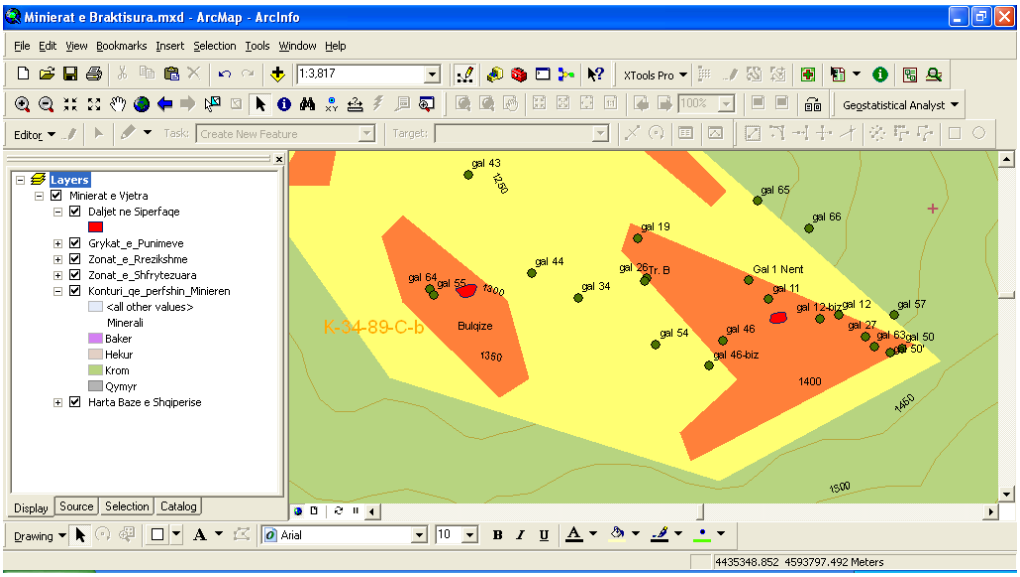


Fig 6 Feature classes for Bulqiza chromium mine

Based on these feature classes are built maps for the position of damage phenomena occurred in the chrome, copper and coal mines (Spaçi, Bulqiza, Valiasi ,etc.) Through GIS technology we can identify types of damage phenomena (mulde, funnel, cleavage, sliding, etc.) (Kratsch, 1983).
Making processing and visualization of geodatabase it is evidenced similarity of physico-mechanical natural conditions in function of the type of the occurrence of the phenomenon (GeoRisk). The totality of

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existing cases allows us to verify the hypotheses mentioned above and, in the final, the computation of GeoRisk to all abandoned mining areas where it is estimated that there is a possibility of demonstration of the phenomena impacted from underground spaces in the ground.

3. CONCLUSIONS

1. GeoRisk in our country is treated as integral measures to avoid or reduce the level of objects damage.
2. Cartography of GeoRisk isn't done in conformity with the required standards. There is no the set (suite) for all the data to create the complete geodatabase.
3. GeoRisk maps in front of the standard that they represent the influence of natural factors and human activity, aren't analyzed to realize the computation of GeoRisk.
4. Standardized Categorizations of appearance forms of expected GeoRisk types are required.
5. Study of appearance impact of exploited spaces at the earth's surface enables their categorization according to the required standards.
6. Evaluation of damages caused at abandoned exploited mines allows estimate of risk including areas not studied yet.
7. Under the conditions of infrastructure and tourism development in our country, the creation of GeoRisk maps is immediately required to take precautions to protect facilities and people's lives.

REFERENCES

[1] Hake Guenter., Gruenreich Dietmar., Meng Liqiu.: Kartographie,2002]
[2] Hennermann K.:Kartographie und GIS (Eine Einfuehrung)", 2006, by EGR, Darmstadt.
[3] Hutchinson, J.N.: 1995: Lqandslide Risk Assenment, New Zealand 1995.
[4] Kratzsch H**.:** Mining Subsidience Engineering", Springer Verlag, Berlin, Heidelberg, Neë York, 1983.
[5] Muka G., Korini, Th**.:** Hartografia dixhitale, Tirane, 2010.
[6] Muka G**.:** Parallogaritja e Mases se Ndikimt te Shfrytesimit per te Zvogeluar e Menjanuar Demet Minerare, Disertacion, Tirane, 1989, ["The preliminary calculation of the mass of influence of the mining to reduce and avoid the mining damages", Dissertation, Tirana, 1989.]
[7] Ruff Michael.: GIS-gestuetzte Risikoanalyse fuer Rutschungen und Felsstuerze in den Ostalpen (Voralberg, Oesterreich), 2005

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THE MAIN GEOLOGICAL FEATURES OF THE BAJGORE – KACANDOLL AREA (VARDAR TECTONIC UNIT), KOSOVO

Blerim MEHOLLI[1], Ibrahim MILUSHI[2]

[1]*Iliria Mining Ltd, Kosove; E-mail: blerimmeholli_30@yahoo.com*
[2]*Instituti i Gjeoshkencave, Energjise, Ujit dhe Mjedisit UPT, Shqiperi. E-mail: ibrahimmilushi@yahoo.com*

ABSTRACT

Bajgora-Kacandoll area is part of the Vardar tectonic unit. Mantle sequence formations, mainly harzburgites and oceanic crust sequences represented by basalt - radiolarites are widespread in the area. The last ones are dated Triassic age by using radiolarians. Ultramaphics rocks do not contain chromite showings and even accessory chromite grains, but they are characterized by an excellent banding. The metamorphic sole, which is evidenced for the first time in the area, is sandwiched between basalt – radiolarites at the floor and hartzburgite at the ceiling.
Upper Jurassic and Lower Cretaceous-Upper Cretaceous flysch deposits overlie the ophiolitic formations of the Central Vardar subzone belonging to Vardari tectonic unit, while the Upper Cretaceous flysch overlies the ophiolitic formations of the western subzone of the Vardar tectonic unit. For the first time in the region are recorded andesite - dacite formations of Miocene age. In the area are identified two sections with different specifications.

KEYWORDS: Triassic ophiolite, Jurassic ophiolite, metamorphic sole, flysch, dacite -andesite

I. INTRODUCTION

Bajgore – Kacandoll is situated in the northern part of Kosovo and is included in the topographic sheet no° K-34-43-Aa (Barrel), (Fig. 1). It is part of the Vardar tectonic unit and an important geological element. The area is located only a fw kilometers east of the well-known polymetallic mine of Trepca.

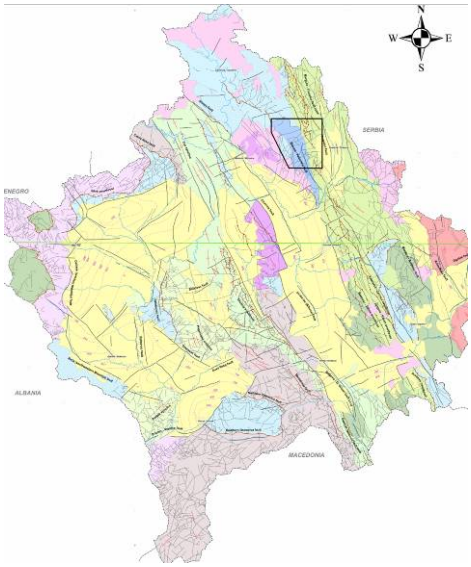


Fig. 1: Schematic tectonic map of Kosovo with location of Bajgore – Kacandoll area

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Studies in recent years have greatly advanced the level of geological knowledge of Bajgore – Kacandoll area.
In addition to mapping specifications, the most important achievements can be mentioned here:
- For the first time in the region of Bajgora - Kacandolli and in the entire zone of Vardar is evidenced the Metamorphic sole formation. Identification and mapping of metamorphic sole are essential to analyze and reconstruct the geodynamic evolution of Vardar oceanic basin.
- Basalt-radiolarian formation of Bajgora -Kacandoll area is considered as oceanic formation of Middle - Upper Triassic age. In the previous studies, this formation was considered as a continental rift product and its age was considerate Paleozoic or Jurassic.
- In the area are clearly distinguished and mapped the Upper Jurassic-Lower Cretaceous flysch formation, carbonate and flysch formations of Upper Cretaceous age. For the first time, in the Upper Jurassic-Lower Cretaceous flysch formation is confirmed with biostratigraphic data, the presence of Upper Tithonian levels below those of Barremian - Valanginian , previously argued.
- During the field observations is identified the andesite – dacite formation of Miocene age along with pyroclastic formations.
- In the southern part of Bajgora – Kacandolli area are identified showings suspected as remnants of meteorites. It is better explained the geological structure of the region and it is emphasized the relationship with the other geological structures from neighboring regions.
- For the first time it was made the structural mapping of the ultrabasic rocks of the Kacandollit area.

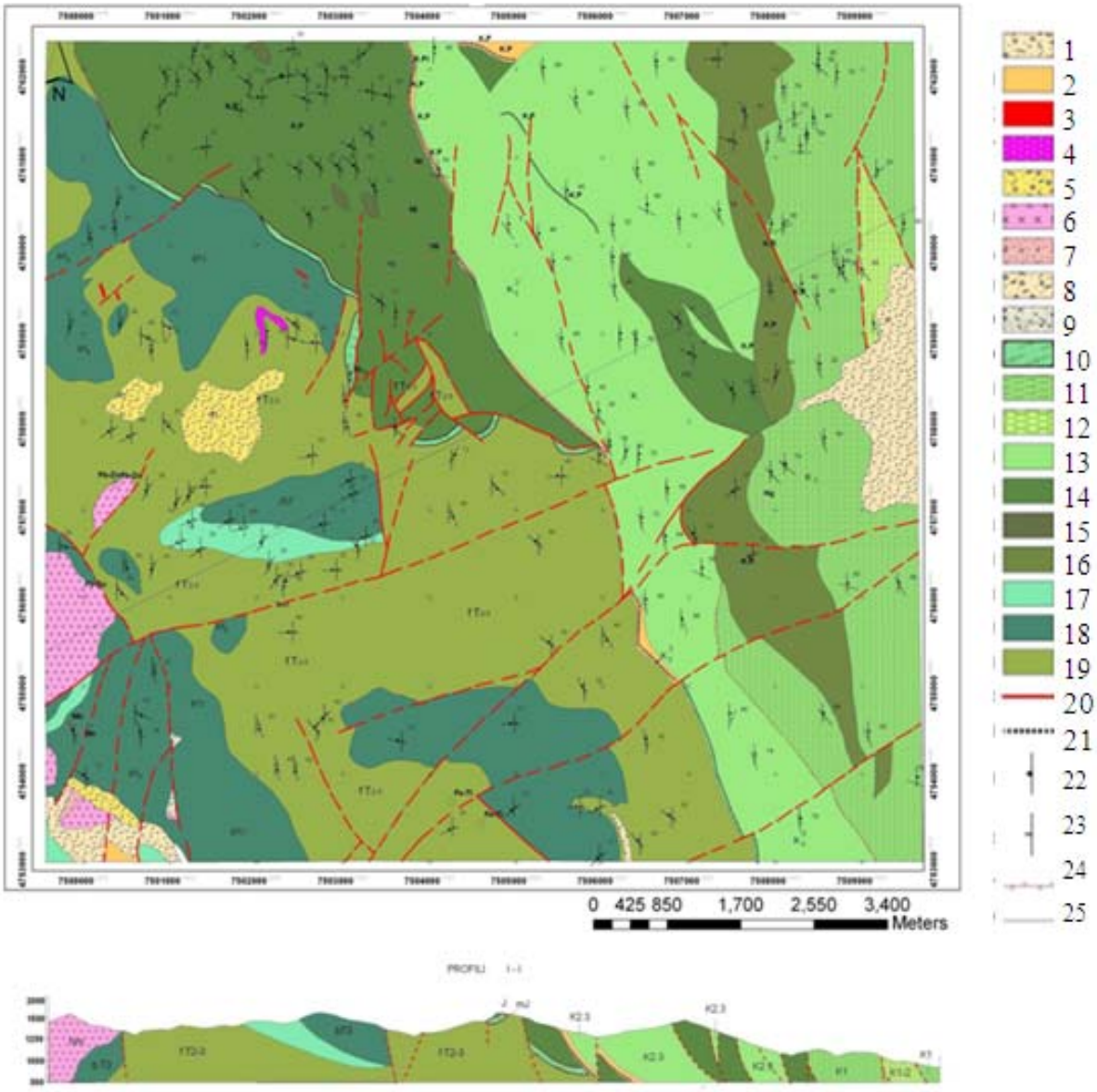
II. BRIEF HISTORY OF GEOLOGICAL STUDIES OF BAJGORE–KACANDOLL AREA

The first general geological data for the territory of Kosovo are given by Kossmat F (1924); Kober L (1929) etc.
The geological studies carried out until 1982 in the region of Bajgora - Kacandoll are those synthesized in the study of Vukmanovic (1982). In this paper, the volcanic rocks constituting the basalt – radiolarian sequence are considered as Jurassic formations overlying the harzburgitic mantle sequence. The metamorphis sole formationis not presented at all in the previous studies. Knoblock &Legler. (2006); Abazi & Legler (2006) etc. made the digital maps referring mainly the previous studies. Kodra and Milushi (2010) in collaboration with some geologists from Kosovo including the first author of this paper, carried out the geological map at scale 1:25000 for the area of Bajgora - Kacandolli explaining and advancing many aspects of the geology and structure of area. In the framework of PhD thesis of B. Meholli were carried out a series of additional works concerning the previously unresolved problems.

III. GEOLOGICAL SETTING OF THE AREA

In Bajgora - Kacandoll area were distinguished the next formations (fig 2):
1. Oceanic formations, 2. Jurassic-Cretaceous and Cretaceous sedimentary formations
3. Miocene magmatic formation containing dacite, andesite and pyroclatic rocks 4. Pliocene-Pleistocene lacustrine molasse formation, 5. Quaternary formations
In the following, each of them is briefly analyzed.

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1.Delluvial and alluvial formations, 2. Weathering crust (KP), 3. Melt-like product and volcanic glass (Q), 4. Granodiorite small bodies, 5. Delluvial formations (dH), 6. Dacite($Q_2N_2m_1$), 7. Andesite (aNm_1), 8. Pyroclastic formations ($vpNm_1$) , 9. Volcanic glass (qNm_1), 10. Platform limestone and conglobreccia at the base (K_{2-3}), 11. Argillaceous –aleuritic metamorphosed flysch, 12. Snastone – aleuritice flysch, 13. Argillaceous –aleuritic flysch, with intercalaitons of limestone and marl(K_{2-3}), 14. Mantle formations (hatzburgite etc, 15. Dunite, 16. Hartzburgite (Hz), 17. Slightly metamorphosed porphyroide(P_1T_3), 18. Slightly metamorphosed basalts with intercalation of radilorite and argillaceous – radiolarite shales (BT_3), 19. Green shales (T_{2-3}), 20. Fault line, 21. Transgresive boundary, 22. Sructural elements, 23. Elements of deformation structures, 24. Overthrusts, 25. Profile line

Fig. 2: Geological map of bajgore – Kacandoll area, scale 1:25000 (sheet map K-34-43-A-a
According to Kadra A., Milushi I. (2010)

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III.1. Oceanic formations

In Bajgora – Kacandolli area, the oceanic formations are widespread and represented by: 1. Basaltic formations and basalt - radiolarites of Triassic age 2. Mantle sequence formation, mainly Jurassic harzburgite, 3.. Metamorphic sole formation.

A summary description for each formation is presented here below:

III.1.1. Basaltic sequence and Triassic basalts and radiolarites

Basalts are widespread in the western part of the area. In the bottom of the sequence they are associated with phyllites, while in the middle and upper parts, in close association with the basalts are encountered radiolarian cherts and argillaceous cherty shales. Basalts are green-gray in color and consist of plagioclase, monocline pyroxene (often epidotized), chlorite and actinolite. Sphene, apatite, leucoxene and carbonates are also present. Few disseminations of sulphide are present. We are talking here about low-grade metamorphism. In the radiolarian siliceous rocks associated with basalts, in north of Gumnishte, Pirdeni determined Archaeodictyomifra sp dating the Upper Triassic age. These definitions support the interpretations made by Kodra & Milushi (2010).

Memovic&Knezevic (1995) and Maliqi. (2003) were carried out the chemical analysis of the basaltic rocks from the region (Table 1)

In previous published maps, the age of basalts of Bajgora – Kacandoll area is considered different by different authors: a. Paleozoic (Barth et. al., 2006); b. Upper Jurassic (Vukmanovic et. al., 1982); Jurassic (undivided) (Knoblock &Legler 2006; Abazi, &Legler 2006); Middle - Upper Triassic (Kodra and Milushi . 2010).

Table 1. Chemical composition of Triassic volcanics (according to Memovic E., Knezhevic V., 1995)

Pr.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O^+	H_2O^-	CO_2	Total
A	47.29	1.62	17.44	5.48	5.77	0.12	8.62	4.20	4.08	0.46	0.09	3.80	0.66	0.29	99.92
B	50.44	1,29	16.78	6.03	3.43	0.10	7.05	4.32	4.38	1.01	0.06	4.23	0.93	0.32	100.37

III.1.2. (Mantle sequence formations)

These formations are widespread in the northern and central parts of Kacandolli area. Mantle sequence formations are represented mainly by hazburgite, up to intensively serpentinized and serpentinite as well. In the northern part of the area are encountered dunite lenses with extension up to 40 - 50 m and the thickness rarely exceeding 2 m. The bending present almost in all harzburgite allows complex measurements of foliation. Characteristic are the complete absence of chromite mineralization and even the almost complete absence of accessory chromite grains.

III.1.3. Metamorpic sole formation

In the northwestern part of Kacandolli area were identified and mapped rocks of metamorphic sole. These rocks have been identified for the first time not only in this area, but in the whole area of the Vardar. The metamorphic sole is located under the mantle harzburgites and over the basalts and shales of Triassic age. It is represented by amphibolites, micaschists and greenschist facies. Clearly we have to do with the process of ironing that "ironed" both basaltic formations and underlined shales. However, a full study of metamorphic formations (metamorphic sole) is necessary for the entire area of the Vardar, which is essential for the interpretation of the geodynamic processes of inter-oceanic breaking-up and plunging-up to the oceanic basin closure of the Vardar. Because of the absence of isotopic previous studies, Kodra and Milushi 2010 are interpreting them in analogy with other similar areas, of Middle Jurassic age.

Chemical analysis of the samples of amphibolites and basalts were performed (Kodra A & Milushi 2010) at ACME Labs in Vancouver, Canada and the results are presented in the in the table here below. (Table 2).

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Tabela 2. Chemical composition of Triassic volcanis and amphibolite (According to Kodra A., Milushi I. 2010)

No.	SiO2 %	Al2O3 %	Fe2O3 %	CaO %	MgO %	Na2O %	K2O %	MnO %	TiO3 %	P2O5 %	Ba %	LOI %	Sum %	Tot/C %	Tot/ S%
19	52.9	16.94	9.56	8.03	3.32	3.28	2.13	0.19	1.29	0.44	0.1	1.73	99.9	0.18	<0.02
21	41.9	13.29	11.24	16.64	9.53	0.6	0.33	0.22	2.2	0.41	<0.01	3.76	100.1	0.06	<0.02
23	44.1	14.18	13.92	12.85	8.49	2.17	0.6	0.21	1.53	0.13	<0.01	1.62	99.78	<0.02	<0.02
24	48.8	14.59	12.54	10.36	5.69	3.28	1.49	0.21	1.6	0.17	0.02	1.62	99.98	<0.02	<0.02
No.	**Ba ppm**	**Be ppm**	**Co ppm**	**Cs ppm**	**Ga ppm**	**Hf ppm**	**Nb ppm**	**Rb ppm**	**Sn ppm**	**Sr ppm**	**Ta ppm**	**Th ppm**	**U ppm**	**V ppm**	**W Ppm**
19	957	2	18.4	6.5	19.5	5	10.3	69.4	2	1073	0.7	12.5	3.6	210	1.1
21	32	2	52.2	<0.1	16.6	4.9	28.5	2.4	2	182.6	1.9	4.1	1.6	344	0.6
23	57	<1	54.3	0.2	17	2.2	3.5	6.4	<1	186.4	0.2	0.3	0.4	404	<0.5
24	175	<1	49.4	1.3	17.3	2.7	4.1	38	<1	228.8	0.3	0.5	0.5	335	<0.5
No.	**Zr ppm**	**Y ppm**	**La ppm**	**Ce ppm**	**Pr ppm**	**Nd ppm**	**Sm ppm**	**Eu ppm**	**Gd ppm**	**Tb ppm**	**Dy ppm**	**Ho ppm**	**Er ppm**	**Tm ppm**	**Yb Ppm**
19	183.2	35	38.7	80	9.93	42.8	8.11	2.09	7.29	1.15	6.53	1.33	3.72	0.53	3.58
21	190.7	30.8	26.2	55.7	7.13	32.9	6.2	2.05	6.45	1.01	5.89	1.16	3.22	0.45	3.11
23	81.6	35.6	3.8	11.8	1.96	11.7	3.57	1.3	5.27	0.96	6.22	1.39	3.98	0.55	3.97
24	96.5	34.3	5.2	14.6	2.39	13.4	3.73	1.33	5.34	0.97	6.18	1.3	3.8	0.54	3.69
No.	**Lu ppm**	**Mo ppm**	**Cu ppm**	**Pb ppm**	**Zn ppm**	**Ni ppm**	**As ppm**	**Cd ppm**	**Sb ppm**	**Bi ppm**	**Ag ppm**	**Au ppb**	**Hg ppm**	**Tl ppm**	**Se ppm**
19	0.53	1.4	13	13.8	72	7.6	2.8	<0.1	<0.1	0.1	0.1	1.3	<0.01	0.1	<0.5
21	0.45	0.2	12.7	46	63	84.5	6.6	<0.1	0.5	<0.1	<0.1	2.5	<0.01	<0.1	<0.5
23	0.58	0.1	85.9	3	45	61.2	0.7	<0.1	<0.1	<0.1	<0.1	0.6	<0.01	<0.1	<0.5
24	0.54	<0.1	27.9	23.5	56	39.1	1.4	<0.1	0.5	<0.1	<0.1	3.3	<0.01	<0.1	<0.5

Based on the above data and compared with those of the Triassic basalts, is clearly verified that we have to do with very similar formations and obviously confirms the interpretation that the metamorphic sole was formed by the metamorphism of the Triassic basalt and shale. From our field observations is indicated that the harzburgites of Kopaonik massif in direct contact with the metamorphic sole are intensively serpentinized and slaty cleavage. In rare cases, are even encountered ultramylonite with very limited size, belonging to a high-pressure and low-temperature metamorphism (LT, HP). Regarding the full mapping of the metamorphic sole, more detailed works are necessary.

III.2. Sedimentary formations of Jurassic - Cretaceous and Cretaceous overlying ophiolites

In Kacandolli area is clearly mapped the flysch of Upper Jurassic - Lower Cretaceous and Lower Cretaceous - Upper Cretaceous spread in the eastern part of the region that is included in the subzone of the EastVardar (Fig. 4) ,and platform limestones and Upper Cretaceous flysch spread in the western part of the region that is included the West Vardar subzone (fig. 3).

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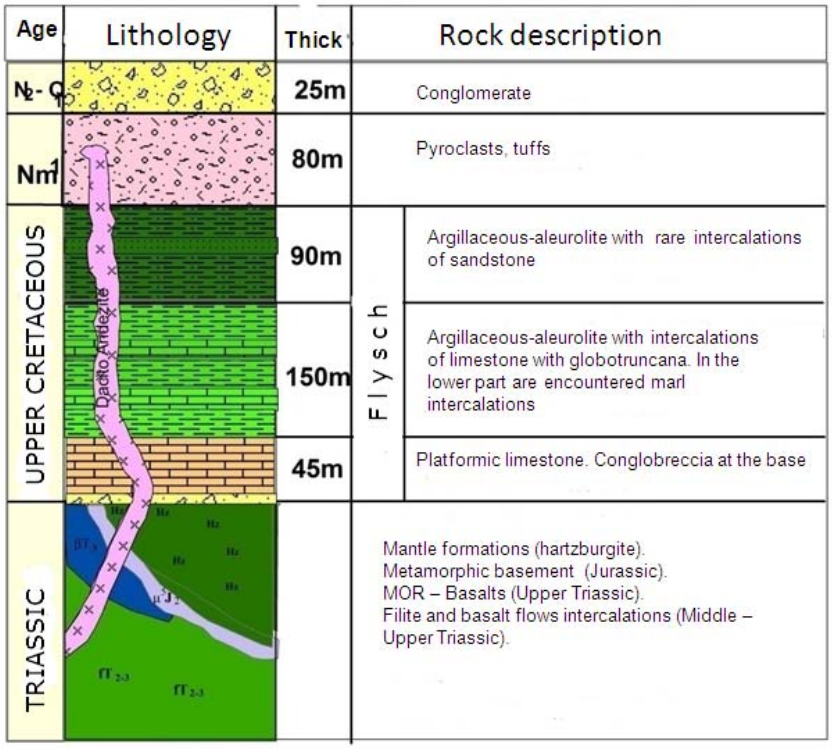


Fig. 3: Lithostratigraphic column of the western sub-zone of the Vardari zone (Bajgore – Kacandoll area)

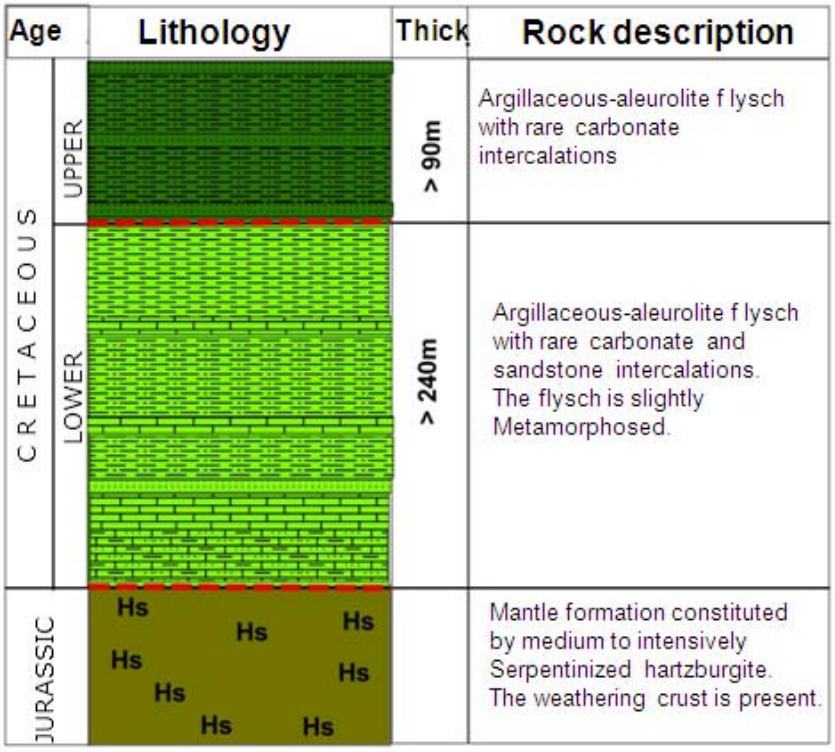


Fig. 4: Lithostratigraphic column of the eastern sub-zone of the Vardari zone (Bajgore – Kacandoll area)

III.2.1. Flysch formations of the Upper Jurassic-Lower Cretaceous

Flysch formations of the Upper Jurassic Lower Cretaceous overlaying the mantle harzburgite are widely spread in the area. They have NNW-SSE striking and sharp dipping toward NNE and a thickness about 150 m. These formations consist ofargillaceous – aleuritic flysch with porcelanous limestone intercalations, siliceous rocks etc. The porcelanous limestone shows pelagic microfacies with calpionellids, radiolarians, sponge spicules, and filaments of pelagic bivalves, etc.

The micropaleontologic associations were determined by Pirdeni and contain abundant *Calpionella alpina* Lorenz, *Crassicollaria intermedia* Duran-Delga, *Crassicollaria parvula* Remane, *Globochahete alpina* Lombard, *Saccocoma* sp.

The associations mentioned above belong to Upper Tithonian. In the eastern part of the region, Vukanoviq, et. al. (1982) identified the presence of *Calpionellopsis oblonga* Cadisch, Tintinopsella sp. etc., showing a Valanginian-Hauterivianage. The presences of calpionellids, red siliceous rocks and the lack of macrofauna etc., are indicators that show the great depth of the marine environment where the formation was settled.

III.2.2. Lower Cretacous-Upper Cretacous flysch formation

This formation has limited spread, only in the eastern part of the region. It is represented mainly by sands and aleurolites with rare intercalations of carbonate rocks.

Vukmanovic et.al. (1982) determined: *Hedbergella* cf. *infracretacea* Glaessner , *Praeglobotruncana* stephani Gandolfi , *Planomalina* cf. *buxtorfi* Gandolfi, *Rotalipora appenninica* Renz, etc. The above mentioned associations belong to Albian – Cenomanian. The thickness of this flysch is about 100 m, while relations with flysch formation of Upper Jurassic-Lower Cretaceous are faulted everywhere

III.2.3.Upper Cretaceous formation

This formation is widely spread in the western part of the region, extending NNW - SSE and dipping towards VLL and can be clearly divided in two sub-formations:

1. A sub-formation of (inner) platform limestones with rudists and a conglobreccia at the base . This sub-formation transgressively lies on the mantle sequence formations (mainly harzburgite), oceanic crust formation (mainly Triassic basalts and in some places over the metamorphic sole). The basal conglomerates (transgressive lag deposit) have limited thickness (up to 10 m) while the overlaying platform limestone, is over 30 - 40 m in thickness, thick –layered and light - gray in color. Conglobreccia contains elements represented by light colored dolomitic sparrudite or bio-sparrudite showing bioclasts represented by algae, rudists,etc..

Vukmanovic et. al. (1982), have reported the presence of: *Hippurites* (Vaccinites) *inaequicostatus Munster*., Hippurites (Vaccinites.) oppeli Douville, Hippurites (Vaccinites.) vredenburgi Kuhn , *Radiolites angeiodes* Lapeirouse, *Radiolites squamosus* d'Orbigny, etc.

Based on the above fauna it is determined the age of Upper Campanian – LowerMaastrichtian

2. A sub-formation of argillaceous aleuritic - marly flysch with intercalations of G (limestones with Globotruncana that represent the gradual and normal continuation of the platform limestones sub-formation. Its thickness is about 240m sub-formation.

The intercalations of pelagic limestones show microfacies with globotruncanids, globigerinids, heterociclids,,radiolarians etc. Pirdeni determined micropaleontological associations represented by:*Globotruncana conica* White, *Globotruncana stuarti* De Lapparent, Abathomphalus mayaroensis Bolli *Rosita contusa* Cushman, etc., belonging to Campanian –Maastrichtian

III.3. Miocene magmatic formations (dacite-andesite and pyroclastic rocks)

Miocene magmatism has limited spread in Bajgora – Kacandolli area. This magmatism is represented by dacites, andesites, pyroxenites and a small outcrop of exo-granodiorite. Andesites are represented by small outcrops of hornblende andesite, gray- brown in color and good crystallization. Dacites are distinguished by the presence of plagioclase and quartz phenocrystals.

- On the basis of chemical analysis the basalts of Bajgora – Kacandolli area are of MORB type.
- For the first time are found in the area andesite and dacite of Miocene age.
- For the first time is deciphered the internal structural construction of the ultrabasic rocks.

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In addition, in this study are done very important structural interpretations

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REFERENCES

Abazi Sh., Legler C. (2006) – Digital Geological Map of Kosovo (Podujeva). Scale. 1: 100 000. Arkiva e KPMM Prishtine.

Barth et. al., (2006) - Map of Minerals of Kosovo. Sc. 1: 200 000. Arkiva e KPMM, Prishtine.

Boue A. (1840) – La Turqie d'Europe.

Elezaj Z., Kodra A. (2008) – Gjeologjia e Kosovës. Botimi i Universitetit te Prishtines. Biblioteka e Universitetit te Prishtines.

Knobloch, Legler,C. (2006) - Geological Map of Kosovo. Scale: 1/ 200 000. Arkiva e KPMM, Prishtine.

Kober L. (1929) – Die grosgliederung der Dinaride Central. F. Min. Abl. B. 425 – 437.

Kodra A., Milushi I. (2010) – Raport i rilevimit gjeologjik ne shkalle 1:25000 ne rajonin Bajgore - Kacandoll. Arkiva e KPMM, Prishtine.

Kossmat F. (1924) – Geologie der Zentralas Balkanhalbisnel. Mi einer Ubersicht des dinarischen Gebirgabaues. 198 f. Berlin

Maliqi G. (2001) – Ndërtimi gjeologjik e strukturor i rajonit të Trepçes. Disertacion. Biblioteka e Universitetit te Prishtines.

Memoviq E., Knezheviq V. (1995) – Triassic volcanic rock from the Trepça area: their petrology and tectonic setting. Am. Geol. Penins. Balk. Belgrade.

Meshi A., Boudier F., Nicolas A., Milushi I. (2009) – Structure and tectonics lower crustal and upper mantle rocks in the Jurassic Mirdita ophiolites. Journal of Alpine Geology, Wien. Vol. 47, pp 103 – 118.

Millosheviq M., Vukanoviq M., et. al. (1980) – Tumaq i kart za list Kurshurulija (K–34–31) Beograd.

Vukanoviq M., et. al. (1982) – Kartu i Tumaq za list Podujevo (K–34–43). Osnovna, Geolloshka Karta 1 : 100 000. Belgrad

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MANAGEMENT OF ANALOGUE SEISMIC DATA STORAGE IN THE AREA OF BELT KORCE-OHER-PESHKOPI (ALBANIA) USING GIS.

Ariana BEJLERI[1], Majlinda CENAMERI[2],
[1] *Polytechnic University of Tirana, Faculty of Information Technology, Tirana, Albania*
[2] *Polytechnic University of Tirana, Faculty of Geology and Mining, Tirana, Albania,*
e-mail: arianabejleri@yahoo.com. m_cenameri@yahoo.com.

ABSTRACT.
This paper presents the use of Geographic Information Systems (GIS) in managing information of earthquakes for period 1998- 2004 in the belt Korce-Oher-Peshkopi. Application of GIS techniques allowed us to manage, and to present seismological activity in the studied region, which itself constitutes the key parameter of the seismic risk. It is developed a relational and integral database in Access which was integrated with GIS software. There are established several maps upon these data, where the manual data are returned in spatial data with respective coordinates. One of the main functions of these thematic maps will be manipulation of this data: time of event, magnitude, intensity, depth of source etc. The graphs have been also plotted, which can be updated at the moment of the data manipulation. This paper is also applicable in future research studies and is a good start, especially in defining the historical seismicity of our country.

KEY WORDS: *Management, GIS, seismic data, Korce-Oher-Peshkopi belt, magnitude, intensity, depth of source.*

1 INTRODUCTION

Albania is a country with high seismic activity. Through seism tectonic studies for Albania are defined several seismic belts. We have taken into consideration seismic events related to Korce-Oher-Peshkopi belt. These data are managed: Event number, Date, Exact Time, Latitude, Longitude, Depth, Magnitude ML (Richter), Intensity (Ball), Epicenter, Areas which lie in this belt [2][4]. With these data it is building a database for seismic events registered from 1998 to 2004. After construction of this database using Geographic information system GIS the data are imported into the map to display clearly the epicenter of the earthquake location to continue their further analysis. The GIS is a useful tool to easily recognize characteristic of seismic events superposing geographic and geological maps as well as data of the seismic events. In this paper Using the GIS, is presented epicenter distribution of earthquakes in this belt and other properties of them.

2 SOURCES OF SEISMIC DATA

A great deal of analogue seismic information has been collected over years by the seismological network in Albania and neighbor countries. Earthquakes registered until 1968 were collected and processed in a systematic way of seismological stations of Europe. After 1968, when the Albanian Seismological Network started operating , it could handle a complete information regarding distribution in space and time of seismic micro-activity with its epicenter not only domestically, but also in neighboring countries or at sea, close our borders [1].

Seism tectonic studies [3] and [4] have determined several seismic belts in Albania; two belts of strong longitudinal: the belt Korcë-Ohër-Peshkopi and the belt Joniko-Adriatik. These areas intersected by transverse powerful lines as Lushnje-Elbasan-Dibër,Shkodër-Pejë and Vlorë-Tepelenë. We have taken into consideration the belt Korce-Oher-Peshkopi. Seismic area Korçe - Oher – Peshkopi. Seismic area, in other words, the active foults of Drinit, has an extension nearly North-South with higher Geodynamic activity and higher seismicity in eastern Albania. With this area are associated a lot of earthquakes both domestically and abroad, belonging instrumental seismicity in the twentieth century [3].This is the reason why the study was undertaken in this region.

3 GEOGRAPHIC INFORMATION SYSTEM (GIS) A GENERAL DESCRIPTION

We have used GIS Arc-View 9.2 software (ESRI) [5] and [6] and is structured in thematic vectorial levels and rasters. A modern Geographical Information System is a computer system designed to store, analyze, and display geographic information. The geographic information may be any of an infinite variety of data sets each associated with a spatial coordinate system. The spatial referencing of the information permits the data sets to be linked. This linkage provides a powerful tool for analysis and integration of data sets from many different sources using the same GIS software. In general, each GIS is comprised of basic components that permit the input, manipulation, analyses, archival, and output of spatially referenced data. Following is a brief summary of technical aspects of these components and associated analyses functions. Formally defined a GIS is a computer-based system that provides for 1) input, 2) management (data storage and retrieval), 3) manipulation and analysis, and 4) output of geo referenced data. These basic components of a GIS are illustrated in Fig. 1.

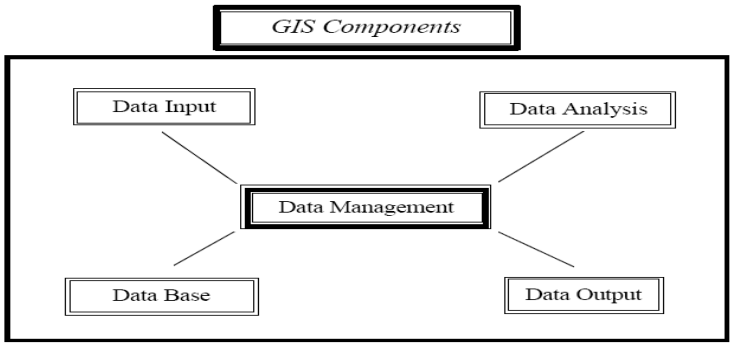


Fig.1. Components of a Geographic Information System (GIS)

The overlapping themes constitute a cartographic data base of the belt. The epicenters are located on a map at a scale of 1:10,000, with all the associated information on the 1998-2004 earthquakes. The GIS is structured in such a way as to be able to be integrated with further georeferenced data and with other databases. It is thus able to provide support for in-depth analyses of the dynamic processes on the belt.

4 CONSTRUCTING THE BASE MAPS

We have analyzed the problems to be solved [8]. We have built the algorithm and have determined which data must be digitalized and how they are related to each other. Microsoft Excel was used to create the earthquake data tables in catalogue view. We have used the earthquake catalogues [4] for the years 1998-2004.The information in these catalogues consist in the: Event number, Date, Exact Time, Event Latitude, Event Longitude, Depth, Magnitude ML (Richter), Intensity(Degree), Epicenter, Areas which lie in this belt. A database is designed upon this catalogue using access techniques.
We have designed tables which contain all the data needed [10]. This tables are related between them with one to many relationships. After that we have built many queries [7]. A lot of them are in SQL language [9]. One of them is a query which gives us the areas lie in the belt Korce-Oher-Peshkopi.

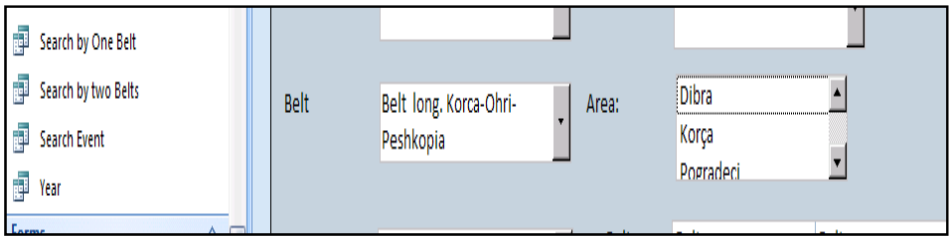


Fig.2. Search by one belt

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We have designed complicated queries to find every data the user needs. One of this queries is the query Search Event. This query searches and displays all the events information occurred in a given date interval, latitude and longitude interval, depth interval, magnitude Ml (Richter) interval and intensity interval.

Home | Search | Search Event

```
SELECT Event.Event_ID, Event.Date, Event.Hour, Event.Event_Latitude, Event.Event_Longitude,
Event.Depth, Event.[Magnitude ML (Rihter)], Event.[Intensity Io (Balli)], Event.Epicentre,
Area.Area_Name, Belts.Belt_Name, Belts_1.Belt_Name
FROM Belts AS Belts_1 INNER JOIN ((Belts INNER JOIN Area ON Belts.Belt_ID=Area.Area_Belt_1)
INNER JOIN Event ON Area.Area_ID=Event.Area_ID) ON Belts_1.Belt_ID=Area.Area_Belt_2

WHERE (((Event.Date)>=forms!Search!YearBelt) And ((Event.Date)<=forms!Search!YearBelt2)
And ((Event.Event_Latitude)>=forms!Search!LatBelt) And ((Event.Event_Latitude)<=forms!Search!LatBelt2)
And ((Event.Event_Longitude)>=forms!Search!LongBelt) And ((Event.Event_Longitude)<=forms!Search!LongBelt2)
And ((Event.Depth)>=forms!Search!DepthBelt) And ((Event.Depth)<=forms!Search!DepthBelt2)
And ((Event.[Magnitude ML (Rihter)])>=forms!Search!MLBelt) And ((Event.[Magnitude ML (Rihter)])<=forms!Search!MLBelt2)
And ((Event.[Intensity Io (Balli)])>=forms!Search!Intensity) And ((Event.[Intensity Io (Balli)])<=forms!Search!Intensity2))

ORDER BY Event.Date, Event.Hour, Event.Event_ID;
```

Fig.3. Search Event

These data are displayed in surface area through thematic maps using GIS program. In Fig.4 is designed the map of seismic belt and neighboring countries. In this map we have used the green color to show the belt and red symbols for epicenters.

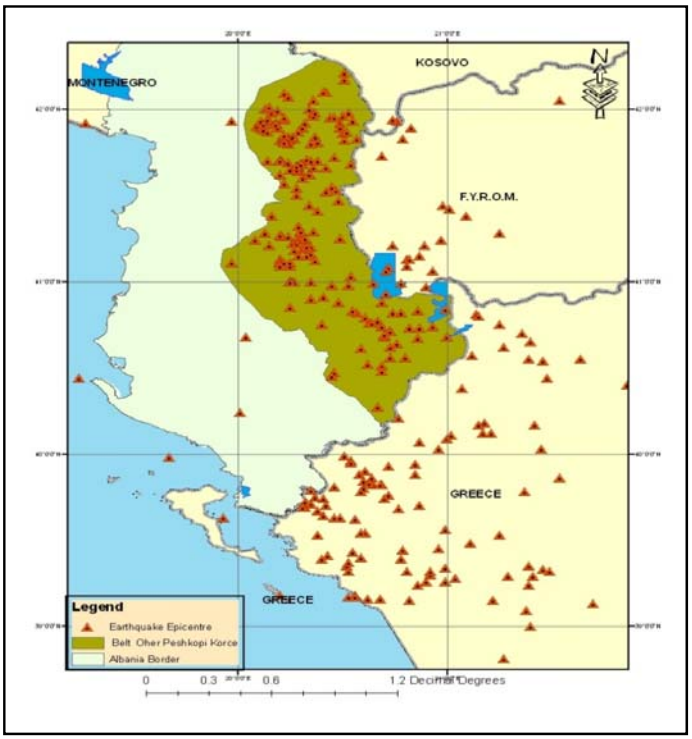


Fig.4. The map of the seismic belt Korce Oher Peshkopi

In the Fig.5 we have designed another thematic map. In this map are presented through red lines the new active faults, blue lines the back thrust tectonic faults and pink the over thrust tectonic faults. It is obviously seen that these lines meet with zones of high density of earthquakes.

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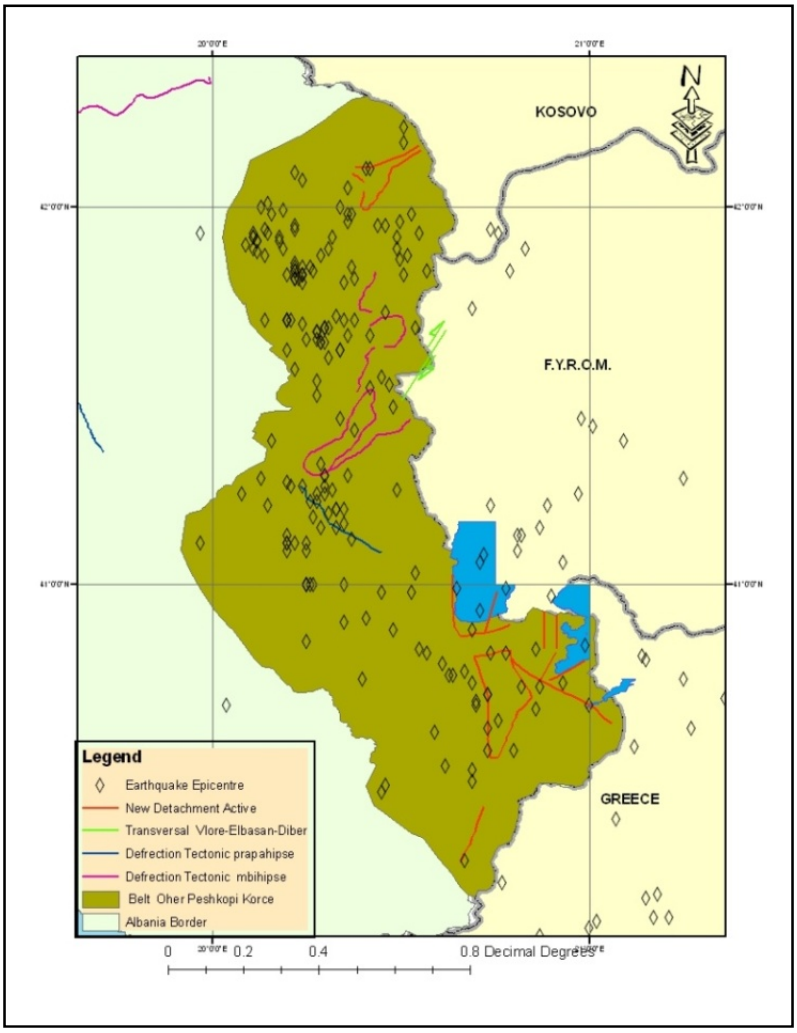


Fig.5. The map of the tectonic faults

In Fig.6 is displayed an identification to show that after any clicking on every epicenter are exposed the corresponding data for example: time, coordinates of epicenter, the depth, magnitude, intensity, **etc.**

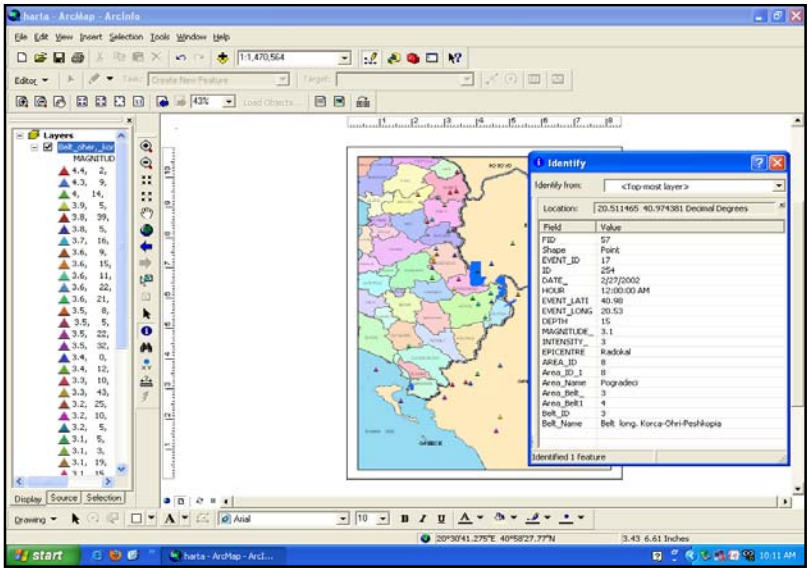


Fig.6. The identification of event properties

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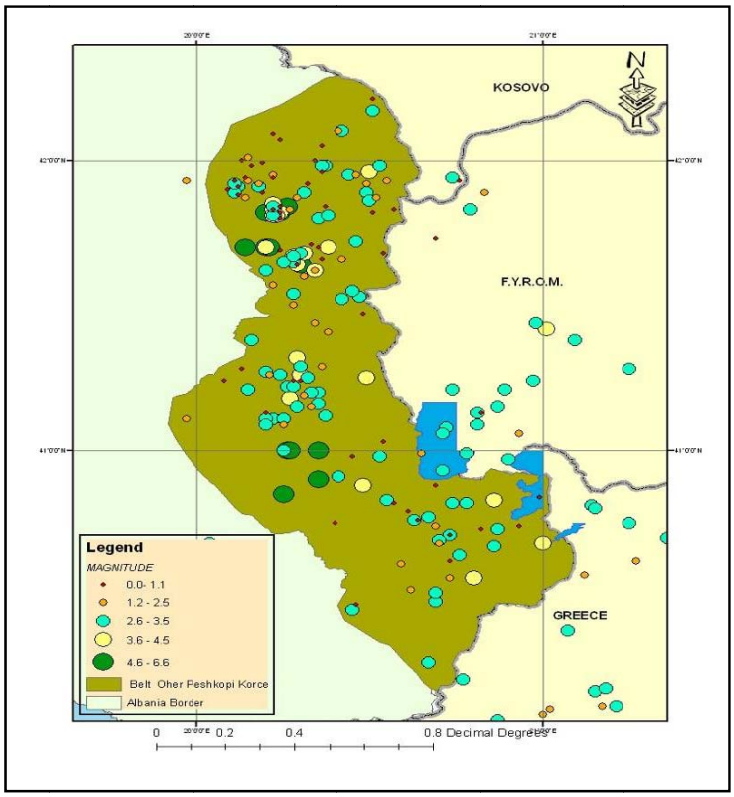


Fig.7. The map of distribution of earthquake epicenters by magnitude

In Fig.7 is displayed the map of spatial distribution of earthquake epicenters, according to 5 groups of magnitude values, shown on the legend of map. The used symbols have different size and colors, according to the intervals of groups values. The distribution of earthquake centers generated from tectonic faults clearly shows the areas of high seismic activity level . By clicking on every epicenter, automatically will be displayed all properties of seismic event.

With this program we can make an infinite number of searches. In the following figures are displayed two examples of searches.

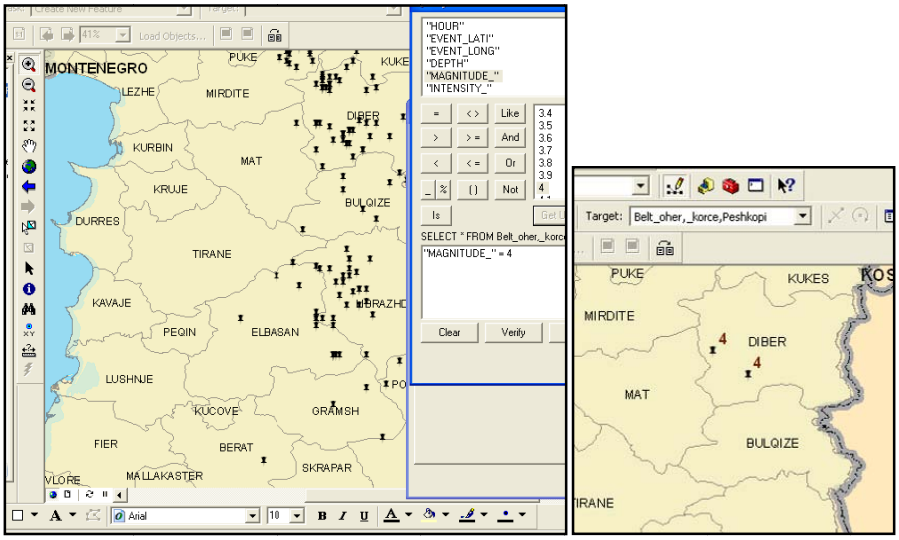


Fig.8. A query of epicenters of earthquake with magnitude 4

In the Fig.8 is designed a query of earthquake epicenters with magnitude 4. In this map we can see only the earthquakes with magnitude 4 associated with label magnitude. In the same way we can design other maps for every value of magnitude.

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In the Fig.9 is designed a query of earthquakes epicenters with intensity equal and more than 6. In this map we can see only the earthquakes with intensity equal or higher than 6.

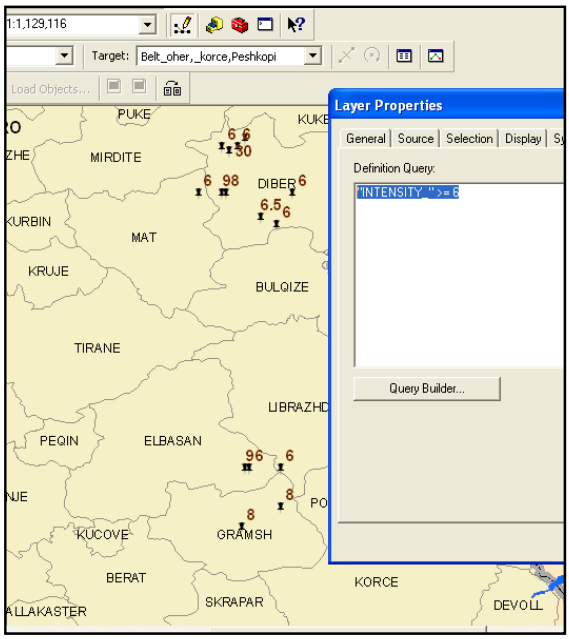


Fig 9. Query of earthquakes epicenters with intensity equal or higher than 6

In Fig.10 is displayed the map of surface distribution of earthquake epicenters, according to 5 groups of depth values, shown on the legend of map. The different symbols in size and color, according to the intervals of groups values, show the type of earthquake: superficial, intermediate or deep. By clicking on every themes in this map we find all the events information (date, latitude, longitude, magnitude Ml (Richter) and intensity).

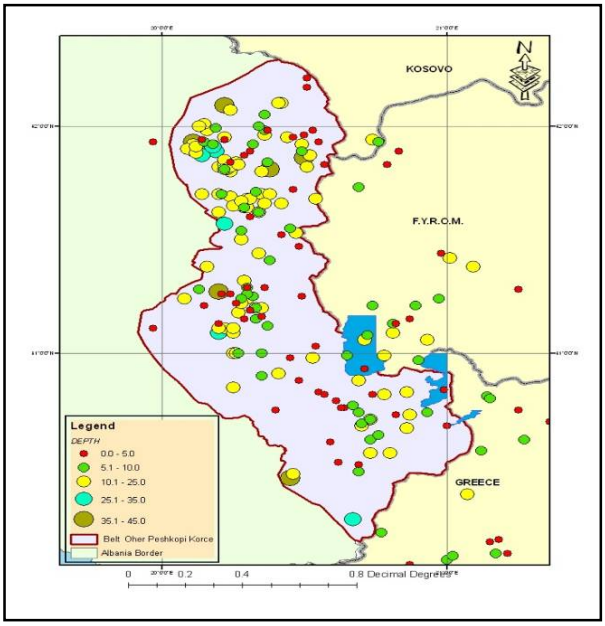


Fig.10. The map of surface distribution of earthquake epicenters, according to 5 groups of depth values

This data searched can also be viewed in graphical view in order to better understand the seismic situation. Figure.11 shows graphical view of intensity level of earthquakes during the interval time 1998-2004 for the belt Korce-Oher-Peshkopi.

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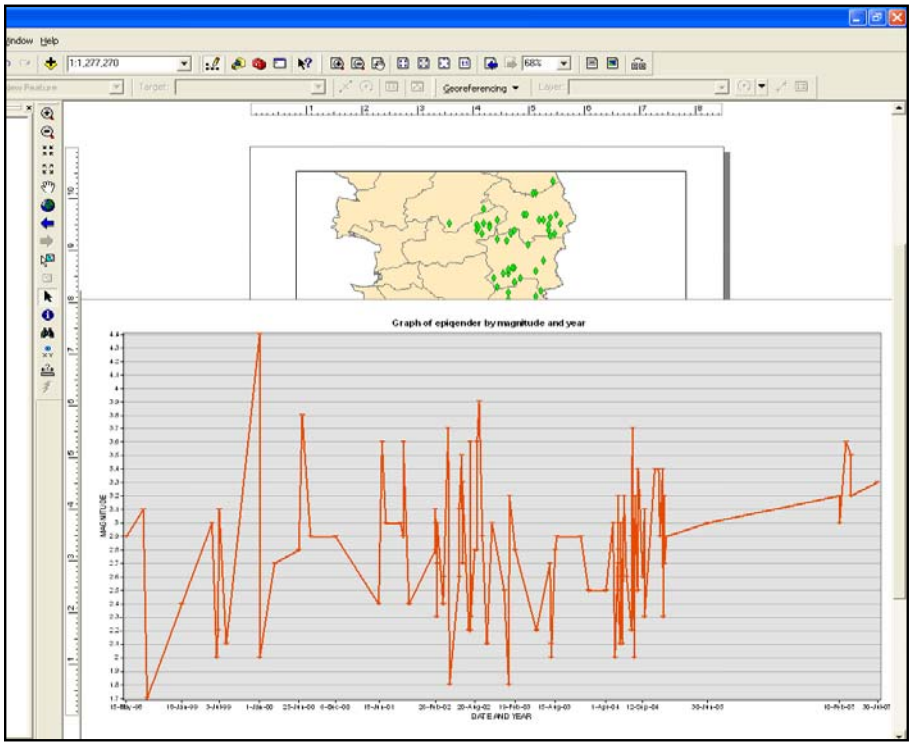


Fig.*11. The graphical view of intensity level of earthquakes during the interval time 1998-2004*

5 CONCLUSIONS

This database:

1. Organizes and displays all information associated with seismic event in the belt Korce-Ohër-Peshkopi.
2. Finds all the events information occurred in a given time interval, latitude and longitude interval, depth interval, magnitude Ml (Richter) interval and intensity interval.
3. Finds all zones included in the belt Korçë-Ohër-Peshkopi.
4. The database is integrated through GIS software reflecting in the map the seismic events occurred in this belt.
5. By clicking on every themes in all maps can be found all the information that accompany a seismic event (date, latitude, longitude, magnitude and intensity).
6. Thematic maps to obtain the detailed information for a single parameter can be set up.
7. Any needed information can be quickly tracked by using thematic maps.
8. Serves as basis for further studies the for complex problems related to seismic activity in the belt Korçë-Ohër-Peshkopi enabling the best decisions to be taken for the future.

REFERENCES

1. Muçaj, B.: Tërmetet, Demonët e tokës. Shtepia botuese enciklopedike. Tiranë(1996)
2. Muçaj, B.: Tërmetet dhe rreziku sizmik. Veprimtaria vullkanike (2002)
3. Aliaj Sh.: Sizmotektonika dhe kriteret gjeologjike të sizmicitetit të Shqipërisë (1979)
4. Buletinet mujore sizmologjike: Instituti Sizmologjik Tiranë. (1998-2007)
5. Applications of Geographic Information System Technology to Seismic Zonation and Earthquake Risk Assessment - Paper presented in Fifth International Conference on Seismic Zonation, (1995).
6. HAZUS Technical Manual
7. McFedries, P.: Microsoft Office Access 2007 Forms, Reports, and Queries. (2007)
8. Alexander, M.: Microsoft Access 2007 Data Analysis. (2007)
9. Demertzoglou, P. E.: Access 2007 Pure SQL: Real, power-packed solutions for business users, developers, and the rest of us (2009)
10. Coronel,C.,Morris, S., Rob, P.: Database Systems: Design, Implementation and Management (2009)

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ADVANCEMENT IN IP/RESISTIVITY "REAL SECTION" PRESENTATION

Perparim ALIKAJ[1,3], Neat LIKAJ[2], Altin KARRIQI[1], Erjon COLLAKU[3],
[1] *Polytechnic University of Tirana, Faculty of Geology and Mining, Tirana, Albania*
[2]*Automation X, Graz, Austria*
[3]*Tirex Explorations, Tirana, Albania*
e-mail: alikajp@albmail.com neat.likaj@automationx.com akarriqi@gmail.com erjon84@gmail.com

ABSTRACT

The paper treats some major advancement in IP/Resistivity "Real Section" presentation regarding terrain correction and current flow distribution between the current electrodes in a Gradient array. Special algorithm and related software was prepared for this purpose and the first tests were conducted in a new exploration area belonging to Tirex Explorations in Northern Mirdita VMS belt, in between Qafe Bari and Munella polymetallic ore deposits in Albania. Through comparison between conventional and corrected IP/Resistivity "Real Section" presentations, an important improvement in target location is observed in the later one. This advancement markedly increases the effectiveness of "Real Section" technique performed with Gradient array.

KEY WORDS: *Induced Polarization, Electrical Resistivity, IP/Resistivity "Real Section", Gradient Array, Terrain Correction.*

INTRODUCTION

The IP/Resistivity "Real Section" technique (Langore, Alikaj & Gjovreku, 1989, Roth 1997) was presented in Albania since 1978 and by 1991 it was implemented in Canada by Perparim Alikaj and Dennis Morrison. The basis of this Electrical Prospecting technique stands in data acquisition, data processing and data presentation. The IP/Resistivity "Real Section" survey employs the measurements in the inner part of electrical field of a current dipole, like Schlumberger, Wenner or Gradient arrays. Due to higher output and simple anomaly shape, the "Real Section" technique has been largely used with Gradient array. Through repeated measurements of multiple Gradient array separations, important horizontal as well vertical information of apparent chargeability and resistivity parameters are obtained in section. The plotting technique of observed measurements in section is realized through some depth coefficients that harmonize the length of current electrode separation with approximate depth of investigation according to studies made for this array by Roy and Apparao in 1971, two dimensional "Real Section" scale models (Alikaj, 1981) and mathematical "Real Section" models (Frasheri, & Frasheri, 2000). Even though the "Real Section" technique provides a qualitative interpretation of apparent chargeability and resistivity parameters (this is the reason why it is under quotation signs), it has shown a very good corroboration with geological sections in various geological environments, providing a so called "physical inversion" of the geoelectrical parameters, similar to electrical tomography. Through IP/Resistivity "Real Section" technique depth of exploration down to over 1000 m has been proved by drillings. The technique is successfully being used by several companies in various parts of the world, sometimes under different names. The applications are in mining exploration, groundwater exploration,

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engineering geology studies, oil and gas exploration, environmental studies, archeological studies, etc.

CORRECTED IP/RESISTIVITY "REAL SECTION"

The IP/Resistivity "Real Section" survey performed with multiple Gradient arrays enjoys all the advantages and disadvantages of a typical Gradient array. The known advantages of such array are: simple anomaly shape (due to array symmetry), deep exploration even over low resistivity cover areas, best resolution in multiple steep dipping targets, etc. Among the disadvantages can be mentioned: poor vertical resolution, strong EM coupling in Frequency Domain IP, anomaly displacement and distortion due to proximity to current electrode sectors, anomaly distortion due to relief, etc.

In "Real Section" technique the poor vertical resolution is overpass through a multiple current electrode separation survey that in addition to excellent horizontal resolution also provides a good vertical one, especially for targets at medium to great depths. To avoid EM coupling in IP measurements with Gradient arrays (especially the long separations), the surveys are carried out in Time Domain.

Unfortunately, the anomaly distortions due to proximity to current electrodes and rugged relief cannot be eliminated through multiple Gradient array data acquisition; moreover the distortions might be more enhanced. Part of solution is the survey restriction in a sector not wider than half of current electrode separation, in the center of array. Anomaly distortions in this interval are less important but again, this "remedy" does not include the terrain correction.

Both, anomaly distortions in proximity to current electrodes and rugged terrain are caused due to distortions of current flow from strictly horizontal direction, as happens in the center of Gradient array in a flat terrain. To make these corrections, an approximate mathematical consideration of current flow distribution between current electrodes (A and B) and its distortions due to terrain variations are merged into a special algorithm. Through a special key the depth of investigation is also incorporated in this algorithm. The related program was compiled in C++ language. The program has been successfully tested in IP/Resistivity "Real Section" scale models as well.

A field test of this program was recently made in a deep IP/Resistivity "Real Section" survey performed on behalf of the Canadian company Tirex Exploration operating in copper/zinc exploration north of Munella mine, in Northern Albania. In Fig. 1 is presented a general sketch of the integrated plan map, north of known VMS Munella mine which includes about 10 million ton with averagely 1.31 % Cu. The geology of the area consists of volcanic rocks, mostly rhyodacite and andesite – basalts. The mineralization comprises disseminated and veinlet/massive sulphides of pyrite, chalcopyrite and sphalerite. Gold and silver are among the associated elements as well. Based on airborne geophysical survey performed by Tirex Explorations an interesting EM anomaly was obtained several hundreds of meters northeast of Munella ore deposit. The anomalous area is located in a rugged terrain with no outcrops. To follow up this anomaly in the ground an IP/Resistivity "Real Section" survey was performed in a line that crosses the anomaly running ENE – WSW with a total survey sector of 1,600 m and depth of exploration down to 500 m in the center.

In Figs.2 and 3 are respectively presented the IP "Real Section" and Resistivity "Real Section" obtained in above mentioned survey line. These are conventional "Real Sections" without any kind of corrections. Two main chargeability anomalies are depicted in the IP presentation. The first one is noticed around the stations -100 and -300 starting from depth 400 m while the second one around stations 200 and 500, starting from depth 150m and remaining open at depth. Both these anomalies corroborate with decreased values in resistivity parameter, as clearly shown in the Resistivity "Real Section". The low resistivity anomaly around stations 200 – 500 near the surface is clearly connected to EM anomaly and is likely to be caused by a broad alteration zone

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of volcanic rocks. The deep component of the anomaly was interpreted as connected to concentrated sulphide mineralization, similarly to the low resistivity anomaly around stations -100 and -500.

The corrected analogous data of Figs. 2 and 3 are respectively presented in Figs. 4 and 5. As can be noticed, there are some drastic changes in both apparent chargeability and resistivity parameters regarding their shape and as a result in target location, particularly to the second anomaly.

To verify the first IP/Resistivity anomaly, a deep drill hole (812 m) was vertically drilled near station -200 with idea of steeply dipping target to the west. The hole intersected initially, at depth 250 m, a weak to medium sulphide zone of thickness 90 m with mostly disseminated to veinlet pyrite and some chalcopyrite and sphalerite in volcanic rocks. Starting from depth 470 m down to the end of hole, a broad zone (over 350 m) of disseminated to thick veins of pyrite but at various intervals with chalcopyrite and sphalerite was encountered. There are several intervals varying from 2.2 m to 11 m with grade 0.2 – 0.33 % Cu in this typical VMS mineralization, similar to Qafe Bari and Munella known ore deposits. The best intervals are 0.6 % to 1 % Cu located inside the 11m sulphide zone.

Looking carefully at conventional and corrected IP "Real Sections", a displacement of chargeability anomaly of about 100 m is noticed between them. If designed based on conventional presentation, the borehole had to be shifted 100 m to the west, which would have intersected a weak sulphide mineralization halo. The same comments stand more or less for resistivity conventional and corrected "Real Sections" in this anomaly.

Regarding the second IP/Resistivity anomaly around stations 200 – 500 in uncorrected or stations 350 – 650 in corrected IP/Resistivity "Real Sections" the shift is more drastic, reaching up to 150 m and switching the target's dip angle, from vertical to the East direction. To better understand this difference in the sections are presented two proposed drill holes, respectively DH 1 and DH 2, for conventional and corrected "Real Sections". The location of DH 1 for conventional IP/Resistivity "Real Sections" (Figs. 2 and 3) looks properly designed but considering the corrected IP/Resistivity "Real Section" (Figs.4 and 5) it seems in a completely wrong direction. If drilled, it would be a negative hole regarding the verification of the expected IP/Resistivity target. For this reason it is proposed that the drill hole DH 2 with right location, to be in opposite direction of drill hole DH 1.

So far, before this correction program, the conventional IP/Resistivity "Real Sections" have been manually considered in an approximate way for proper drill-hole design. The further surveys in this area and related verifying drillings will better prove the effectiveness of the corrected IP/Resistivity "Real Section" program.

CONCLUSIONS AND RECOMMENDATIONS

The corrected IP/Resistivity "Real Section" presentation markedly increases the effectiveness of target delineation in a geological section. The corrections include electrical current distribution between current electrodes and the terrain shape. The comparison between conventional and corrected IP/Resistivity "Real Sections" in a deep exploration area in northern part of Munella VMS ore deposit, in Albania, clearly indicates the better effectiveness of the later one.

We strongly recommend this correction in any IP/Resistivity "Real Section" survey technique.

ACKNOWLEDGEMENTS

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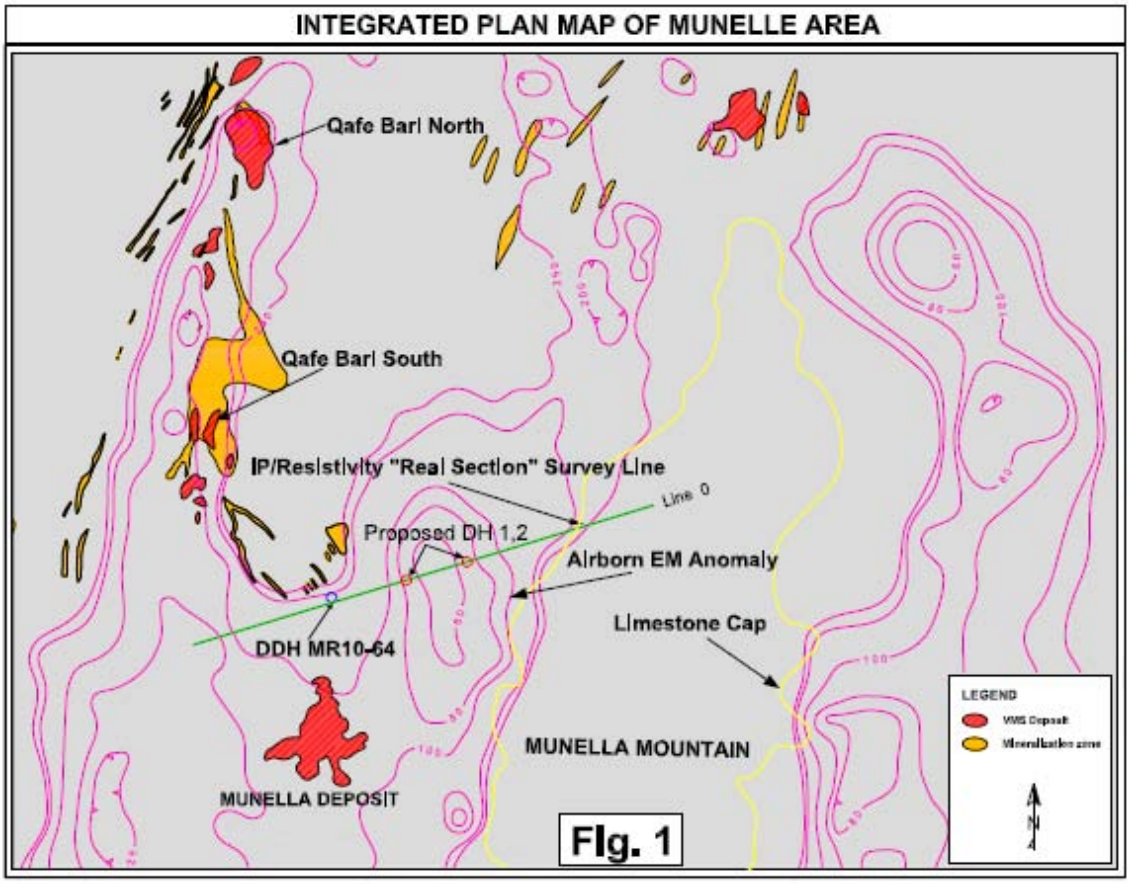
REFERENCES

Alikaj P., 1981 – Physical modeling of "Real Sections" performed with different separations of Gradient array. *Geophysical Enterprise Archive, Tirana, Albania.*

Frasheri A. and Frasheri N, 2000 – Finite element modeling of IP anomalous effect from bodies of any shape located in the rugged terrain area. *Journal of Balkan Geophysical Society, Vol. 3, No.1, February 2000.*

Langore L., Alikaj P. and Gjovreku D., 1989 – Achievements in copper sulphide exploration with IP and EM methods. *Geophysical Prospecting, Vol. 38, p 975 – 991.*

Roy A. and Apparao A., 1971 – Depth investigation in direct current methods. *Geophysics 36, p. 943 – 959.*



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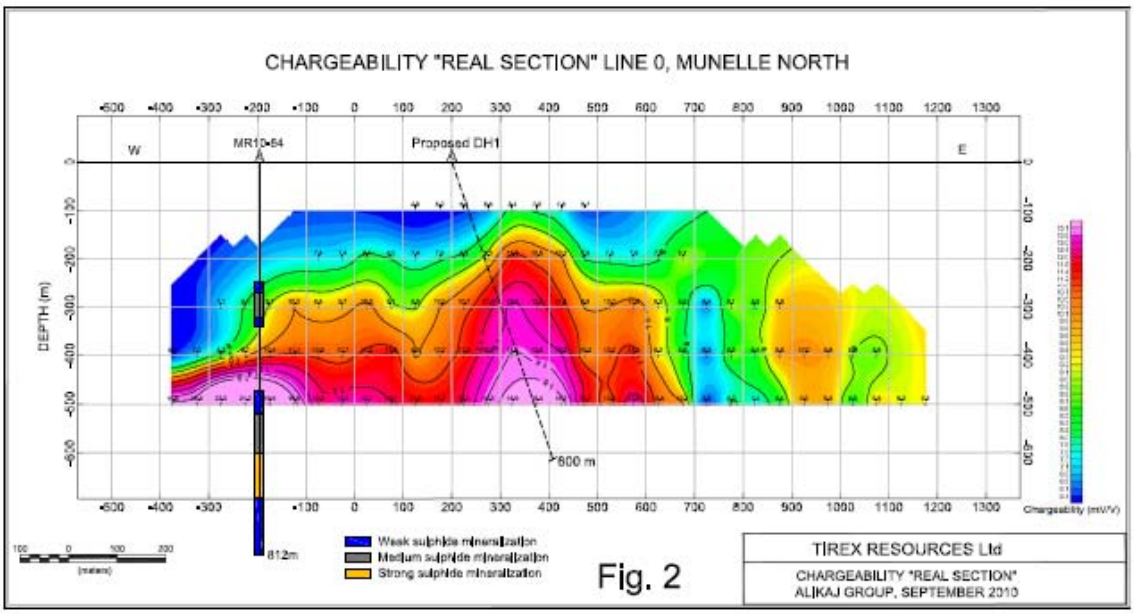


Fig. 2

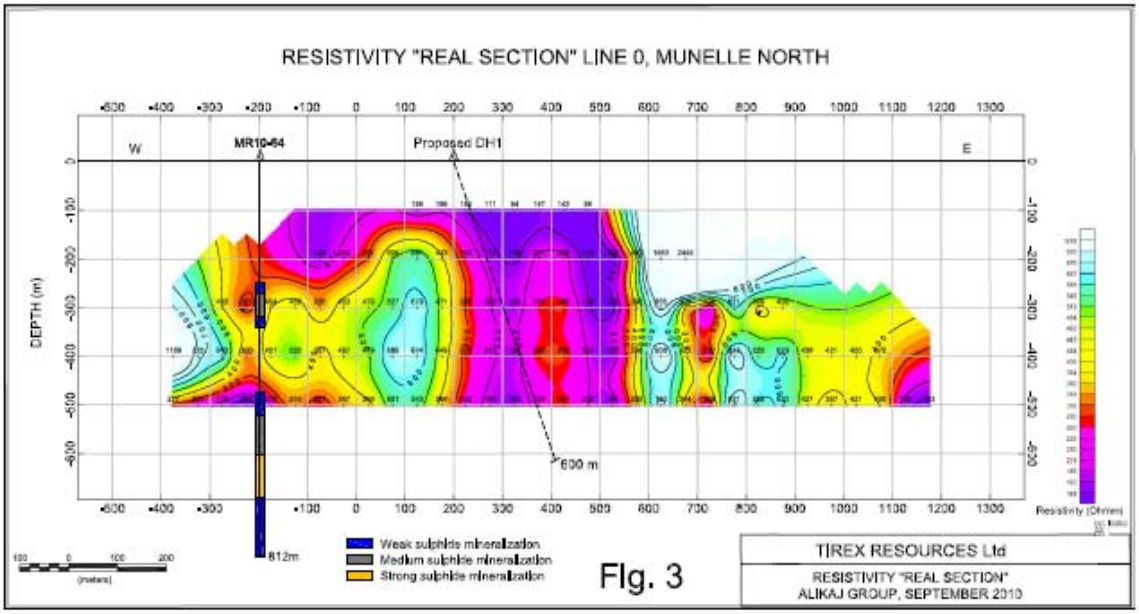


Fig. 3

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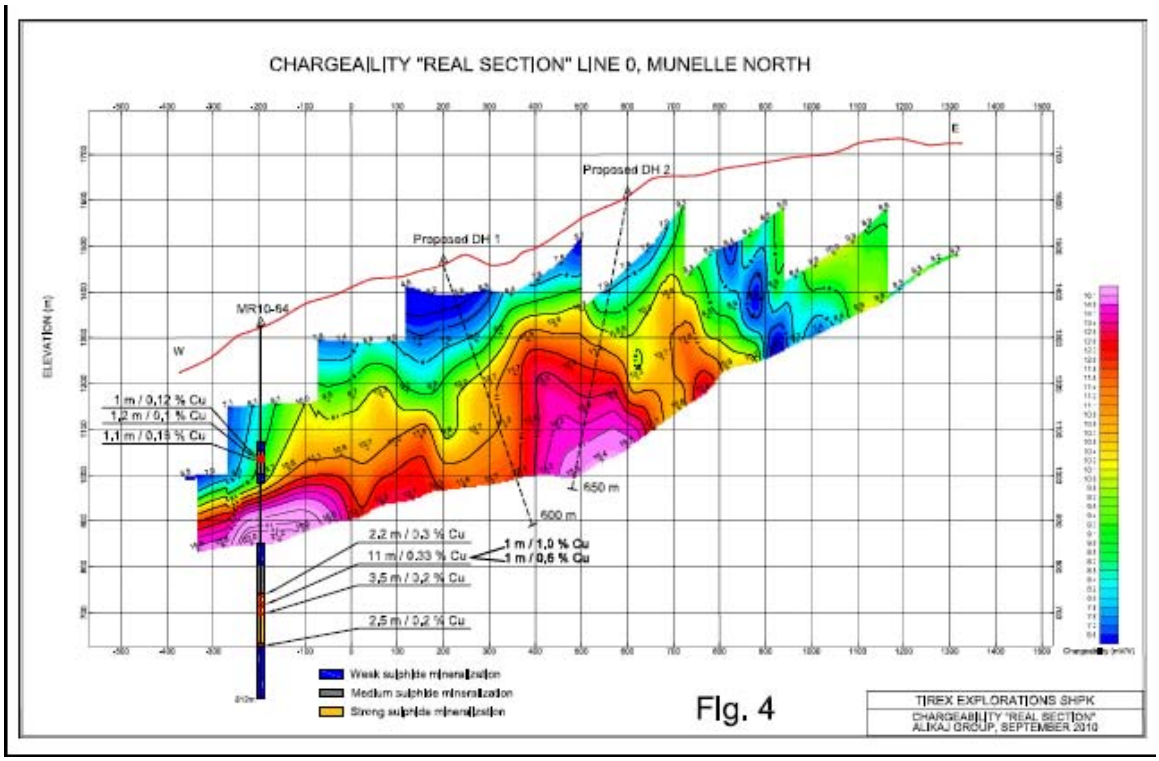


Fig. 4

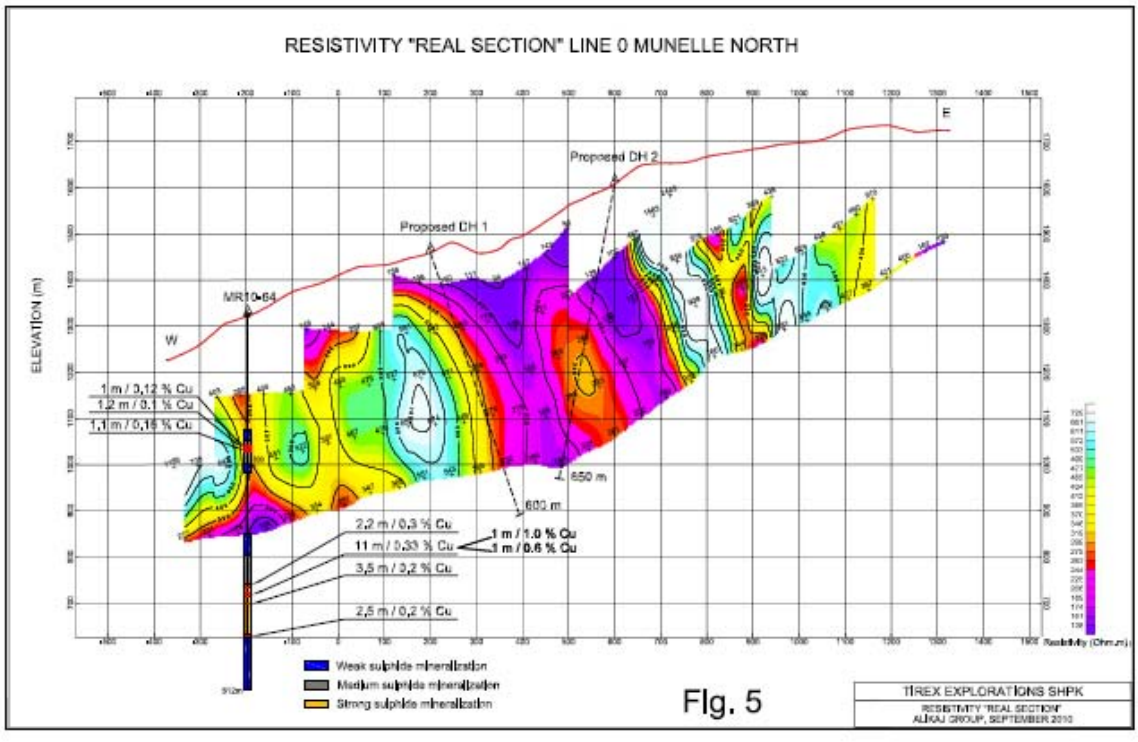


Fig. 5

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GENERALIZED GEOPHYSICAL OVERVIEW ON SHKODËR-PEJË DEEP TRANSVERSAL FRACTURE

Alfred FRASHËRI[1]; Salvatore BUSHATI[2];Neki FRASHËRI[3] ; Shpresa DEMA[4]

[1]Faculty of Geology and Mining, Polytechnic University of Tirana
[2] Academy of Sciences of Albania
[3] Faculty of Information Technology, Polytechnic University of Tirana
[4]Albanian Geological Survey
e-mail: alfred.frasheri@yahoo.com

ABSTRACT

Gravity, Magnetic, Paleomagnetic, Geothermal, Seismological and Remote Sensing geophysical data of Cukali tectonic subzone, where it crosses the deep transversal fracture Shkodër – Pejë, marine seismic data and hydrological observations on the shelf of the Southern Adriatic Basin. Analyses of the results of these studies are based on regional geological setting data are here in this paper overviewed.
Regional geological-tectonic setting of Shkodër-Pejë sector of Mediterranean Alpine Folded Belt, testifies the existence of this important disjunctive deep tectonics element. At the Earth's surface, no outcrop of this thrust has been traced neither by geological surveys, detailed mapping at the scale 1:25.000 or regional studies at the scale 1:200.000. Consequently, the different concepts on thrust such as "scharung" (1901), "deviation" (1920—1930), "an accident" (1960), "transform transversal fault" (1970-2012), "transverse fault" (1990-2012), "deep transversal fracture" (2012) have been provided. In addition efforts either to silence about its existence or to deny its presence have been made. These changes in the course of a century, not just in terms of use, relate to different geological schools concerning the geological setting of the Albanides. These changes in the terms unfortunately even in our days in some studies, related to the fact that the geological hypothesis or theories about the geological-tectonic setting of the region base on surface geological surveys, which undertake to presented geological setting to the Moho Discontinuity without geophysical data, as necessary to known the depth.
In the last two decades, geophysical surveys polygons have been carried out in the Shkodër-Pejë region. Gravity Bouguer Anomaly Map, Magnetic Anomaly Map, Paleomagnetic Studies, Heat Flow Density Map, analysis of the satellite imagery, have provided important information about tectonic setting in the depth of the region. This information, interpreted in complex with the existing geological-tectonic data has cast light on the depth of the area, where it crosses the transverse Shkodër-Pejë. They argued that it represent a deep transverse vertical fracture, which affects the Moho Discontinuity. Its amplitude at those levels is about 4 km. It decreases toward the Earth's surface, until extinguished in some segments. This fracture represent a wide belt, was also interrupted by the deep regional or lowest order longitudinal thrusts.

KEY WORDS: *Mediterranean Alpine Folded Belt, Shkodër - Pejë transversal, geophysical anomalies, deep fracture, gravity anomalies inversion.*

1. INTRODUCTION AS A HISTORIC REVIEW

Hellenides-Albanides-Dinarides, branch of the Mediterranean Alpine Folded Belt, are interrupted by a deep transversal tectonic fracture in the Shkodër-Pejë segments. This fracture correlates with contact between Eurasian and African Plates in Drini Bay in Adriatic Sea (Fig. 1-a, b, c). Cvijich, (1901) described for the first time this fracture by calling it "scharung". Kosmat, (1924); Koberh, (1929), Nopca, (1929); Bourcart (1919;1925); Novack,. (1929), Zuber, (1940) et al. (Kosmat, 1924; Koberh, 1929; Nopca,1929; Bourcart, 1919, 1925; Novack, 1929, Zuber, 1940), called this "scharung" "deviation". Aubouin and Ndoja, (1964) called it "accident". In addition, Aubouin et al. (1970) called it "element thsy inherits of the Tethyan Ocean paleogeography". Moreover, Çollaku & Cadet (1991) called it "Faille transversale Scutari-Pec".
For almost several decades, Albanian geological studies, did not relate to this fracture because the Albanides geological setting and its geologic history were based on geosyncline's theory (Geology of Albania, 1970). Only later, some authors, who admitted the opening of the Mirdita Ocean and interpreted this transversal as oceanic transform fracture. Shkodër-Pejë transform fault is represented by the north-western front of the ophiolitic belt (Kodra, et al. 1994, Melo, 1986, Melo, et al. 1991, Peza et al. 1971, Xhomo et al. 2002), or

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this transversal is represented by the northern border of Cukali subzone as natural geological border between Alps Zone and Cukali ones (Papa et al. 1991). Qirinxhi et al. (1983; 1991), the co-author of Geological Map of Albania at the scale 1:200.000, said that showing that the existence of Shkodër – Pejë thrust and its position cannot being observed and mapped during geological field surveys, but, perhaps, exist in the deep. The seismological studies report the presence of an active fault zone according to the well known Shkodër-Pejë direction (Aliaj, 1988; Muço et al. 2001; Sulstarova, et al. 1972). Aliaj (1988; 2006) said Sh. "…the Shkodër-Pejë transverse fault dividing Dinarides from the Hellenides". The above interpretations regarding the Shkodër-Pejë fracture also have resulted in alternative of the geological opinion concerning its position.
During the last quarter century, the remote sensing study has observed some tectonic lineaments along the Shkodër-Pejë transversal zone (Chorowicz, et al. 1981).

2. METHODOLOGY OF STUDY

Geologic-tectonic settings of Shkodër-Pejë region is compiled in the regional Geological Maps of Albania, by (Nopça 1929; Novack 1929; Zuber,1940), in the Geological Maps of Albania at the scale 1:200.000 (1967, 1983, 2002), and in the Tectonics Map at the scale 1:200.000 (1984), and in the Neotectonics Maps of Albania, and seismicity studies (Sulstarova, et al. 2011). Detailed geological setting of the Kiraj-Ndreaj-Brashtë in Cukali zone was provided by the Geological Map at the scale 1:25.000 (Qirinxhi, et al. 1983). Results of integrated surveys and studies including Shkodër-Pejë fracture zone are already available(Frashëri, et al 2009).
In the area of seismicity of Albania, historical and instrumental data, and the distribution in time and space of the seismic activity in Albania and surrounding areas, which covers a period of about 2000 years have been analyzed (Sulstarova et al. 2011; Aliaj, 1988; Sulstarova, 1986; Tagari, 1993; Muço, 1994). The seismic hazard estimation of Albania, which is part of seismological studies, is accompanied and with important geological information to investigated the Earth Crust structure of Albanides.
Bushati (1988;1998) compiled the Map of Gravity Bouguer Anomalies of Albania and the Map of Total Magnetic Vector (T) of Albania at the scales 1:200.000 respectively. For the Shkodër - Pejë area have been observed also two detailled profiles (Fig. 1-b). Gravity and magnetic surveys were accompanied with density and magnetic properties of the rock, and detailled geological studies (Qirinxhi, et al. 1983).
Dynamic evolution data from 1991to1995 have been provided (Mauritsch, et al 1991; 1994, Kissel,. et al, 1992; 1994, and 1995; Mauritsch, et al. 1995; Speranza,1995; Frashëri and Bushati , 1995).
Geophysical investigation was a means to provide some information related to the crystal basement of Albanides (Aliaj, 2006; Frashëri, et al. 1991; 2004; 2010; Bushati, 1988, 1998; Koçiu, 1989). Propagation of the Earth Thermal Field was particularly analyzed (Frashëri,. et al. 2004). Marine currents, waves, water salinity and temperature at various depths and Earth Heat Flow Density at the sea bottom in the offshore of Drini Bay, at the south-western edge of Shkodër - Pejë fracture zone have been observed (Frashëri,. *et al.* 2011; Geothermal Atlas of Europe, 1992).
Remote sensing based on Landsat and Modis data was used to identify some regional geological features and analyse the ground temperatures.

3. RESULTS AND DISCUSSION

Complex methods used for studies also in northern Albania and in the Adriatic Sea provides some new information of great value for the Albanides depth, as it provides some information on Shkodra - Peja fracture zone. Geophysical investigation results show that crystal basement of Albanides is blocks in structure(Fig. 2) (Bushati, 1988; 1998, Koçiu, 1989; Frashëri et al; 1991; 2010). Thickness of the location of these blocks is shallower in the Mirdita Tectonic Zone. The crust construction and their dynamics are reflected in the geological setting of the Albanides tectonic zones, and their tectonic styles. Block structure is controlled by a system of NW-SE longitudinal faults and transverse ones. Local heat hearths put in evidence the transversal faults. Geothermal energy relates to a great heat flow coming through these fractures (Fig. 3) (Frashëri, et al. 2004).
The Shkodër-Pejë deep fracture represents one of deep thrusts, which divided Albanides in two parts transversally (Fig. 3, 4). The northern part are including western-northern edge of Kruja tectonic zone, northern part of Cukali zone, Albanian Alps and Gashi zones, which follow by the Dinarides tectonic zones: Budva, High Karst, Dalmate, Durmitor, Serbian, and Golia zone. In the southern part of the Albanides, represented by Sazani, Ionian, southern part of Cukali zone, Krasta-Cukali, Mirdita and Korabi tectonic zones, which follows by the Hellenides. This deep fracture generally considered a multi phase's transversal

tectonic faults zone, with a north-eastern extension of about 30°. Consequently, Shkodër-Pejë deep fracture divides two big areas with different geological settings and developing geological history, but not only in the continent, also to the orogenic front in the Adriatic Shelf.

The Albanian orogenic thrust front is cut and displaced by the Othoni Island-Dhërmi, the north of Sazani Island, and the Gjiri i Drinit-Lezha strike-slip faults (Fig. 5) (Aliaj Sh., 2006). The orogenic front, north of the Drini Bay-Lezha town strike-slip fault, in the Adriatic offshore, belongs to the Kruja Zone. During the Tertiary phase, this strike-slip fault functioned as a right pushing, being shifted towardsthe south-western inner zones (Sulstarova E. et al. 2011). Ophiolitic Belt of the Mirdita Tectonic Zone is displaced more than 100 km south - west. In outer zones, at the transversal Drini Bay - Lezha Town, cut and displaced front thrust of the orogen (Sulstarova E. et al. 2011).

Offshore seismic surveying at the Montenegrin Adriatic shelf and deep wells (Dragasević T. 1983, Picha F.J. 2002) very well have enlightened geological setting at the depth on the western edge of Shkodër-Pejë deep thrust in the Adriatic shelf (Fig. 6, 7).

Onshore geological surveys from Adriatic coast line-Shkodër-Cukal-Tropoja have mapping two regional disjunctive tectonics in northern southern borders of Cukali subzone, divided this subzone from Alps zone and Mirdita zone, respectively (Fig. 4). For this transversal fault's zone were an alternative: as a transform tranversal fault, aligned with the overthrust tectonic in the northern boundary of the Mirdita zone (Kodra A. et al. 1994, Xhomo A. et al. 2002), or as a tectonique border between Cukali and Alps zone as natural geological border between them (Papa A. et al. 1991). Intensively folded structure of the Cukali subzone has northwest-southeast strike. From surface geological data, ranging from the Permian rocks of Albanian Alps tectonic zone, the Upper Triassic - Maastrichtian- Paleocene - Eocene rocks in Cukali subzone, and also from all magmatic and sedimentary rocks that spread of the Mirdita zone at the surface, had not been deduced any arguments which can help to accept the presence at the surface of the Shkodër-Pejë transversal fault (Qirinxhi A. et al. 1983). In contrast with surface geological surveys, the geophysical studies have provided information on the presence of the regional transversal deep thrust through Cukali subzone.

3.2. Gravity and Magnetic data

Scattering of gravity and magnetic fields have very well contoured Inner Albanides, particularly the ophiolitic belt (Fig. 8, 9). Bouguer gravity anomaly and magnetic ones have common peculiarities: a) epicenters are located over the eastern belt of the ophiolites; b) Ophiolitic belt represented in two parts: northern and southern, separated by flyschoid corridor; c) gravity and magnetic anomalies are very intensive, compared with Internal Albanides. These pecularities and anomaly configuration have argued the nape character of the ophiolitic belt [Frashëri A. et al. 1991, 2010].

According the gravity and magnetic surveing (Bushati S. 1987), Alps zone represented by a minimum of Bouguer gravity anomaly in general, with particularly a small amplitude anomaly in southern part of the Alp's zone (Fig. 8). In the northern direction there are observed the trend of the increasing of the intensivity of magnetic anomaly. This pecularity of the magnetic anomaly express overthrust character of the Albanian Alps, too. Over the Cukali subzone is observed a linear upward trend of the intensity of the Bouguer anomaly toward the Mirdita zone (Fig. 8, 10). This trend's anomaly can explained by the presence of the vertical deep tectonic thrust.

After the inversion model, thrust level resulted with amplitude about 4km in the Moho Discontinuity (Fig. 10). Thrust amplitude toward the Earth's surface is gradually reduced and, until the surface of the Earth, is almost extinguished, also according to the geological mapping. This deep thrust represents Shkodër - Pejë fracture. By analogy with the deep strike-fault in the Adrietic Shelf Crust (Fig. 7) and this, Shkodër - Pejë deep fracture, at the depth expected to be composed by several branches, occupying a wide zone of their influence and action.

3.3. Paleomagnetic surveys - an important indicator of the presence of Shkodër - Pejë deep fracture and its geodynamic evolution role in Alpine Mediterranean Foldet Belt Hellenide-Albanides-Dynarides

Dynamic evolution of the Northern Albanides has its reflection in paleomagnetic data, collected from the paleomagnetic studies in Albania, which were performed during 90 years, performed by Mauritsch H.J. et al. (1991-1995), Kissel C. et al. (1992-), Muttoni G. et al (1940), Frashëri A. and Bushati S. (1995) [Frashëri A. et al., 1995; Kissel C. et al., 1995; Mauritsch H.J. et al., 1995, 2006, Mauritsch H.J. 2000, Muttoni G. et al. 1994, Speranca F. 1995]. Paleomagnetic studies shows that Ionic and Kruja tectonic zones, located at southern side of the Shkodër - Pejë transversal, have support a joint clockwise rotation, with an angle 45-50° during and after Eocene-Oligocene period. This rotation has been realized through two phases, by 25° every phase in the middle Miocene up to Plio-Pleistocen. Ionic and Kruja zones don't have any different rotation

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between each other. Clockwise rotation for 40^o-45^o since Early-Middle Miocene is observed at Kçira site. For this rotation, the Kçira pole acquires a West Gondwana affinity [Mutoni G. et al. 1996]. A large Neogene clockwise rotation, D=40^o, I=3.8^o, is observed also in the Mirdita zone of Inner Albanides, at southern Albania, northern of Albanian-Greek border [Mauritsch et al., 1994].

Eocene limestone anticlines of the Renz and Kakariq area, which are located in southern side of the Shkodër - Pejë transversal zone, have a rotation about 31^o. Consequently, these two anticlines have a declination with 18^o smaller than the declination of the Eocene limestone in the Central Albania. These two anticlines maybe have superposition of two rotations with inverse sense: clockwise rotation of 50^o, which has been subdued all External Albanides structures and local counterclockwise rotation by 25^o, which has rotated only these two anticlines that have a Dinaride strike.

At the Komani area, in the southern side of Shkodër - Pejë transvesal, at north-western edge of the ophiolitic belt of Mirdita zone, have been observed declinations, which show the 82^o-140^o clockwise rotation of the Jurassic limestone. The same 28^o-57^o clockwise rotation is observed for ultrabasic rocks of western edge of the Gomsiqe massive, at south-western direction from Komani (Fig. 11). Gabro massive at Bozhaj, southern of Korça city have a magnetization vector with declination Do=282^o and inclination Io=60.9^o, the same direction as in the Khalkidhiki in Greece (D=240^o-312^o and I=30^o-68^o), which have demonstrated an Upper Cretaceous anti-clockwise rotation, and Upper Tertiary clockwise rotation of the Khalkidhiki [Feinberg H. et al. 1996].

Limestone samples from Albanian Alps at Selca area, in the north of Shkodër - Pejë transversal, shows a counterclockwise rotation for 20^o in relation with present north, the same value as in southern Dinaride's structures. The analogue counterclockwise rotation as in Selca area, have also Jurassic limestone at southern Shkodra lakeshore. This fact shows that both these sections appertain to the same tectonic zone, in northern of Shkodër-Pejë transversal area.

The Kotori to the Split area, which belongs to the Dinarides in Dalmatia in the North is almost immovable for the time period being studies starting from the Eocene onwards. Dinaride's orogen in the north are characterized by the regional direction f the structures N12^o, unlike the Albanides orogen structures with a direction N150^o, as in southern Hellenides [Kissel C., 1994; Mauritch H.J. et al 1993, 1995, 2006; Mauritch H.J. 2000]. Paleomagnetic studies in the external Dinarides have shown that this orogen has no any significant counter-clockwise rotation in relation to Africa, ranking from the Eocene, such small rotation that is observed in limestone of the Albanian Alps to the southern shore of Shkodra Lake.

Paleomagnetic directions demonstrate a strong tectonic disturbance in the Central part of Shkodër - Pejë zone. In the Jurassic limestone of the northern side of Cukali subzone, about 4 km northwest of Prekali village, is observed a country-clockwise rotation for about 45^o. Only in less than 2 km south, a 60^o clockwise rotation is observed. Such result attests to the strong tectonic influence in transversal thrust zone.

Paleomagnetic studies have demonstrated that Shkodër - Pejë belt presents a transition zone between counter-clockwise rotation in the north, and clockwise rotation in the south sides (Fig. 11, 12). Consequently has a great tectonic influence over Cukali subzone. Thus, Shkodër-Pejë lineament, defines a transition zone which separates the Albanian Alps and the Dinarides (counterclockwise rotation), from Albanides and Hellenides (clockwise rotation). For the rotation pole located at Shkodër - Pejë transversal thrust, Southern Albania has undergone a horizontal displacement is about 173 Km [Speranza F., 1995].

3.4. Seismological pecularities related to Shkodra-Peja seismoactive tranversal fault zone

Seismological studies carried during the last half of century in Albania have mapping seismoactive longitudinal and transversal deep tectonic fault zones of the Albanides. Among them is situated the Shkodër - Pejë transversal fault zone (Fig. 13 and 14). (Muço B., 1984; 1991, Sulstarova S. et al. 2011). Shkodër - Pejë transversal fault zone divided in two segments the northern part of the Ionian-Adriatic thrust fault zone, which presented the longest fault zone along the Adriatic and Ionian coasts. Based on focal mechanism solution, results that in Northern littoral side of the Shkodër- Pejë fault zone, the compression strain has a P=16^0 NE-W strike, and 10^0 plunge, while the axis of expansion T = 124^0 and 79^0 dep. In the Southern side of the Shkodër- Pejë fault zone, the compression strain has a P=274^0 E-W strike, and 10^0 deep, and the axis of expansion T = 164^0 SE-NW and 64^0 deep (Sulstarova, 1988, Tagari 1993). In the internal area, region Vau i Dejes-Pukë-Tropojë, the tensional stress regime has a NWN extention (Muço,1994; Sulstarova, 1988).

Offshore geophysical explorations have discovered a deep fractures zone in the Adriatic Sea between Buna River discharge and Kotorri Estuary, about 15-20 km from coastline, with the NW strike direction. In this Adriatic offshore area, near Albanian-Montenegrin border, at the northern side of the Shkodra - Peja fault zone, was located focus of earthquake, 15 April 1979 (Sulstarova, et al. 2011). The analyze of the seismic P waves velocities (Vp) and ratio Vp/Vs show that exist a difference between upper part of the Earth Crust (0-

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30 km) in the both side of the Shkodra-Peja fault zone (Ormëni, 2010).
The stress field, the fault system and the spatial distribution of the seismic activity shows that the Albanian territory and the surrounding areas consists of many blocks which move relatively to each other due to the collision of the Eurasia and African plates, in the region of the Adriatic promontory of African plate (Sulstarova et al. 2011). All the aforementioned seismological features report a deep Shkodra-Peja transversal fracture, which is a relatively wide active fault zone that separates the paleogeographic units with different geological settings, and dynamic of their developments.

3.5. Heat Flow density anomalies

Geothermal studies at Northern Albania have been performed in 19 boreholes and in one deep well. Heat Flow Density anomalies axes are presented in Fig. 3. Two of them locate in the unit axis, which extends from northeast to southwest, over the overthrust tectonics in the northern border of the ophiolitic belt. Thirty axes locate in Keçel village in eastern site of the Kukësi ultrabasic massif. The heat flow density values are up to 60-70 mW/m^2. Radiogenic heat generation of the ophiolites is very low. Here, the increase of the heat flow in the ophiolitic belt relates to the heat flow coming through the depth. The granites of the crystalline basement, with the radiogenic heat generation, represent the heat source. Heat flow anomalies base on intensive heat transmitted through deep and transversal fractures. We assume that this thermal anomaly associates with the branches of transversal fracture when comparing these characteristic of the thermal field and zone geological setting with structure of the strike-fault system in southwestern side of the Shkodër - Pejë transversal in Adriatic Shelf.
The thermal anomaly over the Adriatic Shelf is observed at the epicenter in Drini Bay (Fig. 15) (Geothermal Atlas of Europe, 1992). At the same time, this thermal anomaly epicenter locates over the prolongation into Albanian Adriatic Shelf of Shkodër - Pejë transversal deep fracture. These facts show that the Shkodër - Pejë transversal deep thrust extends in the Adriatic Shelf, where it is interrupted by Adriatic longitudinal strike-slip fault system.

3.5. Remote sensing and GIS information

First study by Landsat imagery has presented a sketch of thrust tectonic in Northern Albania, which differenced clearly main segments of Shkodër - Pejë transversal fault (Fig 16) (Chorowich, et al. 1981). According to the geophysical studies results above indicated, as well as satellite image, have paved Shkodër – Pejë tranversal fault (Fig. 17).
GIS and seismological investigations helped determine velocities of microplates movement in Adriatiuc Sea. Nubia (Africa) microplate is moving NW with respect to Eurasia with a velocity of 6 mm/yr, while the Adria microplate moves NE at a rate of 4-5 mm/yr (Fig. 18) (Battaglia, et al. 2004). Adria is considered as an independent microplate within Nubia – Eurasia plate boundary one (Nocquet, et al. 2001), which is divided by Gargano-Dubrovnic fault in two blocks (Oldov et al. (2002). In the frame of these interpretation data is necessary to discussed also the position of NW edge of Otranto Street, which is located in the direction of the Shkodër-Pejë deep transversal fault in the eastern Adriatic Shelf, that result parallel with Gargano – Dubrovnic fault zone (Fig. 19).
Usage of satellite imagery for identification of geological structures resulted difficult because of vegetation coverage of the area and soil coverage of rocks. Nevertheless in different band combinations from Landsat, it is possible to distinguish two areas separated during the same delineation of Shkodra – Pejë fault (Fig. 20). Analysis of ground temperature from MODIS images was done calculating the average for day and night temperatures from 24 images spanned in the period 2004 – 2006. In these images it is visible a "bridge" of relatively higher temperature delineated between Shkodra and Peja (Fig. 21).

4. CONLUSIONS

The conclusions drawn are: i) Earth Crust of the Albanides have a block structure controlled by a system of NW-SE longitudinal and transverse faults. The blocks have different thickness, ii) according to the gravity data inversion, Shkodër-Pejë zone present a vertical deep transversal fracture, which separate two Earth crust blocks. Fracture interrupts the MOHO Discontinuity with amplitude about 4 km that decrease towards the Earth surface. This fracture is a seismically active belt. Based on satellite images, this vertical fracture outcropped through Cukali subzone, iii) paleomagnetic studies have demonstrated that assemblage of the Albanides margin encountered a clockwise rotation of about 45^o, after upper Oligocene. Shkodër-Pejë transverse fault represents a transition zone between the clockwise rotation of the Albanides and Hellenides and the counterclockwise of Albanian Alps on e and Dinarides. For the rotation pole located at Shkodër-Pejë transverse fault, the horizontal displacement is about 173 Km in Southern Albanian border, iv) continuation

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of Shkodër-Pejë fracture in the Albanian Adriatic Shelf in Drini Bay passes over the epicenter of Heat Flow. This correlation proves the relation of the geothermal anomaly with depth fractures of the Earth Crust in Adriatic Shelf.

REFERENCES

Aliaj Sh, 2006. The Albanian orogen: Convergence zone between Eurasia and the Adria microplate. The Adria Microplate: GPS Geodesy. Tectonic and Hazards, NATO Science Series, IV. Earth and Environmental Sciences, Vol.61, 133-149.

Aliaj Sh. 1988. Features of the neotectonic structures of Albania. (In Albaniua, abstract in french) Geographical Studies, 3, 37-53.

Aubouen, J, Ndojaj, I. 1964. Regards sur la géologie de l'Albanie e sa place dans la géologie des Dinarides: Bull. Soc. France (97) VI, 593-625.

Aubouen J, Blanchet R, Cadet JP, Celet P, Charvet J, Chorowicz J, Cousin M, Rampou JP. 1970. Essai sur la geologie des Dinaride. B.S.G.F. (7), VI, 593-624.

Battaglia M, Murray MH, Serpelloni E, and Bürgmann, 2004. The Adriatic Region: And independent microplates within the Africa-Eurasia Collision one. Berkeley Seismological Laboratory, Annual Reports. http://seismo.berkeley.edu/annual_report/ar03.

Bushati S, Dema Sh. 1985. Gravity Map of Albania at the scale 1:200.000. Geophysical Center, Tirana.

Bushati S. 1988. Regional study of the distribution of gravity field of the Internal Albanides, for tectonics and metallogenic zoning (In Albanian): Ph.D. thesis Polytechnic University of Tirana.

Bushati S. 1997. Total magnetic field anomalies of Albania, at the scale 1:200.000. Geophysical Center, Tirana.

Cadet JP, Bonneau M, Çollaku A. 1991. Sur la position de l'Albanie dans le systeme Dinarico-Hellenique. Séance spécialisée de la Societe Geologiqiue Francese (S.G.F.) Colloque sur la "Gologie de l?Albanie", Paris, 12-13 Avril, 1991.

Chorowich J, Cadet JP, Stephan JF. 1981. Le secteur tranversal de Scuari-Pec: apports de l'etude de la fracturation à partir does donne Landsat. B.S.G.F. (7), XXIII, 217-228.

Cvijiç J. 1901. Die Dinarics Albanische scharung-sitzba. D.Kais Ak. D. wiss. Bt.CX. Wien, 1901.

Çollaku A., Cadet J.P., 1991. Sur L'Allochtone des Albanides: Apport des donnes de L'Albanie Septentrionale. (In French, resume in Albanian). Symposium «Thrust tectonics in Albania. Bulletin of Geological Sciences, 1, 255-271.

Dercourt J. 1967. Sur l'accident de Scutari.Pec, la signification paléogéographique de quelque series condense en Albanie Septentrionale. Annales Soc. Gel. Du Nord, t. 98, p. 109-117.

Dietrich D, Carnevale GF, Orlandi P. 2002. Adriatic simulations by DieCAST. Center for Turbulence Research , Proceedings of the Summer Program 2002, 269.

Dragasević T.1983. Oil geologic exploration in the Montenegro offshore in Yugoslavia. Nafta, 34 (7-8), 397-404.

Frashëri A, Bushati S, Bare V, 2010. Geophysical outlook on structure of the Albanides. Journal of Balkan Geophysical Society (JBGS), Vol. 12, 2009, pp. 9-30.

Frashëri A, Cermak V, Doracaj M, Lico R, Safanda J, Bakalli F, Kresl M, Kapedani N, Stulc P, Malasi E, Çanga B, Vokopola E, Halimi H, Kucerova L, Jareci E. 2004. Atlas of Geothermal Resources in Albania. Published by Faculty of Geology and Mining, Polytechnic University of Tirana and Academy of Sciences of Albania.

Frashëri A, Bushati S. 1995. Paleomagnetic outlook on geodynamics of Albanides (In Albanian): Report Faculty of Geology and Mining, Polytechnic University of Tirana, Geophysical-Geochemical Center of Tirana.

Frashëri N, Pano N., Frashëri A, Bushati S, 2011. Outlook on seawaters dynamics and geological setting factors for the Albanian Adriatic coastline developments. EGU 2011, Wiena.

Feinberg H, Edel B, Kondopoulou D, Michard A, 1996. Implications of ophiolite palaeomagnetism for the interpretation of the geodynamics of Northern Greece. The Geological Society.

Geothermal Atlas of Europe, 1992.[Eds. Hurtig E., Çermak V., Haenel R. and Zui V.], International Heat Flow Commission, Herman Haak Vertagsgesellschaft mbH, Germany.

Institute of Geologinal &Mining Studies and Design. 1970.Geology of Albania. Explanatory text of Geological Map of Albania, at the scale 1:200.000. (in Albanian). Publishing House Naim Frashëri, Tirana, 343.

Institute of Geological Studies, Faculty of Geology and Mining, Geological Insitute of Oil and Gas, 1983.

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Geological Map of Albania, at scale 1:200.000.
Institute of Geological Studies, Faculty of Geology and Mining, Geological Institute of Oil and Gas. 1983. Tectonic Map of Albania, at the scale 1:200.000.
Kissel C, Speranza, F, Islami I, Hyseni A. 1995. Paleomagnetic evidence for Cenozoic clockwise rotation of External Albanides: Earth and Planetary Science Letters, 129, 121-134.
Kober L. 1914. Geological map of Balkan, at scale 1:15.000.000
Koçiu S. 1989. On the construction of the Earth Crust in Albania according to the first onset of P waves in the seismologic stations. (In Albanian, abstract in English): Bull. of the Geological Sciences, 1, 137-159,
Kodra A, Vergely P, Meshi A. 1994. Tectonic evolution of the ophiolite in Albania. Geological Archive of Institute Geological Studies and Projects, Tirana.
Komatina M, Komatina-Petrovic S. 2009. Geodynamics af Serbia. 5th Congress of Balkan Geophysical Society, Belgrade, Serbia, 10-16 May, 2009.
Mauritsch JH, Scholger R, Bushati S, Xhomo A, Pirdeni A. Paleomagnetic works in the field of the Krasta-Cukali, Alps and Sazani zones carried out in September 1993, Conference in Albanian Geological Institute of GEOALBA, November 1994, etc., publications. Tectonophysics. 1995.
Mauritsch HJ, Scholger R, Bushati S, Xhomo A. 2006. Palaeomagnetic investigations in Northern Albania and their significance for the geodynamic evolution of the Adriatic-Aegean realm. Geological Society, London, Special Publications. 260,155-178.
Magnetic Map of Albania. Monography, Center of Geophysical and Geochemical Investigation: Albanian Geological Survey. Viti 1999.
Meço S, Aliaj Sh, Turku I, 2000 - Geology of Albania. Gebrüder Borntraeger. Berlin. Stuttgart, 205 page.
Melo V. 1986. Structural Geology, Geotectonic (Geological setting and geodynamics development of Albanides. (In Albanian), Published by Faculty of Geology and Mining, Polytechnic University of Tirana, Text Books Typography, Tirana, 169.
Melo V, Shallo M, Aliaj Sh, Xhomo A, Bakia H. 1991. Thrust and cover tectonics in the geological structure of the Albanides. Bul. Shk. Gjeol., 1, 7-20.
Muço B. 1994. Focal mechanism solutions of earthquakes for the period 1964-1988. Techtonophysics, 231.
Muttoni G, Dennis VK, Meço S, Nicora A, Gaetani M, Bahini M, Germani D, Rettori R. 1996. Magnetostratigraphy of the Spathian to Anician (Lower.Middle Triassic) Kçira section, Albania. Geophys. J. Int. 127, 503-514.
Nopçsa F.1929. Geographie und Geologie Nord- Albaniens. Geol. Hungarica, S. geol., III, 1-704.
Nocquet JM, Altamini CE, Sillart P, Bounder C. 2001. Intraplate deformation in Western Europe deducted from an analysis of the International Terrestrial Reference Frame 1997 (ITRF97) velocity field. J. Geophys. Rs. 106, 11,239-11,257.
Nowack E.1929. Geologische Ubersicht von Albanien. Salzburg.
Oldow J.S. et al. 2002. Active fragmentation of Adria, the North Africa promontory, Central Mediterranean Orogen. Geology, 30, 779-782.
Papa A. et al., 1985. Shkodra-Peja transversal and its role in Albanides. 5th National Geological Conference, Tirana.
Papa A, Xhomo A, Aliaj Sh. 1991. Le secteur transversal Shkoder-Peje et sn role dans l'evolution geologique des Albanides". Séance spécialisée de la Societe geologiqiue Francese (S.G.F.) Colloque sur la "Gologie de l'Albanie", Paris, 12-13 Avril, 1991.
Peza L, Xhomo A, Qirinxhi A. 1971. Geology of Albania. (In Albanian). The Publishing House of Universitary Books, Tirana.
Picha FJ. 2002. Late orogenic strike-slip faulting and escape tectonics in frontal Dinarides-Hellenides, Croatia, yugoslavia, Albania, and Greece. AAPG Bulletin, v.86, 9, 1659-1671.
Qirinxhi A, Nyftari A, Bicaj Z, Tashko A, Zhegu V, Kosho P, Bushati S, Monika K, Kastrati N, 1983. Geological Setting and utile minerals of the Kçira-Ndrecaj-Brashtë region, and geochemical and geophysical surveys performed during 1981-1982. Technical rapport. Geological Archive, Geological Service of Albania, Tirana.
Qirinxhi A, Nasi V, Hyseni A, Kokobobo A, Leci V. 1991. Review on relation of Albanides tectonic zones and main featuresnof their inner structure. (In Albanian, resume in English). Symposium «Thrust tectonics in Albania. Bulletin of Geological Sciences, 1, 129-139.
Speranza F. 1995. Evolution of Cenozoic geodynamic of Alpine Belt at Mediterranean Centrale: Paleomagnetisme contribution. Ph.D. University Pierre and Marie Curie, Paris VI, France, 294.
Sulstarova E, Koçiaj S, Aliaj Sh. 1972. Seismic map of Popular Republic of Albania, at scale 1.250.000. (In Albania), Published by Faculty of Geology and Mining, Polytechnoc University of Tirana, 201.

Sulstarova E. 1988. The seismic faults in Albania. Proceedings of first symposium on the Recent Trends in Seismology and Geophysics og Aegean Area, July 1-3, Thessaloniki, Greece, 164-180.

Sulstarova E, Aliaj Sh, Muço B, Koçiu S. 2011. Seismicity, seismotectonics and seismic hazard esstimation in Albania. Academy of Sciences of Albania, Tirana, 310.

Tagari Dh. 1993.Etude neotectonique et seismotectonique des Albanides: Analyse des deformations et geodynamique du Langhien a l'actuel. These de Docteur en Science. Paris-Sud, Orsay.

Shehu R, Shallo M, Kodra A, Vranai A, Gjata K, Gjata Th, Melo V, Yzeiri D, Bakiaj H, Xhomo A, Aliaj Sh, Pirdeni A, Pashko P. 1990. Geology of Albania. Published Home "8 Nëntori" Tirana.

Shehu V. 1967. On so-called Shkoder.Peje transversal and some problems of the geological setting of the Albania. (In Albanian, abstract In French), Bulletin of the State University of Tirana, Serie of Natural Sciences, 3, 87-96.

Vranaj A, Shallo M, Xhomo A. 1997. Geology of Albania. Published Home "Universitary Books"

Xhomo A, Kodra A, Xhafa Z, Shallo M. 2002. Geology of Albania. Geological Survey of Albania, ALBPETROL, Faculty of Geology and Mining, Tirana, 171.

Zuber S.1940. Appunti sulla tettonica e sull'evoluzione geologica dei giacimenti metalliferi albanesi. AIPA, Publ. Sc. Techn., Fasc. 1, Roma.

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Fig. 1. Shkodër-Pejë deep transversal fracture belt according to the geophysical data:

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Fig. 1-b: Western Balkans Tectonic Maps [International Tectonic Map of Europe, at scale 1:5.000.000].

Fig. 1- c: Regional Geological settings of central part of western Balkan Peninsula [Geological Map of Europe, http://www.bgr.de/igme5000/igme_frame.php].

1- Quaternary; 2- Neogene; 3- Oligocene; 4- Paleocene-Eocene; 5- Cretaceous; 6- Jurassic; 7 - Alpine, 8 Triassic; 9 - Mesozoic; 10 - Permian; 11- Carboniferous- Permian; 12- Devonian; 13- Silurian; 14- Cambrian; 15- Palaeozoic; 16- Ophiolite complex; 17 - Palaeozoic plutonite; 18- Mesozoic plutonite.

Fig. 1-d: Geological Map of Northern region of Albania, at scale 1:200.000, (Xhomo A. et al. 2002), and neigbor area from the Geological Map of Kosova.

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AF - Adriatic strike-slip fault system; U - Lucan deep structure;

A/T direction of strike-slip motion: A- away; T- toward.

Fig. 8. Gravity Bouguer Anomaly Map of Albania [Bushati S. 1988]

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Fig. 9. Magnetic Anomaly Map of Albania [Bushati S. 1998]
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INTEGRATED GEOPHYSICAL-GEOCHEMICAL STUDIES IN REGION OF TIRANA-DURRES-KAVAJE WITH TECHNOLOGY GIS

Fatbardha VINÇANI[1], Piro LEKA[1], Fatbardha CARA[1], Petrika KOSHO[1], Safet DOGJANI[1]

[1]Institute of Geosciences, Energy, Water and Environment, Tirana, Albania),
E-mail: bardha_vin@yahoo.com, p.leka@yahoo.com, bardha.c2012@yahoo.com, pkosho@yahoo.com, sdogjani@yahoo.com

ABSTRACT

During the period of 20 years in the region of Tirana-Durres-Kavaja, many geological-geophysical studies have been carried out, which have provided research-scientific information to the surface and at depth, helping in solving geological, geoenvironmental, civil geology, geological-sedimentological, engineering-geology, hydrogeological and archaeological tasks at various degrees. To standardize the information collected over the years, to coordinate and to annex it to any other type of support information for performing processing, further re-interpretation, it was necessary to use technology GIS (International Geographical System) in order to integrate them.
GIS in this region is implemented in 20 topographic sheets, scale 1: 25000, for the eight components: Topography, Geology, Environmental Geology, Engineering-Geology, Geomorfology, Hydrogeology, Minerals, Quaternary Geology and Geophysics. Geophysical prospecting surveys are performed with Electrical, Magnetic, Gravimetric, and Radiometric methods. The Electrical Prospecting methods, mainly the apparent resistivity has occupied important place in geological studies.
Geological-geophysical-geochemical studies included in these sheets resolved these tasks: determining of the thickness of Quaternary deposits, the study of land for social buildings, exploration of minerals, groundwater exploration and the micro-zoning of Tirana-Durres-Kavaje region, evaluating the background level of the analyzed elements and the influence of the human activity in the urban and rural zones.
In these components for each topographic sheet at scale 1: 25000 are included geological-geophysical-geochemical survey data and related graphics in topographic maps, surface geological maps of Quaternary deposits, engineering-geological maps, geomorphological maps, hydrogeological maps, metallogenic maps and geophysical maps as well as geological-geophysical cross-sections of surveyed lines in softwares AutoCAD Map, Surfer, Grapher, Access etc.. All these taken together are represented in ArcView GIS software, according to the topographic sheets, scale 1: 25000, where they are implemented.
Techniques used in GIS and advantages of ArcView GIS software make it possible to integrate, store, edit and analyze the above-mentioned research-scientific information. This process is quick, accurate and practical way to be familiar with research-scientific issues of priority research fields of Earth Sciences and to solve geological-geophysical tasks in the future in this region.

KEWORDS *GIS, Geophysical and Geochemical map, Topographic sheet, Tirana-Durre-Kavaja region*

INTRODUCTION

During a period of 20 years in the region of Tirana-Durres-Kavaja (TDK), many geophysical studies have been carried out with Electrical, Magnetic, Gravimetric and Radiometric methods, with numerous data both in surface area and sections.
Important place in these studies has taken Electrical Prospecting survey, mainly with method of apparent electrical resistivity. Results obtained in the most important regions of our country as Tirana, Durres and Kavaja provide the supporting basis for all infrastructure projects and major works.
Diverse thematic and tasks that have been resolved belong to scientific-research issues: Geology, Environmental Geology, Engineering Geology, Hydrogeology, Minerals, and Quaternary Geology.
To integrate and standardize the information collected over the years, to coordinate and to annex it to any other type of support information for further processing and re-interpretations, it is necessary to use technology GIS (International Geographical System).
Territory where it is carried out GIS includes geophysical-geochemical studies carried out in 20 sheets, on which are the administrative centers of the cities: Tirana, Durres and Kavaja as follows (Figure 1) (Leka, P. and Vinçani, F., 2003).

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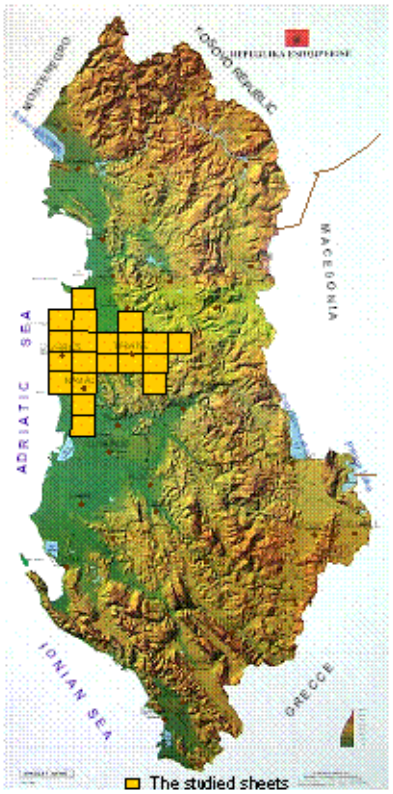


Fig.1. The topographic map of Albania with the studied area, region of Tirana, Durres, Kavaja

METHODOLOGY OF DATABASE SETUP OF GEOPHYSICAL-GEOCHEMICAL STUDIES

To set up the database of geophysical-geochemical studies at Tirana-Durres-Kavaja region was used the following methodology (Vinçani F., 2010):

1. Creating a database for electrical surveys carried out at the Tirana-Durres-Kavaja region, which includes "initial data" and "interpreted data". (No. of Region, Line number, performed VES number, AB/2 spacing, Stations, Coordinates - X, Y, elevation H, Apparent Electrical Resistivity, Depth, Thickness and Lithology of the layer) according to the Access software for every VES performed in Line (Vinçani F., Leka P., 2009).
2. Creating a database for magnetic surveys on the above region. This includes magnetic data at scale 1: 200,000 as well as the more detailed ones for alluvial deposits, regional-sedimentological studies and archaeological research according to the Access software at the following format: ID, Coordinates - X, Y, Elevation H, Value of the Full Intensity of Earth Magnetic Field and Note.
3. Creating of database for gravimetric surveys of this region, which includes the gravimetric data at scale 1: 200,000 and more detailed ones according to the Access software in the following format: ID, Coordinates - X, Y, Elevation H, Value of Gravity, and Note.
4. Creating of database for Radiometric surveyes of this region, which includes the data on natural radioactivity at scale 1: 200,000 and more detailed ones according to Access software in the following format: ID, coordinates - X, Y, Value of Natural Radioactivity, and Note.
5. It is also created the Radiometric survey data of this region at scale 1: 25,000 which includes a) voluminous activity data b) gas permeability data c) Radon risk data according to the software Access in the following format: ID, Coordinates - X, Y, Value of Voluminous Activity, Value of Gas Permeability and Value of Radon Risk, Note.
6. Creating of database for geochemical-environmental studies of this region, which includes the Coordinates - X, Y, Depth of sample and the content of the analyzed elements at scale 1: 25,000.

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GIS OF GEOPHYSICAL-GEOCHEMICAL STUDIES PERFORMED IN THE TIRANA-DURRES-KAVAJA REGION

Geophysical-geochemical studies included in these sheets have solved the following tasks (Vinçani F., Leka P., 2005):

1. Electrical Prospecting

- Evaluation of groundwater bearing potential at basin of Tirana, Durres and Kavaja
- Study for "Micro-zoning" at Tirana and Durres region.
- Searching for rock-salt in Kanapar Tilaj region (Kavaja).
- Searching for bauxite ore in Dajt- Kruje region.
- Searching for alluvial deposits of heavy and rare minerals in Rrushkull-Hamallaj region.
- Engineering-geology study of Bovilla-Tirana Water Supply and of land for the construction of social objects.

2. Magnetometry

- Magnetometric survey at scale 1: 200,000 and more detailed maps as well as Magnetic Support Network.

3. Gravimetry

- Gravimetric survey at scale 1: 200,000 and Gravimetric Support Network.

4. Radiometry

- Radiometric survey for natural radioactivity at scale 1: 200,000 and for Radon risk at scale 1: 25,000.

5. Geochemistry

- Geochemical mapping and sampling as well as maps of element distribution in the soils (Mazreku A. & Cara F., 2003).

Techniques used in GIS and advantages of ArcMap-ArcGIS software make it possible to integrate, store, edit and analyze the above-mentioned research-scientific information. This process is a quick, accurate and practical way to be familiar with research-scientific issues of priority research fields of Earth Sciences and to solve geological-geophysical tasks in the future in this region (URL-1).

The realization of the tasks and the objectives of geo-information geophysical data at TDK region are related with the GIS application program, according to the creation concept of data base, in total.

Process has passed some phases like as: preliminary data preparation and latter computer data processing, etc., (Vinçani F., Leka P., 2005).

Based on existing technology (hard-software) it was achieved to build GIS for geophysical studies at the region of TDK for 20 sheets. In coordination with them, were used other scientific components as well such as Geology, Environmental Geology, Engineering Geology, Geomorphology, Hydrogeology, Minerals, and Quaternary Geology.

THE IMPLEMENTATION OF THE GEOPHYSICAL-GEOCHEMICAL STUDIES IN ARC MAP GIS 9.1.

To realize the GIS of geophysical-geochemical studies of TDK region, along with the creating of database, has been also important the compilation of geophysical survey maps of this region. This was achieved according to the following procedures, (Vinçani F.**,** Cara F., Leka P., 2010):

Integration of geophysical studies with the technology GIS according to software ArcMap 9.1 through these phases:

- Implementation in ArcMap 9.1 of electrical studies performed in the region of Tirana, Durres and Kavaja for each topographic sheet at 1: 25 000 scale, (Vinçani F., Leka P., 2010).
- Implementation in ArcMap 9.1 of the results obtained from magnetometric studies in this region.
- Implementation in ArcMap 9.1 of the results obtained from gravimetric studies in this region.
- Implementation in ArcMap 9.1 of the results obtained from radiometric studies in this region.
- Implementation in ArcMap 9.1 of the results obtained from geochemical studies in this region.

For Electrical studies were performed:

- Processing and computerization of graphic material according to the topographic sheet at the scale 1: 25,000 (geoelectrical cross-section, geological-geophysical cross-section and the maps of resistivity, depth and thickness of layers etc.) according to softwares: Surfer 8, Grapher 4, Auto Cad Map 3D 2008, etc.

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- GIS results of electrical studies mentioned above (determining of the thickness of Quaternary deposits, the study of land for social buildings, water research, micro-zoning and geological-engineering studies) are included in ArcViewGis 9.1 according to topographical sheets at scale 1: 25,000 for the region of TDK. Geological-geophysical cross-sections of observed profiles are also included (Fig. 2).

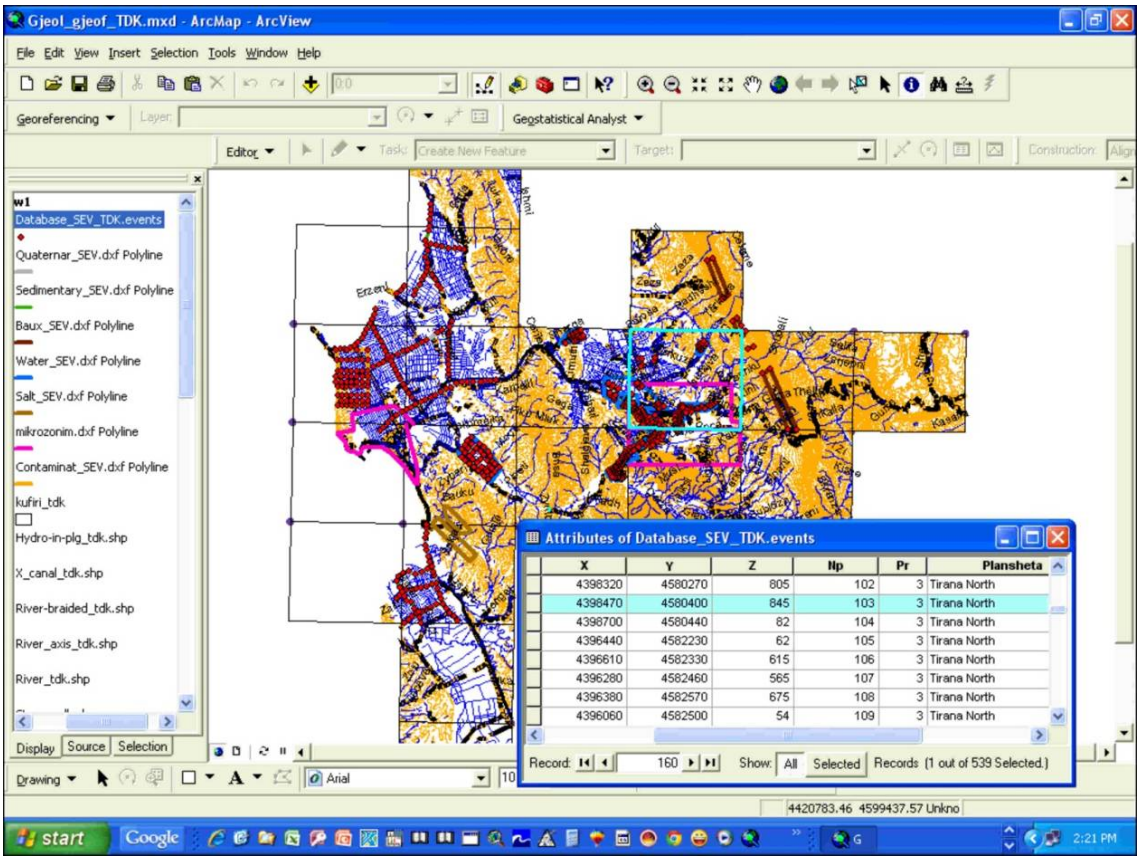


Fig. 2. The representation of geoelectric studies through Arc View Gis 9.1 software for Tirana-Durres-Kavaja region

For magnetometric studies were performed:

- Processing and computerization of graphic material according to the topographical sheet at scale 1: 25,000 (magnetic cross-section, geological-geophysical cross-section and the map of full intensity of the Earth's magnetic field etc.) according to the softwares: Surfer 8, Grapher 4, Auto Cad Map 3D 2008, etc.).
- GIS results of magnetic studies mentioned above are included in ArcViewGis 9.1 according to topographic sheets at scale 1: 25,000 for the region of TDK (Fig. 3).

For gravimetric studies were performed:

- Processing and computerization of graphic material according to the topographic sheet at scale 1: 25,000 (gravimetric cross-section, geological-geophysical cross-section and the map of gravity anomalies under Bouguer correction) according to the mentioned software.
- GIS results of gravimetric studies mentioned above are included in ArcViewGis 9.1 according to topographic sheets at scale 1: 25,000 for the region of TDK (Fig. 4).

For radiometric studies were performed:

- Processing and compilation of natural radioactivity map for this region according to the software Surfer 8;
- Processing and compilation of voluminous activity map, permeability Radon gas map and Radon risk map, realized through software Arc Map GIS 9.1.
- GIS results of magnetic studies mentioned above are included in ArcViewGis 9.1 according to topographic sheets at scale 1: 25,000 for the region of TDK (Fig. 5).

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For geochemical studies were performed:

- Processing and computerization of graphic material according to the topographical sheet at scale 1: 25 000 (Map of the factual material, maps of the geochemical elements distributed in the soils, histograms of the analyzed elements, according to the softwares: Surfer 8, Grapher 4, Auto Cad Map 3D 2008, etc.).
- GIS results of geochemical studies mentioned above are included in ArcViewGis 9.1 according to topographic sheets at scale 1: 25,000 for the region of TDK (Fig. 6).

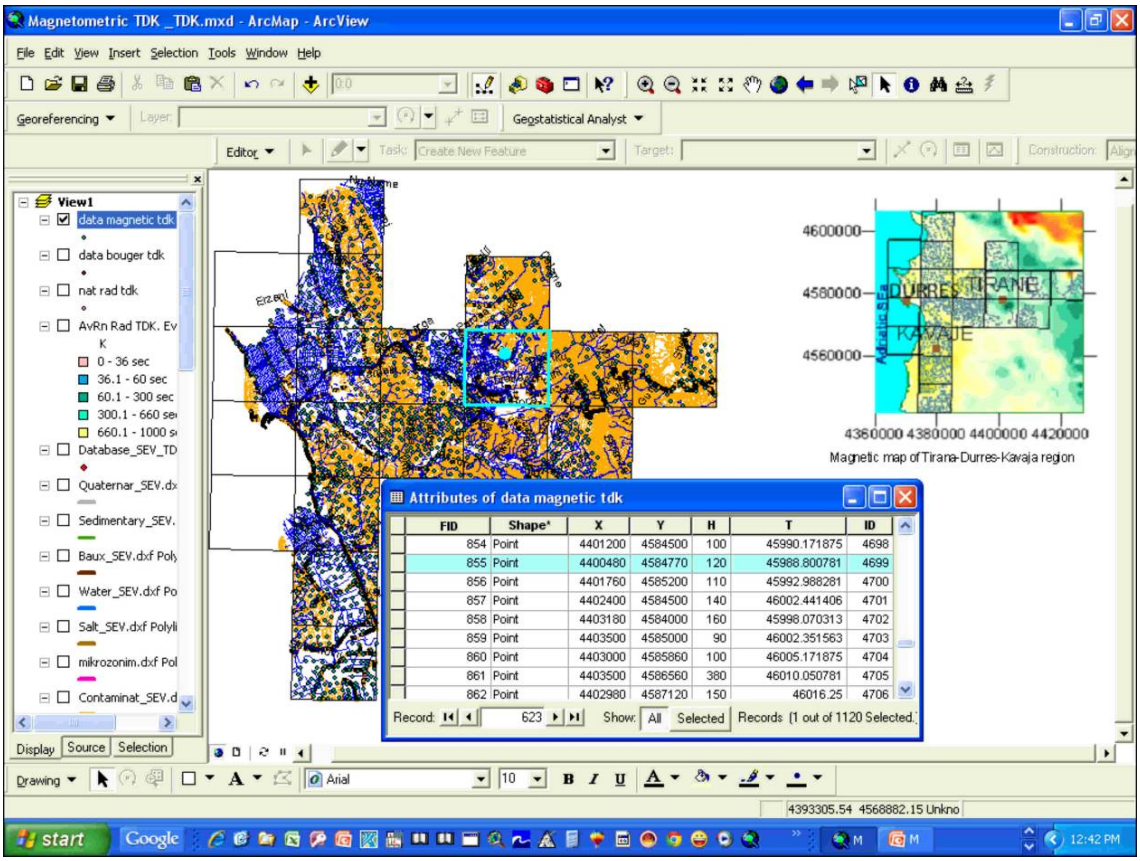


Fig. 3. The representation of magnetometric studies through Arc View Gis 9.1 software for TDK region

The realization of GIS through ArcGIS-ArcMap software provides full computerization of scientific-research information of geophysical studies, performed for a long period in this area. Integration of geophysical studies in particular and the geological-geophysical studies in general with the technology GIS, is a great source of information which is easily analyzed and managed for reprocessing and further re-interpretation.

It will also help us in selection of methods, new methodologies of a contemporary technology to carry out studies in other sectors, areas or regions of Albania for sustainable planning, administration and management of natural and land resources in these fields.

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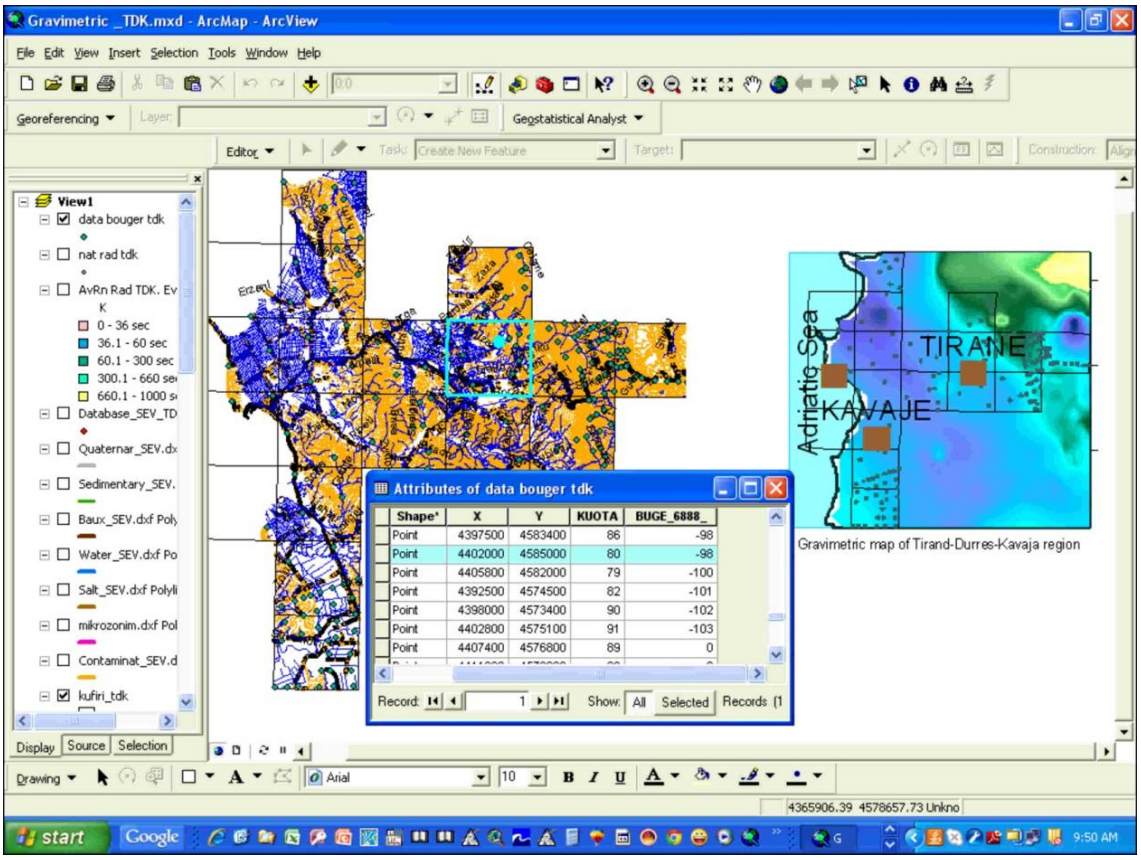


Fig. 4. The representation of gravimetric studies through Arc View Gis 9.1 software for TDK region

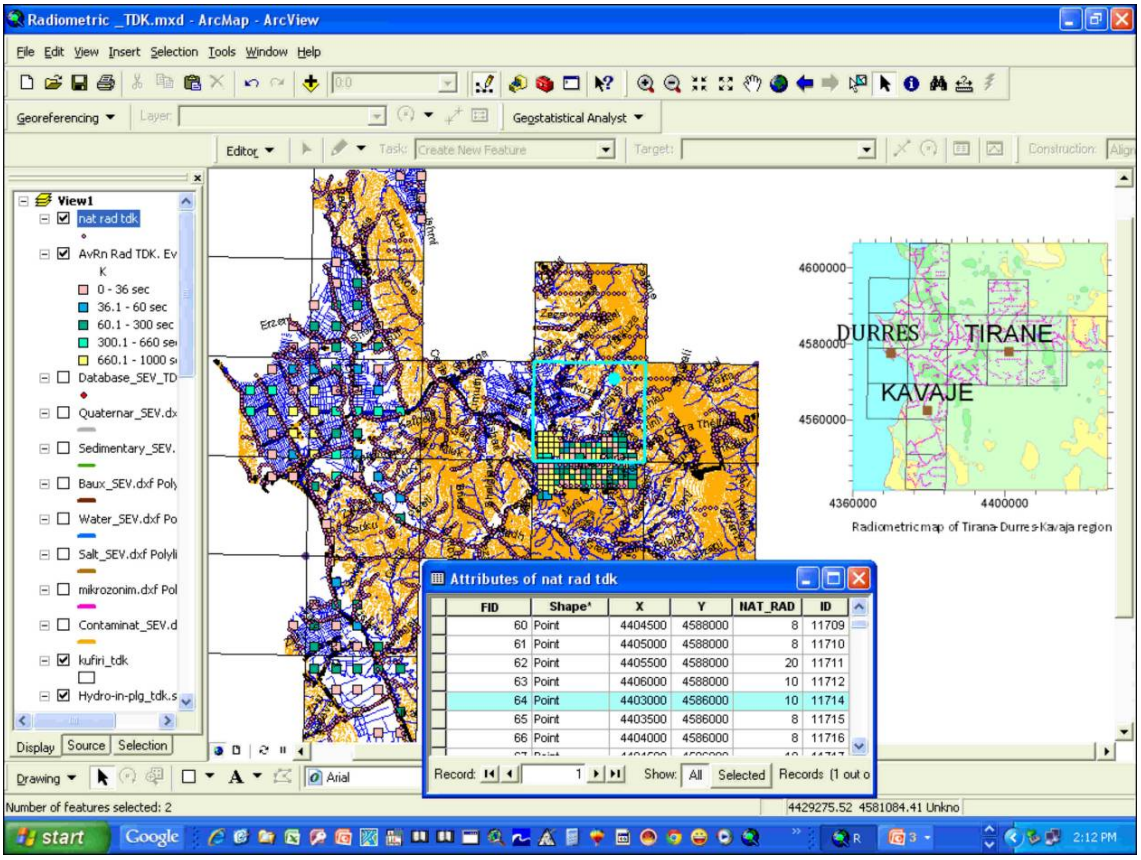


Fig. 5. The representation of radiometric studies through Arc View Gis 9.1 software for TDK region

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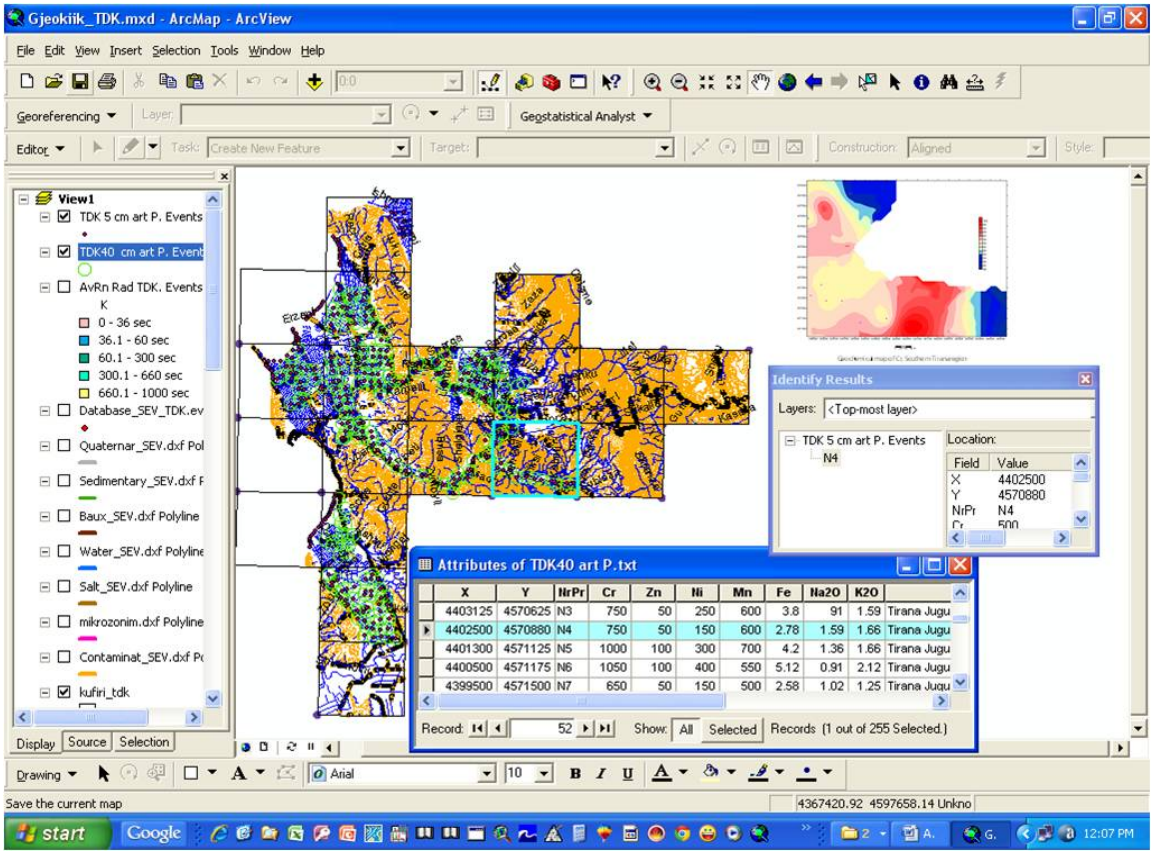


Fig. 6. The representation of geochemical studies through Arc View Gis 9.1 software for TDK region

CONCLUSIONS

- The realization of geophysical, geochemical studies through ArcView GIS 9.1 software according to topographic sheet at scale 1: 25,000 in the TDK region is a practical, accurate and quick facility of information needed to any government or private entities or individuals.
- Integration of geophysical-geochemical studies for the region of Tirana-Durres-Kavaja with the technology GIS assists in analyzing and management of geophysical data for solving research problems of the region under study.
- GIS geophysical studies conducted according to topographic sheet at scale 1: 25,000 will serve in the future to conduct further re-interpretation and revision, supported by other geological geo-environmental, geological-sedimentological, engineering-geology studies, etc. to help resolve research required problems.
- The realization of GIS for geophysical- geochemical studies in 20 topographic sheets at scale 1: 25,000 for the region of Tirana-Durres-Kavaje represents also the model for the standardization of processes and information system for other regions of geophysical studies.

REFERENCES

Leka, P. and Vinçani F., 2003. Administration of territory and natural resources: Geology- Territory-Environment of Tirana-Durres-Kavaje during 2001-2003 years (Geophysics), Center of Geophysics, Tirana, Albania.

Mazreku A., Cara F., 2003. Administration of territory and natural resources: Geology- Territory-Environment of Tirana-Durres-Kavaje during 2001-2003 years (Geochemistry), Geological Survey of Albania, Tirana, Albania.

Vinçani F., Leka P., 2005. Geoinformatization of geophysical data for management of natural resources in Lowland Adriatic Sea (region of Tirana – Durres – Kavaja, Albania), The 4th Balkan Geophysical Congress – International Conference of Applied Geophysics and Earth Physics, 09 -12 October 2005, Bucharest, Rumania.

ISSN 2306-9600

Vinçani F., Leka P., 2009. Processing and presentation of VES results through ArcGis 8.2 software for the Lalzi Gulf region, Bulletin of Technical Sciences, Albania.

Vinçani F.**,** Cara F., Leka P., 2010. Geochemical-geophysical studies for tecnogen pollution in Porto Romano, Albania and their integration in GIS, Journal of International Environmental Application & Science, Jieas-5-1-08, Vol 5, 2010.

Vinçani F., 2010. Ph.D.: "Integration of geophysical studies in Near-Coastal Lowland of Albania with GIS technology", Faculty of Geology and Mines, Tirana, Albania.

Vinçani F., Leka P., 2010. Realization in ArcView GIS 8.2 of electrometric studies of VES performed in region of Karpen-Rodon Cape, Bulletin of Geological Sciences, N0. 1, Albania.

URL-1. http://www.esri.com/software/arcgis/arcview/.

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ELECTROMETRIC CONTRIBUTION FOR THE DETERMENIATION 2D AND 3D OF THE QUATERNARY DEPOSITIONS IN ALBANIA

Piro LEKA[1], Fatbardha VINÇANI[1], Petrika KOSHO[1]
[1]*Institute of Geosciences, Energy, Water and Environment, Tirana, Albania),*
E-mail: p.leka@yahoo.com, bardha_vin@yahoo.com, pkosho@yahoo.com

ABSTRACT

The Quaternary depositions occupy about 46% of Adriatic Sea lowland in several geographical units. Among them, the main unit consists of plains and hills between Lezha, Tirana, Durresi and Kavaja. They cover the terrigenous-carbonatic-basement of Kruja structural unit and the molasses of Adriatic Sea lowland. The electrical soundings performed in these areas with Schlumberger array are the main Electrical Prospecting surveys considered in this study. The longest spacing in these soundings was up to AB/2 = 1000 m, the distance between lines 4-9 km, while the one between the soundings, 500 m. The values of electrical resistivity parameter for Lalzi, Durres and Rodon Gulf are low, from 1 to 30-40 ohmm The lowest values of electrical resistivity 0.1-1 ohmm represent the marine lagoonal swamp sediments mainly clays with satly water, while the values of electrical resistivity 1-5 ohmm represent a mixture of clay and sand with salt water. Alluvial sediments of the first terrace, clay and alevrolite have the values of electrical resistivity 5-10 ohmm while the values of electrical resistivity 10-20 ohmm, represent fluvial and alluvial sediments. The highest values of 20 - 40 ohmm belong to gravel, sandy clay and alevrolie..To deepen more the studies for the environmental- geological study of Quaternary depositions at perspective areas it was necessary to perform surveys with Schlumberger electrical soundings in a regular grid and in more detailed scale.

KEY WORDS *Electrical Prospecting Data, Quaternary Depositions, Electrical Resistivity, Well logging.*

INTRODUCTION

The Quaternary depositions occupy about 45 % of Adriatic Sea lowland and they include some geographical units. The main unit consists of plains and hills between Lezha, Tirana, Durresi and Kavaja. They cover the terrigenous - carbonatic basement of Kruja structural unit and the molasses of Adriatic Sea lowland (Hoxha J. & Hysenaj R., 2004).
The Electrical Prospecting surveys (Electrical Soundings with Schlumberger array) are usually carried out in such cases in a regional scale to determine the lithologies and their thicknesses of Quaternary depositions, particularly for the coarse grain layers (sands and gravels) and the depth of basement as well (Atzemoglou, A. & Tsourlos, P., 2002).

QUATERNARY DEPOSITIONS AND ELECTRICAL SURVEYS

The Quaternary important events in Alpine belt in Europe, all other places and in Albania, occurred after Pliocene age. Our division of Quaternary period is in the concordance with International Commission of Stratigraphy.
The lowland of Adriatic Sea includes many types of depositions such as alluvial (first, second, third terrace), aeolan, marine, swamp, lagoonal sediments and sediments of piedmont slope, slope breccia, etc. (Hoxha, J., et al., 2004)
Electrical surveys are carried out with the resistivity method of electrical soundings - Schlumberger array, with AB/2 up to 1000 m. The distance between lines is 4 – 9 km, while the one between the soundings is 500 m. For the study of anisotropy in the geological environment are carried out the measurements of soundings at the same point, but at different azimuth directions.
The quality interpretation of apparent resistivity curves is carried out with the approximate method applying to the "Resist" program, for the models with 5 and 6 layers. For the study on the lithological formational sediments of Quaternary depositions in lowland of Adriatic Sea in depth are compiled the resistivity maps for the different hypsometric levels.

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Fig. 1. Map of Electrometric studies in Quternary depositions

2D and 3D GEOELECTRICAL MODELS

Lalzi Gulf region

At the processed resistivity map for the studied depth of H=12 m, is shown that the values of electrical resistivity parameter for Lalzi Gulf are low, from 1 to 30 ohm (Fig. 2a, 2b).

Based on the geological-geophysical interpretation of the obtained data in this region results that the lowest values of resistivity 0.1-1 ohmm represent the marine, lagoonal, swamp sediments, mainly clays with salty water, while the values of 1-5 ohmm indicate added sand in them. Alluvial sediments of the first terrace, clays and alevrolite have values of resistivity 5-10 ohmm, while the values of resistivity 10-20 ohmm represent fluvial and alluvial sediments. The highest values 20-30 ohmm represent gravels, sands, clays and alevrolite mixture (Leka P., et al., 2005).

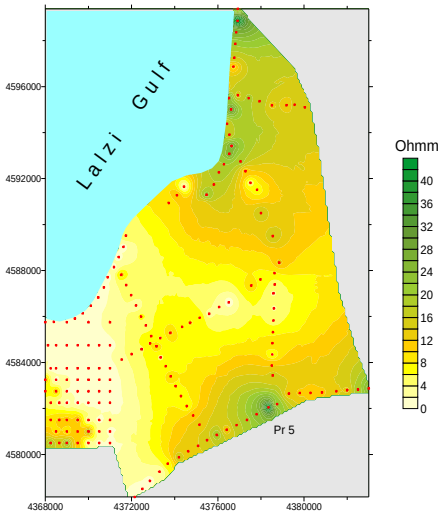


FIG. 3. Electrical resistivity map for study depth h= 12 m Lalzi Gulf region

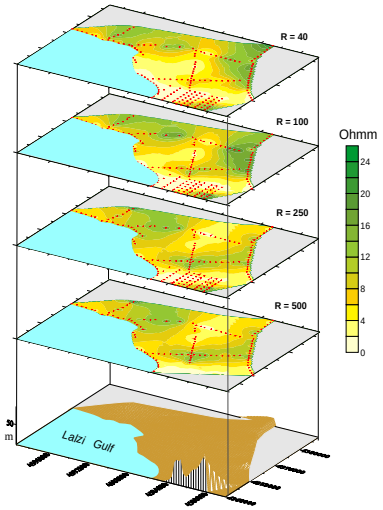


Fig2. a) 2D Electrical resistivity map for study depth h=12 b) Electrical resistivity depths and topographic maps, Lalzi Gulf regionProfile 1, Porto Romano – Fllakë.

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The geoelectrical survey was done in SW - NE direction, across the Chemical Factory and urban areas of Porto Romano – Fllakë (Mazreku A. &Cara F., 2003).
Geoelectrical image of this line is presented by almost horizontal layers. In this line are delineated 5 geoelectrical layers with different litological composition. Beginning from the surface, the first layer with values of resistivity 6-20 ohmm and thickness 0.9-3 m, represents the marine, lagoon–swampy sediments with clay and sand composition (Leka P.& Vinçani F., 2003; Hoxha J., et al., 2005).
The second layer with the values of resistivity 4-9 ohmm and the thickness up to 100 m, represents the alluvial sediments of the first terrace with clay and alevrolite composition, while the third layer with interruption at stations 6-11, with the values of resistivity 2-4 ohmm and thickness up to 100 m represents clay and sand sediments.
The forth layer with interruption at stations 1- 4 and station 7, with values of resistivity 20-45 ohmm and thickness up to 70 m, represents sediments with the interweaving of gravel, sand and clay composition. In resistivity decreased values has influenced the presence of water in gravel layer. This layer is almost uniform throughout the geoelectrical cross-section and is based on the sediments of basement (Fig.3).

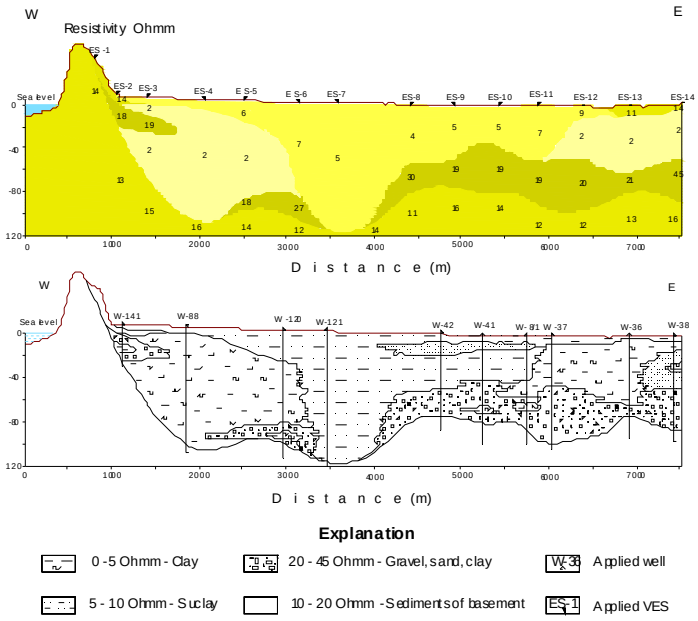


Fig. 3. Geological –geophysical cross- section after VES in Profile I, Chemical Factory, Porto Romano – Fllake, (after Leka P., Vinçani F.,Hoxha J., 2005)

The sediments of basement compose the fifth and the last layer with values of resistivity of 10 - 20 ohmm and are composed by clay and sand mixture. The drilled wells in this line (W-141, W-88, W-120, W-21, W-42, W-41, W-8/1, W-37, W-36 and W-38) helped in the quantitative interpretation of electrical resistivity curves, defining exactly the boundaries of these geoelectrical layers.

Well loggings

In this region are carried out the well logging surveys applying 3-electrode AMN array (gradient – potential) to delineate exactly the depth and the thickness of sediments with interweaving of gravel and sand composition. These surveys have served to support 1- Dimensional quantitative interpretation of electrical resistivity curves carried out in between above-mentioned wells. Coordination of the obtained results from the achievement of surveys in depth with accomplished ones on surface helped out in the output of conclusions with theoretical-practical values in the study of technogen contamination spreading to the groundwater at depth.
In electrical resistivity curve obtained in well No. 12 are delineated low values of 0.5-3 ohmm down to 12 m of depth, that represent the marine, lagoonal, swamp sediments, with silky clay and sand composition (Koçiaj S., et al.,1985).
The values of electrical resistivity increase from 5 to 10 ohmm down to 20 m depth and represent the sediments of first terrace with clay and alevrolite composition. Below to 20 m depth, the values of

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electrical resistivity increase over 10 ohmm and represent clay, sand near the basement of Quaternary deposit, composed from clay with sandy content (Fig. 4).

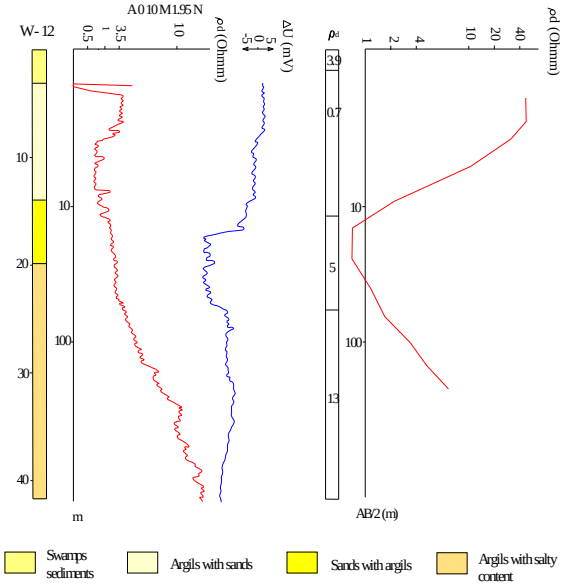


Fig. 4. Electrical resistivity curves ($p_{d,}\Delta U$) through well No.12 and after VES, Vrinas – Durres, (after Koçiaj S., Kapllani L., etc., 1985)

Durres Gulf region

From the processed resistivity map for the studied depth of H= 50 m is noticed that the values of this parameter for the Durres Gulf are low, in the range 1 to 20 ohmm. The values about 1 ohmm represent the marine, lagoonal, swamp sediments, mainly clays with salty water, while the values of electrical resistivity 1 to 5 ohmm, indicate some added sand, too. (Fig. 5a).
The values varying from 5 to 10 ohmm represent alluvial sediments of the first terrace with clays and alevrolite compositions, while the values of electrical resistivity varying from 10-20 ohmm, represent fluvial and alluvial sediments (Leka P. & Vinçani, 2005), (Fig. 5b).

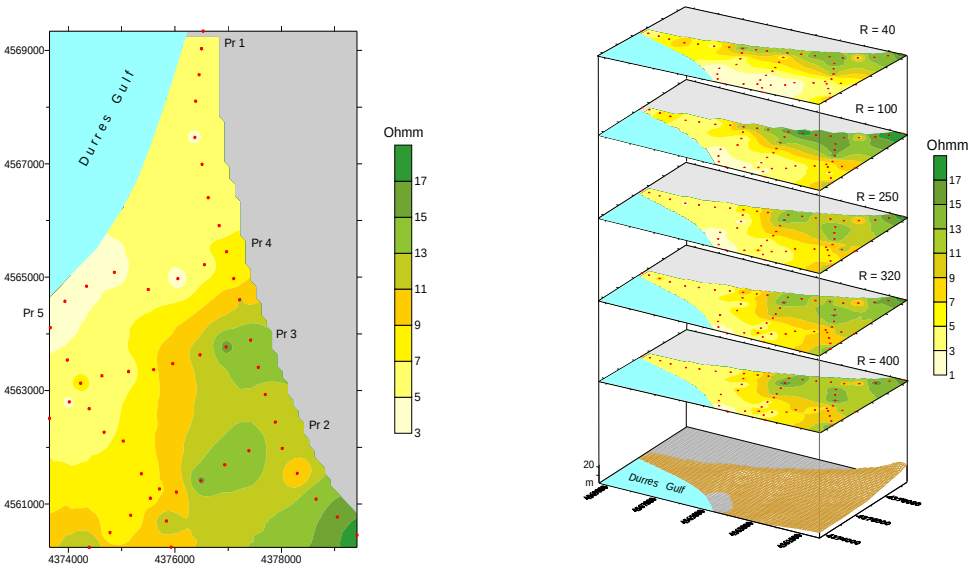


Fig. 5. a) 2D Electrical resistivity map for study depth h=50 m, b) Electrical resistivity depths and topographic maps, Durres Gulf region

At the 2D resistivity pseudo-section on Line 2 in Synej – Bagoja are delineated 6 geoelectrical layers (Fig. 6).

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The first and fifth layers with the resistivity values of 5-10 ohmm and of thickness 3-50 m, represent the alluvial sediments of the first terrace with clays and alevrolite. The second with the values of resistivity 8-20 ohmm and of thickness 4-6 m, represents the alluvial sediments. The third layer, at the (5 -1/ 5), with the values of resistivity 7-12 ohmm and of thickness 6-18 m, represents clays and alevrolite, while at (2-6) ES, with values of resistivity 2-5 ohmm and of thickness 18-23 m, represents clays and sands.

At these sites varies also the lithological composition of fourth layer, where the values of resistivity 8-11 ohmm, and of thickness 45-55 m, represent clays and alevrolite, while the values of resistivity 19-20 ohmm, and of thickness 30-51 m, represent sands, gravels, clays and alevrolite. The sixth layer with the values of resistivity 26-30 ohmm and 14-20 ohmm, represents the sediments of the basement of Quaternary depositions, with conglomerates, sands, clays and alevrolite composition.

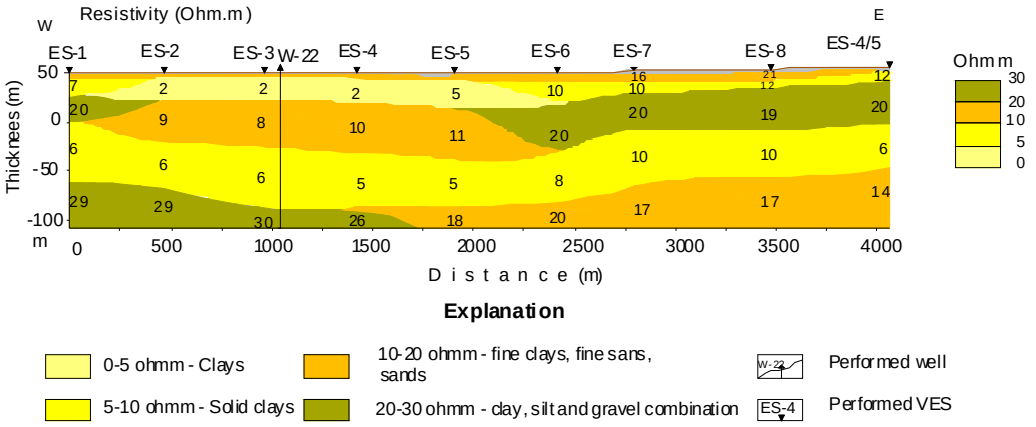


Fig. 6. Geological – geophysical cross-section by VES carried out in the Line2 Synej-Bagoja

Rodon Gulf region

At the 2D resistivity pseudo - section Line 3 of Ishem - Burizan are delineated 5 geoelectrical layers (Fig.7).
The first layer with the values of resistivity 20-30 ohmm and thickness 3 m, represents the alluvial sediments with clay mixture, while the second layer with the values of resistivity 5-11 ohmm and thickness 2-10 m, represents sediments with clays and alevrolite composition.
The third layer, with values of resistivity 8-20 ohmm and thickness 12-56 m, represents sands, clays and alevrolite, while the fourth layer, with values of resistivity 25-60 ohmm and thickness 2-70 m, represents gravels and less sands, clays. The fifth layer with values of resistivity 18-29 ohmm, represents the sediments of the basement of Quaternary depositions, with sands, gravels, clays and alevrolite composition (Leka, P. and Vinçani, F., 2003).

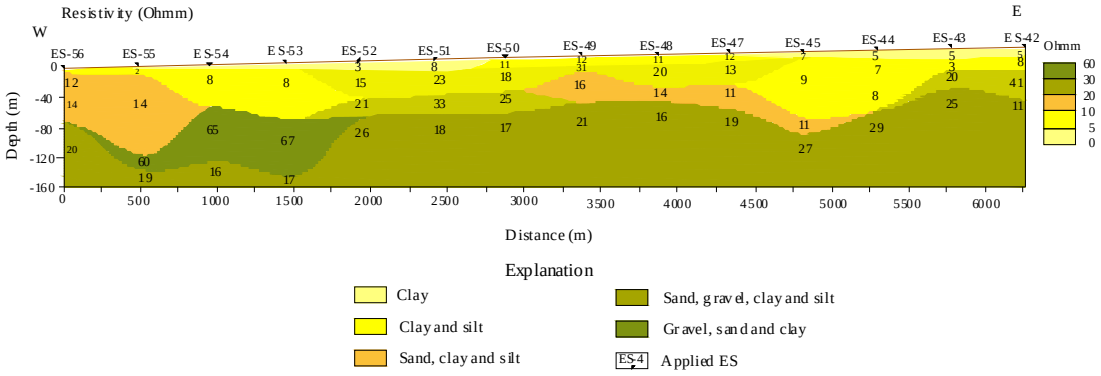


Fig. 7. Resistivity pseudo-2D section 3, Ishem-Borizan region

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Zheje-Mamurras region

Based on the above-mentioned geothermal modeling for the determination of thermal waters zone, we have used the induced polarization, Resistivity and Self Potential methods. For the first two methods we have selected the Schlumberger array from AB/2=15 m up to AB/2=1000 m, with observation grid 500x500 (250) m and 250x250 m, while in the SP method, the potential of electrical field with observation grid 250x250 m, is used (Fig.8).

On the 2-3 dimensional pseudo-sections of resistivity can be noticed a common feature of the presence of a low resistivity layer up to 4-9 ohmm, that should be related to its saturation with thermal water through their vertical infiltration towards the surface. Its location between two layers of high resistivity up to 400 ohmm makes more reliable its composition. Figure 9 shows that the drillings S_1 and S_2, performed on Line 24, close to the station 300, have confirmed the presence of the thermal waters (Leka P., Vinçani F., Hoxha J., 2003).

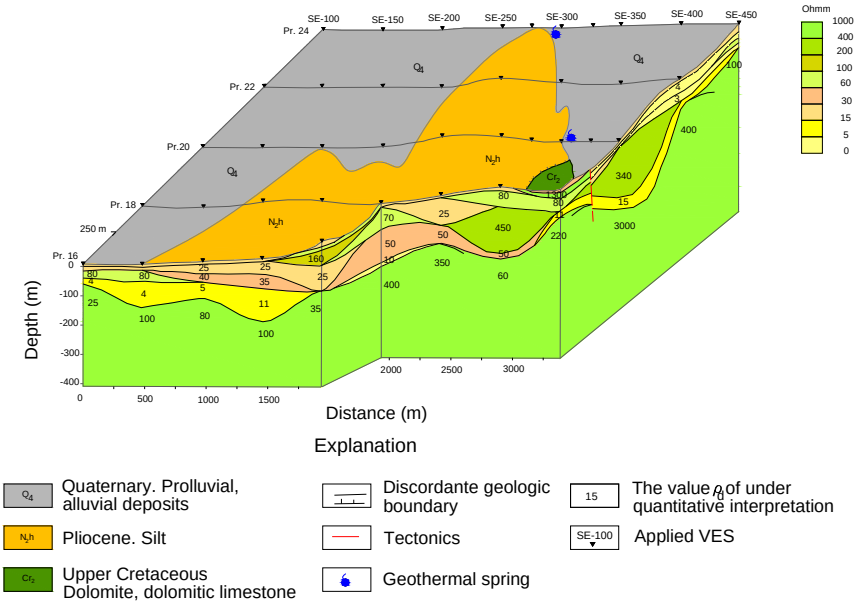


Fig. 8. The geologic map of Quaternary deposition, Zheje-Mamurras region.

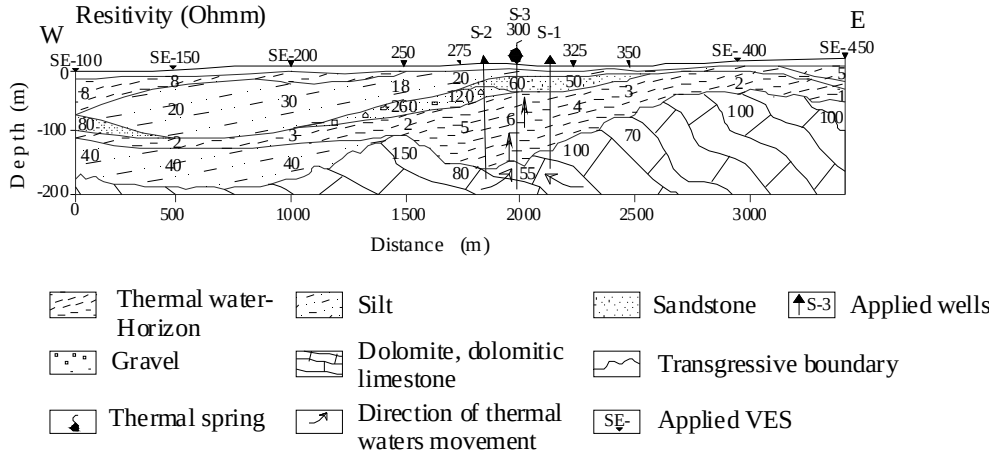


Fig. 9. Geological – geophysical cross-section after VES carried out on Line 24, Zheje – Mamurras region

Elbasani region

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Elbasani's Aquifer Basin represents one of the largest water resources of Albania.
Its aquifer potential is conditioned by the development of extensional tectonic system, related with early transversal fault of Vlorë - Ebasan – Dibër and its tectonic regimes.
This basin is characterized by three important objects:

- Aquifer basin of Quaternary depositions, which is related to gravel terraces of Shkumbin's river and represents one of the most potential drinking water resources of this region.
- Aquifer basin of Mirdita's zone, which is related to Triassic limestone and extensional tectonic regime and presented evidently by surface springs.
- Aquifer basin of Krasta's zone, which is related to Turanian – Mastriktian limestone and extensional tectonic regime, which resources drain into fluvial formations and into Shkumbin's River bottom.

Region Labinot – Fushë – Elbasan – Cërrik, at conditions of continued subsidence has incurred successive burying of fluvial terraces, creating the necessary conditions for the sedimentation of the thick gravel horizon.
Waterbearing layer is in discordance to Ionian's, Kruja's, Krasta's and Mirdita's tectonic zones with tectonic system of faults, characterized by potential hydrological parameters.
In this region, other waterbearing layers are carbonates of Mirdita's tectonic zone of sub-zone Krasta, represented at depth with extensional tectonic regime, which serves at once like drained planes of potential aquifer resources.
For aquifer studies that are related to waterbearing horizons above it is used the method of Electrical resistivity, with Schlumberger array soundings for AB/2 up to 500 m.
For modeling of the structure of Elbasani gravel basin on strike and at depth are carried out two survey lines (Vidhasi-Gjergjan, Muriqan-Jagodinë), but for separation of complex aquifer setting, that is related to extensional tectonic regime, is carried out one survey line (Krastë – Shushicë) (Naço P., et al., 2006).

Vidhas Gjegjan Profile

2 D Geoelectrical image of gravel horizon, with tectonic system of faults is characterized as complicated for Line 1-1 "Vidhas – Gjergjan". The third layer presents interest with values of electrical resistivity from 200 to 500 Ohmm, thickness from 7 to 200 m that characterizes the gravels, creating a grabben structure in the central part of this Line, due to normal slides periodically situated in the tectonic system of faults in the valley of Shkumbini River (Leka P., 2007), (Fig. 10).

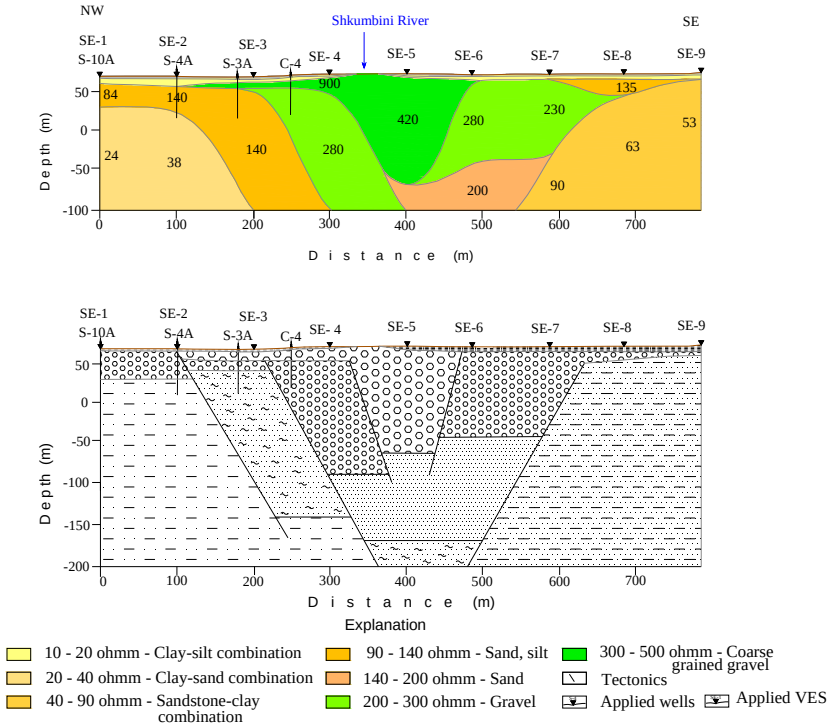


Fig. 10. Geological – geophysical cross-section after VES carried out on Line 1-1 Vidhas – Gjergjan

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CONCLUSIONS

In processed electrical resistivity maps for the studies of lowland from depth H=12 m to H=120 m, is generally shown that the values of electrical resistivity parameter in Lalzi Gulf and Durres Gulf regions are various, reflecting the non-uniform vertical distribution of sediments.

- Geoelectrical layer with electrical resistivity values of 20-45 ohmm, thickness 20-100 m, that represent sediments with mixture of gravel, sand, clay and silt is permeable of technogen contamination in Porto Romano, Durres.
- The electrical surveys used at Zheje-Mamurras region have mapped with accuracy a thermal water-bearing layer with low resistivity due to its saturation with thermal waters during their upwards infiltration towards the surface through the faults.
- Geological-geophysical interpretation of three lines as mentioned above indicates clearly that the riverbed and the valley of Shkumbini River have large aquifer resources and to evaluate from a quantitative point of view the Elbasani Aquifer basin on strike, it is necessary to be carried out the geoelectrical surveys at scales 1: 25,000 and 1: 10,000 with regular rectangular grid accompanied by some hydrogeological wells.
- To increase the potential of thermal waters in these areas, it is necessary the application of electrical methods in delineation of sectors of the thermal waters.
- The range of above-mentioned electrical resistivities is in conformity to values of electrical resistivities defined by quantitative interpretation of electrical resistivity curves obtained by accomplishment of VES in the vicinity to known wells.

REFERENCES

Atzemoglou A. and Tsourlos P., 2002. *A large scale electrical sounding survey at the Amynteon Basin (Greece).* 3rd Balkan Geophysical Congress and Exhibition 24-28 June 2002, Sofia, Bulgaria.

Hoxha J. and Hysenaj R., 2004. *Quaternary of deposition in Albania*. Bulletin of Geological Sciences, N.01, Tirana.

Hoxha J., Leka P., Vinçani F., Dhimitri A., 2004. *On the contribution of the environmental geological map series for the investigation of the Albanian River Net in the Lowland of Adriatic Sea, River* Mining Workshop 29 - 31 March 2004, Tirana, Albania.

Leka P. & Vinçani F., 2003. *Administration of territory and natural resources: Geology-Territory-Environment of Tirana – Durres – Kavaje during 2001 - 2003 years (Geophysics)*. Center of Geophysics, Tirana, Albania.

Leka P., Vinçani F., Hoxha J., 2003. *Delineation of the thermal waters zone with electrical methods at the region Zheje and Hidrat.* International Geophysical & Exhibition, 1-4 September 2003, Moscow, Russia.

Leka P., Vinçani F., Hoxha J., 2005 – *Electrometric surveys at small scale on new Quaternary deposit of Adraitic Lowland (Lalezi Gulf, Durres and Rodon).* Bulletin of Geological Science, Nr. 2, 83 - 91. Tirana.

Leka P., Vinçani F., 2005 - *Geoelectrical models of Quaternary deposition in Lowland of Adriatic Sea, Albania*. Journal of the Balkan Geophysical Society. Vol. 8, 2005, Suppl. 1, 621-625.

Mazreku A., Cara F., 2003. *Geochemical study of Tirana – Durrës – Kavajë region*. Fund of Geological Archives, Tirana.

Koçiaj S., Kapllani L., etc., 1985 - *Seismic microzone of Durres region*. Fund of seismic Institute, Tirana.

Naço P., Bedini E., Leka P., 2006. *The Aquifer Basin of Elbasani, Albania and the problems of its management*. Bulletin of Geological Science, Nr. 1, 47 – 57, Tirana.

Leka P., Naço P., Vinçani F., Bedini E., 2007. *Qualificative assesment of Elbasani aquifer basin through Schlumberger Electrical Soundings*. Bulletin of Geological Science, Nr. 2, 47 – 56, Tirana.

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INTEGRATED GEOLOGICAL-GEOPHYSICAL STUDY OF SHEET "75" (VITHKUQI)

Petrika KOSHO[1], Fatbardha VINÇANI[1], Kujtim ONUZI[1], Piro LEKA[1]

[1]Institute of Geosciences, Energy, Water and Environment, Tirana, Albania)
E-mail: pkosho@yahoo.com, bardha_vin@yahoo.com, konuzi@yahoo.com, p.leka@yahoo.com,

ABSTRACT

In sheet "75" (Vithkuqi) was carried out an integrated geological-geophysical study. In this area are carried out the measurements of total magnetic field intensity "T" and magnetic susceptibility "K".
Graphical image of the total intensity anomaly "Ta" and magnetic susceptibility "K" in the form of 2-D and 3-D maps, histograms and geological-magnetometric cross-section have given a significant contribution in accompanying geological studies to further refine the geological mapping, its tectonic-structural relationships, formational rocky types, etc.
Integrated geomagnetic study has also determined the magmatic rocks below overlay, the dip angle of contacts between rocky types with magnetic contrast, it gives direct contribution in studying and determining of the tectonic-structural relations of ultrabasic rocks with flisch deposits, volcanites limestone etc., which lie on the periphery and inside of them, and indirectly helps studies for mineral-bearing on them.

KEW WORDS *Total magnetic intensity "T", magnetic susceptibility "K", magmatic rocks*

INTRODUCTION

Geomagnetic studies integrated with geological ones at scale 1: 25 000 and in more detailed surveys have helped in geological mapping, outlining of magmatic rocks below overlay, in dip angle evaluation of contacts between rocky types with magnetic contrasts and have outlined their tectonic structural features.
They have also given opinions and solutions on shape and continuity of ultrabasic and gabbroid massifs, etc. By analyzing and interpreting the character of geomagnetic field anomaly is made possible the outline of zones of mineral-bearing (like chrome-bearing) from the barren ones in ultrabasic rocks (Ground Magnetic Surveys, 1999), (Kosho P., 2001).
In sheet "75" (Vithkuqi) was carried out a complex geological-geophysical-geochemical study. Magnetometric survey has been carried out with the grid of (500x50) m, according to the lines of azimuth 65^0. Measurements of the intensity "T" and susceptibility "K" were carried out respectively by proton magnetometer MP-2 (sensitivity ± 1nT) and kappa-meter KT-5 (sensitivity $1x10^{-5}$ SI units).

GEOMAGNETIC STUDIES PERFORMED IN SHEET "75" (VITHKUQI) AND INTERPRETATION OF THEIR RESULTS

Graphical image of the intensity anomaly "Ta" and magnetic susceptibility "K" in 2-D and 3-D maps, histograms and geological-magnetometric cross-section have given a significant contribution in accompanying geological studies to further accuracy of the geological mapping, its tectonic-structural relationships, mineral-bearing, etc., formational rocky types, representing this sheet (Fig. 1), (Kosho P., 2001).

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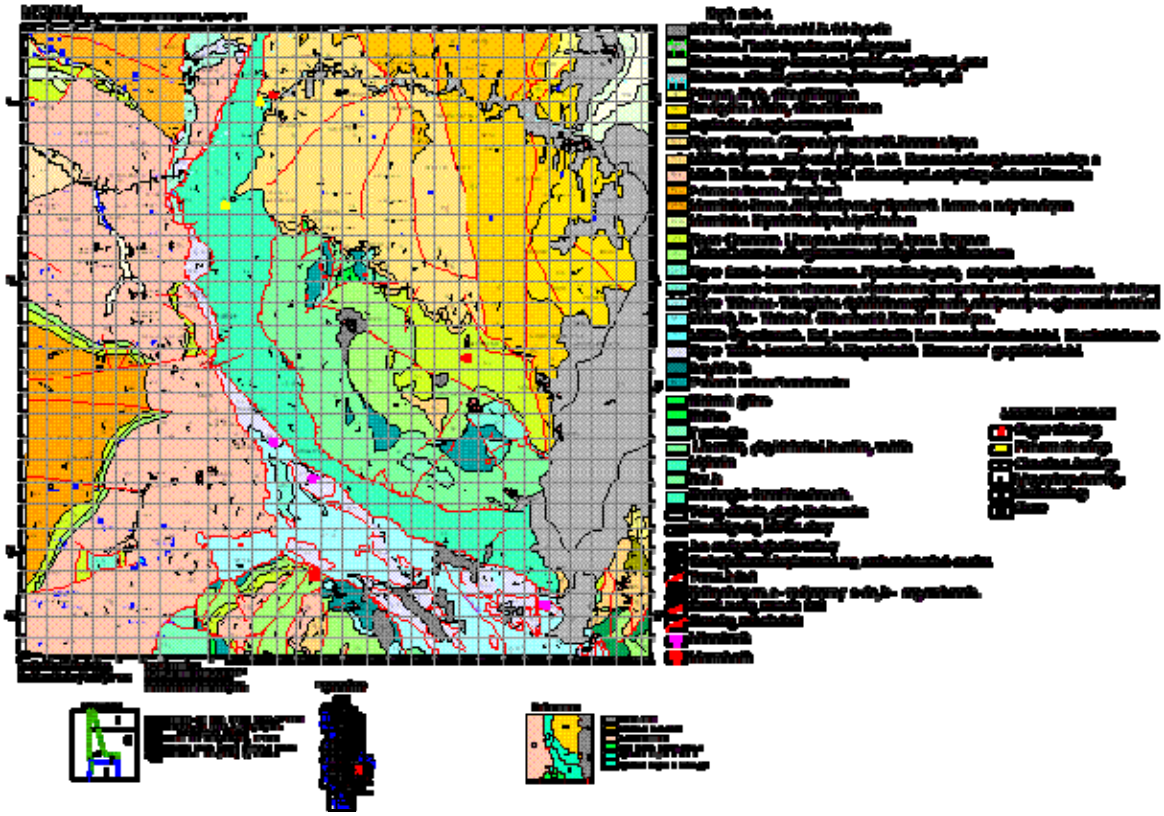


Fig. 1. Geological map, sheet "75" (Vithkuqi)

Flisch deposits are evidenced with a low background (1.4 - 2.5 x10^{-3} SI units). Passing on the flysch depositions of Paleogene, the magnetic susceptibility is decreased to 1.0x10^{-3} SI units. The limestone formations of Triassic, Jurassic and Cretaceous are clearly separated, respectively, very weak magnetic to non-magnetic (0.04x10^{-3} SI units), (Fig. 2).

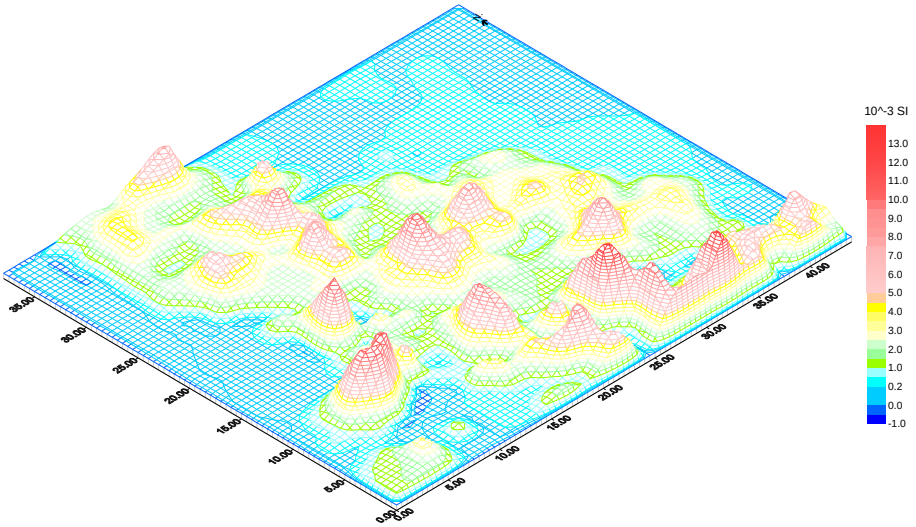


Fig. 2. The map of magnetic susceptibility" (3-D), sheet "75"

The image of the geomagnetic anomaly field "Ta" in the sheet "75" (Vithkuqi), similar to that observed in other parts of the ophiolites in our country, reflects the characteristics of petromagnetic differentiation of its respective geological and lithological components (Fig. 3), (Onuzi K. etc., 2002).

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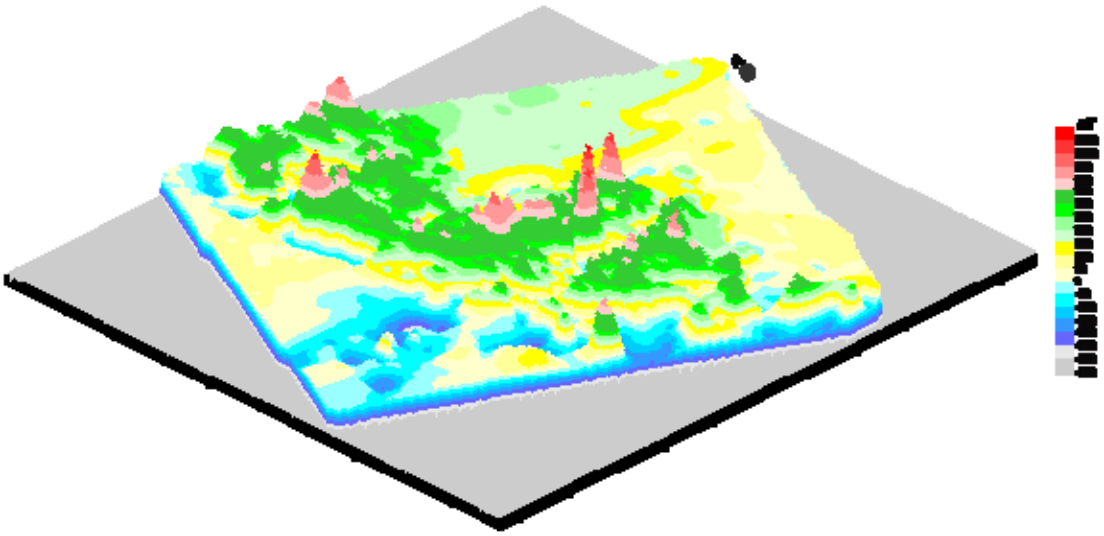


Fig. 3. The map of total anomalous magnetic intensity "Ta", sheet "75"

Generally, the values obtained on tectonic peridotites are less intense (300-850 nT) and more stable than those obtained on cumulate, plagioclasite and amphibolitized ultrabasics. The values of the anomaly intensity "Ta" on the last ones are high, variable, with irregular frequency and amplitude (with irregular crossing of "Ta" from "positive" values of +1600 nT to "negative" ones of -900 nT).
Tectonic peridotites are less magnetic than the amphibolitized plagioclasite ultrabasics (Fig. 3).
Geological magnetometric cross-sections show clearly this variation of anomalous geomagnetic field over them (Fig. 4).

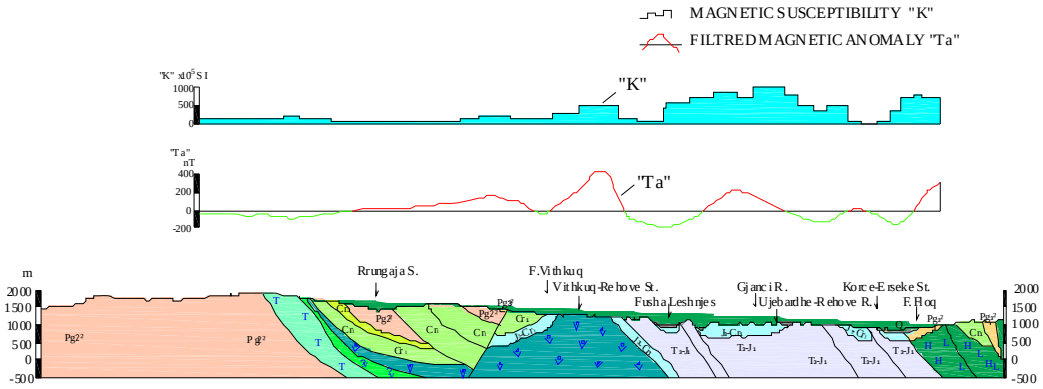


Fig 4. Geological-magnetometric cross section, profile IV, sheet "75" (Vithkuqi)

Based on the outlining, variability, amplitude, frequency of the intensity values "Ta" and on the map of magnetic susceptibility "K", there is a differentiation between rocky and formational types, representing the geological setting of sheet "75" (Vithkuqi). The complex appearance of magnetic anomaly "Ta" in this region expressed a relatively high degree of serpentinization of peridotites and a powerful tectonic activity (which intersects these rocks in different directions).
Generally, Voskopoja ultrabasic massif has undergone a secondary powerful processes activity.
The geomagnetic studies not only reflect the faults and tectonic zones, determined by surveying and geological study, but also outline the new ones (Onuzi K., Koller F., Hock V., Kosho P., Palko A, 2010).
Triassic limestones which limit the Voskopoja ultrabasic massif in the southern corner vary in terms of thickness and tectonic relationships, from those that are located to the west.
In the first case, the intensity of the "Ta" anomaly indicates that these are fragments and overlap the ultrabasic rocks, while in the second case, as from the lower values of the "Ta" anomaly the limestone are thicker and dip towards the east, below the ultrabasic rocks.

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Values of intensity anomaly "Ta" that obtained on flisch deposits of (J3-Cr1) are rather irregular and conditioned by their predominant ultrabasic composition.
Contact of Cretaceous limestone (in the southeast) with the Voskopoja ultrabasic massif is reflected very clear and coincides completely with that determined by geological studies.
The higher amplitude and greater variability of the values of anomalous intensity "Ta" is noted on the cumulate rocks and the deposits defined as J_3-Cr_1.
The features of the magnetic anomaly shows that volcanite (βJ_{2-3}) have the thickness that increases from west to east.
"Spots" of volcanite J_3 between peridotites, reflected with similar characteristics to those of ultrabasics.
Horizontal gradient of intensity "Ta" from west to east (-900 ± 1000 nT) and anomalous magnetic picture show that the contact of flysch with Voskopoja ultrabasic massif strikes toward the east, with "soft" angle.
Shifting of "negative" values of intensity "Ta" on ultrabasic reflects the presence of the Triassic limestones under them.
In geomagnetic maps and geological-magnetometric cross-sections is seen that volcanites (βJ_{2-3}), being weak magnetic until no-magnetic, have low intensity values "Ta" (up to 300 nT), distinct from the ultrabasics background.
In some sectors the anomalous magnetic features suggest that their thickness is not small and the few early flysch deposits placed on them.
Gabbroid rocks, on the east are more magnetic than volcanites. Intensity values "Ta", obtained on them reach up to 760 nT.
According to the results of geomagnetic studies, we think that the anomalous magnetic picture obtained in the Voskopoja ultrabasic massif has similarities to that of Shpat ultrabasic massif. Besides this phenomenon, they also have similar petromagnetic features, comparable spatial placement, and similar chemical composition. Graphics of intensity "Ta" may not always shed light on the structure, thickness and "form" of ultrabasic massifs.
Complicated to interpret in this regard are also graphics that can be selected transversal to Voskopoja massif.
However, the interpretation of the maps above, notes that the largest thickness is on the east, and obtaining anomalous magnetic zone (reflecting of various rocky types, tectonic faults, etc.), generally coincides with their structural-tectonic study. In view of the contribution that gives magnetometric study in this region (sheet) in determining of the chromiferous, magnetic picture described above, classifies Voskopoja massif in union of western ultrabasic belt, with chromiferous potential lower than that of the eastern belt.
Matching the results of studies of integrated geological-geophysical (magnetometric) shows once again that they directly or indirectly express different indicators and components of the same physical-chemical phenomena, which in particular, has limited chromshpinelid different concentrations.

CONCLUSIONS

Most important conclusions derived from the interpretation of magnetometric study results in sheet "75" (Vithkuqi) are:

1. Magnetometric study helps direct lithological mapping of this region.
2. Anomalous magnetic features in it, expressing petromagnetic changes, indirectly reflect petromineral changes of rocks and formations that compose its geological construction.
3. According to the above characteristics, the rocks that build the Voskopoja massif, are more magnetic and have undergone a powerful dynamometamorphism activity.
4. It gives direct contribution in studying and determining of the tectonic-structural relations of ultrabasic rocks with flysch deposits, volcanites, limestone etc., which lie on the periphery and inside of them, and indirectly helps studies for mineral-bearing on them.
5. Through the optimum processing of magnetometric data, obtained information and geomagnetic maps that help and refine their interpretation, to solve the aforementioned problems.

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LITERATURE

Kosho P., 2001. Report on "Results of regional magnetometric studies performed in sheet 75 (Vithkuqi)", *Central Fund of Geological Archives*, Tirana.

Onuzi K. etc., 2002. Study on "Complex research-surveying at 1: 25 000 scale, sheet 75 (Vithkuqi), *Central Fund of Geological Archives*, Tirana.

Onuzi K., Koller F., Hock V., Kosho P., Palko A, 2010. "Geological-geophysical study on sheet 42 (Maliqi)", Fund of Geosciences Institute.

"Ground Magnetic Surveys", 1999.

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MULTICHANEL ANALYSIS OF SURFACE WAVES (MASW) IN EVALUATION OF SHEAR WAVE VELOCITY. A CASE STUDY

Altin KARRIQI[1], Elsa VESELI[2]

[1]*Faculty of Geology and Mining, Tirana, Albania, altin.karriqi@fgjm.edu.al*
[2]*Faculty of Civil Engineering, Tirana, Albania, ing_elsaveseli@hotmail.com*

ABSTRACT

Recently, the interest of scientific and professional community on the method of Multichannel Analysis of Surface Waves (MASW) has markedly increased. We describe in this paper the principles of this method, field procedures applied for the recording of Rayleigh waves and the processing of the recorded wave field obtained in a test site in Southern Albania. The data permited us to develop an two-dimentional section in terms of shear wave velocity, Vs. In order to assess the reliability and accuracy of the MASW technique, the 2D profile was compared to the geotechnical data obtained in the site by a number of bore holes and the good characterization of the Quaternary medium by Vs distribution is evidenced.

KEY WORDS *Multichannel Analysis of Surface Waves, shear –waves velocity, Rayleigh waves, dispersion curve.*

INTRODUCTION

Soil stiffness is one of the critical material parameters considered during an early stage of most geotechnical construction. Traditionally, several geotechnical or geophysical methods have been used to quantify soil stiffness. These include the cone penetration test (CPT) and down-hole seismic methods. CPT is an in-situ method that evaluates stiffness by measuring resistance to the penetration of a probe. Down-hole seismic method measures travel times to establish seismic velocities that are linked to the stiffness. Among all other elastic parameters of the materials, shear-wave velocity is the best indicator of stiffness. CPT and down-hole methods require the drilling of holes for probe penetration and give stiffness information that is representative of a localized volume near the hole. Shear-wave down-hole methods are generally considered less reliable because of difficulties in generating pure shear waves and processing the acquired data.

The surface wave methods have recently become the seismic techniques that are frequently used to estimate the shear-wave velocity structure of soil because of their non-invasive nature and greater efficiency in data acquisition as well as processing. Propagation velocity of surface wave is frequency dependent. This property is called dispersion. The heterogeneity in soils is determined mainly by the vertical variation of shear-wave velocity. The heterogeneous properties of soils can be measured by recording the fundamental-mode Rayleigh waves propagating horizontally. The fundamental-mode is usually represented by a curve depicting the variation of phase velocities with frequency. This curve is then used to estimate the vertical variation of V_s (shear-wave) through a process called inversion.

The steady state Rayleigh wave / Continuous Surface Wave (CSW) technique was introduced by Jones (1958) into the field of geotechnical engineering. It was subsequently developed by others, such as Tokimatsu et al. (1991) and Mathews et al. (1996). The CSW method uses an energy source such as vibrator to produce surface waves.

In the early 1980's the widely used Spectral Analysis of Surface Waves (SASW) method was developed by Heisey et al (1982) and by Nazarian and Stokoe (1984). The SASW method uses a single pair of receivers that are placed collinear with an impulsive source (e.g. a sledgehammer). The MASW technique was introduced in the late 1990's by the Kansas Geological Survey (Park et al., 1999) in order to address the problems associated with SASW.

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The MASW method exploits multichannel recording and processing techniques that are similar to those used in conventional seismic reflection surveys. The MASW method has improved production in field due to multiple transducers, and improved characterization of dispersion relationship by sampling spatial wave-field with multiple receivers. Advantages of this method include the need for only one-shot gather and its capability of identifying and isolating noise. Significant user experience and intervention is required for more complex profiles as the inversion formulation in MASW can suffer the same uniqueness problems as in SASW.

SHEAR WAVE VELOCITIES FROM SURFACE WAVES

A series of Rayleigh waves of different frequencies can have the same wave velocity. These different frequency Rayleigh waves for a given phase velocity are known as modes and are characterized by their different number of horizontal nodal planes (planes of no particle displacement within the layer). In other words, more than one phase velocity can be associated with a given frequency of Rayleigh wave, simply because these waves can travel at different velocities for a given frequency (Garland, 1979).
The lowest velocity for any given frequencyis called the fundamental-mode velocity (or the first mode). The next higher velocity above the fundamental-mode phase velocity is called the second-mode velocity, and so on.
The type of surface wave that is used in geotechnical surface wave surveys is the vertically polarized Rayleigh wave. In a non-uniform, heterogeneous medium, the propagation velocity of a Rayleigh wave is dependent on the wavelength (or frequency) of that wave. The Rayleigh waves with short wavelengths (or high frequencies) will be influenced by material closer to the surface than the Rayleigh waves with longer wavelengths (or low frequencies), which reflect properties of deeper material. This dependence of phase velocity on frequency is called dispersion. Therefore, by generating a wide range of frequencies, surface wave surveys use dispersion to produce velocity and frequency (or wavelength) correlations called dispersion curves.
After the development of a dispersion curve, the next step involves the inversion of this curve using the software *SeisImager/SW,* which was developed by the Geometrics Inc. S wave velocities are the dominant influence on a dispersion curve in a high frequency range (>5Hz). The inversion method is an iterative one. Due to its influence on the dispersion curve, only the shear wave velocity is updated after each of iteration until the synthetic dispersion curve closely matches the field curve. At the end, SeisImager SW provides 2D Vs section obtained from MASW technique.

FIELD TEST TECHNIQUE

The field configuration is the same as in Seismic Refraction Method. In our test we have used a fixed receiver array to obtain MASW data. This type of configuration is the easiest one in case the line length is short or the field crowd is small. The fixed receiver array used by us in the test site is shown on the fig. 1

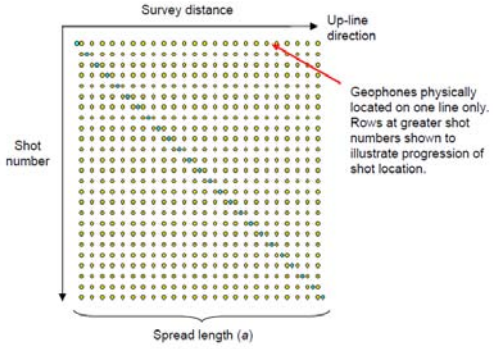


Fig. 1. *2D MASW fixed receiver spread configuration. (Geometrics Inc. manual).*

Twenty four 4.5 Hz geophones are laid down in a linear array. The interval between geophones was 1m, giving a general line length of 23m. An impulsive source (sledgehammer about 10 kg of weight) was used to generate the surface waves. The first shot point was placed in western side of the line with an offset of 0.5m from the first geophone. The shot point was moving with a distance equal to geophones interval (1m) along the line. The eastern offset was also 0.5m. In total, there were performed 25 shots in line (23 shots in the line and 2 offset shot points). Seismic data were recorded using a GEODE 24 channels seismograph.
Theoretically the depth of study varies in an interval a/4 – a (where a is active survey line length). With a fixed shot point interval between geophones, the depth of study is deeper in the center of the array and it decreases in the corners. Considering 23 m the line length and a good signal / noise ratio a depth of study about 10 m is provided.

LOCATION AND GEOTECHNICAL INFORMATION OF THE TEST SITE

The investigation site is located alongside the roadway Vlore – Orikum, about 2 km far from the Orikum town. It is placed near the roadway and the beach (50 m from the shoreline), in a favorable zone for building tourist infrastructure. The location of the test site is shown on the fig. 2.



Fig. 2. Location of test site near Orikum, Vlora. The profile investigated with the MASW-2D method is shown with the red line

Based on logs of 8 bore holes performed in the investigation site, the following typical lithologies have been encountered from top to the bottom of section: a top layer of fillings up to 0.9 m thick (BH 6 and BH 8), pebbles and thin gravel of grey to white colors, a mixture of silt and gravel of grey color, further is encountered dusty/fine grain sand of blue to light blue color, light sub-clay and weak loamy sub-sand (with weak physical – mechanical properties) follow and in the bottom all bore holes are closed in compact and pressed dark blue clay.
As it can be noticed from the above mentioned engineering – geology sections, all the layers have continuity and are met in all bore holes. Throughout the construction site at around depth 6.0 – 6.3 m a layer of thickness 3.5 – 4.0 m with weak physical – mechanical properties, is encoutered.

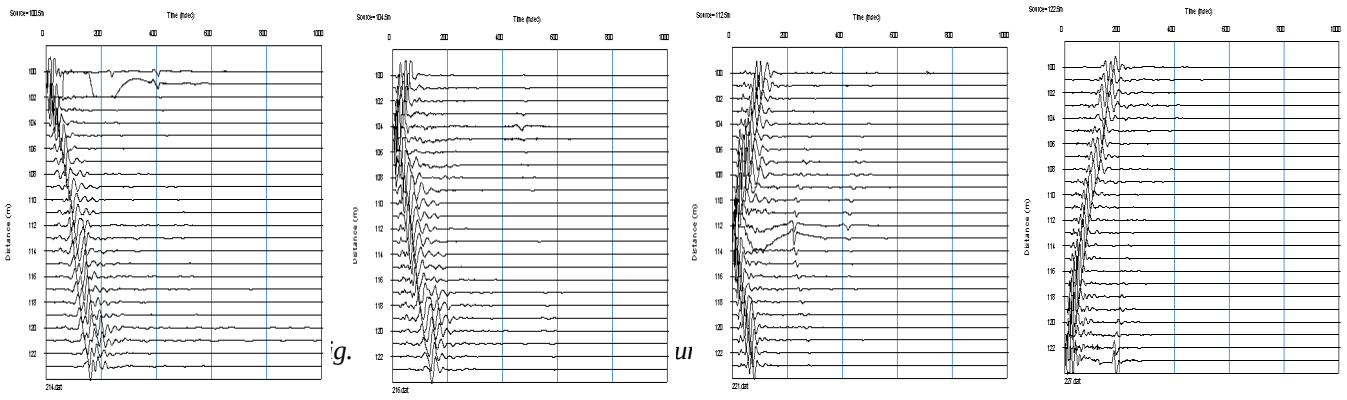
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Fig. 3. Sketch presentation of the borehole network performed at the test site.

DATA PROCESSING AND INTERPRETATION

As an ilustration of the wave formes obtained, in fig. 4 presented are the recorded data for four locations of the energy source. In total 25 recordings were obtained, one for each shooting point. As above mentioned, twenty four 4.5 Hz vertical – component geophones deployed at 1 m intervals were used for recording of the wave field. The dispersion curves for all measurements performed alongside the line, as well the 2D velocity section obtained according to above mentioned methodology are presented on the fig. 5 and 6. The mid-point of this line corresponds to location of borehole S – 4 where the velocity inversion is obviously noticed. The value of transverse wave velocity in the interval 5 – 10 m varies in the range Vs = 140 – 200 m/sec.



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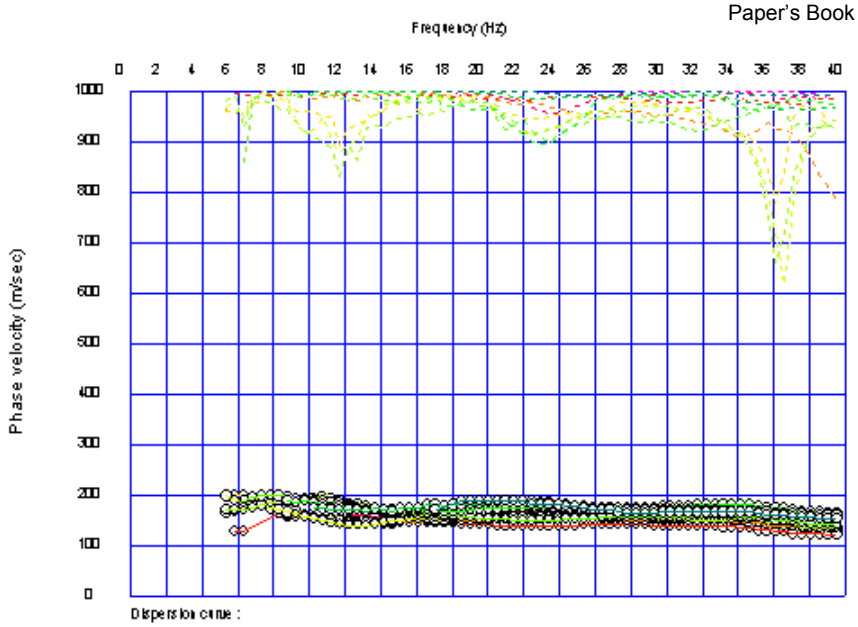


Fig. 5. Dispersion curves derived from all raw data.

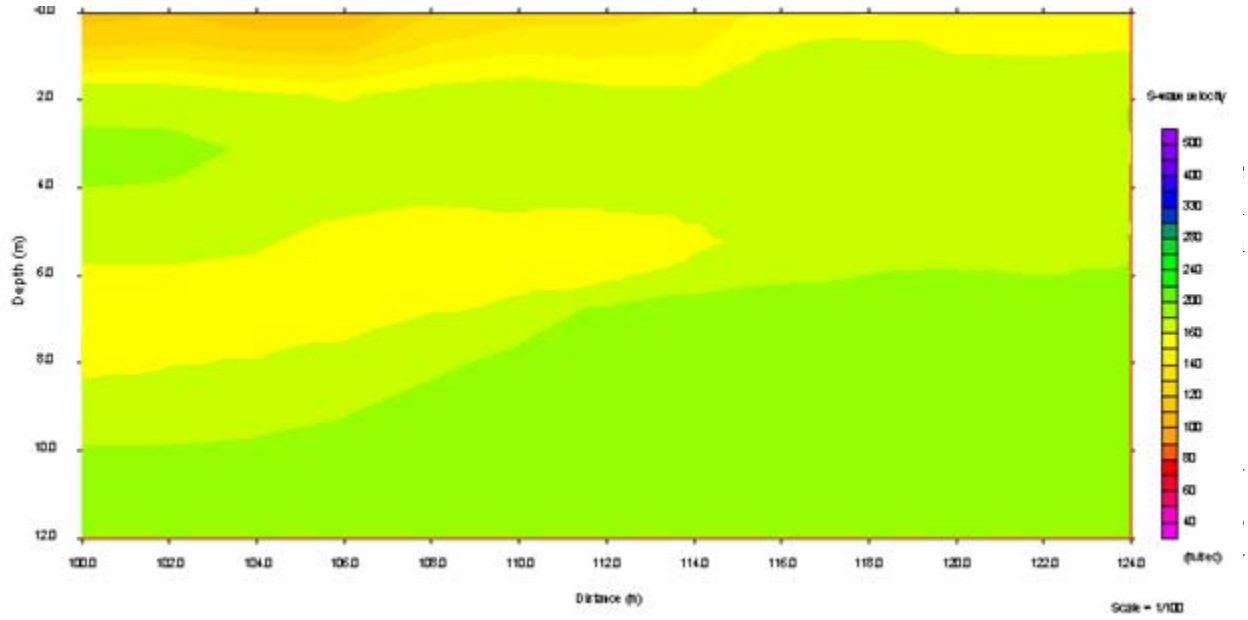


Fig. 6. Vs section obtained from interpretation of field data with MASW 2D method.

As it can be seen from Fig. 6, a velocity inversion is observed on the left part of the profile, which is in good agreement with the geotechnical data from the bore holes drilled in this site. Based on seismic survey, the thickness of this layer is defined in the range of 3 m. As can be noticed from the presentation, its thickness is not the same throughout the investigated section but it wedges out near the line center. The velocity of S wave through which this layer is characterized ranges in between 120 and 160 m/sec.

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CONCLUSIONS

MASW method not only provides accurate near-surface S wave velocities, but in some geologic settings it is the only surface seismic way to obtain S-wave velocity information. Examples are a dipping layer where converted P-wave velocity could occur in a shear-wave refraction survey or in the case of velocity inversions (a higher velocity layer on the top of a lower velocity layer), which precludes refractions event from returning from the interface.

Our first and simple test of MASW 2D in Orikumi site indicates the presence of a low velocity layer which corresponds to the layer of weak physical – mechanical properties intersected in the performed bore holes.

Other tests are in progress in this site in order to improve the data acquisition and processing methodology and to increase the accuracy of interpretation of Surface Waves Shallow Seismic surveys.

REFERENCES

Karriqi, A. 2012, Metoda Spektrale e Valëve Sipërfaqësore në vlerësimin e shpejtësive të Valëve Tërthore, Mikroteze.

Xia, J., Miller, R. D., and Park, C. B., 1999, Estimation of near-surface shear-wave velocity by inversion of Rayleigh wave: Geophysics, **64**, 691–700.

Park, C.B., Miller, R.D., and Xia, J., 1999b, Multi-channel analysis of surface waves (MASW): *Geophysics*, 64, 800 – 808.

Sheriff, R. E., 1991, Encyclopedic dictionary of exploration geophysics (third edition): Society of Exploration Geophysicists.

Nazarian, S., and Stokoe, K.H. 1984. In situ shear wave velocities from spectral analysis of surface waves.*In* Proceedings 8engineering., pp 31-38th world conf. on earthquake.

SeisImager/SW^{TM} Manual, Windows Software for Analysis of Surface Waves, Geometrics Inc. 2009.

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CORNER FREQYENCY (f_0) OF ALBANIAN EARTHQUAKES DERIVED FROM THE DATA OF THE STRONG MOTION NETWORK

Llambro DUNI[1]

[1]*Institute of Geosciences, Energy, Water and Environment, Tirana, Albania, duni@geo.edu.al*

ABSTRACT

We analyse the strong motion time histories recorded by our network with the aim to determine the corner frequency, as one of the most important earthquake source parameters. Two methods were applied for this analysis: the first is the equation that relates the stress drop, seismic moment and shear waves velocity on the earthquake source zone; the second is the far field Fourier amplitude spectrum of earthquake displacement ground motion. The analysis was extended to the time duration of the rupture process of the source zone, comparing the time duration resulting from the corner frequecy assessment with the observed time duration by joint inspection of the velocity and displacement time histories .

KEY WORDS: *Corner frequency, time duration, strong motion record, far field Fourier amplitude spectrum*

INTRODUCTION

Starting from 2002, 16 digitally upgraded accelerographs are in operation as part of the Albanian Strong Motion Network (ASMN) and a number of acceleration time-histories are recorded (Duni et al., 2004). Since the installation of the first digitally upgraded SMA-1 instrument on June 2002, the network has recorded 15 accelerograms from 14 mainly small intensity earthquakes. The strongest earthquakes recorded by the network are those of Leskoviku of November 23, 2004 with M_w=5.4, Durrësi earthquake of September 05, 2007 with M_w=5.0 and Gjorica earthquake of September 6, 2009 with M_w=5.3. Considering that the strong earthquakes have high return periods, the recorded time-histories are valuable information for various purposes. From one point of view these time histories of ground motion can be used as input functions from the engineering community to represent the seismic action for various structural analyses. From the other side, these records are important for the seismologists, because they are the major fount of information for the assessment of the source physical parameters of the strong earthquakes.

The source parameters of major importance are considered the spectral parameter f_0, seismic moment M_o and stress-drop ($\Delta\sigma$). In a number of papers the detailed procedure followed for the assessment of stress-drop, seismic moment and high frequency diminishing parameter from the data collected by the ASMN has been described (Duni and Kuka, 2005[1,2,3]; 2008[1,2,3], Duni, 2010). As a result, the two main parameters necessary for the construction of the seismological model that can support the simulation of high-frequency ground motions, the Brune stress-drop and the high-frequency diminution parameter (the high-frequency cut-off filter) have been determined for two main seismotectonic settings of the country. Two distinct variation intervals of Brune stress-drop have been observed. The first interval is related to values between 15 bars and 60 bars, while the second one is characterized by values in the range $\Delta\sigma$=200–300 bars (Duni and Kuka, 2005[1,2,3]; Duni and Kuka, 2008[1]). Regarding the values of the high-frequency cut-off filter, the analysis have differenced the ground type A according to the EC8 by values in the range $0.02 \leq \kappa_o \leq 0.04$, while for the ground type B the estimates for the two sites are quite similar with κ_o=0.07 (Duni and Kuka, 2005[1,2]; Duni and Kuka, 2008[2]).

THEORETICAL CONSIDERATIONS

In order to better understand the various steps that follow our investigation, here we'll present some basic concepts of some of the most known of earthquake source parameters.

BRUNE SOURCE MODEL, SPECTRAL PARAMETER f_0 AND f_{max}

To understand the effect of the earthquake source on ground motion it is useful to look at the simple source model devised by the Brune (1970, 1971). He considered a simple circular fault of radius r that

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ruptures over its whole area at the same time. The *far field* Fourier amplitude spectrum of ground motion displacement for shear waves from this simplified source can be seen in Fig. 1 (Reiter, 1990).

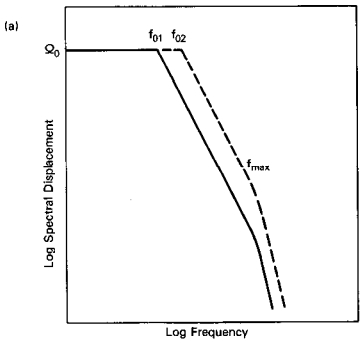


Fig. 1. Idealized Brune (1970, 1971) model of far field Fourier amplitude spectrum of earthquake ground motion (shear waves), modified to include f_{max} (displacement spectrum)(Reiter, 1990).

The far field for earthquake ground motion is defined as distances (R) from the earthquake source significantly greater than the dimensions of the source itself and greater than the wave length of the seismic waves being considered. At closer distances, in the near field, earthquake ground motion is more complicated. Higher order terms in the equations of motion (those proportional to R^{-2}) and the finiteness of the fault become important. Earthquake ground motion becomes much more sensitive to the details of fault location and its exact configuration. The seismic moment is proportional to the low frequency (long period) level (Ω_o) of the displacement spectrum shown in Fig. 1. The corner frequency (f_0), that frequency at which the spectrum changes character from a relatively constant level at lower frequencies to a decreasing level at higher frequencies is proportional to the reciprocal of the source size, or (Reiter, 1990):

$$f_0 = 0.37\,\beta / r \qquad (1)$$

where β is the shear wave velocity in the fault zone volume. Shown in this plot is another frequency, $f_{max,}$ at which the spectral level begins to drop even faster. f_{max} was not defined by Brune, but was described by Hanks (1982). There is some debate among seismologists as to whether this additional change in the spectrum is due to source properties or the effect of local soil conditions. Fig. 2 shows the far field acceleration spectrum from the same source. In this case the displacement spectrum is simply rotated by a factor of f^2. As a result, the maximum spectral accelerations are between f_0 and f_{max} (Reiter, 1990).

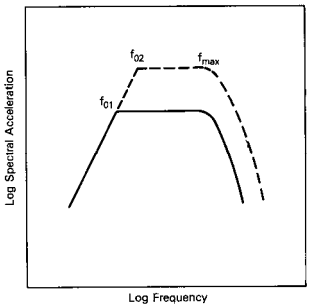


Fig. 2 Idealized Brune (1970, 1971) model of far field Fourier amplitude spectrum of earthquake ground motion (shear waves), modified to include f_{max} (acceleration spectrum) (*Reiter, 1990*).

SEISMIC MOMENT, M_0

Different magnitude scales are actually used in order to characterize the earthquake strength and a large number of papers defining the advantages and shortcomings of each of them have been published (Reiter, 1990). Given these limitations of the various magnitude scales, it has been beneficial the creation of a single unified magnitude scale applicable to earthquakes of all sizes, depths and locations could be developed. Such a magnitude scale has been developed and it stems from the concept of *seismic moment*. Geologically, seismic moment (M_0) is a description of the extent of deformation at the earthquake source. It is simply defined as (Reiter, 1990):

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$$M_0 = \mu A D \qquad (2)$$

where μ is the rigidity modulus (resistance to shearing motion), A is the fault rupture area and D is the average dislocation or relative movement (slip) between the opposite sides of the fault.
There is another way of expressing seismic moment that has bearing upon estimation of maximum magnitude. Brune (1970, 1971) showed that for a simple circular fault rupture of radius r the seismic moment may be written as:

$$M_0 = 16/7\ (r^3)\ \Delta\sigma \qquad (3)$$

where $\Delta\sigma$ is the *stress drop* (see below) associated with the earthquake. Equation (3) indicates that if the fault rupture dimensions remain constant, an increase in stress drop would result in an increase in seismic moment. It can also be shown that, if other factors remain constant, stress drop is proportional to rigidity and, most important, to fault displacement. Earthquake size can therefore be related to rigidity, fault rupture area or fault rupture length and fault rupture width (the down-dip distance to the bottom of the rupture in the fault plane) fault rupture displacement and stress drop.

STRESS DROP, Δσ

Another parameter of interest is the stress drop ($\Delta\sigma$). Stress drop is the change in stress along the fault during the earthquake. This stress release can be though of as being related to the strength of the fault zone or the intensity of rupture needed to overcome that strength. It is important in earthquake source theory and ground motion estimation. Brune (1970) defined the stress drop as being related to *effective stress*, or the difference between the stress along the fault just before the earthquake and the dynamic frictional stress between the two sides of the fault which resist motion. This effective stress or *dynamic stress drop* represents the change in shear stress at a particular point as a result of the earthquake. Brune related this stress drop to the average *static stress drop* as (Reiter, 1990):

$$\Delta\sigma = \mu\ (7/16)\ (u/r) \qquad (4)$$

where μ is the rigidity modulus and u is the average displacement or slip along the fault during the earthquake. In Brune's model the stress drop can be related to the seismic moment (M_0) and corner frequency by:

$$f_0 = 4.9 \times 10^6\ \beta\ (\Delta\sigma / M_0)^{1/3} \qquad (5)$$

where f_0 is in Hertz, β is in kilometers/second, $\Delta\sigma$ is in bars, and M_0 is in dyne-cm. Therefore as stress drop increases for an earthquake of a given moment, so does f_0 and, as can be seen from Fig. 2, so does the amplitude of high frequency motion. In fact, in this model, the spectral acceleration at frequencies greater than f_0 (but less than f_{max}) are proportional to $M_0(f_0)^2$. Following Hanks and McGuire (1981), the time duration of the rupture T_d is related to the corner frequency by the relation:

$$T_d = f_0^{-1} \qquad (6)$$

Using equation (5) and Fourier spectra from recorded earthquakes many stress drops have been calculated. Fig. 3 shows the Fourier amplitude spectrum of the 1971 San Fernando, California earthquake recorded at Pacoima Dam. Estimates of f_0 and f_{max} are shown (Reiter, 1990). However, the choice of corner frequency, empirically defined by a break in slope of the spectrum, is often more difficult than shown here.

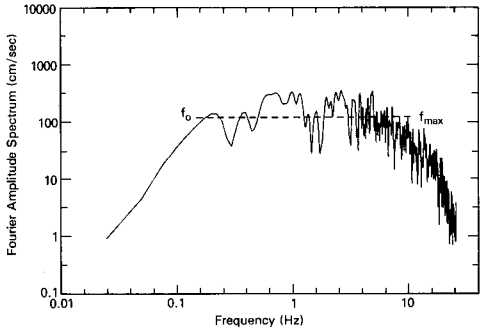


Fig.3 Fourier amplitude spectrum of the February 9, 1971 San Fernando, California earthquake recorded at Pacoima Dam. f_0 and f_{max} are estimated as indicated (*Reiter, 1990*)

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DATA

After the first installation in June 2002, the network has recorded fifteen time histories of fourteen earthquakes, among them ten main shocks; these are the earthquakes of March 27, 2003 and June 28, 2004 near Tepelena (Southern Albania); the earthquakes of December 5, 2003 and August 28, 2004 (Central Albania), the earthquake of November 23, 2004, in Leskoviku, near the border to Greece, the Elbasani earthquakes on December 26, 2005, June 15, 2006 and April 16, 2007 recorded by the instrument installed on the ground level of a small building in the centre of the Elbasani town on alluvium sediments, the Durrësi earthquake of September 05, 2007, installed also on alluvium sediments on the sity center and the earthquake of Gjorica, near Peshkopi occurred on September 06, 2009 (Duni et al., 2004; Duni and Kuka 2005[1,2,3]; 2008[1,2,3], Duni, 2010). The remaining events are aftershocks of the June 28, 2004, earthquake. The earthquake of August 28, 2004 is the only event that has been recorded by two instruments situated at the center of the Tirana City on alluvium sediments. All these records have been processed using the SMA software of Kinemetrics. In Table 1 we present information on these earthquakes and the filters applied during their processing.

Table 1. Data on earthquakes recorded and filters applied

Earthquake Code	Data (yymmdd)	Time (hhmmss)	M_w	Earthq. Coord. Epic.		Geogr. name	Source Depth (km)	Epic. Dist. (km)	Record. Station	Filters (Hz)	
				Lat.	Long.					Low-c	High-c
TPE-03-1	030327	043541	4.9	40.34	20.02	Bënçë	20	5.6	TPE	1.6-2.0	25-27
TIR-03-1	031205	033149	4.8	41.44	20.02	Xibër	24	16.7	TIR	1.6-2.0	25-27
TPE-04-1	040628	174434	4.4	40.27	20.02	Tepelenë	10	2.4	TPE	0.4-0.6	25-27
TPE-04-2	040708	174027	4.0	40.26	20.06	Tepelenë	7	5.4	TPE	1.9-2.2	25-27
TPE-04-3	040711	131624	3.9	40.22	19.85	Lekdush	5	15.7	TPE	2.8-3.6	25-27
TPE-04-4	040712	044240	4.0	40.28	19.97	Tepelenë	1	3.6	TPE	0.6-1.0	25-27
TPE-04-5	040712	054050	4.0	40.26	20.02	Tepelenë	1	3.4	TPE	2.6-3.0	25-27
TIR-04-1	040828	221648	4.0	41.31	19.69	Prezë	23	11.3	TIR2	2.3-2.5	25-27
TIR-04-1	040828	221648	4.0	41.31	19.69	Prezë	23	10.9	TIR3	0.8-1.3	25-27
LSK-04-1	041123	022614	5.4	40.23	20.64	Leskovik	6.9	9.5	LSK	0.2-0.3	25-27
ELB-05-1	051226	055327	4.3	41.14	20.08	Elbasan	10	2.6	ELB	1.2-1.5	25-27
ELB-06-1	060515	233655	4.4	41.13	20.05	Elbasan	9.9	3.0	ELB	0.9-1.2	25-27
ELB-07-1	070416	073855	4.9	41.24	20.01	Elbasan	27	15.0	ELB	0.4-0.6	25-27
DURR-07-1	070905	051254	5.0	41.39	19.37	Durrës	21	5.2	DURR	0.4-0.5	25-27
PHP-09-1	090906	214942	5.3	41.46	20.41	Gjoricë	5	20.1	PHP	0.4-0.5	25-27

METHOD OF ANALYSIS

We have shown the adequacy of the single corner-frequency ω^{-2} source model in estimating stress-drop parameter through comparing visually simulated and observed PSRV response spectra. We observed two distinct variation intervals of Brune stress-drop in analyzing the records of our data set shown on the Tables 1 and 2. The first interval is related to values between 15 bars and 60 bars with the main shocks having the largest values $\Delta\sigma$=50–60 bars, typical for areas of normal focal mechanism. The second interval is characterized by values in the range $\Delta\sigma$=200–300 bars, but the estimates are based on only five records generated by four earthquakes. The latter values are typical for thrust focal mechanism (Duni and Kuka, 2005[1,2,3]; Duni and Kuka, 2008[1,2,3]).

After the examination of the stress drop parameter, the next step in our earthquake source parameters evaluation is the determination of the *corner frequency* for each earthquake listed in Table 1. For this reason we used the equation 5. Knowing all other parameters, the only unknown remains the corner frequency. As noted by Margaris and Boore (1998), although the stress parameter enters into simulations through this equation for f_0, we are not fitting the corner frequency of the Fourier amplitude spectrum and then determining $\Delta\sigma$ from f_0. Instead, what we have done in this analysis is to find the $\Delta\sigma$ that produces the best overall fit to the response spectrum over a range of frequencies, and generally it is the portion of the Fourier spectrum for frequencies greater than the corner frequency that is controlling the level of the

response spectra. From $\Delta\sigma$, we can use the equation 5 to estimate f_0. In the Table 2 presented are the values of f_{01} derived from the equation 5.

Table 2. Earthquake data and values of the corner frequecies determined from equation 5 and method of asymptotes

Earthquake Code	M_L	M_o dyne-cm	M_w	Stress-drop (bars)	f_{01} (Hz)	T_{d1} (sec)	f_{02} (Hz)			T_{d2} (sec)	Obs. time dur. (sec)
							E-W	N-S	Mean		
TPE-03-1	4.0	$2.51x10^{23}$	4.9	50	1.0445	0.96	1.17	0.78	0.975	1.00	0.90
TIR-03-1	4.0	$1.51x10^{23}$	4.8	200	1.9641	0.51	1.95	1.95	1.95	0.49	0.60
TPE-04-1	3.9	$3.98x10^{22}$	4.4	60	1.9103	0.52	1.17	1.25	1.21	0.83	0.65
TPE-04-2	3.4	$1.07x10^{22}$	4.0	40	2.5856	0.39	1.75	1.95	1.85	0.54	0.50
TPE-04-3	2.6	$9.12x10^{21}$	3.9	55	3.2109	0.31	2.54	1.00	1.77	0.56	0.40
TPE-04-4	3.1	$1.15x10^{22}$	4.0	30	1.7538	0.57	1.95	1.95	1.95	0.51	0.39
TPE-04-5	3.0	$9.49x10^{21}$	4.0	15	1.4840	0.67	2.34	2.34	2.34	0.43	0.24
TIR-04-1	4.0	$1.16x10^{22}$	4.0	250	4.9772	0.20	4.29	2.73	3.57	0.28	0.25
TIR-04-1	4.0	$1.16x10^{22}$	4.0	300	5.2890	0.19	2.73	2.73	2.73	0.37	0.40
LSK-04-1	4.8	$1.85x10^{24}$	5.4	60	0.5313	1.88	0.49	0.49	0.49	2.04	4.50
ELB-05-1	4.1	$3.61x10^{22}$	4.3	25	1.5823	0.63	1.26	1.17	1.22	0.82	1.10
ELB-06-1	4.0	$3.98x10^{22}$	4.4	40	1.7669	0.57	1.56	3.12	2.34	0.43	1.10
ELB-07-1	4.7	$2.60x10^{23}$	4.9	250	1.7411	0.57	1.56	1.56	1.56	0.64	0.75
DURR-07-1	4.8	$0.33x10^{24}$	5.0	300	1.7088	0.59	1.07	1.17	1.12	0.89	1.30
PHP-09-1	5.4	$1.05x10^{24}$	5.3	50	0.6394	1.56	0.78	0.97	0.88	1.14	2.75

Another approach can be used for the determination of f_o and this is related to the Brune model model of far field Fourier amplitude spectrum of earthquake displacement ground motion (shear waves). The far-field spectrum is characterized by 2 parameters: 1. the low-frequency level Ω_o which is proportional to seismic moment; 2. corner frequency, f_o. Following Brune model we shall define the corner frequency at the intersection of the low- and high-frequency asymptotes in the far-field shear-wave spectrum. The f_{02} estimated by this method is determined by eye fitting low- and high-frequency asymptotes to the each of the observed spectra, and these are listed in the Table 2, also. The spectra and the asymptotes for each earthquake are presented in Fig. 4**.** The mean value of f_{02} from the two components (E-W and N-S) is taken as final value of f_0 estimated from this method (mean value in the Table 2).

RESULTS OF ANALYSIS

As it can been seen from the values of f_0 estimated by the two methods, some small differences are observed. The largest difference is observed for the TPE-04-2, TPE-04-3 and TPE-04-5 events, the aftershocks of the TPE-04-1 earthquake. The same is observed for the TIR-04-1 event, also. The f_0 estimates by equation (5) and asymptotes of Fig. 4 differ considerably from each other, although the asymptote method gives more robust evaluations of f_0 for this event. It should be mention that for events TIR-03-1, TPE-04-4, TPE-04-5, TIR-04-1, LSK-04-1 and ELB-07-1 we have the same result from the two components by the asymptote method. We start the analysis of corner frequency evaluation by evaluating the source duration of the events. As previously stated we accept as earthquake source duration the inverse of corner frequency. In Table 2 we have presented the source duration for each event under analysis as expression of the inverse of corner frequencies evaluated by the two methods. So, T_{d1} is the source duration determined by f_{01} and T_{d2} is the source duration determined by the f_{02} mean value. Further on, we'll compare the source durations shown in Table 2 with the source durations in the time domain by the joint inspection of velocity and displacement time histories on the horizontal components. In Fig. 5 we have presented the examples of eleven time histories of ground motion (transversal components) of our data set. The two vertical red lines confine the sector with the largest amplitude of shear waves in terms of displacement and velocity. Comparing the displacement and velocity time histories we observe quite good agreement between estimates of time duration T_d by the two methods (equation 5 and

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asymptote) with the duration of the portion of the ground motion identified with the shear wave arrivals for the events TPE-03-1, TIR-03-1, TPE-04-1, TPE-04-2, TPE-04-3, TPE-04-4, TIR-04-1, ELB-05-1, ELB-07-1. We can observe also that the maximum acceleration amplitudes fall in the same interval of source duration for these events.

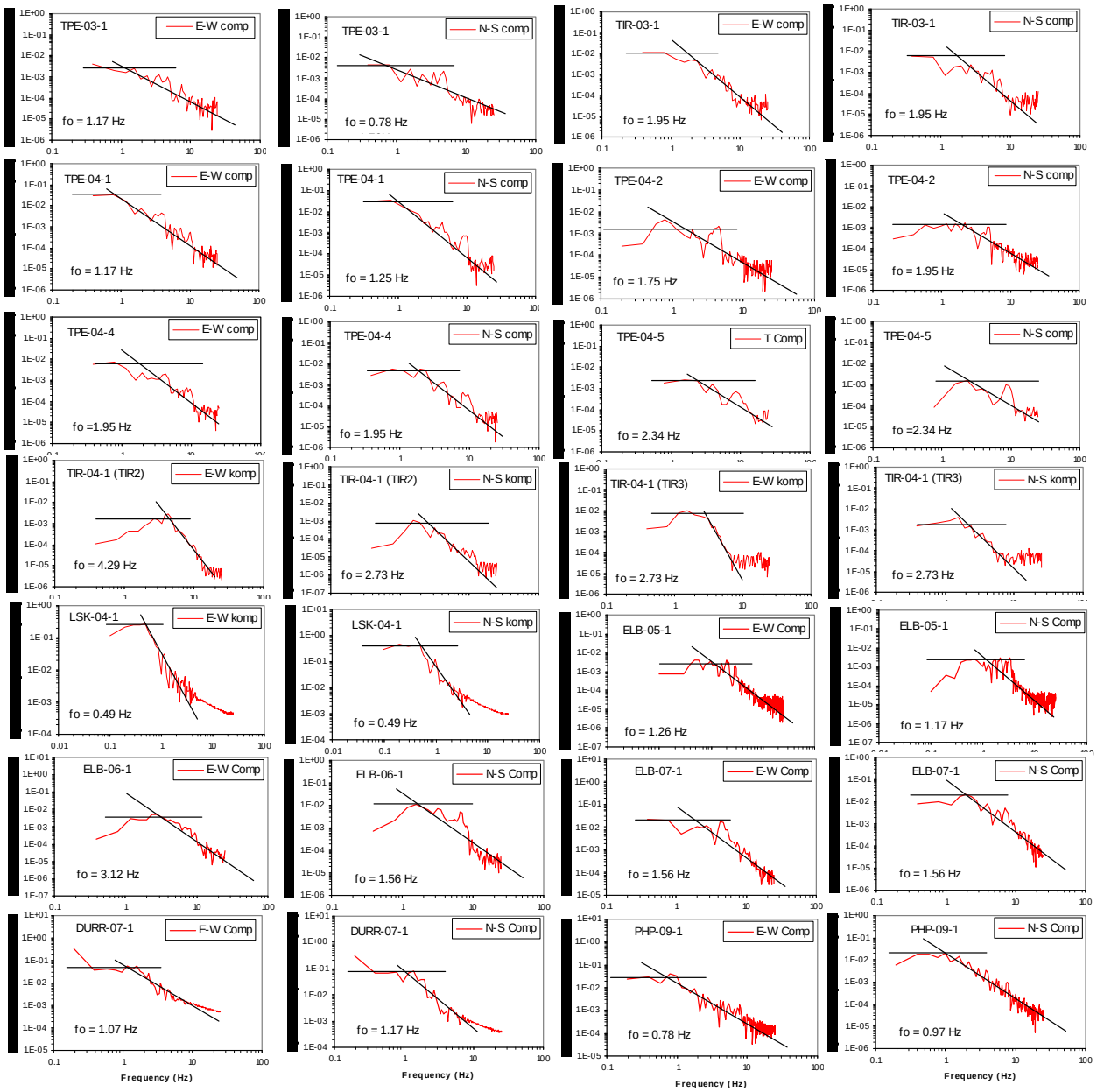


Fig. 4. Far field Fourier amplitude spectrum of earthquake displacement ground motion for the events listed in the Tables 1 and 2 and the asymptotes determining the corner frequencies for each component. The low and high frequency asymptotes (straight lines) were fitted by eye.

DISCUSSION AND CONCLUSIONS

The major discrepancies in terms of time duration are observed for the events LSK-04-1, ELB-06-1, DURR-07-1 and PHP-09-1. For these events the observed time duration of the source process are greater than the time duration determined by the application of the equation 5 and by the far-field displacement spectra. The LSK-04-1 event is the strongest event recorded up to now by the Albanian Strong Motion Network, with M_w=5.4. We have the same value of corner frequency estimated by the two methods described previously, f_{02}=0.49 Hz (source duration T_{d2}=2.04 sec) and f_{01}=0.53 Hz (source duration T_{d1}=1.88 sec). We should mention the validity of the method based on the far-field Fourier amplitude spectrum of shear waves for the estimation of the corner frequency. As it can been seen from the plots of

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Fig. 4 the break point which determines the value of f_{02} is the same for the two horizontal components of this event. To our opinion, the source duration that results from the joint inspection of displacement and velocity time histories is T_d=4.50 sec. It is difficult to exactly determine the source duration of this event, because as it can been seen from the Fig. 5, we have at least a relatively strong shaking of 2.0 sec on the left part of the first line that we may relate to the intense P-wave arrivals of this event. Anyway, differently from the other smaller events described previously, where we have had a quite simple description of source duration comparison, in this case this comparison is difficult.

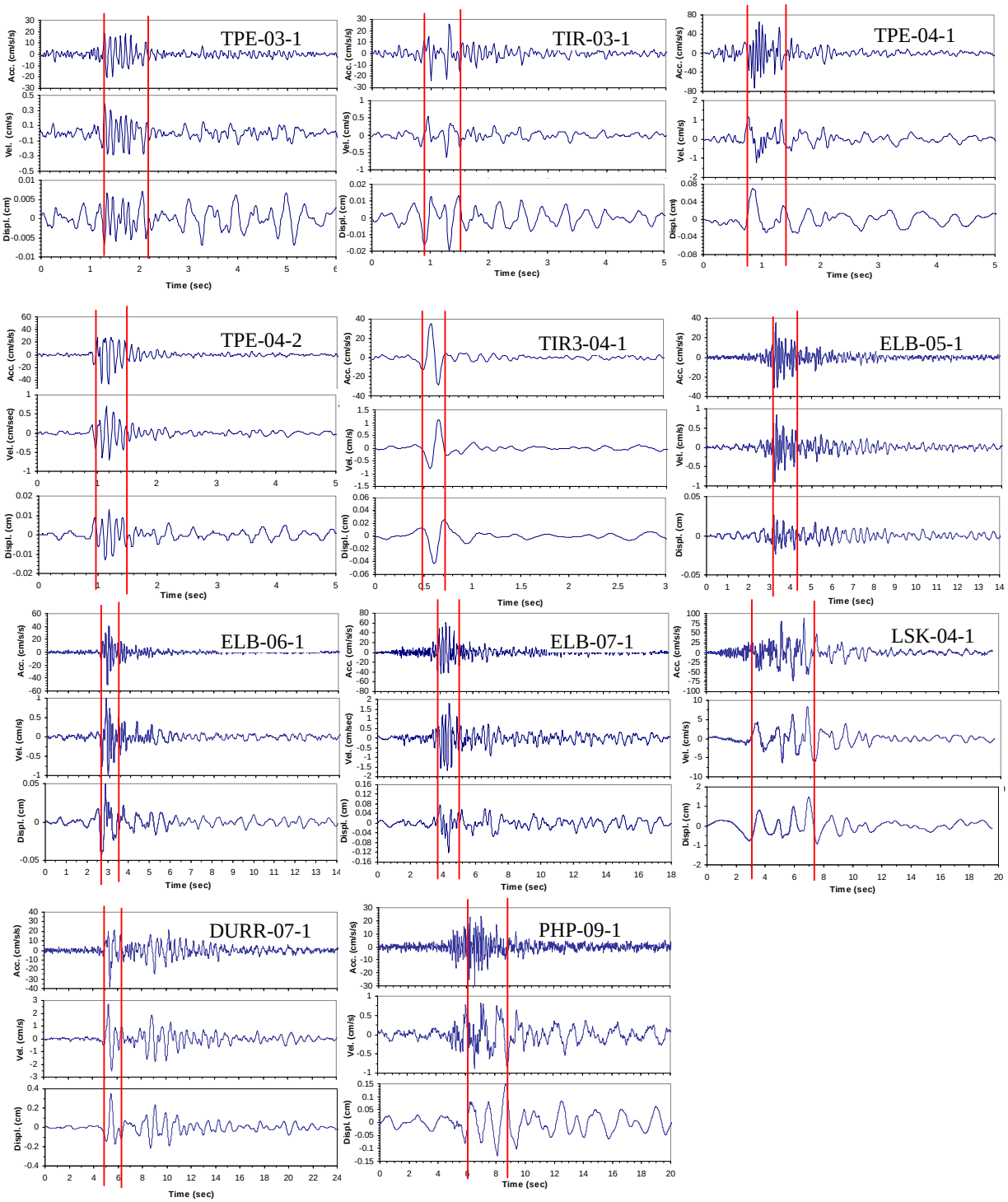


Fig. 5. Corrected ground motion waveforms derived from eleven accelerograms of the data set .The red lines confine the sectors with the largest amplitudes of acceleration, velocity and displacement, indicating in this way the duration of the earthquake source process.

The same problem is evident for the PHP-09-1 earthquake. The time duration defined from the joint inspection of displacement and velocity time histories results about 1.2 sec higher in comparison to the two other methods. What is interesting for this event is the lower time interval covered by the shear wave arrivals in the acceleration time history compared to the higher portion of shear waves on the velocity and displacement time histories. Further investigations are necessary for better understand of this disprepancy.
The case of DURR-07-1 earthquake is the most interesting in regard to the source duration assessment. From the joint inspection of the three time histories it is evident that in the case of this earthquake we have a double event, producing the present record, separated by a small time interval of about two seconds by each other. If we consider the first shock in our analysis of time duration comparison, then there is a relatively acceptable agreement between the observed time duration and that determined by the joint inspection of the time histories.
As a conclusion, we can say that the analysis presented in this paper represents the first attempt to describe one of the most important earthquake source parameter, the f_0. In general, we have observed a quite good description of this parameter for the majority of the events recorded up to now. The confront of f_0 with the source duration T_d gives more credibility of the analysis and can serve, as in the case of the DURR-07-1 earthquake, to investigate the natyre of the source rupture.
We should take into account that the events under analysis are mainly small intensity ones. Many uncertainties remain and further investigations have to be performed in order to understand better the reasons for these discrepancies.

REFERENCES

Brune J. N., 1970. *Tectonic stress and the spectra of seismic shear waves from earthquakes*. Journal of Geophysical Research, 76:5002.

Brune J. N., 1971. *Correction*. Journal of Geophysical Research. 76:5002.

Duni Ll., Aliaj Sh., Kuka N., Skrami J., 2004. *The reorganization of the Albanian Strong Motion Network*. Project Report No 01/2001. Archive of Institute of Geosciences, Energy, Water and Environment, 18p, (in Albanian).

Duni Ll., Kuka N., 2005[1]. *Strong ground motion simulation through the stochastic method*. Scientific report of the project Nr. 1/2003, Archive of Institute of Geosciences, Energy, Water and Environment, 69p, (in Albanian).

Duni Ll., Kuka N., 2005[2]. *Stochastic simulation of ground motions based on data from recent accelerometric records in Albania*, in "Book of Abstracts", NATO Advanced Research Workshop "Earthquake Monitoring and Seismic Hazard Mitigation in Balkan Countries", Borovetz-Rila Mountin, Bulgaria, September 11-17, 2005, pp. 108-112.

Duni Ll., Kuka N., 2005[3]. *Stress-drop estimates from recent strong motion records in Albania*, in the *Proceedings* of the 2-nd International Conference in the framework of Central European Initiative (CEI), "Science and Technology for Safe Development of Lifeline Systems", Bratislava, Slovak Republic, October 24-25, 2005, 6 p.

Duni Ll., Kuka N., 2008[1]. *Estimates of stress-drop and high frequency diminution parameter from strong motion data recorded in Albania*, in the book "Earthquake Monitoring and Seismic hazard Mitigation in Balkan Countries", E. S. Husebye editor, published by Spinger Science+Business Media, pp. 57-79.

Duni Ll., Kuka N., 2008[2]. *Analysis of strong motion data from three events (Mw=4.3-4.9) recorded recently in central Albania area*, Acta Geod. Geoph. Hung. Vol. 43, No. 2-3, pp. 321-229.

Duni Ll., Kuka N., 2008[3]. *The earthquake of September 5, 2007 (M_w=4.8) in Albania. Analysis of the accelerographic data recorded in Durresi town*, 14-th World Conference on Earthquake Engineering, October 12-17, 2008, Beijing, China, on CD.

Duni Ll., 2010. *Maximum Parameters of ground motion derived from strong motion data in Albania*, Acta Geod. Geoph. Hung, Vol. 45, No.3, pp. 307-316.

Hanks T. C., McGuire R., 1981. *The character of high-frequency strong ground motion*. Bull. Seism. Soc. Am. 71: 2071-2095.

Hanks T. C., 1982. f_{max}. Bull. Seism. Soc. Am. 72:1867-1879.

Margaris B., Boore D., 1998. *Determination of $\Delta\sigma$ and κ_o from response spectra of large earthquakes in Greece*. Bull. Seism. Soc. Am. 88: 170–182.

Reiter L., 1990. *Earthquake hazard analysis*, Columbia University Press, New York, 254p.

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SEISMIC REFRACTION PERFORMED ON SUPPORT TO GEOTECHNICAL INVESTIGATIONS AND SEISMIC HAZARD EVALUATION FOR HPP ASHTA, ALBANIA

Erald SILO[*], Salvatore BUSHATI[2], Vilson SILO[1], Edmond DUSHI[3],
[1]*Faculty of Geology and Mining, Tirana, ALBANIA;* [2]Academy of Sciences, Tirana, ALBANIA;
[3]*Geosciences Institute, Tirana, ALBANIA*

ABSTRACT

The Ashta HPP is located on the lower part of the Drini River in Northern Albania, and constitutes the largest river system of the country. It is composed of two plants; Ashta1 and Ashta2 HPP without major dam structures. This HPP is mainly located on the Quaternary Zadrima Depression near the Shkodra city. The Quaternary cover vary from 30-40 up to 70-80 m and is composed mainly by alluvial gravel and sand deposits. The position of the Ashta1 HPP and the headrace channel are located on the Quaternary alluvial deposits of the Fushe-Zadrima intermountain Depression, composed of sandy gravels. The Ashta2 HPP is located at the Ashta hill, composed of Paleogene flysch deposits, represented by intercalations of sandstones, siltstones and mudstones. From the seismic point of view this Paleogene flysch formation here is considered bedrock, which, to the east up to the Ashta1 HPP, underlies the Quaternary alluvial gravel deposits. The objective of our study was the assessment of seismic hazard of the Ashta construction site and based on this we have computed the Peak Ground Acceleration (PGA) and Spectral Accelerations (SA) by two different methods: ***i)-*** *Cornell-McGuire Probabilistic Seismic Hazard Assessment (PSHA) methodology from which we obtained the PGA and SA for rock site conditions for 475 years of return period (RP), and ii) by using the data of the geotechnical profile, Vs_{30}, SPT-N and soil correction factors of the National Earthquake Hazard Reduction Programme tables which is applied here for the first time.*
*Albania is characterized by shallow crustal seismicity. For the appropriate assessment of the seismic hazard it is necessary to take into account the different present-day tectonic regime in eastern and western Albania and this can be done by the use of different strong motion relations. The style of faulting parameter is used to distinguish between different source types. It is important for such critical structures, as HPP Ashta is, to estimate the greatest possible seismic hazard, based on fault types, which are the source of earthquake generation in or near the area under study. Probabilistic approach used for the seismic hazard study of HPP Ashta, consists of following basic steps: i)- Source zone model delineation and ii)- Selection of appropriate attenuation relations. Based on the above-mentioned differences in ground motions for crustal earthquakes generated by normal or thrust faulting, for HPP Ashta seismic hazard study we have used the following attenuation relations of ground motions: The attenuation relation of Somerville et al. 2001, for seismic source zones in compression regime (thrust faulting) characteristic for the western Albania, and the attenuation relation of Spudich et al. 1999, for seismic source zones in extensional reg****ime*** *(normal faulting) located in eastern Albania.*
The Ambraseys et al. 1996 attenuation relation, which does not take into consideration the faulting style, is also used for this study. So we have compared hazard results obtained by different ground motion prediction equations. Adopting the Cornell-McGuire 2004 probabilistic approach and applying two different attenuation relations, the ground motion values for rock sites, differentiated by shear wave velocity, are calculated. The results obtained from seismic hazard calculations are presented on two hazard maps and in tabular format as well. So finally, the PGA seismic hazard maps for rock site conditions at probabilities 10% /50 years are compiled.

KEY WORDS*: compression regime; extensional regime*; *Zadrima lowlands; two diverse seismic hazard estimates.*

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METHODOLOGY

This scientific paper includes a probabilistic seismic hazard analysis which consists of *four basic steps*: **i**)- Seismic source zone identification; **ii**)- Probabilistic characterization of source zone activity. Calculate time dependent recurrences of different sizes of earthquakes for each source based on the activity rate; **iii**)- Selection of attenuation relations; **iv**)- Integration of the whole range of magnitudes and distances for the evaluation of ground shaking. The PSHA incorporates the element of time in the assessment of the earthquake threat at a site. The objective of PSHA is to compute for a given exposure time the probability of exceed corresponding to various levels of ground motion parameter. Typically the ground motion parameter is either PGA, Peak Ground Velocity (PGV) or SA.

The assessment of seismic hazard is carried out for two levels of probability in accordance of EuroCode 8 standard: ***10% in 50 years (475 years return period) and 10% in 10 years (95 years return period).*** The intensity of seismic ground motion is a function of earthquake magnitude and distance from the seismic source, as well as local soil conditions, topography and geological conditions. Amplification of ground motion due to local soil conditions depends primarily on soil type, physical-mechanical properties and thickness of the unconsolidated sediments over the bedrock. For PGA bedrock in the range of 0.1g we observe amplification of this parameter on the surface. The greatest amplification is observed on "*soft to medium stiff clay and sand*". The soft clay sites amplify PGA up to 0.4g, beyond which de-amplification occurs. Generally soil sites shows higher amplification than rock sites for periods longer than about 0.2sec. The Uniform Building Code (UBC) and the 1997 National Earthquake Hazard Reduction Programme (NEHRP) have adopted the 30 meter velocity of shear waves as the primary basis for site classification for purposes of incorporating local site conditions in the estimation of strong ground motion. Six site classes are defined in terms of Vs_{30}, and SPT-N shown on Table 1.

According to McGuire 2004, there are two ways in which local site conditions can be incorporated into a PSHA: *First and most directly*, site-specific attenuation relationships can be developed that predict ground motion amplitudes at the specific site as a function of magnitude and source-site-distance. *Second*, a PSHA for a baseline condition (e.g. hard rock) can be performed first, and these results can be translated into the site-specific condition. *In our case we have proceeded by the second way of PSHA, using soil correction factors of the NEHRP tables.* Then the soil correction coefficient tables are used to get the final PGA and SA (0.3 and 1.0sec) values on specific site conditions. To evaluate the PGA on required soil sites of HPP Ashta, we have got the necessary data of geotechnical profile from bedrock depth to the surface, as well as the Vs_{30}, and SPT-N for Quaternary gravel sequence, lying on bedrock, composed of Paleogene flysch formation.

Table 1: Site Classes Defined in the International Building Code 2003

Site Class	**Soil Profile Name**	**Shear Wave Velocity Vs_{30}, (m/s)**	**Standard Penetration Resistance, N (blows/30 cm)**
A	Hard rock	>1500	N/A
B	Rock	$760 < Vs \leq 1500$	N/A
C	Very dense soil and soft rock	$360 < Vs \leq 760$	N>50
D	Stiff soil profile	$180 \leq Vs \leq 360$	$15 \leq N \leq 50$
E	Soft soil profile	<180	N<15
F	Soil requiring site specific evaluation		

N/A = Not applicable

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EVALUATION OF HPP ASHTA SEISMIC HAZARD ON ROCK SITE CONDITIONS

Below shortly are described only two strongest earthquakes that affected the HPP Ashta region in the past. The strongest shock occurred on June 1, 1905 at 4 hour 42 min 43 sec (GMT). The magnitude of this earthquake was determined as M_S=6.6. The duration of the earthquake was 10-12 sec and caused big damage among the population and property in town of Shkodra and surrounding villages. The earthquake of April 15, 1979 is one of the strongest earthquakes occurred in the Balkan Peninsula during the 20th century. Its magnitude has been evaluated from 6.6 to 7.2 and in our catalogue we assigned the value of M_S=6.9 (Karnik, 1996). The epicentre of this earthquake is in the coastal area, near Petrovac, Montenegro. It happened at 06 h 19min of April 15, 1979. Many foreshocks occurred about two weeks before the main shock of April 15, and the aftershocks continued for more than 9 months. More than 100.000 inhabitants (mostly in the districts of Shkoder and Lezha) were left homeless. The majority of casualties and economic loss were caused on the coastal part of Montenegro. The earthquake of April 15, 1979 has been accompanied by a lot of physical-geological phenomena on the ground. In Shkoder and Lezha districts many soil cracks, liquefaction phenomena, riverbanks subsidence and rock falls were evidenced. The liquefaction phenomena accompanying in many cases earthquakes are a very important factor to be considered on hazard analysis of a country. In Albania and its surroundings, the following 9 seismic source zones are defined: 1. Lezha-Ulqini (LU) zone, 2. Peri-Adriatic Lowland (PL) zone, 3. Ionian Coast (IC) zone, 4. Ohrid-Korça seismic (KO) source zone, 5. Elbasani-Dibra-Tetova (EDT) zone, 6. Kukesi-Peshkopi (KP) zone, 7. Shkodra-Tropoja (ST) zone, 8. Peja-Prizreni (PP) zone, 9. Skopje (SK) zone, shown on the figure 1.

Probabilistic approach used for seismic hazard study of HPP Ashta, consists of following basic steps:

(**i**)- Source zone model. The seismic source model presented in figure 1 was used for seismic hazard evaluation of HPP Ashta.

(**ii**)- Selection of attenuation relations. The different present-day tectonic regime in eastern and western Albania requires the use of different strong motion relations. *The extensional region, into which the normal faulting earthquakes are generated, is located in eastern Albania. The compression region, into which mainly thrust faulting and much rare strike-slip faulting earthquakes are generated, is located in western part of it.* The style of faulting parameter is used to distinguish between different source types. For crustal earthquakes, ground motions systematically differ when generated by strike-slip, thrust, or normal fault mechanisms (Bolt and Abrahamson, 2003). Even the same earthquake magnitude, distance to site, and site condition, the ground motions from thrust earthquakes tend to be larger than the ground motions from the strike-slip earthquakes (about 20÷30%), and the ground motions from normal faulting earthquakes tend to be smaller than the ground motions from strike-slip earthquakes (about 20% smaller) (Somerville et al., 2001; Spudich et al, 1999).

Based on the above-mentioned differences in ground motions for crustal earthquakes generated by normal or thrust faulting, for HPP Ashta seismic hazard study we have used the following attenuation relations of ground motions: The attenuation relation of Somerville et al. 2001, for seismic source *zones in compression regime* (thrust faulting) located in western Albania; and the attenuation relation of Spudich et al. 1999, for seismic source *zones in extensional regime* (normal faulting) located in eastern Albania. For seismic hazard calculation is also used the Ambraseys et al. 1996, attenuation relation which do not take into consideration the faulting style. So, we have compared hazard results retrieved by different ground motion prediction equations.

(**iii**)- For seismic hazard calculation the Albanian territory and its surroundings, included with coordinates 38.8° - 43.2° N and 18.3° – 21.7° E, is divided into 1530 cells with 0.1 degree grid. Adopting the Cornell-McGuire probabilistic approach, the ground motion values for rock sites that correspond to a *shear wave velocity of 760 m/s in the top 30m*, with two different attenuation relations, have been assessed. The design data are presented as PGA and SA at 0.3 and 1.0 sec for two probability levels 95 and 475 year RP considering a rock site condition. The results obtained from seismic hazard calculations are presented on two maps of seismic hazard and in tabular format, as well. So finally, the PGA seismic hazard maps for rock site conditions (*B site class*) at probabilities 10% /50 years are compiled, using two different attenuation relations, as follows:

1. Map of PGA on rock sites for a probability 10% /50 year, calculated using Somerville et al., 2001 and Spudich et al. 1999, attenuation relations, figure 2.

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2. Map of Peak Ground Acceleration on rock sites for a probability 10% /50 year, calculated using Ambraseys et al. 1996, attenuation relation, figure 3.

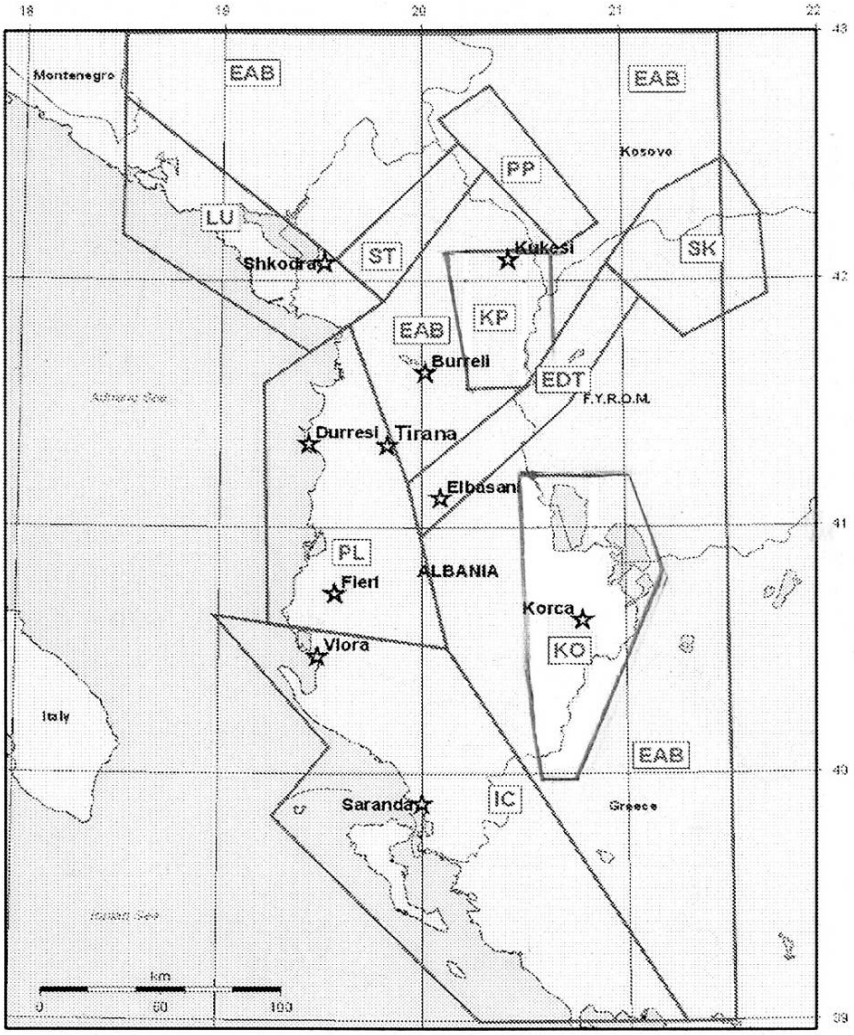


Figure 1: Map of seismic zones in Albania, (Aliaj, Sh., et al. 2003)

The PGA values *on rock site conditions* presented on the figure 2, are the largest ones along the Adriatic-Ionian coastal earthquake belt going from 0.36g in Southern Albania to 0.40÷0.45g from Vlore to Lezha towns, and up to 0.50÷0.60g from Shkoder to WNW along the Dalmatian coast. The highest values in Eastern Albania 0.25÷0.35g are along the Elbasani-Dibra-Tetova and Shkodra-Tropoja transversals. The are the lowest ones values of PGA, starting from 0.23 up to 0.27g are observed on the Ohrid Lake up to Leskoviku town and from Kukesi to Peshkopi districts as well; while the highest values in Eastern Albania 0.25÷0.35g are along the Elbasani-Dibra-Tetova and Shkodra-Tropoja transversals. ***On the HPP Ashta area, taking place into northern segment of the Ionian-Adriatic coastal strong earthquake belt, the PGA values are more than 0.50g,*** *figure 2.*
The PGA values *on rock site conditions* figure 3, are the largest ones along the Adriatic-Ionian coastal earthquake belt going from 0.20g in Southern Albania to 0.25÷0.30g from Vlore to Lezha towns, and up to more than 0.35g from Shkoder to WNW along the Dalmatian coast. The highest values in Eastern Albania 0.30÷0.35g are observed along the Elbasani-Dibra-Tetova and Shkodra-Tropoja

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transversals. ***On the HPP Ashta area, taking place into northern segment of the Ionian-Adriatic coastal strong earthquake belt, the PGA values are > 0.30g,*** *figure 3*.
We have evaluated the seismic parameters PGA and Sa (0.3 and 1.0 sec) for HPP Ashta for several sites on rock conditions using two different attenuation relations. Velocity of shear waves taken into account for calculation of PGV values are the followings: for rock > 750 m/s, for stiff soil 200÷750 m/s and for soft soil < 200 m/s. Due to the seismic parameters measured in the field and according to the borehole log for all drilling, the sites on the Ashta area were classified as rock (Ashta 2) and stiff soil (Ashta 1), so PGV-values we have calculated are for rock and stiff soil. For each of sites belonging to the analysed area of HPP Ashta the following data are determined using attenuation relations of Somerville et al., 2001 and Spudich et al., 1999, as well as that of Ambraseys et al., 1996.
The results of PGA and Sa (0.3 and 1.0sec) for HPP Ashta specified sites on rock site conditions, calculated with two different attenuation relations, are shown in the Table 2. This table shows that Peak Ground Acceleration – PGA values calculated with Somerville et al., 2001 and Spudich et al., 1999 are much higher than PGA values calculated with Ambraseys et al., 1996, about 1.5÷1.6 time. ***For HPP Ashta should be used seismic parameters that we have calculated using attenuation relations of Somerville et al., 2001 and Spudich et al., 1999***.

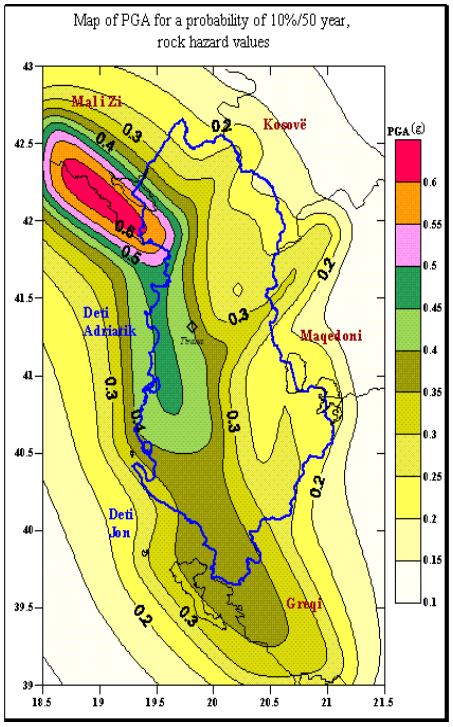


Figure 2: Map of **P**eak **G**round **A**cceleration on rock sites for a probability 10%/50 year, calculated using Somerville et al., 2001 and Spudich et al., 1999 attenuation relations.

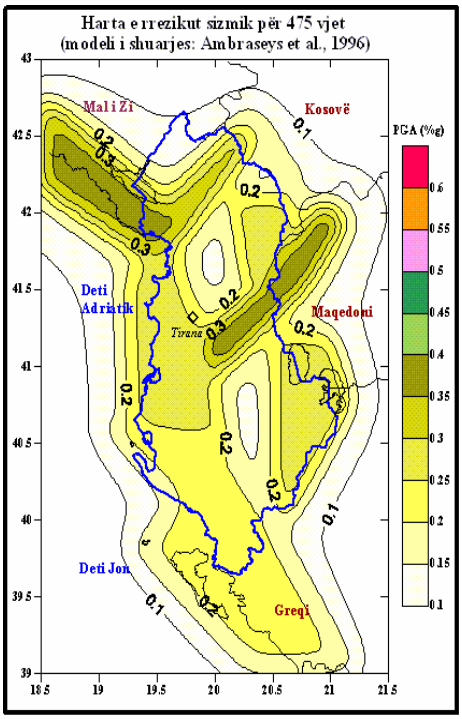


Figure 3: Map of **P**eak **G**round **A**cceleration on rock sites for a probability 10%/50 year, calculated using Ambraseys et al., 1996 attenuation relation.

The Ashta2 HPP is located at the Ashta hill, composed of Paleogene flysch deposits, represented by sandstone, siltstone and mudstone intercalations. This Paleogene flysch formation represents the bedrock underlies the Quaternary alluvial gravel deposits shown on the figure 4. From the recent drilling campaign results we have selected and summarized the geotechnical profile of CD 05/08 for HPP Ashta 1 and CD 05/08 sites, shown in the Table 3. The average properties in top 30m of Vs and SPT–N are used to classify a site, although the site categorizing can be made using only one of the above-mentioned parameters measured in the field. According to the borehole log for all drillings, the

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measured SPT-N values, we have concluded that the value of SPT-N 15÷50 is generally encountered up to the depth 3÷6m, the value SPT-N > 50 from 6÷9m up to 30÷35m depth. Maximum SPT-N values are N>100 and N112. At CD-2 site where the HPP Ashta 1 will be build, the SPT-N are more than N50 at 3m depth, while at CD-5 site, the SPT-N are more than N50 at 6m depth.

The next step in the process of seismic hazard assessment was the campaign of seismic field measurements carried out with the aim to determine the shear wave velocity Vs_{30}, for gravel thick deposits and for flysch rock ones. The seismic refraction method has been used extensively around the world for geological and geotechnical investigations for hydro power projects, etc. On Ashta area seismic explorations with refracted waves on two profiles at HPP Ashta 1 and Ashta 2 shown on the figure 4 were performed.

The method employs the principles that form the basis of Snell's law that elastic waves in the ground will be refracted by different material depending on the velocity of wave propagation in each different deposit. Normally the wave velocity in soil increases with depth, and bedrock velocity is generally higher than soil velocities. This fact makes it possible for parts of the energy, sent down into the soil and bedrock, to be refracted back to the surface where the vibrations can be detected and recorded. Therefore it is possible to determine the arrival times for the waves arriving from different layers in order to estimate thickness and character of the different soil layers over bedrock. As far as the energy source is concerned we used the mechanical strike with a big sledge hammer and the distance between geophones we have get it 5 meters, and the total array was 115m long.

The ground vibrations are picked up by a spread of 24 geophones and the signals generated by geophones are recorded by the instrument and stored on computer. A new seismic equipment ***GEODE 24-channel***, is used for recording the seismic signals (figure 5). For data processings we have used a very powerful refraction package software called ***SeisImager/2D***. It offers linear least-squares inversion technique, especially the tomographic method. The tomographic method, involves the creation of an initial velocity model and then iteratively tracing rays through the model, comparing the calculated traveltimes to the measured traveltimes, modifying the model, and repeating the process until the difference between calculated and measured times is minimized. The shear wave's velocity Vs, and the layer thickness are calculated from the field data. Several continuous iterations were applied in data processing until the detailed seismic velocity model obtained across the litho logical layers at depth was established (Silo V., Bushati S., Silo E. 2012).

The representative values of the S–wave velocity are obtained after a general evaluation of the complete seismic measurements. The interpretation of the seismic refracted surveys, bring into evidence the geologic section composed by the presence of a slipping body, shear wave velocity values, etc. These results are shown in the figures (6, 7). Soil shear wave velocities in top 30 m (Vs_{30}) at HPP Ashta 1 and Ashta 2, as they resulted from direct field measurements are shown on the figures (6, 7) and can be summarized as follows: HPP Ashta 1, Vs_{30} = 490 m/s, HPP Ashta 2, Vs_{30} = 840 to 1320 m/s, (Silo, V. 2009). The standard penetration test measurements at HPP Ashta 1 shows values of SPT-N >50.

The Vs_{30} and SPT-N data confirm that the *HPP Ashta 1 site is classified at B site class according to Euro Code 8,* and at *C site class according to International Building Code,* while the *HPP Ashta 2 site is classified as A site class according to Euro Code 8,* and as *B site class according to International Building Code.*

The design data are presented as PGA and spectral acceleration at 0.3 and 1.0 sec for two probability levels 95 and 475 year return periods considering a rock site condition. Then the results are scaled to the real soil conditions using soil correction factors of the NEHRP tables. Based on the provided Vs_{30} and SPT-N data, the specific site conditions according to International Building Code for the sites under investigations are classified as follows, Table 1: ***HPP Ashta 1 and CD 05/08 sites to C site class (i.e. very dense soil and soft rock site), HPP Ashta 2 site to B site class (i.e. rock site).***

The PGA and SA values on C site class at HPP Ashta 1 and at CD 05/08 sites are calculated with soil correction factors of the NEHRP tables. For each of sites belonging to analysis area of HPP Ashta the following data are determined using the attenuation relations of Somerville et al., 2001 and Spudich et al., 1999: ***PGA and Sa (0.3 and 1.0 sec) for B and C site classes at probabilities 10%/10 years and 10%/50 years***.

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Table 2: PGA and Sa (0.3 and 1.0 sec) for specified sites of HPP Ashta using different attenuation relations.

Location	Ambraseys et al. 1996.	Somerville et al. 2001 and Spudich et al., 1999.
Spectral Parameters		
Ashta 1		
PGA	0.345	0.509
Sa (0.3)	0.857	0.827
Sa (1.0)	0.277	0.215
CD 05/08		
PGA	0.345	0.509
Sa (0.3)	0.857	0.827
Sa (1.0)	0.277	0.215
Ashta 2		
PGA	0.353	0.565
Sa (0.3)	0.885	0.896
Sa (1.0)	0.291	0.219

Table 3: The geotechnical profile for HPP Ashta 1 and CD-05/08

No	Depth in meters	Layer content
1	0.00 – 9.00	Sand with gravel intercalations at 0.00-1.00m and 4.50-5.00m depth
2	9.00 - 15.00	Gravel with sand intercalation at 10.00-11.50m depth
3	15.00–17.30	Sand
4	17.30–30.00	Gravel with sand intercalations at 18.45-18.60, 21.65-21.75 and 24.00–25.00m depth
5	30.00–32.40	Sand
6	32.40–35.00	Gravel with sand intercalation at 34.20–35.00m depth

The results of seismic hazard for HPP Ashta sites on their specific site conditions at probability 10%/50 years are summarized in the Table 4. In addition to the tabulations shown above, we prepared Uniform Hazard Spectra (UHS), and hazard curves for HPP Ashta sites. The hazard curves are presented on figures 8 and 9 and allow to read the ground motion values for three spectral periods: PGA's; one short period Sa (0.3sec) and one long period Sa (1.0sec), for rock sites at probabilities of 10% /10 years and 10% /50 years. Finally we have issued one uniform hazard spectra (UHS) on rock site conditions for HPP Ashta 1 and Ashta 2 sites at 475 years return period (see figure 10). These uniform hazard spectra consider a probability of 10% /50 years, and a spectral acceleration range from 0.01 to 2.0 sec. The results of seismic hazard for HPP Ashta sites on their specific site conditions at probability 10%/50 years are summarized in the Table 4, which are taken into consideration for HPP Ashta site design.

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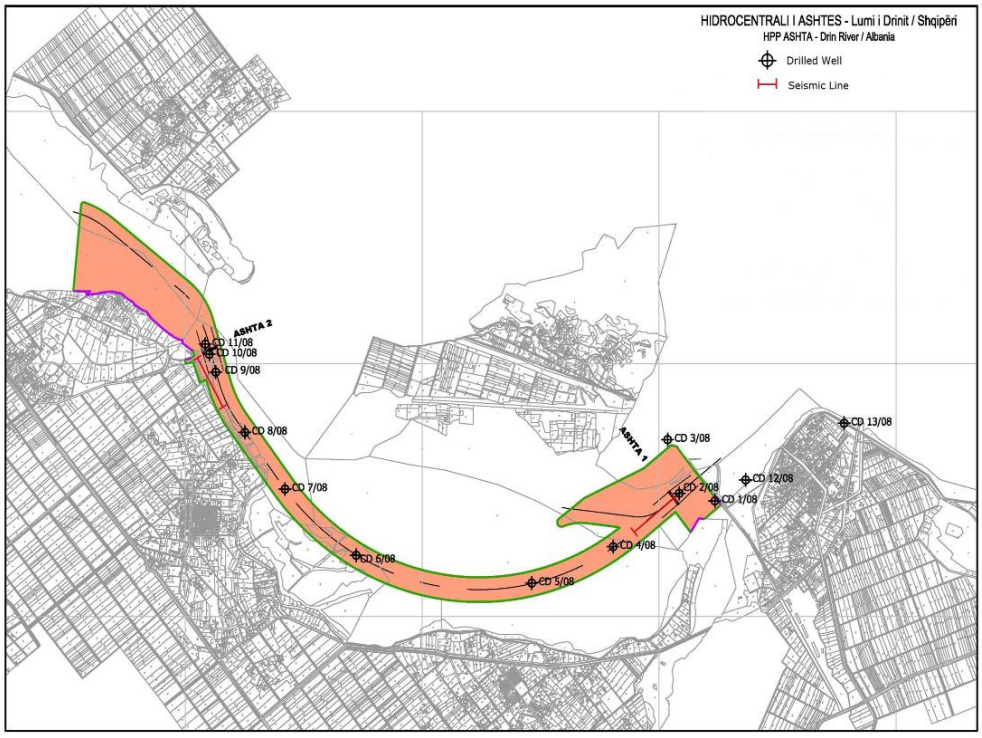


Figure 4: A planimerty of HPP Ashta – Drini River.

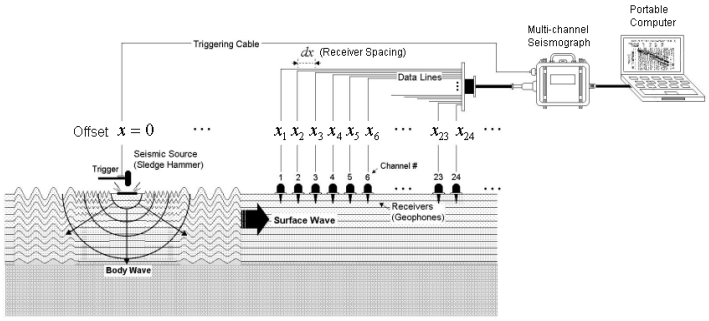


Figure 5. - A schematic configuration for seismic wave's record.

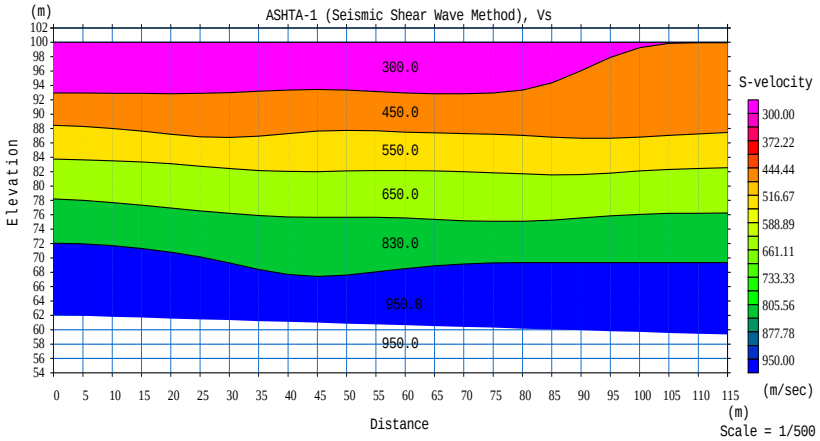


Figure 6: Seismic shear wave velocity cross-section on HPP Ashta 1.

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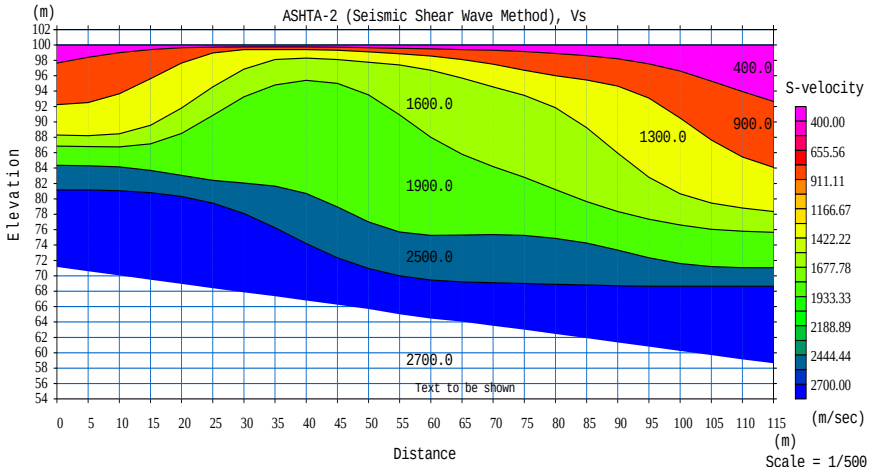


Figure 7: Seismic shear wave velocity cross-section on HPP Ashta 2.

Table 4: Seismic hazard parameters for HPP Ashta sites on their specific site conditions at probability 10% /50 years.

Location	Northing	Easting	Site Class	PGA [g]	PGV [cm/s]	Sa(0.3) [g]	Sa(1.0) [g]
Ashta 1	42.002 N	19.600 E	C	0.509	59.55	0.827	0.348
CD 05/08	41.995 N	19.585E	C	0.509	59.55	0.827	0.348
Ashta 2	42.012 N	19.551 E	B	0.565	46.33	0.896	0.219

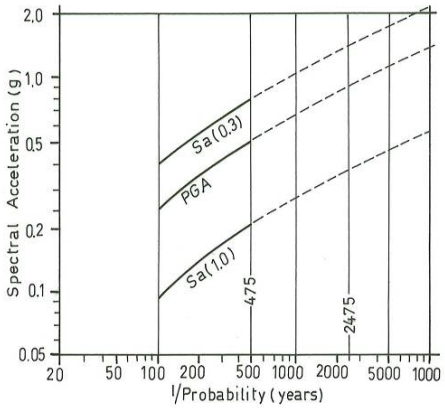


Figure 8: Hazard curves of PGA and Sa (0.3 and 1.0 sec) for HPP Ashta 1 site

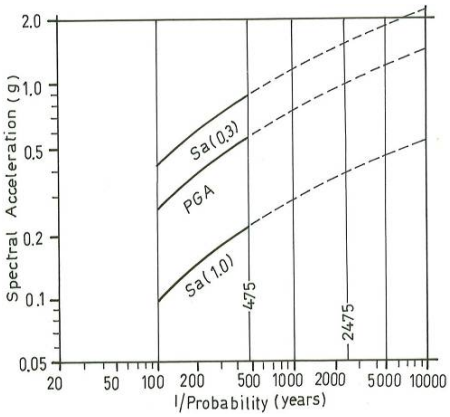


Figure 9: Hazard curves of PGA and Sa (0.3 and 1.0 sec) for HPP Ashta 2 site

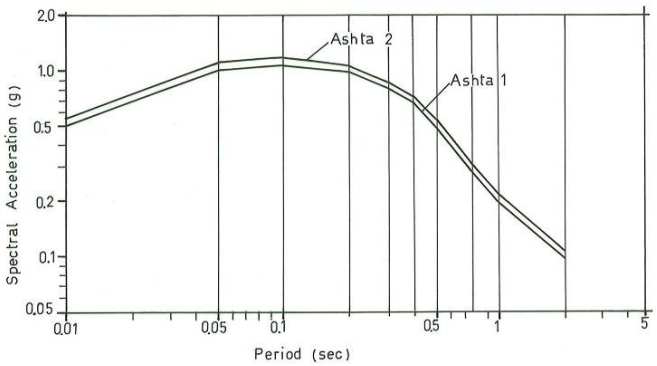


Figure 10: Uniform hazard spectra for HPP Ashta 1 and Ashta 2 sites at 475 years return period on rock site conditions.

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CONCLUSIONS

The Vs_{30} and SPT-N data confirm that the HPP Ashta 1 site is classified at B site class according to Euro Code 8, and at C site class according to International Building Code, while the HPP Ashta 2 site is classified at A site class according to Euro Code 8, and at B site class according to International Building Code.

The two different seismic hazard estimates, using different Ground Motion Prediction Equations, are presented for the HPP Ashta sites. The results of PGA and Sa for HPP Ashta specified sites on rock site conditions, calculated with two different attenuation relations, are shown in the Table 2. ***For HPP Ashta should be used seismic parameters that we have calculated using attenuation relations of Somerville et al., 2001 and Spudich et al., 1999***.

We recommend for the HPP Ashta design to choose the seismic hazard parameters at probability 10%/50 years, see also summarized values in Table 4.

REFERENCES

Aliaj, Sh., 2003. Seismic source zones in Albania. *Paper presented in Albanian Seminar, Paris 26-28 June, 2003 and published in Final Report, NATO Science for Peace Programme, Project "Seism tectonics and Seismic Hazard Assessment in Albania", 2004.*

Ambraseys, N.N., et al 1996. Prediction of horizontal response spectra in Europe. *Earthquake Engineering and Structural Dynamics* 25 (4), 371-400.

Bolt B.A. and N.. Abrahamson, 2003. Estimation of Strong Ground Motions. In *W.H.K. Lee et al. (Editors), International Handbook of Earthquake and Engineering Seismology, Part B*., 983-1001.

Federal Emergency Management Agency, 1997. NEHRP Recommended Provisions for Seismic Regulations for New buildings and Other Structures. Washington, D.C., FEMA 302.

Karnik, V., 1996 Seismicity of Europe and the Mediterranean. Ed: K. Klima. Geophysical Institute of Academy of Sciences of the Czech Republic and Studia Geo, Praha.

McGuire R. K., 2004. Seismic hazard and risk analysis. EERI Monograph MNO-10. Earthq. Eng. Res. Inst., Oakland, Ca.

Silo, V. 2009. Results of shear wave velocity measurements in two sites of HPP Ashta (Ashta 1 and Ashta 2).

Silo, V., Bushati S., Silo E. 2012. Applied geophysics on Earth Sciences. (Geology and Mine Faculty, Earth Sciences Department, Tirana, Albania).

Somerville, P. and N. Abrahamson, 2001. Prediction of ground motion for thrust earthquakes. *Data Utilization Rept. No CSMIP/00-01 (OSMS 00-03), California. Strong Moption Instrumentation Program, Sacramento, CA.*

Spudich, et al., 1999.: A revised ground motion prediction relation for use in extensional tectonic regimes. *Bulletin of the Seismological Society of America* 89 (5), 1156 -1170.

Sulstarova, E., Muço, B., Koçiu, S., and Peçi, V., 2005. Catalogue of historical and instrumental earthquakes in Albania with Ms ≥ 4.5. *Seismological Institute Tirana.*

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SOME FEATURES OF ACTIVE TECTONICS AND SEISMICITY IN FIERI REGION OF ALBANIA

Petraq NAÇO[1], Edmond DUSHI[1], Fatbardha VINÇANI[1], Jani SKRAMI[1]

[1]Institute of Geosciences, Energy, Water and Environment / Polytechnic University of Tirana, (Rr. Don Bosko, Nr. 60, Tirana, Albania),
E-mail: petraqnaco@yahoo.com, edmonddushi@yahoo.com, bardha_vin@yahoo.com, janskrame@yahoo.com

ABSTRACT

Fieri region is an important domain for the Albanides tectonic structure extension where collision of Albanides orogene together with the Apulian platform occurs. It is the impression that we are dealing with a collision zone. Fieri region is regarded since antiquity as an area with significant activity seismic. Different historical chronicles testify for disastrous earthquakes that hit the ancient city of Apollonia. Detailed data of these geological phenomena exists after 1900, after the beginning of instrumental seismological recording in our region. Since 1920 up to now more than 12 recorded earthquakes with M> 5.0 have hit the city of Fier and its surroundings. The analyses of seismicity characteristics and mainly in focal mechanism solution report that the generation of earthquakes relates to the tectonic deformations caused by compressive phases. This region and its surroundings have been strongly deformed by folds, reverse faults, including both thrusts and occasional back-thrusts, and strike-slips; all faults are inherited from the main Alpine compressive phases. Compressive deformations continue up to present-days.

The main tectonic line is the anticline structures of Patos-Verbas-Cakrani that standing at the forefront of Albanides orogen. Also it is the main tectonic line transmitting towards the west the tectonic stress energy coming from regional compression axes. To its west most front is situated the regional Ardenica backthrust. This tectonic line has a depth of 7-8 km and its upper trace is near the surface bearing the molasses formation folding process.

From the orientation point of view, these lines go transversal to the main Albanides structure identifying as the most active segment of Vlora-Elbasani-Dibra transversal tectonic fault. The depth and its intense geodynamics are expressed with the evaporite outcrop to the surface, the presence of surface backthrusts and seismicity.

KEYWORDS*: *Fieri region, seismicity, earthquakes, tectonics

INTRODUCTION

The region surrounding Fieri is geologically interesting, as it is characterized by geological events, phenomena's and important underground resources. Some important hydrocarbon deposits have been discovered, in this area, such as that of Marinza, Patosi, Visoka, Ballshi, etc. The oil bearing layers are concentrated along the carbonate section of Cretaceous-Eocene and the Tortonian-Messinian molasse formations. This element led us to understand that forming and reforming of hydrocarbon deposits has occurred, thus the region has undergone strong tectonic movements, time to time. Also its surface layer is characterized by important geological phenomena such as Serravallian, Tortonian-Messinian and Pliocene transgression which are elements that reveal these strong tectonic movements. From the structural point of view, many structures are developed in the surface and deep inside of this region. Let's mention here, the Kremenara and Shendellia surface carbonates anticlines, deep Ballshi and Cakrani anticlines and Patos-Verbasi burred anticline. All these elements help understand the strong structural movements of this region since earliest geological time. We consider the most important geodynamic reality, especially the Patos-Verbasi burred anticline, not only for its large scale, but also its diversity of the tectonic movements bearded by this structure. Based on above description, it is clearly shown that Fieri region is characterized from a distinct geodynamics during the geological time. This conclusion is supported also from many strong earthquakes, coming in evidence not only from historical but also from recent instrumental seismicity, which have hit the region. These are the main direction that will be treated within this paper in order to reveal the active tectonics and seismicity main features.

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POSITION OF THE REGION IN THE ALBANIDES FRAME

The region here investigated**,** belongs geologically to the outer Albanides, explicitly to the Ionian tectonic zone, laying in the northernmost part of it, (Fig. 1). While from the geomorphologic standpoint it is placed in the area expressesing the transition from the mountainous region of southern Albania to the Myzeqeja lowland. This transition is gradual through a hills system continuing nearly from Greshica to the south to the Dukas village at the north. From the lythofacias aspect, the hills system is constructed mainly from flysch formations, while in the northern part of it, in the transition area to Myzeqeja, from molasses. Whether from formational point of view, this region is positioning between carbonates structures outcrop to the surface in the south and Pliocene molasses in the north. Thus, this region lies in the north of Vlora-Elbasani-Dibra transversal tectonic, an important element contributing to the uplifting and folding of mountainous structures of southern Albania, (Naço et al., 2011). This is a fundamental regional tectonic element contributing to the general geological and geodynamic events and seismic activity of the region. Parts of this geodynamism are the burred underground structures of Cakrani, Kreshpani, Balleshi and Patos-Verbasi. Thus this region has a vast coverage and very complex characteristics, being in the frontal collision between Adria (Apulian platform-Sazani zone) and Albanian Orogene.

DATA USED

Different data sources cab is used to explain the active tectonics and seismicity characteristics of Fieri region. Because of the interest of hydrocarbon exploration in this region, these data have been increased. Several important geological studies are conducted, on the surface and to the depth, of this area. Also several seismic profiles make possible the depth structure modeling and revealing of tectonic lines developed along it. Oil exploration wells are projected and drilled. Their number is considerable, a hundred of them, with depth varying from 1000-2000 m to 6700 m. The greatest drilled depth belongs to Ardenica 18 well. Based on this vast information, the depth structural scheme of the carbonate bed of Cretaceous-Eocene has been constructed. This scheme is the bases to delineation of the structural units and tectonic lines. The most important and coherent element to explain the active tectonics of this region, are data recorded on earthquakes as accompanying phenomenon of these movements. Taking into account only the moderate to strong earthquakes (M > 4.5), a set of 17 events has been selected to be analyzed in this paper, (Tab. 1). These events belongs to the catalogue of strong earthquakes of Albania (Sulstarova, et al., 2000), which cover the time period from 58 BC to 2005. Important information, especially to connect the earthquakes to the respective active faults causing them, is the focal mechanism solution. Many studies have been done on this subject (Muço, 1999; 2007; Sulstarova, 1978; 1985; 2000). We have selected focal mechanism solutions only for three of these events, which better characterize the general style of active tectonics in this region, (Tab. 2).

Table 1. Strong earthquakes occurred in Fieri region (217 BC-2006), M > 4.5

No.	Date yyyy/mm/dd	Time hh:mm:ss	Coordinates N-S	E-W	Dep.	Mag.	I_0	Epicenter Location
1	0217/00/00	00:00:00	40.74	19.47	33	6.3	8.3	1.5 km from Pojani
2	1929/01/17	00:06:40	40.60	19.60	18	5.1	6.5	4.5 km NW of Gorishova
3	1929/01/30	13:53:04	40.60	19.60	39	5.4	7.0	4 km NW of Gorishova
4	1930/12/25	23:45:00	40.60	19.30	19	4.6	6.0	14 km W of Novosela
5	1931/09/20	03:30:30	40.60	19.70	13	5.0	6.5	3 km NW of Balleshi
6	1939/08/09	03:30:24	40.60	19.70	14	5.3	7.0	3 km NW of Balleshi
7	1940/02/23	03:39:56	40.60	19.60	13	5.5	7.0	4 km NW of Gorishova
8	1940/03/06	00:00:00	40.60	19.60	18	4.9	6.5	4 km NW of Gorishova
9	1940/03/18	03:50:00	40.60	19.60	18	4.6	6.0	4 km NW of Gorishova
10	1952/06/19	00:22:59	40.60	19.70	8	4.5	6.0	3 km NW of Balleshi
11	1959/09/03	04:02:06	40.70	19.60	17	4.5	6.0	4 km SE of Fieri
12	1962/03/18	15:30:32	40.66	19.59	14	6.0	8.0	3 km SW of Patosi (Rerez)

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13	1967/07/13	14:38:58	40.70	19.70	17	4.7	6.0	4 km W of Kurjani (Fier)
14	1967/09/07	03:32:22	40.70	19.60	13	4.8	6.0	4 km SE of Fieri
15	1976/09/07	19:41:34	40.66	19.59	11	5.0	7.1	3 km SW of Patosi (Rerez)
16	1982/11/16	23:41:21	40.70	19.65	15	5.7	7.0	near Rroskoveci
17	1985/01/16	23:35:58	40.67	19.28	23	5.0	6.5	Vjosa outfall

Table 2. Focal mechanism solutions for three events (M > 4.5), occurred near Fieri

No.	Date yyyy/mm/dd	Time hh:mm:ss	Coordinates N-S	E-W	Dep.	Mag.	M_W	PL1	PL2	P-axes	T-axes
1	1967/07/13	14:38:58	40.70	19.70	17	4.7	5.0	282/57	172/62	135/45	228/3
2	1982/11/16	23:41:21	40.70	19.65	15	5.7	5.6	336/49	79/75	202/16	306/41
3	1985/01/16	23:35:58	40.67	19.28	23	5.0	5.3	22/78	290/79	336/1	246/17

Based on above, it is understandable that the used information in organizing this paper, has been collected from four different sources of data: the surface geological data recorded from several profiles in different years, depth data like vertical profiles from seismic work, lithofacial columns data from drilled wells for hydrocarbon exploration and seismicity data from albanian and foreign vast seismological studies.

SURFACE STRUCTURES AND TECTONIC LINES

To better understand what is going on in connection with active tectonics (Fig. 1) and seismicity of Fieri region (Fig. 6), we consider essential to extend our debate towards the structural elements and the most important geological phenomena that are met along them.

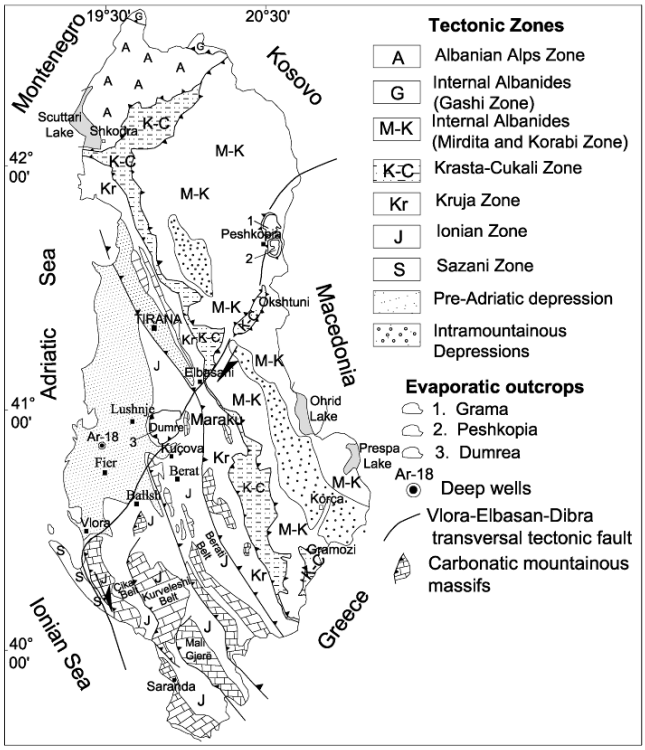


Fig. 1. Schematic tectonic map of Albania

In the southern part are developed Kremenara and Shendellia carbonate anticlines, (Fig. 2) as a northeastern continuity of Çika and Kurveleshi anticline belts, while in the Kuçova vicinity, Shpiragu and Kullesi carbonates anticlines are developed, as a northern continuity of Berati anticline belt. We can see that the alignment of these structures towards the north is confined along a same line pointing northeast, transversally to the Albanide's orientation. This line acts like a dissecting border, where on both sides different structural evolution exists. To the south, is developed the mountainous massifs of southern

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Albania, that shows a strong structuring and folding correspondingly to a high dynamics and intensity of the regional compression axis activity. While to the north are developed the lowland regions of the syncline shape, expressing a depressive tectonic regime compared to that in the south. We think that exists a deep transversal fault, which is created since the earliest geological era and is still active, playing an important role in the development and structuring of Albanides, on both sides of this segment (Naço et al., 2011). Permo-Triassic in age, Dumrea evaporates diapir locate in the northeast of the investigated area. Based on its earlier age compared to the surrounding rocks, we judge that it is an expression of the communication between the underground great depths with the surface, considering it an important tectonic element in explaining the geodynamics and seismicity characterizing Fieri region. This element become more important when we take into account the ductile property of evaporates and their vicinity to the transversal fault of Vlora-Elbasani-Dibra. Other distinct elements are the Selenica, Patosi and Kuçova moulds, (Fig. 2).

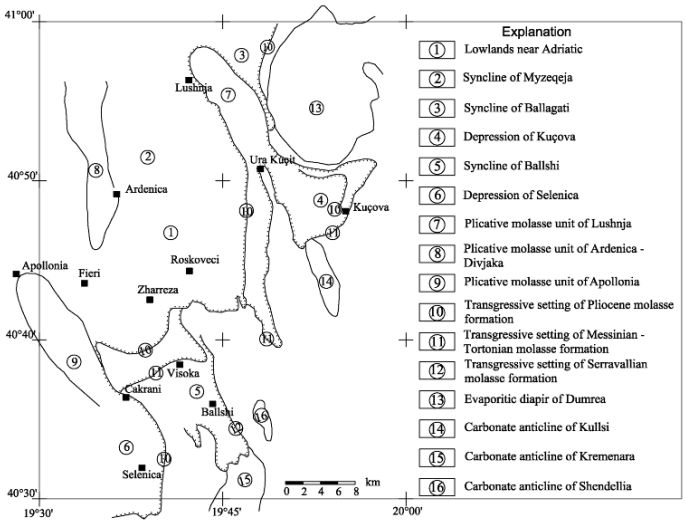


Fig. 2. Surface scheme with the main tectonic units

They are situated consequently, from the southwest to northeast, aligning almost parallel with the up mentioned confining tectonic line. Reasoning this way, we would say that these lowland units, at the north of transversal Vlora-Elbasani-Dibra tectonic fault, are of pre Pliocene age as facts of depressional regime under which they have been formed, experienced by this region. They are situated as well at the front of Preadriatic depression, in relation to the Orogenic zone, in surface conditions as a expression of young and important tectonic movements. These moulds cover some buried carbonates anticlines, showing that this region have changed from a orogenic region experiencing continuous uplifting and erosion to in filled lowland units led to molasses formation. Thus, Selenica, Patosi and Kuçova moulds are product of the depressional tectonic movements where have been involved respectively the Selenica, Patos-Verbasi and Kuçova anticlines. These facts, beside a complex geodynamics, caused from the Vlora-Elbasani-Dibra transversal active fault, show the relatively young age of this tectonic activity. An important structural and geodynamic element are considered the molasses folds of Lushnja, Ardenica-Divjaka and Kreshpan-Frakull-Apollonia, (Fig. 2). They are expression of the later folding regime and neotectonic activity experienced by the region. Ardenica and Apollonia molasses folds, to their development toward the southeast, becomes part of the north periclinal of Cakrani flysch fold (Geological Map, 1:200 000, Xhomo et al., 2002). Thus, we have a collision or unification of the surface structural units, which indirectly indicates the depth origin of this collision, where begun the folding process. The Preadriatic depression is an important and potential unit in the geological structure of Albanides. This because of its large scale and considerable thickness of the rock formations by which it is constructed, as well as for many events and structural and tectonic elements developed in this unit. Let's mention here the Serravallian transgression of Mesinian-Tortonian and Pliocene (Fig. 2), which indicate for important events of strong folding, happened to this region. These transgressive lines like marker shapes, are met in the surface, in conditions of lateral sides, but they continue also in the depth, giving it the characteristics of a layer structured region. From this point we understand that during the structuring process, it has passed through several folding phases, some of them even very young ones, such as that of Pliocene and post Pliocene. On the surface of this region, several tectonic lines have been delineated, from different

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researchers, (Fig. 3). These tectonic faults, in this case, we consider very important because they are the direct expression of displacement movements, which has undergone the investigated region. These faults are still active now a days. They have made possible the structuring of Cakrani carbonate anticline and tectonic-structuring frontal contact between Ardenica-Kreshpan molasses folds and Apollonia. Based on above statements, it is believed that is sufficient to demonstrate that surface geological elements are very important to understand what is going on to the great depths.

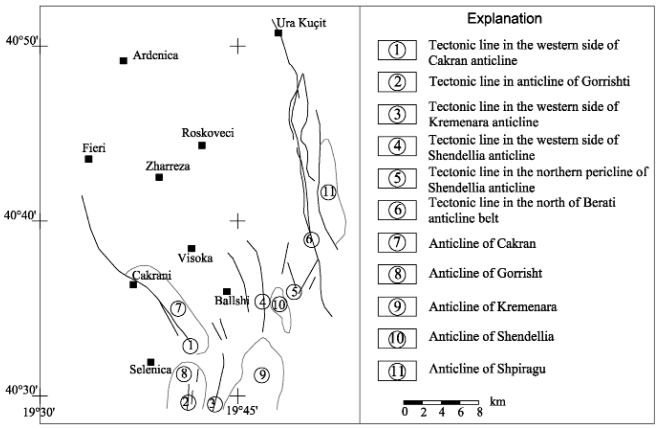


Fig. 3. Surface scheme with the tectonic lines

DEPTH STRUCTURES AND TECTONIC LINES

The depth of structure mostly reflects the surface geology of a region. But in many cases, especially in highly developed tectonic and structural floor regions, it appears more complicated. In order to understand the structural and tectonic construction of the region, we have been referred to the structural-depth map, according the top limestone's of Triassic-Eocene (Fig. 4). As it can be seen from this map the majority of the area is covered from the structural block of Cakran-Patos-Verbasi, which is organizes through the structural lines of Mollas-Cakran-Kreshpani and Hekal-Balleshi-Patos-Verbasi. Both lines are confined to the west by thrust tectonic contacts. The Cakrani line is the deepest, the most southwestern and underlayed to that of Patos-Verbasi. Just to the southeast of Fieri town, exists a frontal contact of two tectonic lines, continuing toward the north as the same lineament, (Fig. 4). The tectonic collision nodes are considered as weakened segments pre-disposed to generate strong earthquakes. To the west of the Cakrani-Patos-Verbasi structural block, the top limestone experiences a strong depression, difficult to be traced even by a 6700m well (Ardenica-18). Thus, obviously there are not only disnivels to the positioning of carbonate structures in space but also some frontal contacts of several tectonic lines, (Fig. 4).

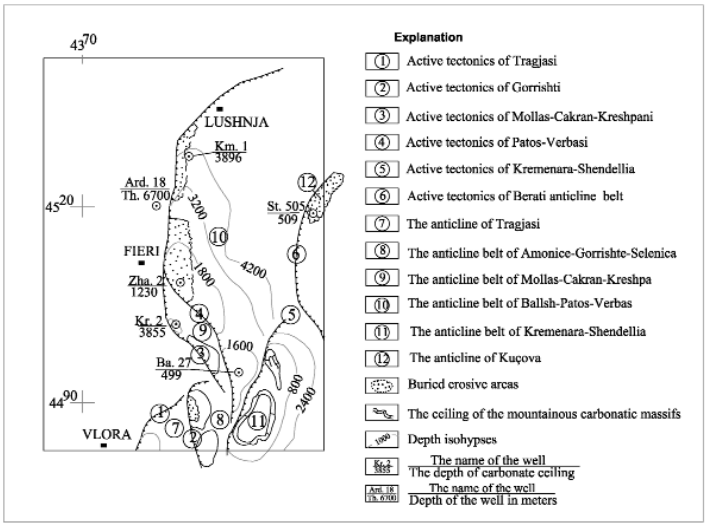


Fig. 4. Structural map under the carbonate ceiling

From the patterns point of view, we consider Selenica-Cakrani-Kremenara area as a weakened tectonic node predisposed to permanent seismic activity generation. This tectonic node, in the regional meaning, constitutes a segment of the Vlora-Elbasani-Dibra transversal active fault dissecting Albanides.

GEODYNAMICS AND TECTONIC MOVEMENT DIVERSITY

The region under study is carachtersize from a distinct geodynamics. Data supporting this argument are considerable. We could mention the structural construction aspects, hydrocarbon pool reformations, the transgressive structures existence as well as earthquakes. This geodynamics is mainly dedicated to the natural and regional stress filed, applied along the regional compression axes. Another important role has also the tectonic fault system of the horst-graben type, created since the tectonic units formation. The main role has supported by the Vlora-Elbasani-Dibra transversal fault, as a regional line, which have made possible to concentrate to its southeastern part, all the regional compression field intensity, (Naço et al., 2011). Is this tectonic regime have defined the thrusted type of this segment as all the tectonic lines lying to its southeast. the product are several anticline and syncline belts up to mountainous missives at the surface, framed within Ionian tectonic zone, (Fig. 1). In its frontal conditions of this orogenic region, anticline belts of Ballesh-Patos-Verbas and Mollas-Cakran-Kreshpan, have been constructed. Most typical one is the Patosi-Verbasi anticline structure, which represents a large scale structure of the Triassic-Eocene carbonate bed, (Fig. 4).The large scale of this structure shows the strength and the intensity of the regional compression stress field, while tectonic complexities show the diversity of the paths along which has been released the cumulative energy. The tectonic line, confining to the west the anticline structure of Patos-Verbas, have served as a promotion of structuring as well as a transitive line to transmit further to the west the continuous energy coming from the regional stress field. As a result have been created the Ardenica and Apollonia molasses folds, (Fig. 2) and the back thrust tectonic of Ardenica. (Fig. 5). Back thrust tectonics are present also along the Patos-Verbasi anticline, cutting the carbonates thickness and more above in the form of alternative lines to release the excessive energy. While the tectonic movements diversity is expressed as along the transgressive borders in the surface (Fig. 2), as well as divergent contacts at the depth, (Fig. 5). As it looks like, during the latest geological time this region is affected by several folding phases accompanied by lifting and depression displacements.

SEISMICITY OF THE REGION

As a result of this complicated structural and tectonic construction expressing a high geodynamic level, the region has been characterized by a frequent seismicity comprising all classes of earthquakes (Fig. 6). Especially strong earthquakes are very important to characterize the deep active faults. From instrumental data (Tab.1), the magnitudes of these events vary from 4.5 to 6.3 (M_S). For the time period 217 BC up to now, a number of 17 strong earthquakes hit the region, (Tab. 1, Fig. 6).

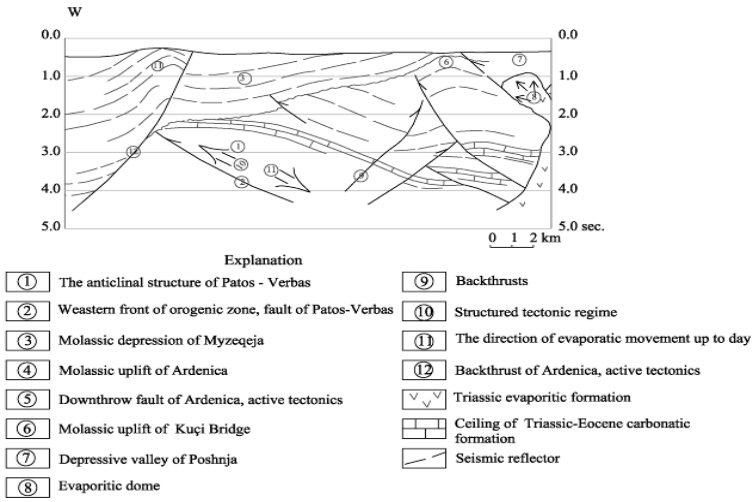
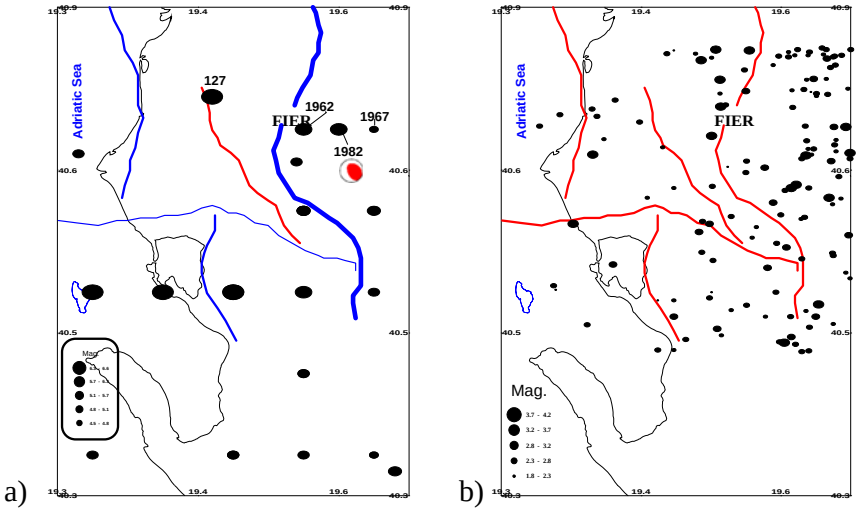


Fig. 5. Geodynamic model of the region Ardenica - Patos -Verbas - Ura Kuç (mapped on the basis of seismic facies).

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a) b)

Fig. 6. Seismicity of Fieri region: a) M> 4.5 for the period 217 BC b) M>2.0 for the period 1964 up to now (Sulstarova, 2005; Muço B, 1999).

While, from 1964 and on about 140 small to moderate earthquakes (Mag. 1.8 – 4.5) have occurred within the area confined between the coordinates 40.25^0 – 40.80^0N and 19.25^0 – 19.75^0E. Seismic moment released varies between 3.34×10^{24} dyne cm and 2.34×10^{26} dyne cm (Muço B., 1976 – 1995), expressing the high level of displacement filed along longitudinal thrust and overthrust faults. The hypocenter depths of strong earthquakes vary from 8- 39 km. These depths are a clear expression of the relation between seismic activity and deep active tectonic lines. They could be related mainly with geodynamics of the buried carbonate structures, while the depth of small and moderate earthquakes doesn't exceed 7 km, relating this frequent activity with the uppermost structures. Main active faults in this sector have a general direction NW-SE. Focal mechanism solutions for some of the earthquakes shows that this region experiences mainly a compressional stress regime in the direction SW-NE, with tectonic faults of thrust and overthrust type striking generally NW-SE and dipping generally to E and NE (Skrami J., & Aliaj Sh. , 1995). More interesting appears several focal mechanism solutions (Tab. 2), which shows also the domination of tensional stress regime and faults of left lateral strike slip type as well. The solution that mostly supports the faulting type in the region, is the focal mechanism solution of the November 16, 1982 earthquake (M_W = 5.6) occurred near Fieri and widely referred in literature as Rroskoveci earthquake (Tab. 2, Fig. 6), of over-thrust type with a strike-slip component (oblique). Two other solutions are achieved, for the earthquake of July 17, 1967 and January 16, 1985 respectively (Tab. 2), showing oblique type faults. The first one is generated from a normal fault with a strike-slip component and the second from a strike-slip fault. These cases support the relation between the transversal active tectonic line of Vlora-Elbasani-Dibra and other longitudinal active lines of thrust and overthrust type (Sulstarova et al., 2000) and its main role in the tectonic processes of the region.

CONCLUSIONS

Fieri region is well known for its frequent earthquake shaking, demonstrating an overloaded region in terms of tectonic energy, witnesses of which are the recorded earthquakes.

Concerning the surface geology aspect, it is part of Patosi mould, thus constructing a segment of the southern flank of the Preadriatic Depression.

From the deep point of view is situated over the structural ensemble which developed in the northwest of the active transversal Vlora-Selenica-Elbasani-Dibra, involved into strong lifting and depression movements.

Seismic activity is product of tectonic faults, which acts sometime like thrusts and other times like normal faults, whether they are caused from the regional compression field or Dumrea evaporite massive stresses.

REFERENCES

Muço B. 2007. *Focal mechanism solutions and stress field distribution in Albania*: AJNTS. 1, 129-138.

Muço B. 1999. *Catalogue of ML >3.0 earthquakes in Albania from 1976 to 1995 and distribution of seismic energy released*: Techtonophysics. 292, 311-319.

ISSN 2306-9600

Naço P, Reçi H, Vinçani F, 2011. *On the Vlora-Elbasan-Dibra – Sharri transversal tectonic fault, as one of the earliest and most active tectonics of structure of Albanides*. Bulletin of the Geological Sciences, Nr. 47, Tirane. 32-59.

Skrami J, Aliaj Sh, 1995. *Thrusts and backthrusts on Preadriatic depression (Albania) deduced from exploration seismic*: Proc. of XV Congress of the Carpatho-Balcan Geol. Assoc., pp. 1139-1143.

Sulstarova E. 1978. *Some characteristics of earthquake foci of Albania and the field of tectonic stressess*. Proccedings of the XVI General Assembly of ESC, Strasbourg 1978. Publ. Inst. Geoph. Polish Academy of Sciences A-9 (135), 79-86.

Sulstarova E. 1985. *Some characteristics of Seismicity of Albania, Acts of International Conference on Seismic Zones in Mediterranean Area*, Matera (Italy) 16-18 November 1981, Centro of Geomorfologi Integrate per l'area del Mediterraneo. Potenza, Italy. 223-131.

Sulstarova E, Peçi P, Shuteriqi P, 2000. *Vlora-Elbasani-Dibra (Albania) transversal fault zone and its seismic activity*: Journal of Seismology. 4, 117-131.

Xhomo A, Kodra A. etc., 2002. Geologic map of Albania, 1: 200 000 scale.

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SOME MAIN ASPECTS AND FEATURES OF SEISMIC ACTIVITY 2011

Rrapo Ormeni[1], Edmond Dushi[1]

[1]*Institute of Geosciences, Energy, Water and Environment, Tirane, Albania.*
e.mail rrapo55@yahoo.com, edmonddushi@yahoo.com

ABSTRACT

We present here the results of the analysis in parameters of events and some features of the seismicity that have occurred in the Albania and surrounding area during 2011. On that territory, 477of total number of earthquakes was located and 10 of them were felt by population of Albania.The earthquake foci are concentrated mostly along the four active fault zones: Vlora-Elbasani-Dibra, Borsh-Kardhiq, Lezha-UlqiniandKurbnesh-Skavice.The strongest earthquake occurred on the 9th of June at 16:16(UTC), with Richter magnitude of 4.3.The local earthquakes are distributed in depth between 0 and 20 km, with maximum concentracion between 1 and 8 km.In the Korca earthquake series were located 27 of earthquakes with ranging magnitude 2.0 to 3.7 Richter.On the epicentral map is showed the seismic activity for the Albanian territory and its surroundings

KEY WORDS: *Earthquakes, Seismicity, epicenter, fault, focal mechanism*

I.INTRODUCTION

Albania is situated in Alpine-Mediterranean seismic belt comprising the zone of contact betweenlithosphere plates of Africa and Eurasia. Here African and Eurasian plates collide, giving origin tosome seismically active belts. In particular Albania is at the junction between the Adriatic microplate and Eurasian plate as it is known, Albania is a country of high seismic activity (Aliaj et al 2012). It ischaracterized by intense micro seismic activity and small and medium-size earthquakes and onlyseldom by large event. The earthquake foci are concentrated mostly along the active faults(Aliaj et al 2001., Ormeni 2007).We present here the results of the analysis in parameters of events and some features ofSeismicity that have occurred in the Albania and surrounding area during 2011. Compared with two last years 2009 and 2010 the seismic activity is lower.The strongest earthquake occurred on the 9th of June at 16:16(UTC), with Richtermagnitude of 4.3. According to ASN data occurred on the vicinity of Berati town, CentralAlbania, the seismic activity reached an intensity of V-VI degrees on MSC-98 scale.

II.MATERIALS AND METHODS

Data

Earthquakes with an epicentral distance fromthe closest station of less than 100 km, recorded by least 3 stations are located. During year 2011, Institute of Geosciences,Energy, Water and Environment, Polytechnic University of Tirana using seismicnetwork, has recorded a moderate seismic activity at the Albania territoryand a slight increase of activity in its surroundings in eastern and southern part. On that territory, between39°00'- 43°00' N and 18°50'-21°50'E, 477of totalnumber of earthquakes was located.Albanian bulletins have location errors, which are negligible for civil protection purposes and largescale seismotectonic analyses, more accurate hypocentral determinations are necessary fordetailed seismotectonic and geodynamic studies (Ormeni 2007) Seismic phases recorded by the Albaniannetwork,

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Thessalonica (Greece) and INGV integrated with bulletin data of Montenegro networks,are used to prepare the database for this study (fig 1).

Method

P-wave arrivals from 477 located earthquakes which occurred during 2011 within Albania andsurrounding area areformatted in New eve program of Seisan. We relocated the earthquakes, which occurred in theAlbania in the last year, achieving constrained hypocentral determinations for the events in the Albania.The standard procedure uses the program HYPO71 (Haskov and Ottemoller., 2008) of the SEISANpacket, and velocity model Vel-Albanid(Ormeni2011) for earthquake locations, while thelocal magnitude of near earthquakes is estimated according to Richter scale. Some formula fordetermination of the magnitude according to the time duration of the seismic signal are also used (Klein, F.W 2007).

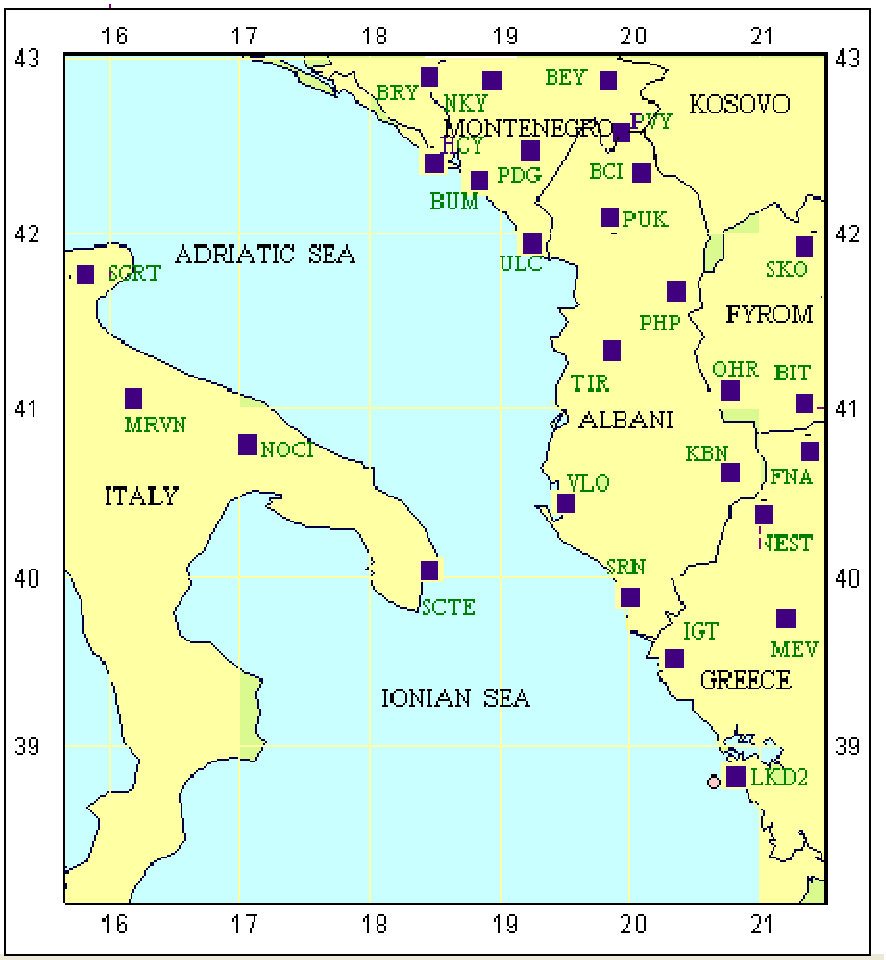


Fig 1. The map of 27 stations used for localization of the earthquakes occurred during 2011

III.RESULTS AND DISCUSSION

During 2011, the seismic stations managed by ASN have recorded 477 local earthquakes, with M_D in the range 1.7-4.2. Earthquakes recorded by at least 3 stations have been located and their epicentres are shown in figure 2. Seismicity is mainly concentrated in the Vlora-Elbasani-Dibra(1), Borsh-Kardhiq (2), Lezha-Ulqini (3) and Kurbnesh-Skavica(4) fault zones (fig 2).

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On the Albanian territorynine of theseearthquakes were felt by population of Albania. The strongest earthquake occurred on the 9th of June at 16:16 (UTC), with Richter magnitude of 4.2on the vicinity of Berati town, Central Albania. The seismic activity reached an intensity of V-VI degrees on MSC-98 scale.The statistic show 122 of seismic events have magnitude $M_L \geq 3.0$. The seismic activity during this year presented lower compared with seismic activity during period of time 2009 - 2010.

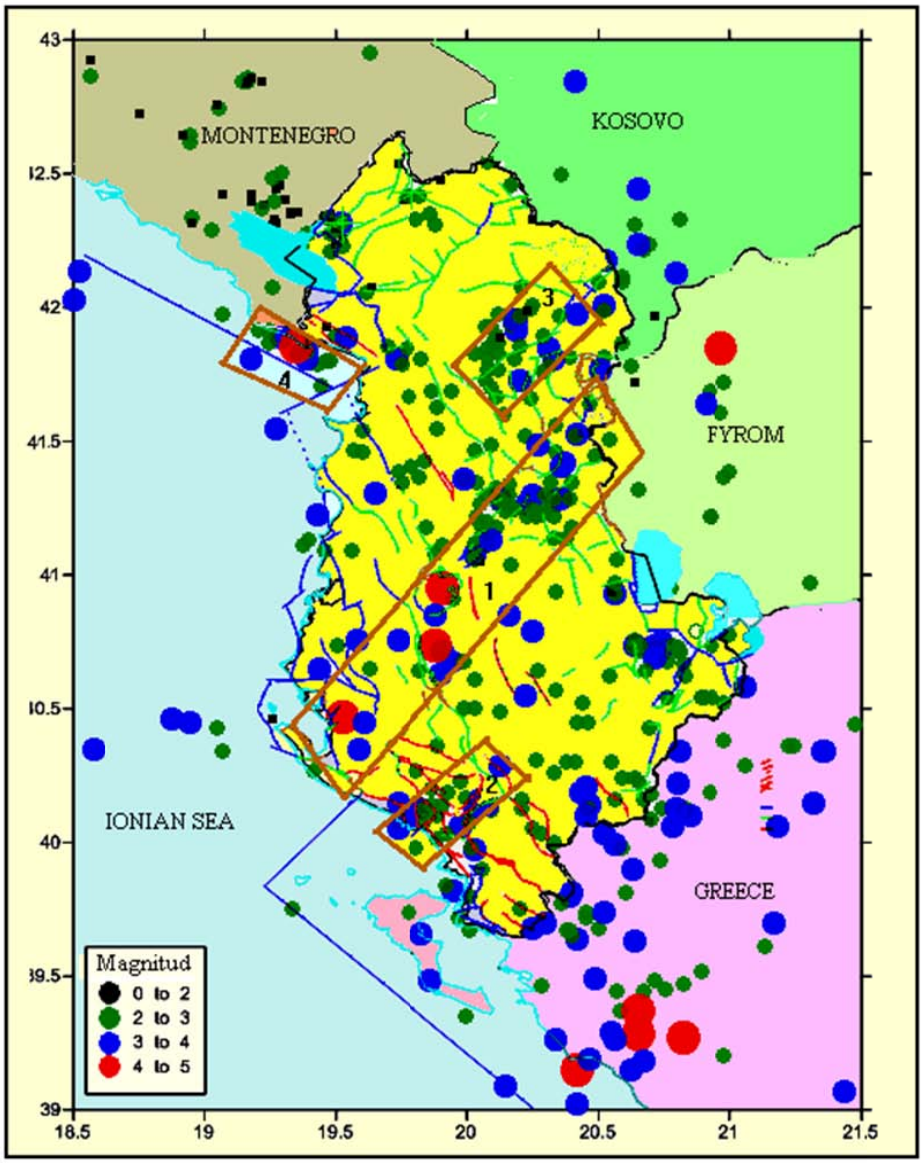


Fig 2.Epicentral map of earthquakes occurrence and the most seismogenic zones during 2011.

The frequency of earthquake occurrence in the region can be perceived from the attached diagrams, through the cumulative number of earthquakes per month.Figure 3 shows the number of earthquakes recorded and located each month in Albania. In January there were 63 located earthquakesdue to the Korca seismic sequence. From Aprile to June there were 30 to 32 located earthquakes. In July the number of located earthquakes largely increases (49) while in August to September the number of located earthquakes stabilizes to less than 30 earthquakes.

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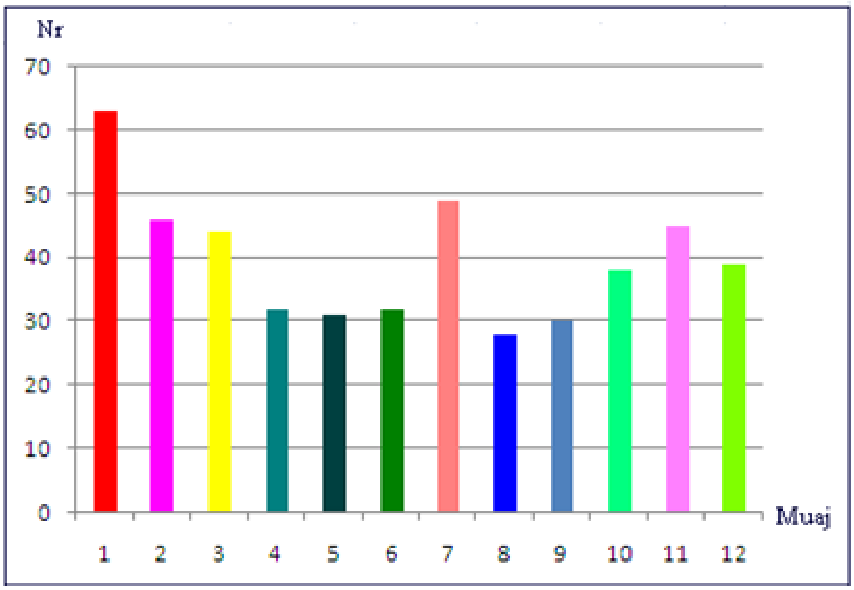
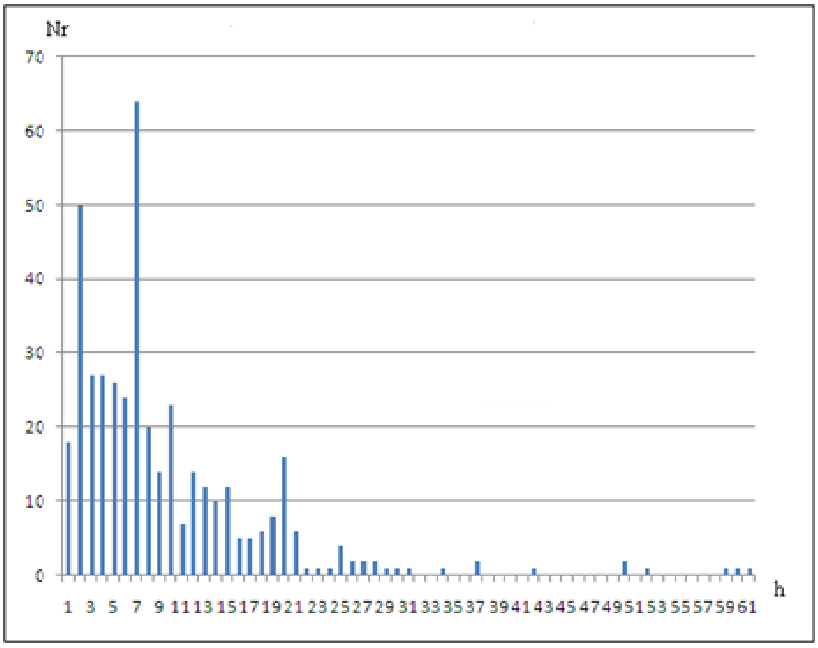


Figure 3. The diagram of earthquake frequency occurrence per month during 2011

The local earthquakes are distributed in depth between 0 and 61 km, with maximum concentration between 1 and 10 km. Most of earthquakes heve bottom at 30 km (fig 4).About 86% of located earthquakes with ML≥1.5 (Richter) across the Albania during 2011 have bottom 20km. By generalizing the data from the depths of earthquakes statements show that the seismoactive layer in Albania is in upper and middle crust.



Eig 4. Number of located earthquakes according to depth

Figure 5, shows the number of recorded and located earthquakes grouped by magnitude. For the located earthquakes the minimum magnitude is 1.5, the maximum number of earthquakes is for magnitude between 2.0 and 3.0, while the catalogue is complete starting from magnitude 1.5.

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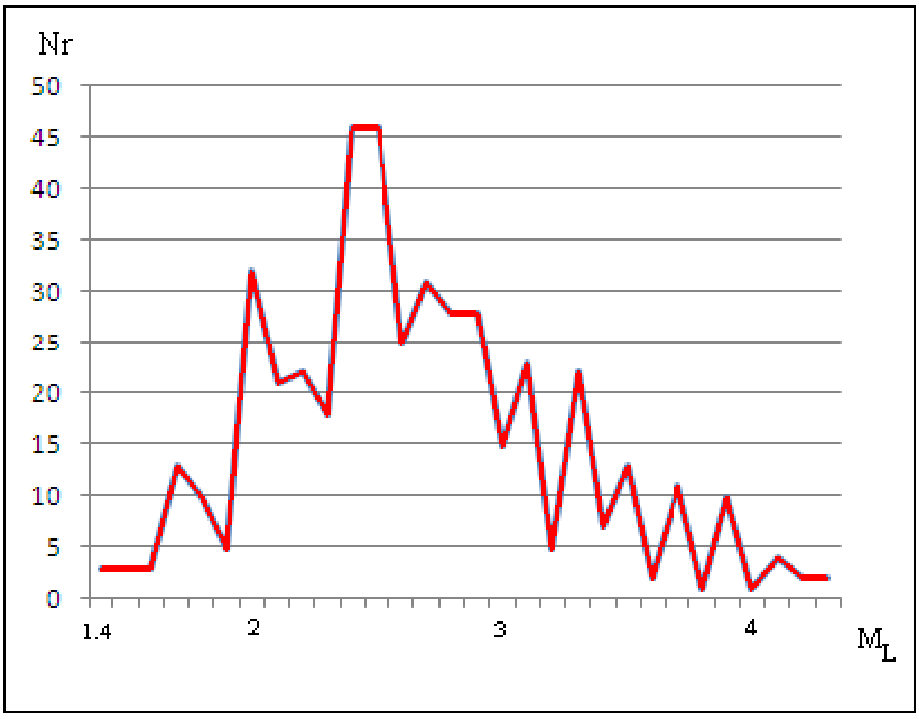


Fig 4.Distribution of the number of earthquakes according to the magnitude

Analyzing of annual seismic activity is a very important step in seismotectonic analysis. The Most of seismicity during 2011 year have occurred along fourseismogenictrasversal belt as following:
a).Vlora-Elbasani-Dibraseismogenic transversal belt has been active during 2011year along all its length. On this transversal zone were located 73 earthquakes with M_L>2.0, 25 earthquakes with M_L>3.0 and the activity of this transversal zone was culminated with 3earthquakes with M_L>4.0 in Vlora-Lushnja segment. The most of earthquakes on the fault Vlora-Elbasan-Dibra during 2011 have occurred mainly in the Elbasani-Dibra segment. This segment comprising fragmentary NE-striking normal faults (Rr. Ormeni and E. Dushi). These earthquakes expresses the increased recently seismic activity of the Vlora-Elbasani-Dibra transversal faulting zone.The earthquakes with M_L>2 (Richter) along this zone during period of time 2011have a range of depth of about 1-30 km. By generalizing the data from the depths of earthquakes statements show that the seismactive layer in Albania is in upper and middle crust (Ormeni.,2007).From theSeismotectonic point of view, the area belongs to a complex faulting environment, and accordingto the actual map of neotectonic zonation of Albania (Fig. 2), it is located in the boundary betweenthe two main tectonic zones characterized by compressional and extensional movements.The strongest earthquake occurred on the 9th of June at 16:16 (UTC), M_L= 4.2 on the vicinity of Berati town, Central Albania. The hypocentral depth determinations are of the order of 15km by a thrust faulting environment according to the neotectonic zonation map of Albania (Aliaj2012) and this explains the wide area where the shaking generated by this event was felt.
b).On the Borsh-Kardhiq fault zone a small increase of seismic activity was presented during 2011(fig 2.zone 2).. During this year were located 27 earthquakes with M_L>2.0 and 10 of them with M_L>3.0. The strongest earthquake occurred on the 16th of March at 09:57 (UTC), epicenter coordinates 40.13°N; 19.82°E, the focal depth 14 km has magnitude (M_L = 3.8).There was a powerful differentiation in the Borsh-Kardhiq zone, closes in the Borsh the structure of Qeparo from the south and at Kardhiqi cuts and seperates the Kurveleshiplateu from the structure of Mali i Gjere through a transversal flyschy structure along wich, on account of a major tectonic rupture, evaporates, amphibolites and effusive rock crop up from deep and emerge on the surface.

c).The Lezhe-Ulqini area, outer side of folded Alpine orogen with high mountains, hilly chains, extensive areas that are entirely under the power dynamics of rivers, abandoned riverbeds, lagoons and numerous wetlands, Shkodra Lake and very near the Adriatic Sea(fig 2.zone 4). Shkoder-Peje strike -slip fault constitutes the most important structural element that passes through the area. This area is characterized by a complex geomorphology and in addition, has been hit by numerous earthquakes (Kociaj, 1988, Ormeni, 2010). On the Lezhe-Ulqini area during year 2011 were located 17 earthquakes with M_L>2.0.The earthquakes with $M_L \geq 2$ (Richter) along this zone during period of time 2011 have a range of depth of about 1-28 kmAn earthquake of magnitude (M_L=4.0) occurred on 22 August 2011, in coastline of Adriatic Sea 8km west of Lezha in the source time 03:26:18 (UTC), epicenter coordinates 41.86°N; 19.35°E, the focal depth 28 km.

d).The Kurbnesh-Skavic transversal seismogenic zone with direction SW-NE in Albania, inner side of folded Alpine orogeny with high mountains(fig 2.zone 3). This fault zone characterized by a complex geomorphology and in addition,this segment has been hit by numerous earthquakes during 2011.During this year were located 39 earthquakes with ML>2.0 and 10 of them with ML>3.0. The moderate earthquake occurred on the 2th of March at 00:29 (UTC), epicenter coordinates 41.92°N; 20.19°E, the focal depth 8 km has magnitude (M_L = 3.9).By generalizing the data from the depths of earthquakes have a range of about 1-25 km show that the seismactive layer in this zone is in upper to middle crust.

Increased seismic activity was registered on the Greece territory, especially in its northern part. The strongest earthquake occurred on the 4th of October at 10:26 local time, with Richtermagnitude of 4.6. The seismic activity reached an intensity of VI degrees on the MSC scale. In the vicinity of Korca, on the 25th of January the first earthquake occurred at 05:06 local time, with Richter magnitude of 3.4 and for a period of some months was registered a small series of earthquakes. In that series, the strongest earthquake occurred on the 26 th of January at 02:11 local time, with Richter magnitude of 3.7 and maximum intensity of IV-V.In this series were located 27 of earthquakes with ranging magnitude 2.0 to 3.7 Richter. During the previous year, in the south Montenegro, an increased seismicity was registered. Inthese earthquakes , the strongest occurred august 2 at 14:45 local time, with Richtermagnitude of 3.2.During this year the Seismicity is mainly concentrated in the predominant belt in Lushnje-Elbasan-Dibra, with extensions in north of its.On the epicentral maps showed the seismic activity for the Albanianterritory and its surroundings.

IV.CONCLUSION

The main earthquakes inside the Albanian territory, analyzed in this paper have beengenerated in an area with complex features from the neotectonic point of view.The most of local earthquakes are distributed in depth between 0 and 20 km, with maximumconcentracion between 1 and 8 km.Most of earthquakes during 2011 are concentrated on the Vlora- Elbasani-Dibra, Borsh-Kardhiq, Lezha-Ulqini and Kurbnesh-Skavic seismic zones.In the vicinity of Korca was registered a small series of earthquakes. Increased seismic activity was registered abroad of Albania on the Greece territory, especially in its northern part.The strongest earthquakes of Albania during 2011 with epicenter in Vlora, Fieri and Lushnje, Borsh, Ulqini, Kurbnesh express the increased seismic activity of the Lezha-Ulqini,Vlora- Elbasani-Dibra, Borsh-Kardhiq and Kurbnesh-Kukes seismic zones. According to the actual map of neotectonic zonation of Albania these active zones belong to complex faulting environments that were the source of earthquakes during 2011year.

REFERENCES

Aliaj Sh., Sulstarova E., Muco B. &Kociu S. (2001).Seismotectonic map of Albania, schale

1:500.000, Seismological Institute Tirane

Aliaj Sh., 2012. Neotektonika e Shqiperise: Published BotimetKlean, Tirane

Haskov, J. and Ottemoller. L. (2008). Seisan: "The earthquake analysis software", University of Bergen, Norway.

ISSN 2306-9600

Klein, F.W., (2002). "User's Guide to Hypoinverse-2000, a Fortran program to solve for earthquake location and Magnitude", USGS

Koçiaj S. (1988). The risk of the Albanian's earth crust and its specification for the ground ofConstrutsion, *PhD thesis, Tirana.*

Ormeni, Rr., (2007). "The general model of construction of the Albanian earth crust and its seism active features according to the seismological data".PhD thesis, Polytechnic University, Tirana.

Ormeni Rr (2009). "Crustal structure beneath the seismogenic zones and lateral velocity contrasts across deep faults of Albania" Journal of the Balkan Geophysical society, Vol 12, No.1, December 2009, p. 1-8

2011.Ormeni Rr. (2011). "P- & S-Wave Velocity Model of the crust and uppermost mantle of the Albania region" ELSEVIER, Journal of Tectonophysic, Vol 497, January 2011, pp 114_121

RrapoOrmeni, Edmond Dushi (2011).."Studim i aktivitetitsizmiktësotëmnësegmentin e thyerjeve tërthoreElbasan-Dibër" Buletini i ShkencaveGjeologjike, SherbimiGjeologjikShqiptar, Tirane

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SPATIOTEMPORAL PATTERNS OF SEISMIC ENERGY RELEASED IN ALBANIA: RECENT ADVANCES

Edmond DUSHI[1]

[1]*Institute of Geosciences, Energy, Water and Environment, Tirana, Albania, e.dushi@geo.edu.al*

ABSTRACT

A spatiotemporal analyses of released seismic energy for the period 1976-2008 is the subject of this paper applying the local energy-magnitude function derived recently for Albania. This relation express the best correlation between radiated seismic energy and local duration magnitude of earthquakes using energy data determined for a random set of earthquakes through spectral analysis and broadband integration. The calibration of the local model is based on a broader analysis of digital waveform recordings assuming all possible corrections for source, path and receiver effects on radiated seismic energy. The interval of magnitudes taken for this calibration extends within 3.0 to 5.5, conditioned from broadband waveforms recorded so far. The method used, to characterize the spatial and implicit temporal patterns of seismic energy released, is the simple and direct empirical determination based on recent developed local model as well as the moving block mapping which have successfully been applied previously in similar studies. The new results suggests increase in the energy values achieved applying the local model showing an underestimation of this important macroscopic parameter due to the absence of the local models. Also some extends of the known zones with higher energy release are achieved. Despite these differences the overall spatial patterns of seismic energy released in Albania are generally in good accordance with previous studies implying the robustness of the method used and a good quality earthquake catalogue for Albania.

KEY WORDS: *Seismic energy, spatiotemporal patterns, local energy-magnitude relation*

INTRODUCTION

Earthquake energy released, the seismic energy radiated in earthquakes, is one of the fundamental measurements of earthquake size (Miao et al., 2008). The total energy radiated from a seismic source can be calculated directly from broadband waveform recordings observed for that earthquake (Kanamori et al., 1993; Singh and Ordaz, 1994; Choy and Boatwright, 1995; Newman and Okal, 1998; Venkataraman et al., 2002; P'erez-Campos et al., 2003; Mayeda et al., 2004; Dushi, 2011). However, this has not become a routine activity of this parameter estimation compared to the determination of hypocenter location or magnitude (Miao, 2008). This is the reason why the energy data is not normally found in the earthquake catalogues. Thus, applying the standard energy-magnitude empirical relation to estimate the earthquake energy remains still crucial. The general model used for this relation is the classical Gutenberg-Richter (1956), a linear mathematical model that relates the decadal logarithm of energy (E_S) with magnitude. Many investigators have used this relation after calibrating it for local seismic conditions (Gutenberg and Richter, 1956; Båth, 1955; Båth et al., 1976; Vassiliou and Kanamori, 1982; Kanamori et al., 1993; Choy and Boatwright, 1995; Dushi, 2011). Untill 2003, when the broadband digital recording of instrumental seismicity in Albania begun, the calibration of a local energy-magnitude relation was not possible. For this purpose, in order to estimate the released seismic energy from the catalogue data, different other relations have been used instead, by different researchers (Muço, 1998). Taking the period 1976-1995, for about 20-years of instrumental recording through analogue instrumentation, the relation determined for Sweden (Båth et al., 1976) has been used in connection with the moving block spatial analyzing method (Båth, 1982; Muço, 1998). This aimed a spatiotemporal distribution analysis of seismic energy as for Sweden like a country with similar seismicity characteristics with Albania. The patterns of this distribution are controlled directly from local tectonics and characteristics of seismic faults and their interaction through the natural stress field, thus being very important for the determination of the seismic hazard in a local scale. Nevertheless, the seismic energy describes in a clear and dynamic way the seismicity, it depends on the size of the earthquakes (Båth, 1982), thus the determination of a local empirical model to this respect would be of a great importance. Obviously, this was possible since 2003 and with the increase of digital waveform database very accurately done after 2006. Consequently, a new

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calibrated local model for a better constrain of released energy from local seismicity has been introduced (Dushi, 2011), and applied for spatial and implicit temporal distribution of energy analyze. This will be discussed in details further throughout this paper.

SEISMOTECTONICS SETTINGS AND DATA USED FOR CALIBRATION

Albania represents a rather complicated region from the geological and seismotectonic point of view (Muço, 1998). The seismic activity is concentrated mostly along known active faults as the main seismic sources (Fig. 1). Albanian territory could be separated into two main domains: the outer domain which comprises coastal parts and lowlands and the internal one, where all the mountain zones of Albania are included. This regionally division is supported from focal mechanism solutions (Muço, 1994). It is revealed predominance of the compressional stress regime in the outer and of an extensional stress regime in the inner domain, coinciding respectively with the parts of the Adria and Eurasian lithospheric plates. In a local scale the territory is cut through by numerous longitudinal and transversal active faults and fault zones, as the main sources of earthquakes. The most important seismogenic zones are: 1- Ionian-Adriatic longitudinal seismogenic zone, coinciding with the boundary between the Adria microplate and the Albanian orogene; 2- The Mat-Moker-Bilisht longitudinal seismogenic zone; 3- The Drini-Ohri-Korça longitudinal seismogenic zone; 4- The Shkodra-Peja transversal seismogenic zone; 5- The Lushnja-Elbasani-Dibra transversal seismogenic zone; 6- The Vlora-Tepelena transversal seismogenic zone (Aliaj, 1988; Aliaj and Muço, 1996; Muço, 1998), (Fig. 1).
Assuming that radiated energy is the proxy factor for elastic potential energy in an elastic lithosphere and due to the fact that earthquakes are the products of complex physical processes involving friction and fracture mechanics, it is likely related with the brittle strength of the crust. Thus mapping the spatial distribution of released energy based on proper models and data relevant to these seismogenic zones would revealed better constrains of local seismotectonics.

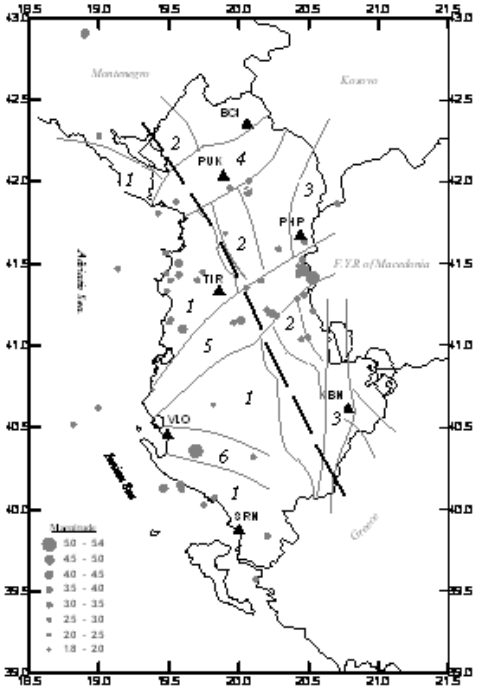


Fig. 1. The main seismogenic zones of Albania. The numbers 1-3 indicate the longitudinal seismogenic zones discussed in the text, while 4-6 the trasversal ones. Scematically the dashed line separates the outer and the inner tectonic domains. Dotes indicates the earthquakes taken in consideration for local energy-magnitude expression calibration, while triangles are the seismological stations of ASN.

Data used to calibrate the empirical energy-magnitude local model for Albania, are observed from earthquakes located within seismogenic zones as above described (Fig. 1). They consist of broadband waveforms recorded in the period 2008-2009. A dataset of 69 earthquakes is chosen as representative population of data to compute the source parameters and radiated seismic energy. Waveforms are recorded by Trillium-40 and CMG-40T (BB) sensors, and sampled at 100 sps prior to the spectral

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analyze. The recording equipments are installed at six permanent seismological stations at specific sites in Albania (Fig.1). To ensure the accuracy of the spectral analyze, the events are relocated with hypocenter routine (Havskov and Ottemöller, 2000). A local horizontal-layered velocity model has been used. It was determined based on the Wadati method (Peçi and Shubleka, 2001). This velocity model express a linear vertical velocity gradient for V_P , changing every 5 km of depth. The accuracy of this model is guaranteed from the large quantity of data used (16 000 local and regional earthquakes), recorded for a 20-years period (1976-1995).

METHODOLOGY

To calibrate the local empirical model of seismic energy 69 seismic events with energy in the interval 10^9 – 10^{20} erg, are used. These data are randomly computed by a full spectral analyze on horizontal components of the observed waveforms (Dushi, 2011). Numerical results represent the total radiated seismic energy from each of the seismic sources computed through spectral integration of the corrected spectra. All the effects such as directivity, radiation pattern and attenuation, etc, are accounted for. Thus, the accuracy of the achieved results from this analyze is guaranteed. They are used to calibrate the local empirical model witch relates the seismic energy and magnitude.
Local magnitudes in the interval 2.3 – 5.6, based on total signal duration and corrected for attenuation with the distance from hypocenter to the seismic stations (Eaton, 1992), are used for calibration of this model. It is determined using the classical linear regression analysis. Values for the coefficients of the model are: A = 2.06 (+ 0.24), B = 9.59 (+0.82); these parameters define a linear regression line witch fits better the observed data with a correlation coefficient of R = 0.72 and a standard deviation of sd ≈ 1.23. Its mathematical form is expressed as follow (1).

$$\log E_s = 2.06\, M_D + 9.59 \qquad (1)$$

Residuals between the model and data vary within the interval ± 2.0, according to a normal distribution function, witch confirms the statistical significance of the model. Spatial patterns of seismic energy computed from above model are determined applying the moving block method (Båth, 1982; Muço, 1998). This approach was accurately applied for Sweden with low seismicity as well as for other regions like Turkey, experiencing high seismicity. The moving block is modeled as a unit cell within the latitude interval 39^0 – 39.5^0N and 18.5^0-19^0E. Thus, the size of the unit cell is 0.5^0 and it is shifted 0.25^0 in longitude and latitude covering all the territory under study. The total energy determined using calibrated model is attributed to the center of each cell as a cumulative energy taking into account all the earthquakes located inside and in the borders of each of the cells.

This method is applied on the catalogue of Albanian instrumental earthquakes covering the period 1976-1995, containing 2153 earthquakes, and the ISC catalogue of Albanian earthquakes for the period 1995-2008, listing about 430 earthquakes with ML ≥ 3.0. In order to correctly apply the local empirical model the datasets are both filtered in the interval 3.0-5.5, excluding events with magnitudes ML ≥ 5.5 witch are not covered by the model. Data of radiated seismic energy are spatially mapped using an interpolation-triangulation process.

ANALITICAL RESULTS

Only energy values computed for seismic events in the period 1976-2008, filtered within the interval of magnitudes 3.0-5.4, are used in the griding process. This assumes that events with ML ≥ 5.5 would generates non accurate results based on local model. The purpose is to compare both empirical models, the one used before (Muço, 1998) to analyze the instrumental period 1976-1995 and the calibrated one (Dushi, 2011), witch takes in analyze besides this period as well as the one extended until 2008. So, an overlap on the period of instrumental seismicity is assumed for applying both empirical expression in a comparative way (Fig. 2). The achieved results are given in graphical form by griding through interpolation/triangulation process to ensure a smoothed pattern of the spatial distribution of radiated seismic energy. These grid points are mapped for both models (Fig. 2), using surfer software.

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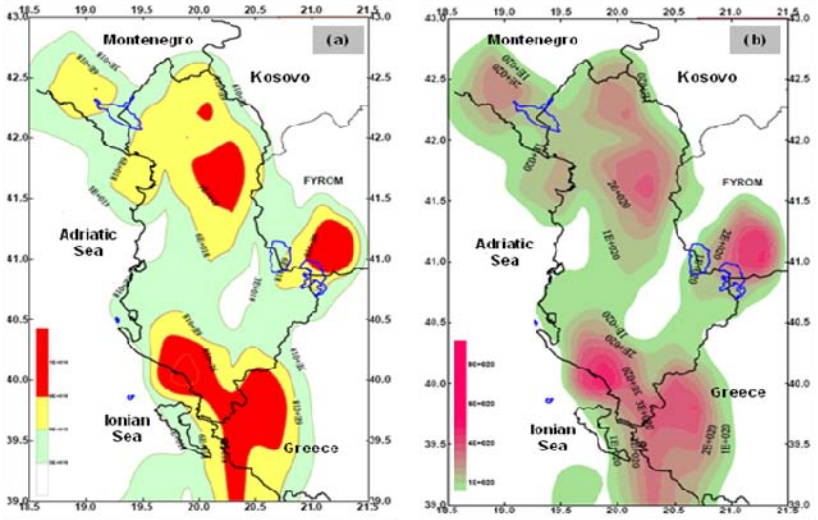


Fig. 2. (a)- Spatial distribution of released seismic energy from earthquakes with $M_L \geq 3.0$ to $M_L = 5.4$ for the period 1976-1995, using the empirical model of Båth (1982) for Sweden, applied for Albania (Muço, 1998); (b)- distribution of released seismic energy from earthquakes with $M_L \geq 3.0$ to $M_L = 5.4$ for the period 1976-1995 using the calibrated local empirical model for Albania (Dushi, 2011).

In order to extent in time the obtained results from the local empirical model, the data from ISC catalogue reported from ASN and covering the time interval 1995-2008, are taken in consideration. The selection criterion is that of magnitude threshold. Only earthquakes with $M_L \geq 3.0$ are taken in consideration. The upper limit for this criterion is set by the local empirical model for seismic energy ($M_L = 5.4$). That implies more than 430 earthquakes used for determination of the released seismic energy locally during this time period. The spatial distribution is given unsmoothed for this period because the locations within each of the unit cells as defined would be very scarce and many of which would results with zero earthquakes so affecting the spatial patterns artificially. They are mapped superposed with the smoothed previously one (Fig. 3).

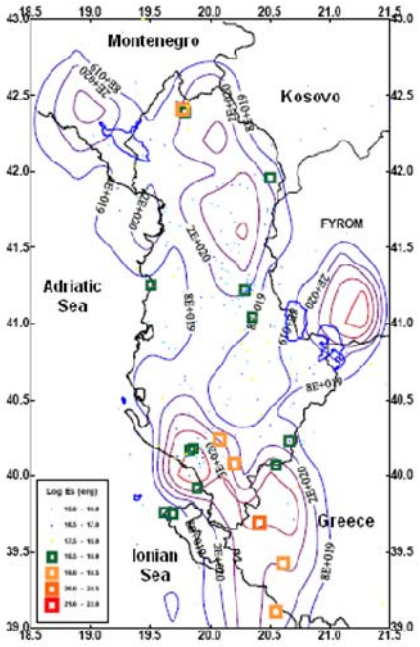


Fig. 3. Spatial distribution of released seismic energy from earthquakes with $M_L \geq 3.0$ to $M_L = 5.4$ for the period 1976-2008, using the calibrated local empirical model for Albania (Dushi, 2011).

From the analytical results as above described, comparing both empirical models, compatible values for released seismic energy in the magnitude range 3.0-4.7 are achieved. While, for magnitudes within the range 4.7-5.4, considerable changes are evident. The residuals between two models are found to vary in

the interval 2.0-5.0 units of the energy scale. Also, an systematically increasing trend is observed for energy residuals between two models, corresponding to the magnitudes ≥ 4.7, maybe because of some extrapolation applied to the model used for Sweden in this range of magnitudes. Taking a period more than 20-years of seismicity for this country, ones can find that the highest cumulative magnitude observed so far is ML = 4.7, thus naturally limiting the model scale from above. While, in the range of magnitudes 3.0-4.7, the residuals of both models are nearly zero suggesting no changes even in the spatial patterns.

DISCUSSION

In the map on fig. 3, both time periods 1975-1995 and 1995-2008, are superposed. This is the time distribution interval of analyses released seismic energy for Albania. This analyze is done applying a more accurate and consistent empirical model. It is recently calibrated based on modern digital recordings of ASN and more sophisticated mathematical applications in the spectral domain of the waveform signals recorded in a broadband frequency range. Previously, other empirical models have been used witch were calibrated for other regions with similar seismicity characteristics. It is well known that changes in the release energy values will affect also the spatial patterns of this macroscopic parameter. Thus, applying different models over the same dataset, important differences for magnitudes ≥ 4.7 have been revealed. The previous calculations have underestimate the released energy for this class of data. While, both models show no differences for lower classes of magnitudes. Applying the local and calibrated model small spatial patterns differences are observed confirming the consistence of applied method of moving block combined with the more accurate empirical model determined recently for Albania. From the other side, the achieved results fully agree with previous studies, so that the distribution of the zones with the maximum seismic energy release is completely confirmed. These zones are: Montenegro coastal area and the northwestern Albania where the maximum released energy accordingly with the selected class of magnitudes is 10^{20} erg; The Bregu i Detit and Kurveleshi regions in Albania where the released maximum seismic energy is 10^{19} -10^{20} erg; Elbasani to Dibra area (10^{20} erg); north to the Prespa lake area and to the east of Ohrid lake (10^{19} -10^{20} erg) and Kukesi-Tropoja area with maximum released energy of 10^{20} erg.

CONCLUSSIONS

1. Spatial distribution of released seismic energy is of great importance revealing the spatial patterns of local seismicity and seismotectonics. It contributes for the accurate determination of the seismic hazard for a given region.
2. From distribution of the radiated seismic energy in the magnitude range 3.0-5.4, applying moving block process and smoothing by interpolation/triangulation griding method, several zones with the maximum released energy are distinguished.
3. The maximum upper limit for each of the zone not exceed 10^{20} erg, corresponding to the maximum local magnitude 5.4, naturally limited from the seismicity observed from 1995 to 2008 within defined class of magnitudes.
4. By taking in consideration earthquakes with magnitudes greater than 4.7 (M_L), clear differences between models used until now are revealed. This is because the previous empirical relation used for this purpose has underestimated seismic energy for higher classes of magnitudes leading to systematical errors because of extrapolation. Thus, the spatial pattern is influenced by this changes.

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REFERENCES

Aliaj, Sh., 1988. *The neotectonics and Seismotectonics of Albania:* D.Sc. Theses, Seismological Center, Tirana, 270 pp.

ISSN 2306-9600

Aliaj, Sh. and Muço, B., 1996. *On seismicity and seismotectonics of Tirana region, in* Int. Project Expert Assessment of Land Subsidence related to Hydrogeological and Engineering Geological Conditions in the Regions of Sofia, Skopje and Tirana, Proceedings, Sofia, pp. 82-88.

Båth, M., Kulhanek, O., Eck, T., Wahkstrom, R., 1976. *Engineering Analysis of Ground Motion in Sweden.* Seismological Institute, Upsala, Rep. 5-76, 37 pp.

Båth, M., 1982. *Seismic energy mapping applied to Sweden.* Tectonophysics 81, 85-98.

Choy, G.L., and J. Boatwright, 1995. *Global patterns of radiated seismic energy and apparent stress.* J. Geophys. Res., 100, 18,205-18,226.

Dushi, E., 2011. *Application of quadratic velocity spectra for evaluation of seismic energy released from earthquakes in our country*. D. Sc. Theses, IGJEUM, Tirana, Albania.

Gutenberg, B., Richter, F. C., 1956. *Earthquake magnitude, intensity, energy and acceleration* (second paper), Bull. Seismol. Soc. Am., 46, 105-145.

Havskov, J., Ottemöller, L., 2000. *SEISAN earthquake analysis software*. Seismological Research letters, 70, 532-534

Kanamori, H., Mori, J., Hauksson, E., Heaton, E., Hutton, T., Jones, K., 1993. *Determination of earthquake energy release and ML using terrascope*. Bull. Seism. Soc. Am., 83(2), 330–346.

Muço, B., 1994. *Focal mechanism solution for Albanian earthquakes for the years 1964-1988*. Tectonophysics, pp. 311-323.

Muço, B., 1998. *Catalogue of ML > 3.0 earthquakes in Albania from 1976-1995 and distribution of seismic energy released*. Tectonophysics, v. 292, pp. 311-319.

Mayeda, K., Dreger, D. S., Walter, W. R., and Tajima, F., 2004. *BDSN calibration for northern california earthquakes from coda-derived source spectra: Moment magnitude and radiated energy* (abstract). Seism. Res. Let., 75, 278.

Miao, Q., Langston, A. Ch., 2008. *Spatial distribution of earthquake energy released in the Central United States from Global Point of View*. Seismological Research Letters, v.79, pp. 33-40.

Newman, A. V., Okal, A. E., 1998. *Teleseismic estimates of radiated seismic energy: The $E=M_0$ discriminant for tsunami earthquakes*, J. Geophys. Res., 103, 26,885-26,898.

Peçi, V., Shubleka, Sh., 2001. *A new elaboration of earthquakes in Albania and surrounding area for the period 1964-1995*, AJNTS, No. 10 pp. 35-42.

P´erez-Campos, X., Singh, S. K., Beroza, G. C., 2003. *Reconciling teleseismic and regional estimates of seismic energy*. Bull. Seism. Soc. Am., 93(2), 2123–2130.

Singh, S. K., Ordaz, M., 1994. *Seismic energy release in mexican subduction zone earthquakes*, Bull. Seismol. Soc. Am., 84, 1533-1550.

Vassilou and Kanamori, 1982. *The energy release in earthquakes*, Bull. Seismol. Soc. Am., 72, 371-387.

Venkataraman, A., Kanamori, H., Rivera, L., 2002. *Radiated energy from the 16 October 1999 Hector Mine Earthquake: Regional and Teleseismic Estimates*. Bull. Seism. Soc. Am., 92, 1256–1265.

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THE KORCA SEISMOGENIC ZONE AND ITS RECENT SEISMIC ACTIVITY

Rrapo ORMENI[1], Kujtim ONUZI[1], Rezart BOZO[1]

[1]*Institute of Geosciences, Energy, Water and Environment,Tirana, Albania*
e-mail: rrapo55@yahoo.com, onuzi@yahoo.com, rrezartbozo@gmail.com

ABSTRACT

We present here the results of our analysis regarding some parameters of events recorded and specific features of seismicity that have occurred in the Korca seismogenic zone during period of time 2001-2011. The number of earthquakes recorded and located within the area that this seismogenic zone covers is 331 in, in the meantime, 165 of them have magnitude M_L>3(Richter). The analysis include the epicenteral location, focal mechanisms solutions, macroseismic description of the main-shocks and their aftershock activity. The focal mechanisms were determined for the August 28, 2008 and the September 11, 2010 earthquakes. The region affected by these earthquakes, together with the strongest earthquake of May 1960, forms a roughly N−S trending active seismotectonic zone in southeastern Albania which presents a threat to nearby urban areas in Albania, Macedonia and Greece.

KEY WORDS: *seismogenic zone, focal mechanism, faults, aftershocks*

I.INTRODUCTION

The Ohrid-Korca graben fault zone with N-S trending, is represented by particular Pliocene-Quaternary normal fault-controlled grabens and half-grabens, which from the north to the south are: a.Ohrid grabens. b. The Korça and Erseka half-grabens. Geodinamically, it is the most active area with the greatest seismicity in the eastern Albania. Seismic activity with moderate to strong events is documented during the last 2000 yrs; the seismic hazard level is among the highest in Albania, Greece and Macedonia. Activity of the youngest faults is evidenced by earthquake data and field observations (Aliaj et al 2004). Morphotectonic features like fault scarps, a stepped series of active normal faults, deformed paleosols, a wind gap and fault-related hydrothermal activity are preserved around Lake Ohrid and allow delineating the tectonic history. It is shown that Korca zone can be characterized as a seismogenic landscape. The significant events that have occurred in Korca zone and its surrounding in 548, 1673, 1871, 1889, 1878, 1896, September 28, 1906**,** February 18, 1911, February 13, 1912, December 22, 1919, September 14, 1920, January 28, 1931, May 26, 1960, (Sulstarova et al, 1980; Ambraseys and Jackson, 1990; Ambraseys, 2009). The recent strongest event in the Korca zone was the earthquake occurred on May 26, 1960 (GMT 07:23:50; Ms=6.4; 40.64° N, 20.70° E; h=19 km), which caused 7deaths, 127 injuries (Sulstarova et.al 1975, 1995). The present-day tectonic stress field has been well studied via microtectonics (Aliaj, 2012) and focal mechanism solutions of earthquakes (Sulstarova, 1980; Muço, 1994; Louvari et al., 2001; Ormeni et al, 2009). The goal of this study is to analysis the features of seismicity and to determine the source parameters of the 2008, 2010 mainshocks and its aftershocks in order to shed light on the seismotectonics of the area and the stress field

II.GEODYNAMIC SETTING

The geodynamics of Albania are mainly controlled by the Northern Hellenic Trench and the North Anatolian Fault Zone (McKenzie, 1972; Armijo et al., 1999; Aliaj 2012)(fig. 1). The Korca and Ohrid basins forms the largest of a number of basins in the Dinaride-Alpine mountain belt that stretches along the western shore of the Balkan Peninsula.

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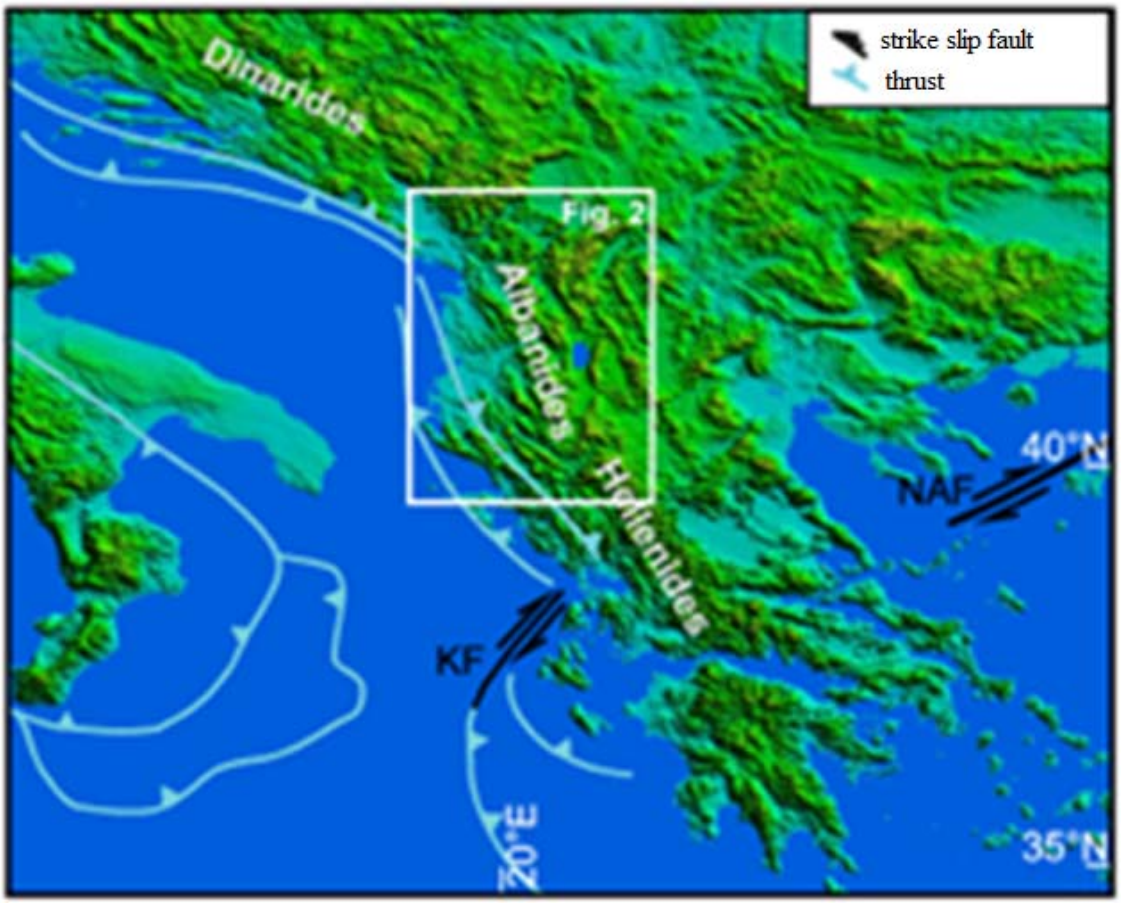


Fig 1. Overview of the eastern Mediterrianen geodynamic situation.

This belt was formed as a result of the Dinaric subduction, still being characterized by a compressional stress regime nowadays (Dumurdzanov et al., 2005). There is at present day no oceanic crust subducting below the Adriatic foreland north of the Kefalonia transform fault. The Ohrid Basin, to the north, Erseka Basins to the south, and the lakes of Great and Small Prespa to the northeast are situated in a basin and range-like geodynamical setting (fig.1). The entire area is controlled by present day E–W extension. Korca and Ohrid basins mark the transition between the Paleozoic orogen in the east (Pelagonian) and the Mesozoic rocks (Apulian) in the west (Onuzi et al., 2006, 2010). Today, the main structural sections of the Eastern Adriatic coast can be subdivided into a compressional coastal domain, followed by a narrow zone of transition west of Lake Ohrid and the extensional domain, in which the Neogene basins formed. Thrusts and folds were the dominating deformations during the Mesozoic orogeny, later dominated by normal and strike-slip faulting, mainly in N–S direction (Dumurdzanov et al., 2005; Onuzi et al., 2011)). Fault patterns of the surroundings of Korca indicate a diverse stress history. Korca and Erseka Basins are half grabens bordered by a NW–SE trending normal fault on their eastern side, while the associated Ohrid Basin is a graben structure caused by the E–W directed extension.

III.DATA AND METHOD

The earthquakes were recorded by permanent broadband seismological stations that are part of the Albanian Seismological Network (ASN) as well by neighboring seismic networks AUTH, MSO, INGV and MEDNET. The seismic events were located using data from three or more seismic stations. There were 331 earthquakes with $1.5 \leq ML \leq 4.5$, (fig 2).The formula to calculate local magnitude is $M_L=\log10(A/1000)-3.37+3\bullet\log10(D)$ that is divided with a regression coefficient for each station. The epicenters were located using P and S onsets making use of the local velocity model (Ormeni, 2011) and the Hypoinverse program (Klein F.W., 2002). The focal mechanism solutions for the main-shocks

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and selected aftershocks are based on the classical method of first-onset polarities, using the Focmec routine in the Seisan package (Haskov and Ottemoler, 2008).

IV.RECENT SEISMICITY

We list small and moderate events for the study area during 2001-2011. On that territory, 331 of total number of earthquakes were located and 165 of them have had magnitude $M_L \geq 3$ (Richter).Also, 3 of them have been characterized with magnitude $M_L \geq 4$ (fig 2). Recent events have shallow epicenters up to 20 km depth, deeper events are rare. About 95% of the located earthquakes with $M_L \geq 1.5$ (Richter) across the Korca zone during period of time 2001-2011 have bottom to the depth of about 20 km.

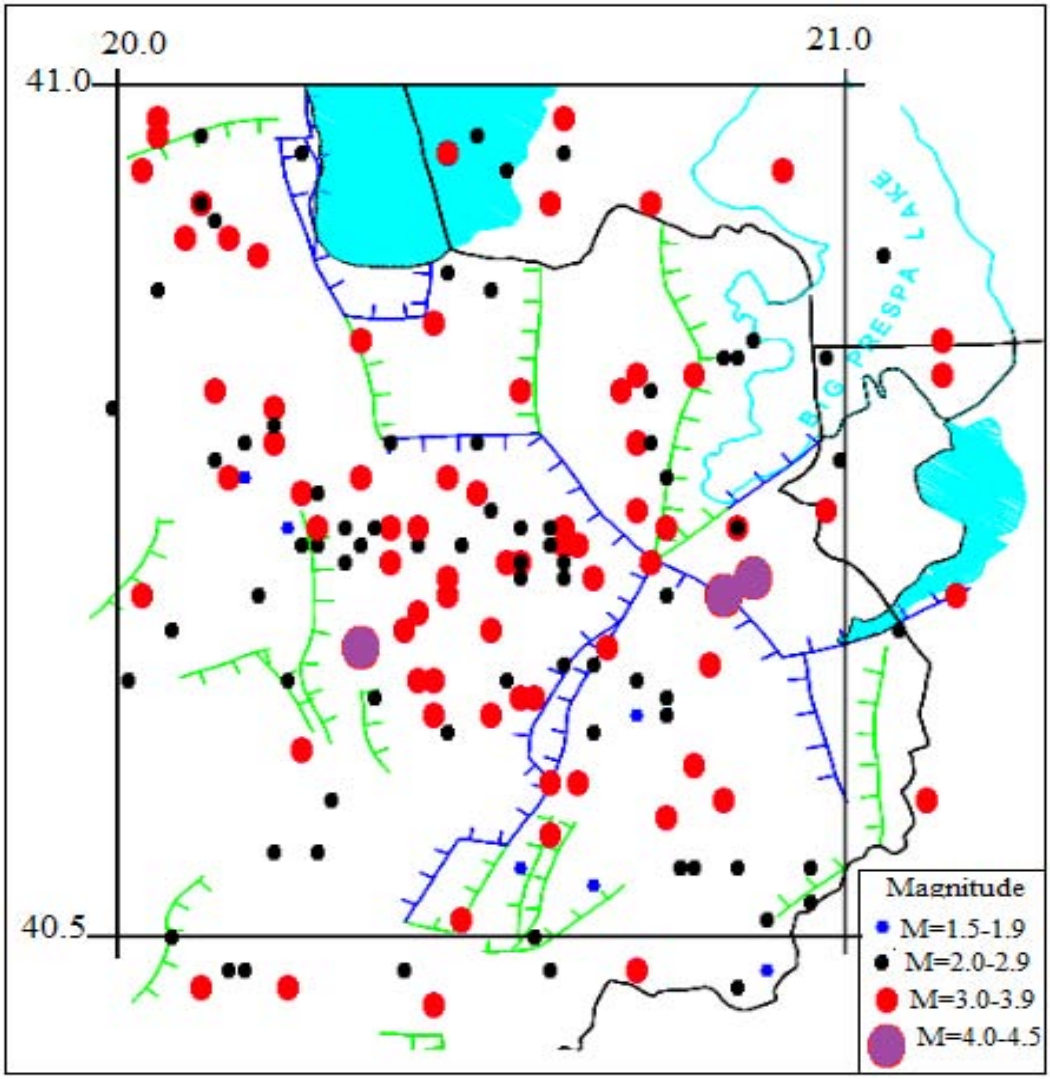


Fig 2.Seismotectonic map and epicenters of earthquakes occured in the period of time 2001-2011.

By generalizing the data from the depths of earthquakes, statements show that the seismoactive layer in Korca zone is in the upper and middle crust. The depth has the maximum value 25 km. Fig. 2 shows the number of earthquakes located for each year in Korca zone. During 2011, 37 earthquakes were located , those related with a serie of small earthquakes occurred in Korca district. In 2008 and 2010 were located 20 earthquakes due to the Voskop and Baban moderate earthquake, while in 2009 the number of located earthquakes was the smallest, 5earthquakes. This is related with the Gjorica earthquake (M5.4) occured in north of Korca zone.

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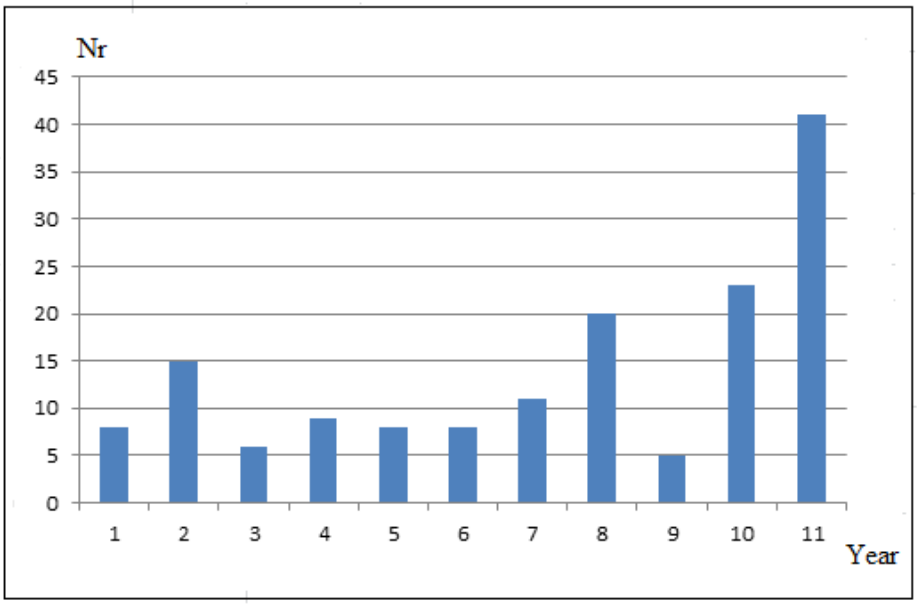


Fig 3.The diagram of earthquake frequency occurrence per year during 2001-2011

The moderate recent events of intensity I_0=V-VI (EMS-98) and $M_{L=}$4.2 struck Korca zone on August 28, 2018 at 05:37:25 (UTC). Its hypocentral coordinates are 40.67°N and 20.67°E, with a focal depth of 13km. The epicenter is situated near the Voskop village, about 7 km northwest of the town of Korca (fig. 4). The mainshock was followed by a number of aftershocks, of which 20 events are located. These aftershocks were recorded from August 28 to September 8, 2008 with magnitude ranging $1.5 \leq M_L \leq 3.4$ (Ormeni et al., 2009). Most of these secondary events occurred to the southeast to northeast of the epicenter. The aftershock activity developed in the seismically active upper crust beneath this zone, which has a thickness of 8-10 km (Ormeni, 2007). Aftershocks began immediately after the main shock and were distributed along a narrow SSE-NNW belt but progressed farwards and backwards from the mainshock. Aftershocks that were distant from the mainshock rupture plane indicate that the stresses on cracks increased as a result of the mainshock

The September 11, 2010 earthquake of intensity I_0=VI (EMS-98), Mw=4.5occurred about 8 km east of the city of Korca, and caused slight damage in the Baban village in the Korca district. Its hypocentral coordinates are 40.65°N and 20.89°E, with a focal depth of 3 km, explaining the localization of the slight damage to the epicentral zone. The main shock was followed by a large number of aftershocks, of which 150 events are located. These aftershocks were recorded from September 11 to September 21, 2010 with magnitude ranging $1.5 \leq M_L \leq 3.4$.The previous strong event in the region was the Korca earthquake on May 26, 1960 (GMT 07:23:50; Ms=6.4; 40.64° N, 20.70° E; h=19 km), which caused 7 deaths, 127 injuries (Sulstarova et al., 1980).

V.FOCAL MECHANISMS

Table 2 shows the focal mechanisms of the August 28, 2010 mainshock and three aftershocks with $M_L \geq 3.0$. The focal mechanisms were determined based on the classical method of first-onset polarities, using the Focmec routine in the Seisan package (Haskov and Ottemoler, 2008). The parameters of the four focal mechanisms are listed in Table 1. The August 28, 2008 mainshock has a strike of 358°, a dip of 30° and a rake of -90°

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Table 1.The focal mechanism parameters of the Voskop earthquake and selected aftershocks.

N	Date Y/m/d	Time h:m:s	Lat	Long	Depth (km)	M_L	Strik	Dip	Rak	Type of Mechanis
1	28/08/2008	03:37	40.67	20.67	13	4.2	358º	30 º	-90 º	
2	28/08/2008	03:52	40.66	20.81	10	3.0	180º	25 º	-90 º	
3	28/08/2008	03:54	40.65	20.83	8		357º	42 º	-90 º	
4	28/08/2008	04:40	40.66	20.83	8		332º	40º	-90 º	

The focal mechanisms of the September 11, 2010 mainshock and two M_L>3.0 aftershocks re listed in Table 2. The September 11, 2010 mainshock has a strike of 182°, a dip of 42° and a rake (slip) of -90° (fig 6).

Table 2.The focal mechanism parameters of the Baban earthquake and selected aftershocks.

N	Date Y/m/d	Time h:m:s	Lat	Long	Dep (km)	M_L	Strik	Dip	Rake	Type of Mechanism.
1	11/09/10	15:47:12	40.64	20.89	7.0	4.5	182 º	42 º	-90 º	
2	11/09/10	15:51:12	40.62	20.90	4	3.1	278 º	80 º	-90 º	
3	20/09/10	02:54:51	40.71	20.83	9.0	3.3	247 º	42 º	-90 º	

VI.SEISMOTECTONIC INTERPRETATIONS

Fault plane solutions of the recent earthquakes fit the geodynamic setting with mainly normal faulting mechanisms that contribute to the extensional domain inland (fig. 4). THE Recent earthquakes show activiation of normal fault with strike slip component.We expect that the normal faults at Korca-Ohrid are prone to generate an earthquake of M 6.5–7 (according to Wells and Coppersmith, 1994; Aliaj., 2012). However, we are not aware about recurrence periods of these majore vents in the Korca area. Taking all this into account, the Korca-Ohrid area is regarded one of the highest seismic hazard zones in Albania, Macedonia and Greece (Aliaj et al., 2004). Based on focal mechanisms, the motion of August 28, 2008 and the September 11, 2010 earthquakes occurred on a normal fault with a E-W extensional stress direction. The region affected by these sequences, together with the seismogenic region of the 1960 Korça event, forms a roughly N−S trending active seismotectonic zone in southeastern Albania that continues in the south of Korca in Leskovik and presents a threat to nearby urban areas in Albania, Greece and the FYROM

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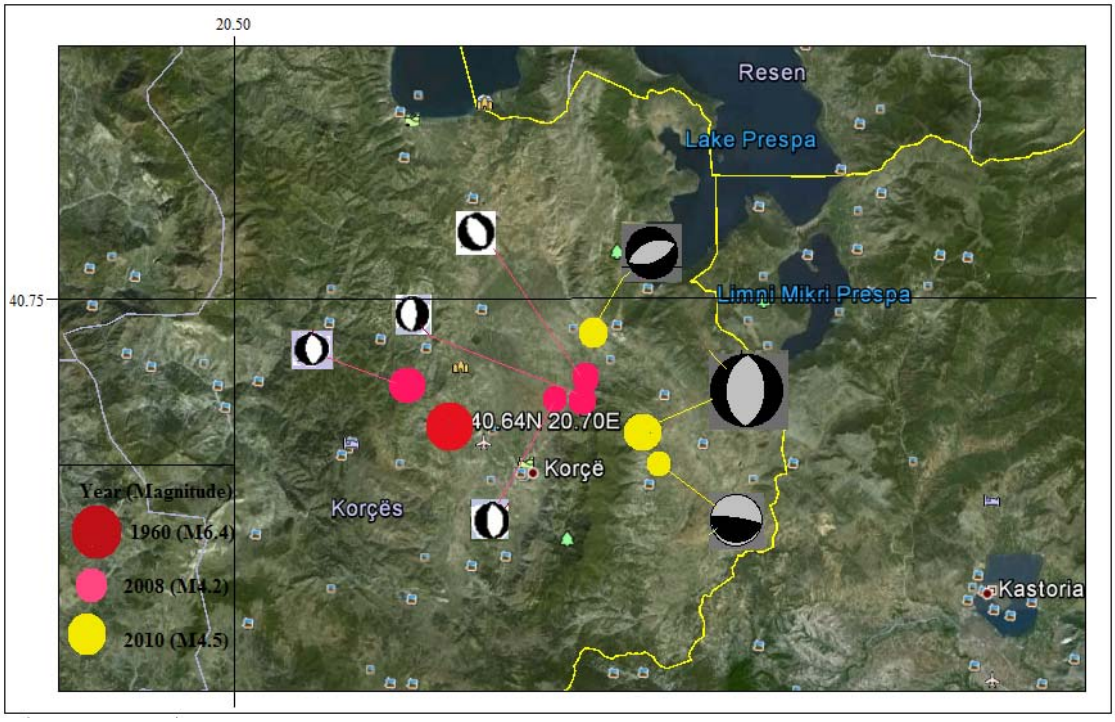


Fig. 4. The map of epicentres of 1960 earthquake (M6.4) and main shock of 2008 (M4.2), 2010 (4.5) their aftershock associate with respective focal mechanisms.

Epicentral zone of September 11, 2010 earthquakes series, extends from the Baban up to Vranisht, Plase, Rrembec, Sovjan, Pirgu, Kakac, Dardhe villages on NNW direction from the main-shock epicenter. The extension of the epicenter of main shock and aftershocks is entirely consistent with the scope of normal displacement system started by the Korca depression countinuing in Erseka-Mokra mountains.From this analysis, the normal faulting mechanisms of the mainshocks are in good accordance with the geologic setting. Based on the spectral values and using the well-known relation Mw = 2/3logMo -6.07, we calculated M_0 = 0.58 x 1016 Nm and M_W = 4.5 for the earthquake of September 11, 2010. The normal faulting mechanism of the mainshock has an active plane striking 182° NNW, an inclination of the hanging wall of 42° and a hanging wall displacement of -90° (downward motion). The first strong aftershock with M=3.1 was 5 minutes after the mainshock and was caused by normal faulting with a strike 278° and a dip of 80°. Focal mechanisms of other aftershock, occurred on September 20, at 08h13m with M=3.4 show normal faulting with a strike 247°.These aftershocks did not occur along the same fault plane as the mainshock. They occurred on faults with different orientations, reflecting the activation of secondary structures in the longitudional Korca-Ohrid fault zone and demonstrating a variety of geologic structures in the area. The most recent Voskop and Baban earthquakes have occurred in the Korca zone, near the border with the Greece, which is strongly affected by tectonic motion. The source parameters of the recently mainshocks and their aftershocks in 2008 and 2010 can be used to shed light on the seismotectonics of the border areas (Albania-Greece and the FYROM) and the current stress field.This analysis of focal mechanisms (Table 1,2) and the focal mechanisms of previous strong earthquakes show that the Korca-Ohrid fault zone plays an important role in the seismotectonics not only to the southeastern Albania but also in Greece and FYROM. The mechanisms show the predominance of normal fault motion with a strike-slip component, and this normal fault motion are compatible with present-day N-S extension. The fact that the focal mechanism of the mainshock shows normal faulting and the mechanisms of aftershocks show also normal faulting and strike-slip motion show that the area is characterized by homogenous stress. This may suggest that during the mainshock, and aftershocks, normal faults were reactivated within the regional (mean) state of stress.

VII. CONCLUSIONS

This study focuses on the seismic activity during 2001-2011 in Korca zone, near its borders with the FYROM and Greece. These earthquakes demonstrates the recent increased seismic activity of the Korca-Ohrid seismic zones. Focal depth analysis reveals that this seismicity was mainly generated in the shallow upper crust, under the tectonic conditions described previously. Analysis of focal mechanisms shows the predominance of normal faulting in southeastern Albania that is compatible with the present-day W- E extenssion. The stress component act toward N-S and in all cases are normal to the geological surface structures or the fault zones. The Korca-Ohrid longitudional fault zone has produced earthquakes in the past, and they are expected to continue to be active in the future. This study emphasizes many geologic and seismotectonic characteristics of the areas constituting a threat for nearby urban areas of Albania, FYROM and Greece.

REFERENCE

Aliaj, S., Adams, J., Halchuk, S., Sulstarova, E., Peci, V., and Muc¸o, B., 2004.*Probabilistic seismic hazard maps for Albania,b13th World Conf. Earthquake Engineering*: Vancouver, BC, Canada, paper no. 2469, 14 pp.

Aliaj, Sh., 2012. *Neotektonika e Shqiperise*: Published Klean, Tirane

Ambraseys, N.N. & Jackson, J.A., 1998. *Faulting associated with historical and recent earthquakes in the Eastern Mediterranean region*: Geophysical Journal International 133, 390–406.

Ambraseys, N.,2009.*Earthquakes in the Mediterranean and Middle East*: Cambridge University Press, New York.

Armijo, D., Meyer, B., Hubert, A. and Barka, A.,1999.*Westward propagation of the North Anatolian fault into the northern Aegean*: Timing and kinematics, Geology, 27, 267–270.

Dumurdzanov, N., Serafimovski, T., and Burchfiel, B. C., 2005.*Cenozoic tectonics of Macedonia and its relation to the South Balkan extensional regime*: Geosphere, 1, 1–22.

Haskov, J & Ottemoller, L.,2008.*Seisan: The erthquake analysis software*: University of Bergen, Norway

Klein, F.W., 2002. *Hypocenter location program Hypoinvers*, USGS.

Louvari, E., Kiratzi, A., Papazachos, B. & Hatzidimitriou, P., 2001. *Fault plane solutions determined by waveform modeling confi rm tectonic collision in eastern Adriatic*: Pure and Applied Geophysics 158, 1613–1638.

Muço, B., 1994. *Focal mechanism solutions for Albanian earthquakes for the years 1964–1988*: Tectonophysics 231, 311–323.

McKenzie., 1972.*Active tectonic of the Mediterranean region, Geophysics*: J.R,Astron, soc v. 30, p 109-135.

Onuzi, K.,Koller, F.,Höck, V.,Palko, A.,Kosho, P.,Ormeni, R., 2010. *Harta gjeologjike e Shqiperise 1:50 000,Plansheti42 Maliq dhe teksti spjegues*: IGJEUM

Onuzi, K., Koller, F., Höck, V., Stoja, Gj., Kosho, P.,Ormeni, R., 2011. *Harta gjeologjike e Shqiperise 1:50 000,Plansheti43 Korca dhe teksti spjegues*: IGJEUM

Onuzi, K., Koller, F.,Hoeck, V.,Puloj, H., Meisel, T., 2006.*Masivet Ofiolitike te Shqiperise Juglindore:*Bul.Shk.Gjeol.1

Ormeni, Rr., 2007. *The general model of construction of the Albanian earth crust and its seismoactive features according to the seismological data*: PhD thesis, Tirana.

Ormeni, Rr., Dushi, E., 2009. *The seismic characteristics of Korca earthquake, 28 August 2008*: "Journal Albanian Oil".

Ormeni, Rr., 2011. *"P- & S-Wave Velocity Model of the crust and uppermost mantle of the Albania region"* ELSEVIER, Journal of Tectonophysic, Vol 497, January 2011, pp 114_121

Ormeni, R., Onuzi, K., 2011.*Karakteristikat e sizmicitetit te planshetit 42-Maliq (3176 III):*(Konferenc Albshkenca)

Sulstarova, E., Kociaj, S., Aliaj, Sh., 1980. "*Seismic Regionalizition of Albania*", Published, Science Academy of Albania, Tiranë.

Wells and Coppersmith., 1994., Wells, D.L. and Coppersmith, K.J., 1994. *New empirical relationships among magnitude, rupture length, rupture width, rupture area and surface displacement*:Bull. Seism. Soc. Am., 84, 974-1002.

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ANALYSIS OF SEISMICITY FEATURES OF ELBASANI-DIBRA SEISMOGENIC ZONE BASED ON RECENTLY OCCURED EARTHQUAKES AND ITS ASSOCIATED HAZARD

Rrapo ORMENI [1], Ibrahim MILUSHI[1]

[1]*Institute of GeoSciences, Energy, Water and Environment , Tirane – Albania*
E-mails: rrapo55@yahoo.com; ibrahimmilushi@yahoo.com

ABSTRACT

Presented in this paper are some results of the seimicity features of the Elbasan-Diber seismogenic zone. The results are based on the seismicity data obtained by the Albanian Seismological Network (ASN) during the period of time 2001-2011. In total, the number of events generated by this seismogenic zone is 461, among them 163 are of magnitude M_L>3, 13 of magnitude M_L>4 and one with M_L>5,0. The focal mechanisms were determined for the earthquake of September 6, 2009 (M_L =5.4) and its aftershocks, the October 24, 2008 Kuturman compound (fourplet) earthquake and Aprile 16, 2007 Bene earthquake. The analysis shows an increase of seismicty of the Elbasan-Dibra seismogenic in this zone and these events are the confirmation. The region affected by the September 2009 sequence and compound earthquake together with the seismogenic region of the 1967 Dibra event, forms a roughly NE−SW trending active seismotectonic zone in eastern Albania that continues in the western FYROM. In this study, a model that clarifies the number of events forecasted and probability of one or more aftershocks by statistical processing of the main shock-aftershock pattern has been defined based on the combination of modified Omori and Gutenberg-Richter models. Elbasani-Dibra seismogenic zone present a threat to nearby urban areas in Albania and the FYROM. Further in this paper presented are some results on the tipology of seismicity, the source parameters of the mainshocks and their aftershocks in order to shed light on the seismotectonics of the area on the stress field and to evaluate the seismic hazard.

KEY WORDS: *seismicity, compound earthquake,Gjorica earthquake, focal mechanism.*

I. INTRODUCTION

The Albanian mountain belt is a segment of the Dinaride-Hellenide orogeny that trends NNW–SSE (Fig. 1). It was formed by Alpine orogenic processes related to the Apulia and Eurasia convergence and the closure of the Mesozoic Tethyan Ocean (Doglioni et al., 2007; Aliaj 2012). Elbasani- Dibra segment with direction SW-NE in Albania, represent an earlier transversal deep fracture, which was hit by the frequent and strong earthquakes, being active now. During the last century, several devastating earthquakes have occurred, causing casualties and substantial damage (Aliaj et al., 2012, Ormeni et al 2009, 2011). The previous strong event in the region was the Dibra earthquake on November 30, 1967 (GMT 07:23:50; Ms6.7; 41.41° N 20.44° E; h=9 km), which caused 19 deaths, 214 injuries and was associated with a N40°E quite 10-km-long discontinuous or eroded surface rupture and a vertical displacement of 50 cm (Sulstarova & Kociaj 1980; Ambraseys & Jackson 1998). The focal mechanism solution of the November 30, 1967 earthquake obtained from waveform modeling (Baker et al. 1997) shows normal faulting along NNE-SSW-trending planes with the T-axis indicating roughly E–W extension. The neotectonic faults in the broader region are high-angle normal faults that have variable trends, N–S or NNE –SSW or NNW–SSE (Kilias et al. 2001, Aliaj 2001), and this is manifested both in the earthquake focal mechanisms and the geomorphology (e.g., Anderson & Jackson 1987; Muço 1994; Louvari et al. 2001 and Ormeni 2009; 2011; Aliaj et al 2012).

II.DATA AND METHOD

The data used in this study were recorded by permanent broadband seismological stations that are part of the ASN as well by neighboring seismic networks NOA, MSO, INGV and MEDNET. The

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earthquakes were located using data from three or more seismic stations. The epicenters were located using P and S onsets, the local velocity model of Ormeni, 2011 and the Hypoinverse program (Klein, F.W., 2002). A complete and homogenous catalog of the earthquakes is provided. The focal mechanism solutions for the main-shocks and selected aftershocks are based on the classical method of first-onset polarities, using the Focmec routine in the Seisan package (Haskov and Ottemoler, 2008). The number of events forecasted and probability of one or more aftershocks has been defined based on the combination of modified Omori and Gutenberg-Richter models.

III. GEOLOGICAL SETTING

The Elbasani-Dibra transversal fault zone of ENE extension, which dislocates the Albanides along all their width is marked out by diapiric cupola of Dumrea, the Quaternary Depression of Elbasan, the belt of trasversal structure of Labinot which continue with the trasversal flysch elevation of Golloborda. From the geological and tectonics-neotectonics phenomena point of view, the region where the studied zone is included takes part in Krasta sub-tectonic zone, which is included in external area of Alpine folding. It is strongly affected by pre-Pliocene tectonics movement. The Krasta sub-tectonic zone has been deformed by folds, normal faults, as well as by strike slips from the main Alpine movement phases which folded the above mentioned tectonic zone (Aliaj et al 2001). Generally, the structures of Krasta sub-tectonic zone extend from North to South (fig.1). The Elbasani-Dibra fault zone (ED), which represent a deep fault that has played an important role in development and structuring of inner Albanides in both sites of it. This transversal fault zone extends from Albania toward the FYROM to the NE. To this zone are related many geological phenomena: Evaporate diapirs of Dumrea and Peshkopi, tectonic window of Okshtumi; the tectonic displacement of Shpati ultrabasic massifs and Quaternary formations (Milushi. I., et.al. 2007); the presence of many buried anticlines under molasse formations; the new tectonic movements evidenced from the fresh normal tectonics and the forming of the erosion valleys; the presence of many hydrocarbon deposits and oil earmarks on surface; the source of the thermal waters; presence of the some hydrothermal mineralization and lastly, the frequent and strong earthquakes, being active now.

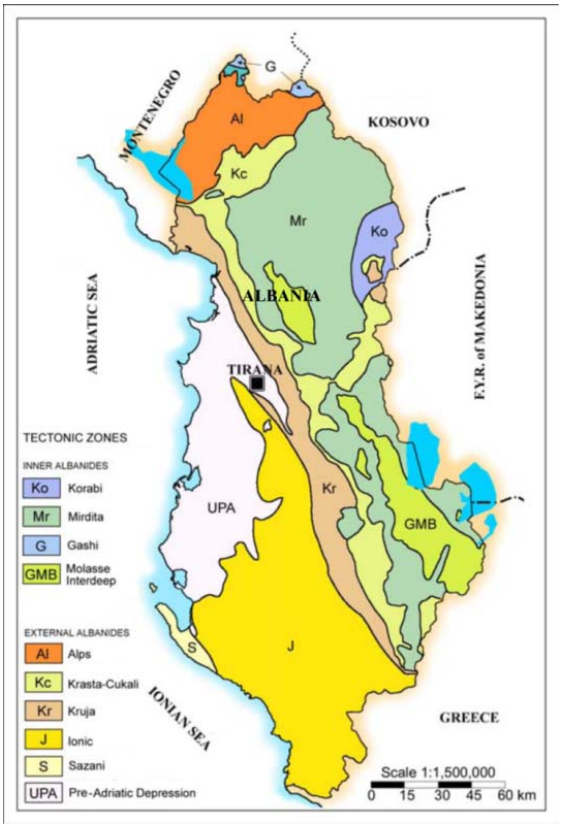


Fig. 1. Schematic tectonic map of Albania

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IV. RECENT SEISMICITY

On the Elbasan-Diber seismogenic zone, 461 earthquakes with M_L>1.5 were located, 163 of which of magnitude M_L>3 , 13 of magnitude M_L>4 and the strongest event with magnitude M=5.4 (fig 2). Focal depth analysis reveals that this seismicity was mainly generated in the upper and middle crust (Ormeni 2007), under the tectonic conditions described previously. Larger number of seismic events are present during 2008-2011 years . The strongest event occurred on 6 september 2009 (M5.4) and three others occurred on Aprile 16, 2007 (M4.5), 24 October 2008 (M4.5) and 9 July 2010 (M=4.6). These earthquakes highlight the increased seismic activity of the Elbasani-Dibra seismogenic zone.

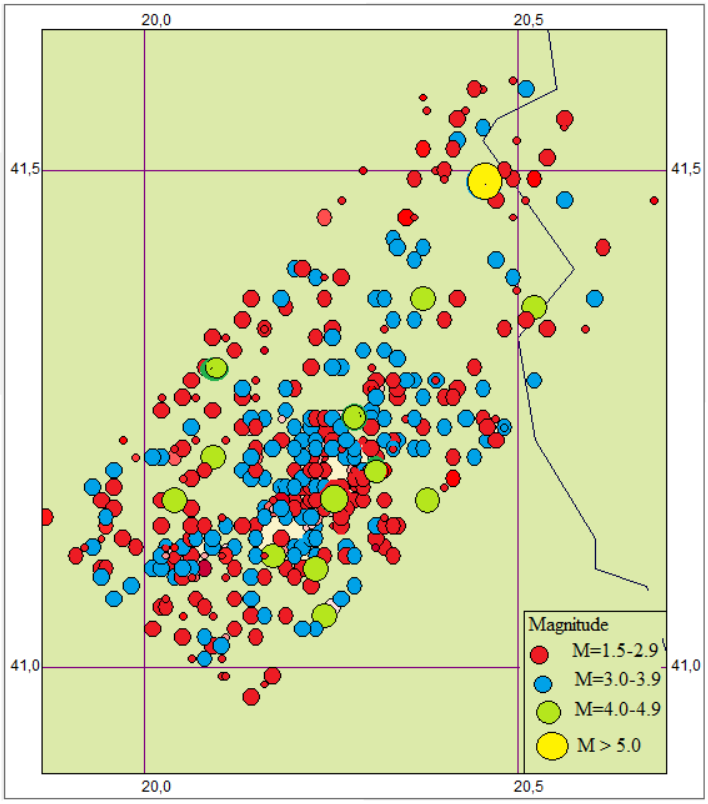


Fig 2. The map of earthquake epicenters occurred in Elbasan-Dibra zone during period 2001-2011

The moderate earthquake of Aprile 16, 2007 at 07:38 local time, M4.5, 19km depth, occurred in the Bene village. In this serie, about 34 aftershocks with magnitude M_L=2.0-3.4 were located.
The October 24, 2008 compound (fourplet) earthquakes occurred near Kuturman village with maximum magnitude M_L=4.5 (Mw=4.9 INGV, ETHZ), 19km depth. The located number of aftershocks in this serie was 52, with magnitude ranging from M_L=2.0-3.4. The September 6, 2009 earthquake occurred inland near Gjorica village with epicenter coordinates 41.490°N and 20.450°E, and it caused heavy damage in the villages of Gjorica, Qerenec and Shupenza in the Dibra district. Its hypocenter depth was 7.6 km, explaining the concentration of the destruction to the epicentral zone. In the series were located 250 aftershocks with magnitude M_L=1.5-4.3 depths ranging from 1-25 km. Figure 3 shows the "*b*" estimate for the eleven years 2001 – 2011 (about 361 events). For the period 2002-2006 the *b* value is lower than 0.7 decreasing for each year because there were not moderate events. After the 2007 there were a few moderate events with the strongest one (M5.4) in 2009. The parameter *b* is believed to depend on the stress regime and tectonic character of the region. Changes in *b*-value are believed to be inversely related to changes in the stress level (Bayrak et al., 2002). The smaller *b*-value means that the stress was high in the Elbasani-Dibra region. The major shock Gjorica earthquake (M5.4) was preceded by an increase in *b*, followed by a decrease in months before this earthquake. After 2009 the *b* coefficent has value bigger than 0.7 correlated with decreasing stress level.

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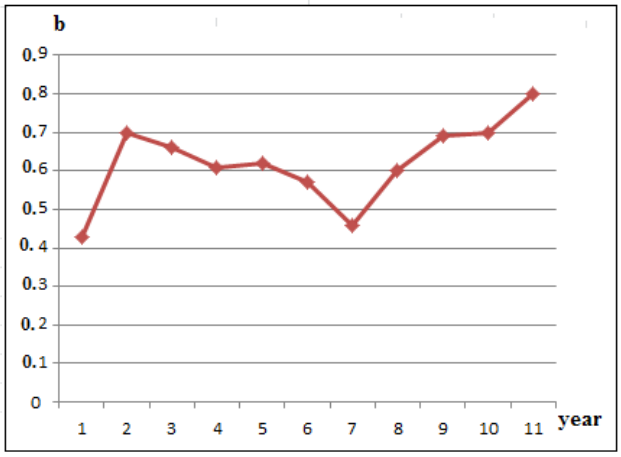


Fig 3.Temporarly distribution 'b' value for each year during this century for events with M_L>2.0

V. CHARACTERISTICS OF COMPOUND EARTHQUAKES

Occasionally, two or more events, often of similar size occur on nearby but different rupture surfaces close together in time, but with a delay such that their rupture times do not overlap. We call this clases of earthquakes compound earthquakes. They are of considerable interest because they imply rupture processes other than those predicted by elastic fracture mechanics. Perhaps the most common type of compound earthquake is when the rupture surfaces of two events are contiguous. Several events in the sequence need not have the same mechanism. Events in the series of sequences of Kuturman have not the same mechanism. The first ruptures in 24 October 2008 of Kuturman earthquake in Albania, for example, were thrust and oblique-faulting events but they were followed closely from dominant rupture by normal-faulting and the fourth rupture by normal-faulting earthquake. These earthquakes have occurred in a four-hour period successively migrated fron W to E. Compound earthquakes sometimes progress in a single direction, thereby define an earthquake migration. The earthquake of Kuturman progressed from Weast to East. These compound earthquakes cannot be explained with linear elastic fracture mechanics because the time delays between the individual events are to long to result from elastic processes. Because an earthquake dynamically loads the surrounding region, compound earthquakes can result from viscoelastic relaxation in the immediate postseismic period, resulting in a redistribution of loads.

VI. SEISMOTECTONIC INTERPRETATIONS FROM SOURCE PARAMETERS OF EARTHQUAKE SEQUENCES.

We determined the focal mechanisms of the September 6, 2009 mainshock and six aftershocks M_L>3.9 as well the focal mechanisms of compound (fourplet) earthquakes using first-onset polarities. The focal mechanism solution of the September 6, 2009 mainshock has an active plane striking (strike) 219.5° NE, an inclination of the hanging wall (dip) of 40° and a hanging wall displacement (rake) of -90° (downward motion), in good acordance with field observations. Based on the focal mechanisms, we find that the September 6, 2009 earthquake was caused by purely normal faulting in a NW-SE extensional stress direction. The first strong aftershock was 35 minutes after the mainshock and was caused by pure normal faulting with a dip of 30°. This aftershock has the same focal mechanism as the mainshock, i.e., it has the same radiation pattern. This shows that this aftershock occurred along the same fault as the mainshock. Focal mechanisms of two other aftershocks, on September 6, at 22h36m and September 7, at 15h20m, show normal faulting with a strike-slip component. The aftershocks on September 7, at 12h21m and September 12, at 18h06m and 18h42m show an oblique strike-slip motion. These focal mechanisms (fig 4, right) show the predominance of normal fault motion with a strike-slip component, and this normal fault motion is compatible with present-day NW-SE extension. Some aftershocks did not occur along the same fault plane as the mainshock; they occurred on faults with different orientations, reflecting the activation of secondary

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structures in the Elbasan-Dibra transverse fault zone and demonstrating a variety of geologic structures in the area with heterogenous stress state and the stress axes may often undergo rotations.

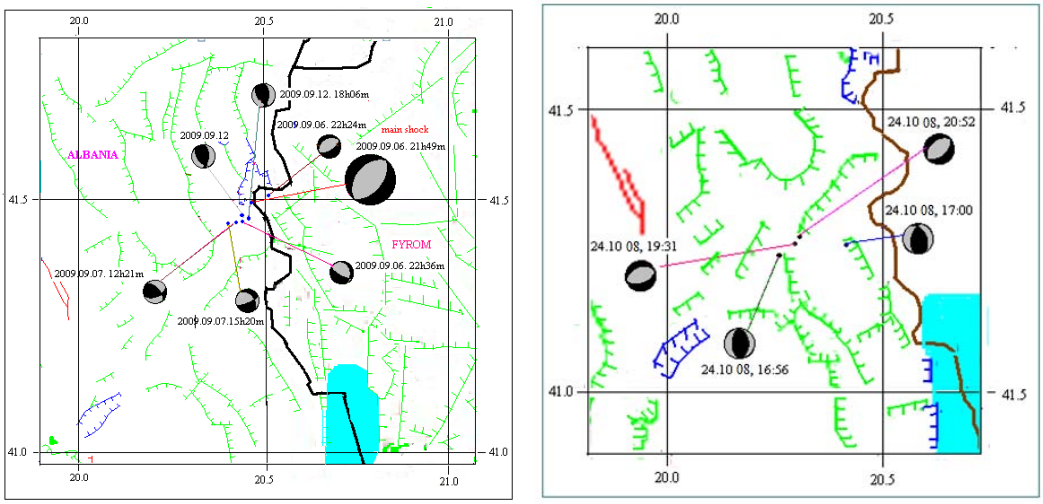


Fig 4. Seismotectonic map of Elbasani-Dibra and the focal mechanism of the September 6, 2009 mainshock and its aftershocks (right) and focal mechanisms of compound earthquakes October 24, 2008 (left)

This may suggest that during the mainshock, normal faults were reactivated within the regional (mean) state of stress, whereas the aftershocks with a strike-slip component correspond to the re-adjustment of displaced blocks within the local stress state.This transverse fault zone is clearly outlined by the locations of aftershocks along this fault and their focal mechanisms (Ormeni 2009). In addition to the study of instrumental seismological data, a field investigation and collection and analysis of macro-seismic data was performed, allowing a full and comprehensive study of the triggering mechanism of the Gjorica earthquake. The field investigation in the epicentral zone revealed several coseismic fractures on the surface. They extend NE-SW and dip to the southeast at 40-50°. These information, in addition to the focal mechanism solution of this earthquake, shows an agreement with the general plane of the Elbasani-Dibra-Tetova transverse fault zone.The focal mechanisms solutions for compound (fourplet) earthquake are: for the first shock, Strike=180°, Dip=50° and Rake (Slip) =90° that was triggered from a pure thrust fault with an W-E stress direction (fig. 4, left). The fault plane, has a dip 50° and and is associated with the activation of the Elbasani-Dibra deep fault zone. The focal mechanism solutions of this earthquake demonstrate an ongoing horizontal extension (thrust faulting) along the fault in the direction of N-S. The solutions for the second shock are: Strike=190.2°, Dip=52.8° and Rake (Slip) =-64°. From the focal mechanism solution results that the earthquake of time 17h00m was triggered from a oblique thrust fault with an N-S stress direction. The third shock 19h31mis the strongest and the fourth time 20h52m have solution respectively: Strike = 249º, Dip = 40°, Rake (Slip) = -90^0 and Strike = 229.3º, Dip = 40° and Rake (Slip) = -90^0. (fig.4, left). From the focal mechanism solution results that the third and fourth earthquakes were triggered from a normal active fault with an NW-SE extensional stress direction

VII. RESULTS OF THE PROBABILITY EVALUATION OF AFTERSHOCKS

An evaluation of the aftershock probability for Gjorica earthquake 2009, Kuturman 2008 and Bene 2007 earthquakes with magnitude level M_L between 3-4.3 is made. All calculations are considered for the starting and ending time intervals of each aftershock sequence. Also, very important parameters in the evaluation of aftershock probability *b*, *K*, *p*, and *c*-values calculated. For the aftershock sequence, the magnitude of randomly chosen events is taken as M_L=3.5-4.0 and the aftershock probability in this magnitude level is shown on figure 5. The expected number of aftershocks with M_L=2.5 is also given on figure 6. The probability of the largest aftershock occurrence for magnitude level of 4.0 is

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calculated as 62.0 % for September 2009 earthquake. The maximum expected numbers of aftershocks for magnitude level of 2.5 was computed 24 (Ormeni et al., 2011).

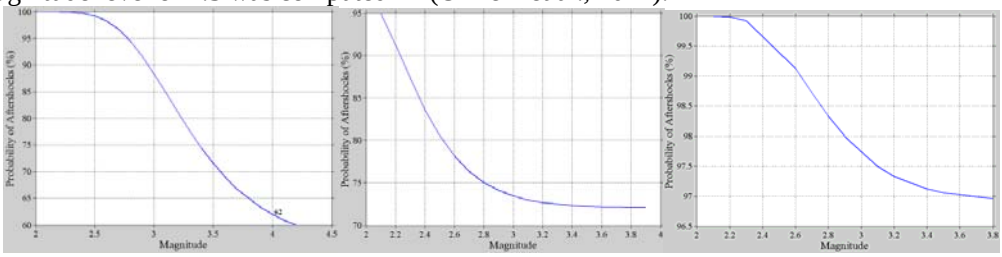


Fig.5. Aftershock occurrence probability for one or more aftershocks (right earthquake of Gjorica 2009, middle earthquake of Kuturman 2008, left earthquake of Bene 2007)

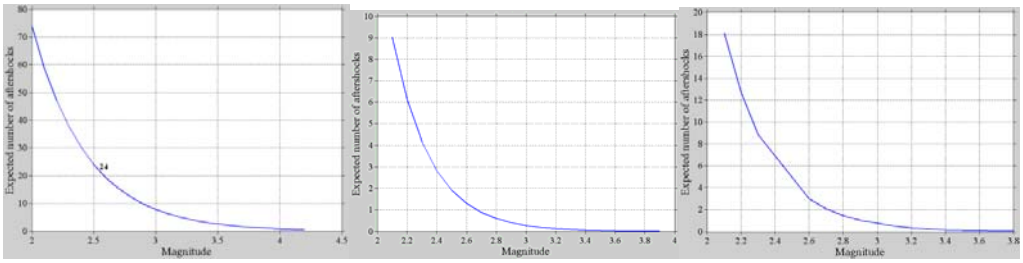


Fig. 6. The number of events forecasted for one or more aftershocks (right earthquake of Gjorica 2009, middle earthquake of Kuturman 2008, left earthquake of Bene 2007)

The probability of the largest aftershock occurrence for magnitude level of 3.5 is calculated as 73.0 % for Kuturman earthquake of October 24, 2008. The maximum expected numbers of aftershocks for magnitude level of 2.5 was computed 19. The probability of the largest aftershock occurrence for magnitude level of 3.5 is calculated as 97.3% for Bene village (Elbasan) earthquakes of April 16, 2007. The maximum expected numbers of aftershocks for magnitude level of 2.5 was computed 50. Also, the number of aftershocks (N), completeness magnitude (Mc), starting ($T1$) and ending ($T2$) times for the sequence, b, K, p, and c-values for aftershock sequences are calculated.

VIII. ELBASANI-DIBRA ZONE AND ITS ASSOCIATE SEISMIC HAZARD

The associated seismic hazard has a direct connection with the geology of the location. Within the epicentral zone, strong rocks such as limestones and ultrabassic deposits result in a lower seismic hazard than in areas with weaker rocks such as flysch and molasse. Significant damages were observed along the contact between the limestone and ultrabassic formations and the areas containing flysch and molasse as well. Geologically, the Cereneci-Gjorica area contains Paleocene-Eocene-Maastrichtian flysch formations. The flysch formation form a folded anticline that is composed of intercalations of thin clay-siltstone-sandstone layers. Generally, the flysch formations are covered by Quaternary silts, silty clay depositions and mixtures of gravels and sands. The September 6, 2009 earthquake caused more damage in the flysch/molasses area of the villages of Gjorica and Qerenec and the Shupenza municipality in the Dibra district. Earthquakes along these fractures revealed associated surface features. It is important to note that the activated regions of the 1967 sequences indicate that this roughly NE–SW-trending structure is an active seismotectonic zone in north-eastern Albania, following the geomorphology. The fact that the epicentre of the 2009 event is close to the previous November 30, 1967 Mw6.7 earthquake probably reflects the genetic relation of these two events through the ideas of static stress changes, whic is not tested in this work (fig. 7).

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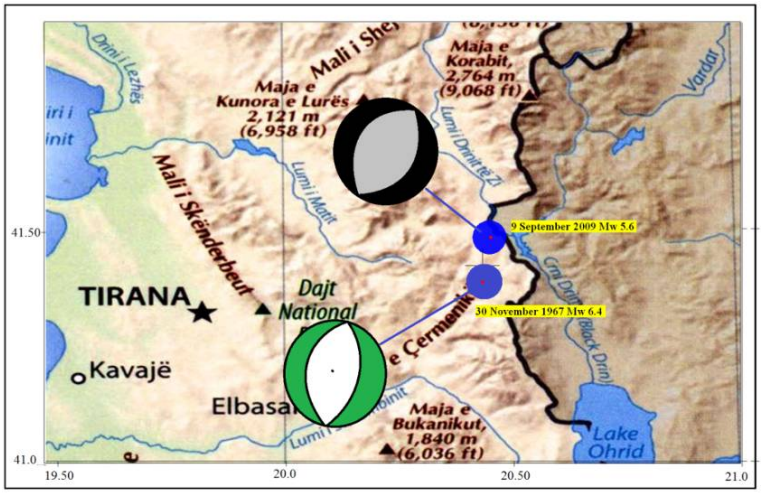


Fig 7. Focal mechanisms of the earthquake of the September9, 2009 Mw5.6 together with the focal mechanism of the previous November 30, 1967 Mw6.4 event (beach-ball colouring as in Figure).

While the seismic hazard resulting from a normal fault earthquake is well recognized and discussed, little attention has been given to quantifying the subsequent aftershock activity and its potential impact on communities in the region. It is therefore of great importance to properly evaluate the seismic hazard of the region, and in this study, the aftershock probability was analyzed to determine the seismic hazard. The aftershock probability evaluation method is an effective way to analyze the aftershock activity of the mainshock-aftershock sequence. An aftershock probability evaluation as it is used here refers to statistically expressing and evaluating the frequency and occurrence probability that an aftershock of a certain magnitude will occur. In this study, a model that clarifies the number of events forecasted and probability of one or more aftershocks by statistical processing of the main shock-aftershock pattern has been defined based on the combination of modified Omori and Gutenberg-Richter models. In many cases, some of these aftershocks can exceed M5.0 and, depending on proximity to communities, these aftershocks can be more damaging than the main event. Earthquakes are invariably complex in their rupture characteristics because of the geometrical regularity of faults and heterogeneity in the various parameters in the rupture resistence.Four compound earthquake (fourplet) of similar size occur on nearby but different rupture surfaces close together in time, but with a delay such that their rupture times do not overlap. Seismic hazard for series of compound earthquakes in this case is very high and direct connection with the geology of the location. Results of seismicity presented in this paper are intended to enable community officials and the general public to better understand the Elbasan-Dibra zone earthquakes threat and to encourage a more comprehensive discussion of the next great Elbasan-Dibra normal-fault event.

IX. CONCLUSIONS

This study focuses on the recent features of seismicity of Elbasan-Dibra most seismogenic zone in Albania. The October 24, earthquake sequence is a typical example of a compound earthquake, involving, two or more events, often of similar size, that occur on nearby but different rupture surfaces close together in time, but with a delay such that their rupture times do not overlap. Based on analysis of the focal mechanisms of moderate earthquake of Gjorica and on the focal mechanisms of compound earthquakes of Kuturman and in previous strong earthquakes, the Elbasani-Dibra-Tetova transverse fault zone plays an important role in the seismotectonics of Albania, as well as the FYROM. Focal depth analysis reveals that this seismicity was mainly generated in the upper and middle crust, under the tectonic conditions described previously. Analysis of focal mechanisms shows the predominance normal faulting with a strike-slip component, and NNW-SSE extension in eastern Albania as a response to the convergence between Adriatic microplate and Albanian orogen. The Elbasan-Dibra Fault zone has produced earthquakes in the past, and is expected to continue to be active in the future. This study of recent seismicity emphasizes many geologic and seismotectonic

characteristics of the areas constituting a threat for nearby urban areas of Albania and the FYROM. The Elbasan-Dibra transversal fault zone zone presents a significant seismic hazard to those living in eastern Albania, western Macedonia, and northeastern Kosovo; not only due to the Elbasan-Dibra normal-fault earthquake and compound earthquakes, but also due to the hundreds of earthquakes certain to follow the mainshock.

REFERENCE

Aliaj Sh., Sulstarova E., Muço B., Koçiu S., 2001. *Seismotectonic map of Albania, schale 1:500.000*: Seismological Institute Tirane

Aliaj Sh., 2012. *Neotektonika e Shqiperise:* Published Botimet Klean, Tirane

Ambraseys, N.N. & Jackson, J.A.., 1998. *Faulting associated with historical and recent earthquakes in the Eastern Mediterranean region*: Geophysical Journal International 133, 390–406.

Anderson, H. & Jackson, J.A., 1987. *Active tectonics of the Adriatic region*: Geophysical Journal of the Royal Astronomical Society 91, 937–983.

Baker, C., Hatzfeld, D., Lyon-Caen H., Papadimitriou E. & Rigo A., 1997. *Earthquake mechanisms of the Adriatic Sea and western Greece:* Geophysical Journal International 131, 559–594.

Bayrak, Y., Yilmazturk, A. and Ozturk, S., 2002. *Lateral variations of the modal (a/b) values for the different regions of the world*: J. Geodyn., 34, 653-666.

Doglion,i C., Carminati E., Cuffaro M. & Scrocca D., 2007. *Subduction kinematics and dynamic Constraints:* Earth Science Reviews 83, 125–175, doi: 10. 1016/j. earscirev. 2007. 04. 001.

Gutenberg, R., Richter, C.F.,1944. *Frequency of earthquakes in California*: Bull. Seism. Soc. Am., 34

Haskov, J. & Ottemoller, L.,2008. *Seisan: The erthquake analysis software*: University Berg, Norway

Klein, F.W. 2002. *Hypocenter location program Hypoinvers*: USGS.

Louvari, E., Kiratzi, A., Papazachos, B. & Hatzidimitriou, P., 2001. *Fault plane solutions determined by waveform modeling confirm tectonic collision in eastern Adriatic*: Pure and Applied Geophysics 158, 1613–1638.

Milushi, I., (drejtues projekti), Onuzi, K., (drejtues projekti), Kodra, A., Gjata, K., Xhomo, A., Gjata, K., Mekshiqi, N., Deda, T., Hoxhaj, J., Hoxha, V., Naço, P. etj., 2007. *"Gjeologjia dhe Metalogjenia e Shqiperisë"*- Një shkurtimore reklamuese dhe prezentuese (Monografi). Arkivi Qendror i Gjeologjise, Tirane

Muço, B., 1994. *Focal mechanism solutions for Albanian earthquakes for the years 1964–1988:* Tectonophysics 231, 311–323.

Ormeni, Rr., 2007. *The general model of construction of the Albanian earth crust and its seismoactive features according to the seismological data.* PhD thesis, Tirana.

Ormeni, Rr., Dush,i E., Koci, R., 2009. *The Gjorica earthquake september 6, 2009 Albania (M5.4)* Newesletter EMSC, Monteller Franc,. December.

Ormeni, Rrapo., Serkan, Öztürk., Shkodrani, Neritan., Daja, Shkelqim., 2011. *"An applıcatıon of the aftershock probabılıty evaluatıon methods for recent albanıa earthquakes based on gutenberg-rıchter and modıfıed omorı models"*: International Balkans Conferance on Challenges of Civil Engineering, BCCCE, May 2011, EPOKA University, Tirana, Albania

Ormeni, Rr., 2011. *"P- & S-Wave Velocity Model of the crust and uppermost mantle of the Albania region"* : ELSEVIER, Journal of Tectonophysic, Vol 497, January 2011, pp 114_121

Sulstarova, E., Kocia,j S., Alia,j Sh., 1980. *"Seismic Regionalizition of Albania*", Published, Science Academy of Albania, Tiranë

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POSSIBLE GEOLOGICAL TARGETS FOR UNDERGROUND STORAGE OF NATURAL GAS IN ALBANIA

Engjell PRENJASI[1], Luan ARAPI[1], Ana QORRI[1], Erald SILO[1]

[1]Polytechnic University of Tirana, Faculty of Geology and Mining, Rruga e Elbasanit, Tirana, Albania.
E-mail: engjell.prenjasi@fgjm.edu.alluan.arapi@fgjm.edu.al ana.qorri@fgjm.edu.al erald_silo@yahoo.com

ABSTRACT

Actually the production of natural gas in Albania is at minimal output and does not provide meeting the immediate and perspective requests of domestic consumers. Also the natural gas contribution to domestic energy balance is at very low level. Consequently, connection of Albania with European gas distribution network, as well as design and erection of the underground storages to meet gas consumers growing requests are very necessary.

Performed studies have resulted in finding out that the needs of Albania for gas may be about 1.2 x 10^9 Nm^3/year. Also there are evidenced the annual requests for natural gas of Montenegro, Kosovo and FYROM. Meeting the needs of Albania consumers for gas, during the winter time is necessary to take a gas amount of about 2 million Nm^3/ day from the underground gas storage. Considering that the winter time in Albania is about 4 months, the capacity of gas storage must be designed of a volume of 150 million Nm^3 of circulating gas. Additionally, taking into consideration the needs for natural gas of Montenegro, Kosovo, FYROM, etc, the underground gas storage must be designed of a volume of about 350 million Nm^3.

Considering the geological setting of Albanides and alternative routes of Trans Adriatic Pipeline (TAP) there are evidenced some potential geological targets for Underground Gas Storage and pointed out the Triassic evaporate deposits of the Dumre diapir as the best option.

KEY WORDS *Geological targets, Natural gas, Trans Adriatic Pipeline (TAP)*

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EVAPORITE FORMATION IN ALBANIA - COMPOSITION, CONDITIONS OF FORMATION AND IMPORTANCE OF EXPLORATION OF ITS RELATED MINERALS

Vesel HOXHA[1], Fotaq DIAMANTI[2], Ibrahim MILUSHI[1],
Eleni GJANI[2], Nezir MEKSHIQI[1]

[1]*Institute of Geosciences, Energy, Water and Enviromment, PUT, "Don Bosko" Street, No. 60, Tirana–Albania*

[2]*Faclty of Geolgy and Mine, PUT, Elbasani Street, Tirana - Albania.*

E-mails: veselhoxha52@yahoo.com, fotaqdiamanti@yahoo.com, ibrahimmilushi@yahoo.com, elenigjani@yahoo.com, nezirmekshiqi@yahoo.com

ABSTRACT

Investigation of evaporate in a sedimentation site basing on the relationship between hydrocarbon and evaporites is of great interest. In this case, role of evaporites does not concern only their insulation abilities of the hydrocarbon collections due to the perfect compactness that they have in depth, but also the formation of traps and in necrosis (erosion) of reservoir rocks. Various mineral salts of Na, K, sulfide minerals, etc., are related to the evaporites. The paper presents data on on the composition, formation conditions and the importance of the explorationof evaporate formation of Albania. In the article are the main results of the present studies on the evaporite of Albania, to provide help to the domestic and foreign researchers and investors involved in the search for hydrocarbon and other useful minerals associated with evaporate formation in the country.

KEYWORDS Evaporite, diapir, paleontology, mineralizations, tektonics, salts.

1. INTRODUCTION

The present investigation was based on: i)geological observations carried out in areas of Peshkopi Elbasan, Gjirokastra, Delvinë, Durres Kavajë, Vlorë and Sarandë; geological observations of drilling core of the wells drilled in areas of the evaporite spreading as Dumre, Picar-Kardhiq, Delvine Xare-Mursi etc., ii) chemical, spectral, mineralogical and petrographic analysis; analysis and interpretation of drilling graph diagrams for composition and correlation of the evaporite setions, iii) age determinations of evaporite and surrounding rocks through spore-pollen analysis (carried out at the Institute of Oil and Gas in Fier, University of Padova in Italy and in China and Romania as well), iv) biostratigraphic studies and absolute age determination by isotopic method of strontium (at Oolithica Geoscience Ltd. , Aberdeen-UK), v) field observations and sampling, in the detrmined network, for determining the density of surface samples in regions of evaporite outcrops in Peshkopi, Picar-Kardhiq, Dumre, Delvinë and Xare-Mursi, and the samples of drilling core, vi) in complex interpretation of the geological-geophysical data of the surface, sizmo-gravimetry and deep drilling results of evaporite outcropin areas, vii) conception of formation mechanism of evaporite in Albania, and faulting – related evaporate and its influence on tectonics of Albanides; viii) previous studies, monographs, PHD thesis, papers and other scientific Albanian and foreign papers related to evaporites of Albania, ix) studies of a large contemporaneous literature provided in different ways by the authors of this paper, and by state-owned and private specialized organizations.

2. GEOLOGICAL SETTING OF THE AREA

2. 1 Spatial position of albanian evaporate formation and its relationship with surrounding rocks

Spatial position of evaporate formation of Albania, its relationship with surrounding formations, both in the surface and in depth were determined according to the geological, paleontological, seismological and

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gravimetric data and the results of deep drilling boreholes carried out in Albania and in its neighboring countries such as Greece, Italy and Montenegro.

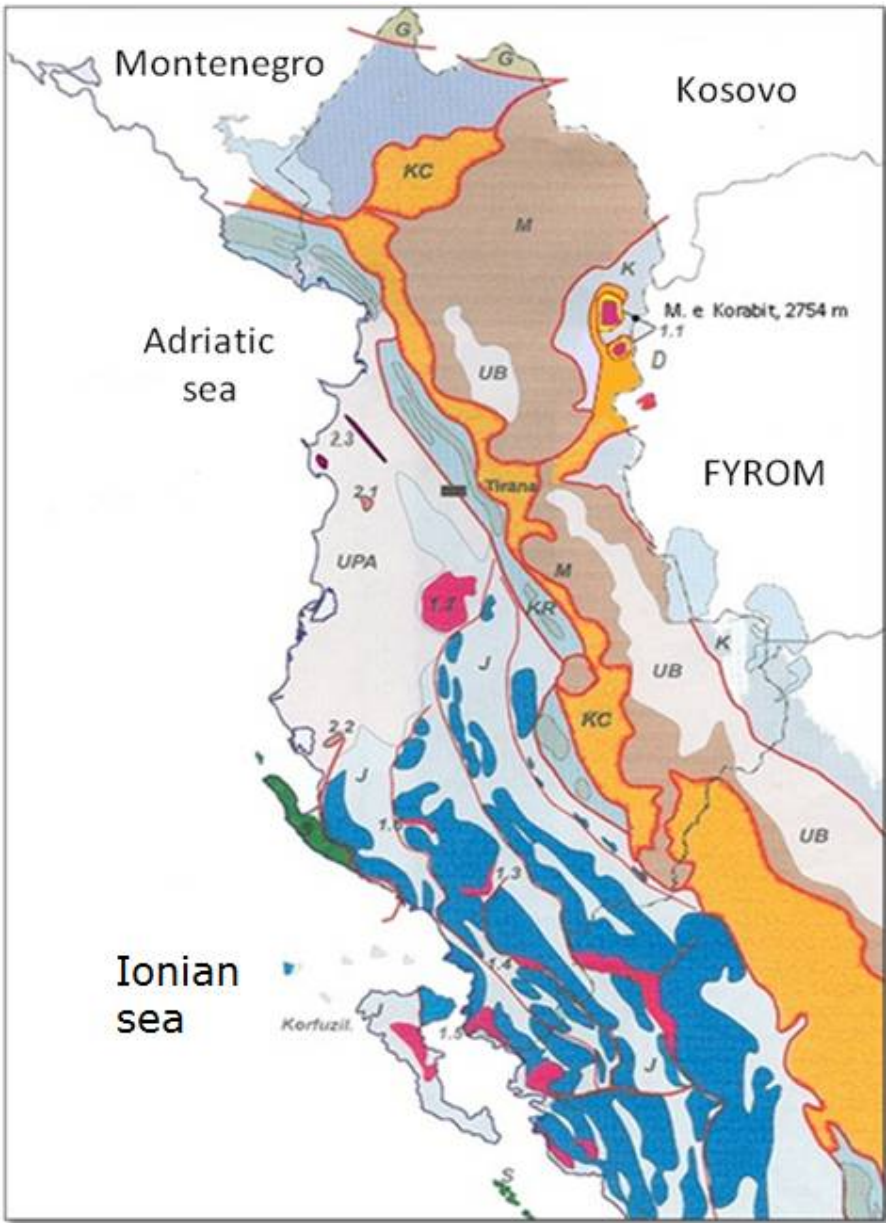


Fig. 1. Geological location of the evaporite massifs in Albania (*(According to Diamanti F., et. Al. 1999, modified)*

Tectonic unuits:S -Sazani; **J**-Ionian; **KR** –Kruja; **K** –Krasta Cukali; **M** –Mirdita; **K** –Korabi; **A** –Albanian Alps; **G** –Gashi; **D** –Dibra; **UPA** –Near Adriatic Lowland; **UB** –Internal depressions (Korça, Pogradeci, Librazhdi, Burreli; etjc); Evaporite masifs: **1 –**Permian – Triassic masifs (1.1- Peshkopia; 1.2 -Dumre; 1.3-Picar Kardhiq; 1.4 -Delvina; 1.5–Xara; 1.6–Bashaj); **2** –Miocenic outcrops: (2.1 -Kavaje (Mengaj, Zbuj, Tilaj, Xikulare etc.); 2.2 –Vlore (Guri i Çifutit, Panaja, Hoshtime, Kus Baba etc.); 2.3 -Durresi (Currila, Manze, Rade, Rubjeke etc.)

In the paper are included the results of the deep borehole drilling of Dumre -7 (Fig. 2), which is the only one in Albania that have intersected the all thickness of the evaporite formation and at depth 6109 m passed to the flysch formation of the lower Oligocene. In addition, other drillings as Dumreja-3, Grekan-4, Vlashuk-1, Paper-1, Picar-10 / s, Xara-1 / s, Butrinti-1 / s, Delvina -4, 9, 12 etc., are also included**.** In this context, the prognose of evaporate in depth, in areas with no access to the surface and their mapping is based on information of drill holes and on the seismic studies. Evaporate formation occupies

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geotectonically a certain position. It generally outcrops at the cross-cutting of transversal and longitudinal fault zones during rifting stages and during collision and post collision stages.

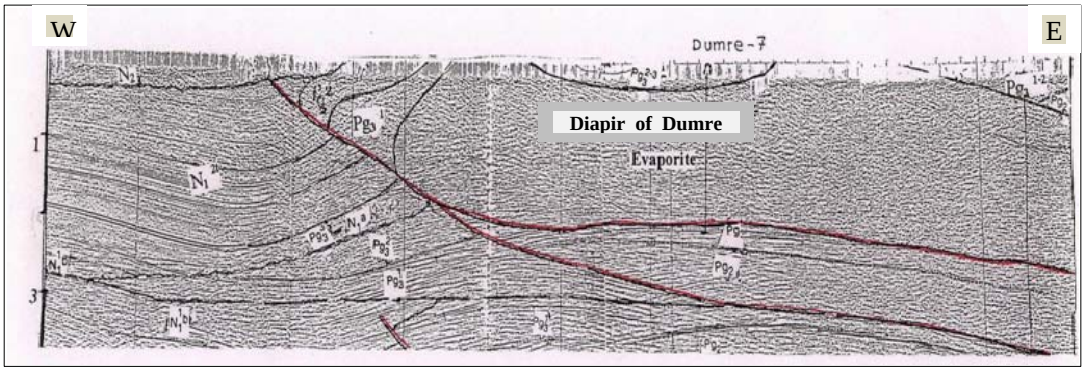


Fig. 2: Seismic section of Dumre diapir, Belsh – Elbasan area (Diamanti, et. al. 1999).

In the sedimentologidal point of view the main formation environment might had been the intertidal one, as a characteristic feature of the continental platform, which during the Triassic covered the largest Mediterranean area. This space has defined the lagoon sedimentary environments of oversaturated salt character. Basing on morphology and age, evaporate formation in Albania could be encountered in two different groups (Fig. 1): i) diapiric evaporate formation of Triassic age, which is characteristic for the Ionian tectonic zone and Dibra unit, has a controversial tectonic affiliation and, ii) evaporite layered formation of Miocenic age (Messinian) is characteristic of Pre-Adriatic depression.
Evaporite layered formation of Miocenic age (Messinian) is represented in Albania by large size diapirs of Peshkopi, Dumre, Picar-Kardhiq, Delvine-Bistrica, Xare-Mursi and some other evaporite massifs of the smaller size as: Gypsum of Kelles at Stanet e Preshit, Glina, Bashaj-Kaparjel-Vermik, Palase, Vuno, Fterre etc.
In Albania, evaporite layer formation of Miocenic age (Messinian) is represented by outcrops of Kavaja (Muharremaj, Seferaj, Tilaj, Xikulare, Zbuj,Mengaj, Cikallesh etc.); Durrësi (Currila, Manz, Rade, Rubjeke etc.) and Vlora area (Hoshtime, Panaja Jew Stone Neck Koçiu Kus Baba etc.), (Fig. 1).

Evaporite Diapir of Peshkopia comprises three separate massifs or three large size tectonic windows (Fig. 1), two out of three could be met in the Peshkopia region, in Albania respectively tectonic window of Mali i Bardhe and Llixhat e Peshkopise (Fig. 3) and one out of three in the territory of FYROM, named the river of Radika.
Recent studies, especially those after 1990, based on the numerous facts the overthrusting character of the Korabi area report that the setions of the Palaeozoic and Triassic depositions comprise all the components and evaporite may not be as their members. Even in neighboring countries, in internal units analogue to Korabi zone are not recognized conditions for evaporite formation. Another interesting fact about for the support the allochtonous charachter of Korab zone is the presence of formations of the external units below it and the interpretations done by Gjata *et. al.*, (1987) for planctonic foraminifera of Miocene encountered in the argillaceous at the contact of gypsum with ultrabasic rocks near Pelpanikut (Bicaje) and planctonic foraminifera of Middle Miocene encountered in the ultrabasic rocks which intersect Triassic deposits of the Stanet e Preshit. Based on the overmentioned facts and in other facts we conclude that: the two major evaporate massifs of Peshkopia area represent tectonic windows.

Tectonic window of Llixhat e Peshkopise (Thermal spring of Peshkopia)

In the torrent of Llixha e Peshkopisë (Thermal spring of Peshkopia), in a form of tectonic window with size 9 x 6 km is exposed Paleogene flysch intersected by evaporite diapir (Fig. 3). Flysch of Llixhat e Peshkopisë (Thermal spring of Peshkopia) represents a "wild" metamorphosed flysch, dominated by the lenses of limestone with numulite. We point out that numulite defined here determine the middle Eocene age, but there are also other data, based on evidence obtained in the vicinity of the village of Slatina, near the contact with the northern evaporite of Mali i Bardhe the numulite are considered as re-deposited fossils (Çollaku Cadet, 1990), raising age limits in the upper Eocene - Lower Miocene.

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Tctonic window of Mali i Bardhe

Evaporate which intersect the Paleogene flysch (Fig. 5/1) form a brahianticline structure up to a dome shape with size 11 x 6 km, which outcrops in the form of a window under allochtonous marly flysch of Ostreni sub-zone, in the north and, under allochtonous of Grama, in the southern part (Malesia e Korabit sub-zone).

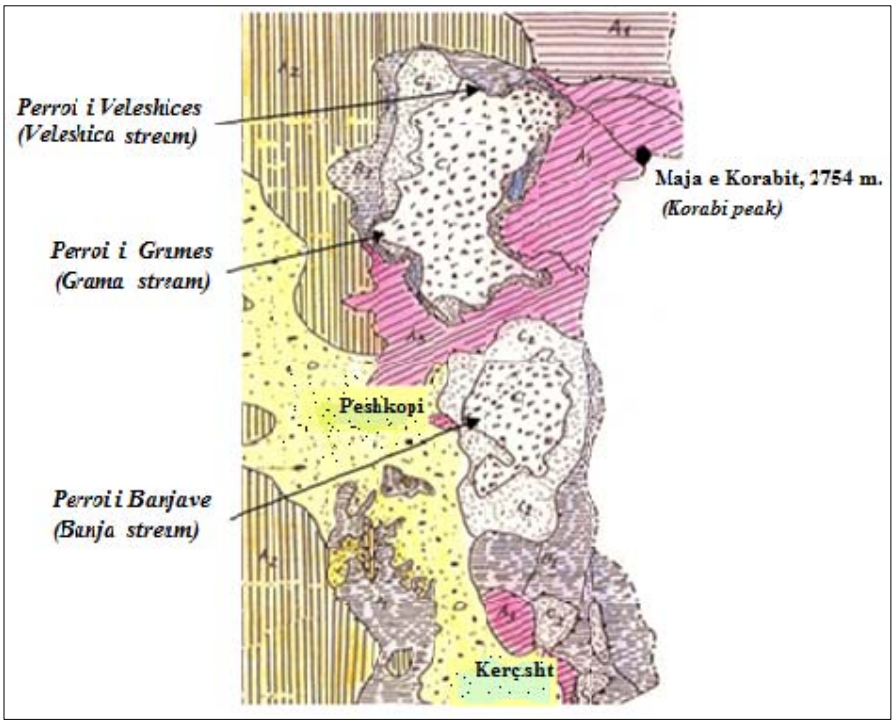


Fig. 3. Tectonic sketch of the locations of Peshkopia evaporate.A. Korabi unit: A_1- Kollovozit sub-unit; A_2- Muhurr –Çaja sub-unit; A_3-Malesia e Korabit sub-unit;B. Krasta- Cukali unit: B_1-Ostreni or Krasta Lindore sub-unit; C. Dibra formations: C_1-C_2, Kruja unit, Ionian unit or Dibra unit? D. Formations of Peshkopia depression of Pliocene Quaternary age.

In the northern part, allochtone of Krasta is covered by Palaeozoic and Triassic depositions of tectonic units of Korab zone (Fig. 3). Paleogene flysch is the same as that of the Peshkopia Thermal spring. Allochtone packages, around Mali i Bardhe tectonic window, are deformed to different degrees. At the same time in the river of Radika area, Diber of Macedonia (FYROM), is developed a tectonic window of Dibra Unit, represented by evaporite and Paleogene flysch, same as in Peshkopi region, despite that in the geological map of Macedonia at scale 1: 200 000 (Skopje, 1977) they are considerd with different age. Evaporite intersect a wide range of formations starting from formations of Palaeozoic to the flysch of Eocene (Fig. 4).

Dumre evaporite diapir (Fig. 1), is widespread, mainly in the meridional direction, with a length of about 20 km and width of 12 km. This diapir belongs to a tectonic junction where the longitudinal block – like faults of orogene, regional faults of Berati anticline chain and regional fault zone of Kruja tectonic unit are intersected.In this tectonic triple junction outcrops the diapir of Dumre, overthrusted considerably towards the west (Fig. 2).Taking into account the shape of evaporite of Dumre, the rock composition (mostly by gypsum and anhydrides), disharmonious intensive faulting, drilling results and geological-geophysical interpretation, it appears that we have to do with a typical evaporate diapir (Fig. 5).

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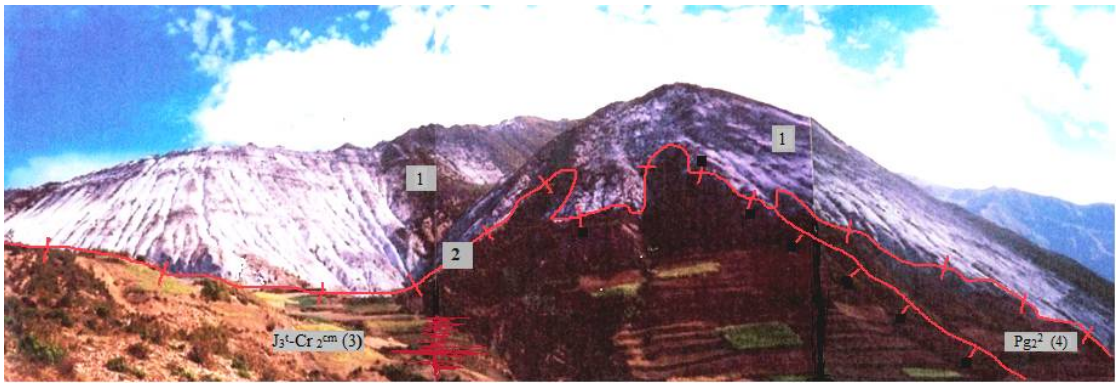


Fig. 5/1. A view of evaporite of Peshkopia northen Diapir (1**)** in the east of Vrenjt village. The fault relationship of evaporite (2) with Eocene flysch of Pg_2^2 (4**)** and with Jurassic–Cretaceous formations (J_3^t-Cr $_2^{cm}$, (3**)**. Jurassic – Cretaceous flysch (3) overlying Eocene flysch (4**).**



Fig. 4. Diapiric (teconic) contact (1) of Eocene flysch (2) with Evaporite (3) near Grama stream in the northen side, next to Dipjaka, Peshkopi.



Fig. 5. A view of evaporite in Trojs (1)and carst hole near it (2).Dumre diapir, Elbasan.

Evaporate diapir of Picar-Kardhiq (Fig. 1), occupies an area of 12 x 3.5 km in size. The surface outcrop of the diapir is a large depression, surrounded by high mountains. In the east the terrain is hilly. Relative geomorphology was formed as a result of a light erosin of evaporite formation as compared to the surrounding carbonate, with intensive developing of Keprok over it (Fig. 6). Evidence for this are karstic holes in the area between streams of Picari and Zhulati, karstic lakes in the vicinity of Kolonja (Fig. 7) as well as numerous of demolitions and gravity slides near Zhulati.

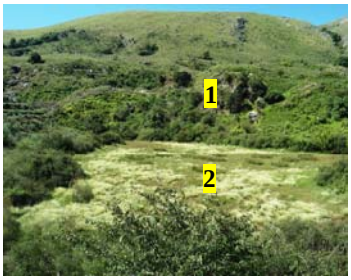


Fig. 8. A view of evaporite outcrop (1) and carst hole (2), near Çiflig village, Sarande.



Fig. 6. A view of Keprok formation(1),over evaporite, nearPicarvillage,Gjirokaster.



Fig. 7. Carst lake (1), on keprok and evaporite near Picar village, Gjirokaster.

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Evaporite diapir of Picar-Kardhiq belongs to the termination of transversal node of Borsh-Kardhiq with western limb of the Fterra and Kurveleshi anticline (Fig. 10). It has fault relationships with surrounding formations of Jurassic to Burdigalian (Fig. 9).According to the geological situation, the shape of evaporite outcrops, radial fractures identified in the surrounding formations, encompassing blocks in the Mesozoic formations etc., we conclude that evaporate of Picar-Kardhiq have reached the point of diapiric evolution.



Fig. 9. Diapiric relationships (3) of Evaporite (2), with porcelanic limestone pack of J_3-Cr_1, (1), carst holes on the left side of photo, Kolonje village, Gjirokaster.

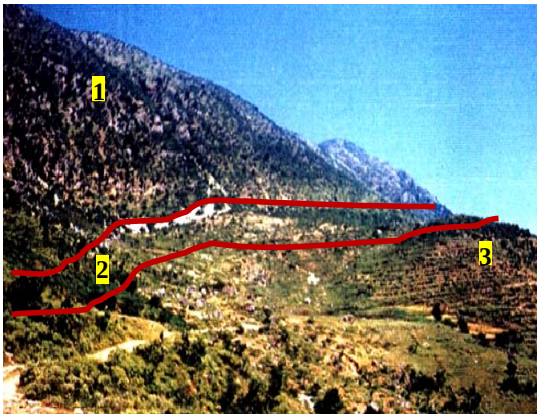


Fig. 10. Cretaceous limestone (1) overthrusting from West towards East, the Oligocene flysch (3), through dip fault accompanied withevaporite (2). Shtepez village, Gjirokaster.

In contrast to the other diapirs (Peshkopi, Dumre, Delvine-Bistrica, Xare-Mursi), in Kardhiqi diapir have been identified bodies of metamorphic and volcanic rocks as amphibolites of Picari and basalt outcrops in northern slope of Torovica. The contacts of the metamorphic and volcanic blocks with surrounding rocks are faulted. Metamorphic rocks consist of amphibolites, amfibolite shale and quartz-garnet- mica shales. Basalts are composed mainly by leukokrate types. They are composed of diabase with olivine and porphyric diabase. The raising of evaporite formation in Picar-Kardhiq is more powerful compared to the other areas of evaporatespreading in Albania.

Evaporite diapir of Delvine - Bistrica (Fig. 1), occupies an area of 12 km x 2 km in the west of the Mali i Gjere, in conformity with the carbonate structures which have SE-NW orientation. The relationship of the evaporite with the surrounding rocks are faulting. They come in contact sometimes with Oligocene flysch, sometimes with carbonate-siliceous rocks of Jurassic and sometimes with Upper Triassic dolomite.Clasts of carbonate rocks within evaporate give to the latter the appearance of brecciated evaporite (Fig. 11). The three –dimensinal shape of the evaporate zone coincides with that of a pillow. The oldest section of the evaporite is composed by colorful clay, dolomite of gypsum (Fig. 12, 13).



Fig. 11. Carbonate clasts within argillaceous-gypsum rocks in the evaporite outcrop within flysch in *Pelaxhi*. (Photo according to Diamanti F. et.al. 1999)



Fig. 12. *Aview of* spotted serie of Bistricë**,** (Photo according to Diamanti F. et.al. 1999)



Fig. 13. *Aview of evaporite*, Bistricë, (Photo according to Diamanti F. et.al. 1999).

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Evaporite diapir of Xare - Mursi (Fig. 1), lies at the SW extreme of Albania up to the lineborder with Greece, with aproximately meridional striking. The outcrop size of the diapir is 7km x 2-3 km and is covered by lacustrine deposits, clay and coal, characteristic for the Pliocenic mulda (depresions). Under this cover is placed stony cap of Keprok and under it, gypsum dome (Fig. 8).

Evaporite formation of Miocene - Mesinian age (Fig. 1), has mainly layered character and outcrops in Mengaj and some neigbouring sectors of Kavaje district, in Guri i Cifutit of Vlora district (Fig. 14, 16), in Rubjeke, Rade and some other sectors of Durres i district (Fig. 15, 17). The deep drilling carried out have intersected Miocene evaporate and other Neogene structures as in Panaja, Frakull, Seman, Divjake, Kryevidh, Durres etc. They relate to the gypsum – bearing horizon of Messinian which is encountered mainly in the western part of the Near Adriatic Lowland (UPA), in the direction of the Adriatic Sea.

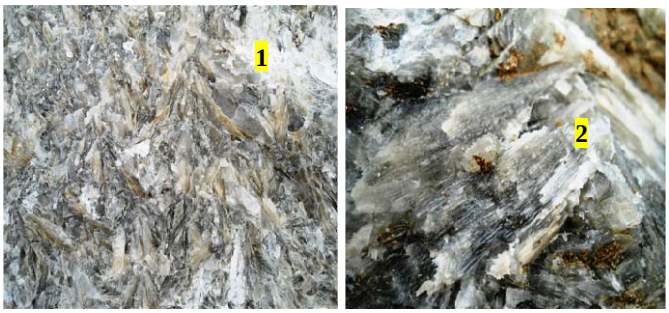


Fig. 14. A view of gypsum (selenite type), mainly swallow tail type (1) and needle- fibrous gypsum of selenite type (2). "*Guri i Çifutit*", Narta area, Vlore.



Fig. 15. Gypsum outcrop (1), *Kodra e Sallakut* area, north of Rrubjeke village, between Manza and



Fig. 16. Partial view of "*Guri i Çifutit*" evaporite deposit. The dipping of layers is towards SE at angle 25^0. Narte area, Vlore.

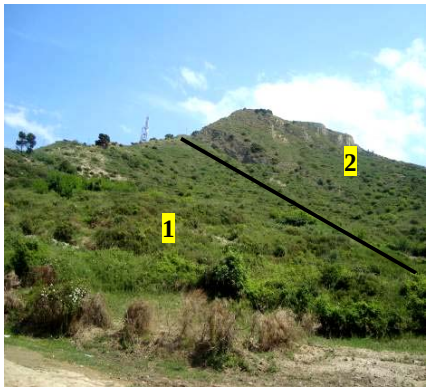


Fig. 17. A view of Mesinian formations N_1^{3-m}- (1), which hosts evaporite, and Pliocene formations N_2- (2), *Currila area*, Durres.

2. 2 In geographical point of view

Regions composed of evaporite (gypsum, anhydrites etc..), due to geological constitution have physical-geographic specific features compared with other regions.
Development of erosion and surface and underground karst (Fig. 18, 19) is responsible for the specific features not only of relief but also other components of the geographical landscape.
During the time when surface water flows are poor, both underground and surroundings are full of water reserves.

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Lands, generally have basic reaction, are ventilated and skeleton, while vegetation consists more of kserofile types.Even the use of gypsum soils by the man has special features.In this context, for each region with the spread of evaporate formation, are given systematically features of the landscape, climate, hydrography, land and vegetation.



Fig. 18. View of karst phenomena in the evaporites(gypsum), north of Vent village, Peshkopi.

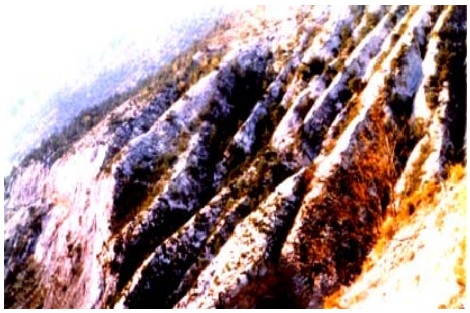


Fig. 19. A view of evaporites is the southern slope of Mali i Bardhë. Erosion and new faulting have significantly modified their relief.

2. 3. Mineralogical-petrographical composition of evaporite formation

This is determined based on observations and numerous of mineralogical-petrographical analyzes, chemical and spectral analysis and on interpretation of geophysical diagrams of the bore holes. It is determined the geological section through the exact separation of solid-cap keprok of the evaporite massifs, the part of the insoluble salts and the soluble ones at the depth. Evaporite formation in Albania, in the most cases, is constituted by solid-cap of keprok in the upper levels (Fig. 20), and intercalations of gypsum-anhydride and layers of argillaceous shale, marls and dolomitore below (Fig. 21, 22).

Soluble salts occupy the deeper levels. Spreading areas of Triassic and Miocene evaporate in Albania have been and remain studying objects for prospecting – exploration and exploitation of gypsum, anhydrides, selenite, alabaster, halite, etc.., in the salt nucleis. In this context, have been identified all showings and and important deposits and in addition the perspective areas for further exploration are delineated.

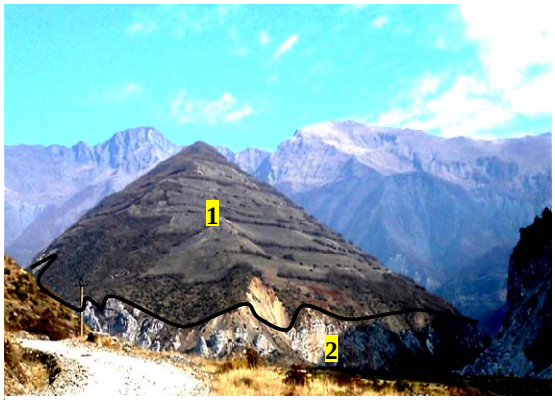


Fig. 20. A view of Keprok formation (1) conical skid shaped, over evaporites (2). Ramification of Llixha stream. Peshkopi.

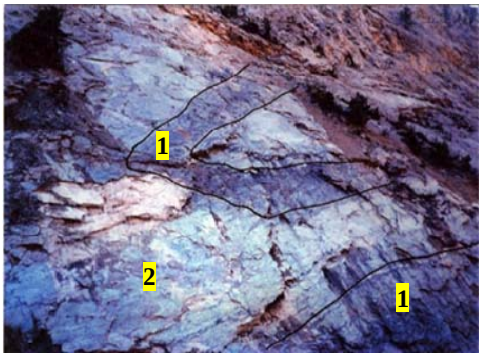


Fig. 21. Folded dolomite (1) within anhydrite (2), near the ramification of Grama stream and Tërshiza stream. Peshkopi.

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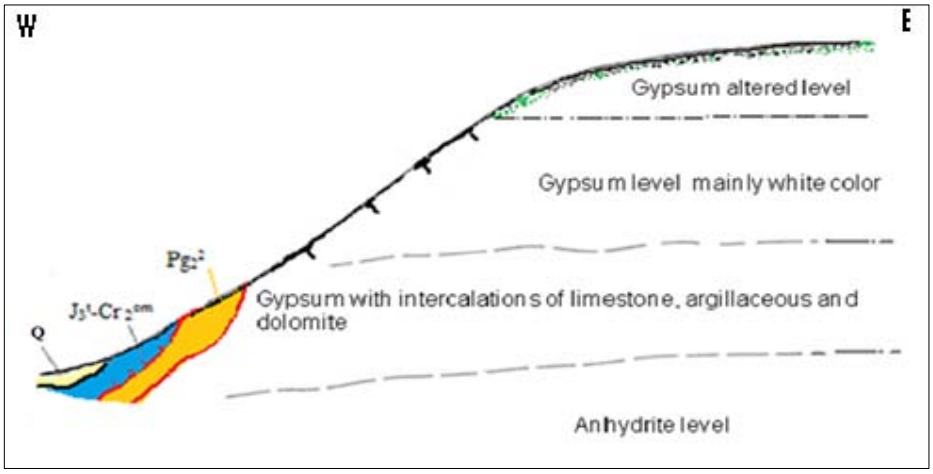


Fig. 22. Representative schematic section of Peshkopia evaporite.

2. 4. The age of evaporite formation

Complete investigations would be important for the Permo-Triassic age. Consequently, a research on the evaporite age determination through association of sporo-pollen and dinoflagelateve, and for absolute age determination was unertaken. Field observations were carried out in the form of routes in evaporate massifs of Peshkopi, Dumre, Picar-Kardhiq and Delvine - Bistrica and for the core of numerous dirill holes which have intersected evaporite diapirs in the Ionian tectonic zone and Dibra unit. Scarce field observations are carried out in the layered evaporate formation of Miocene age (Messinian) in Near Adriatic Lowlands. At the same time were studied and evaluated all previous tests carried out as regarding the age determination of evaporate. In the focus were especially evaluations of sporo – pollen determinations of Bistrica section by Cirielli and Montanari (1994)according to field observations carried out in partnership with Prof. F. Diamanti. The determination of absolute age of evaporate for two gypsum - anhydrides samples of Peshkopia and Dumre diapirs was made using dating techniques of strontium isotope, in the laboratory of Oolitica Geoscience Ldt, Aberdeen, Scolland-UK. A petrographic study of samples was firstly done and latter analysis strontium isotopes (Sr87 / Sr86). Both samples, in the paleontological point of view, were sterile (containig no fauna), therefore not suitable for biostratigraphic determination. Samples were analyzed using masspectrometry VG 354 calibrated against NBS Sr87/Sr86 0.71025 of standard. Analysis of Strontium isotope were carried out by Dr. Euan Mearns from Isotope Analytical Service, Aberdeen. Age interpretation of the results was made by Christopher Toland from Oolitika Geoscience Ldt. Absolute age data are based on a scale (separation) time of Herland et. al. (1989).

Based on the sporo-pollen association and dinoflagelate, evaporites formation is Upper Triassic (Karnian) in age. The results of Strontium isotope analysis show that samples of evaporites from Peshkopia are Lower Permian - late Wordianit or middle Changxingian (252. 5 or 246 million years) in age and the sample of Dumreja (Grekan) is middle Permian - Lower Artiskian (266. 5 million years) or Lower Triassic (245 million years) in age. Evaporate samples from Peshkopia and Dumre are considered potentially appropriate for Strontium dating, but the mixed lithology reduces significantly the reliability in the age determining, so the priority is given to the sporo - pollen age determination. Sporo-pollen associations of Miocene age which are encountered in different locations in the evaporate diapirs of Triassic might be related with infiltrators of karstic activity.

2. 5. Evaluation of the age for the surrounding rocks

For this are used geological comparisions with the other similar areas and especially the data of foraminifera and nanoplanctone. Therefore, have been carried out, in the framework of this study, observations on the areas of Peshkopi, Dumre, Picar - Kardhiq and Delvina, with sampling to determine biostratigraphy from the surrounding rocks. Also biostratigraphic observations were carried out for the core samples of several drill holes and, in addition are used the previous geological and biostratigraphic data. They show that evaporite formation intersects the whole thickness of sedimentary formations of the Ionian zone, from the Upper Triassic (Delvinë) to Pliocene (Dumre).

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2. 6. The studing of density of the evaporite deposition

The recent study conducted for evaporite has shown that in the context of Albanides, the density decreases in the north-south direction. In southern Albania the values of thensity are 2.58 - 2.59 g/cm^3 for the evaporate formations of Xare - Butrint and Picar - Kardhiq, in central Albania the values of density are 2.55 g/cm^3 for the evaporite of Dumre, while in the north, in Peshkopi, reaches values of 2.49 g /cm^3. This, apparently, must be the result of increasingly large presence of gypsum and clean salt in the general mass of evaporate, from the south towards the north. Regarding reflection of evaporite of Albanides in the field of gravity, when evaporate contact at surface with limestone (i.e. Picar-Kardhiq, Delvine- Bistrica, Xare-Mursi, etc..), they reflect negative anomalies, because their small density, whereas when the contact at surface is with flysch formations of Tortonian-Pliocene with a lower density (Dumre), the evaporite reflect positive anomalies. In contrast to all other areas, the evaporite formation of Peshkopi area, almost does not reflect anything as concerning the spread of the gravity field. This can be explained by the assumption that their thickness in depth should be relatively small, such that their impact is almost insignificant in the negative anomaly which characterizes the tectonic building at depth and geological structure of the area.

2. 7. The main features of evaporite in seismic profiles.

Is the introduction of a facie "chaotic", without visible reflections or reflections that have limited spread, in the shape of the detached blocks. This phenomenon is observed in almost all interpreted seismic profiles.

2. 8. Evaporite diapirism and its influence on tectonics of the external Albanides

It dealt with all its own complexity.

a. Is recorded the concentration of evaporite diapirs in three tectonic positions: i) Evaporite diapirs which have broken during demolition plan regional pershtjellues character limit orogjenin with different age rrudhosese defining the main tectonic features external Albanides (Dumre, Glina etc..), ii) Evaporate diapirs which have intruded along the vertical fault zones of anticline structures, being in general in their western flanks (Delvine, Bashaj, Palase, Fterre, etc.) and, iii) sub-vertical evaporite diapirs developed in the central part of the anticline structures (Navarice, Janice, Xare, etc.).

b. It is analysed the mechanism of the tectonic action of the evaporite diapirism, its influence in the basic structural building features. In this context, specific other areas are analyzed as Peshkopi, Dumre, Picar-Kardhiq, Delvine Xare.

c. The main features of the diapir formation are given.

2. 9. The deciphering of the geological structure in the areas of the spreading of the evaporite formation

New observations were carried out in the field and in addition are used all previous geological-geophysical studies carried out and the results of drilling wells in and around evaporite. It is grown recognition of the geological structure for the areas of Dumre, Picar-Kardhiq, Delvina and Xare-Mursi. In this paper is presented an interpretation version which is supported by a complex of geological-geophysical study that may be closer to reality. Evaporite diapir of Dumre represents a "giant trunk" flowing westward and towards south-west, covering and masking deep anticline structures. It is belived that this structures continue eastward. Towards the north the diapiric body of Dumre is "closed" between flysch deposits, whereas the fault at the floor of this diapiric body continues towards the north and the south, having the nature of a inter-flysch fault, with represents an overthrust of the geological units developed after orogeny. Under these conditions, is supported the existence of anticline structure of Dumre, which is developed under the overthrust of the evaporite diapir (Fig. 2).

In evaporite area of Picar-Kardhiq is made possible outlining the evaporite body and are constructed the time and depth schemes for horizons that are reflected under evaporate body. The geological structure of the evaporite formation and the surrounding formations is analysed as well. So, the structural model of the section under evaporite formation , which show mainly a block character. A possible structure is dedicated under evaporate section.

In Delvine – Bistrica area, the diapir of Delvina is developed from Dhrovjani to Kopaçez. Evaporite have fault contact with all depositions and around structures. The diapir plunges eastward, and in this

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direction thickness is increased. Drillings have shown that under the diapir body the flysch deposits of middle Oligocene are developed. The dipping of diapir is towards east, which argues development of the eastern syncline (Dhrovjan-Humelice), as well as for large scale overthrusting of the diapir.

In the Xare – Mursi area, the evaporite diapir intruded in the center of the anticline of Bogaz, dividing it into two parts, the east with simple geological construction and the western (Korafi monocline) very destroyed by faulting. Towards the north the diapirism is less powerful, otherwise, towards the south, in the Greek territory, the diapirism is very powerful, showing strong destruction of the structures around it. Under the chaotic picture that represents the thickness of the evaporite, were registered reflective horizons with the east dipping which represent any possible structure at the level of the ceiling of limestone platform (Preapuliane zone).

2. 10. Organic geochemistry of evaporite formation in Albania, the assessment of parent rocks of oil and gas, traces of gas oil on the surface and in depth during drilling of the exploration wells, migration and accumulation processes for formation of oil and gas horizons

For this purpose were conducted field observations of the evaporite outcrops of Peshkopi, Dumre, Picar-Kardhiq and Delvina, and in addition we checked the drilling samples for providing evidences of pyrolytic optical, gascomatographic and mass spectroscopic determinations. Collated and analyzed material showed that organic matter of evaporite formation in Albania has the ability to generate limited amounts of hydrocarbon gas without maturing. But in strong thermobaric conditions, their generation potential is increased. Geochemical characterization of oil and gas traces and correlation gas-gas, oil-oil and gas / oil- parent rock have determined the nature of the gases and oil traces in evaporite formation. Hydrocarbon gases with izomeration ratio < 1 are mature, they prevail in the section of drill hole Dumre - 7, but not related to organic matter of evaporate, hydrocarbon gases of this group are generated from parent rocks involved in the generation area of the condensed and fatted gas. These parent rocks should belong to the oldest section of the Ionic basin. Hydrocarbon gases with izomeration ratio >1 are generated from organic matter of evaporite. Traces of oil, encountered in Delvina evaporite, are not generated from organic matter evaporite. Taking in consideration that oil and condensate traces in Delvina have some different features from all other oil types in Albanides, is supposed that these oils have generated from parent rocks older than those exposed to the surface in Ionian basin, possibly belonging to the inter-platformic section. In the practical context, the geochemical and epigenetic nature of hydrocarbon and gases encountered in Dumre, suggest that possible horizons under diapir of Dumre, in carbonate depositions, shuould be mainly saturated with fatty hydrocarbon gases and dry ones.

3. THE POSSIBILITY OF TRAPPING OF HYDROCARBONS

It was treated closely linked with effect of evaporite tectonics which happen parallely with the tectonic effect of rifting phase and orogenic compression phase, giving a significant impact on the amplitude of overthrusting of structures and the creation of favorable structures (traps) for hydrocarbon.
Influence of evaporite tectonics is recorded: i) by westward overthrust of anticline structural units, phenomena that are observed mainly in the anticline belt of Kurveleshi, such as Mali i Gjere, Gribe, Kurveleshi, Ballsh, Patos - Verbasit, masking the deep carbonate structures, ii) by westward overthrust of anticline structures, through back - thrust faults, faults which are characterized by reaction of blocking of overthrusting faul westward by evaporite movement. Such phenomena are recorded in the eastern flank of the anticlines of Tragjasi, Saranda, Çembel, Kurvelesh, Nemerçke, etc. As a result of this phenomenon can be formed traps tectonically screened in evaporite, iii) by westward overthrust of structural belts of Berati and Kurvelesh, masking underneath a structural anticline line, the type of Dumre and Sqepuri anticlines of Berati belt, iv) in the overall overthrusting process of external Albanide orogene which overly the Apuliane platform and South Adriatic Basin and, v) in evaporite faulting development process, where around evaporite diapirs are created tektonicaly screened traps which are areas for exploration of hydrocarbons. Such traps should be formed around Kardhiqi diapir, or around the "root" of Dumre diapir (which should be much more to the east than the current position of the present Dumre outcroping), as well as in tectonic contact between the overthrusted evaporate diapir and overthrusted limestone. In the last one, there are possibilities of formation of tectonically screened traps of different shapes.
Finally we note the possibility of hydrocarbon trapping within evaporite section as a result of vertical diffusion of hydrocarbons from oil and gas structures at depth or around evaporite.

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4. METALOGENIC PROGNOSIS OF EVAPORATE FORMATION

In nuclei of soluble salts of Permian-Triassic evaporites diapirs and Miocene evaporite of Near Adriatic Lowland have been discovered and estimated halite salt deposits, showings of halite salt and traces of potassium salts in Dhrovjan - Delvinë, Kolonjë, Picar-Kardhiq, Shëngjergj, Vlashuk, Gradisht - Belsh, Shalës-Dumre and Mengaj-Kavajë. In the future studies, simultaneously to the evaluation of gypsum, anhydrides, selenite, alabaster, etc. (especially Peshkopia outcrops, as Perroi i Grames,Veleshica, Bahutaj, Llixhat, near the Vrenjt village, near Maja e Pelpanikut in Maja e Bardhe etc.) Vleshes, in the east of Sllatina, Venishtit, Greves strike etc., attention should be paid to traces of sulfur, strontium, barite, potassium salts, magnesium and their associated elements (Li, Ta, Rb, Cz, B, etc.). Explorations of sulphur and polymetallic showings are of great importance for the regions where the solid caps (keproku)are met. In the areas of the developing of mulds and Kenozoic depressions, must be explored in argillaceous formations for tuffs, peat and coal. In evaporite structures are estimated thermal and mineralized waters and traces of the direct presence of soluble salts and hydrocarbons. Already are evaluated thermo-mineral waters of Llixhat e Peshkopise, Llixhat e Dumrese, Ishmit, Mamurras and Makaresht, and mineral waters of Glina, etc.

REFERENCES

Bunin MV, Artamonov VV. 1959. *Geollogiçeskoje strojenie i poleznie iskopajemie, Peshkopijskovo rajona*. NRA, 1959, Tirana.

Çollaku A, Cadet JP. 1991. *Sur l'allochtonie des Albanides: Apport des données de l'Albanie septentrionale*. Bul. Shken. Gjeol. Nr. 1. Tiranë,

Diamanti F, Velaj T, Myftari S, Prifti I, Gjani E, Veizaj V, Hyseni A, Jano K, Ndroi V, Hoxha V. 1999. Raport shkencor me titull: *"Formacioni evaporitik në Shqipëri, mundësia e kurtheve të hidrokarburev dhe kërkimit të mineraleve të tjerë të dobishëm*". Tirane, Fondi i Fakultetit te Gjeologjisë dhe i Minierave.

El Tabakh M, et.al., 1998. *"Diagjenetic origin of basal anhydrite in the Cretaceous Maha Sarakham salt: Khorat Platean"*. Ne Thailand, Sedimentology, V. 45, Nr. 3, pp. 579-594.

Grup autorësh. 2004. Harta Gjeologjike e Shqipërisë në shk. 1: 200 000, viti 2002 dhe teksti shpjegues i saj. Arkivi Qëndror i Shërbimit Gjeologjik, Tiranë

Grup autorësh. 2007. *Një shkurtimore mbi Gjeologjinë dhe Metalogjeninë e Shqipërise*. Arkivi Qëndror i Shërbimit Gjeologjik Shqiptar, Tiranë.

Grup autorësh. 1991. Gjeografia fizike e Shqiperise. Vol. 2. Tiranë.

Grup autorësh. 1977. Harta Gjeologjike e Maqedonise ne shk. 1: 200 000. Shkup,

Gjata K, Kodra A, et. al.,1984. *Rreth pranise se shkembinjve te Miocenit te Mesem ne rajonin e Dibres*. Bul. Shkenc. Gjeol. Nr. 4. Tiranë,

Hoxha V. 1999. Raport shkencor i projektit:"*Studim prognoze mbi sasinë dhe cilesinë e Gjipsit, Anhidritit e Selenitit në objektet e evaporiteve të Korabit*". Arkivi Qëndror i Shërbimit Gjeologjik Shqiptar, Tiranë.

Hoxha V. 1999. "*Mineralizimi i squfurit dhe mineralizime te tjera ne rajonin Kerçisht i Siperm-Kllobçisht*". Bul. Shkenc. Gjeol. Tiranë.

Hoxha V. 2000. *Harta gjeologjike dhe e pasurive minerale te rrethit Diber ne shkallen 1:50 000 me tekstin shpjegues perkates*. Arkivi Qendror i Sherbimit Gjeologjik Shqiptar, Tiranë.

Hoxha V. 2001. *Tiparet themelore te gjeologjisë dhe perspektiva e kërkimeve në rajonin Kërçisht-Sorokol.* Disertacion, Universiteti i Tiranës.

Hoxha V, Milushi I, Mekshiqi N, Diamanti F, Bakellbashi J. 2011. *Geological and Mineral bearing Aspects of Evaporites in Peshkopia Area*. Proceedings. 284-292. Mineral Resources and their perspective,International Geo-Science Conference "GeoAlb 2011", 27–30, September 2011. Mitrovice - Republika e Kosovës, ISBN: 978-9951-612-00-5

Hoxha V, Seferi N. 1997. *Studim gjeologjik dhe projekt shfrytëzimi i objektit të Gjipseve Vrenjt – Peshkopi*. (Porositur nga Shoqëria Shqiptaro–Italiane "MEC–EAST". Sh. p. k.). Bulqizë, Fondi i Ndërmarrjes Gjeologjike Bulqizë.

Hoxha V, Milushi I. 2011. Raport shkencor i projektit studimor me teme*: "Evaporitet e Shqiperise dheMineralmbajtja e Tyre"*. Arkivi i Institutit te Gjeoshkencave, Energjise, Ujit dhe Mjedisit, Universiteti Politeknik i Tiranes

Kodra A. 1981. *Shkëmbinjtë Jurasike dhe Jurasiko-Kretake ne rajonet verilindore të Albanideve (ne verilindje të ofioliteve te zones Mirdita)*. Përmbl. Stud. Nr. 4, Tiranë.

ISSN 2306-9600

Kici V. etj., 1988. *Studim mbi stratigrafine e depozitimeve Mesozoike e Terciare te rajonit Kërçisht-Peshkopi (maj, 1997- Prill 1998)*. Arkivi Qëndror i Shërbimit Gjeologjik Shqiptar.

Kodra B, Alliu I, Hoxha V, etj., 1986. Studim tematiko-përgjithësues e rilevues kompleks për sqarimin e perspektivës së mineralit të hekurit dhe mineralizimeve të tjera në rajonin e Radomirës. Tiranë. Arkivi Qëndror i Shërbimit Gjeologjik Shqiptar.

Lleshi B. 2010. Shkëmbinjtë dhe mineralet industriale (jometalore) të Shqipërisë. (Tekst mësimor)

Lleshi B, Vaso P, Leka Gj, Hoxha V, etj., 2005. *Studim mbi shkëmbinjet dhe mineralet industriale të Shqipërisë*, në zbatim të projektit madhor me titull: *Strategjia e zhvillimit të industrisë minerare bazuar në politikën rajonale për menaxhimin me efikasitet të burimeve minerale ekzistuese dhe të atyre që do të zbulohen për një periudhë 15 vjeçare*. Peshkopi-Tiranë. Arkivi Qëndror i Shërbimit Gjeologjik Shqiptar.

Melo V, Aliaj Sh, Kodra A, Hoxha V, etj., 1991. *Dritare tektonike të zonave të jashtme ne rajonet lindore te Albanideve*. Bul. Shkenc. Gjeol. Nr. 1. Tiranë.

Naço P. 1995. Disertacion për kerkimin e gradës shkencore "Doktor". Tiranë.

Naço P. 2010. Thyerja e thellë Vlorë-Elbasan-Dibër si linjë tektonike që gjeneron seizmicitet të vazhdueshëm. Tiranë.

Qirici V, Kodra B, Manjani, Hoxha V, etj., 1982. *Studim tematiko-përgjithësues dhe rilevues kompleks për sqarimin e perspektivës hekurmbajtëse në zonën Zall Dardhë-Topojan, për vitet 1980-1981*. Tiranë.

Qirinxhi A, Kita N. 1971. *Relacion shoqerues i hartës gjeologjike skematike të zonës Grame–Tomin*. Arkivi Qëndror i Sherbimit Gjeologjik Shqiptar.

Smirnov SS. 1966. Geologia Rudnih Mestorazhdenij. Moskva.

Serjani A, Gucaj A, Husi R.1976. Të dhëna e mendime për tektoniken e brezit antiklinal te Kurveleshit. Bul. Shk. Gjeol. Nr. 3.

Tershana A. 1995. *Venburimet e mineraleve te dobishme jo metalore dhe kerkimi i tyre*. Tekst universitar. Tiranë,

Vranai. A, Shallo M, Xhomo. A. 1997. Gjeologjia e Shqiperise. Tiranë.

Velaj T.1991. Diapirizmi evaporitik në Shqipëri dhe influenca e tij në stilin tektonik mbulesor. Bul. Shk. Gjeol. Nr., Tiranë.

Velaj T.1978. *Ndërtimi gjeologjik dhe naftëgazmbajtja e rajonit Delvinë-Fushë Bardhë*. Fier.

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OIL AND GAS EXPLORATION IN THE FOLD AND THRUST BELT REGION OF SOUTH - WESTERN ALBANIA

Luan NIKOLLA[1]

[1] *National Agency of Natural Resources, Tirane, ALBANIA, luannikolla@yahoo.com*

ABSTRACT

The aim of this paper is to present a general outline of the potential oil and gas accumulations in the fold and thrust belt of the Albanian Orogene.
The fold and thrust belt is present over the whole Albania and occurres since Upper Oligocene to present.
Thrusting migrated in a westward direction, subsequently stacking the thrust sheets on top of one another. On the continental-side of each of these imbricated thrust sheets, a structural foreland basin was created which received sediment shed from the thrust sheets. The thrust faults have moved their thrust sheets with tens of kilometers of displacement and the large folds have amplitudes of up to 2000 m.
The thrust faults of the Thrust Belt are considered to be "thin-skinned"and are represented by an active zone of compressional deformation.
Structural geometries suggest that prospective traps are mainly developed in the frontal part of the Albanides fold-thrust. The complex imbricated structures offer the possibility of multiple Mesozoic and Cenozoic carbonate and clastic reservoirs and seals. Seismic reflection profiles with far offsets are necessary to define the geometry of the subthrust structures.

KEY WORDS: *Thrust fault, foreland basin, Albania.*

INTRODUCTION

This area represents the main target for exploration in Albania. A field mapping study was conducted in the Cika and Karaburun-Sazani areas, where the outcropping Mesozoic Ionian basinal carbonate sequences together with the neritic limestones facies of the Sazan-Karaburuni Platform and their respective structural setting could be evaluated.
The main goals were: 1) to evaluate the deformation history of the contact area between the Apulian and Ionian tectonic Zones, and 2) to document the faults on the surface and review the individual structures and their displacements.
The results of these geological observations, together with well data and seismic profiles were interpreted.
Two geological cross-sections were constructed from surface mapping to aid in the interpretation of the 2D seismic over the South Adriatic and Ionian Basin to better understand the thickness variations and the regional structural relationships between the major units of the Apulian Platform, Adriatic Foredeep and the Ionian Basin.

STRATIGRAPHY

The stratigraphic development of the area comprises three different and genetically related units which refer to the Mesozoic carbonates of the Sazani Zone, the adjacent Mesozoic – Paleogene Ionian Zone basinal and flysch deposits and the siliciclastic overburden of the Neogene Peri-Adriatic Depression.

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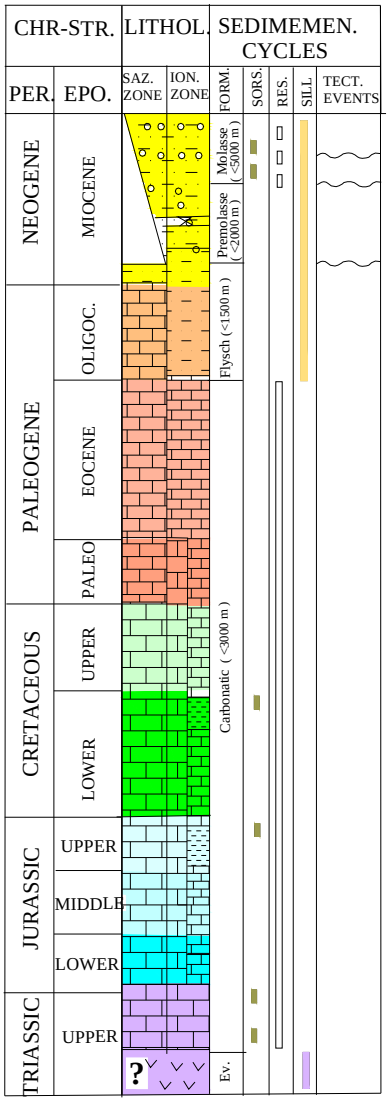


Fig. 2 Generalized chronostratygraphy

The geological history of the region can be traced from the Upper Triassic and clearly indicates a *pre-extensional, extensional and compressional tectonostratigraphic episodes*, which, sequentially, created the final geological setting of the area. These episodes control the presence of the source rocks, seal and reservoirs, the presence of structural traps and the maturation and migration history of the hydrocarbons.

Upper Triassic shallow marine organic-rich carbonates and evaporites outcrop in South Albania (Delvinë, Butrint, Kardhiq) and belong to the *pre-extensional* sedimentary cycles.

Tectonostratigraphic sequences of the *extensional* megacycle are represented by "carbonatic series" deposited in the time span from the Early Jurassic to Oligocene as pelagic Ionian intraplatform and basinal deposits. During this time, on the neighbouring Sazani platform, the deposition of shallow water platform carbonates took place (Kovacic et al, 2003).

The flysch represents a regressive sedimentary cycle closing with a predominantly sandstone deposits of the Early Miocene (Aquitanian). The thickness of the flysch formation increases towards the South and East of the area.

Further compression resulted in the succeeding transgressive cycles and in the opening of the large Neogene South Adriatic Basin (premolasse deposits) which in the onshore part of Albania is named the Peri-Adriatic Depression (Gjoka & Dulaj, 1997). It starts with Burdigalian deposits which uncomformably overlie the flanks and is comformable in the deepest parts of the flysch basin. It was closed by the regional uncomformity at the end of the Burdigalian. The molasse deposits represent the final *compressional* phase, which started in Tortonian and lasted till the present.

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TECTONICS

In the External Albanides, compression started in the Late Cretaceous (Cukali Zone) and progressed westward through time; it resulted in a large amount of horizontal shortening by folding and faulting within the thrust belt system. The structural style of the External Albanides is characterised by SW directed overthrusting (drag folds on thrust faults, backthrusting, passive roof duplexes and triangle zones) and differential horizontal displacement due to the presence of several detachment horizons. These oroclines often created the large longitudinal NW-SE stretching structures with narrow surface folds (3-6 km wide) and four-way dip closures along the major thrusts.

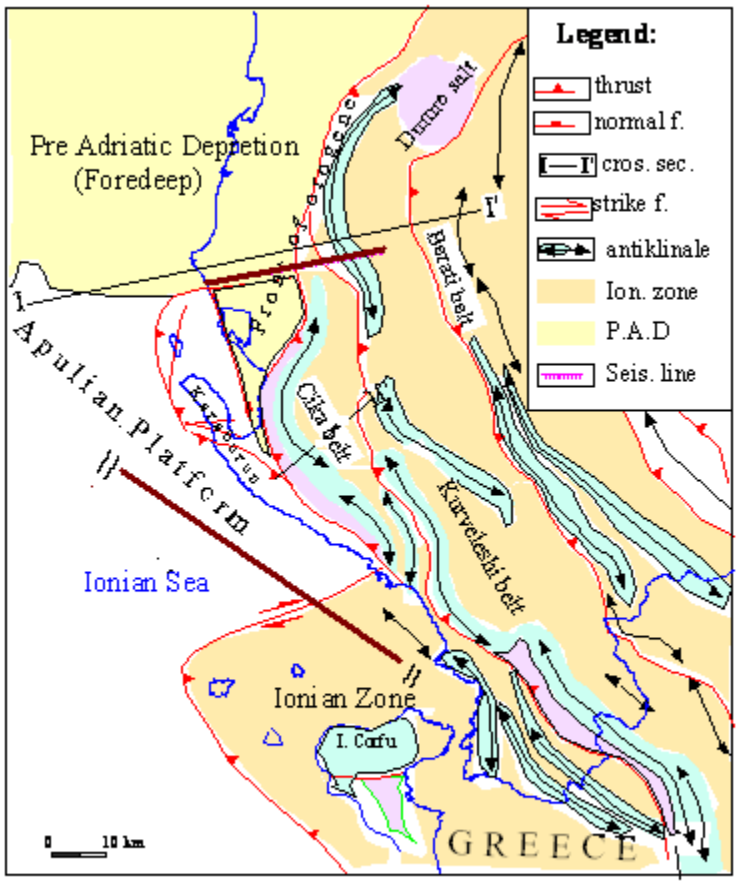


Fig. 3 **Tectonic units and structures of South-Western part of Albania**

The time of compression is dated by abrupt lithological changes and by the age of the siliciclastic overburden (foredeeps) above the pre-existing deposits. It comprises Oligocene and Early Miocene flysch sequence (Davide Scrocca et al., 2008), followed by premolasse and molasse of Middle Miocene to Pliocene age. Strike slip faults (Vlore-Elbasan, North Corfu – Himare) have also played an important role in dividing this area into tectonic segments (Alia Sh., 2000).

The presence of Pliocene deposits covering Mesozoic rocks in the southern part of the Vlore-Elbasani lineament indicates late movements along this feature. This is confirmed by earthquake activity along this lineament.

The deformed Ionian Foreland Basin is characterized by folds and thrusts, which can be divided into three belts: Berati, Kurveleshi, and Cika. At their front, they are bounded by major low angle reverse faults (Nikolla L. et al, 2002). Each belt comprises different thrust sheets usually detached at the Jurassic shale level.

During the Middle Miocene, Pliocene and post - Pliocene, thrusting of the Cika belt over the Adriatic Foreland took place. The faults are generally parallel to the thrust direction.

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SOURCE ROCKS

Several horizons of source rocks are present in the Mesozoic Ionian carbonate sequence and especially in the following intervals:

a)Triassic dolomites (Dukat, Cike) (TOC =0,02 - 38%)
b)Black shales of the early Jurassic (TOC=0.1-51%) (Delvine)
c)Posidonia shales of Toarcian age
d)Early and late Cretaceous shales that arer widely spread throughout the Ionian zone (fig.2).

These source rocks are mainly Type I and II, oil prone, marine kerogen (Dulaj at al., 1999).
The maturity of the source rocks in the Ionian zone is uniformly high (Vitrinite Reflectance,V.R = 045-0.85 %) and they should all have generated hydrocarbons, initially light oil, but with gas as the final component. Taking into consideration oil analyses from available wells, two main phases of migration have been derived from this source. The latest one in the post - Pliocene was initiated by higher temperatures and pressures, related to deeper burial and to thrust emplacement and molasse deposition. Each of the carbonate thrust sheets identified to date, acts as a separate petroleum system, with mature source rocks to the east feeding into reservoir–seal combinations trapped in thrusted anticlinal structures.

RESERVOIR

In the studied area, Ionian fractured basinal carbonates represent the best reservoir rocks due to the excellent fracture porosity developed by folding and thrusting in this sequence. The fracturing of brittle carbonate rock is most intense in the areas with a high flexure due to active tectonics. The spacing and intersection patterns of fracture networks in the form of a widespread brecciation can provide permeability and significantly enhance reservoir porosity storage capacity and deliverability as evidenced in existing oil fields. Although matrix porosity of the Upper Cretaceous- Eocene reservoirs is between 2 to 3%, the intense deformation of the brittle carbonate series during thrusting and folding creates a dense network of fractures (Fig. 4).

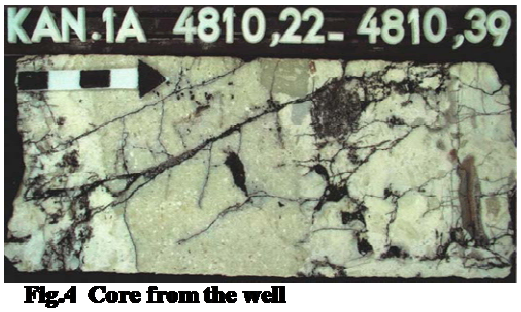


Fig.4 Core from the well

Seal

The carbonate reservoirs are regionally sealed with 20–30 m thick "transitional marls" and Oligocene flysch deposits. The flysch deposits are predominantly pelitic and can be up to a few hundred metres thick above the transition marls. The "transitional marls" represents a transitional unit which is present throughout the Ionian zone and forms an effective top seal.

Structural interpretation

In this article, the structural features of the Ionian thrust belt are presented using field data together with limited seismic reflection profiles and subsurface wells. The presence of high impedance in the carbonate sheet bodies represents a major obstacle to obtain good quality seismic data. Some of this variation is undoubtedly caused by tectonic complexity and some by

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surface conditions as seen in the seismic profiles (Fig. 4, 6). The seismic has been tied directly to outcrop geology for the different horizons mapped.

Surface and subthrust structures in the study area are interpreted as having the same decolement stratigraphic level, based on the fact that the salt formation of Triassic age appears immediately adjacent to major thrust faults in the hanging wall and extend along the fault trace

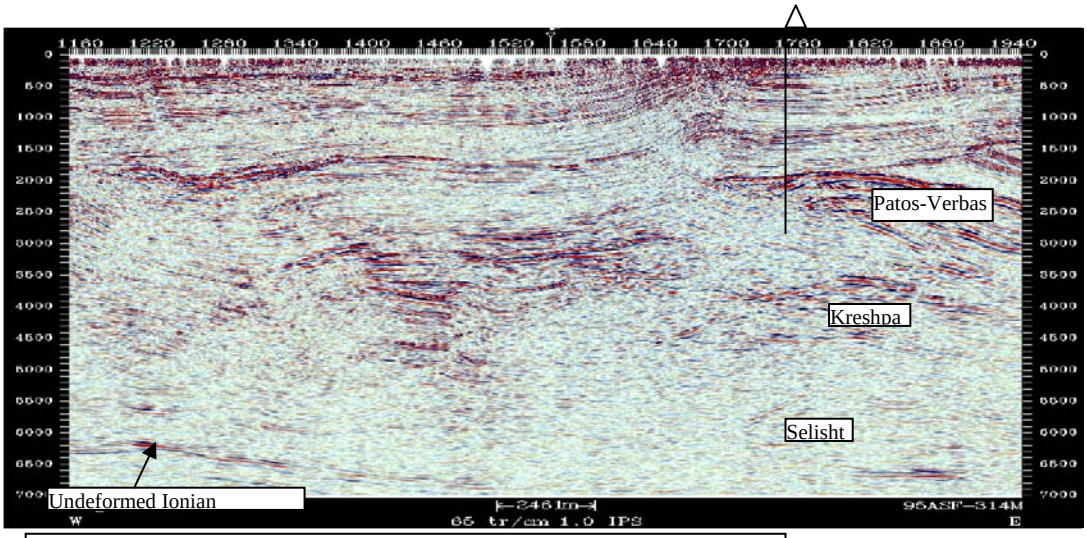


Fig. 5a Onshore Seismic line (middle part of interpreted geological cross

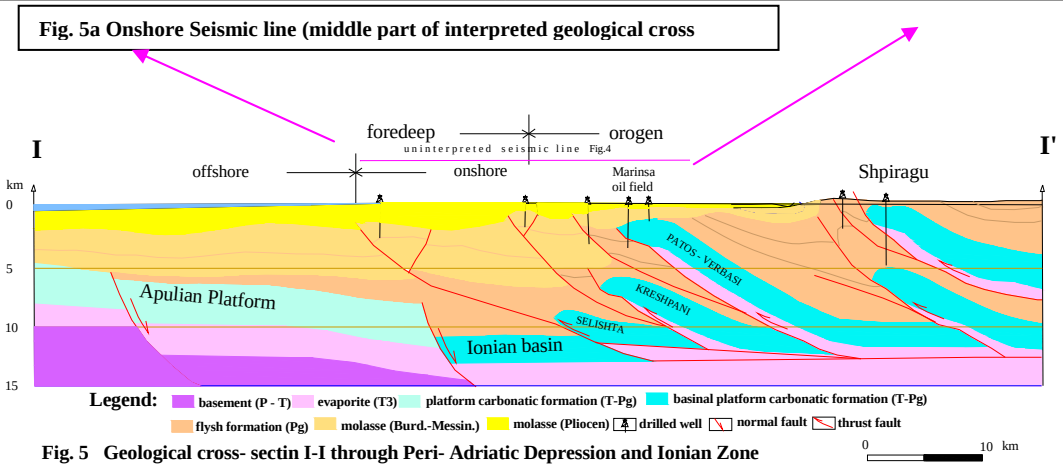


Fig. 5 Geological cross- sectin I-I through Peri- Adriatic Depression and Ionian Zone

for a considerable distance as well (Velaj T. 1995 and Fig. 3, 4).

In the geological section I-I and II-II, the structures are well defined and generally move westward with respect to the Pre-Adriatic Depression. (Fig.5). Also the molasse deposits onlapping the previously imbricated structural units (Patos-Verbas, Kreshpan) parallel with the front of the Orogene (Fig. 4, 5). The reactivation of this dextral displacement (Vlore-Elbasani) and North Corfu – Himare (Fig. 6) are determined by the age of mollase basin formed synchronously with the strike-slip movement along this lineament (Roure F. at al., 2004).

Deep drilling in the Patos-Verbasi structure and seismic profiles indicate that a significant amount of pre - molasse strata is involved in the deformation.

The frontal thrusts consist of, (from West to East), the Selishta Thrust, the Kreshpani Thrust, and the Patos – Verbasi Thrust (Fig.5).

The other major thrust faults, located in the southernmost region of Albania, are: the Tragjasi Thrust, the continuation of the Cika Thrust, the Selenice-Gorisht - Amonice Thrust, and Griba Thrust to the east. (Fig. 6). These thrust faults are the bottom boundary of each thrust sheet, and each thrust sheet is about 3000m to 4000 m thick. Thrusting migrated in a westward direction,

subsequently stacking the thrust sheets on top of one another. The thrust faults occur at shallow levels, implying that the fault geometry is generally not very deep and flattens at depth. (Paul Link et al. 2000). The hanging walls of the anticlines are linear and asymmetric, whereas the forelimbs are steeply dipping (L. Nikolla at al., 2003).
Many oilfields are located in this area and we believe that many undrilled structures remain to be explored. This area is considered to be highly prospective and the presence of subthrust structures

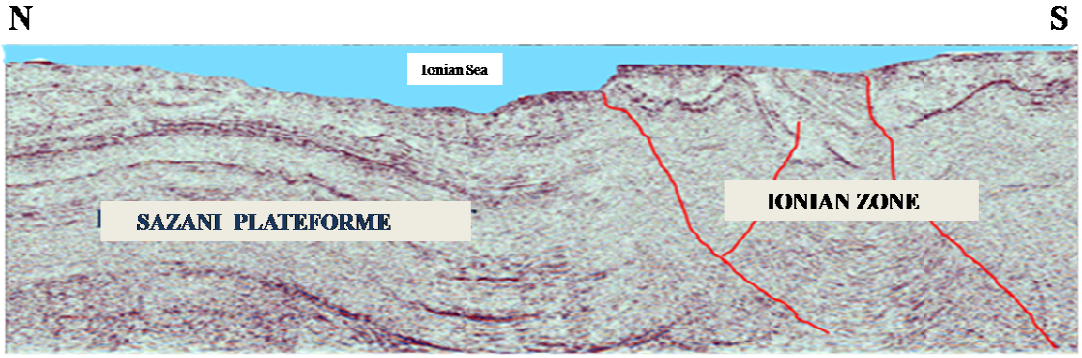


Fig. 6 Tectonic relation between Ionian and Sazani Zone (line II-II)

with considerable amplitude, increase the possibility for significant new discoveries.

CONCLUSIONS:

- The Fold and Thrust Belt of Southwest Albania represent a highly prospective area for future oil and gas exploration. With the available data (seismic and geological), this area is considered to have high potential for the discovery of new and economic reserves in the Mesozoic and Cenozoic.
- Surface thrust belts are masking the sub-surface structures with potential for significant discoveries trending N-S and with similar trend to the Cakran, Amonice, and Delvina oil and gas fields.
- In this region, , the presence of subthrust structures with considerable amplitude increase the possibility for new discoveries taking into consideration that the presence of mature source rocks is proven and considered to be very low risk.
- Deeper carbonate exploration targets within the Triassic-Lower Cretaceous should be assessed as viable reservoir objectives. This deeper play has not yet been fully documented.

REFERENCES:

Aleksander Dulaj, Luan Nikolla (1999). *Genetic relation of hydrocarbons in the central part of Kurveleshi Belt and Northern part of Cika Belt, Vlora Distrikt, Albania. 2nd International Symposium on Petroleum Geology, Zagreb.*

Davide Scrocca, Carlo Doglioni, Paola Arecco, Luan Nikolla, DomenicoCannata, Lorenzo Petracchini 2 Riccardo Recanati (2008). *The Outer Albanides: Geodinamic setting, structural architecture, and petroleum potential. Fold-Thrust Belt Exploration – London, May 14--16, 2008.*

I.S.P.GJ-I.GJ.N. 1983. *Geologjical Map of Albania. Tirana, Albania. Scale 1:200000.*

Luan Nikolla, Vlasta Tari-Kovaćić, & Arso Putniković. (2002). *Stratigraphy and evolution of Ionian foreland basin. 3rd International Symposium on Petroleum Geology, Zagreb.*

ISSN 2306-9600

Mihal Gjoka, Aleksander Dulaj (1997*) Overpressuring in the molasse deposits of the Adriatic Basin in Albania. EAGE.Petroleum Geoscience, Vol,3. P.259-268.London.*

Paul Link &Laura DeGre (2000) *Mesozoic Idaho-Wyoming Fold and thrust belt. Idaho State University.*

Roure F, Sh Nazaj, K Muska, I Fili, J P. Cadet, and M Bonneau (2004*). Kinematic evolution and petroleum system-An appraisal of the Outer Albanides, Thrust tectonic and hydrocarbon systems: AAPG Memoir 82,p. 474-493.*

Shuqyri Aliaj (2006) *The Albanian orogen: Convergence zone between Euroasia and the Adria microplate. GPS Geodezi, Tectonic and Hazard, 133-149, Netherland.*

Velaj T. Xhufi C. (1995) *The evaporate effect in tectonic style of the internal Ionian subzone of the Albanides. The 57th EAGE Conference and technical exhibition Glasgow Abst P.574.*

Vlasta Tari-Kovacic et al. 2002. *Stratigraphic interpretation of Sazani island and Karaburuni peninsula area Block Panaja and P-4, Albania. Field trip report, Zagreb, Croatia. 5 -15.*

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SUGGESTED GEOLOGICAL UNITS FOR STORAGE OF CO_2 IN ALBANIA

Irakli PRIFTI[1] Adil NEZIRAJ[2]

[1]*Polytechnic University of Tirana, Rruga e Elbasanit,Tirana, Albania, E-mail: irakliprifti@yahoo.com*
[2]*Albanian Geological Survey, Rruga e Kavajës, 153, Tirana, Albania, E-mail: A-neziraj@yahoo.com*

ABSTRACT

Emissions of CO_2 from fuel combustion have a dominant influence on the increasing trends in atmospheric CO_2 concentration in Albania. Pollution in Albanian sites is very high (grave situation) and is made only by cars. Estimation process of CO_2 emissions is impossible.
Geological model of Albania favors the storage of CO_2, except the storage in Adriatic and Ionian sea whichs is impossible because of their depths not more than 2000m.
In Albania there are some types of geological CO_2 storage: carbonate reservoirs of oil fields; sandstone reservoirs of oil fields; sandstone reservoirs of gas fields; sandstone reservoirs under the over pressure level in Adriatic depression (or deep saline aquifers); carbonate reservoirs of saline aquifers (anticline of Kozan in carbonatic section, north side of Elbasani city); salt body within diapir evaporites (Dumre, Peshkopi, Xara, etc.); coal basins (Tirana coal basin, Korça coal basin, etc.); using silicate rocks such as serpentine and olivine in eastern part of Albania.
Calculations of CO_2 capacity are done in conformity with "Geocapacity" program of EU Geological Survey. Until now we have calculated CO_2 storage capacity of Albanian oil fields and salt body within Dumre diapir, while calculations for other geological models are planned in the future. Calculation process involve the knowledge of the volume of the structure or reservoirs (m^3); the porosity of the reservoirs; geological reserves of hydrocarbons; in situ CO_2 density at reservoir conditions; the sweeping efficiency, often also referred to as the storage efficiency.
Total estimated CO_2 storage capacity in deep salt body of Dumre diaper is 10 Million tons. While total estimated CO_2 storage capacity for all Albania oil fields is 111.2046926 *Million tons.*

KEY WORDS

CO_2 storage capacity, reservoirs, geological reserves, oil fields, storage efficiency

INTRODUCTION

Twenty years ago in Albania were 12 power plants located near the Albanian factories. The majority of the heavy industry is not working anymore. Actually in our country are working two Fe-Cr metallurgical plant, cement factories, lime factories and oil refineries (Ballshi, Fieri) together with their power plants. The power plants belonging to cement factories and in "KURUM" iron industry are working for short periods of time and depend from energy supplying.
Albania's total emissions for 1994 are are equivalent with 7 061.45 Gg CO_2. During 2006 the quantity of total emissions is higher. The main sources of CO_2 for the last year are: energy sector, industrial sector and transport sector. In the transport sector are included about 500 000 cars and CO_2 emissions are uncontrolled (I. Prifti et al).
The emissions of CO_2 are related with: energy, industrial processes, transport (uncontrolled), uncontrolled human activity (greenhouse gases) the bad use of lands use and forestry (uncontrolled) and different accidents.
We have calculated a total of CO_2 emissions of about 181 000 tones for Fieri power plant which now is closed.
For the future are programmed the constructions of some power plants in Vlora with diesel combustible (now is preparing the first stage of energy production); in Delvina, Korca and Fieri with hydrocarbon gas; in Durresi with coal which will be imported from Italy).
The effective storage capacity is based on various coefficients whose numerical values have to be determined through numerical simulations and field experience. Geological structure of Albanides creates many possibilities for CO_2 storage capacity as following:

- Sandstones reservoirs from Miocene and Pliocene deposits from gas fields (Adriatic depression);

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- Sandstones reservoirs from Miocene deposits (oilfields);
- Limestones reservoirs from T-Pg section (oilfields);
- Sandstones reservoirs from Miocene and Pliocene deposits in Adriatic sea;
- Salt body within diapir evaporites (Dumre, Peshkopi, Xara, etc.);
- Coal seams within the section of coal depression;
- Present of siliceous rocks (serpentine, olivine) in eastern part of Albania.

Calculations of CO_2 capacity are done in compliance by "Geocapacity" program of EU Geological Survey. Reserves of oils are estimated during the process of oil production, which are main parameters for calculations of storage of CO_2.

GEOLOGICAL SETTING

Albania is part of the Alpine fold belt including the Dinarides, the Albanides and the Hellenides. The Albanides can be subdivided in the Internal Albanides, an intensely tectonized zone dominated by ophiolites and metamorphic complexes and the External Albanides represented by a series of thrust sheets in front of the Internal Albanides and built by sedimentary rocks of Triassic to Pliocene age (Fig.1).

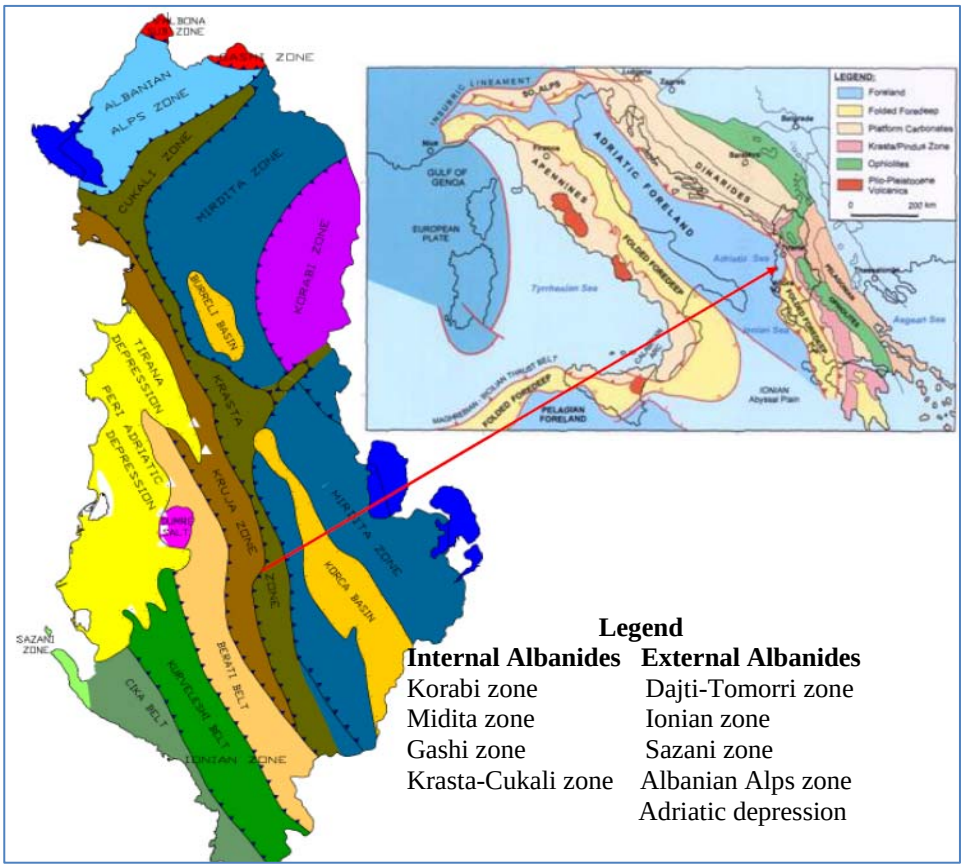


Fig.1.The main geotectonic zones of Albania

External Albanides are a suitable unit in CO_2 storage process especially the carbonate formation of Ionian zone. The Thrust Belt consists of five rocky formations as follows:

a) The carbonate formation ranging from Upper Triassic to Eocene age which is the main reservoir for storage of CO_2. Sometimes they are interrupted by the evaporitic rocks of Upper Triassic age that have emerged from their normal position owing to a common effect of tectonic forces and diapir phenomenon, such as the Upper Triassic evaporitic rocks from Dumre diapir

b) The Oligocene flysch formation that often increases considerably its thickness due to a triple common effect of lithological changes, tectonic folding and clay diapir.

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c) The Upper Oligocene-Lower Miocene flyschoid formation chiefly consists of thick beddedsandstone intercalations, silts and clays.
d) The Burdigalian-Tortonian premolassic formation that chiefly consists of massive marls and marly clays with intercalations of sandy limestones with Lithotamnium.
Adriatic depression*:* It is filled up with Messinian and Pliocene that was settled during the Upper Tectonic Stage and lies uncomfortably on both units: the African Platform and Albania Thrust Belt. Nevertheless, the Neogene structures of the Circum – Adriatic basin more or less must have inherited the form of the anticline structure of the Lower Tectonic Stage. Sometimes the unconformity between the tectonic stages becomes gradually invisible (George Hadzijanis, Irakli Prifti et al).

METHODOLOGY

For CO_2 storage to be an effective way of avoiding climate change, the CO_2 must be stored for several hundreds or thousands years. CO_2 storage also needs to have low environmental impact, low cost and to be conform to national and international laws The main options for storing CO_2 underground are in depleted oil and gas reservoirs (J. Davison et al., 2001), where Finiq-Krane hydrocarbon trap represents the typical case, deep saline reservoirs and unminable coal seams. The diagrams of possible CO_2 capture and storage (CCS) systems are showedin figure 2 (A Summary of a Special Report by the Intergovernmental Panel on Climate Change, 2007. Facts on CO_2 and Storage).

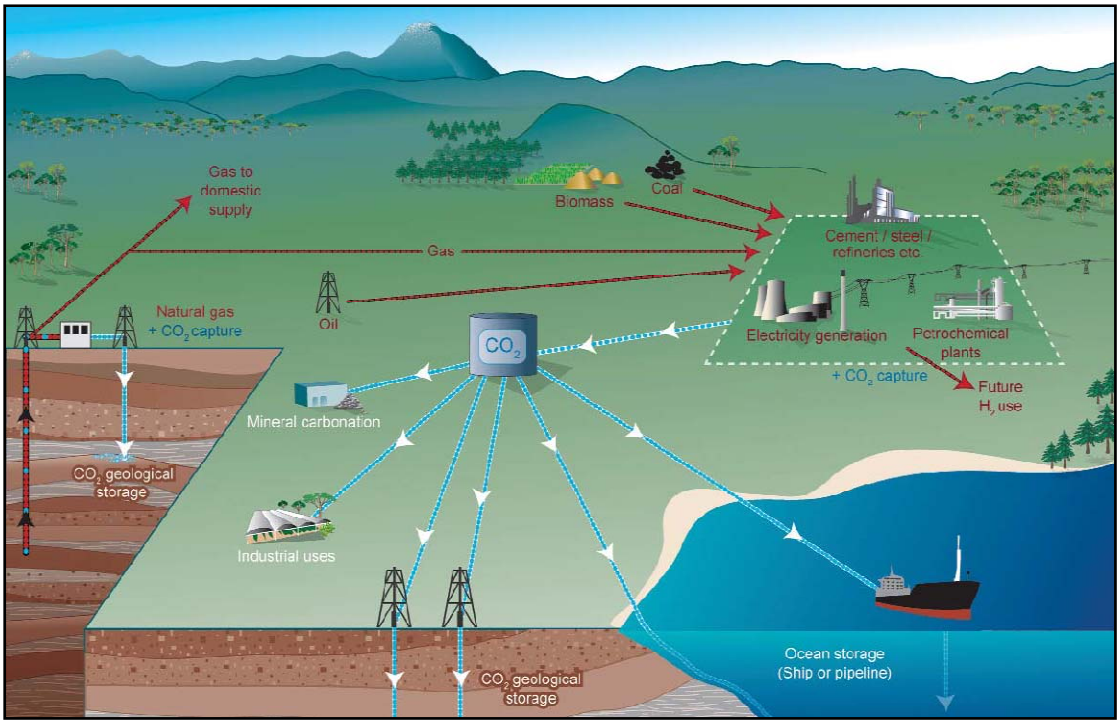


Fig.2. Diagram of possible CO_2 Capture and storage (CCS) systems

Methods of estimation for CO_2 storage capacity on geological models are suggested by EU Geological Survey.
Underground caverns, such as mined salt domes could be created to store CO_2. Such caverns are used for short term storage of natural gas and certain industrial gases, but the quantities of CO_2 that would need to be stored are very much larger.
Another option is to react CO_2 with naturally occurring minerals such as magnesium silicate, to produce carbonates that could be stored permanently. However, the mass of mineral that would need to be

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quarried and stored would be more substantially than the mass of CO_2 and costs would be much higher than those for storage in oil and gas reservoirs, aquifers and coal seams. An advantage of this option is that the CO_2 would be locked-up for extremely long time periods. However, a better way to achieve this is maybe to inject CO_2 into underground reservoirs that contain minerals that will react with CO_2 (J. Davison et al., 2001).

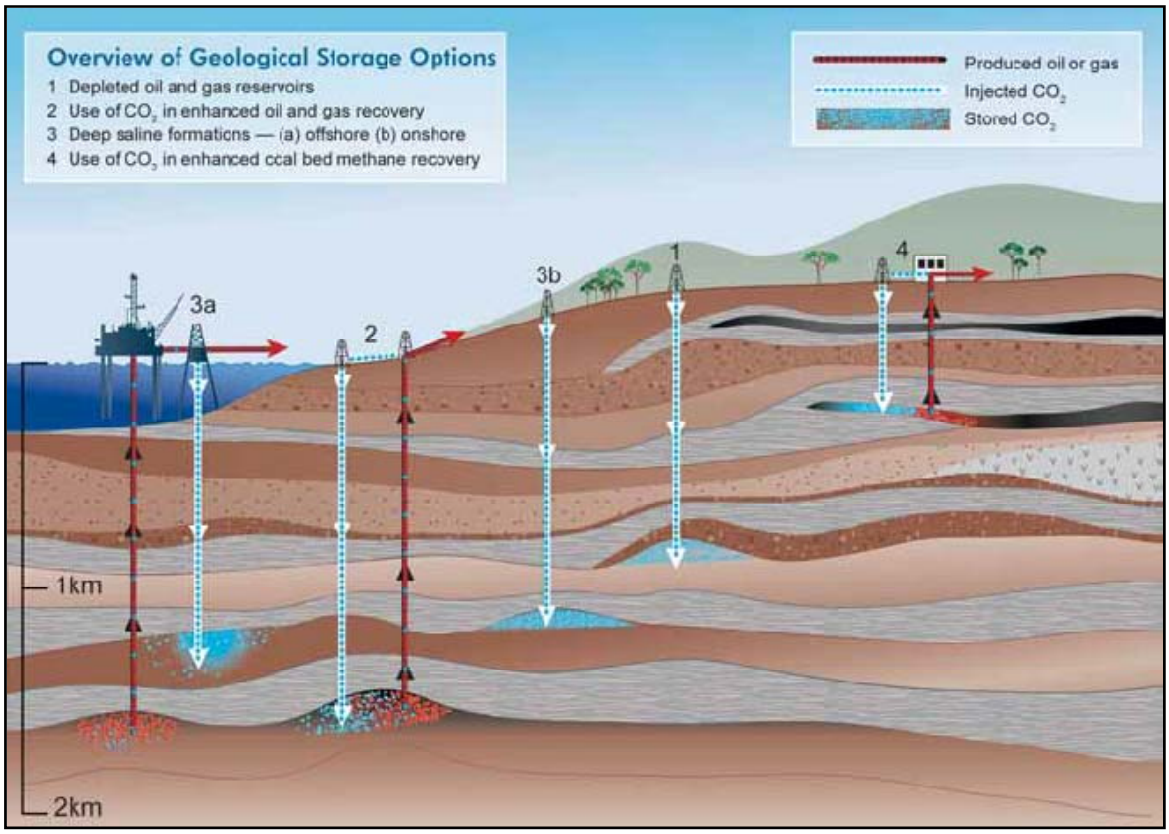


Fig.3. Overview of geological storage options (after Intergovernmental Panel on Climate Change)

Only some methods are used in estimation of CO_2 storage capacity on geological models in Albania. Up to now are calculated storage capacities on caverns which need to create within salt body of Dumre diapir. While CO_2 storage capacity is estimated in reservoirs of Albanian oilfields.
First we suggest some methods that are not evaluated such as: saline aquifers, unminable coal and mineral carbonation.
The assessment of CO_2 storage capacity in deep saline aquifer in Kozani anticline is not evaluated (Fig.4.).

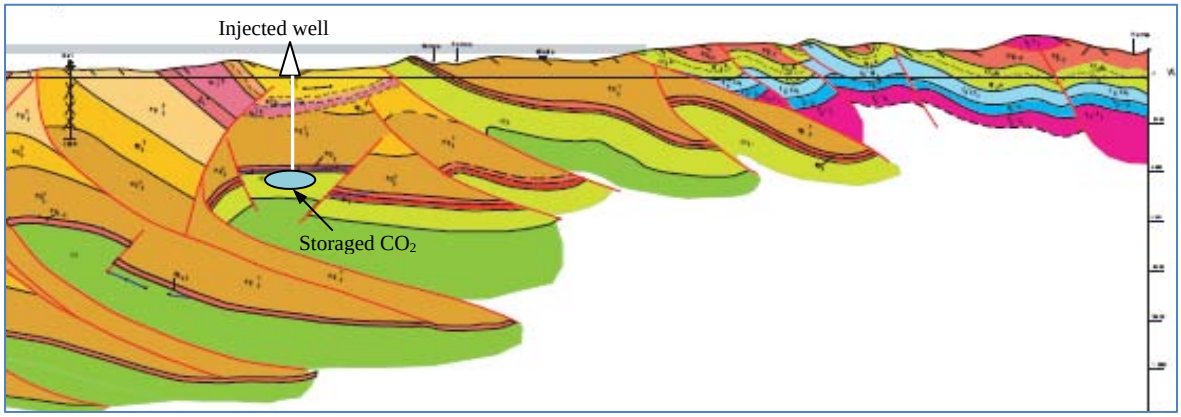


Fig.4. Possibility of CO_2 storage capacity in anticline of Kozan (carbonate formation)

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Another saline aquifer is the anticline of Fitore (carbonate formation) in the eastern side of Saranda .
The estimated capacity needs to be calculating according to the methodology described for deep saline aquifers in "GeoCapacity program" by using the next formula (George Hadzijanis, Irakli Prifti et al):

$$M_{CO2t} = A \times h_{ef} \times \phi \times \rho_{CO2r} \times S_{eff}$$

where:
M_{CO2t}: "trap" storage capacity
A: area of aquifer in trap (is not estimated)
h_{ef}: average effective thickness of aquifer (is not estimated)
ϕ: average porosity of reservoir of aquifer (is not estimated)
ρ_{CO2r}: CO_2 density at reservoir conditions (is not estimated)
S_{eff} : storage efficiency factor (for trap volume)

Another medium potential storage is the unminable coal. CO_2 can be injected into suitable coal seams where it will be adsorbed onto the coal, locking it up permanently provided the coal is never mind. Moreover, it is preferable to displace the methane that exists in the coal. Methane is already extracted from coal seams by depressurization, but this typically recovers represent only about 50% of the gas in place. Injection of CO_2 enables more methane to be extracted, while at the same time sequestering CO_2 (Fig.5.). Coal can adsorbs about twice much CO_2 by volume as methane, so even if the recovered methane is burned and the resulting CO_2 is injected again, the coal bed can still provide net storage of CO_2 (J. Davison et al., 2001).

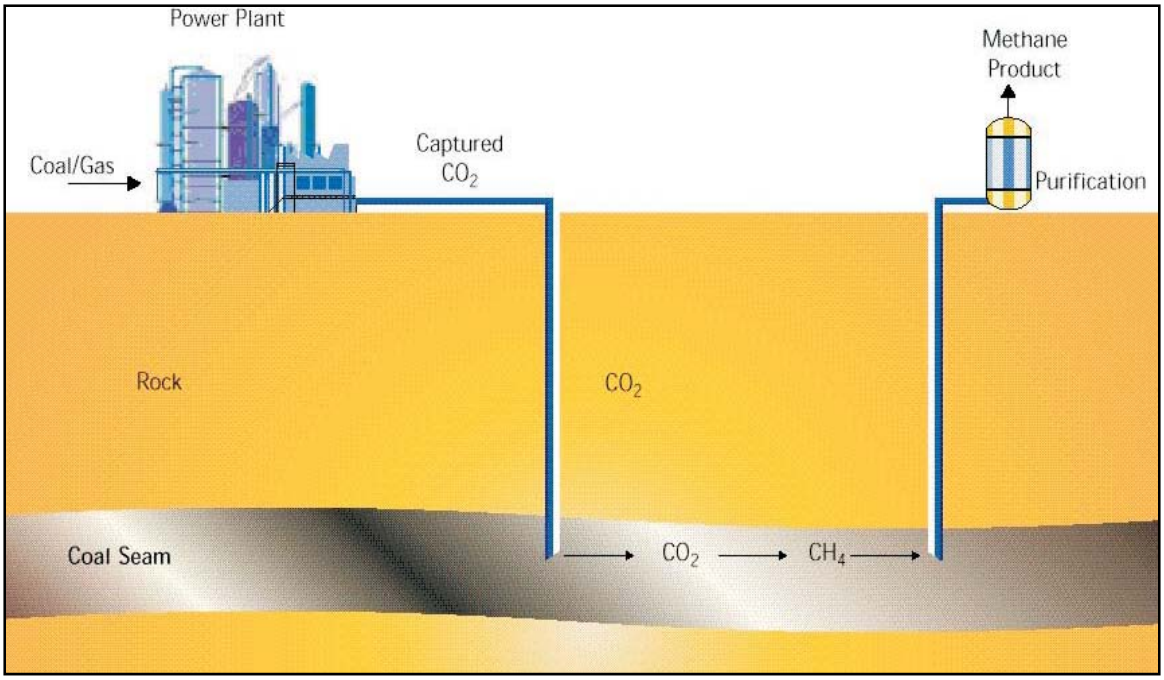


Fig. 5. CO_2 enhanced coal bed methane production

Another method is mineral carbonation, which involves converting CO_2 to solid inorganic carbonates using chemical reactions.
Mineral carbonation refers to the fixation of CO_2 using alkaline and alkaline-earth oxides, such as magnesium oxide (MgO) and calcium oxide (CaO), which are present in naturally occurring silicate rocks such as serpentine and olivine. Chemical reactions between these materials and CO_2 produce compounds such as magnesium carbonate ($MgCO_3$) and calcium carbonate ($CaCO_3$, commonly known as limestone). The quantity of metal oxides in the siliceous rocks that take place in the Earth's crust exceeds the amounts needed to fix all the CO_2 that would be produced by the combustion of all available fossil fuel reserves. These oxides

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are also present in small quantities in some industrial wastes, such as stainless steel slags and ashes. Mineral carbonation produces silica and carbonates that are stable over long time scales and can therefore be disposed in areas such as silicate mines or re-used for construction purposes (Fig. 6.), although such re-use is likely to be small relative to the amounts produced. After carbonation, CO_2 would not be released to the atmosphere. This method will be evaluated in future time.

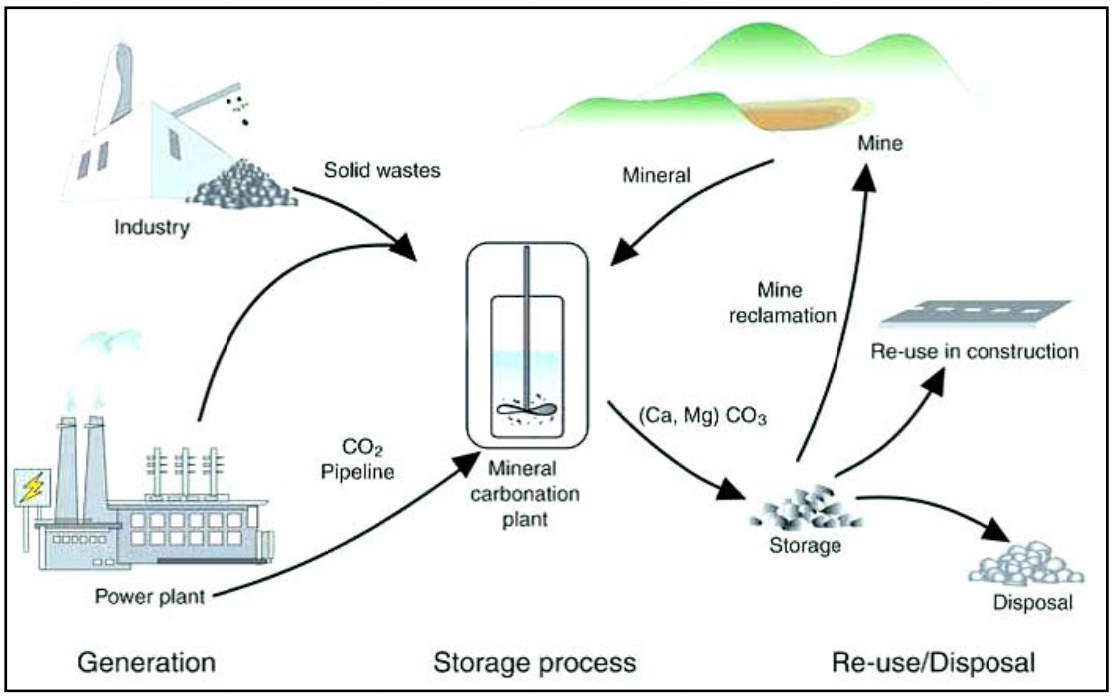


Fig.6.Material fluxes and process steps associated with the mineral carbonation of silicate rocks or industrial residues

We have estimated the storage capacity of CO_2 for Dumre salt dome and Albanian oil fields.
The case study for Albania refers to CO_2 storage in a big salt dome in Dumre area, in southern central part of the country. The salt dome is of Triassic age and has been emplaced in the limestone section of Ionian zone. The dimensions of the dome on the surface exposure are from 12 to 18 km and the vertical thickness exceeds 6 km.
The CO_2 storage can be carried out after the creation of caverns. The caverns are to be made by using solution from salt formations as is shown in figure 7.
A single cavern created in this way with dimensions R=40 m and H=300 m (but depend from content of salt) has a storage capacity of about 1 Mt of CO_2 in supercritical state. The calculation is based on the formula (George Hadzijanis, Irakli Prifti et al):

$M_{CO2} = \pi * R^2 * H * \rho_{co2}$

where,

R = radius of cavern
H = vertical height of cavern
ρ_{co2} = density of CO_2 at the depth of 2000 m
π= 3,14

Therefore in the area of the dome (12 by 18 km), more than 50 caverns could be created and the storage capacity potential exceeds decades of millions tones of CO_2.

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Authors propose first a testing well to determine the dimensions of the cavern because the salt minerals are in thin bodies within the evaporite sediments of the diapir.

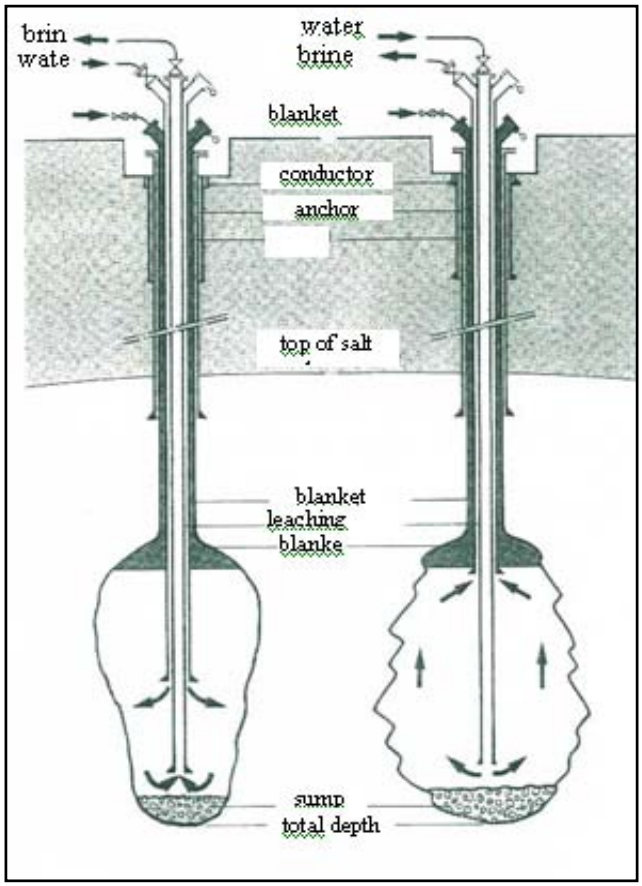


Fig.7. Sketch diagram of cavern creation.

Capacity estimation in Albanian oil fields is calculated for two types of reservoirs: limestones and sandstones. The main oil and gas fields inAlbania occur in reservoirs as sandstones and limestones. All parameters or calculation are well estimate.
The storage capacity of the Albanian oil fields has been estimated using the formula from the" Gecapacity" program assuming a 1:1 volumetric replacement ratio between hydrocarbons and CO_2:

$Mco_2 = \rho_{co2r} \times UR_p \times B$

where:

Mco_2: hydrocarbon field storage capacity
ρ_{co2r}: CO_2 density at reservoir conditions
UR_p: proven ultimate recoverable oil or gas
B: oil or gas formation volume factor

Albanian oil fields are suitable for stoking CO_2 and it depend from following reasons:

- their oil production are in the final stage;
- injection of CO_2 increases the energy in reservoirs and increases the production of oil, as is shown in figure 8;
- increasing capacity of CO_2 storage.

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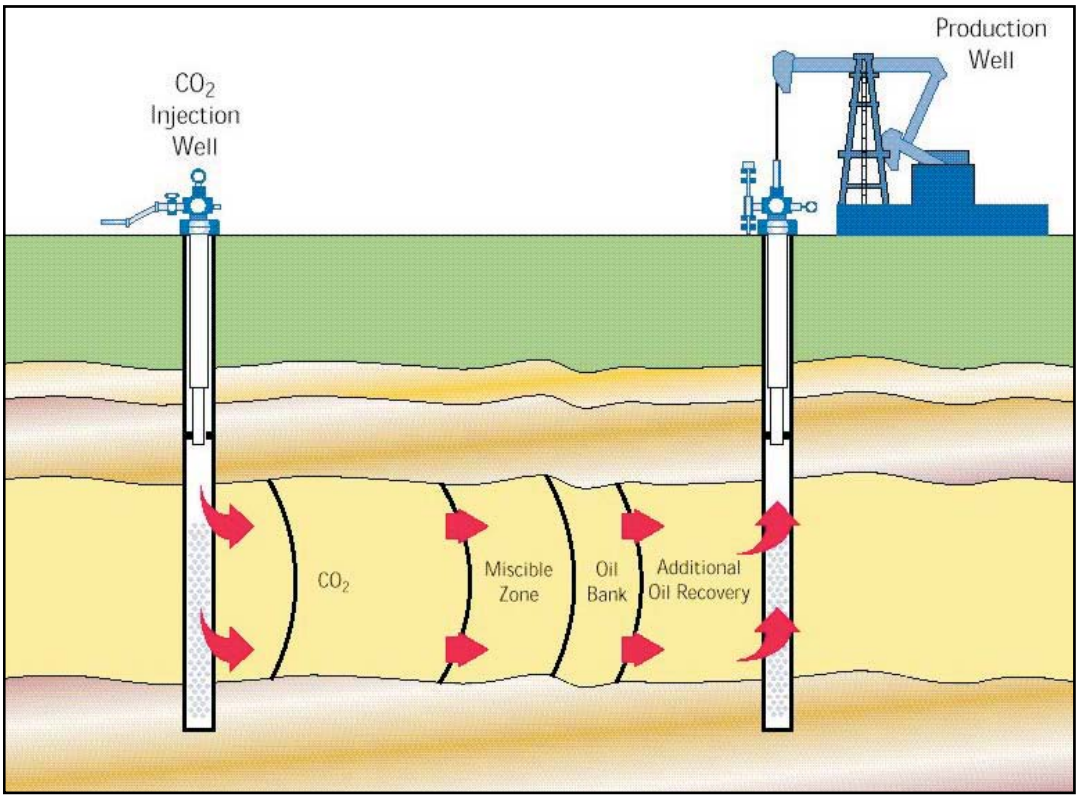


Fig.8. Scheme of CO_2 enhanced oil recovery in sandstone reservoir

ANALYTICAL RESULTS AND DISCUSSIONS

Based on above functions are calculated analytical results of CO_2 storage. Storage capacity estimation for the Dumre salt dome is 10 million tones CO_2 only for 10 caverns with dimensions of R=40 m and H=300 m.

Table 1. Storage capacity estimation for the Dumre salt dome.

Structure/Zone	**Area (m^2)**	**Effective thickness of aquifer (m)**	**Net/gross ratio**	**Effective Porosity (%)**	**CO_2 density 1.1.1**	**1.1.2 Storage efficiency 1.1.3 factor (%) 1.1.4**	**1.1.5 Total estimated CO_2 storage Capacity 1.1.6 (Million ton) 1.1.7**
Dumrea dome	**1.1.8** 5000*10=50000	**1.1.9** 300	**1.1.10**	**1.1.11**	**1.1.12**	**1.1.13** 1	**1.1.14** 10
10 caverns will be created		**1.1.15**	**1.1.16**	**1.1.17**	**1.1.18**	**1.1.19**	**1.1.20**
Total estimated CO_2 storage capacity in deep saline aquifers (Mt)							**10**

Based on the information for the existing oil and natural gas fields we conclude that:
In the known oil and natural gas fields in Albania there are 3.630 billion Nm^3 recoverable reserves of gas. From them, roughly 22 millions of N m^3 occur in the fields of natural gas while 3.610 billions of Nm^3 of gas

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occur in the fields of oil and condensed gas and in the form of dissolved gas in oil or condensed and free gas in the gas caps of certain fields.
The storage capacity of CO_2 is estimated from summary information on the individual oil fields and functions where parameters are well estimate.
Summary information on the individual oil fields are taken from "Assessing European Capacity for Geological Storage of Carbon Dioxide (CENTRAL EAST GROUP)" project. While in table 2, is given the basis for the capacity calculation and the estimated CO_2 storage capacity for each oil field.
Ballshi oilfield is the best case for stoke of CO_2. We suggest that injection of CO_2 need to realize into the water zone of oil trap, via Ballshi-27 well (Fig.9).

The total estimated CO_2 storage capacity for the Albanian hydrocarbon fields amounts to 111 Mt.
Within the Albanides are others geological objects for storage of CO_2 (Miocene and Pliocene deposits).
In conformity with some preliminary calculation in Albania, they can be able to storage more than 200 million ton CO_2.

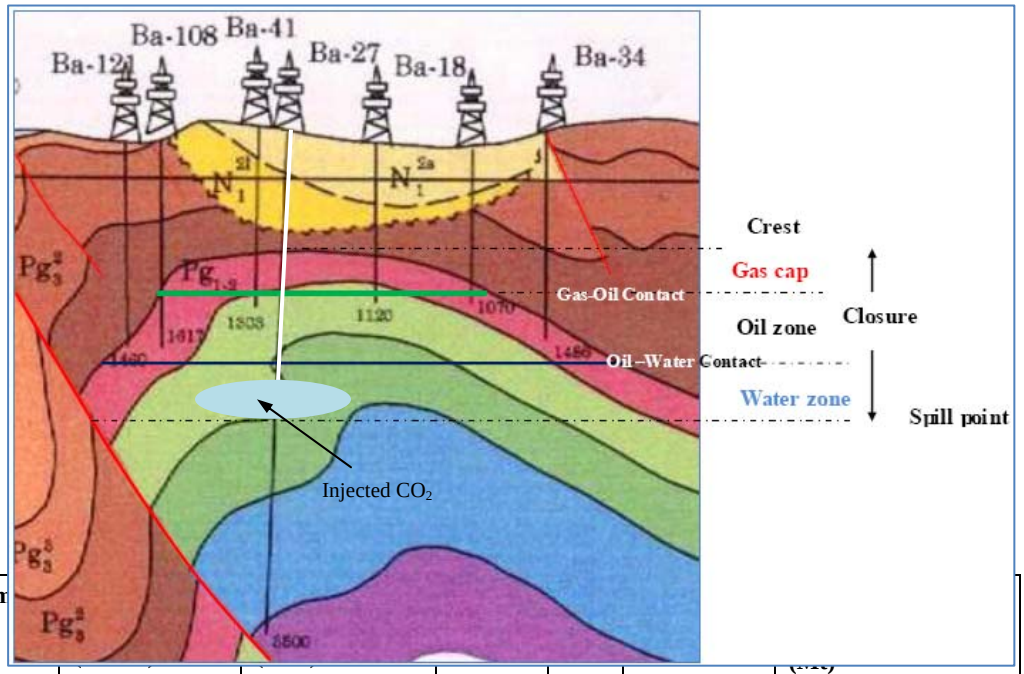


Fig.9. Injection of CO_2 in Ballshi oilfield

Oil Field Nam						
Cakran - Mollaj	8	8.144469	0.0043	1.2	0.7	28.39851121
Ballsh - Hekal	0.545344	6.359844	0.0065	1.2	0.7	7.69045006

Oilfields of Gorishti, Visoka and Ballshi are the better units for stokage of CO_2. Power plants need to be built near the Geological units because the financial cost of transport must be higher.*Table 2 Storage capacity estimation for Albanian oil fields.*

Gorisht - Kocul	0.594306	14.674087	0.0065	1.2	0.7	14.66821737
Karbunare	0.0081	0.135700	0.0055	1.2	0.7	0,13564572
Amonice	0.06914	1.503	0.005	1.2	0.7	1,5023988
Visoke - Kolonje	0.2394141	6.806956	0.0065	1.2	0.7	6,804233218
Delvine	1.17	0.134	0.0038	1.2	0.7	3,2461464
Finiq - Krane	0.878	0.154117	0.005	1.2	0.7	3,227055353
Drashovica	0.000264	0.024	0.0065	1.2	0.7	0,0239904
Bubullima suit	0.20990835	0.494140	0.005	1.2	0.7	1,035583332
Marinza suit	0.9265	8.481394	0.0057	1.2	0.7	10,36726644
Driza suit	0.50146	20.0584	0.0057	1.2	0.7	20,05037664
Gorani suit	0.074553616	2.086252	0.006	1.2	0.7	2,090079499
Kucove	0.9122098	11.772486	0.0065	1.2	0.7	11,76777701
Rase - Pekisht	0.0018357	0.197040	0.005	1.2	0.7	0,196961184
Total estimated CO_2 storage capacity for all Albania hydrocarbon fields (Mt)						**111.2046926**

CONCLUSIONS

Uncontrolled emissions of CO_2 exist in Albania. The technological process is not including the capture equipment and liquidification of CO_2.
Main geological units for the storage of CO_2 are limestones and sandstones reservoirs in oilfields, caverns within the evaporite body of Dumre.
Saline aquifers are placed in Kozan and Fitore anticlines made-upby carbonate formations, while in Adriatic depresion are under overpressure levels (sandstone reservoirs).
The total estimated CO_2 storage capacity for the Albanian oil fields amounts to 111 Million tone. But based on our preliminary calculation in Albania, can be possible a capacity of storage of more than 200 million tones CO_2.
The power plants need to be located directly above a geological storage site and the captured CO_2 must be transported from the point of capture to a storage site. The principal methods of CO_2 transport are pipelines, roads and rail tankers.

ACKNOWLEDGES

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LITERATURE

A Summary of a Special Report by the Intergovernmental Panel on Climate Change, 2007. *Facts on CO_2 Capture and Storage*

George Hadzijanis, Irakli Prifti , Agim Shenjatari , Apostol Qirko . 2009. Athens. *Assessing European Capacity for Geological Storage of Carbon Dioxide (CENTRAL EAST GROUP)*

J. Davison, P. Freund and A. Smith. February 2001. *Putting carbon back into the ground:* 13-16

Intergovernmental Panel on Climate Change. 2001. *CARBON DIOXIDE CAPTURE AND STORAGE:* 5-36

ISSN 2306-9600

I. Prifti**,** A. Shenjatari, A. Neziraj. *Geological capacity for CO_2 storage in southern Albania*
Referuar në "Workshop",Prishtinë, korrik 2007.

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THE GEOLOGICAL SETTING AND EXPLORATIONS IN VLORA SAZAN REGION

Sazan GURI[1], Marianthi GURI[2]

[1] *G&G group Institute, Tirana, Albania*
[1] *G&G group Institute, Tirana, Albania*

ABSTRACT

Vlora Sazan region is a well studied area from the geological point of view, where the contribution of regional seismic line and new processing ones have been of great importance. The object of this article is to analyse the geological setting, tectonic mechanisms and hydrocarbon prospections. Based on new geological and seismic data, a new interpretation is accomplished to evaluate the possible carbonate structure. The paper is a brief summary of a regional study in which many problems about stratigraphy, geodynamic, hydrocarbon potential and the exploration discovering ways are in details treated.

KEY WORDS: *hydrocarbon prospect, south adriatic basin, ionian basin, sazan platforms, anticlyne of Rreza e Kanalit, ionian folded zone, anticline of vlora, periadriatic depression*

1. INTRODUCTION

Vlora region represents the most complicated zone from tectonic point of view. (Fig. – 1). In its south (Llogara Pass), the tectonic Çika zone is confronted in an intensive collision with Apulia-Sazan folded part. In Vlora Sazan region, the the setting carbonate deposits, flysch and molasse formations takes place from Upper Triassic to Pliocene. This area is consisted of the possible hydrocarbon objects. From the oil exploration point of view, the prospections are concentrated in the top part of Vlora structure, which is not proved by the well drillings, yet. This upper part, as mention above is under Vlora city. It is tectonically closed, have averagedimensions that may still have a more favorable framework. As to gas exploration, in the neogenic Vlora-Panaja structures, the prospect is more favorable in Panaja, where the slope fan turbiditic sandstones are more accumulative or gas bearing than coastal sandstones of Vlora region. However, the exploration prospect from this study result to be in upperpart of neogenic Vlora structure (west of well Vl-6, 5, 2), which is actually in the offshore. [1]

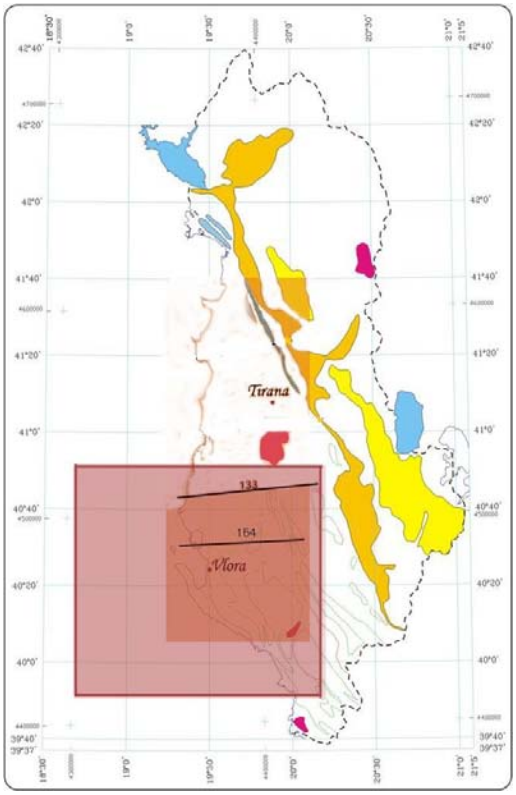


Figure 1. Study area map.

2. MATERIALS AND METHODS

In Vlora Sazan region, the setting of carbonate deposits, flysch and molasses formations takes place from Upper Triassic to Pliocene. According to the genetic context [2], they will be described in two great tectonic units:

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- Sazan -Zvernec zone
- Ionian zone.

Upper Triassic and Lower middle Lias

In Sazan Zvernec zone, the deposits are represented by dolomites and dolomitic limestone's (T_3) and detritallimestones (J_{1-2}) of a neritic facies. In Ionian zone, where Vlora is included, the evaporitic formation was formed under the massive dolomites with limestone fragments, with a poor fauna, excepting corals and megalodants (T_3) and by dolomitic limestones with cherts and dolomitic limestones or ???dolomites without cherts (J_{1-2}).

Toarcian-Lower Cretaceous

In Sazan-Zvernec zone, this section is represented by dolomites, dolomitic and oolithic limestones with gastropods. In the Ionian zone, the marly shale package (J_1^3), lower cherty package (I2), upper cherty package and Majolica limestones (J_3), micritic limestones are distinguished ,where the clayey and marly ones, intercalated with cherts increase upward. The sea depth reaches the maximum values, covering the Liassic neritic deposits.

Upper Cretaceous

In Sazan-Zvernec zone, the dolomitic limestones and dolomites with well preserved rudists and gastropods are developed. In the Ionian zone, a platy marly section is continuing, but the clayey material is decreasing and the detritic one is increasing.

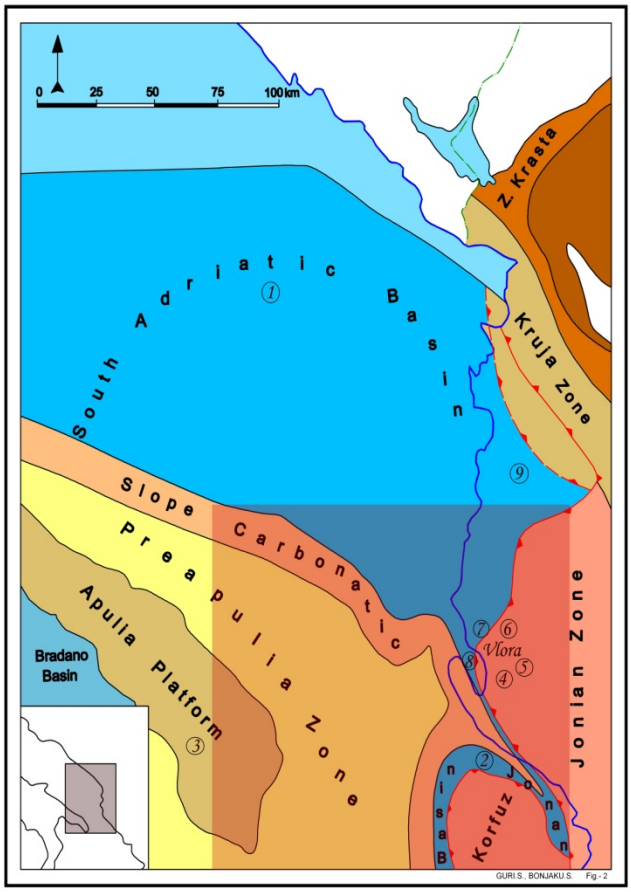


Figure 2. Facial Scheme of South Adriatic and Ionian Carbonate Basin

Eocene - Paleocene

In Sazan-Zvernec zone, the deposits are represented by nummulitic limestones and an unconformity of this section with the older deposits is clearly noticed (well Zv-3). In the Ionian zone, these deposits are represented by detritical limestones that increase upward, with intercalations of micritic limestones, where limestone and wackstone type predominates. (well Vl-10, 11).

Flysch formation

In Sazan-Zvernec zone, this formation is almost absent. Where is encountered, it has a carbonatic nature, under the influence of exposed Apulia-Sazan platform. In Ionian zone, the flysch deposits are represented by thin rythmic intercalations of sandstones and claystones, where marly and detrital limestone beds are present. (Fig. – 2).

Flyschoidal Formation

In Sazan-Zvernec zone, this is almost absent because the deposits have been onlapped toward Apulia-Sazan platform slope wall. Where it appears, it is represented by massive carbonatic clays with intercalations of sandstone clay silts with underwater slumping horizons. In recent biostratigraphical interpretations in Vlora region, is concluded that the section of Acquitanian in the well Vlora-11 is absent. As a consequence, there is a gap between the Burdigalian deposits and Upper Oligocen.

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Shlier deposits

In the studied area, these deposits are almost encountered in unconformity with the older ones. The appearance of marls and the increase of clayey matter are the characteristic of this section.

Molassic Formation

Premolassic formation (Serravalian) is composed of clays, scarcely sandstones and detritic limestones. They continue successively, but towards the basin margin they are in discordance with the older deposits. The typical molasses formation (Tortonian topresent) is represented by intercalation of sandstones with silt, clays, where the clay content is increased toward ??depocenter.

The Messinian rocks

Are represented by massive clays intercalated with sandstones which predominate upward, (Fig. - 3). The clays haveblue color, are compact and with somesilty material. From mineralogical point of view, based on diffractometry, the clays assemblages are represented bymontmorillonit (45-60%), ilit (15-20%) kaolinit (10-15%) and other minerals of mix bedding (up to 5-7%). The cement is of mix contact and it's mainly represented by the spatic carbonate. [3]

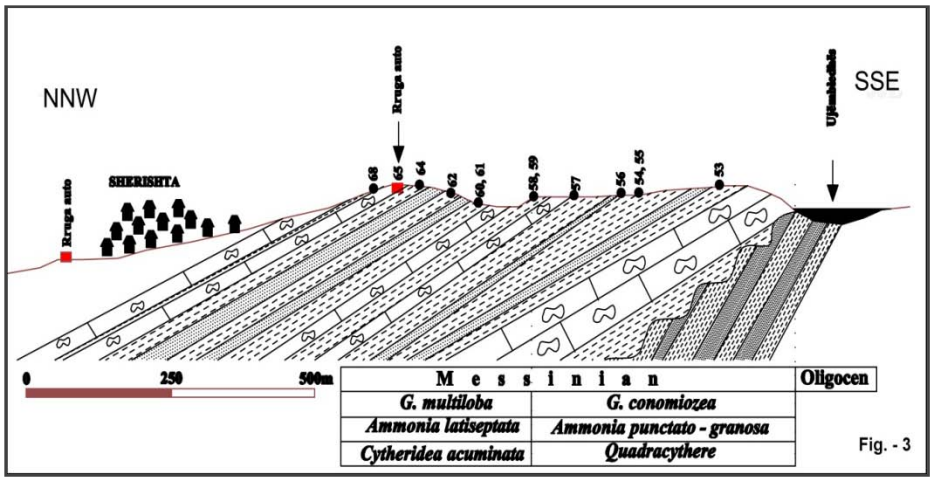


Figure 3. Cross Section of Kanina area

The Pliocene rocks take place along the eastern part of studied area, beginning from the rock of Kavaja down to the city of Fieri. The Pliocene is represented by two known formation such are Helmesi suit and Rrogozhina . The deposits of Helmasi suit begin with basal sandstones and conglomerates, interbedded with clays that predominate upwards. Both sandstones and claystones have the same mineralogical constituent as in Messinian rocks.

Covering Formation

Based on many field trips and many drilled wells, it is thought that the Quaternary loose deposits are composed by delluvional, alluvial, lagoon-marshes andcoastal-deltas deposits. [4]

Delluvional deposits take mainly place near the foothills of bedrocks with a thickness of 4-5m that is reducing westward, going laterally and facially in alluvial deposits. It's difficult to distinguish it in the subsurface sections because of its similarity with the alluvial ones.

Alluvial deposits seize the major part of studied area and it's presented as a vegetal land. They are mainly represented by plastic to weaklycompact subclays. Near the water stream (river, drainage), it is represented by light subsands up to half of this century, as that of Semani, or withoutoptimal constructive rhythms as Vjosa or Shkumbini river. Another reason of delta destruction is the finishing of the constructive cycle's period of agradational and progradational parasequence set. They will prolong not more than 40-50 years. The knowing and the evidentation of above-mentioned parameters make possible to forecast a definite geomorphology on the benefit and/or on the serve of water source exploration. Medium grain size gravels saturated with water represent them. It's also evident in the subsurface section during the highstand system tract, especially in the

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last one.

Lagoon and marshes deposits emerge as a strip accompanying the beach zone. They are represented by wet up to flowing clays, with brown to dark color and with abundant quantity of organic matter, as plant remnants, cool matter, torph and mud. On surface, it's presented as a hyper saline land without vegetation. In subsurface (well sections), it is distinguished by individualizing the coal markers or clay thickness with abandoned organic matters. The lagoon and marshes environments migrate westward to younger stratigraphic levels.

Coastal deposits consist of beach and front delta sediments. Small and medium grain size sands, grey to beige color, semi compact and with some light subclay laminations. Along the seacoast, these deposits have a thickness of 17-20m. On the subsurface, they took place during the highstand of each depositional sequence and they are preserved in the last one. This environment also migrates westward to younger stratigraphic levels.

THE GEODYNAMIC

From tectonic point of view, Vlora region represents the most complicated zone In its south (Llogara Pass), the tectonic Çika zone is confronted in an intensive collision with Apulia-Sazan folded part (Fig. -2). In this context, several tectonic segments take part:

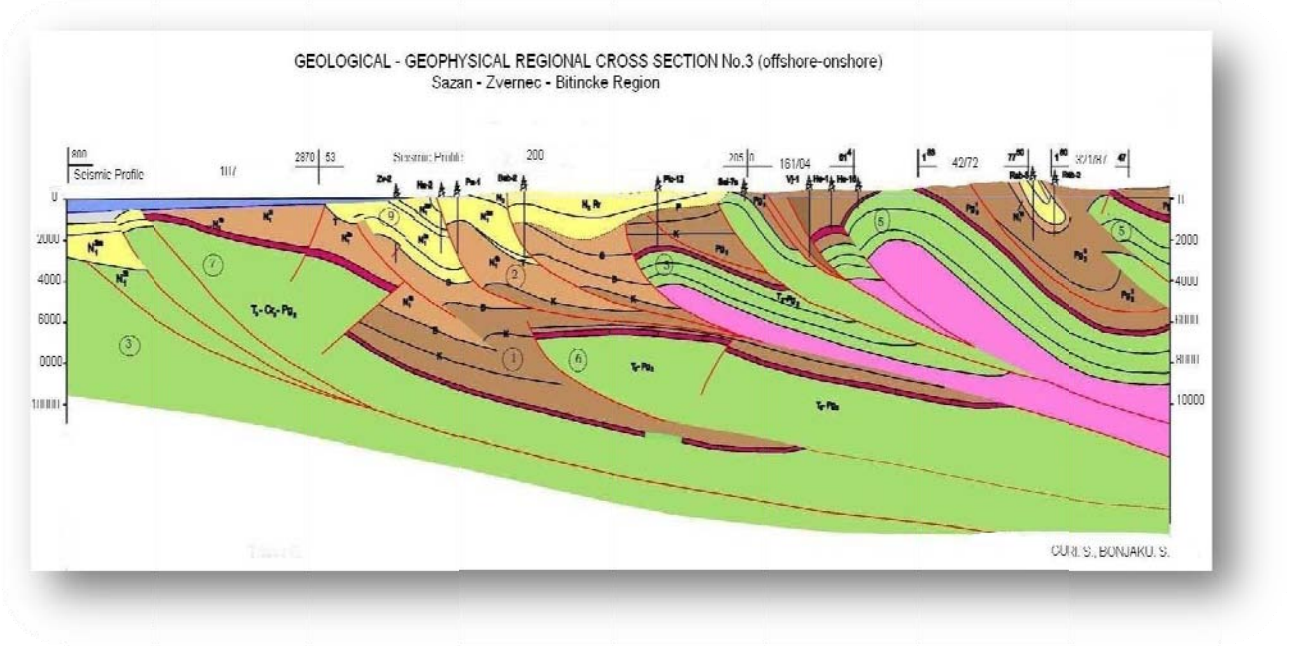
1. South Adriatic Basin
2. Ionian Basin
3. Apulia Sazan platforms
4. Anticline of Rreza e Kanalit
5. The Ionian folded zone(anticline of Çika-Tragjas)
6. The anticline of Vlora
7. The slice of Sazan-Zvernec
8. The slice of Vlora
9. Periadriatic depression

The main characteristic of tectonic segments

1. South Adriatic basin (SAB)
It is represented especially by carbonate deposits fromthe sedimentation area between Kruja-Dalmatia zone (east) including Apulia-Sarande (west) Based on gravimetry anomaly and facial constituents [5], the SAB is individualised from the north Adriatic basin toIonian basin (South). As sedimentary feature, we expect a diversity of facies, from neritic to outer shelf (Apulia-Sazan platform) facies, continuing laterally with slope and basin pelagic facies (south Adriatic Basin). In the tectonic aspect, the major part of SAB eastern flank is overthrusted southwestward (Paper-Rodon, Tirane-Ishem, belt, ect.).

2. Ionian Basin (JB)
It represents the sedimentary area between Kruja-Gavrova zone (east) toSazan-Paksos one (west) From sedimentarypoint of view, we have to expect the same depositional system characteristic for neritic facies for the platform settings, and a pelagic facies for the basin settings. Tectonicallyit is noticed that the most part of its eastern flank is folded and overthrusted northwestward. Its structural belts lose their significance toward the north, such as Korfuz, Çika, Kurveleshi belts, etc.

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3. Apulia- Sazan Platform (ASP)

ASP represents a depositional area where neritic facies is generally sedimented. It accompanies linearly the SAB and IB according the northwest - southeast direction. Tectonically it represents the foreland of passive margin basins, the greater part of which is not affected by the tectonic orogenic forces.

. Rreza e Kanalit anticlyne

It represents the folded zone of themost outer part of Apulian-Sazan platform ASP. As a result of orogenic forces, we have an anticline with regular eastern and western flanks and with somewhat readable northern periclynal under Sazani Island. The western flank with many and very small tectonic faults pass to an unfolded platformic zone. (Seismic line H -111/91,112/91, 111/91, ch-129, 127/90, etc.). In the east it has to be accompanied with a normal type tectonic that serves as a slope zone of South Adriatic Basinand Ionian Basin

5. Çika - Tragjas, anticline

It represents a known belt and it is connected with the orogenised part of the Ionian basin An interrupted overthrusting of this one is the main factor for a complicate tectonic s

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in studied area. In retrospective, it would have had a more pelagic than Vlora region.

6. The individual of Sazan-Zvernec

This massive block represents the part from the eastern flank of "Rreza e Kanalit anticline as result of its collision with Çika belt. From the depositional point of view, we deal with the existence the outer shelf part, where the facies of reef build-upsand reef type are expected and encountered (Sa-1, Zv-2, Falko-1). This individual slice is surrounded and related with the other units by tectonic faults, the mounting of which in the place, where derived from completes "Rreza e Kanalit" anticline. (Fig. – 4)

The individual slice of Vlora

From tectonic point of view, the slice part derived from the south eastern part of Vlora ???fundamental structure. It corresponds with the known zone of Vlora, proved by the wells Vl-11, Vl-10 in the upper partpart and which is developed northwestward, under the city of Vlora. Together with the fundamental Vlora structure, it represents an orogenic folded structure. The western fault put this one in contact with the unfolded Ionian basin part. From structural point of viewa brahifolded structure is distinguished, whereas is limited and separated in structural fragments by many overthrusting tectonic faults which are often accompanied by the backthrust ones. In this structure, an eastern flank, a periclynal and the top parts can be easily individualized.

Periadriatic Foredeep (PAF)

PAF in the studied area is represented from the trough between Tragjas orogen (east) and Apulia-Sazan Platform (west) overlying part [6]. Through this zone is preserved the molassic basin communication between south Adriatic basin Ionian basin. In tectonic aspect, a several structures of pop-up type is connected with the Neogenic deposits as:

- Vlore - Panaja - structure
- Zvernec - Povelçe - structure
- Sazan - monocline.

Vlore - Panaja Neogenic structure

It represents a neogene anticline structure with Burdigalian deposits up to Messinian that sinks northward (Panaja). It is accompanied by the main tectonic fault (Narta fault) in the west side which loses its role together with the structure northward. Another fault in the east flank of "backthrust" type individualizes the structure as "pop up" type.

Zvernec - Povelçe neogenic structure

It is a neogenic anticline structure and occurs in the Poro-Povelçe-Seman structural belt. It is accompanied by a faults family in the western side (Zverneci-Seman fault), but there are also present the backthrust type faults in the eastern flank. Burdigalian deposits consist of the marls on which the Serravalian up to Pliocene deposits are transgressively discordantly onlapping. We deal with a pelagic facies of deposition (outer shelf, slope - basin) [7]

3. RESULTS AND DISCUSSIONS

The prospect and the exploration strategy

From this study, in Vlora-Sazan region results that is effectively increased the interest to continue the exploration methods for oil gas bearing fields discoversg. Now, it is not difficult to recognize the zones of great interest for study and exploration. First, it must be included the zones that need more seismic lines and deep processing, such as:

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- The zone in Zvernec with the depth of 3000-3500m which is clay cussed to represent an anticline deep structure.
- The zone in Vlora region in the time of l.5 - l.6sek (lines 129/94, 126/94 ecc.), which is discussed to be as an individual slice of so-called shallow Vlora.
- The zone in the south of Vlora structure where another structure begin under Tragjas overthrusted anticline, as a continuation of the knowned Vlora structure.
- The deep Vlora structure, which we expect to be a fundamental one in the time from 2,6 sek. down to 3.5 sek.

The above mentioned zone is considered as possible object for future studies. In the exploration aspect, the prospect in concentrated in the top part of Vlora structure, which is not proved by the well drillings yet. This top part, is situated under Vlora city. It is tectonically closed, with average dimensions that may still have a more favorable framework.

- we shall have a more quality processing of seismic lines
- a more dense seismic net in the southwest of Vlora city

As to gas exploration, in the neogenic Vlora-Panaja structures, the prospect is more favorable in Panaja where the slope fan turbiditic sandstones are more accumulative or gas bearing than the coastal sandstones of Vlora region. However, the exploration prospect from this study result to be in upper part of neogenic Vlora structure (west of well Vl-6, 5, 2), which is actually in the offshore. [8] In Vlora-Sazan region, from this study results to continue the exploration in oil and gas bearing targets, such as in:

- Zvernec zone, in the depth 3000-3500m, which is interpreted to represent an anticline deep structure.
- Vlora region, where we expect a deep carbonate structure in the time from 2,6 sek. down to 3.5 sek.

IV. CONCLUSIONS

1. The mentioned zone consist of the possible hydrocarbon objects;
2. The prospect is concentrated in the top part of Vlora structure, tectonically closed and in medium dimensions.
3. As to gas exploration, the prospect is more favorable in the turbidities sandstones of slope fan than coastal sandstones.

V. REFERENCE

[1] Scientific Report, Apennines' – Hellenizes Geodynamic
[2] Guri S, Ismaili J. The basin study of the Preadriatic Depression (Albania). Archive of Oil and Gas Institute, Fier 1993
[3] Guri S., Mehillka LL. -The structural model of external Albanides and hydrocarbon prospects Archive of Oil and Gas Institute, Fier 1995
[4] Mahmutaj L. The mineralogic – petrographic study of clayrocks in pre Adriatic depression. Archive of Oil and Gas Institute, Fier, 1989

[5] Bally A. Plate tectonics, structural styles and the evolution of sedimentary basins. Oil & Gas Institute, 1989
[6] Guri S. et al The molassic basin analyses of PAF. Oil and Gas Institute, Fund. (1989)

[7] Skrami J., Guri S. Some trends of the study of Quaternary loose deposits on the Durres-Vlora coastal zone. Publicize of "Universita degli Studi di Bari" (Italy),p. 185-187, Gennaio, 1999, Scientific Library of Oil & Gas Institute, Fier – Albania

ISSN 2306-9600

[8] Dhimulla I. The structural model of external Albanides. Oil and Gas Institute, Fund,1989

[9] Possamentier, H.V. et al - Eustatic controls on clastic deposition SEPM Special Publication, 42 p.109 -154, 1988

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REGION OF KUSHE A GOOD POSSIBILITY FOR THE DISCOVERY OF AN OIL-BEARING DEPOSIT

Petraq NAÇO[1], Fatbardha VINÇANI[1], Viktor DODA[1]

[1]*Institute of Geosciences, Energy, Water and Environment / Polytechnic University of Tirana, (Rr. Don Bosko, Nr. 60, Tirana, Albania),*

E-mails: petraqnaco@yahoo.com, bardha_vin@yahoo.com, viktor.doda@gmail.com

ABSTRACT

Search for hydrocarbons has consistently been one of the most important and most successful underground assets in Albania. Results have been numerous, are discovered oil and gas deposits, as Kuçova, Patos, Pekisht-Hawthorn, Marinëz, Gorrisht, Divjakae, Ball, Hekal-Karbunara, Cakran etc. Many of these deposits continue to be exploited until this day, making it interesting and attractive for many foreign companies that deal with the exploitation of hydrocarbon deposits.

But also, the search for hydrocarbons is a difficult field and higher economic risk, but a very important and lucrative potential development of each country. Concretely, the searches in the geological structure of Albanides are becoming increasingly difficult, especially in these last two decades. Have suffered serious breakdowns and foreign companies, known in the field of oil and gas research. This highlights not only the complicated geological construction of Albanides but still derecognition of tectonic style, which has led to incorrect interpretation of seismic facie, as well as of the geological construction.

In these conditions, through this paper we want to draw out two things: the great possibilities that provides the geological structure of Albanides to search hydrocarbons, as well as the importance of seismic method, as one of the basic methods for obtaining the geological information from the depths of the underground. Just as important we consider and modeling of geological construction, through the information provided by this method, as well as its position in accordance with the tectonic structure of Albanides.

Kushe region offers a lot of data, both in terms of depth, via seismic profiles and the wells drilled in the border regions, as well as through the surface, both in terms of the positioning of the structural model and multiple signs of oil captured from wells drilled out the structural model.

In this presentation, through the example of Kushe region, will show that geological regions of Albanides there are yet many possibilities for research and discovery of hydrocarbon deposits.

KEWORDS

Kushe region, searching of hydrocarbons, seismic profiles, modeling of geological construction.

1. INTRODUCTION

Kushe region is one of numerous regions in the area of Albanides which offer possibility for petroleum exploration. In terms of degree of difficulty,this region can be considered a difficult one because the structural building of surface goes into inverse with the image of the depth structural model, outlined via seismic profiles. Such models are popular in our country, for example thedeposit of Ballshi oil-gas bearing. The outlining of the hydrocarbon potential of this deposit is made by informations coming from the depth, with the help of seismic studies, but also by the connection of this data block with the regional structural background. Seen in a wider area than the region where is prognosticated the deposit, we observe that are provided the data through seismic works, wells drilled, oil marks on the surface, regional structural model indicating that Kushe region represents a good possibility for discovery of a hydrocarbon deposit. The purpose of this paper is that through a concrete example to show that the geological regions of Albania provide numerous opportunities for petroleum exploration.

2. GEOTECTONIC POSITION

The spatial position of Kushe region, in ordedto analyze it, it is considered by interesting and very important. It is outlined in the contact area between Kruje and Ionian tectonic zones (Fig. 1).

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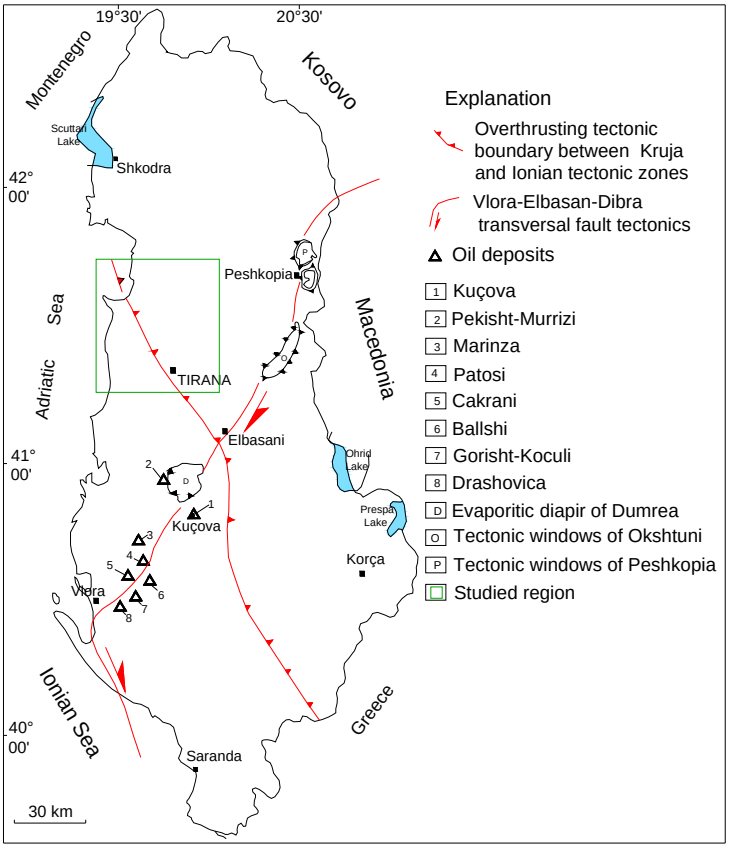


Fig. 1. Geotectonic position of the Kushe region

Hence, to understand that prognostic carbonate anticline structure of Kushe as structural mounted unit, is the product of that powerful orogenic process, who has followed the evolution of relations between two major units of Albanides as it is between the Ionian and Kruja tectonic zones (Velaj T. et al., 1999). It is interesting that the prognostic structure is outlined in that segment of Albanides which is characterized by powerful fold formation processes, therefore high probability of meeting of anticline structures as under overthrusted tectonic plane, as well as on the forehead of the overthrusting tectonic unit (Naco P., 1999; Naço P., Vinçani F., 2011). While important we regard in the sense that forecasted carbonate anticline of Kushe is positioned near a major tectonic contact, such is the case between the Ionian and Kruja tectonic zones. This contact consider a regional tectonic fault, early and deep, thus a positive factor, as in the sense of orogenic powerful that has leaked through it, as well as in terms of communication of great depths of underground with of forecasted structure for oil-bearing deposit searching. We must remember that many oil deposits in Albania are concentrated near major tectonic fault, such as, for example, transversal tectonic fault of Vlora-Elbasan-Dibra (Naco P., 1997; Naço P. et al., 2011).

3. DATA AND THEIR ANALYSIS

Prognosis of oil-bearing structures is not a simple process, therefore their reaserch is constantly accompanied by the performance of a wide range of geological-geophysical works. In this variety of used methods, an important place occupied seismic works (Çollaku A. et al., 2000). The data presented by themmake possible the realization of geological modeling to considerable depths. It is understood that this geological modeling conducted in closely related to surface geological data, drilled wells, if such exist, as well as other information to help at the realization of a study as more scientific. Even earlier geological region, which includes Kushe region, has undergone seismic works and drilling for oil exploration. So, for the realization of this forecast are used data presented by seismic works, deep-drilled wells, geological maps, etc.

Seismic works are the main works on the forecast of Kushe oil-bearing structure. (Fig. 2).

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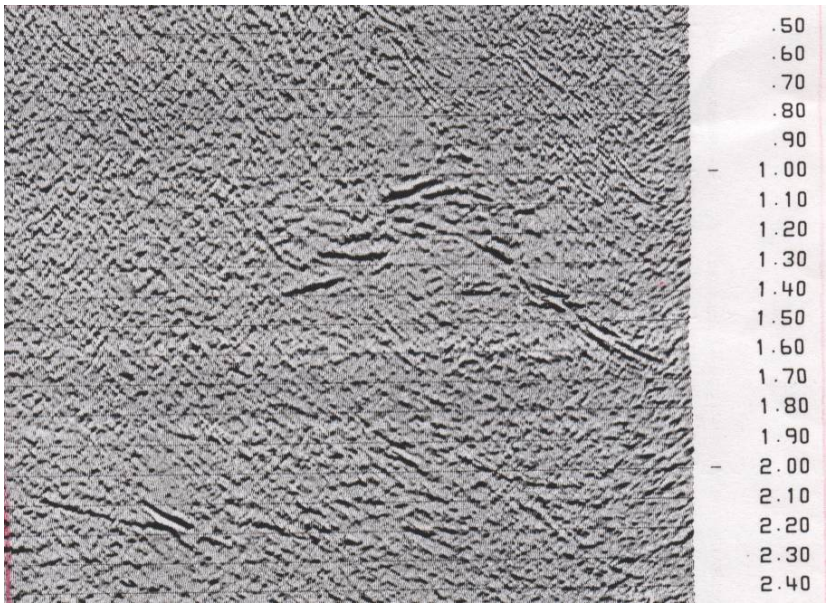


Fig. 2. Seismic cross-section, the peak of forecasted structure of Kushe

Through the information obtained from them, it has become possible not only the determination of carbonates ceiling, namely oil-bearing reservoir ceiling, but also the delineation of this possible hydrocarbon prospectus. The contribution of seismic works consists in behavior of a powerful signal, in the form of a reflector, which allows for the modeling. So seismic facies acquired, which served us in the form of vertical cross-section, gives the opportunity not only to determine the ceiling of carbonates, which think at the same time as oil-bearing reservoir ceiling, but also to delinate and other possible geological elements (Fig. 3). Another important point worth mention is the seismic signal stability. Different seismic profiles, performed in different extents and in the timing difference with each other, have taken the same seismic signal with the same stability and the same reflective power (Fig. 2, 3, 4).

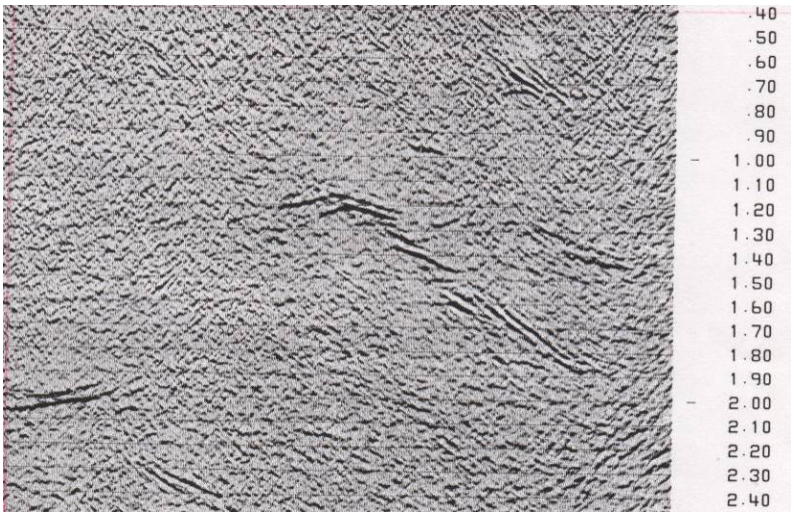


Fig. 3. Seismic cross-section, Kushe region

This gives us the argument to think that the powerful reflector identified as such, represents the boundary between two geological formations clearly distinct, the Trissic-Eocene carbonate sand the Oligocene flysch. On the basis of the stable signal, is designed not only the hydrocarbon potential prospect in area, but is also built the depth structural map, which will treat below. Another indicator that think to treat is the depth of the seismic signal registration. It coincides with the time from 1.1 to 1.2 seconds, that referring to averaged speed of geological formations that build the region, indicating that the forecasted oil-bearing structure to be at the depth of about 2000 meters. This is another indication, more favorable at increasing of interest for exploring of this the hydrocarbon potential prospectus.

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Fig. 4. Seismic cross-section, southern pericline of Kushe structure

Fortunately, in the eastern peripheries of region we discuss, several wells drilled for petroleum research. Data presented by them are very interesting for oil-bearing structureprognosis Well 1, which is located on the eastern edge of one of the seismic profiles, has been left hanging in the lower levels of Lower Oligocene flysch formation. This data, projected on seismic profile allows us to judge, that powerful reflector, registered in all profiles, there is nothing to reflect than the boundary between the carbonate and the flysch formation. So, in this way, we have identified the seismic reflector as carbonate formation ceiling, where we have also designed the hydrocarbon potential prospects. From the acquisition of the wells were taken many signs oil and gas, even in a few liters, representing a strong indicator for the oil-bearing potential of the area and of concrete region.

4. STRUCTURAL MODEL AND GEOCHEMICAL FEATURES

Forecasted anticline structure of Kushe, as we said above, is modeled on the basis of depth information, obtained from the performance of seismic profiles in thefield. Through them is made possible, not only possible hydrocarbon prospect positioning in space, but also its structural delineation in the extent. As shown in the structural map (Fig. 5), with the help of seismic reflector, it represents an anticline structurewith a length of about 9 km and a width of 5 km.

So, as we see, said more specifically, we are dealing with a brachyanticline structure, which is on the west side and not only is broken tectonically, but is also powerful shifted to the west. Approximately it comes to a horizontal displacement amplitude of 4-5 km and vertical amplitude of about 1.5 km. On the structural side, the forecasted hydrocarbon prospect of Kushe, can be considered as an anticline structure, or brachyanticline, with Albanide azimuthal extent and profound structural element. It is characterized by a strong eastern side, which clearly is read at all the profiles, with a dip angle of about 45 degrees. This structural trend is supported by the well drilled in the eastern peripheries of the region (Fig. 6), which could not reach the ceiling of carbonates in the depth of 2300 m, but remained dependent on the lower levels of Lower Oligocen flysch formation. While to the west, the anticline of Kushe is limited tectonically, characterized by a western side, partially developed, read and drawn clearly as in seismic profiles, as well as in structural scheme (Fig. 2, 3, 5). In structural modeling, obtained with the help of seismic profiles and expressed graphically in structural scheme (Fig. 5), we see that the carbonate anticline of Kushe is structurally closed, both northward and southward, expressed through northern and southern periclines.

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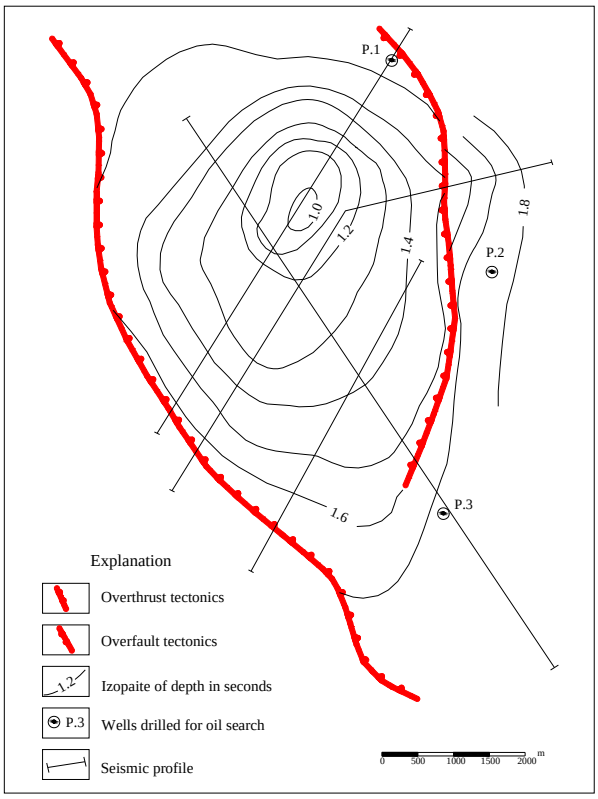


Fig. 5. Structural map under Eocene carbonates ceiling of Kushe anticline structure

In this sense, the anticline structure of Kushe, satisfies all the necessary parameters to be a closed trap for hydrocarbon accumulation. In terms of complications, it is characterized by a stressing geodynamism expressed through thrust and overthrust tectonics (Fig. 2, 6), especially in the peak, a phenomenon which significantly improves the capabilities and parameters of carbonate reservoir in terms of oil-bearing. At the geochemical aspect, the forecasted structure of Kushe is part of geological space, which has been proven generating oil-gas and oil-gas bearing potential.

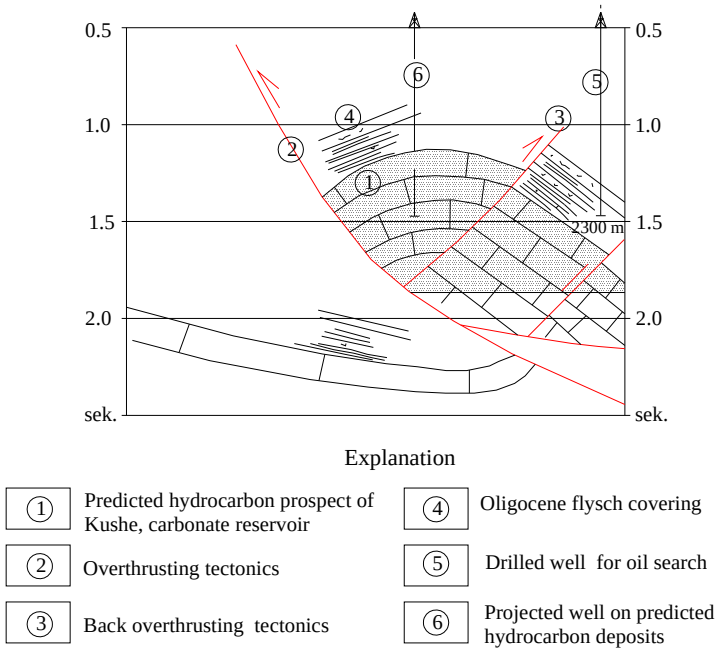


Fig. 6. Geological cross-section of predicted structure of Kushe, built through the seismic profile.

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5. CONCLUSIONS

- Study and the search for hydrocarbons has been one of the most successful underground assets in Albania. The complex of methods used for their implementation has been of the contemporary level.
- Over geological Treves of Albanides, Albanian geologistsfrom the Petroleum Geological Institute, during the period 1950-1990have discovered dozens of oil and gas deposits, indicating for the numerous possibilities offered by the Albanian land, in the field of research for oil and gas.
- After 1990, along the geological Treves of Albanides, have performed the research for the discovery of hydrocarbon deposits many foreign companies, even more popular in the field of petroleum research. Up to now, none of them has achieved positive results, although drilled wells that have passed the limits of 5000 meters depth. On first appearance, this creates the impression that in geological district of Albanides, there is no space for petroleum exploration.
- In this paper, under the illustration of concrete data from the terrain, we want to show that the geological regions and tectonic Albanides, offers many possibilities for research and discovery of new hydrocarbon deposits.
- Kushe Region is one of these possibilities where by information coming from the depth, with the help of geophysical methods, it has become possible modeling and forecast of a specific hydrocarbon prospects.

6. LITERATURE

Çollaku A., Deville E., Naço P., 2000. *New seismic data for hydrocarbon exploration under Kruja overthrust.* 8th Albanian Congress of Geosciences, pp. 61, Tirana.

Naço P., 1997. *On the progress of the flysch in the north of salten diapir of Dumrea.* Bulletin of Geological Sciences, N0. 1, pp. 13-28, Albania.

Naço P., 1999. *Some information on the identification of oil-gas bearing structures in areas with developed tectonics of southwestern Albanides, (anticline belt of Kurveleshi).* Bulletin of Geological Sciences, N0. 1, pp. 33-42, Albania.

Naço P., Reçi H., Vinçani F., 2011. *On the Vlora-Elbasan-Dibra transversal tectonic fault, as one of the earliest and most active tectonics of structure of Albanides.* Bulletin of Geological Sciences, N0. 47, pp. 32-59, Albania.

Naço P., Vinçani F., 2011. *Opportunities for Hydrocarbon Exploration beneath Large-Scale Thrusts in the Geological Structures of Albania*. Journal of International Environmental Application & Science, Vol. 6, Issue 1.

Velaj T., Davison I., Serjani A., Alsop I., 1999. *Thrust tectonics and the role of evaporites in the Ionian zone of the Albanides*. AAPG Bulletin, V. 83, No. 9, pp. 1408-1425.

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GEOTECTONIC SETTING OF THE KRUJA ZONE SOUTHERN PART.

Ana QORRI[1], Shaqir NAZAJ[2]
[1]*Faculty of Geology and Mining, Rruga e Elbasanit,Tirana, Albania*
e-mail ***ana.qorri@fgjm.edu.al shaqir.nazaj@fgjm.edu.al***

ABSTRACT

This article dealt tectonic style of carbonate structures of the Kruja zone southern part. Based on the work performed in the field to identify and analyze geological phenomena of the geological-geophysical material, several conclusions were carried out for the sedimentation environment of these deposits and the determination of geological-tectonic position of Kulmaka, Qeshibeshi and Kerpica anticline structures. This article brings interesting arguments regarding Kulmaka, Qeshibeshi and Kerpica anticline structure type.

KEY WORDS: *Kruja Zone, Sedimentation environment, Anticline structure, Carbonates.*

INTRODUCTION

The Kruja zone is integral part of the Albanian Thrust Belt, which lie directly in the northern continuation of the Western Hellenic Nappes up to their interruption against overthrust front. Numerous detailed geological surveys, seismic surveys and exploratory wells, carried out along the area between the above-mentioned tectonic zone have provided an invaluable information on its facial, structural and tectonic features. Gavrova's zone (Kruja Zone in Albania), geological section begins with Upper Triassic deposits until Eocene and belongs to a shallow facie. It is divided into two mega sequences before rifting and after rifting (fig.1). In Albanian territory the lower part of this complex is unidentified. The oldest deposits that are present in the study area are those of the lower Cretaceous in Tomorri, Kulmaka and Qeshibeshi. This complex is mainly sedimented in a ridge (shallow neritic environments, intertidal and tidal).

GEOLOGICAL SETTING

Geological setting of the study area consists in two main complexes:

a. Carbonate complex.
b. Terrigenous complex (flysch and premolasses).

a. Carbonate complex.

From the application by zoning benthic foraminifera were carried out three main carbonate facies deposits:

1. Neritic facies, are present in Tervolli eastern subzone structures, (Holta section) (fig.2).
2. Mixed facies, are present in Tomorri subzone structures.
3. Pelagic facies are present in Melesini (Leskovik) anticline.

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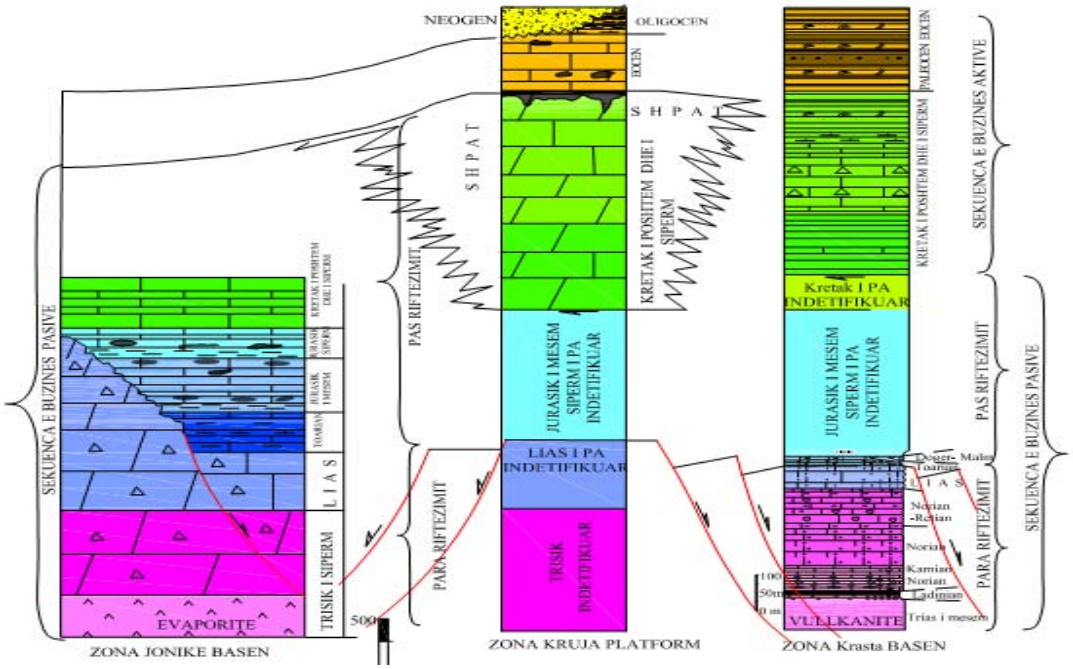


Figure 1. Lithostratigraphic column of Kruja zone compared with close areas.

In upper Cretaceous deposits, in Tervolli structures CS.B 5-7 benthic zones could be distincted. In Tomorri, Kulmaka, Qeshibeshi, and Kerpica structures, except the same deposits belonging to SBZ 2-7 benthic zones, G. gansseri A. mayeroensis, R. fornicata and G. stuartiformis planktonic zones could be distinguished. In Melesini structure in Upper Cretaceous deposits has been distinguished A. Mayeroensis, G.gansseri planktonic zones (fig.2). Carbonate deposits facial changes of structural belts are explained by the presence of longitudinal fault combined with transversal one during rifting and their time after time reactivation. Paleocene-Eocene deposits are generally mixed facies carbonates that lie transgressively on Upper Cretaceous limestones (fig 3). These deposits show the exposure and erosion of older deposits often intercalated with bauxite levels (fig 1, 2).

b. Terrigenous Complex

Terrigenous complex includes lower Oligocene flysch and middle Oligocene deposits. These are placed successively on oldest deposits, while in Qeshibeshi, Kulmaka and Kerpica structures different levels of lower Oligocene flysch lie transgressively on Upper Cretaceous limestones and rarely on Upper Eocene deposits and transitional marly package (fig. 4).

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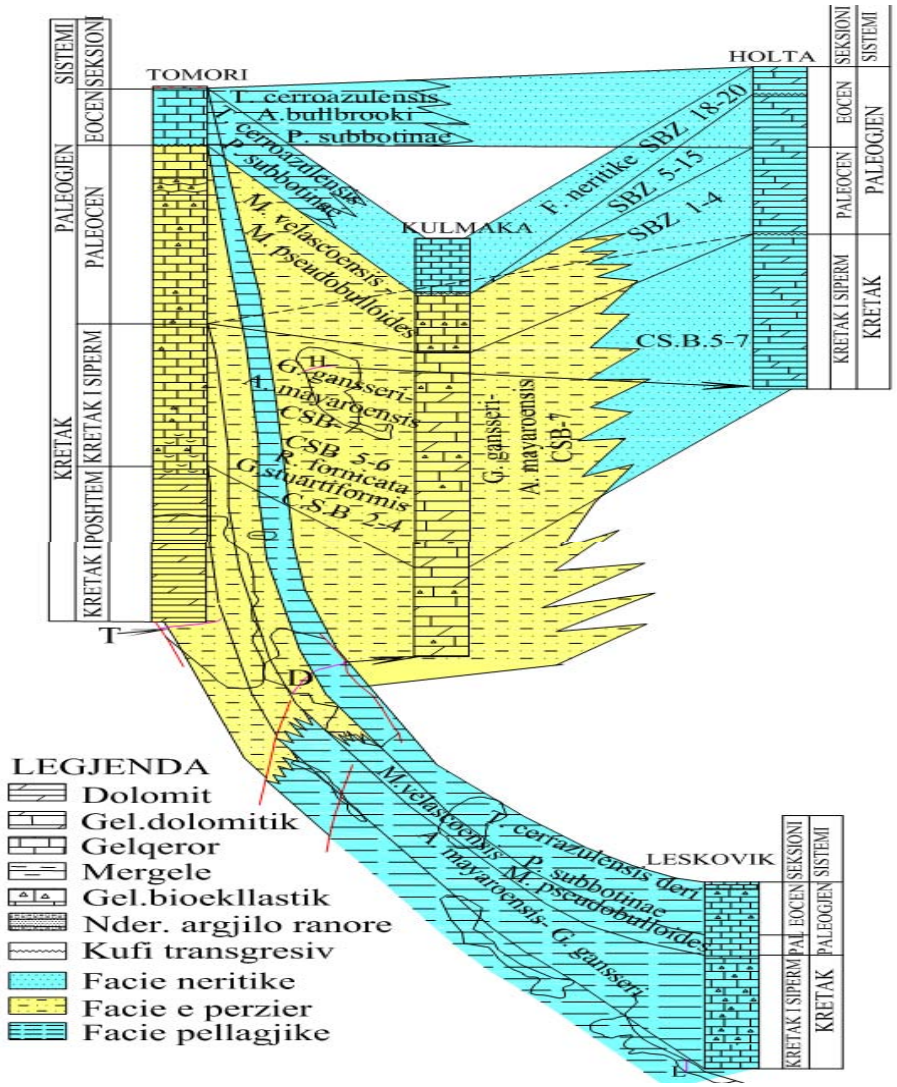


Fig. 2: Correlation scheme of some stratigraphic sections reflecting relationship between neritic and pelagic facies.

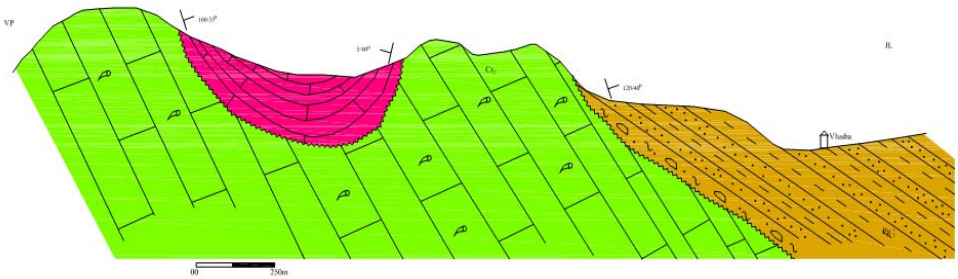


Fig. 3: Upper Eocene limestone lying transgressively on Kulmaka Upper Cretaceous limestone.

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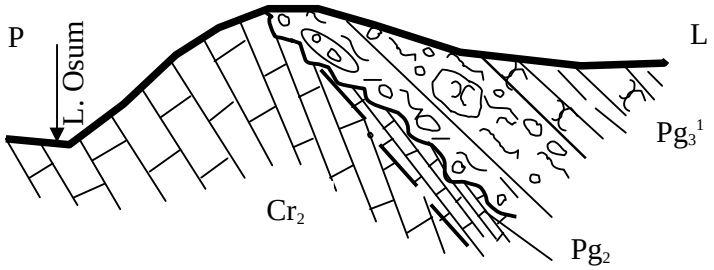


Figure 4. Qeshibeshi lower Oligocene flysch lying transgressively on Upper Cretaceous limestone (Pg_3^1g).

1. Geotectonic position and structural model

The investigated area regionally belongs to Kruja tectonic zone, which is part of outer western area of external Albanides (1, 6), characterized by considerable thickness of carbonate and terrigenous complex. Kruja zone represents a ridge bordered on east by tectonic zone of Krasta-Cukali, while in the west by Ionian tectoniczone and the southern Adriatic zone. Study area extends from Elbasani until Leskoviku, belonging to the southern part of the area Kruja which continues to the south with Gavrova zone. Pelagic limestone presence in Melesini structure, has led some researchers (7, 12) to treat these structures as Ionian tectonic zone units. Different hypothesis has been carried out about Tomorri anticline belt structures labeling it as a tectonic belt inserted in Kruja zone, Ionian zone and frequently in an intermediate position. Analyzing all the geological, tectonic, lithological, and facial factors, the study area is part of Kruja zone, but with distinctive facial tectonic features from north eastern structures. Maintaining tectonic geological criteria used to date tectonic sharing, based on the latest study of geological map of Albania 1:200000 (14), are distinguished western Tomorri subzone and eastern Dajti subzone. Tomorri-Melesini and Kerpica-Kulmaka-Qeshibeshi belt structures are part of Tomorri subzone while anticline belt structures of Letani-Tervolli are part of Dajti subzone. As mentioned before structures that are part of study area, though they are part of Kruja tectonic zone have distinctive features and characteristics from the structures of the northern part of it. Thus, in the northern part geological structure is represented by four structural belts with extended structures and small separate pass, narrow and deep dividing sincline, neritic facie, while in southern part structural model appear quite different.

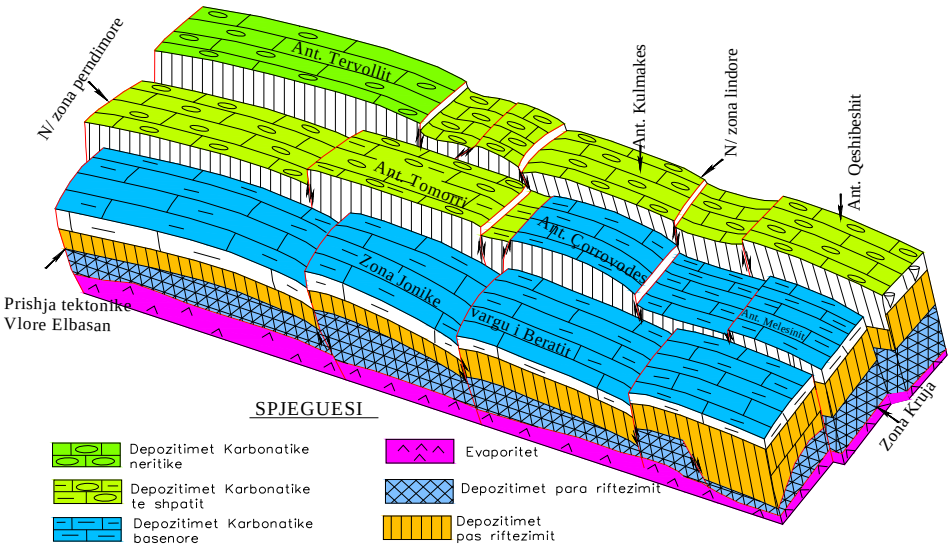


Fig.5 Schematic overview of zones, subzones and structural belts relationships. The combination of tectonic transversal faults with the longitudinal ones brings different sedimentation environments and tectonic zones.

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Anticline structures with pericline and horst-graben type separate the pass which is due to normal transversal and longitudinal detachments effects during rifting process and their later reactivation. Carbonate deposits facies of two western belts are distinct from eastern belts. Shallow marine carbonates deposits constitute eastern belt, while in western belts mixed facies benthic and planktonic foraminifera are also present. Moving toward south in western belt (Melesini) pelagic facie is present, further to south Ionian zone structures get unified (outside of our territory, Greece) with it (fig 5). This leads to arguments for horst type building in the whole area and especially Kulmaka and Qeshibeshi anticline structures.

2. Tectonic setting

Study area is limited on west by Ionian tectonic zone with Berati subzone anticline belt and to east by Krasta–Cukali zone. Kruja Zone southern part has different tectonic setting from northern part of it. Western parts of Kruja zone, has Tomorri subzone which include both structural belts: a. Sarandaporo-Melesini-Lengatice-Çorovode-Tomorri anticline belt. b. Qeshibeshi-Kulmaka-Kerpica eastern belt.
Tomorri structural belt locates in the west of Kruja zone. This anticline structure has 22 km length and 6 km width. Its core is made up of lower Cretaceous dolomite and dolomitic limestone. Anticline eastern flank dips with 25-30^0 and two periclines. In the west it is bounded by a **tectonic overlap** that separates it with the eastern side of Permeti syncline. Sometimes along tectonic contact are visible small Eocene limestone outcrops**.** They represent western flank fragments, which must be reversed and tectonically masked (Figure 6c). In the northern pericline a series of tectonic transversal faults allow it to sink rapidly.

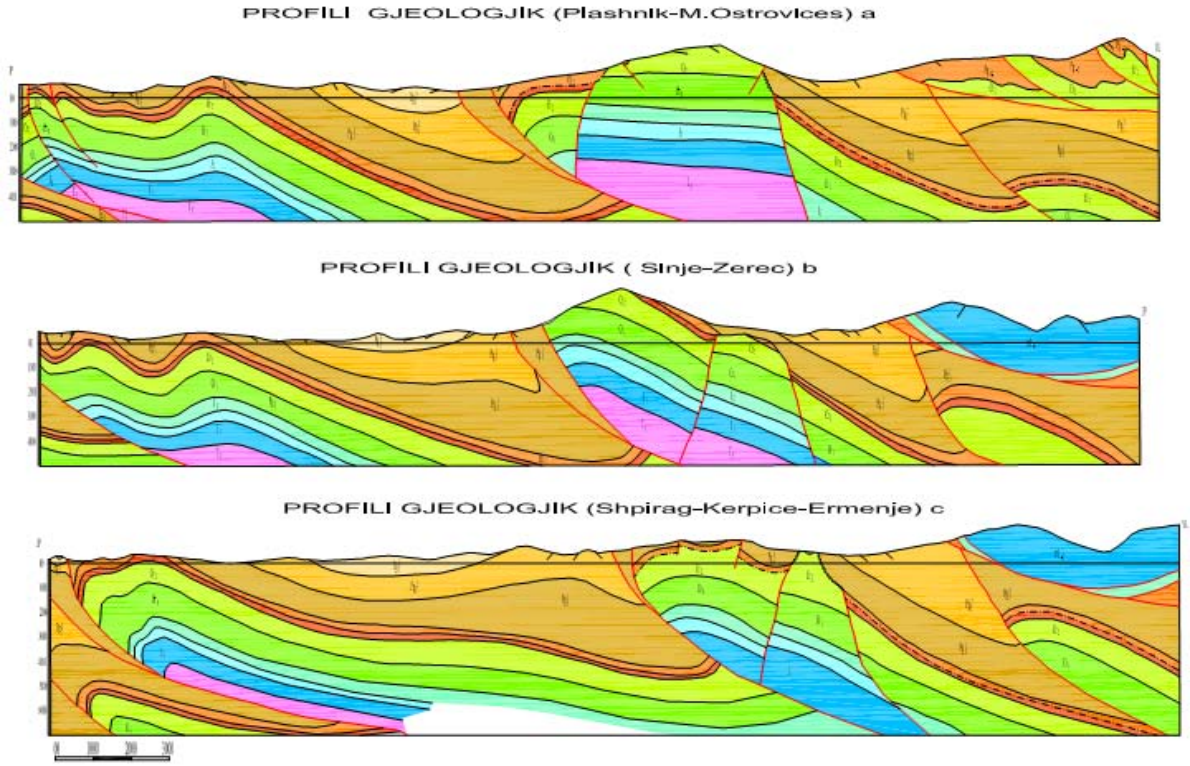


Figure 6. Geological profile showing the relationship between structural belts and special structures..

Southern pericline is tectonically quiet and connected with Çorovoda-Sarandaporo south structures. These are linear structures. In some cases longitudinal tectonic faults on eastern flank are observed. Its core structures are represented by Upper Cretaceous pelagic deposits. Longitudinal tectonic faults on western flank in NW-SE direction restrict these structures with Permeti sincline. Towards south in Greece, Permeti sincline, Nemerçka, Melesini anticline outcrops form a pelagic marine carbonates massive. This occurs as a result of a series of transversal tectonic faults combined with longitudinal one, this leads to a kind of "independence" between sectors. The structures of this belt are distinguished by Kerpica on north, while

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towards south they continue with Kulmaka and Qeshibeshi (fig.6) and outside our territory with carbonate structure outcrops, in east of Konica**.** The carbonate deposits are covered transgresivelly by lower Oligocene flysch which dips on east**.** Since Cretaceous limestone facie of Tomorr anticline is the same as in Kulmaka and Qeshibeshi, where benthic and planktonic foraminifera are present, showing the same sedimentation conditions, unlike eastern structures (Letan-Tervolli belt) where there are only benthic foraminifera**.** The presence of the lower Cretaceous limestone in Qeshibeshi and Kulmaka anticline structures and their stratigraphic succession up to Paleocene, like in Tomorri showing that these two outcrops don't represent olistolites. Nearly the same stratigraphic break we met in Tomorri and Kulmaka Upper Eocene limestone overlying Paleocene and Cretaceous deposits showing on a nearly equal dynamic development of these structures. Syncline separator absence between these anticline structures and full folding elements (side, periklinale etc.) leads us to interpret like 'horst' type Kulmaka, Qeshibeshi and Kerpica anticline structures in the framework of eastern flank of Tomorri-Melesini structural belt.

CONCLUSIONS

Based on the overall Albanides development and in what we briefly described these are our considerations. During Triassic Sazani, Ionian and Kruja zone have represented a single carbonate platform. In this period external Albanides have had a blocky structure accompanied with listric fractures which converge toward the center of trough. Kruja zone also has been individualized from two neighbor units like a mega horst limited by symmetrical and asymmetrical tectonic faults. Cretaceous facial changes especially during the late Cretaceous, demonstrates that new belts have not been sustained in length and width but were divided into several blocks. So, in addition to longitudinal listric fractures has had also tectonic fault which were associated with them. External Albanides blocky structure influence was not only during the process of sedimentation expressed by facial changes but, also in tectogenesis of carbonate structures style throughout their geodynamic development. Therefore, for the study area special impact have had along transversal fracture Vlora-Elbasani other fractures like the one in the north and south of Tomorri other up to Leskoviku, which may be a continuation of those in the west (fig.5). Transversal and longitudinal fractures development and their interaction has led to a variety of "horst" and "graben" structures which in accordance with tectonic intensity have had different impulses to increase and decrease their appearance on the water. According to this significant facial changes explanation are observed in Upper Cretaceous deposits, Tomorri structural subzone new deposits and in general for the whole area. During the Upper Cretaceous in transversal direction essential differences are noted in all over carbonate facies. It shows that during this period Kruja zone has represented a ridge divided into several blocks like Tomorri subzone, Dajti central subzone and further to east is assumed that another one has existed to pass then in Krasta graben. This seems to be a good assumption when we consider the continuation of analog Kruja zone in south (Gavrovo - Tripoliza in Greece) and to north (Budva in Montenegro). Neritic facies presence like benthic foraminifera in Dajti structures show shallow sedimentation conditions, Rudistes and Gastropods are also numerous. While in the west Tomorri subzone represent essentially the western slope of the ridge. Kruja basin was deeper, creating favorable conditions for development of benthic and planktonic foraminifera as Globotruncana, Heterohelisidaeve, Globigerinidae, Rugoglobigerinidae Pithonella. In the longitudinal direction, as noted above, as a result of transversal and longitudinal fractures, basin has been deeper and deeper as far as Leskoviku structure was nearly equivalent with Ionian trough, thus creating conditions for an entirely pelagic facie sedimentation. This is expressed by the presence of planktonic foraminifera in Upper Cretaceous deposits in the structure of Melesini as Globotruncana Arca, G. stuartiformes, Rosita formicata, R. contusa, Rugoglobigerina rugosa, Abathonphalus mayaroensis etc. Globotruncanas presence in Kulmaka and Qeshibeshi structures shows similar conditions with those of the western belt. Upper Cretaceous greater thickness, Rudists and other Gastropods abundance show almost reef conditions. So in this period should be established Kulmaka, Qeshibeshi etc. which continued like this during all carbonate sedimentation. During Paleocene Kruja ridge were maintained almost the same sedimentation conditions. In shallower basin areas, sedimentation rate is lower, while along the slopes is higher because of carbonate and clastic mixed material fast flows, and their slide, expressed with a greater thickness of bioclastik limestone sedimentation (Tomorri section). In the east as a result of the uplfit and approaching the continent towards west of Krasta zone, terrigenous material begins to sediment expressed that by the presence of Maastrihtian-Eocene flysch. In the early Eocene whole Kruja ridge undergoes to a general uplift, which is demonstrated by the presence of bauxite level. During this period eastern subzone and Kulmaka, Qeshibeshi, Kerpica structures were subject

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to erosion (perhaps underwater washing) expressed by the absence of the lower Eocene and partially Paleocene in many structures (Letan, Kulmaka, Qeshibeshi, partly Tomorri, etc.). During middle-upper Eocene Kruja ridge immersion brings the sedimentation of micritic limestone with planktonic foraminifera as Morozovella and Akarinina, which lie in a clear stratigraphic discordance throughout Kruja tectonic zone. This phenomenon is also evident in horsts with the presence of many Upper Eocene limestone stamps (upper part of it) on Cretaceous deposits. During late Eocene, Krasta zone rise out of the water together with the internal zone becoming a source area for the western basin. Oligocene characteristic basin is the constant movement of the coast line in association with subduction area. In the eastern part of Kruja zone as a result of continuous immersion and source area vicinity has led to a rapid sedimentation, expressed by a great thickness of Oligocene flysch in eastern sections (Kabashi, Frasheri) and the presence of numerous slump horizons, Eocene and Cretaceous limestone blocks and olistolites. These are thought to have come from Qeshibeshit and Kulmaka horst, which during this time were on the water and subjected to erosion. It argued Oligocene Flysch lie transgresivelly over these horst Cretaceous limestones with a 1500m thickness. Same conditions continued in the middle Oligocene. Upper Oligocene lack deposits in the eastern part of the area prove that this part has already been raised above the water level and shifted basin constantly northwest. Transgressive setting of akutaniani deposits in Tervolli shows the advancement of coast line eastward creating a shallow micro basin where have been sedimented mainly gravel, asorted sandstone, clasts and limestone blocks. During later period the whole study area has been a continent and it has attended all tectonic stages up to the end of Pliocene taking today's appearance.

REFERENCES

Brahimi C, Nurçe L, Agalliu L. 1981. Ndertimi gjeologjik dhe perspektiva nafte-gazmbajtese e rajonit Gjerbes (rilevim 1:25000).

Etyde geologique de l' Epire (Grece nordoccidentale) Paris 1966

Yzeiri D etj. 2002. Studimi gjeologo-tektonik i pjeses jugore te zones Kruja. Fier viti

Fili I, Hyka F, Mehmeti B, Laçi B. 1975.Ndertimi gjeologjik dhe perspektiva nafte-gazmbajtese e rajonit Sulove-Tervoll " (rilevim 1:25000).

Harta gjeologjike e Shqiperise shk. 1:200000

Jovani A, Tzeiraj D, Mahmutaj L, Bega I, Gega N. 1975.Ndertimi gjeolgjik dhe perspektiva nafte-gazmbajtese e rajonit Qeshibesh.

Koroveshi T, Sadushi P., Meçaj B. 2000.Stratigrafia e depozitimeve karbonatike te Kret-Paleogenit te zones Kruja dhe brezit te Tomorrit.

Mehillka Ll., Hysi K. Veizi V., Rapaj D. 2000.Modeli strukturoro-tektonik i Albanideve te jashtme dhe ndertimi i hartes tektonike ne shkalle 1:100 000 " (Toke-det) Viti

Misha V, Valbona U, Hyseni A. 1974.Ndertimi gjeologjik dhe perspektiva nafte-gazmbajtese e rajonit Çarshove- Leskovik". (rilevim 1:25000).

Prenjasi E, Shteto Th, Iljazi F. 1981.Ndertimi gjeologjik dhe perspektiva nafte-gazmbajtese e rajonit Dobrenj-Zelevizhde" (rilevim 1:25000).

Shehu H, Kici V, Skela V, Sadushi P, Shehu D, Ylli L, Druga Dh. 1971.Stratigrafia e depozitimeve terigjene te Paleogenit ne brezat strukturor Berat-Tomorr.

Shehu H, Sadushi P, Ylli L, Shehu D, Kici V, Skela V, Druga Dh. 1975.Stratigrafia e depozitimeve terigjene te Paleogenit ne zonen tektonike te Krujes". Viti

Shteto Th, Nurçe L, Iljazi F. 1982.Ndertimi gjeologjik dhe perspektiva nafte-gazmbajtese e rajonit Potom Kulmak" (rilevim 1:25000). Viti

Valbona U, Nazaj Sh, Iljazi F. 1984. Ndertimi gjeologjik dhe perspektiva nafte-gazmbajtese e rajonit Bodar" (rilevim 1:25000).

Yzeiraj D, Misha V, Bega I. 1978. Ndertimi gjeologjik dhe perspektiva nafte-gazmbajtese e rajonit Terpan (rilevim 1:25000).

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THE HYDROCARBON EXPLORATION PROSPECT IN THE CARBONATE DEPOSITS IN THE IONIAN ZONE ALBANIA

Kristaq MUSKA[1]

[1]*Fakulteti i Gjeologji_Miniera, Rruga e Elbasanit, Tiranë, Albania, kristaqmuska@yahoo.fr*

ABSTRACT

Hydrocarbon exploration is a difficult undertaking. Deep knowledge on geology, seismic and geochemistry are necessary for a given region. Opinion on oil field types up today discovered, main features of the general structural model of the ionian zone, the exploration prospect for oil and gas in the carbonate deposits of the ionian zone, are presented in this paper.

KEY WORDS *source rock, hydrocarbon potential, Ionian zone, carbonates, oil field*

INTRODUCTION

Many geological - geophysical studies, numerous wells data, as well as the discovery of many hydrocarbon fields, clearly show high prospect of the Ionian zone and an evident hydrocarbon potential.
From geological and - geochemical point of view, the problem of source rocks is solved, so that the concept of researching only the trap has become usual in our practice, considering indisputably the hydrocarbon presence.
There are five source rock levels in the carbonates of Ionian zone: in the Upper Triassic deposits, in those of the Triassic - Jurassic boundary, in Toarcian deposits as well as in those of Jurassic and Cretaceous age (Photo 1,2).
It is to be underlined that all carbonate oil fields, with rare exceptions (Ballshi, Visoka), have their traps filled with hydrocarbon, thus arguing indisputably an important hydrocarbon potential of the carbonate section.
Not full with hydrocarbons of the Ballshi 's (up to its 70 %) is related to its structural plane change in young times. Whereas the unfilled Visoka 's trap is related to oil field destruction in active hydrodynamic conditions.
So, we have not any restricted potential in these two traps. As a seal, in the carbonates case are the flysch deposits of Oligocene with a regional spread and with good sealing features. High reserves in Messinian - Tortonian sandstones are generated from underlying carbonates and migrated later (e.g. Patos - Marineza and Kuçova).



Photo.1. Mali i Gjërë. Source rock levels



Photo 2. Organic- rich shale

OIL FIELD TYPES UP TODAY DISCOVERED.

The three types of deposits discovered until now are:

1. *Oil, gas condensate fields concentrated in the top of the anticlinal structures.*

In this type we may mention the Gorisht - Kocul's (Fig. 1), Cakran - Mollaj's, Amonica's, Finiq - Krane's, Delvina's etc. The structures have western asymmetry, with the western flank overturned and with tectonic. Their internal model is presented of hump form individual axe of which forms an angle of 25 - 30° with general trend. The dimensions are considerable and range from 3 - 8 x 1 - 4 km,they frequently have very dip eastern flanks and sometime are overturned. In their top, the terrigenous deposits are condensed and there, in general two unconformities are distinguished, thoseof

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Burdigalian and Hatian - Aquitanian. The thickness changes from the flank to the top structure amount the ratio 10:1 and it is associated with lithological changes.

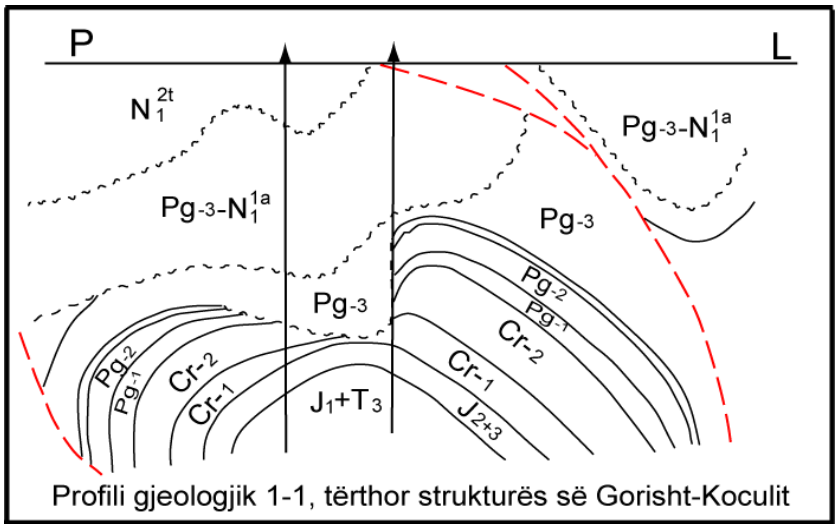


Figure1. Gorisht-Kocul oil field

2. Oilfields of carbonate tectonic blocks.

A typical field of this kind is Karbunara's oil field (Fig.2)., where the tectonic blocks are of "wedge" form with eastern dip. They are set one over other and are separated by some ten meters of flysch. They are formed as a result of a cutting-up of the western structure from the eastern one during the thrusting process, (chiefly on and post Tortonian). The carbonate blocks dimensions are relatively small, but the well production flows are considerable due to high fractures (fissures).

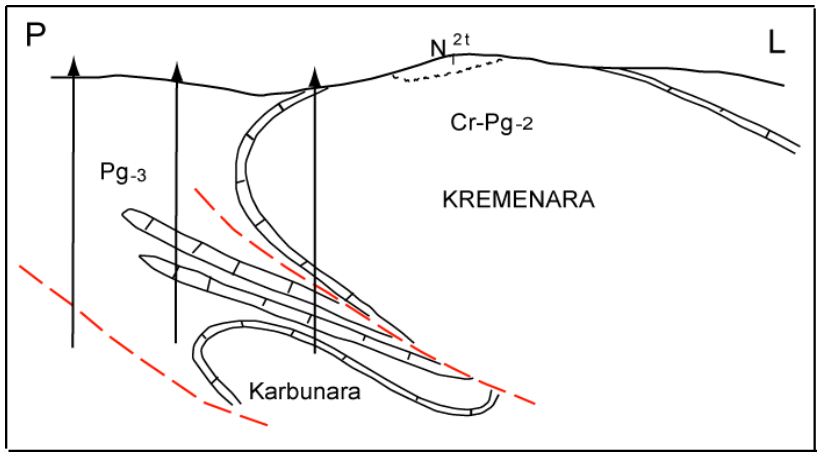


Figure2. Karbunara oil field

3. Oilfield of combined traps' (- structural- hydrodynamic - reservoir - traps).

In this type are the Visoka and Kallm oil fields (Fig.3). These fields are related with the big structure of Patos - Verbas and are located in its near top or in its periclinals. They belong to Cretaceous - Eocene carbonates, sometimes eroded and covered by Tortonian deposits.

Reservoir feature changes of the carbonates, especially those of Eocene, as well as an active water movement created traps of combined (structural, - reservoir, - hydrodynamic) type, in strike direction of the Patos - Verbas . The dimensions of these fields are different from relatively small to big, with considerable reserves.

The joint characteristic of all above traps is their location on/or near to the top structure in old structural lines, associated by the co-nsedimentation event. This characteristic has led up today in the exploration criterion according to the continuation of the anticlinal carbonate lines. This criterion is principal for the future as well.

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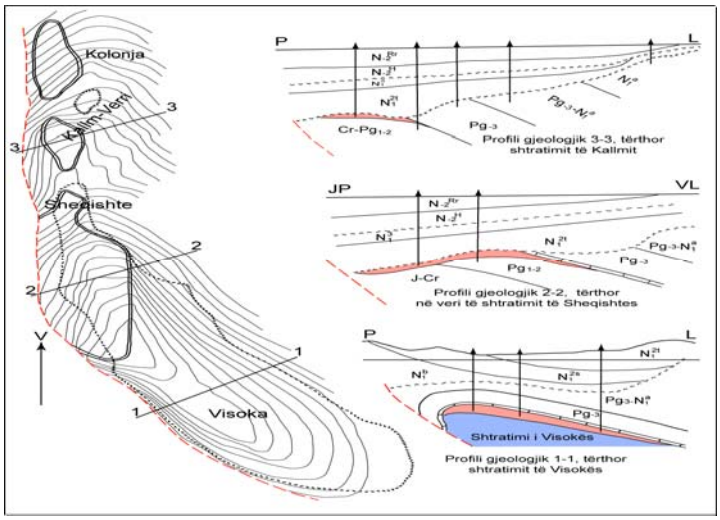


Figure 3. Visoka and Kallm oil field

MAIN FEATURES OF THE GENERAL STRUCTURAL MODEL OF THE IONIAN ZONE

Two main features have strongly affected the structural - tectonic model of this zone:
a- *The presence of the evaporites as substratum of the carbonates complex and their diapiric development.*
b- *High westward thrusting rate of the internal Albanides zones and Ionian zone.*

a- On the Ionian evaporites and their role in structuration.
Evaporitic outcrops in Albania, such as in Dumrea's, Bogaz', Kardhiq's, Matogjin's etc., as well as those of Greece territory, show that they must represent a sedimentary formation of a general spread in the Ionian zone. As they are tectonically encountered under the Upper Triassic carbonates, they have to belong to Upper Triassic and older ages, thus showing the platformic phase of the further nearly undifferentiated Alpine orogen. Based on their huge volume (of 1000 km3 in the Dumrea's), their thickness is to be some kilometres.
Such a big plastic mass has played a great role in favoring the westward thrusting. On the other hand, the diapiric movements have also affected the structural model. So the evaporites have westward moved to small pressures using western faults and causing new faults in the top of the structuresand some time in their eastern flanks. In this last case of eastern flanks andfaults, a backthrust happens and sometimes the structure takes a fan form.

b- High westward thrusting rate of all internal Albanides zone and especially that Ionian zone.
Within our country territory, the facts like the presence of the flysch tongue of the Krasta deposits under those of the Mirdita's and the encounter of the three tectonic zones Mirdita's, Krasta's and Ionian's at the same place in Leskovik, show an over 50 - 60 km overthrusting of the internal zones westwards.
Based on the complex geological-geophysical data, there are these considerations: The Kruja zone overthrust in the Elbasan - Laç sector is of over 40-50 km.
The Marak's thrust (above Dumrea's) is estimated to be over 15 km, the Tragjas anticlinal above that Vlora's is of 25-30 km.
The westward Ionian zone overthrust has to be greater than their individual structural lines, so it may be of 30-40 km.
The backthrust model of the structures is created due to the resistance encountered during thrusting the eastern structures through/above the adjacent western structures. The eastward movement in this case is relative or apparent because the structures have really moved only westward.
The backthrust faults are developed there, where the structures are more approached with each other (Goliko-Kurvelesh, Kurveiesh-Mali i Gjere etc., which is expressed on the surface, whereas in depth it may be separated as a duplex backthrust.
They are less developed there, where the structures are away from one another and the backthrust event in this case is expected to be only in depth and of a less amplitude (Ftera, Cika).

The horizontal throw of these backthrusts is of a range of some kilometers and because of thrusting the eastern structures, an apparent view of closing the synclines have created but in depth we have an open sector of triangle zone model

As a conclusion, based on the above analysis of "backthrust" faults, the thrusting amplitude of the Ionian zone has to be of the range of tens or more kilometers.

THE EXPLORATION PROSPECT FOR OIL AND GAS IN THE CARBONATE DEPOSITS OF THE IONIAN ZONE

The main exploration prospect in the carbonates is related to anticlinal lines.
Based on the tectonic style of the Ionian zone, the expecting carbonate structures are related to:

1. Continuation of rise existing structural lines underlying the adjacent structures and under the evaporites.
2. Continuation, of the structural lines of the Ionian zone northward in the square Durres - Laç - Paper – Lushnje.

Numerous structures, which are predicted by geological - geophysical data, are included in the first group. So, by same particular seismic lines, a structure (Sevaster's anticline) is notified as a southern continuation of the Kremenara, but it is lied under the Griba anticline. Also, south to the Gorisht - Amonica - Amantia, the Velça structure is now being explored and more to south, another structure (Bolena 's) is notified by seismic lines. It is expected partly masked by the Fterra anticline.

The northern continuation of the Berati belt structure (Kasithiari's, Greece) is only as geological prognoses. Of this kind of study (only geological) is also the northern continuation of the Borsh anticline under the Fterra's thrust.

Some more prepared by geological - geophysical data are the carbonate plays of the Dumrea, Sqepur, Vlora etc.

The first group structures are with considerable dimensions, with setting depth of 2000 -5000m, complicated from structural and tectonic point of view.

In the second expecting structures group are involved those whose existence is related with the problem of continuation or not continuation of the Ionian zone under the molasse unconformity. This problem is also related to the conception on the Vlora - Elbasan strike-slip.

Since the carbonate structures of the Tragjas-Selishte, Kreshpan, Patos-Verbas, are technically interrupted northward, and the general geological in this sector suffers a considerable plunge due to the southern Adriatic Basin plunging there, the carbonate level of the Ionian zone is expected to be relatively deep, but above that of the Adriatic basin. That's why seismic information in this sector is not sufficient.

The interruption of the structural units of the Kruja zone, due to the Vlora - Elbasan transversal fault, shows only a change in structural - tectonic model, but the structures continue. That is an argument that the structural lines of the Ionian zone must continue northward. From the tectonic point of view there are other strike-slip faults like Vlora -Elbasani in the Ionian zone, such as: Krongji - Paleokaster's, Kremenara- Shendelli's, north to Sazani's, etc. They are always associated by a northeastern bounding and by a northward shift of the structural model.

The analysis of the western margin of the orogen starting from the Mediterranean Sea (Greece) and northwards, shows that the most western structural lines are technically closed northward, but gradually and one by one. In an analogue manner, north to the Vlora -Dumrea sector, we ought to expect that only the western anticlinal line of Cika – Tragjas has to finish, whereas they more to east (the Berati and Kurveleshi belts) have to continue but relatively deep. At the same time their structural and tectonic model must change, dictated by the partly joint geological life with that of South Adriatric, the carbonates of which are in depth of 12-13 km.

In supporting the idea of the Ionian zone northward, continuation shows the seismic data which give signals on deep carbonate structures presence like Mlik, Shenkollas etc. The structures of this group are expected of big dimensions, with a small developed tectonic and a setting depth of 5000 m range.

REFERENCES

Albpetrol, 1993. *Petroleum exploration opportunities in Albania: 1st onshore licensing round in Albania*. Publicity brochure, Western Geophysical, London.

Curi F., 1993. *Oil generation and accumulation in the Albanian Ionian basin.* In Spencer A.M., ed., Generation, accumulation and production of Europe's hydrocarbons, Springer, EAPG Spec. Publ., 3, 281-285.

ISSN 2306-9600

Curi F., Stamuli T., Dule A. et Gjermeni M., 1990. *Geochemical conditions of hydrocarbon generation, migration and accumulation in carbonate and molasse deposits*. Nafta dhe Gazi, Fieri, 97-111. (in Albanian)

Danelian T. et Baudin F., 1990. *Découverte d'un horizon carbonaté, riche en matière organique, au sommet des radiolarites d'Epire (zone ionienne, Grèce)*: le Monte de Paliambela. C. R. Acad. Sci., Paris, 311, II, 421-428.

Danelian T., De Wever P. et Vrielynck B., 1986. *Datations nouvelles fondées sur les faunes de Radiolaires de la série jurassique des Schistes à Posidonies (zone ionienne, Epire, Grèce)*. Rev. Paléobiol., Genève, 5, 1, 37-41.

Diamanti F., Sadikaj Y., Zaimi L., Tushe I., Gjoka M., Prifti I. et Murataj B., 1995. *Hydrocarbon potential of Albania*. In 1965-1995, 30 years Oil and Gas Institute, Albpetrol ed., 300 p.

Frasheri A., Kapedani N., Lico R., Canga B. et Jareci E., 1995. *Geothermy of External Albanides*. In 1965-1995, 30 years Oil and Gas Institute, Albpetrol ed., 300 p.

Muska K., 2002. *Termicité, transferts et diagenese des reservoirs dans les unités externes des albanides (Bassin ionien)*. Thèse de Doctorat, Paris VI.

Roure F., Lafargue E., Müller C., Fili I., Muska K., Nazaj S., Seiti H., Cadet J.P., Bonneau M. et Mio I., 1998. *Evolution structurale et pétrolière des Albanides externes. Résultats de la modélisation Thrustpack et des analyses géochimiques complémentaires*. Rapport IFP report 44888 pour OGI. (confidentiel).

Roure F., Nazaj S., Muska K., Fili I., Cadet J.P. et Bonneau M., 1999. *Kinematic evolution and petroleum systems: an appraisal of the Outer Albanides.* In McKlay K., ed., Thrust tectonics 1999, in press.

Roure F., Prenjasi E. et Xhafa Z., 1995. *Petroleum geology of the Albanian thrust belt*. Guide book to the Field Trip 7, AAPG, Nice, 50 p.

Roure F. et Sassi W., 1995. *Kinematics of deformation and petroleum system appraisal in Neogene foreland fold-and-thrust belts*. Petroleum Geosciences, v. 1, p. 253-269.

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THE MENILITE FORMATION (OLIGOCENE) OF THE SKOLE AND SUBSILESIAN NAPPES, POLISH CARPATHIANS - OXYGENATION HISTORY

Alfred UCHMAN[1], Janusz KOTLARCZYK[2]

[1]*Institute of Geological Sciences, Jagiellonian University, Oleandry 2a; 30-063 Kraków, Poland*;
[2]*Department of General Geology, Environment Protection and Geoturism, Faculty of Geology, Geophysics and Environment Protection, AGH – University of Sciences and Technology, Mickiewicza 30; 30-059 Kraków, Poland*
e-mail: alfred.uchman@uj.edu.pl

ABSTRACT

The Menilite Formation (Oligocene) occupies large part of the Carpathians. It is dominated by dark sediments, which are considered as deposited under anoxic conditions. They contain well preserved fishes that are an evidence of anoxia on the sea floor. However, at least in the Skole and Subsilesian nappes, Polish Carpathians, layers of green or grey-green bioturbated background mudstones occur between mostly dark, fine-grained, laminated mudstones and other sediments. The green layers contain trace fossils Halimedides annulata, Multina isp., Palaeophycus ?tubularis, ?Planolites isp., Rhizocorallium isp., Trichichnus isp. and Zoophycos isp., which are an evidence of dysoxic or oxic conditions. The suite Trichichnus–Palaeophycus–(Multina, Halimedides)–Rhizocorallium indicates an increase in oxygenation of pore waters. The dark laminated sediments contain different ecological groups of fishes, including epipelagic, bathypelagic, benthopelagic, neritic and reef, and demersal taxa, which contributions changes significantly through the stratigraphic column. The absence or reduction of bathypelagic fishes points to anoxia in the water column. The combination of ichnological and ichthyological data allowed a reconstruction of oxygenation changes in sediment and water column during sedimentation of the Menilite Formation. The total anoxia in the sea floor and water column was present only during the ichthyofaunal Zone IPM2 (part of NP23), and is referred to the extremely rich organic productivity in anti-estuarine circulation conditions in boreal waters, which were forced to enter the photic zone. During sedimentation of the upper part of the Menilite Formation, the anoxia was present only on the sea floor or upper slope, and is referred partly to upwellings.

KEY WORDS: *Menilite Formation, Carpathian, epipelagic, bathypelagic, benthopelagic, neritic.*

REFERENCES

Kotlarczyk, J., Uchman, A., 2012. Integrated ichnological and ichthyological analysis of oxygenation changes in the Menilite Formation during Oligocene, Skole and Subsilesian nappes, Polish Carpathians. Palaeogeography, Palaeoclimatology, Palaeoecology, 331-332: 104-118.

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MESSINIAN EVAPORITES IN PRE-ADRIATIC DEPRESSION

Pandeli PASHKO[1], Ibrahim MILUSHI[1], Vesel HOXHA[1]

[1] *Instituti Gjeoshkencave, Enegjise, Ujit dhe Mjedisit. . Rr. Don Bosko 60. Tirane.Albania.*
Email: pandipashko@yahoo.com; ibrahimmilushi@yahoo.com; ; veselhoxha52@yahoo.com

ABSTRACT

A detailed stratigraphy for the Messinian deposits of the Pre - Adriatic Depression is proposed here. The Messinian deposits start from the top of the Tortonian marine deposits with Under Gypsum Marls and consist also of the Gips-Sharre Gypsum (Lower Gypsum), Inter-Gypsum Marls with a salt level, separated by an Intra-Messinian Unconformity and followed by Mushnike gypsum (Upper Gypsum). The top of the Messinian consist of the rhythmic cyclic succession of marls and sandstones (Over-Gypsum Marls). In the southern and northern regions, respectively Vlore and Durres of the Kavaja region, the Lower Gypsum is cut on the top by the Pliocene erosion surface. Messinian deposits yield an oligotypical, dwarf planktonic and scarce benthic foraminifer's assemblage.

KEYWORDS: *Messinian evaporites, Pre-Adriatic Depression, Stratigraphy.*

INTRODUCTION

This paper develops the stratigraphy of Messinian sedimentary succession in the Pre-Adriatic Depression (PAD), (Fig.1). The Messinian evaporates outcropping in the PAD are the only one of the Messinian deposits along the eastern side of the Adriatic Sea, and what is more contain a salt level. For this reason they are important and have a special value for stratigraphy and regional correlation in the Mediterranean. Primarly only evaporitic facies are named Upper Miocene (Murataj & al. 1958), latter is given complete Messinian section which consists from topmost of the Tortonian (Mengaj Fm.) to Pliocene, named Messinian stage. (Pashko & al. 1969a,b; Pashko 1970, 1973). Messinian evaporitic deposits of the PAD are intersected by boreholes over western part of the depression (Fig.1). They normally cover the marine deposits of Tortonian, Mengaj Fm. (Pashko 1970) with marine (stenohaline) foraminifers and molluscs assemblages, and are overlain by the marine deposits of Pliocene. The complitly sections of the Messinian deposits occurs only at the central part of PAD (Kavaje Basin), where an sub-aerial erosion surface, Inter-Messinian unconformity, separed Lower Gypsum from salt layer (halite) with re-sedimented gypsum in it lower-most part. The Upper Gypsum (Mushnike Gypsum) followed overlaid by the Over-Gypsum Marls, which is overlaid by the Pliocene deposits. More in north (Durres) and in southern part (Vlore) of PAD, the Messinian section consists only of the Gips-Sharre Gypsum overlie with unconformity by the Pliocene deposits. Towards the south of Kavaje area, the Messinian gypsum undergoes an abrupt change in lithology, grading to a clastic unit. (Fig. 1 and 3).

The Tortonian / Messinian boundary is marked on the top-most, 80-97m thick (Under Gypsum Marls) of the Tortonian marine, Mengaj Fm. (Fig. 2 Tortonian), where salinity increase are indicated by the decrease of diversity and abundance of the foraminifers and molluscs assemblages and it coincides with sharp environmental change. The upper Messinian boundary with Pliocene follows the establishment of the marine conditions at the base of Pliocene (Acme Sphaeroidinellopsis and Pliocene molluscs). The complete section of the Messinian evaporates has been studied at Kavaje area: Kavaje and Mushnike sections, (Pashko & al.1969a), (Fig.2) and by boreholes (Cocoli et al. 1989, 1992, Liko et al.1971), at Kryevidhi (ISKNG 1966) and Panaja-Zvernec (ISKNG 1966) and more (Hoxha et al. 2011a,b).

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Figure 1. Geological map of the Pre-Adriatic Depression with stratigraphical studied sections. Ka.- Kavaje, Mu.- Mushnike, Du.- Durres, Pa.- Patos and Vl.- Vlore sections, s- halite.

STRATIGRAPHY

Messinian succession of Kavaja Deep Basin.

Based on the above considerations of stratigraphic and biostratigraphic characteristics the Messinian succession in PAD is here proposed. Lithostratigraphic Messinian sequence up to 750m thick, from the bottom to the top divided into four lithostratigraphic units (Fig.2).

Messinian Under Gypsum Marls (Fig. 2 -a) composes the top of the Tortonian pre-evaporitic Mengaj Fm., some 80 – 97 m thick, consisting of grey clays and marls with oligotypical foraminifer's

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assemblage (low diversity and abundance of foraminifer) and extinction of molluscs suggesting a rapid changes of normal marine to over saturated halite conditions. This strong environmental change coincides with Messinian Salinity Crisis.



Photo 1. The T/M boundary, Lower Gypsum Gips-Sharre Gypsum) and Inter-Messinian unconformity of the Kavaja section

b. Gips-Sharre Gypsum (Lower Gypsum), (Fig. 2 - b) consist of a cyclic succession of clays, marls with gypsum and sandstone beds and they represent the Lower Evaporites. It contains 2-4 anhydrite gypsum levels. The marls are of grey to light blue color, highly claye and they forme packages of various thickness from 7-8 m to 58 m. At the uppermost part, there are thin layers (0.2 – 0.4 m) of fine-grained sandstones. At Mengaj, the lower Gypsum represented by some 60 m thick gypsum bed, that laterally grades in 2-4 separated levels. The its lower half consists of twins of big grey – brown crystals, up to 10-12 cm (macro-crystalline) and upwards massive selenite gypsum, white in color and grey–pink spots predominates. The uppermost part consist by massive selenite gypsum. There is also white microcrystalline platy gypsum with needle crystals. Layers and lenses of fine-grained dolomites, 0.25-0.30 m thick, inter-bedded to marls, occur within massive selenite gypsum. The Gips-Sharre Gypsum are 286 m thick, (Fig.2).

c. Inter-Gypsum Marls (Fig.2 -c) is separated by the Gips-Sharre Gypsum by an unconformity, which is a important subaeral erosion surface (int.53 of sections), 1.0–1.5 m thick. Conglomerates consisting of small gravels mainly of limestones and less of ophiolites and clasts of marls and gypsum of Lower Gypsum. Inter-gypsum marls consists of grey clays and marls intercalated with scarce thin fine-grained sandstone layers, some 0.30 m thick, but two of them, (int. 55 and 57) are 12.8 m and 14.0 m thick, respectively. The bottom of this unit consists of halite level, some 30 m thick, that does not crop out and is intersected by several boreholes. At the lowermost part of the halite layer (2-3 m) there are marls and gypsum clasts of size 2-5 cm up to 30 cm, belonging from the Lower Gypsum. The thickness of units is 281m.

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d. Mushnike Gypsum (Upper Gypsum) (Fig. 2 -d) is represented by a level of massive selenite gypsum, rich in clays and with frequent changes, both in its composition (gypsum/mudstone) and thickness. Thickness is 3- 4 m.

e. Over-Gypsum Marls (Lago Mare) (Fig. 2-e) is post-evaporitic unit and is characterized by the

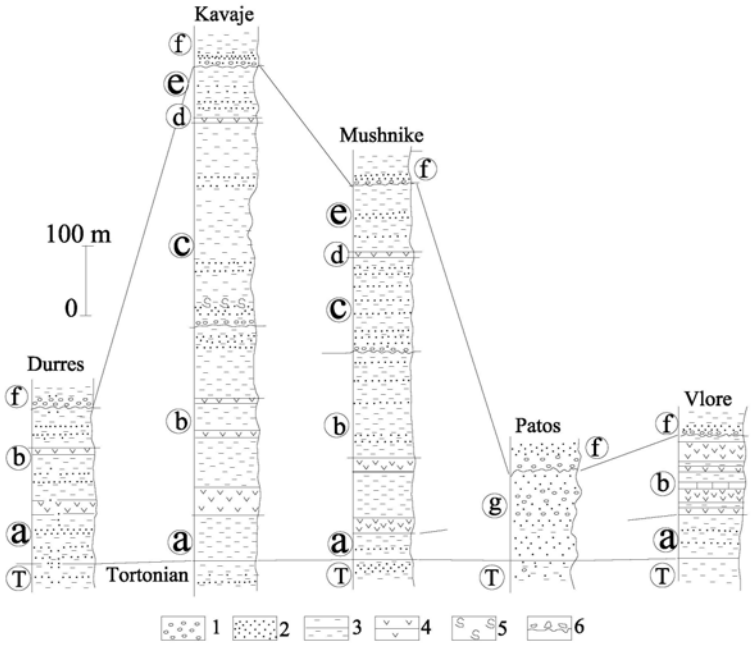


Figure 2. Stratigraphical column of the studied sections: T-Tortonian, a-Under-Gypsum Marls, b- Gips- Sharre Gypsum, c-Inter-Gypsum Marls, d-Mushnike Gypsum, e-Over-Gypsum Marls, f-Pliocene, g. Messinian Coarse Unit. 1. Conglomerates, 2. Sandstones, 3. Clayss, marls, 4. Gypsum. 5. Salt, 6. Unconformity.

regular alternation of grey marls and clays and thin sandstone layers, often very frequent grading to a rhythmic, cyclic succession of marls 5-10 cm thick and sandstones 3-5-7cm thick with small nodules of white carbonaceous sands.
The oligotypic foraminifer's assemblage is represented by well preserved and abundant hypo-haline benthic foraminifera and marine plankton foraminifera. The total thickness is up to 82 m.

The **Pliocene** deposits (Fig. 2 - f), that, through a layer of massive, coarse-grained sandstones and gravel-conglomerates, 10-12 m thick, overly the Messinian deposits and followed by grayish marls-clays with marine foraminifers (Acme *Sphaeroidinellopsis*) and molluscs. (Zanclean).

Marginal Basins

In the marginal basins, the Gips-Sharre Gypsum is cut on top by an important, Pre-Pliocene aerial erosion surface. At their extension towards the north, the Messinian gypsum crops out north of Durres, from Porto Romano up to Kepi i Rodonit. At Durres (Manza and Aremadhi sections), about 270 m thick, only the Lower Gypsum unit occur, consisting of two levels of anhydrite and selenite gypsum, 15 m and 4-5 m thick. At the edge of PAD, towards the south of Kavaje area, the Messinian gypsum undergo an abrupt change in lithology grading to a clastic unit, characterized by the lateral facies of the coarse and medium grained sandstones and polymictid pebble conglomerate (Polovina Formation up to 180m thick), that contain silicified woods (Patos) some meters long, recording a fluvial and deltaic activity (Fig. 3).
At Vlora area, the Messinian Evaporites about 190m thick, consists only of Lower Gypsum with one dolomite layer (0,3m), that overlie the marine Tortonian and underlie of the Zanclean

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sediments with unconformity. There are three potential levels of anhydrite, mainly macro-crystalline gypsum.

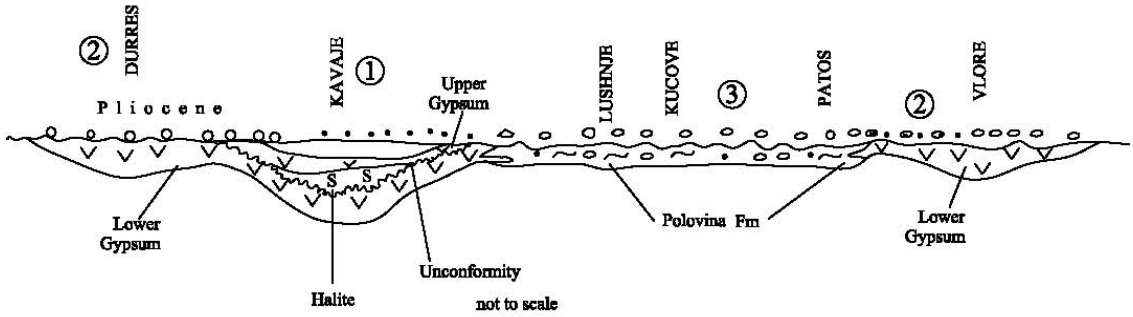


Fig 3. The physical-stratigraphic correlation between deep and marginal Messinian basins in PAD. 1. Deep Kavaje Basin. 2. Marginal Durres and Vlore basins. 3. Lateral clastic facies.

BIOSTRATIGRAPHY

The physical and biostratigraphical approaches allow establishing a chronostratigraphy of sedimentary successions of the Messinian evaporitic deposits. After the Tortonian normal marine assemblage's foraminifera, (*Globorotalia scitula* zone) and molluscs, mainly gastropods, similar to those of Tortonian type (Roba 1968), in top-most Mengaj Fm., are followed by oligotypical assemblages. This decrease of diversity and abundance of the foraminifer and mollusks assemblages is recovered 97m (Kavaje section) bellow the first gypsum and clearly reflects environmental stress: faunal assemblages characterized by the decrease in diversity and dwarf planctonic specimen and of low diversity benthic, dominated by brackish specimens of foraminifera and scarcity up to extinction of the marine molluscs. This faunal changes recorded in Messinian succession, which coincides with the environmental changes indicate shallow, hypersaline conditions. The planctic foraminifera assemblage are relativelly abundant and still dominated by mostly small *Globigerinoides spp.*, followed by *Globigerina bulloides*, G. *quinqueloba*, *Globorotalia menardi* , *Orbulina universa.* The benthic assemblage consists of low diversity, dominated by *Ammonia beccari* and A. *beccarii tepida*, and followed by *Elphidium spp*., *Bulimina spp*., *Bolivina spp*. The Ostracoda is represented by the rare *Cyprideis*, mainly in Messinian deposits of marginal basins. Contents fish, *Mictophum sp*. These faunal assemblages indicate generalized brackish to hyperhaline conditions gradually evolving and after the Messinian Salinity Crisis, in Over-Gypsum, following of towards hypohaline assemblage. The Pliocene sediments yields normal marine molluscs and foraminifers (Acme *Sphaeroidinellopsis*), which represents the return to fully marine conditions after MSC.

CONCLUSIONS

The complete section of the Messinian Evaporite occurs at Kavaja area and commenced with Under Gypsum Marls which consist of top of the Tortonian marine Mengaj Fm. with oligotypical foraminifer's assemblage. They are followed by the Gips-Sharre Gypsum and Inter-Gypsum Marls, separated by an important regional Intra-Messinian unconformity. Salts presents in lower part of the Inter-Gypsum Marls above this regional unconformity contain at their bottom re-sedimented clasts of marls and gypsum belonging to Lower Gypsum unit. The Mushnike Gypsum represents the Lower Gypsum and followed by the Over-Gypsum marls at consists of the interbeded marls and sandstones. (Lago Mare). More, in the north (Durres) and in the south (Vlore) of Kavaje area, only the Lower Gypsum occur, that overlie by Pliocene transgresive deposits. These Messinian sedimentary successions record shallow and deep-water sedimentation. The Gips-Share Gypsum had been deposited in shallow-water basin whereas the Intra-Gypsum Claystones with halite had been deposited under very deep water conditions. The Mushnike

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Gypsum and Over-Gypsum Marls have a deep-water character. The lateral clastic deposits (Polovina Fm.) record a fluvial-deltaic facies. The Tortonian/Messinian and Messinian/Pliocene boundarys has been defined. Foraminiferal assemblage in the Messinian sediments are generally scarce, represented by dwarf planctonic and scarce benthic, dominated by brackish specimens.

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REFERENCES

Caushi, N., Pashko, P. (1989). *Projekt gjeologjik mbi punimet* e *kerkim-zbulimit per kripe guri ne objektin Tilaj* (*Golem*). Tirane. Unpublished. (In Albanian).

Caushi, N., Pashko, P. (1992). *Ligjesite* e *perhapjes stratigrafike dhe kushtet sedimentologjike te evaporiteve* (*kripe guri*, *gjips*, *anhidrit* etj.) *ne depozitimet* e *messinianit te Ultesires Pranadriatike dhe vleresimi ekonomik* i *perdorimit te tyre*. Projekt. Tirane. Unpublished. (In Albanian).

Garori Sh. (1969). *Foraminiferet* e *Tortonianit* (*pjeserisht*) *dhe te Miocenit te Siperm ne zonat jashtme te Shqiprese*. Tirane. Unpublished. (In Albanian).

Hoxha V. (1999). *Studim prognoze mbi sasine dhe cilesine* e *gjipsit, anhidritit* e *selenitit ne objektet* e *evaporiteve te Peshkopise*. Studim. Tirane. Unpublished. (In Albanian)

Hoxha V., Milushi I., Mekshiqi N., Diamanti F., Bakallbashi J..(2011a). *Geological and Mineral Bearing. Aspects of Evaporites in Peshkopia Area*. GeoAlb 2011. Proceed. 27-30. Kosove.

Hoxha V., Milushi I. (2011b). *Evaporitet* e *Shqiperise dhe mineralmbajtja* e *tyre*. Tirane. Unpublished. (In Albanian)

Kadilli F., Gjikopulli M., Muhameti P., Shehu Xh. (1965). *Mbi rezultatet* e *pergjithesimit te materialeve gjeologjiko-gjeofizike per strukturat perendimore te Ulesires Pranadriatike*. Qyteti S talin. Unpublished. (In Albanian)

Murataj P., Plaku K. (1958). *Ndertimi gjeologjik* dhe *perspektiva* e *naftes dhe* e *gazit ne rajonin* e *Kavajes*. Vlore. Unpublished. (In Albanian)

Pashko P. (1970). *Suita argjilore* e *Mengejt*. Permb. Stud. no 2 (15). Tirane. (In Albanian.,Abst. in French.)

Pashko P.(1971). *Mbi moshen* e *Suites se Kucoves ne rajonin* e *Patosit*. Bul. USHT. Ser. Shken. Nat. 4, p. 37-46. Tirane. (In Albanian. Abst. in French).

Pashko P. (1973). *Kati Mesinian ne zonen Jonike*. Permb. Stud. nr. 3., p 51-69. Tirane. (In Albanian. , Abst. In French).

Pashko P., Garori Sh., Myftari A. (1969a). *Stratigrafia* e *Tortonianit* (*pjeserisht*) *dhe* e *Miocenit te Siperm ne zonat* e *jashtme te Shqiprese*. Tirane. Unpublished. (In Albanian).

Pashko P., Garori Sh., Myftari A. (1969b). *Te dhena* paraprake *mbi stratigrafine dhe* faciet e *Mesinianit te zones Jonike*. Permbl. Stud. no. 12, p. 13-24. Tirane. (Abst. in French).

Robba E. (1968). *Molluschi del Tortoniano tipo* (*Piemonte*). Riv. Ital. Paleontol. Vol.74, 2. Milano.

Roveri M., Manzi V. (2006). *The Messinian salinity crisis*:*Looking for* a *new paradigm* ?. Palaeogeol. Palaeoclim., Palaeoecol.238, p.386-398.

Roveri M., Lugli S., Manzi V., Schreiber Ch. (2008). *The Messinian Sicilian stratigraphy revised*: *new insight for the Messinian salinity crisis*. Terra Nova vol.00, p. 1-6.

Roveri M., Vinicio M., Gennari R., Iaccarinno S. M., Lugli S., (2008). *Recent advancement in the Messinian stratigraphy of Italy and their Mediterranean- scale implications*. Boll. Soc.Paleont. Italiana 47,(2), p. 71-85.

Roveri M., Bertini A., Consentino D., Di Stefano A., Gennari R., Gliozzi E., Grossi F., Iaccarinno S.M., Lugli S., Manzi V., Taviani V. (2008). *A high resolution stratigraphic framework for the latest Messinian events in the Mediterranean area*. Stratigraphy vol.5,nos. 3-4, p. 323-342. Geologia 2, XXVIII. Bologna.

ISSN 2306-9600

Selli R. (1960). *Messiniano Mayer-Ermayer 1867***.** *Proposta di un neostratotipo***.** Giornale Geologia 2, XXVIII. Bologna.

Venzo S. (1963). *La malacofauna Tortoniana.* Paleont. Italica. LXIII, (n. ser. XXVIII). Pisa.

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MOLASSES BASIN ANALYSES IN THE ADRIATIC FOREDEEP THE SEQUENCE STRATIGRAPHY

Sazan GURI[1], Gledis GURI[2]

[1] *G&G group Institute, Tirana, Albania*
[2]*Faculty of Geology and Mine*

ABSTRACT

The purpose of this article is to illustrate the principles of seismic facies analysis used in the interpretation of sedimentary rocks, in siliciclastic deposits, especially in Molassic ones. The recognition and definition of a seismic facies and the analysis of its vertical evolution (facies associations) lead to an environmental interpretation, which can give useful information on both sedimentary facies and reservoir characteristics. With this aim, the major depositional systems, from continental to deep marine, and the depositional elements in which they can be subdivided, will be briefly overviewed in terms of extension, geometry, continuity and lateral variations. For each of these systems, the major physical active processes during the deposition, the resulting sedimentary structures and their vertical and lateral evolution have been pointed out. The comparison between the environmental interpretation derived from bottom cores, well - logs and that derived from the current depositional models, is used to predict the nature and distribution of reservoir and sealing rocks.

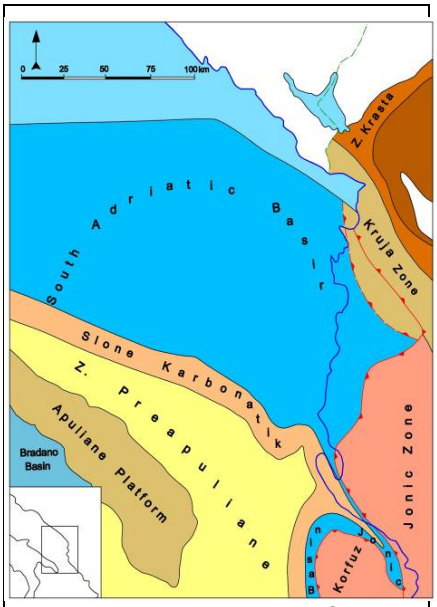


Fig. - 1 Facial scheme of South Adriatic and Jonian basin

KEY WORDS: depositional sequence, seismic facies, reflection terminations, sequence boundary, system tracts, reflection configuration ratio, sea level changes, Molassic, pre Adriatic Foredeep.

INTRODUCTION

The aim of this paper is to present an analysis of seismic facies of siliciclastic deposits, especially the molasses ones, in Pre Adriatic Foredeep. (Fig. – 1) The seismic facies analyses are a new approach and many of phenomena are already better explained. Many paleogeographycal and structural studies, in this region have been performed [1], but using applied seismic facies analyses method have been performed the facies and paleoenvironments geometry, and often gives the possible predictions on reservoirs quality, especially on Molassic deposits. All indicators data of multidiscipline (seismic, palaeontology, sedimentology, etc.) have been integrated. Based on the deep processing seismic lines, by interpreting the reflection terminations such as downlap, onlapped, toplap, erosional truncation, apparent truncation etc., [2], is attained to identify:

- The sequence boundary of basal surface type (Sb_1 or Sb_2)
- The boundary surfaces such as downlap, transgression and flooding ones
- System tracts and seismic facie within siliciclastic sequences

In each sequence, it is analysed the eustasy (sea level changes), the reflection configuration, such as sheet, hummocky, oblique, sigmoid, parallel to sub parallel, divergent, etc., the main facies and paleoenvironments. Due to base lap + toplap/reflection configuration ratio, a certain numbers of seismic facie maps have been compiled.

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1. THE GEOLOGICAL SETTING

The pre Adriatic Foredeep is a well studied region from geological point of view, where the contribution of seismic facies analyses is of a great importance. In stratigraphic aspect, it originates since Serravalian, and it is represented by a premolassic and a Molassic facies, [3]. South Adriatic basin and Ionian (Fig.-2) one take part in the geological constitution of the study area, where the pre Adriatic Foredeep is in concordance with these basins, but in discordance and transgressive in their borders. It is formed in a compression regime. This paper intends also to give the characterization of Molasses and Quaternary loose deposits by evaluating lithological-geologic parameters, depositional environments and the tectonic events. The main objective is the lithologic-facial zoning by mapping of lithologic composition and facies distribution; the Quaternary basin analyses by interpreting depositional sequences of third and forth order, where system tracts such as lowstand, shelf wedge, transgressive and highstand have been individualized. Seismic sections provide physical evidence for unconformities at sequence boundaries. Seismic-sequence analyses are based on identification of discrete stratigraphic units within relatively conformable intervals of strata by using reflection patterns. Glacial periods may exhibit chaotic bedding surfaces, whereas interglacial periods may display parallel bedding surfaces. The sedimentary response to the rising and lowering of sea level is recognized on seismic sections by onlapping or downlapping cycle termination and amplitude contrast. Such high stands of sea level commonly trap coarse sediments on the shelves. Two main formational types represent the study area:

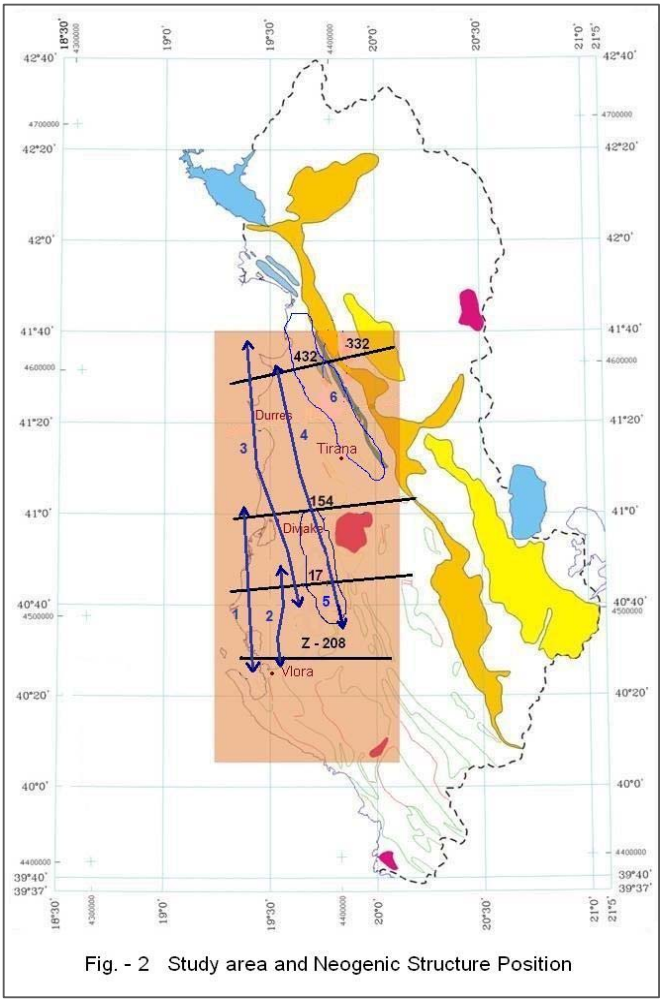


Fig. - 2 Study area and Neogenic Structure Position

- Bedrock Formation (Messinian and Pliocene)
- Covering formation (Quaternary loose deposits)

2. SEQUENCE STRATIGRAPHY2.1 CRITERIA OF CORRELATION

The correlation of depositional units is based on the combination of seismic data with biostratigraphical ones. In local correlation, the well - logs are used, as well. In a regional context, the microfacies and biozones, (Fig.-3) seismic facies and reflection terminations have been used as a criterion in the evaluation of sequence boundaries, downlap surfaces, transgression surfaces and maximum flooding surfaces. By means of seismic facies parameters, it is attained to be individualized genetic units, such as depositional sequences and system tracts. In Molassic formation, ten sequences of third and forth orders are individualized, which correspond to the base of stages or respectively to the biozones bases. It happens to be more than two or three sequences in one stage, as in Tortonian, lower Pliocene and Quaternary. Based on numerous seismic data and many well - logs, these sequences compound the most recognizable ones. [4]

2.2 The interpretation of sequences

2.2.1 Serravalian sequence

In the eastern part of the PAF, near the front of the orogen, the chaotic and the reflections free one are the most characteristic internal reflection patterns, whereas the high continuity and low amplitude reflection is observed westward. The model c – c / p (c – c the concordance in the upper and lower parts of the sequence,

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p – the parallel internal reflection configuration) is the main seismic facie of this sequence, but it is also present another seismic facie according to the model onlap – toplap / sigmoid – progradational internal reflection configuration [5]. It is also observed:

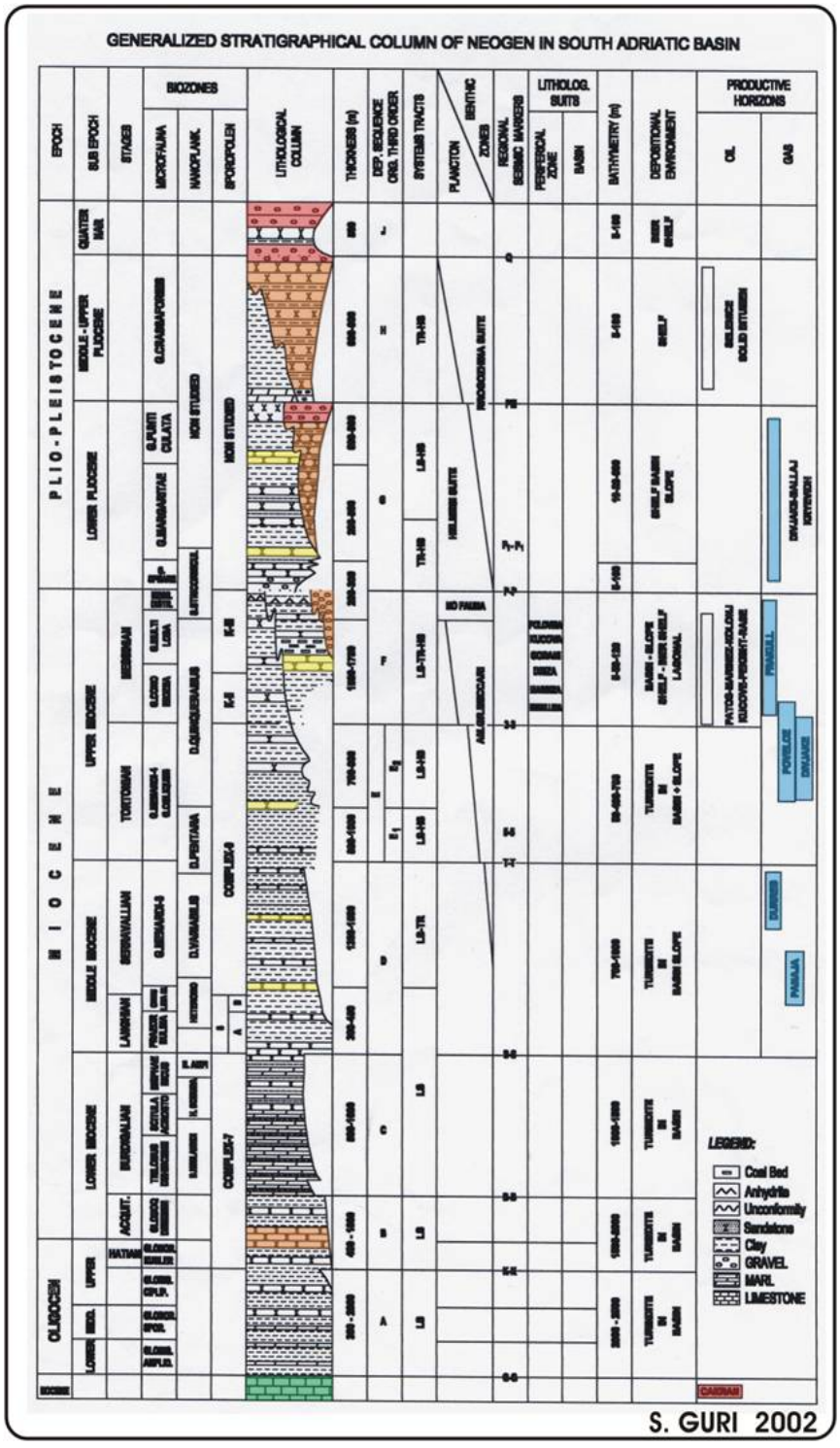
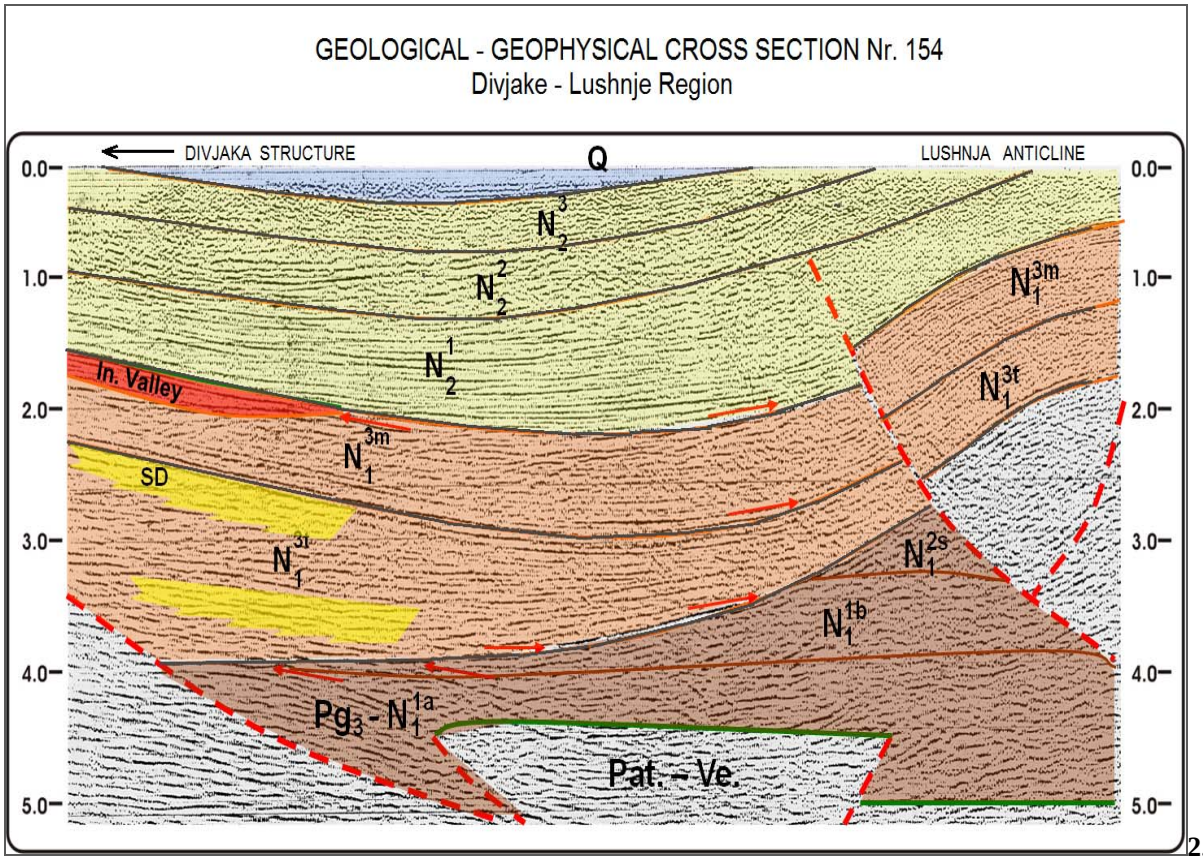


Fig. – 3 Generalized stratigraphical column of Neogene in South Adriatic basin (S.Guri, 2002)

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- The presence of primary sedimentary structures in outcrops, such as flute cast, groove cast, ball and pillow structure, clay balls, immature minerals;
- A sedimentation bathymetry, from ecological point of view of 700-800m;
- A poor well sorted and graded bedding sandstones with a low matrix – grains ratio;
- A marine offlap and marine onlap;
- A shale prone facie intercalated with channel or thin capricious sandstones;

By integrating the above-mentioned data, we draw out the conclusion that the sedimentation is controlled by turbidite currents. The basin and slope fans of lowstand system tracts predominate in this sequence



2.

Fig.4 Geological-geophysical cross section nr. 154 Divjake-Lushnje Region

2.2 TORTONIAN SEQUENCES

Two sequences of third order are identified in this stage. A parallel to sub parallel internal reflection configuration is the main feature of the seismic facies in Tortonian basin borders, on the over thrusted zones. In this part, in whole the seismic lines, onlap and toplap reflection termination is encountered on the base and below the top of sequence boundary (Fig.-4). The most common characteristic of reflection is the high continuity and high amplitude. In the cases of deltaic sedimentation, a low continuity and moderate amplitude is present. A divergent to oblique – sigmoid complex reflection configuration, or slope front fill are distinguished westward, where a moderate to high continuity and high amplitude characterize the morphology beyond the shelf edge. Toward the depocenter, there are generally separated the mounded external reflection forms with a variable continuity and amplitude, somewhere else with drape external reflection form accompanied by high continuity and low to moderate amplitude. Together with the multidisciplinary data, such as the presence of considerable sandstones, right in the base of sequence and the sedimentary package onlapping toward the slope in the east is done possible to be individualized the slope and basin floor fans. The second sequence of Tortonian has the same features, but the facies itself migrates toward the depocenter. Besides this, the geometry of fan system (outer, middle and inner parts), as well as the deltaic sedimentation are identified and shaped based on the well data and seismic facies (Guri S., Gjika A. 1992). As a result, in the Tortonian sequences, the lowstand and highstand system tracts for the

northern part of PAF onshore and the lowstand and transgressive system tracts for the southern part have been distinguished.

2.2.3 MESSINIAN SEQUENCE

corresponds with Messinian stage or G. Conomiozea biozones. The lower boundary of this sequence is of Sb_1 type, as it is evidenced by:

The reflection termination, as marine and coastal onlap;

- Erosional truncation under it;
- The exposure of the majority part of the shelf;

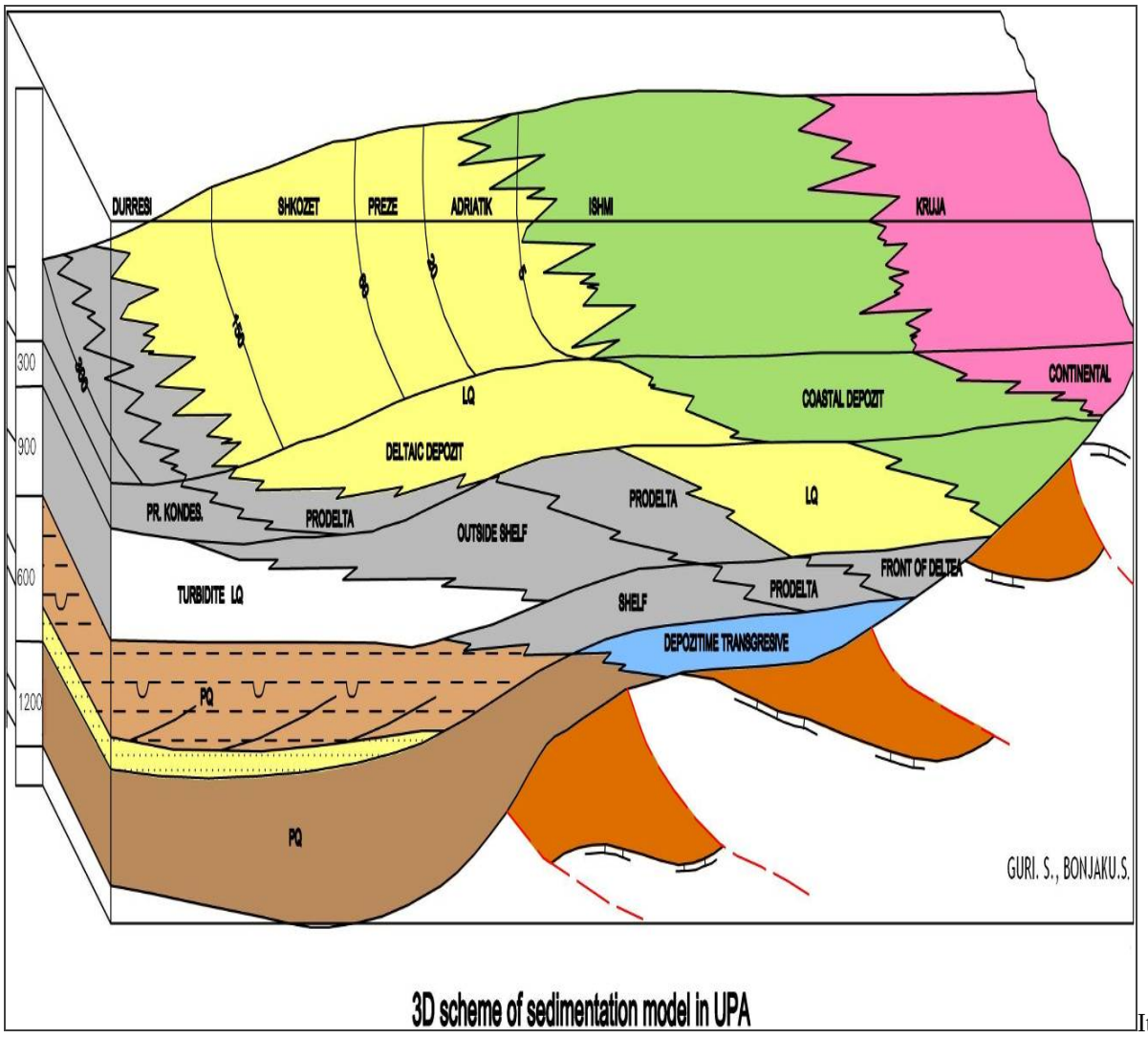


Fig. - 5

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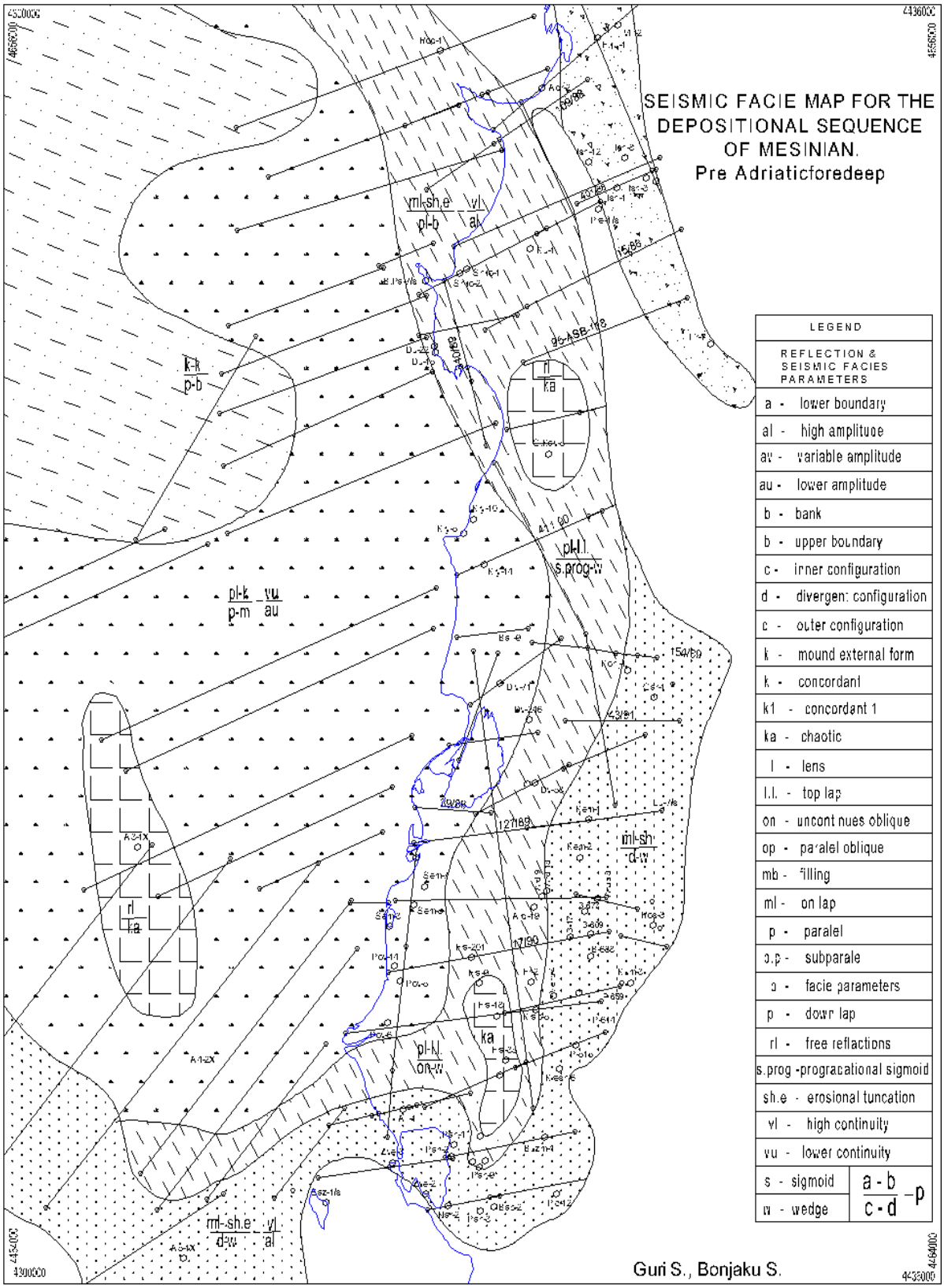


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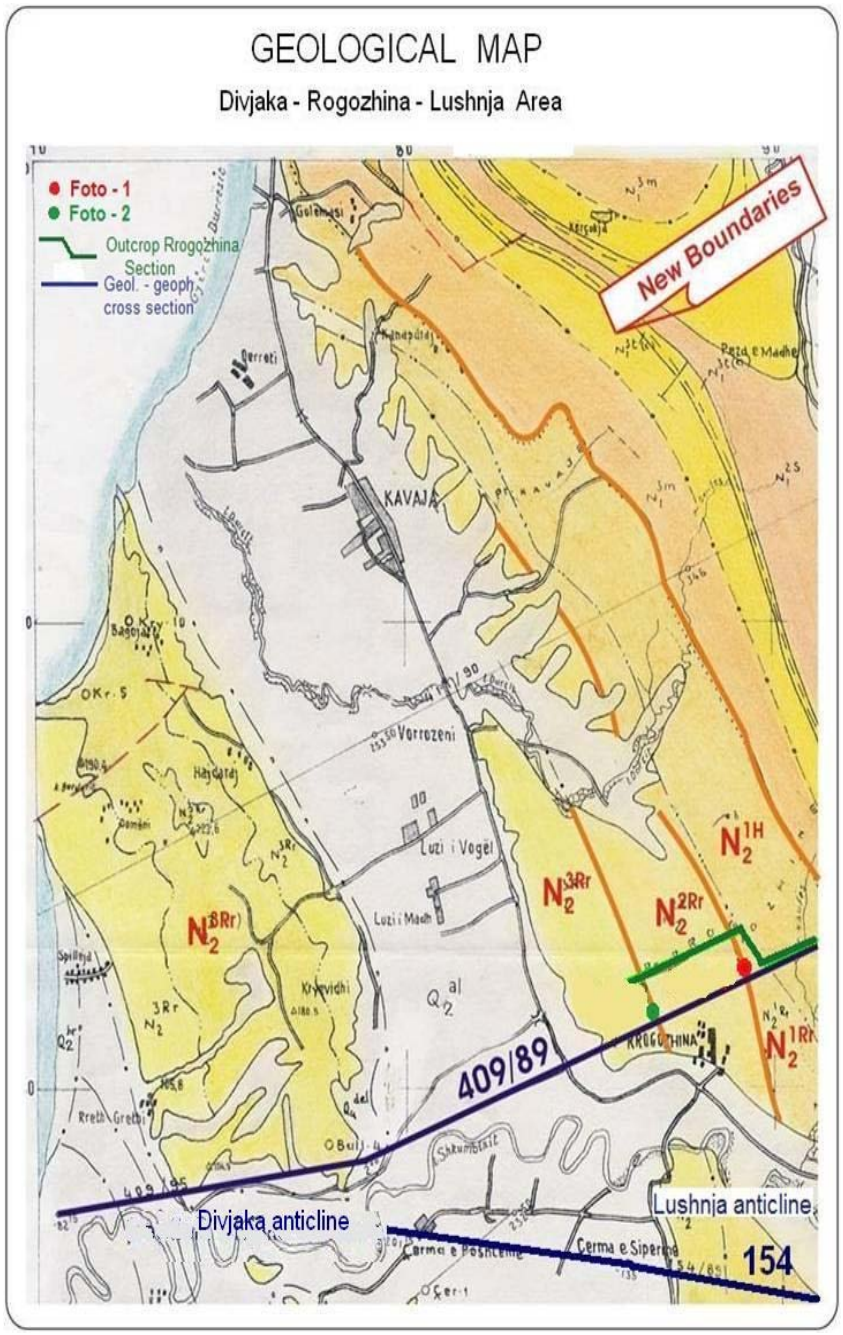


Fig. - 7

A basin flore fan with external reflection (Fig.-5) configuration as a mound, and compounded of many sandstones bodies is observed and contoured. A diversity seismic facie is laterally developing from east to west or from basin margins to the depocenter of the basin. The onlap and toplap reflections termination are encountered on the base and under the top of sequence boundary. The most common characteristic of reflection is the high continuity and high amplitude, which are presented as parallel to divergent. The seismic facie parameters ratio, combined with the paleogeographycal maps, in this case indicates shelf condition sedimentation. Another type of seismic facie, such as oblique – sigmoid complex reflection configuration, or slope front fill is distinguished
westward, from a moderate to high continuity and amplitude, which characterizes
the morphology beyond the shelf edge, (Seismic line 17/89, Fig.- 12). Toward the depocenter, there are generally separated the mounded external reflection forms with variable continuity and amplitude, somewhere else with drape external reflection form accompanied by high continuity and low to moderate

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amplitude. Hereon, all the system tracts of a depositional sequence, including the late highstand are preserved and encountered. This is depicted by the seismic facies interpretation, as well.

2.2.4 Pliocene sequences

This sequence immediately occurs after a rapid falling of the sea level at the end of upper Miocene. It is proved by encountering a sequence boundary of Sb1 type, (Fig.-7, photo - 1,2) on the over thrusting zones, where this boundary surface is onlapped and toplapped by seismic reflection groups. In the onshore of the PAF, the transgressive and highstand system tracts are represented. The lowstand is thought to be developed in the Albania offshore. Parallel to sub parallel reflection going to divergent one have been distinguished more westward than the former

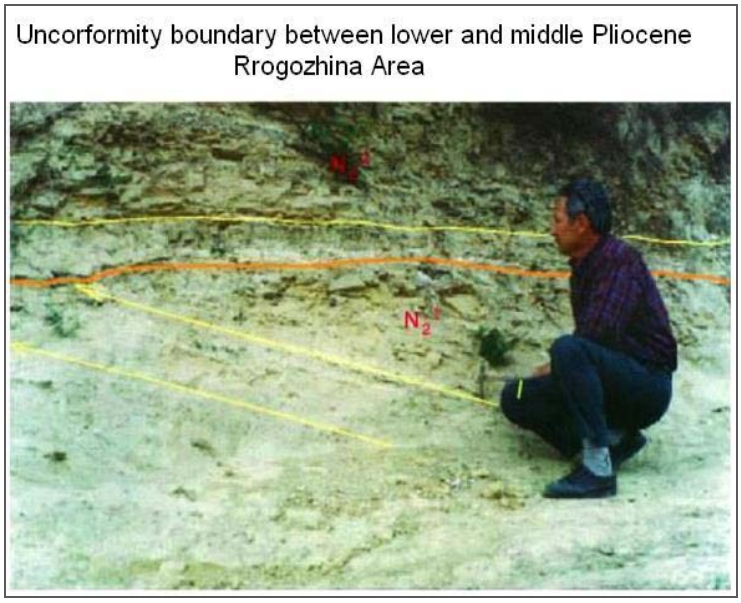


Foto – 1

sequence. A retro gradational facie is distinguished in the Albania onshore over the orogen and a progradational one (oblique and sigmoid one) is encountered near the seacoast. We come across the same seismic facie parameters ratio, with the exception that they always represent a sedimentary facie in a more restricted basin, westwards.

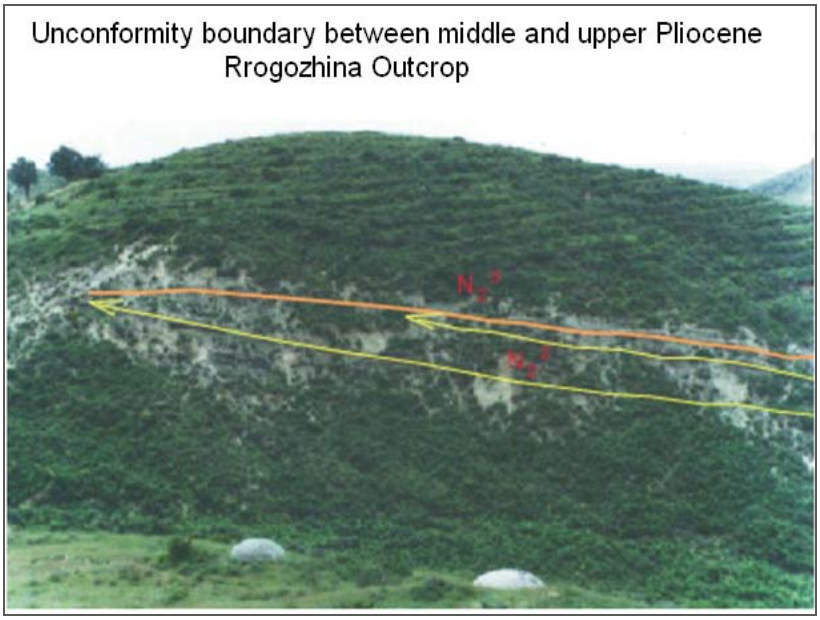


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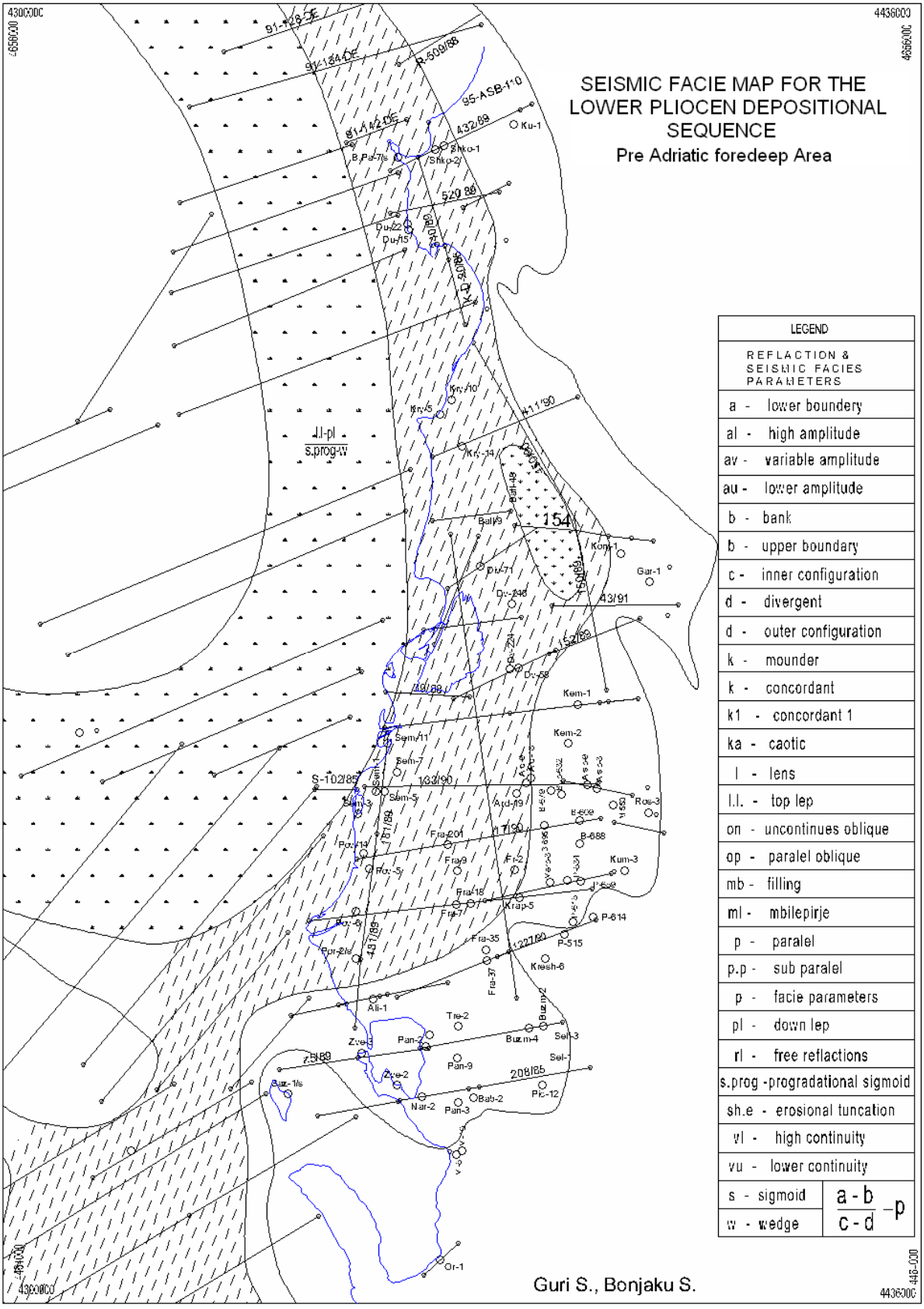


Fig. - 8

The second sequence

The second depositional sequence took place 800 thousand years ago. Its boundary surface is encountered in both sides of Quaternary basin (offshore seismic lines), where onlapped reflection terminations are observed.

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The nature of reflections and their geometry indicates inner shelf sedimentation (Albania onshore) and an outer shelf to basin sedimentation (Albania-Italian offshore). Parts of transgressive and highstand system tracts, with predominant fluvial processes, can be interpreted in the study area. The sedimentary environments (alluvial plain, deltaic plain, lagoon, marshes, delta fronts) migrate westward to younger stratigraphic levels. (Fig.-9)

The third sequence

The third sequence belongs to Holocene and has just taken place with its sediments not farther than 0.05 million years ago. It's no evidence of the lowstand system tract away in offshore, but we

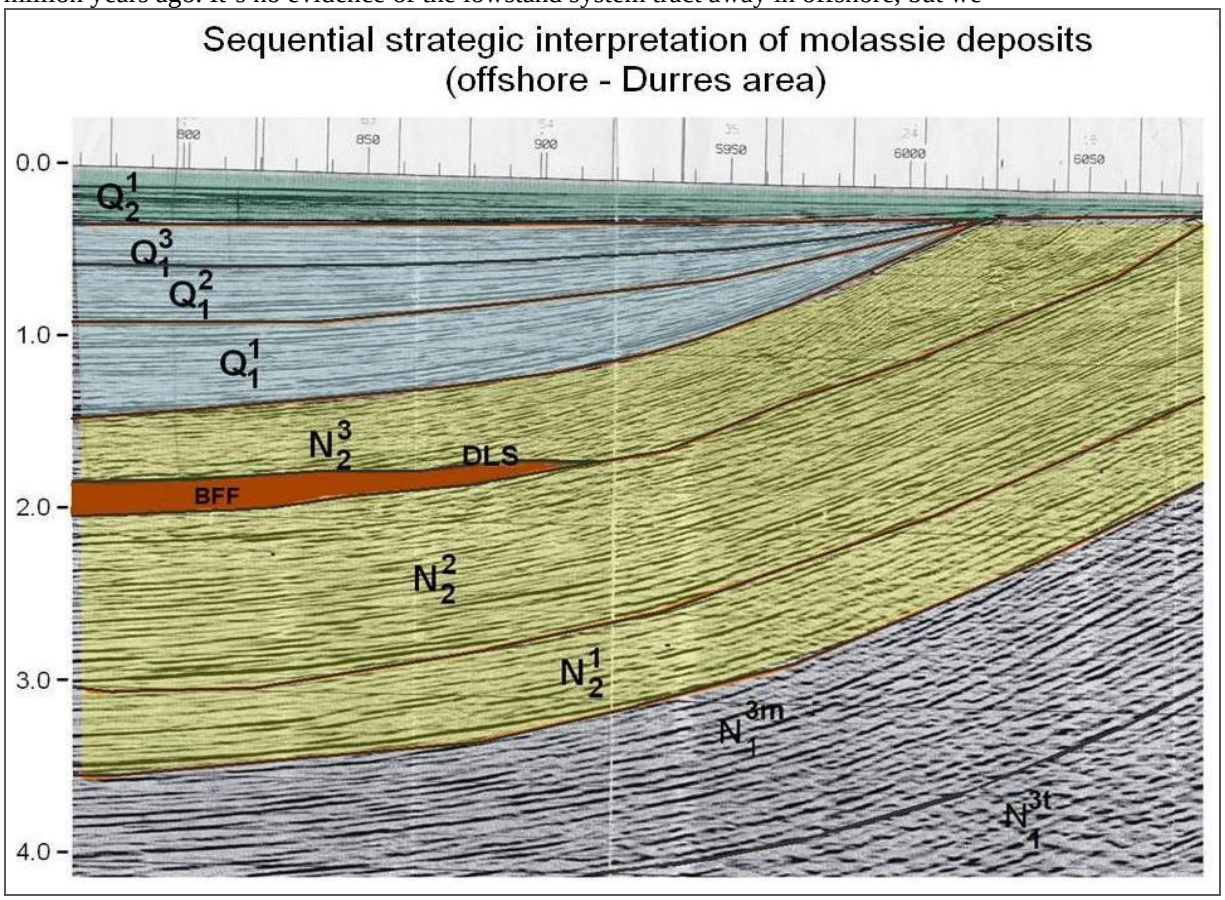


Fig. - 9

can deal with that of highstand in our study area. The presence of fluvial processes is typical, and better preserved than in the older sequences.

3. LITHOLOGY AND FACIES DISTRIBUTION

3.1 Bed rocks

The Messinian rocks are appeared in Currila sector and around the "rock of Kavaja". It's represented by massive clay stones intercalated with sandstones, which predominate upward. The clays are blue colored, compact and with few silty. From mineralogical point of view, based on diffractometry, the clays constitutes of montmorillonit (45-60%), illit (15-20%), caolinit (10-15%) and other minerals (up to 5-7%). [6]). The cement is of a mixture contact, and it's mainly represented by the spatic carbonate. Pliocene rocks take place along the eastern part of the study area, beginning from the "rock of Kavaja" down to the city of Fieri. Two known formations take part in its constitution:

- Helmasi formation;
- Rrogozhina formation;

The deposits of Helmasi formation begin with basal sandstones and conglomerates, interbedded with clays that predominate upwards. Both sandstones and claystones have the same mineralogical constituents as in the Messinian.

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3.2 COVERING FORMATION

Based on surface geology and on numerous drillings wells, the Quaternary loose deposits are considered to be composed of deluvial, alluvial, lagoon-marshes and coastal-deltas deposits. Deluvial deposits outcrops near the foothills of bedrocks with a thickness of 4-5m, which is being reduced westward, going laterally and facially in alluvial ones. It's difficult to be identified in the subsurface sections, because of its similarity with alluvial ones, (fig.-2). Alluvial deposits seize the major part of the study area, presented as a vegetal land. These are mainly represented by plastic to little compact subclays. Lagoon and marshes deposits emerge as a strip, accompanying the beach zone. They are represented by wet up to flowing clays, with brown to dark color and with abundant quantity of organic matter, as plant remnants, cool matter, lignite and mud. On surface, it's presented as a hyper saline land, with no vegetation. In subsurface (well sections), it is distinguished by individualizing the coal markers or clay thickness with abundant organic matters. The lagoon and marshes environments migrate westward to younger stratigraphic levels, Coastal deposits are consisted of beach and front delta sediments. Small and medium grain size sands, gray to beige color, semi compact and with some light subclay laminations represent them. Along the seacoast, these deposits have generally a thickness of 17-20m. On the subsurface, they took place during the respective highstand of each depositional sequence and they are preserved in the last one. This environment also migrates westward to younger stratigraphic levels.

4. BRIEFLY ON AREA GEODYNAMIC

4.1 Neogenic Structures and their tectonic

The thickness of Quaternary deposits covers several neogenic structures as:

1. Zvërneci - Povelca – Seman;
2. Vlora – Panaja –Frakull;
3. Ardenica-Divjake-Ballaj-Kryevidh-Durrës
4. Karbunara-Lushnje-Golem-Kavaja-Shkoza;
5. Patos - Marinza Monoclinal
6. Tirana-Ishëm Monoclinal

which are related to the orogenic tectonic. As a consequence, overthrusted and backthrusted faults accompany them, where the key role generally belongs to the overthrusted one. (Scientific Report, Apennines-Helenides Geodynamic). Occasionally, where neogenic structures are nearby the competent masses (carbonate structures), triangular zones are formed, and the key role of faults is exchanged passing to the backthrusted one, such as in Durres, Preza, Ardenica. A feature of tectonic faults is the diminution of their range toward the surface that does not often appear on the ground.[8] The Plio-Quaternary deposits are not often affected, neither by overthrusted or backthrusted faults. But, their evidences toward the surface take importance for the fact that, these faults play a key role in fluvial processes, coastline shifting as well as in the distribution of gas reservoirs and in seismicity of the zone. Another feature of tectonic active faults is the diminution of their range northwards, too. So, the faults of Zvernec-Poro-Povelçe-Seman and that of Kraps-
Ardenice-Divake-Kryevidh do not respectively continue or lose the orogenic role seawards. The structural plane continues to preserve the same values originated since Tortonian, where a subsidence of above-mentioned structures is evidenced. Besides the overthrusted faults that accompany the neogenic structures, we come across transcurrent system faults, just where the key role of the overthrusted fault is passing to the backthrusted one (Ardenice-Divjaka, Kryevidh-Durres). This fault type directly influences in the formation of subsidence zones. They also effect in the destruction of deltas such as Seman, especially during the ingression of the sea. As above, we can draw out the conclusion that the tectonic and neotectonic take directly part in the eustatic sea level processes by creating a relative sea level change, in the overthrusting and/or subsidence zones. [9]

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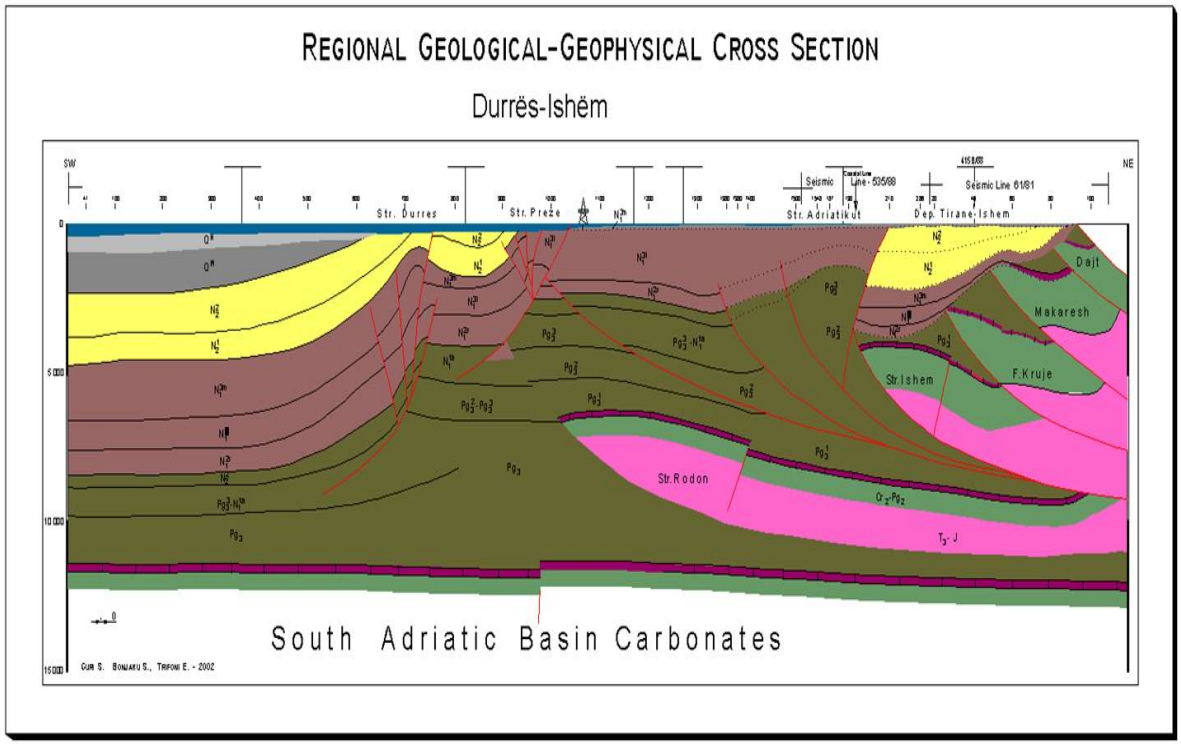


Fig. - 10

4.2. Actual sedimentology

Eustasy, tectonics, climate and sediments influx are four of factors controlling the coastal line shift in each position of globe. During last century, it seems that a postglacial period has been established. The glaciers melting caused an increasing of eustatic sea level change, but combining with a determined tectonic factor, it brings out the falling or rising of this level. Practically, the zone of Seman-Spile and the Karpen-Golem one, present features of subsidence zones, because of structural plane character, which always dips from south (Zvernec, Kraps) to the Quaternary basin depocenter. During this time, the tectonic processes and the eustatic sea level changes have created in these zone conditions for a shift of coastal line toward orogen. [10] Being that these deposits coincide with late highstand, where the fluvial processes dominate or determine the controlling of sedimentation. Large delta plains are formed, accompanied with respective delta fronts as those of Seman, Shkumbin rivers and generally occurs an aggradations of river side or a displace of shoreline seaward and / or formations of land tracts. The humid climate and the vicinity of source rocks contribute to large sedimentary loads, which limit the aggressivity of the sea, but not stopping it into interdeltaic zones. Basing on these data, we can understand the presence of the interdeltaic zone between Vjosa and Semani delta, or Semani and Shkumbini one, etc. During the last years, the human interference in natural processes has caused the diminution of sedimentary loads. The combination of this factor with those mentioned above (tectonic, eustasy) have made possible to be destroyed the geomorphologic equilibrium, on the detriment of the formation of new land such as delta front, beaches, delta plain, marshes lagoons, etc., creating in this way new delta fronts, delta plain, beaches, marshes, etc. On the other hand, this has caused the demolition of old deltas formed in the first sequences.

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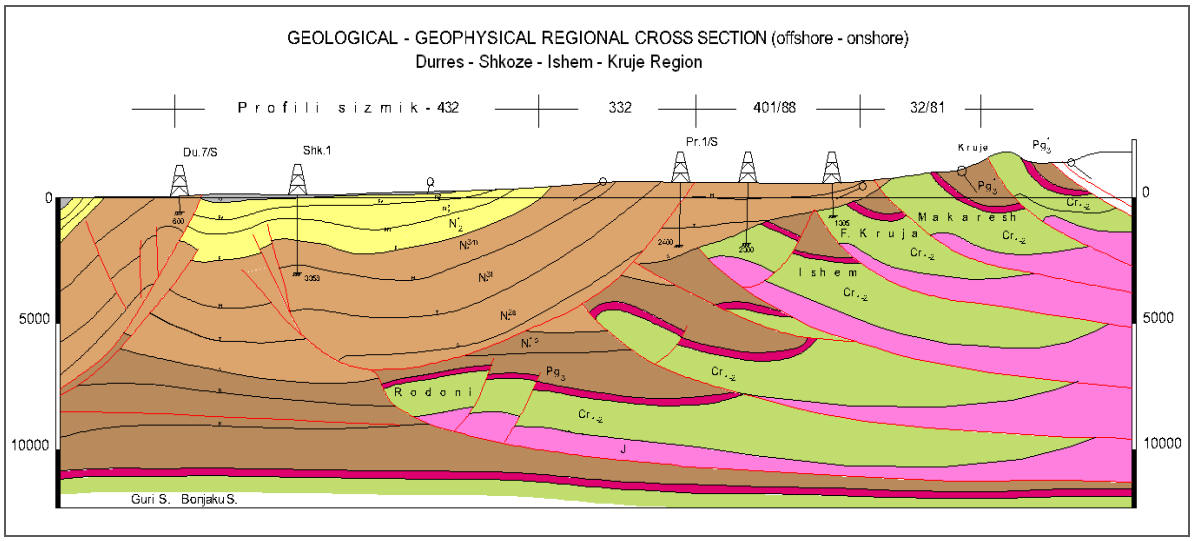


Fig. - 11

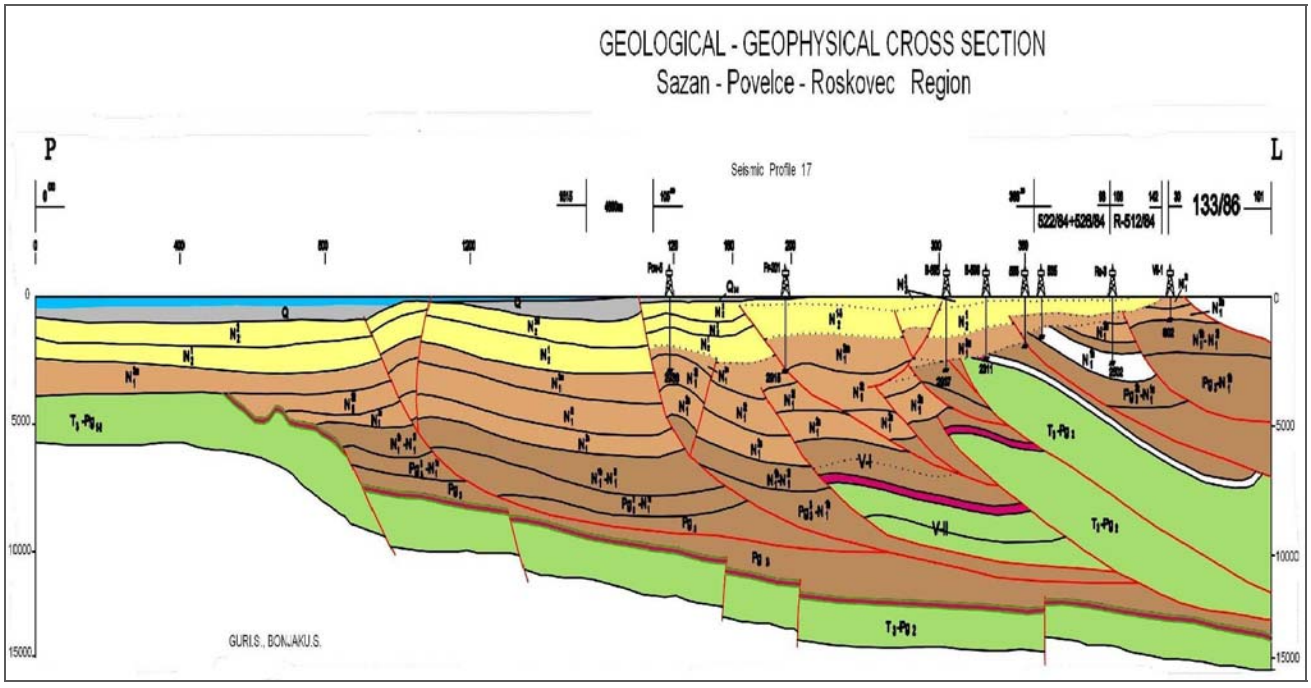


Fig. - 12

CONCLUSIONS

The depositional sequences generally belong to type-1, with Sb_1 basal boundary and rarely of Sb_2 type. The lowstand system tract is more preserved, but the highstand took place almost in the whole depositional sequences and it is dominant in the younger ones, since Tortonian onwards.

A reliable and a resistible correlation of genetically related units according to chrono stratigraphic significance are obtained. Through seismic facie parameters, sedimentary environments with their respective facie have been evaluated.

Two main formational types represent the study area Bedrock's formation (Messinian and Pliocene). Two known formation take part in the Pliocene rocks constitution: Helmasi and Rrogozhina formation. The deposits of Helmasi formation begin with basal sandstones and conglomerates.

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The Quaternary is composed of deluvial, alluvial, lagoon-marshes and coastal-deltas deposits.
Three depositional sequences of third order have been recognized. These sequences took place soon after the sea level fall at the end of upper Pliocene, where the boundary surface is onlapped and toplapped by seismic reflection groups. The second depositional sequence occurred 800 thousand years ago. Its boundary surface is encountered in both sides of Quaternary basin.

The nature of reflections and their geometry indicate an inner shelf sedimentation of (Albania onshore) and on outer shelf to basin one (Albania-Italian offshore). The third sequence belongs to Holocene and has just taken place with its sediments not farther than 0.05 million years ago. There is no noticed the lowstand system tract

The Quaternary deposits cover several neogenic structures, which are related to the orogenic tectonic. The tectonic and neotectonic take directly part in the eustatic sea level processes by creating the relative sea level change, in the overthrusting and / or the subsidence zones. The tectonic processes and the eustatic sea level changes have created in these zones conditions for a shift of coastal line towards orogen.

The human interference in natural processes has caused the diminution of sedimentary loads. The combination of this factor with those mentioned above (tectonic, eustasy) led to the destruction of the geomorphologic equilibrium, in this area.

REFERENCES

[1] Guri S., Ismaili J. The basin study of the Preadriatic Depression (Albania), Archive of Oil and Gas Institute, Fier, 1993
[2] AAPG Memoir 26, 36, 39, and 42. Oil and Gas Institute.
[3] Arapi M. (1994) The geological framework and the oil - gas bearing in the South Adriatic basin. Oil and Gas Institute, Fund.
[4] Guri S., Mehillka LL. The structural model of external Albanides and hydrocarbon prospects,Archive of Oil and Gas Institute, Fier 1995
[5] Guri S., Xhango V. The geologic - geophysical study in the Divjaka gas field region, Archive of Oil and Gas Institute, Fier, 1986
[6] Mahmutaj L. The mineralogic-petrographic study of clay rocks in pre Adriatic depression, Archive of Oil and Gas Institute, Fier, 1989
[7] Skrami J., Guri S. - Some trends of the study of Quaternary loose deposits on the Durres-Vlora coastal zone. Publicize of "Universita degli Studi di Bari" (Italy),p. 185-187 Gennaio, 1999, Scientific Library of Oil & Gas Institute, Fier – Albania
[8] Guri S., Rakipi N., (1992) The interpretation of sequence stratigraphy in molassic deposits of PAF. Oil and Gas Institute, Fund.
[9] Zeqo B. The geologic field survey of Durres - Kavaje area in scale 1: 25000, Archive of Oil and Gas Institute, Fier, 1989
[10] Possamentier, H.V. et al - Eustatic controls on clastic deposition SEPM Special Publication, 42 p.109-154, 1988

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MICROENCRUSTERS AND MICROBIAL STRUCTURES IN THE TRIASSIC LIMESTONES FROM MIRDITA ZONE, THEIR PALEOENVIRONMENTAL SIGNIFICANCE.

Andreea UTA[1]
[1]Institute of Geosciences, Energy, Water and Environment Tirana, Albania,
e-mail: andreauta@gmail.com>

ABSTRACT

Ignored for a long period of time, microbes contributed to the construction of Middle and Late Triassic reef frameworks, some Late Triassic reefs were almost exclusively formed by stromatolites and microbial crusts. The Upper Triassic limestones from Mirdita zone partly consisting of reef-builds up and microbial deposits of lagoonal environments are characterized by an important component of microbial organisms. This paper describes and illustrates some of the most important structures interpreted as having a microbial nature: microproblematica, "Tubiphytes" and "Bacinella" type structures, cyanobacterial structures, micritic crusts and peloidal structures from two geological sections belonging to Mirdita carbonate platform: Lura section in pelagic deep water to reefal and shallow subtidal platform environments and Staveci section in shallow subtidal-lagoonal, peritidal (inter/supratidal) environments.

KEY WORDS: *Mirdita zone, microencrusters, microbial structures, Triassic, paleoenvironment.*

GEOLOGICAL SETTING

The Albanides show a complex structural evolution. To the west and north, the tectonic units belonging to the Apulian plate-margin were progressively emplaced in a subductional geodynamic environment and characterize an in-sequence thrust system (External Albanides; fig 1). This thrusting was active during the Eocene time in the internal part of the structure and affected the more external zones during Pliocene time. Eastern and Central Albania (Internal Albanides; fig 1) show oceanic units (Ophiolitic Mirdita nappe) and their tectonic substratum.
Within the ophiolites and napes of Krasta Zone (External Albanides) there is a very deformed tectonic complex interpreted and named in different ways: as peripheral complex according to Robertson & Shallo (2000) or Hajmeli, Qerret-Miliska and Gjalica according to KODRA & al. (1993), MECO & ALIAJ (2000). This tectonic complex can be divided into three main structures. The lower structure is characterized by a thick carbonate platform sequence and according to KODRA & al. 1993 it was named Hajmeli in the western part of Mirdita and Gjalica in the eastern part.
The second structure settled on the carbonate platform is represented by a volcanic, volcano-detritic and pelagic (limestones and cherts) sequence confirmed and dated in different countries by microfauna, radiolareans and conodontes (KODRA &al., 1993; MEÇO & ALIAJ, 2000). The name of this complex is Rubiku nape.
The third complex consists of ophiolites of Mirdita Zone and is divided in two belts: the ophiolitic belt of Western Mirdita (OMP) and the ophiolitic belt of Eastern Mirdita (OML) (SHALLO & al., 1987; BECCALUVA et al., 1994; TASHKO 1996). Mirdita ophiolitic nape has been overthrusted or obducted during Middle Jurassic (DIMO, 1997; DIMO-LAHITTE & al., 2001), shortly after their magmatic setting. After this process of tectonic setting, the ophiolites have been subject to erosion.
The post-obduction sediments consist of a chaotic association coming from the internal structures and ophiolites. However, the ophiolitic elements are quite rare, undoubtedly as a result of climatic conditions in which it is developed and carried the erosion of OML. The chaotic sequence is covered by turbidites from Tithonian-Lower Cretaceous (SHGJSH, 2003), and then by thin carbonate formations of Hauterivian – Barremian and Upper Cretaceous turbidites (SHGJSH, 2003; PEZA, 1985; SHALLO, 1990).

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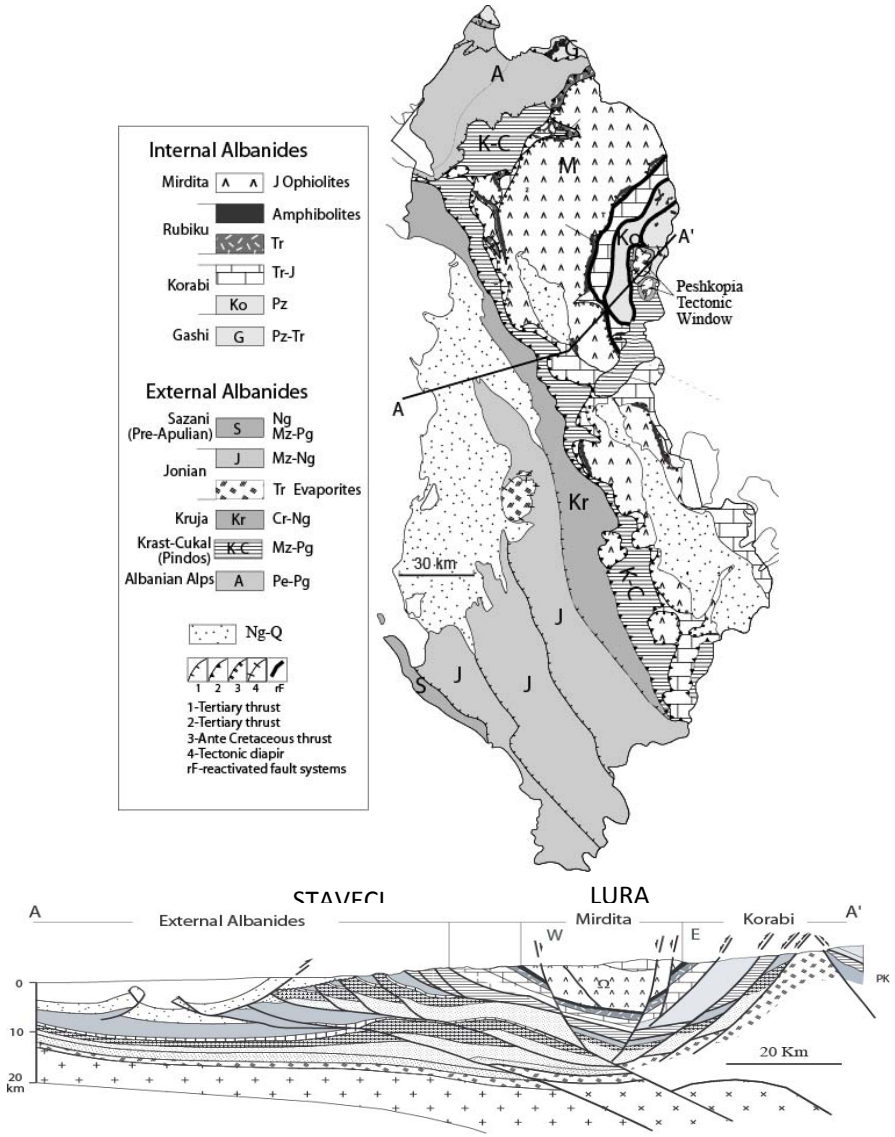


Figure 1. Schematic geological map and cross-section of the Albanides (modified after MUCEKU et al. 2008)

The stratigraphy of Lura and Staveci deposits, equivalents of Gjalica and Hajmeli, is well known (GJATA K ET al., 1980; SHALLO et al., 1986; GJATA TH. et al., 1985, 1987; GODROLI, 1992) and will be not described here.

MICROFACIES TYPES

In Lura Section in pelagic to external platform facies (including coral-microbial reefal build-ups) and shallow subtidal platform, the sedimentary succession starts with argillaceous schists interbedded with black marls (Plate I, Fig.2) and biocalcarenitic (Plate I, Fig.1) limestones followed by red radiolarites with hematitic matrix, rare radiolaritic marls (Plate I, Fig.4) and microbreciated turbiditic limestones (Plate 1, Fig.3),radiolarian wackestone-packestones, algal crinoidal wackestones, coralgal wackestone-packestones to biosparudites, peloidal and oncoidal wackestone-packestones, algal packestone-grainstones, bioclastic mudstones while in Staveci section are present oncoidal peloidal mudstones and respectively peloidal wackestone-packestones, flat laminated algal stromatolites,

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bioclastic mudstones with Rivularia-type cyanobacteria , floatstone with megalodonts and gastropods (Plates 1-6).
The carbonate deposits from the two units (Lura and Staveci) contains faunal assemblages represented by: *Bacanella floriformis* PANTIC, the problematical organism *Ladinella porata* OTT typical for the Ladinian reefs, *Earlandia (Aeolisacus) aplimuralis* PANTIC, *Galleanela panticae* ZANINETTI and BRONNIMANN, *Tubiphytes* sp, the sphinctozoans *Cryptocoelia zitelli* STEINMANN and *Colospongia catenulata* OTT, *Ophtalmidium sp, Duostomina, Triassina hantkeni* MAJZON, *Trochammina alpina* KRISTAN-TOLLMANN, *Vidalina martana* FARINACCI, *Involutina liassica* JONES, *Thaumatoporella parvovesiculifera* Raineri, *Involutina gaschei* KOEHN-ZANINETTI and Bronnimann, *Trochammina alpina* KRISTAN-TOLLMANN, *Ophtalmidium* sp, *Earlandia sp*, associated to dasycladacean alga, ostracods, brachiopods and gastropods.

MICROBIAL STRUCTURES AND MICROENCRUSTERS

It is well known that stromatolites and other microbial carbonates played an important role in the formation of Middle Triassic and Upper Triassic limestones in settings including shallow-marine platform and reef carbonates environments. Crusts are frequent in Ladinian and Early Carnian reefs and are characterized by various associations of sponges, microbes, and microbially induced carbonate cement. The composition of Late Carnian reefs differs significantly in that lowgrowing sponges and porostromate cyanobacteria dominate. A complete change took place in the Norian (Late Triassic) when biogenic crusts become highly diverse and mainly built by microbialites, sphinctozoan and chaetetid sponges and micro-encruster associations.

Types of structures and their significance
a) Lura section

Microproblematica presents in our studied area can be assigned to informal groups characterized by the dominating morphology:hollow tubes (e.g. *Aeolisaccus)*, isolated or closely packed spheroids consisting of radially arranged calcite crystals or spheroids (e.g. *Baccanella, Globochaete)* and cell assemblages (e.g. *Bacinella, Ladinella, Thaumatoporella*).

***Globochaete* Lombard 1945**
This genus is abundant in open-marine pelagic carbonates, but also occurs in shallow-marine environments (SCHAFER & SENOBARY-DARYAN 1980; BACHMAN 1987). Originally interpreted as calcified zoospores of chlorophycean, alga *Globochaete* is now considered as a planktonic single-celled green alga (SKOMPSKI 1982).

***Baccanella* Pantic 1971**
This genus is a common constituent of cryptic cavities in the central part of Middle and Late Triassic reefs and has been interpreted as algae, bacteria, bacterially induced carbonate precipitate or diagenetic product caused by recrystallization of micritic High-Mg cacite and aragonite on the sea floor (Pratt 1997) (Plate III, Fig. 6).

***Thaumatoporella* Raineri 1924**
This genus known from Middle Triassic to Late Cretaceous deposits is widely distributed in platform carbonates and occurs in lagoonal and reefal settings, frequent with Bacinella. It was originally regarded as red alga and later dasycladacean algae or possible sponges. *Thaumathoporella* is now interpreted as belonging to a separate group of green algae (DeCASTRO 1990).

Bacinella
This structure is still under intense debate (RADOICIC1959, SEGONZAC & MARIN, 1972, BANNER et al., 1990, SCHMID & LEINFEDER 1995, SCHAFFER & SENOWBARY-DARYAN

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1983, MAURIN et al., 1985 and CAMOIN & MAURIN 1988 argued with the possible microbial nature. CAMOIN & MAURIN 1988, consider bacinelloid structures as microbial products, this being reinforced by UTA & BUCUR 2003. According to NEUWEILLER 1992, *Bacinella* (bacinelloid *Lithocodium* in the terminology of Neuweiller) together with other alga and microbes "is a major constituent of thrombolitic mud mounds".

***Tubiphytes* Maslov 1960**

Tubiphytes is one of the most common microproblematica in Late Paleozoic and its name should be replaced by *Shamovella* for reasons of priority (Riding 1993), but most people still use the familiar old name. *Tubiphytes* are major constituents of Middle Triassic reefs but minor elements in Late Triassic reefs and *has* been attributed to various algal groups, cyanobacteria as well as sponges, hydrozoans and foraminifera (Riding and Guo 1992). It consists of a "core"/nucleus" represented by a nubeculariid foraminifer (showing a central or subcentral arrangement of the chambers) surrounded by micritic envelope. The nature of this structure type has been long time under debate (e.g. Bernier, 1984); one of the most recent interpretations (Schmid, 1995) considers the whole structure as representing a double-layered foraminifer.

The current explanation for some Triassic *Tubiphytes* is a symbiotic commensalism of different organisms recorded by the spar-filled 'cavities' and tubes and calcified cyanobacteria represented by the surrounding network (Plate 2. Fig.3).

Microbial void fillings

In Lura section, some of the corals within the coral biolithites underwent microbial micritization of septa, the solution voids between (or within) the septa being partly filled with micrite of presumed microbial nature (Plate II, Figs. 3-4). Some of these voids might represent *veneers* sensu Riding (2002).

b) Staveci Section

Peloidal structures

Frequently the limestones contain structures consisting of relatively small micritic peloids sometimes associated with micritic-laminated structures with some stromatolitic-thrombolitic levels. It is generally accepted thet most of the peloids of this type are a product of cyanobacterial-induced calcification (Chaefez, 1986) (Plate IV, Figs. 2 and 6, Plate 5, Fig.6).

Cyanobacteria

Rivularian-type cyanobacteria are abundant in the black fenestral mudstones with sparite filling fractures, calcite filled-voids, geopetal and birds eyes structures or dessication cracks from Staveci section (Plate IV, Fig.4).

Flat laminated algal stromatolites

In Staveci section, common features are dense autochthonous micrites, micro-laminated fabrics (e.g. stromatolites), millimeter-to centimeter-sized micritic crusts, non-laminated micritic and peloidal structures, and limestones exhibiting microfossils represented by cyanobacteria.

Here is recommended the *definition* proposed by Riding (1999): Stromatolites are *laminated benthic microbial deposits*. (Plate IV, Fig.3).

This microfacies are characterized by well-developed laminations, desiccation cracks and bird's eyes containing internal vadose sediment at the base and spar filling in the residual space (geopetal structures). Thrombolitic structures composed of dark, clotted micrite with peloids are common. *Fine-grained, well laminated stromatolites* characterized by conspicuous lamination, due to episodic sedimentation and trapping of fine-grained sediment. Lamination may be smooth (subaqueous) or crinkled with fenestrae (due to exposure and desiccation on tidal flats or lake margins).

This microfacies can represent the member B of a loferitic cycle.

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In Staveci section, the flat laminated algal stromatolites are associated with typical floatstone with Megalodonts and gastropods and represent a typical Alpine Dachstein Lofer cycles. FISCHER (1964) provided a detailed description of loferitic facies as it follows: a disconformity at the base; member A – a basal argillaceous member (red or green) representing reworked residue of altered material; member B – intertidal member of loferites with algal stromatolitic mats, geopetal structures and desiccation features; member C – subtidal megalodont limestone. The identified cyclothem in Staveci section is incomplete and shows members B and C from a typical lofer cycle described by FISCHER (1964): the intertidal member with algal mats and abundant geopetal structures corresponds to member B while the subtital carbonate facies with Megalodontes correspond to Member C of the typical Dachstein Lofer Cycle.

PALEOENVIRONMENTAL REMARKS

Microbialites, including microencruster associations are important elements in paleoceanograpic and paleopathymetric reconstructions.
The recognized microfacies of both selected outcrops allows us to distinguish two categories of carbonate platform facies: open-marine shallow subtidal facies in Lura section, extending from pelagic deep water to reefal and shallow-subtidal carbonate platform environments while in Staveci section, we have identified restricted facies typical for shallow subtidal-lagoonal and inter-supratidal depositional environment corresponding to an inner restricted platform–tidal flat system. Both sections are overlayed by the condensed facies comprise nodular limestones and specific faunal assemblage formed in pelagic conditions.
Globochaete alpine ? Lombard and Bacanella floriformis associated to radiolarians in the radiolarian wackestone-packstones were widely distributed throughout the Late Triassic (Carnian-Norian) Tethys and were typical for pelagic environments. Globochaete alpina? Lombard also occurs in shallow-marine environments (SCHAFER & SENOWBARI-DARYAN 1980, BACHMAN 1987).
Bacanella floriformis Pantic is common in the shallow-water reef facies and is a constituent of cryptic cavities in the central parts of Middle and Late Triassic reefs. *Galeanella panticae* ZANINETTI & BRONNIMANN associated to micritic clasts is located in marge platform reefs and *Cryptocoelia zitteli* STEINMANN is among the most common sponges presents in the Ladinian and Carnian reefs builders.
The flat laminated algal stromatolitic facies with "fenestra" and rich in gastropods and ostracodes can be interpreted as a subtital deposits.
The laminated and fenestral mudstones characterized by well-developed laminations, probably of microbial origin, small fenestrae with geopetal filling and a variety of desiccation structures can be interpreted as inter-supratidal facies.
The facies from Staveci section are typical for shallow subtidal-lagoonal and inter-supratidal depositional environment corresponding to an inner restricted platform–tidal flat system, the platform being affected by several subaerial exposure-related by the presence of geopetal fillings of pores
The microfauna of Upper Triassic limestones from Staveci are characteristic for a tropical lagoon with low water energy. The deposits show similarities with the Alpine Dachstein Lofer cycles and show a general regressive upward-shallowing tendency with its top preserving subaerial exposure evidences. The identified cyclothem in Staveci is incomplete in the studied section, members B and C from a typical lofer cycle described by FISCHER (1964). The subtidal carbonate facies with Megalodontes correspond to Member C of the typical Dachstein Lofer Cycle and the intertidal member with algal mats and abundant desiccations corresponds to member B.

CONCLUSIONS

Microbialites, including microencrusters associations are important elements in **paleoenvironmental and paleopathymetric reconstructions.**
A large range of microbial structures and microencrusters were noticed in the studied deposits: Tubiphytes, Bacinella, algal-mat type structures, stromatolitic, thrombolitic and peloidal structures, micritic crusts. The coral bioconstructions were intensely by microbial and algal structures.
Most of these structures are related to shallow-water reef environments with variable hydrodinamic regimes (from intertidal to protected low energy subtidal and supratidal environment).

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BACHMANN GH. 1987**.** *Globochaete alpina Lombard (Chlorophyceae) im Oberen Muschelkalk von Suedwest-Deutschland*. Neues Jahrbuch fuer Geologie und Palaeontologie. Monatshefte. Stuttgart. **7**: 385-395.

BANNER F.T., FINCH E.M., SIMMONS M.D. 1990. *On Lithocodium Elliot (Calcareous algae); its paleobiological and stratigraphical significance.* Journal of Micropaleontology. London. **9:** 21-36

BERNIER P. 1984. *Les formations carbonates du Kimmeridgien et du Portlandien dans le Jura Méridional.* Domcuments des Laboratoires de Géologie. Lyon. **92/2** : 449-796.

CAMOIN G & MAURIN A-F. 1988. *Roles des micro-organismes (bactéries, cyanobactéries) dans la genèse des « Mud Mounds ». Exemple du Turonien des Jebels Bireno et Mrhila (Tunisie).*Paris. C. R. Acad. Sci. **307/4** : 401-407.

BECCALUVA L., COLTORTI M., PREMTI M., SACCANI E., SIENA F., ZEDA O. 1994. *Mid-ocean ridge and supra-subduction affinities in ophiolitic belts from Albania*. Ofioliti. Edizioni ETS. Pisa. **19**:77-96

DE CASTRO P. 1990. *Thaumatoporelle: conoscenze attuale a appoccio all'interpretazione*. – Bolletino della Società Paleontologica Italiana. Roma. **29** :176-206

DIMO A. 1997. *Le mechanisme de mise en place des ophiolites d'Albanie*. PhD Thesis. Université Paris Sud. 308pp and annexes.

DIMO-LAHITTE A., MONIE A., VERGELEY P. 2001. *Metamorphic soles from the Albanian ophiolites: petrology, geochronology,and geodynamic evolution*. Tectonics. American Geophysical Union. Washington. **20**: 78-96.

FISCHER A. G. 1964. *The Lofer cyclothems of the Alpine Triassic.* In: Merriam, D.F. (Ed.), Symposium on Cyclic Sedimentation. Kansas Geological. Survey Bulletin. **169**:107–146.

GJATA K., KODRA A., PIRDENI A. 1980. *Géologie de certains parties périphériques de la zone Mirdita*. Permbledhje. Studimesh. Tirana. **3**:57-73.

GODROLI M. 1992. *Tectonique des ophiolites dans les zones internes: Modalites d'ouverture et de fermeture d'un basin océanique étroit (exemple des ophiolites de la zone de Mirdita)*. These. Orsay. 324pp.

KODRA A., GJATA K., BAKALLI L. 1993. *Les principales étapes de l'évolution paléogéographique et géodynamique des Albanides internes au cours du Mésozoïque*. Bulletin de la Société Géologique de France. Paris. **164**: 69-77.

MAURIN A.F. , BERNET-ROLLANDE M.C., MONTI C.L.V., NAZHAT S. 1985. *The microbial nature of bacinellid textures-sedimentological bearings.*Abstracts, 6th European Regional Meeting of Sedimentology, International Association of Sedimentologists. Lerida. 285-287.

MECO S. & ALIAJ S. 2000. *Geology of Albania*. Beiträge zur Regionalen Geologie der Erde. Borntraeger Science

RIDING R. 1999. *The term stromatolite: towards an essential definition.* Lethaia. Stuttgart. **32**: 321–330.

MUCEKU B., VAN DER BECK P., BERNET M., REINERS P., MASCLE G., TASHKO A. 2008. *Thermochronological evidence for Mio-Pliocene late orogenic extension in the eastern Albanides.* Terra Nova. Wiley-Blackwell. Oxford. **20**: 180 - 187.

NEUWEILLER F & REITNER J 1992. *Karbonatbänke mit Lithocodium aggregatum Elliott/Bacinella irregularis* Radoicic. *Berliner geowissenschaften Abhandlungen* (E). Berlin **3**:.273-293.

PEZA L. 1985. *Depozitimet e Neokomianit ne nenzonen e Malsise se Madhe*. Bulletini i Shkencave Gjeologjike. Tirana. **1**: 41-53.

RADOICIC R. 1959. *Some problematic microfosils from dinarian Cretaceous*. Bulletin of Geology-Geophysics, Popular Republic of Serbia. Belgrad. **17**:90-92.

RIDING R & GUO L. 1992. *Affinity of Tubiphytes*. – Palaeontology. **35**:37-49

RIDING R. 1993. *Shamovella obscura: the correct name for Tubiphytes obscurus (Fossil). Taxon*. W. Kiessling/W. Kiessling. **42**:71-73.

RIDDING R.2002. *Biofilm architecture of Phanerozoic cryptic carbonate marine veneers.* Geology. Cardiff. **30/1**:31-34.

ROBERTSON A. & SHALO M. 2000. *Mesozoic-Tertiary evolution of Albania in its regional Eastern mediterranean context.* Tectonophysics. Elsevier. Amsterdam. **316**: 197-254.

SEGONZAC C & MAURIN P. 1972. *Lithocodium aggregatum* Elliot et *Bacinella irregularis* Radoicic *de l'Aptien de Teruel (Espagne): deux strades de croissance d'un seul et meme organisme incertae sedis.*Bulletin de la Société Géologique de France. Paris. **7/14**: 331-335.

SCHAFER P. & SENOWBARY-DARYAN B. 1980. *Globochaeten-Zoosporen aus obertriadischen Riffkalken südlich von Salzburg (nördliche Kalkalpen).* Verhandlungen der Geologischen Bundesanstalt. Wien: 97-103.

SCHAFER P. & SENOWBARY-DARYAN B. 1983. *Die Kalkalgen aus des Obertrias von Hydra, Griechland.* Paleontografica. Stuttgart. **185**:83-142.

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SCHMID D.U & LEINFELDER R.R. 1985. *Lithocodium aggregatum* Elliot *n'est pas une algue mais un foraminifére encroutant, commensalisé par le foraminifer Troglotella incrustans* WERNLI & FOOKES. Compte Rendu de l'Academie des Sciences. Paris. **320 :** 531-538.

SHALLO M., VRANAJ A., KATI P. 1986(a). *Nodules manganeux dans les calcaires pélagiques du jurassique des Albanides internes.* Bulletini i Shkencave Gjeologjike. Tirana. **2**: 33-47.

SHALLO M., KOTE DH., VRANAJ A., PREMTI I. 1986(b). *Particularitées pétrochimiques des volcanites associées aux ophiolites des Albanides*. Bulletini i Shkencave Gjeologjike.Tirana. **3**:103-118.

SHALLO M., KOTE DH., PREMTI I. 1987. *Geochemistry of the volcanics from ophiolitic belts of Albanides.* Ofioliti. Edizioni ETS. Pisa. **12**: 125-136.

SHALLO M. 1990. *Ophiolitic melange and flyschoidal sediments of the Tithonian-Lower Cretaceous in Albania*. Terra Nova. Wiley-Blackwell. Oxford. **2**: 470-488.

SKOMSKI P.1982. *The nature and systematic position of the microfossil Globochaete alpina* Lombard, 1945. – Acta Geologica Polonica. Cracow. **32**:47-56

SHGJSH-SHERBIMI GJEOLOGJIK SHQIPTAR 2003. *Geological map of Albania*. Scale 1/200.000. 2nd Edition. Tirana.

TASHKO A., ROEUER O., TERSHANA A. 1996. *Biotite-granitic dikes with accessory Monazite cutting the mantle ultramafic rocks of Bulqiza ultramafic massif (Albania): witness of a "hot" obduction*. Bulletini i Shkencave Gjeologjike. Tirana. **1-2**:115-125.

UTA A & BUCUR I. 2003, *Microbial structures and microencrusters in the Upper Jurassic-Lower Cretaceous deposits from Buila-Vânturariţa Massif (South Carpathians*). Studia Universitatis Babeş-Bolyai, Geologia, Cluj-Napoca. **XLVIII/2**:3-14.

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PLATE I-VI

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Plate I - Lura / Plansa I - Lura

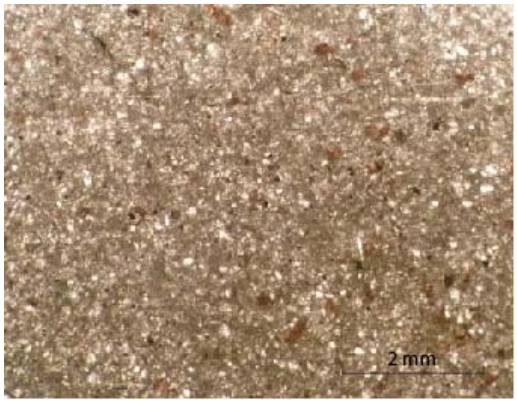


Figure 1. Microcalcarenite limestone with authigenic quartz , sample 1579 (original).
Figura 1. Calcar microcalcarenitic cu cuart autigen, proba 1579 (original).

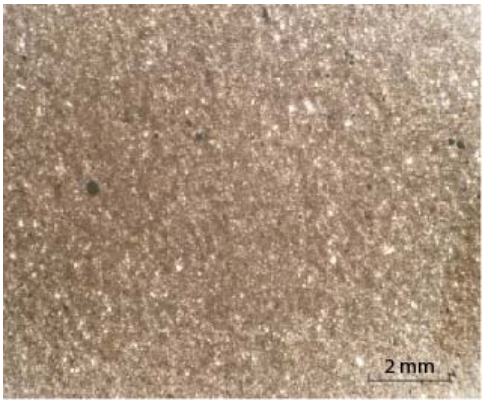


Figure 2. Black marl with dispersed pyrite crystals, sample 1579a (original).
Figura 2. Marna neagră cu cristale de pirită, proba 1579a (original).



Figure 3. Microbreciated turbiditic limestone, sample 1581a (original).
Figura 3. Calcar turbiditic microbreciat, proba 1581a (original).

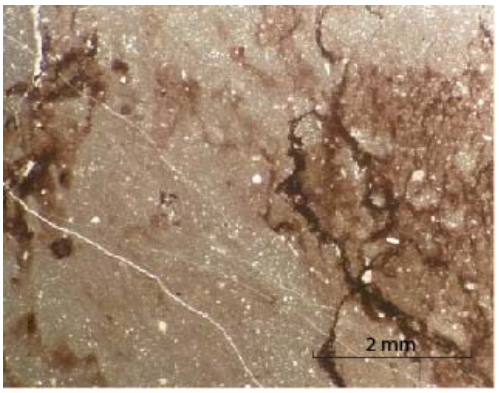


Figure 4. Marl, sample 1584 (original).
Figura 4. Marnă, proba 1584 (original).

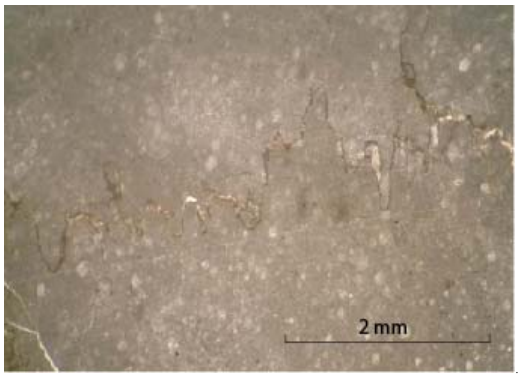


Figure 5. Radiolarian wackestone-packstone with stylolites, sample 1594 (original).
Figura 5. Wacestone-packstone radiolaritic cu stilolite, proba 1594 (original).

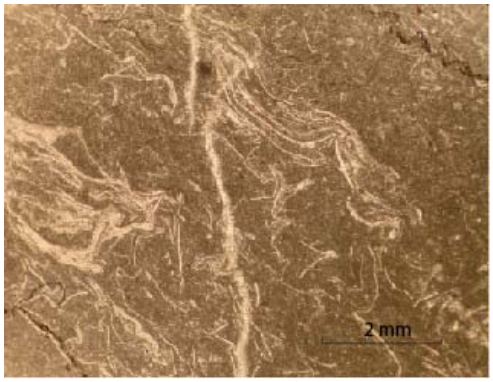


Figure 6. Radiolarian wackestone-packstone with *Halobia* sp., sample 1604 (original).
Figura. 6. Wackestone-packestone radiolaritic cu *Halobia* sp, proba 1604 (original).

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Plate II – Lura / Plansa II – Lura

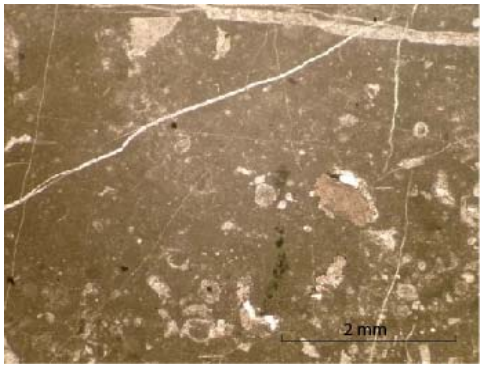


Figure 1. Radiolarian wackestone-packstone with *Bacanella floriformis*, sample 1620-(original).
Figura 1. Wackestone-packestone radiolaritic cu *Bacanella floriformis*, proba 1620-(original).

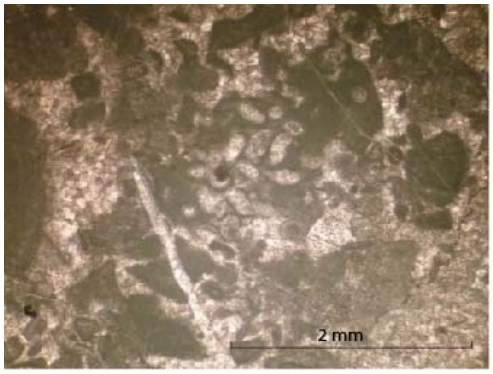


Figure 2. Coralgal wackestone-packstone with *Ladinella porata*, sample 1626 (original).
Figura 2. Wackestone-packestone coralgal cu *Ladinella porata* , proba 1626 (original).

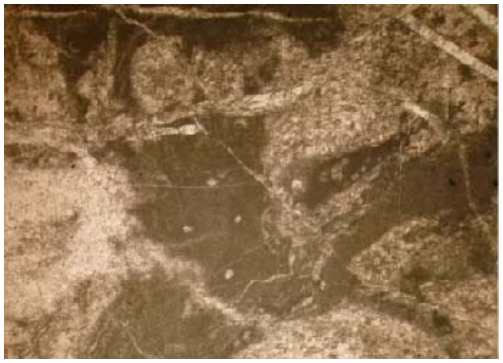


Figure 3. Coralgal wackestone-packstone with Tubipytes sp, sample 1648 (original).
Figura 3. Wackestone-packestone coralgal cu Tubiphytes sp, proba 1648 (original).

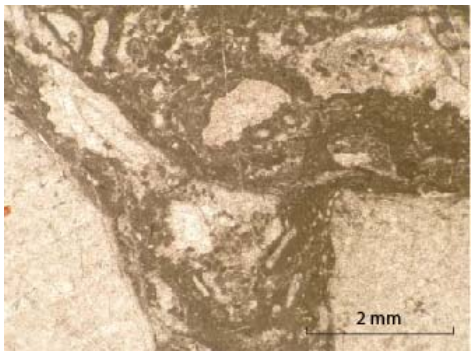


Figure 4. Recrystallized corals surounded by thin micritic crusts, sample 1654-(original).
Figura 4. Corali recristalizati inconjurati de cruste Micritice, proba 1654 (original).

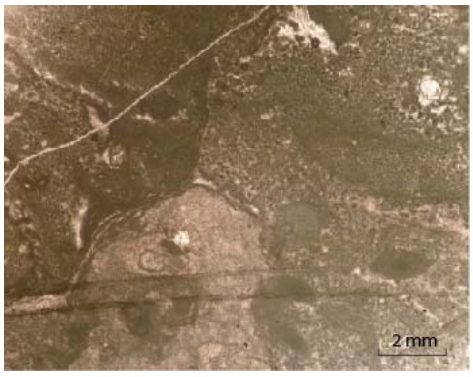


Figure 5. Coralgal wackestone-packstone - biosparudit, sample1658 (original).
Figura 5. Wackestone-packestone coralgal- biosparudit, proba 1658 (original).

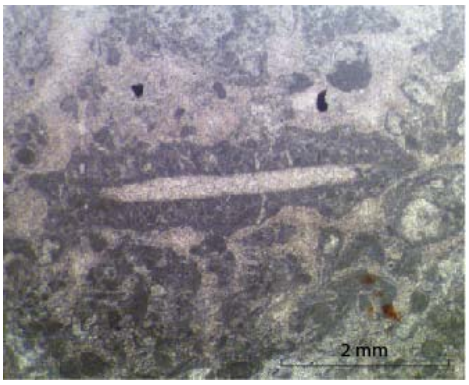


Figure. 6. Dasycladacean alga (oblique section), sample 1672 (original).
Figura 6. Alga dasycladacee (sectiune oblică), proba 1672 (original).

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Plate III – Lura / Plansa III – Lura

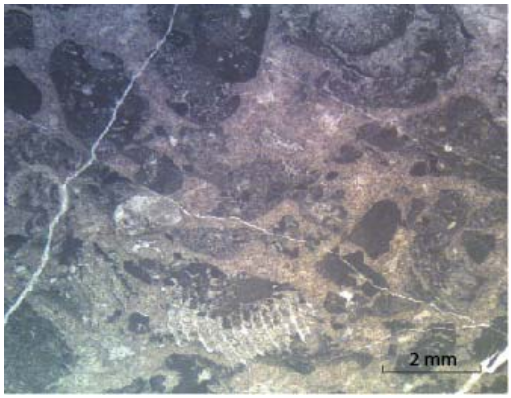


Figure 1. Coralgal wackestone-packstone, sample 1673 (original).
Figura 1. Wackestone-packestone coralgal, proba 1673 (original).

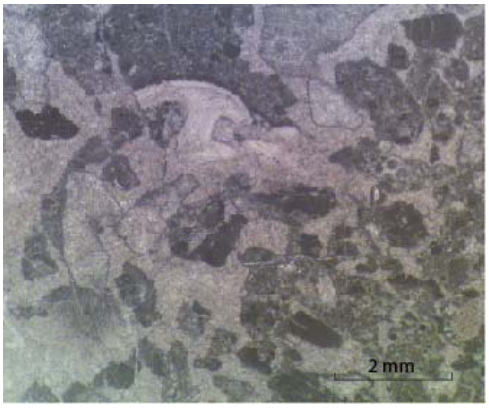


Figure 2. Coralgal wackestone-packestone with brachiopods and dasycladacean alga, sample 1675 (original).
Figura 2. Wackestone-packestone coralgal cu brahipode si alge dasycladacee, proba 1675 (original).

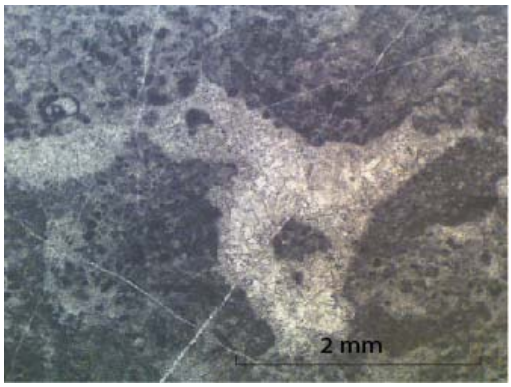


Figure 3. Drusy (blocky) cement in an algal packestone-grainstone, sample 1676 (original).
Figura 3. Drusy (blocky) cement in an algal packestone-grainstone, proba 1676 (original).

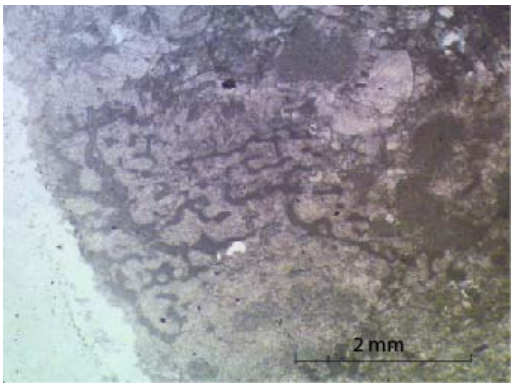


Figure 4. Algal packestone-grainstone *with Cryptocoelia Zittelli*, sample 1681 (original).
Figura 4. Packestone-grainstone algal cu *Cryptocoelia zittelli* , proba 1681 (original).

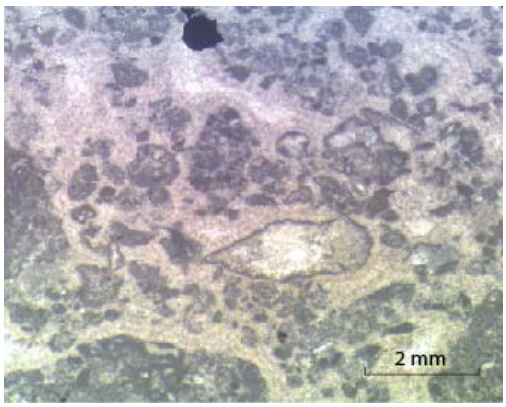


Figure 5. Algal packestone-grainstone biosparuditic, sample 1688 (original).
Figura 5. Packestone-grainstone biosparuditic, proba 1688 (original).



Figure 6. Peloidal-oncoidal wackestone-packestone, sample 1689 (original).
Figura 6. Wackestone-packestone peloidal-oncoidal, proba 1689 (original).

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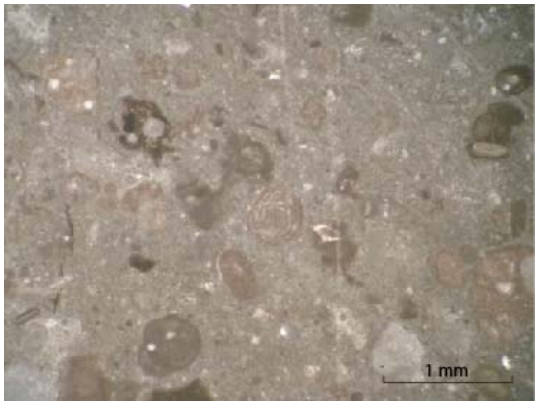


Figure 1. Peloidal packstone-grainstone, sample 3101 (original).
Figura 1. Packstone-grainstone peloidal, proba 3101 (original).

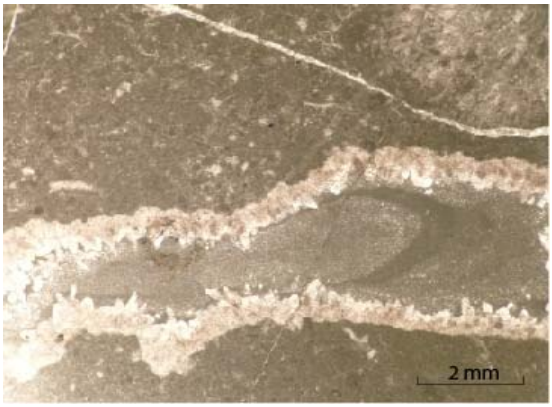


Figure 2. Void filled with a fine peloids and lined with scalenohedral dogtooth cement, sample 3109 (original)
Figura 2. Gol umplut cu peloide fine si marginit de ciment de tip "dogtooth", proba 3109 (original).

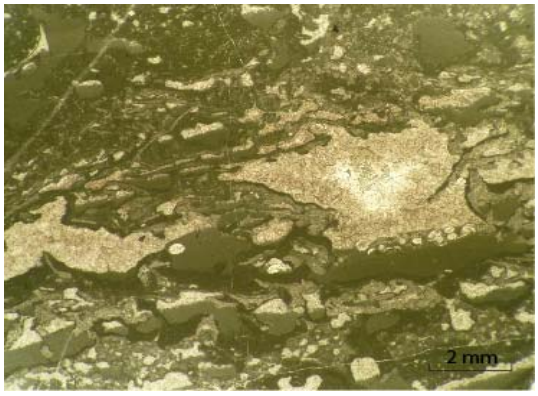


Figure 3. Flat laminated algal stromatolite facies, sample 3115 (original).
Figura 3. Stromatolite algale laminitice plane, proba 3115 (original).

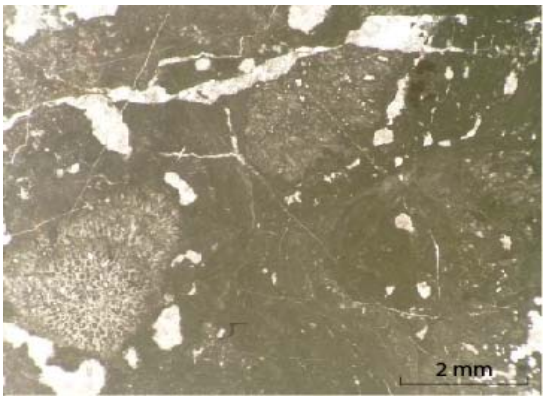


Figure 4. Mudstone with Rivulariacean-type cyanobacteria, sample 3117 (original).
Figura 4. Mudstone cu Rivulariacee, proba 3117 (original).

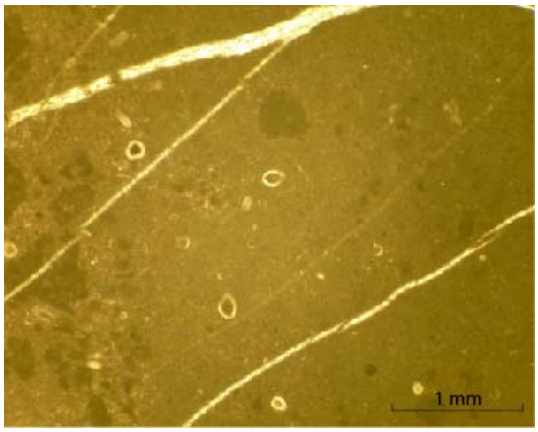


Figure 5. Mudstone with Ostracods, sample 3122 (original).
Figura 5. Mudstone cu Ostracode, proba 3122 (original).

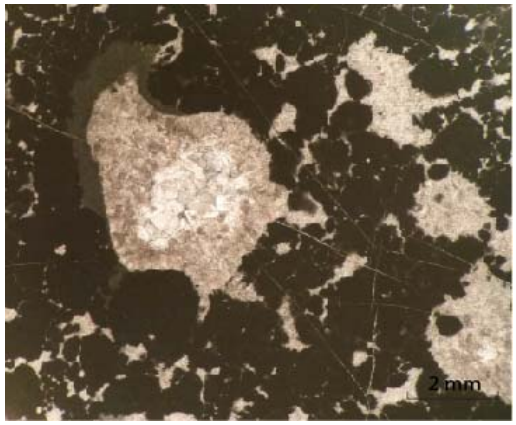


Figure 6. Voids filled with diagenetic cement in a peloidal wackestone, sample 3125 (original).
Figura. 6 Goluri umplute cu ciment diagenetic intr-un wackestone peloidal, proba 3125 (original).

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Plate V- Staveci / Plansa V – Staveci

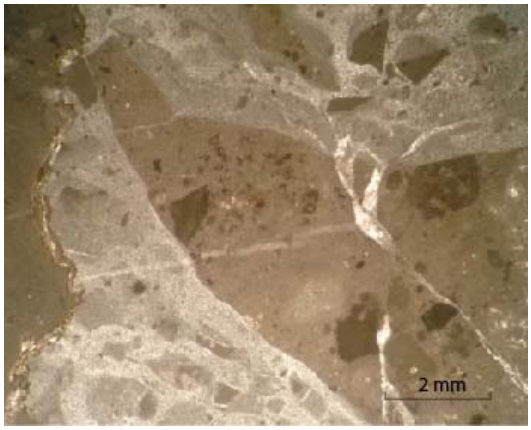


Figure 1 Brecciated limestone, sample 3133 (original).
Figura 1 Calcar breciat, proba 3133 (original).

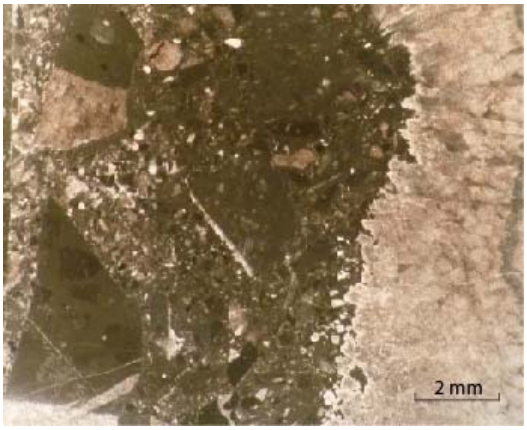


Figure 2. Brecciated limestone, sample 3136 (original).
Figura 2. Calcar breciat, proba 3136 (original).

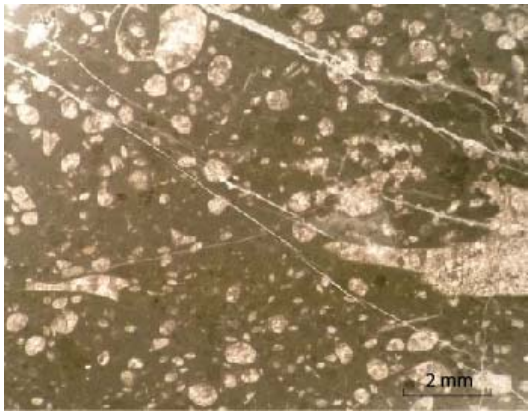


Figure 3. Typical facies with Megalodonts and Gastropods, sample 3139 (original).
Figura 3. Facies tipic cu Megalodonte si gastropode, proba 3139-(original).

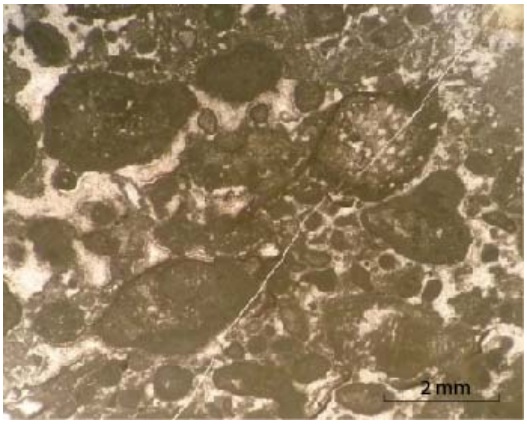


Figure 4. Oncolitic packstone, sample 3145 (original).
Figura 4. Packstone oncolitic, proba 3145 (original).

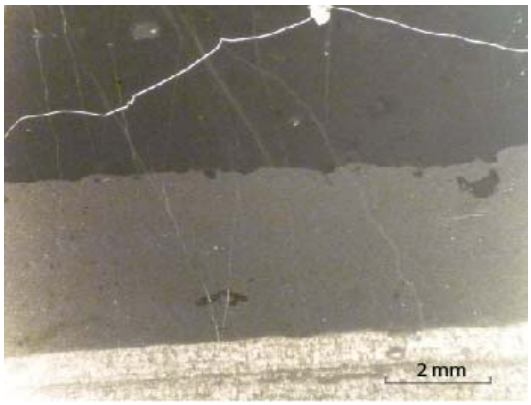


Figure 5. Small calcite filled-voids in a laminated dolomite mudstone, sample3149 (original).
Figura 5. Mici goluri uplute cu calcit intr-un mudstone dolomitic laminat, proba 3149 (original).

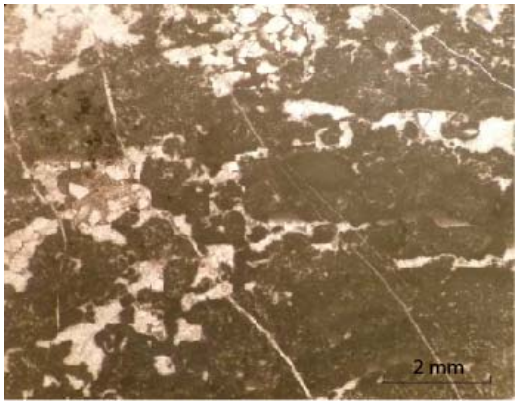


Figure 6. Voids with mechanically deposited calcite Crystals, sample 3166 (original).
Figura 6. Goluri cu cristale de calcit, proba 3166 (original).

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Plate IV – Staveci / Plansa IV – Staveci

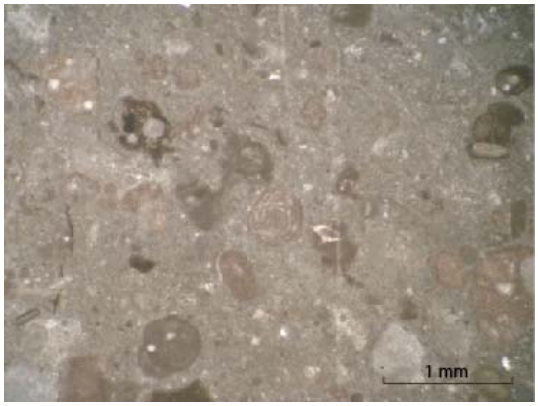


Figure 1. Peloidal packstone-grainstone, sample 3101 (original).
Figura 1. Packstone-grainstone peloidal, proba 3101 (original).

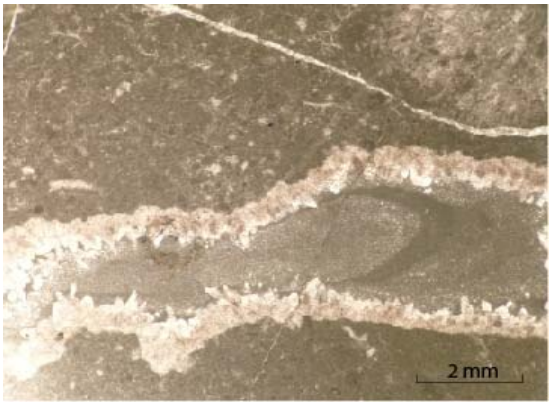


Figure 2. Void filled with a fine peloids and lined with scalenohedral dogtooth cement, sample 3109 (original)
Figura 2. Gol umplut cu peloide fine si marginit de ciment de tip "dogtooth", proba 3109 (original).

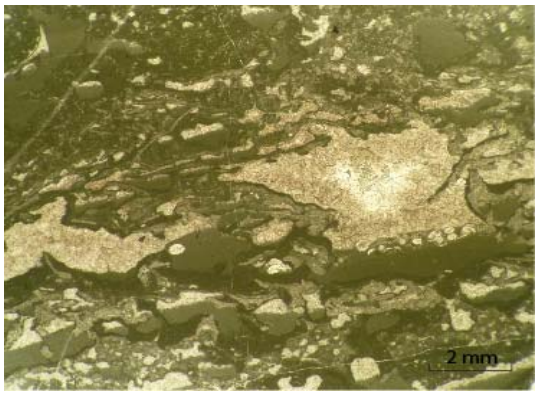


Figure 3. Flat laminated algal stromatolite facies, sample 3115 (original).
Figura 3. Stromatolite algale laminitice plane, proba 3115 (original).

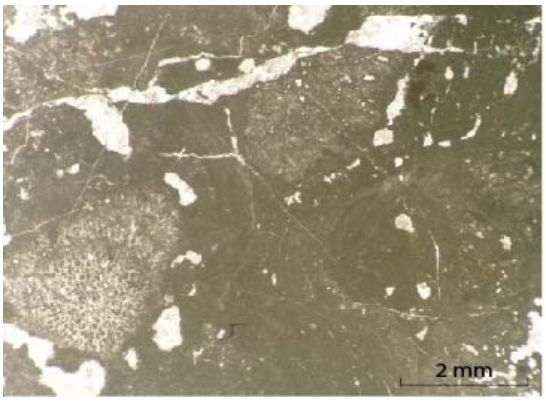


Figure 4. Mudstone with Rivulariacean-type cyanobacteria, sample 3117 (original).
Figura 4. Mudstone cu Rivulariacee, proba 3117 (original).

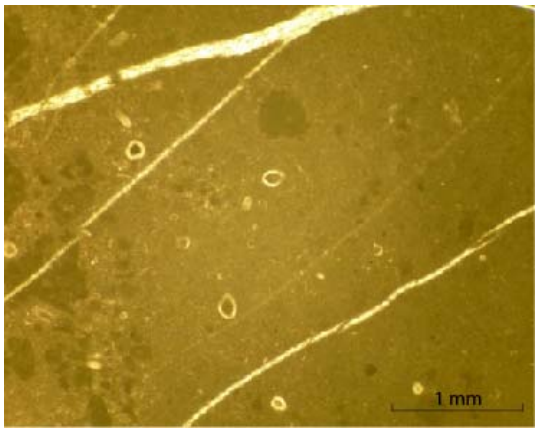


Figure 5. Mudstone with Ostracods, sample 3122 (original).
Figura 5. Mudstone cu Ostracode, proba 3122 (original).

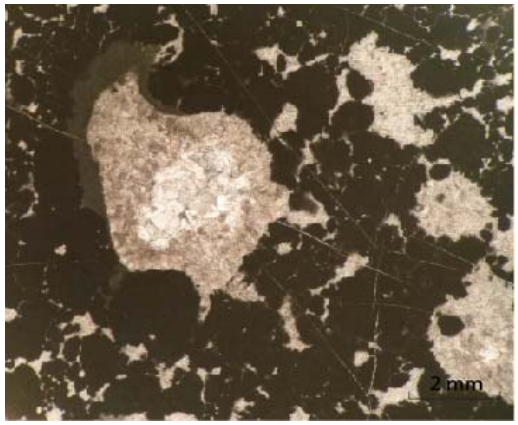


Figure 6. Voids filled with diagenetic cement in a peloidal wackestone, sample 3125 (original).
Figura. 6 Goluri umplute cu ciment diagenetic intr-un wackestone peloidal, proba 3125 (original).

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Plate V- Staveci / Plansa V – Staveci

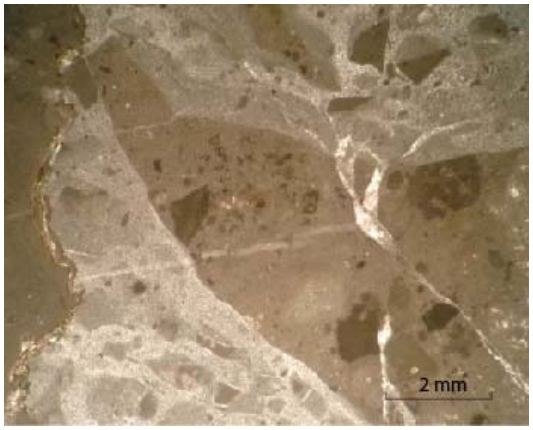


Figure 1 Brecciated limestone, sample 3133 (original).
Figura 1 Calcar breciat, proba 3133 (original).

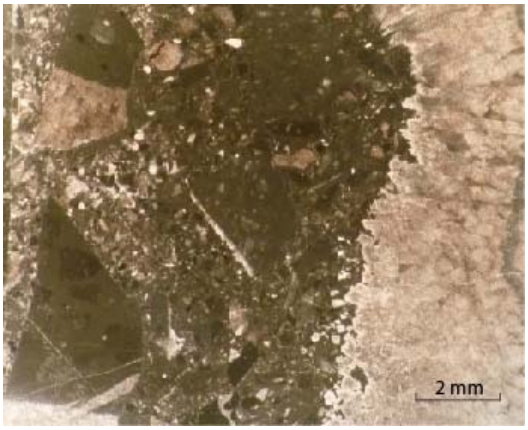


Figure 2. Brecciated limestone, sample 3136 (original).
Figura 2. Calcar breciat, proba 3136 (original).

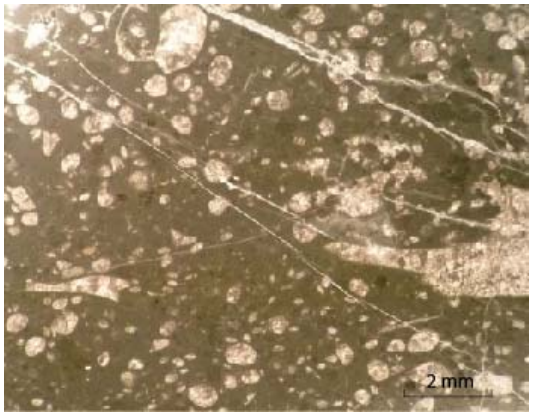


Figure 3. Typical facies with Megalodonts and Gastropods, sample 3139 (original).
Figura 3. Facies tipic cu Megalodonte si gastropode, proba 3139-(original).

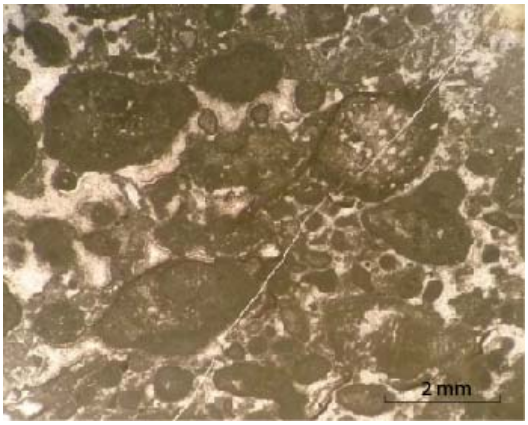


Figure 4. Oncolitic packstone, sample 3145 (original).
Figura 4. Packstone oncolitic, proba 3145 (original).

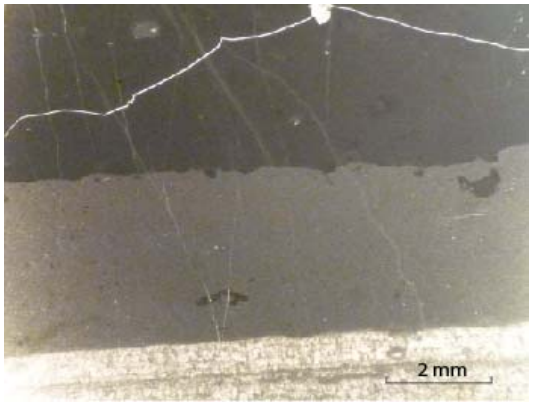


Figure 5. Small calcite filled-voids in a laminated dolomite mudstone, sample3149 (original).
Figura 5. Mici goluri uplute cu calcit intr-un mudstone dolomitic laminat, proba 3149 (original).

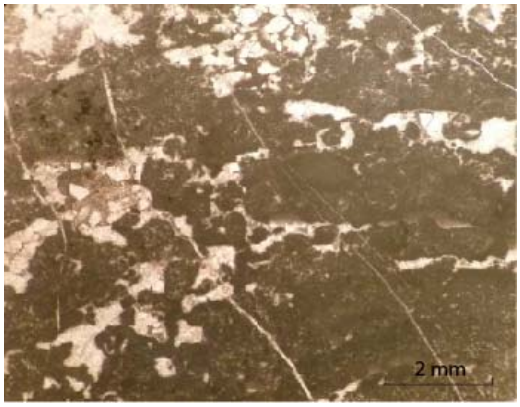


Figure 6. Voids with mechanically deposited calcite Crystals, sample 3166 (original).
Figura 6. Goluri cu cristale de calcit, proba 3166 (original).

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Plate VI – Staveci / Plansa VI – Staveci

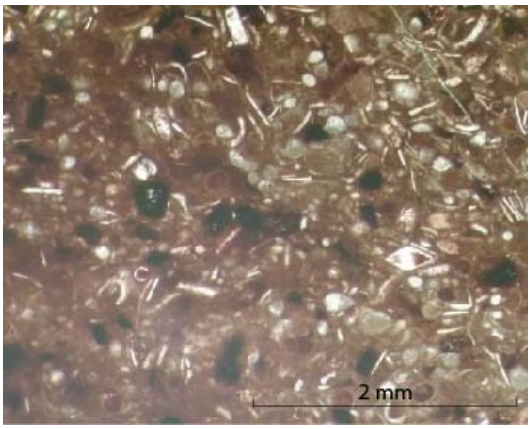


Figure 1. Typical condensed facies with embryonic ammonits, sample 3173 (original).
Figura 1 Facies condensat tipic cu amoniti embrionali, proba 3173 (original).

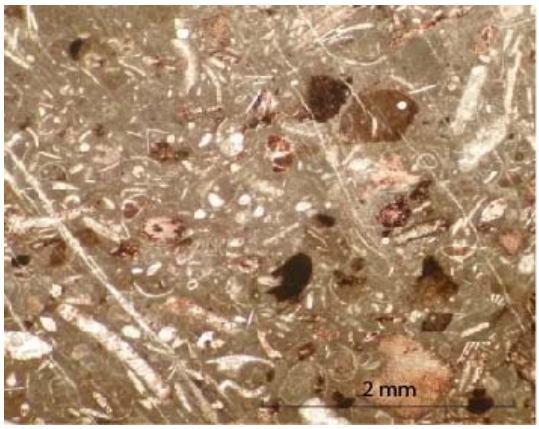


Figure 2. Typical condensed facies with crinoids, sample 3175-(original).
Figura 2. Facies condensat tipic cu crinoide, proba 3175 (original).

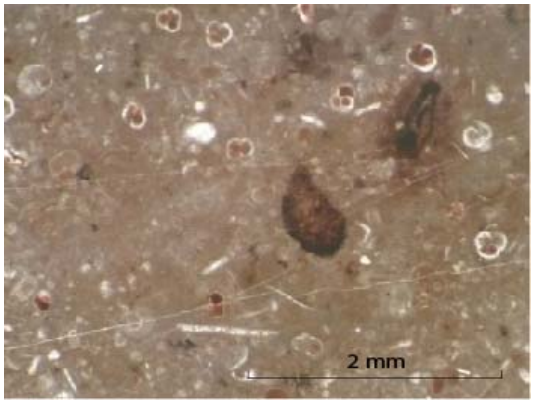


Figure 3. Typical condensed facies with Protoglobogerinids, sample 3176 (original).
Figura 3. Facies condensattipic cu protoglobigerine, proba 3176 (original).

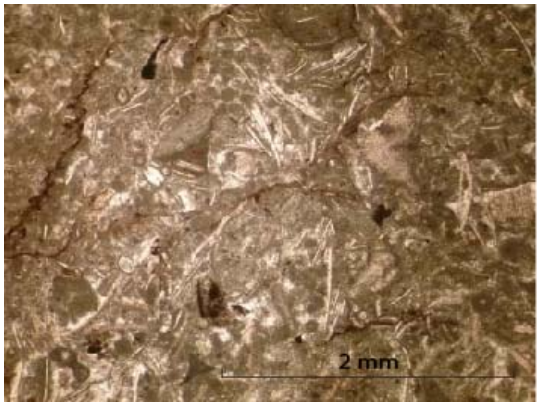


Figure 4. Typical condensed facies with pelagic bivalves, sample 3184 (original).
Figura 4. Facies tipic condensat cu bivalve pelagice, proba 3184 (original).

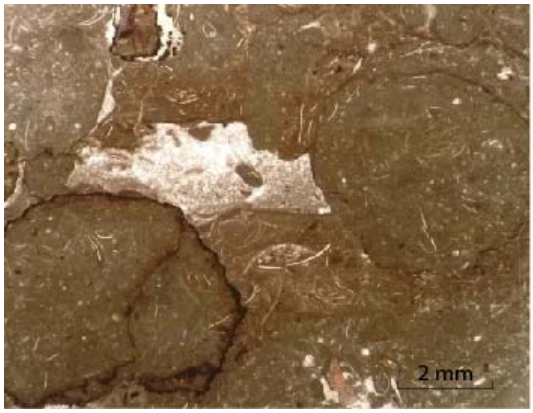


Figure 5. Typical nodular amonitic limestone, sample 3188 (original).
Figura. 5 Facies amonitic nodular tipic, proba 3188 (original).

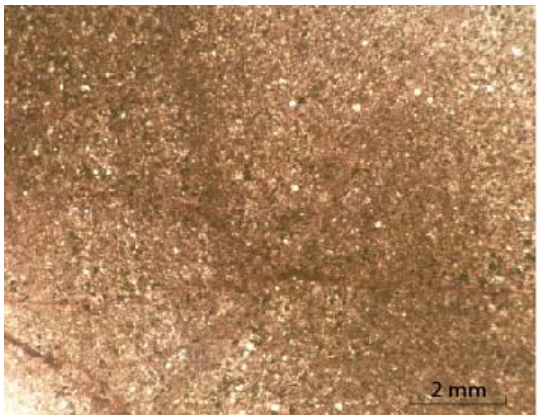


Figure 6. Radiolarit, sample 3189 (original).
Figura 6. Radiolarit, proba 3189 (original).

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THE CHARACTERISTICS AND AGE OF SEDIMENTS IN THE LAKE OF SHKODRA

Rexhep KOÇI[1], Enkela BEGU[1], Rezart BOZO[1], Irena YMETI[1]
[1]Instituti i Gjeoshkencave, Energjise, Ujit dhe Mjedisit, UPT, Rruga "Don Bosko", Tirane, Shqiperi.

ABSTRACT

This article presents the result of analysis conducted on samples taken from different depth level of sediments in Shkora Lake. These samples are taken via a small miniplatform of UWITEC type with a length of 90 cm untill 7.5 m. Those samples of length 90cm are through a free fall method while those taken with 7.5m are of knocking method.
All these samples are analysed in details in terms of their age, lithological and granulometrical composition as well as the structure of sediments where special attention is made to anomalies on radoactivity levels.
The aging parameters are calculated through the stydu of carbon radioactivity 14 (C^{14}) which was found in the carnonized organic material of some samples. The contant of carbon 14 (C^{14}) and the analysis of the half dismantling period has helped in determining the age of sediments up to 4.5m of depth. The lithological copmposition has been studied in order to gain insight about the origine of these sediments while the analysis of granulometrical composition has contributed in rvealing the date of foodings in the lake which are suppossed to been caused by changes in the environment. Special attention is dedicated to the structure of sediments, aiming to find out data related to strong seismic activities that ahs occured in the past in this area.The structure of the sediments has been analysed through the magnetic curve of sediment's sensitivity.
The study of increasing values of Lead 210 (Pb^{210}), Ceziumit 137 (Cs^{137}) and Amerikum 241 (Am^{241}) in curve's profiles helped in specifying sedimentation rhythms of sediements in Shkodra Lake during the last century.

INTRODUCTION

The lake of Shkodra is located in the border area between Albania and Montenegro, in northwest part of albanian territory and in the western part of Albanian Alps. It is the lake with the greatest surface in Ballkan Peninsula. The dimensions of this lake are: length 48km, width 15-26km, depth 6-8m (fig.2). Its surface is inconsistent, however the average is 368 km^2 from which 149 km^2 are inside the albanian territory, while the rest lays in the territory of Montenegro (fig.1). The watershed has a surface of 5180 km^2**,** and an average height of 770m above sea level.
The geomorphology of the lake shows that it is a plain lake although it is surrounded by mountanious areas. This indicates that this lake collects its water from mountanious territory. As such it is a lake in which the water circulation is made throughout the year i n an uniterrupted way and its dimensions are changeable.
The lake's dimensions change upon precipitation and water influx levels.In the case of abundant influx, especially during autumn, winter and spring, the level of water in Drini and Buna rivers raises, as a result even the level of Shkodra lake raises with about 2m (above normal level). This phenomena has been observed during 1962-'63- 74 and recently during 2010-2011. The maximum depth of Shkodra lake is 44m and can be found in northeast part of it, which is outside the albanian territory (Geço, P. 1961).
In those cases of maximum increase of lake level its surface reaches up to 542 km^2, covering a big part of Shkodra field and some territories in northwestern part of the city itself (Koçi, 2004).Along its periphery this lake is surrounded by coal formations of age Triassic upper (T3), Jurassic lower, middle, upper (J_{1-2-3}) & Cretaceous lower (Cr_1)**.** On the east part there have a considerable dispersion the proluvial deposits

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which cover the whole area of Shkodra field. The area around Shkodra lake is confined in all directions from tectonic faults of Pliocen-Holocen age (fig.1). The developed tectonic in lake area shows that Shkodra lake has tectonic origin, where you can found carstic phenomenon. These faults are very active and this is proved by the great number of active events which have occured in teh past but nowadays as well in Shkodra lake (fig.1)

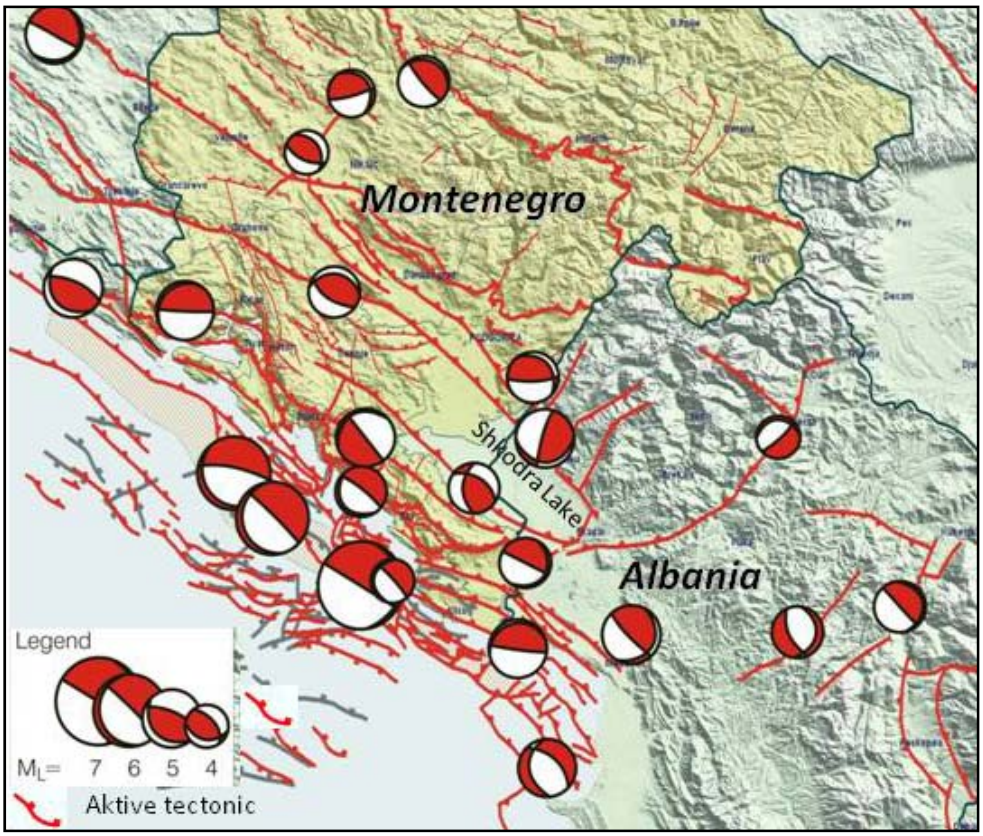


Figure 1- Map of active tectonic faults and seismic acitivity of area around Shkodra Lake

The sediments of Shkodra lake are located in a coal basement where the carstic phenomenon is very much developed. After years 2000 in the Shkodra lake deposits there are undertaken detailed studies based on contemporary methods and in collaboration with experts University of Savoie, France. These studies has been focused on defining the age of lake's deposits, their type, granulometry and the rhythms of sediments sedimentation along with identification of different natyral or anthropogen events that might have accored there. The aim is to identify the old traces of possible seismic activity of deformation in sediments structure.

We must emphasize that the area of Shkodra lake is located on the section of big fracture Shkoder-Peje which divides Dinarides from Albanides. This fracture is generally not very active but some segments like Shkoder-Bune estuary show a high rate of seismicity. Very active as well is the of Montenegro bordering our country (Aliaj 1996 , Koçi 2004) (Fig. 1).

Apart from a light seismicity rate but continous, caused mainly from changes of the underground water level (Muço 1998, 1999), Albania has been striked also from strong and devastating erthquakes (Muço et al. 2002; Duni et al. 2003). Two of them with a magnitude of 6.6 ocurred in 1905 and 1979 (epicenters are shown in figure nr.1) which caused huge material damages and casualties in Shkodra city and the

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surroundings areas (Duni et al. 2003; Sulstarova et al. 2003; Koçiaj and Sulstarova 1980). The earthquake of June 1905 had a high intensity of IX ***and*** MSK-64 scale as well as a great number of aftershocks (around 600 in one year).
The ground conditions had a great influence over the observed intensity (Koçiaj and Sulstarova 1980).
The magnitude of main events is calculated as Mw=6.6 (Sulstarova and Koçiaj 1975 where Mw = magnitude of the moment); the shock lasted for 10-12 seconds (Mihajlovic 1949). As a result of this earthquake, many houses were destroyed and there have been identified areas of ground fissures, changes on underground water level, liquefaction of the ground and rock fallings (Koçiaj and Sulstarova 1980; Mihajloviç 1949). The earthquake of 1979, known also as "Montenegro Earthquake" is the strongest one that has ever striked Albania and in the meantime, one of the strongest in the Ballkans (Duni et al. 2003).Its epicenter was located in Adriatic coast of Montenegro with a magnitude between Mw=6.6–7.2 (Duni et al. 2003; Karnik 1996; Papazachos and Papazachos 2001). Such phenomenon have aocurred also in the Shkodra area, especially along lake sides.

In order to make the evaluation of this impact, many detailed paleoenvironmental analysis have been made using the wellknown clasical parameters. The period of investigations covers the time between të 5^{th} and 7^{th} century before Christ up to nowadays. In dependence from the position of samples that have been taken, the length of them varies from 90cm to 7.5m. A special attention has been made??? to the last century period (where the thicnkess of sediments vary from 20-40cm) for two reasons:first, this interval include wellknown historical earfthquakes and second, the radioactivity level of Pb^{210} and Cs^{137} allows a precised cronological control over the sedimentation rhythms.

METHODS OF SAMPLING FOR THE STUDY OF SHKODRA LAKE SEDIMENTS

Shkodra Lake is surrounded nearly on all sides by carbonate deposits that have a big dip towards the lake. These deposits build high mountains of 1600-1700 m. above the sea level. Such a differentiated relief favors the accumulation of sediments in the lake.
Surface hydric network also plays an important part in the accumulation of sediments in the lake. It brings from the Alps zone thick halfrounded matters in breccia-conglomerate form. In times of rapid and frequent load, during fall-winter-spring period, arteries of hydric network around the water-bearing basin of the Shkodra Lake bring down to the lake basin fine clay deposits, too, besides thick ones.
Among the elements of the ecosystem of Shkodra Lake as a whole, two of them are the most essential, water mass and the sediments. In this connexion, in recent years, large scale research has been carried out on sediments, as to their lithology, age, paleoseismicity and as to the rhythm of sedimentation, as well. Interesting data on the sediment accumulation in Shkodra Lake has offered the work made in this lake during the research for the project "Quantitative assessment of present-day tectonics".

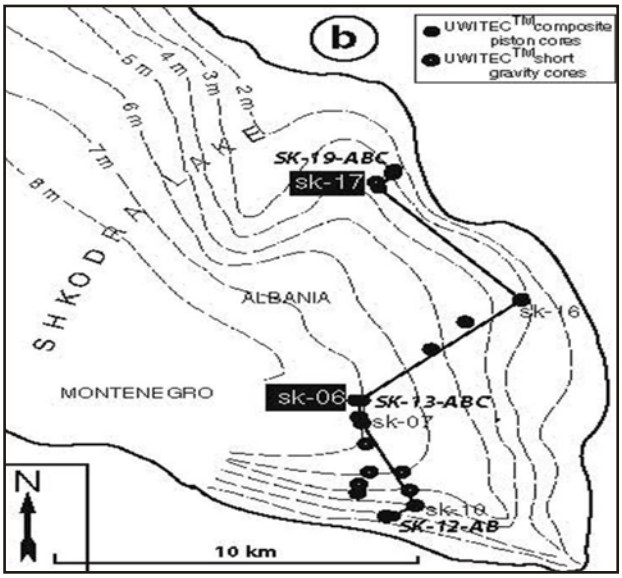


Figure 2. Profile of samples taking in Shkodra Lake

The above-mentioned work was carried out by means of a self-moving platform of UWITEC^{TM} type, able for obtaining, by a hermetical sample of various dimensions for detailed sedimentology studies. In the process of work, there were obtained 17 samples of 70-90 cm. in length and 4 samples up to 7.5 m in

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length. Sampling was carried out in the way of a ruptured profile from Shiroka village to Koplik town (inside the lake) (Fig. 2).
Samples up to 90 cm length are obtained by free dip, whereas those of greater length by shock drilling. Sampling was carried out in such a way as to preserve the samples in depth conditions, by keeping them hermetically in a special drilling bit obtaining cores to keep the volatile elements and the structure intact. Their examination was accomplished in the Laboratory of Alps Geodynamics in Grenoble, France.

DECODING THE AGE OF SHKODRA LAKE DEPOSITS

In order to identify the age of sediments in the lake of Shkodra, the method of coal 14 (C^{14}), corrected as well with that of tephrochronology has been used for the sediments of Adriatic sea from Di Vito et al 1999, Isaia et al 2004 dhe Wulf et al 2004. The method of tephrochronology is used for the study of volcanic ash. We must emphasize that even in the samples which have been taken in Shkodra Lake are found horizons which contain volcanic ash related to volcanic eruption in Mediterranean region (Wan Velden 2008).
The analysis for the aging are concentrated mainly in three samples (samples Sk.12, 13 and 19). Those are selected according to a profile (fig.2). Sample 13 is taken from the center where the depth reaches 7.5-8m while sample 12 is taken on the western side where the depth goes up to 2m; sample 19 is taken on the east side where the depth is 3m. There have been analyzed 9 segments for the aging determination, 5 of them from the samples 19, 3 from sample 13 and one in sample 12 (table 1). The results from sample 19 shows that the deposits on Shkodra Lake in a depth of 435cm have an age of 6510 ±40 years (BP) (table 1& fig. 3).At the same time the table shows that there exist a good correlation in aging aspect but the thickness of sediments differs from periphery towards lake's center. This is due to different rhythms of sedimentation where as a result of sloppiness these sediments have a tendency to pile-up more in center (table 2). The data on the below table illustrate that the deposits of Shkodra lake up to 4.5m of depth are from 775 until 6510 years old (BP), therefore have an Holocene age.

Raport 733/04	Poznam	Radiocarbon
Core Sk 19 Lab. No.	Profondeur	Radiocarbon
Poz-9251	81 cm	775 ± 30 BP
Poz-9201	207 cm	2500 ± 30 BP
Poz-9252	310,5 cm	3220 ± 35 BP
Poz-9199	370 cm	4645 ± 35 BP
Poz-9250	435 cm	6510 ± 30 BP
Report 1425/06		
Core Sk 13 Lab. No.		
Poz-15211	183 cm	745 ± 30 BP
Poz-15212	268,5 cm	1695 ± 30 BP
Poz-15214	655,5 cm	3760 ± 35 BP
Core Sk 12 Lab. No.		
Poz-16325	259 cm	3105 ± 35 BP

Table 1 Age of samples Sk 19,13 and 12.

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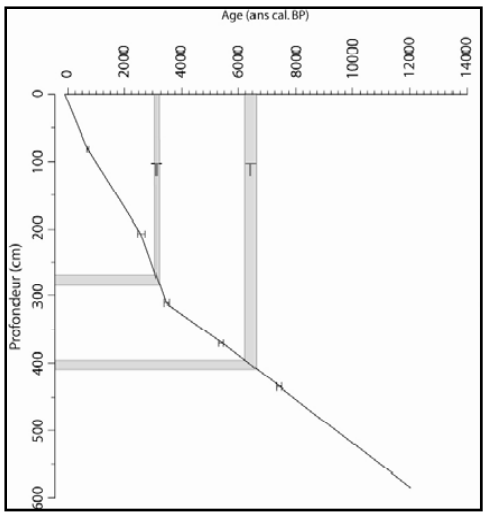


Fig. 3 *Age vs depth diagram for SK19 core.* ^{14}*C dating*

LATERAL CORRELATIONS AND ^{14}C-DERIVED CHRONOLOGY

Two different records: one along the main axis of the lake where sedimentation was relatively. Except for a few dark brownish levels, no clear layering could be visually identified in short cores. Neither laminations nor strata were observed on split cores. Only subtile color changes could be seen in the core. Sedimentation rates derived from ^{14}C dating of long cores (Van Welden *et al*., in press, (Fig. 3) show various sedimentation rates at sites within the lake: 1.50 mm/year for the central core (SK. 13), 0.60 mm/year for the easternmost part (SK 19) and 0.85 mm/year for the western part of the lake. Long cores also show higher MS values with strong fluctuations mostly related to tephra layers (van Welden *et al.*, 2008).

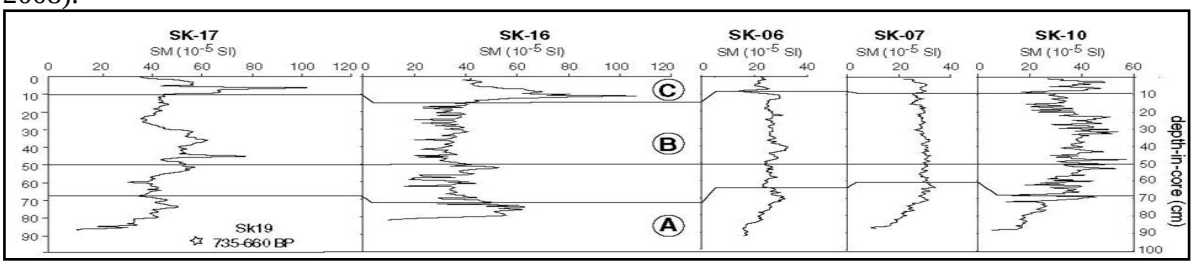


Figure 4. Correlation between short cores magnetic susceptibility profiles, measured on split cores with contact sensor and 5 mm spacing ^{14}C AMS dating comes from SK-19 piston core as the 90 cm of SK-17 core correspond to the 90 first centimetres of SK-19 piston core. ^{14}C age is 775±30 year BP (Reimer *et al*., 2004)

Extrapolating the mean sedimentation rates, cores SK-17 and SK-06 should respectively represent six and three centuries. The cores were chosen to compare constant with higher sedimentation rates, and one in a more coastal situation where sedimentation was slower, but more variable through time.

Depth correlation between short cores is based on MS profiles (Fig. 4). Unit A is defined by a global increase in MS (magnetic susceptibility) whereas unit B exhibits fluctuations in MS that cannot be correlated in all cores, except for proximal cores SK17 and SK16 (Fig. 3). Top of unit "C" is characterized in all the cores by strong MS values.

GRAIN SIZE AND MAGNETIC SUSCEPTIBILITY OF THE SEDIMENTS & RADIOCHRONOLOGY

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Sediments are fine-grained, brownish to reddish, with no visible bioturbations. Karaman & Beeton, 1981 did not mention in their benthic fauna list, any deep dwelling organisms, only some grazing epibenthic fauna (gastropods, bivalves, chironomids). The sediment basically consists of carbonate grains (detrital calcite and dolomite, in situ bio-induced calcite), clay minerals, oxidized (brown) organic matter (OM); quartz, opaque particles and diatom frustules represent a minor component. OM ranges from 5%wg to 11%wg and carbonate content comprises between 30%wg and 55%wg (Fig. 5, 6). X-ray diffractometry (XRD) performed on the upper part of core SK-19 (van Welden *et al.*, in press) indicates domination of illite and chlorite (80%) minerals with a minor contribution of kaolinite (15%).

Some levels contain large (mm-cm) shell fragments mixed in a clayey-silty matrix (Fig. 5, 6). Long-term transport of either aquatic or terrestrial gastropod shells by floating is a common phenomenon in lakes, sometimes powered by wind rather than currents.

SK17 and SK06 cores present similar grain size evolution characteristics (Fig. 5, 6): 1–5% of very fine sand 20-40% silt. Greater sand content appears in the upper 8 cm (SK-17) or the upper 10 cm (SK-06). Modes, medians, and mean grain sizes similarly evolve in both cores: they range from 5 to 20 µm. Sorting is generally weak (SO index between 2 and 2,5) except in the upper part of core SK-17, with values between 1,5 and 2,0. Skewness is high (index SK<<1) reflecting a strong asymmetry towards fine-grained particles. Organic matter comprises between 7%$_{wg}$ in SK-17 (Fig. 4) and is quite stable around 9%$_{wg\ in}$ Sk-06 core (Fig. 5). Carbonate content varies between 15%$_{wg}$ and 18%$_{wg}$ in SK-17 core with an increase in the last 6 cm. The mean carbonate value is about 18%$_{wg}$ in SK-06 core with an increase of 2%$_{wg}$ within the last 10 cm (van Welden *et al.*, 2008).

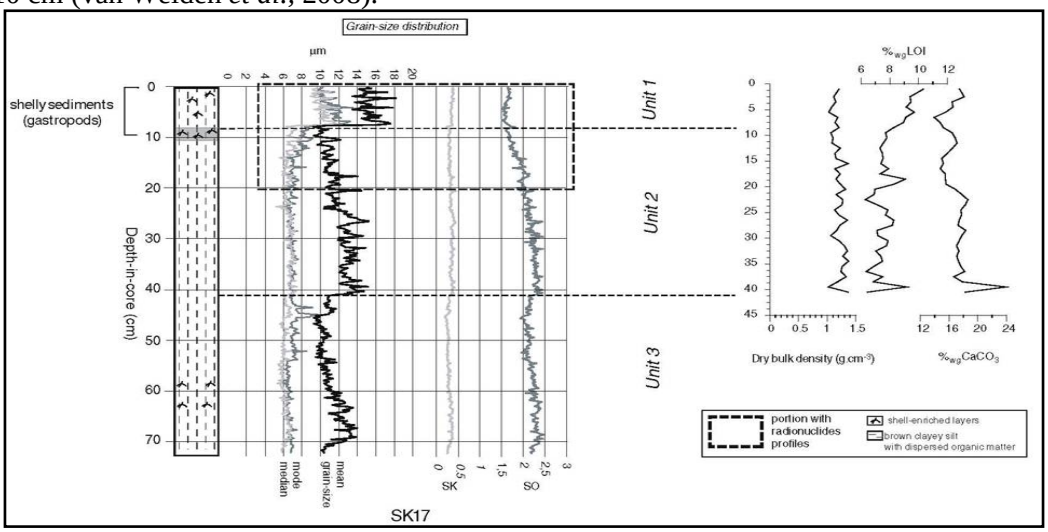


Figure 5. Detailed grain-size distribution and LOI of core SK-17 (after Welden et al, 2008)

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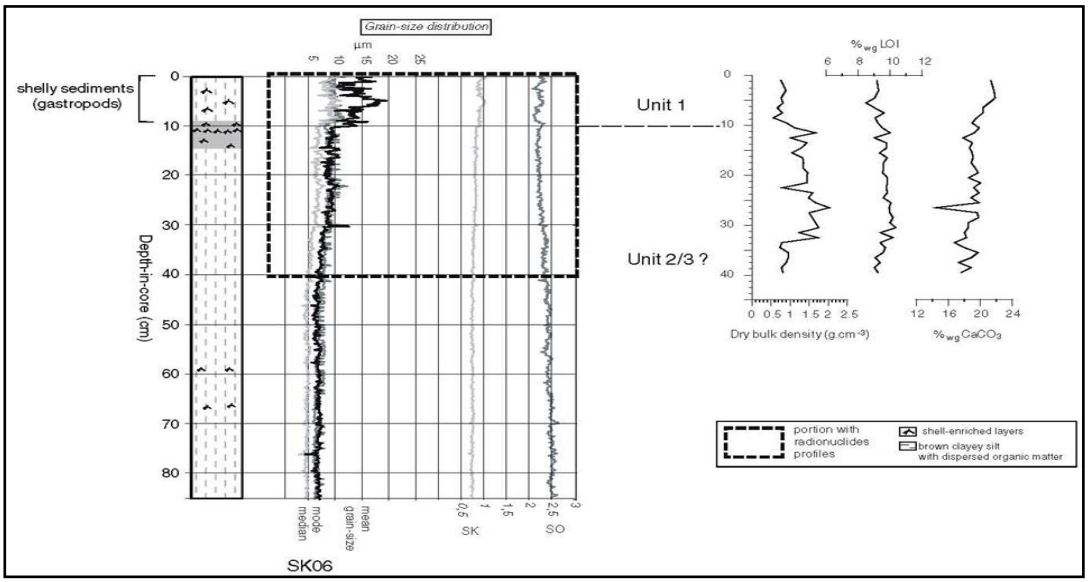


Figure 6. Detailed LOI and grain-size distribution of core SK-06 (after Welden et al, 2008)

Analyzing the depth cores from the lake according to the Shirok-Koplik direction show that the average sedimentation rates in the central part are 4-5 mm/year, while in the sides of the lake it is 1,7 mm/year (see Table-2). Based on the isotope analysis of carbon 14 (^{14}C) the age of the sediments at 4,5 - 5 m deep, in core 13, result 7500-10000 years (Bekc *et al*., 2007). The age of the sediments at the depth 90 cm in the core SK-19 result 735 ± 30 (van Welden *et al*., 2008).

The radioactivity was not measured in Albanian territory during the period of nuclear tests or during the time of Chernobylnuclear accident . We got the data measured in Greece and from the European Atlass for Cesium radioactivity during the time of Chernobyl nuclear accident Those data were used comparing with the radioactivity of the sediments in Shkodra Lake.

Detailed analysis of the content of the radioactive elements like ^{210}Pb, ^{137}Cs, ^{241}Am, ^{226}Ra show anomaly in two periods: the first is dated 1963 and the second 1986 (Fig 7&8). The first is related with any nuclear eruption test and the second is related with the Chernobyl nuclear The high values of those radioactive elements tell a lot for the sedimentation rates during the last century (Table-1). The dated section covers sedimentation from about 1900 to 2003.

Results shown in (Table-2) confirm that below 5 cm, the ^{210}Pbxs-derived dating is in quite good agreement with a 1.7 mm/year.

For the SK06 core (Fig. 8), accumulation rates derived from the three radionuclides have quite similar values, between 5 and 3 mm/year (Table 2). We chose a mean value of 4 mm/year. As for the SK17 core, almost one century of sedimentation is datable with radionuclides. These derived accumulation rates may be extrapolated to the bases of cores SK-17 and SK-06.

Regarding the possible record of major seismic events, the 1979 and 1905 earthquakes had noticeable impacts in the town of Shkodra, and a resulting seiche was observed. Thus we would expect some traces in the sediments. Cores do not exhibit any liquefaction or mass movement-related deposit associated with the earthquakes. Furthermore, ^{210}Pb does not exhibit any disturbance that could be related to the 1979 or 1905 earthquakes.

Table 2.Data on sedimentation velocity according to samples SK-06 and SK-17

Radionuclide/event	**Depth**	**Accumulation rates (AR) mm/year**

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SK-17		
^{210}Pb	Under 5cm	1,7
1986 Chernobyl	5,8	3,4
1963 Nuclear tests	7,8-12	1-3
1986-1963	2-6,2 cm thickness	0,9-,3
1986-1963 ^{210}Pb	9,7 cm	1,7
SK-06		
^{210}Pb	Full archive	5,1
1986 Chernobyl	5 cm	2,9
1963 Nuclear tests	13,5-16 cm	3,4-4
1986-1963	8,5-11 cm thickness	3,7-4,8
1986-1963 ^{210}Pb	16,7 cm	5,1

Grain size evolution and LOI values do not display any evidence of strong changes of the sedimentation dynamics as a consequence of either event except for the break in sedimentation (and associated shell levels in both cores) around 1979. If this change in sedimentation dynamics is associated with the 1979 earthquake event, we might expect to see evidence of the 1905 earthquake too. We explain this lack of recording of rather strong earthquakes to: the shallow depth, the lack of dipping deltaic forests, and (at least in the analyzed upper meter) the lack of contrasting lithology in successive layers. Similar shallow lakes in coastal situations (unlike the situation discussed here) may record tsunamis when receiving marine allochthonous particles.

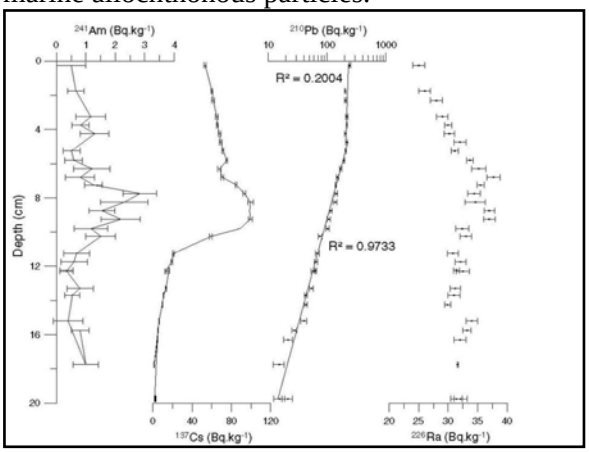


Figure 7. $^{210}Pb_{xs,}$ ^{137}Cs, ^{241}Am and ^{226}Ra radionuclide profiles for core SK-17. core.

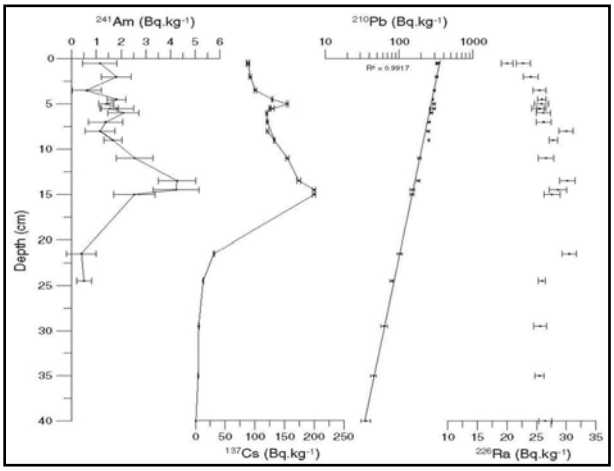


Figure 8. ^{210} $Pb_{xs,}$ 137,Cs ^{241}Am and ^{226}Ra radionuclide profiles for core SK-06

REFERENCES

[1] Aliaj, Sh., Neo-tectonic of Albania, 2012 Tirana, Albania, National Library, p.180-184.

Geço, P. 1961. Observations on some features in Shkodra Lake (Albanian). *Buletini U.SH.T. Seria e Shkencave IV*.

Duni, L., Kuka, N. & Dushi, E. 2003. Monitoring of seismicity in Albania. *CSEM/ESMC Newslett.*, 24.

Karaman, G.S. & Beeton, A. 1981. The biota and limnology of Lake Shkoder. Smithonian Institution, Washington DC and Univerzitet Veljko Vlahvic, Titograd: 450.

Kociaj, S. & Sulstarova, E. 1980. The earthquake of June 1, 1905, Shkodra, Albania; Intensity distribution and macroseismic epicentre. *Tectonophysics*. 67: 319–332.

ISSN 2306-9600

Koçi, R. & Bushati, S. 2004. Shkodra Lake, the origine and accumulation of sediments (Albanian), *Seismological Studies*, Nr 11. Archive of Institute of Geosciences,Water, Energy and Environment.

Mihajlovic, J. 1949. La Sismicité de la Région du Lac de Scutari. *Geofisica Pura e Applicata* 14: 3–4.

Muço, B. 1998. Catalogue of earthquakes in Albania from 1976 to 1995 and distribution of seismic energy released. *Tectonophysics*, 292: 311–319.

Muço, B. 1999. Statistical investigation on possible seasonality of seismic activity and rainfall-induced earthquakes in Balkan area. *Phys. Earth Planet* N. 114: 119–127.

Muço, B., Vaccari, F., Panza, G. & Kuka, N. 2002. Seismic zonation in Albania using a deterministic approach. *Tectonophysics*, 344:277–288.

Papazachos, C.B. & Papazachos, B.C. 2001. Precursory seismic deformation in the Aegean area. *Ann geofisica* 44: 461–474.

Sulstarova, E., Kociaj, S., 1975. Albanian Earthquake catalogue, Academy of science of albania, center of Seismology, Tirana,.

Sulstarova, E., Muço, B., Aliaj, S., Kuka, N. & Duni, L. 2003. Earthquakes, seismic hazard and seismic risk in Albania. Archive of the Seismological Institute (Internal report): 82.

Wan Velden , A, Beck, C, Reyss j. L, Bushati, S, Koçi, R, Jouanne, F, Mugnier, J. L. 2008. The last 500 year of sedimentation in Shkodra Lake(Albania/Montenegro): paleoenvironmental evolution and potential for paleoseismicity studies. J. Paleolimnol 40:619-633.

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EVAPORITIC DEPOSITS IN ALBANIA, DATA ON THEIR AGE

Megi RUSI[1], Eleni GJANI[2],

[1]*LIM-EM Construction l.t.d, Tirana, Albania, megirusi@yahoo.com*
[2]*Faculty of Geology and Mining, Politechnic University of Tirana, Albania, gjani_eleni@yahoo.com*

ABSTRACT

Evaporite is a name for a water-soluble mineral sediment that results from concentration and crystallization by evaporation from an aqueous solution. Evaporitic deposits are common in Albania and their study is very important for paloecological, paleogeographical and paleoclimatological researchs.The main subject of this paper is to study the age of the evaporitic deposits by using spores/pollen and dinoflagellata associations. The absolute-age dating of these formations has been performed by using strontium isotopes as well. Both methods have their advantages and their weak points, which through this study we were able to evaluate. Practical work, both laboratory and field studies, as well as in the office have been essential parts for the results shown in this paper. Data collection campaigns and their analysis were conducted for severals weeks from a specialised work team. Former data and available researchs were used as study base as well. Several stratigraphical cross sections were made for the all evaporitic formations in Albania and the main results are shown in this paper. In Albania, the evaporitic formations are encountered in two different morphological forms and ages. Diapiric Evaporite formations (explosive) of Triassic age and the layered evaporite formations of Miocene age (Messinian) characteristic for the Peri-Adriatic Depression UPA.

KEY WORDS

Evaporites, age, dinoflagellata, spore-pollen, strontium.

INTRODUCTION

Evaporitic deposits are very important for paloecological, paleogeographical and paleoclimatological studies. An interesting and important fact about the evaporitic deposits is the possibility of existence of hydrocarbon traps that are closely related to the evaporite tectonic movements.

On the other hand, the thickness of evaporite deposits is considered to be a safe cover for carbon structures in the preservation of hydrocarbon accumulations.

The metalogenic prognosis of the evaporite deposits can determine the possibility for minerals as well.

In the core of the soluble salts of permo-triassic evaporitic diapirs and miocene evaporites of the UPA (near Adriatic lowland) rock salt sources are evaluated and exploited as well in the form of potasium salts traces in Dhrovjan –Delvinë, Kolonjë, Picar – Kardhiq, Shëngjergj, Vlashuk, Gradishte – Belsh e Shalës – Dumre, Mengaj –Kavajë, etc.

The main subject of this paper is to study the age of the evaporite deposits by using spores/pollen and dinoflagellata associations as well as absolute dating.

For this purpose, field observations, mapping and drilling campaigns were carried out in the evaporite deposits of Peshkopi, Dumre, Picar – Kardhiq, Delvinë – Bistricë. Field observations were carried out in the layered evaporite formations of Miocene age in UPA.

The absolute age dating of the evaporites is been performed by using the strontium isotopes dating method. Based on the spore/pollen associations and dinoflagellates, the age of the diapiric evaporite deposits is Upper Triassic (Carnian).

The results of strontium isotopes analysis show that the age of the sample taken in Peshkopia is Lower Permian, Late Wordian or Middle Changxingian, while for the sample taken in Dumre the age is Middle Permian, Lower Artinskian or Lower Triassic.

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In the circumstances where the evaporite samples (Peshkopi and Dumre) are considered potentially suitable for strontium dating, but the mixed lithology reduces significantly the reliability in determining the age, the priority is given to the spores/-pollen age dating.

Spores/pollen associations of Miocene age which are encountered from time to time in the Triassic diapiric evaporites should be conected to the infiltration karstic activities.

GENERAL DATA

Evaporite formations are a kind of foundation, underneath the sediment layer. They represent a level of ductile halogenes, built up by non competent plastic rocks, easily deformable, where strong sedimentary section on it, is built up by competent rocks.

From geotectonic point of view, the evaporite formations have a determined position. It comes to the surface in intersections of the longitudinal tectonic faults (mainly in the western limbs of the sinclinal ranges) with the transversal ones, as tectonic weakened joints during rift stage, and during the collision and after collision, which has favorised the development of diapirs under the effect of gravitational impermanence, as well as under the orogenic activity.

In the sedimentology concepts, the main sedimentation environment must have been intertidal settings as a main feature of a continental platform which covered most of the Mediterranean area during the Triassic age. In this intertidal zone were determined lagoonal environments with hypersaline features.

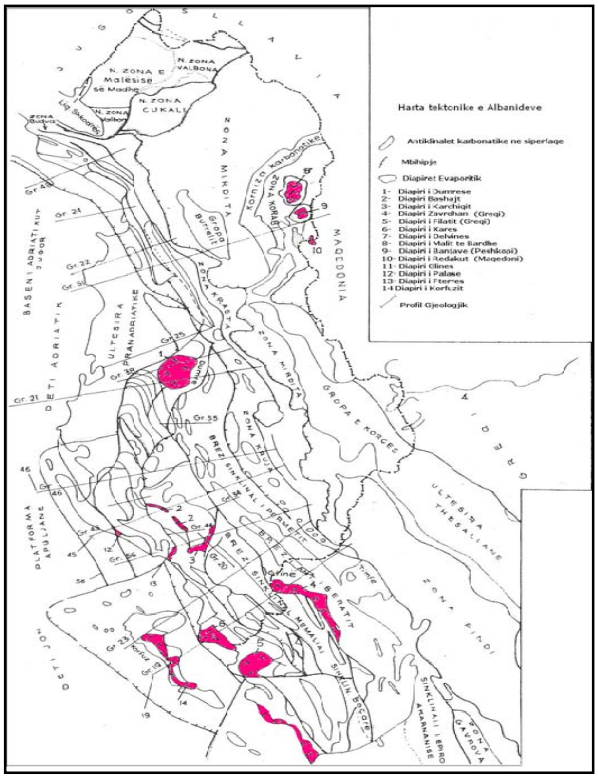


Fig. 1. Evaporite deposits locations in Albania and vicinities

Evaporite Deposits locations in Albania

Evaporite formations in Albania are encountered in two different morphological forms and ages.

1. Diapiric Evaporitic formations (explosive) of Triassic age, characteristic for the Ionian and Korabi tectonic zones.
2. Layered evaporite formations of Miocene age (Messinian) characteristic forthe Peri-Adriatic Depression UPA.

Surface geological data, borehole drilling logs and seismic data indicate that the Triassic evaporites are widely spread in the orogenic areas of the Helenido-Albanido - Dinarido – Apeninnic tectonic ensemble, as well as in the Apulian platform, which represents its passive province.

The Triassic evaporites are superficaly widely spread in the orogenic Ionian zones in Albania and Greece, Kruja (Dalmatia - Montenegroin

Montenegro and Croatia), Umbro- Marchigiane (Italy) and in the Apulian platform. In addition, Triassic evaporites are encountered in the "internal areas", as Korabi in Albania and Macedonia and Tuscany in Italy.

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Because of the spatial spreading effects, the description of the evaporite formations will start with the surface occurence of Triassic age from north to south, following the order of Peshkopi diapir, Picar - Kardhiqi, Delvin-Bistrica, Xara - Mursisë and smaller units, and then continuing with the Messinian evaporites of UPA.

Peshkopia Evaporitic Diapirs are wide spread in the form of three spots or tectonic windows, two of which in the region of Peshkopi, the White Mountain and Peshkopi tectonic window and the Radek tectonic window in Macedonia. Evaporites disrupt very old formations of Palaeozoic age (The Veleshica Stream) as well as young flysch deposits of Eocene. Smaller ocurrences are encounterend as well in the surroundingsareas.

Dumre Evaporitic Diapir has a broad spreading, mainly in the meridional direction, with a length of 20 km. It belongs to a tectonic fault, where the frontal longitudinal orogenic fault, the provincial fault of the Berat anticline and Kruja zone intesect. In this triple tectonic joint, the Dumre diapir crops out overthrusting significantly westward. The tectonic fault Elbasan - Debar continues in this tectonic position toeast untill the evaporatic diapir of Korabi Zone.

Taking into consideration the shape in the spreading plan of Dumre evaporites, the composition of the rocks where gypsum and anhydrides play the main role, the intensive disharmonic tectonics, the drilling results and geological- geophysical interpretation it results that we are dealing with a typical evaporate diapirism.

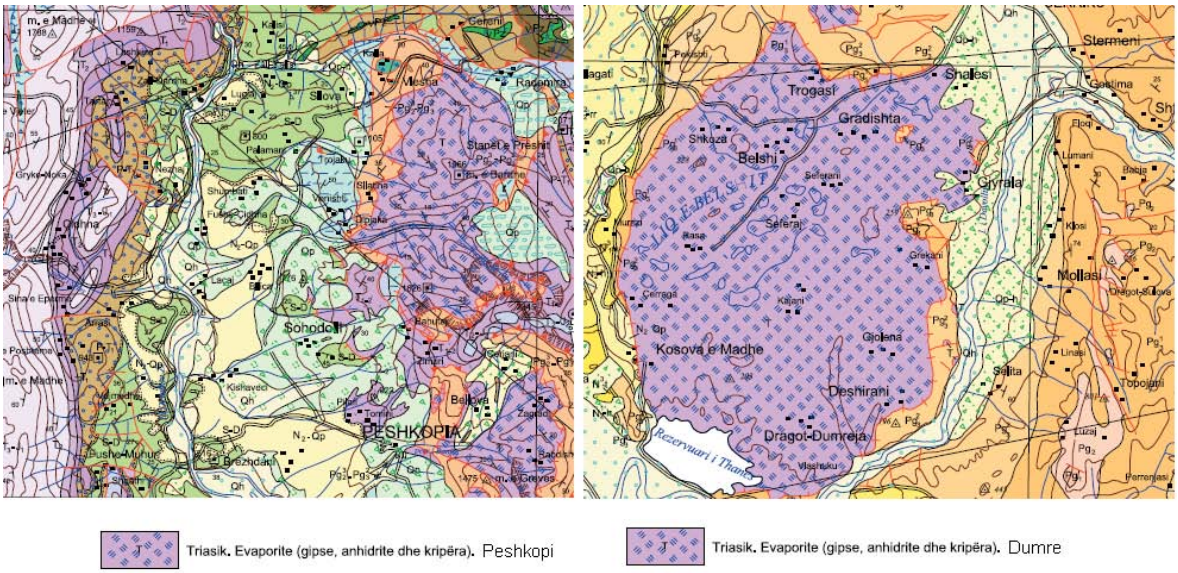


Fig. 2. Evaporite diapires of Peshkopia and Dumre

Picar-Kardhiq Evaporitic Diapir is placed in the anticline belt of Kurveleshi. The diapir lies in an area from southwest (Zhulat-Kardhiq) to the northeast (Kolonje - Picar - Shtepës) of aproxximately 12x3.5 km. The Picar-Kardhiq diapir belongs to the crosssection of the transversal fault of Borsh -Kardhiq with the western limb of the Fterra and Kurvelesh anticline.

According to the actual geological situation, the shape of the evaporites outcrops the radial fractures identified in the surrounding formations, blocks of the Mesozoic structures etc allow to judge that the Picar - Kardhiqi evaporites have reached the stade of diapiritic evolution.

In contrast to other diapirs (Peshkopi, Dumre, Delvin Bistric, Xara-Mursi), in the Kardhiq diapir, metamorphic and igneous rock bodies were evidenced, like the Picari amphibolites and the diabase outcrops in the northern side of Taroninës.

The contacts of the metamorphic and volcanic blocks with the surrounding rocks is tectonic.

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The metamorphic rocks consist of amphibolites, amphibolite shales and Quartz - Granite - mikor shales. Diabases are mainly represented by leucorate types composed of olivine and porphyre diabases.

The uplift of the evaporite formation in Kardhiq is stronger than in other areas of evaporitic diapirism in Albania.

Delvinë-Bistricë Evaporitic Diapir lies in an area of aproximately 12x2 km west of Mali i Gjërë, almost paralel to the deep fault of Shtugarë-Delvinë-Skerficë-Plesat and at the same time, parallel to the orientation of the carbonate structures themselves, from southeast to northwest.

The evaporites outcrop west of Mali i Gjere, extending discontiuously from each other for about 30km from Leshnica, in the south and to Kopaçëz, in the north.

Within the evaporite outcrop there is afault between Dhrovjanit and Navaricë anticline.

The relationships of the evaporites with the surrounding rocks are tectonic. The evaporites are in contact with the Oligocene flysch on both sides of Kopaçëz, Dhrovjan and Leshnica. While in the area of Bistrica Blue Eye until Delvinë, the evaporites are in contact with the Jurassic carbonatic-siliceous rocks and from place to place with Upper Triassic dolomites.

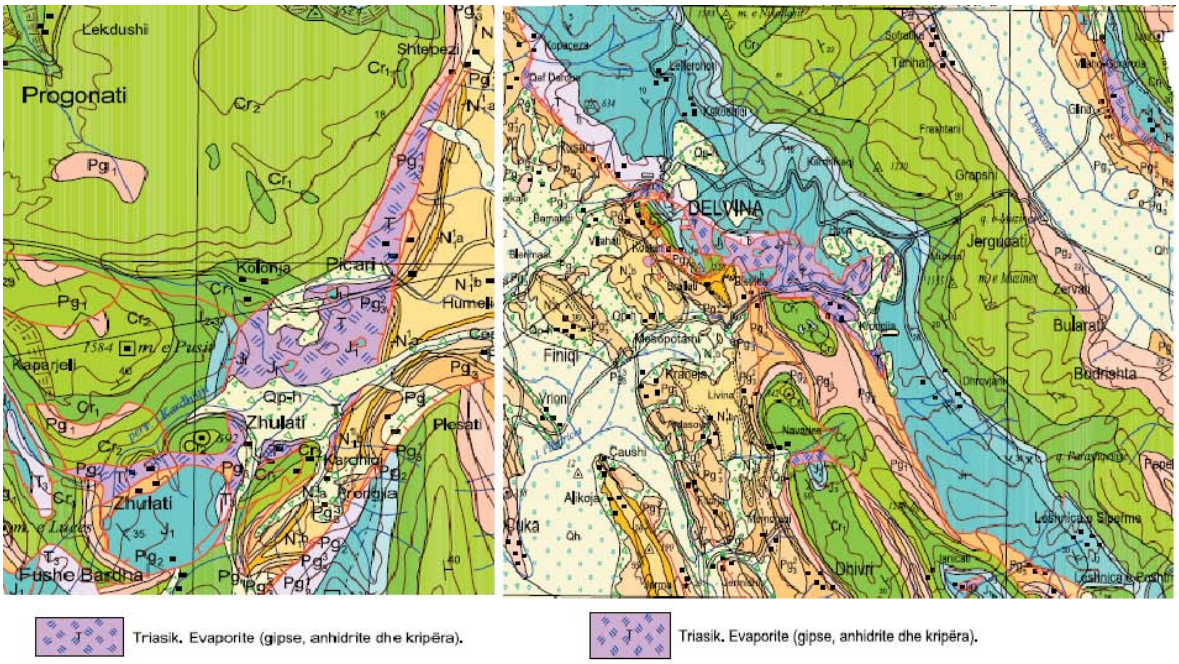


Fig. 3. Evaporite diapires of Picar-Kardhiq and Delvinë-Bistricë

THE METHOD

Two methods to determine the age of evaporite deposits in Albania have been used. According to the first method, the age of the formation is determined by the study of spores, pollen and dinoflagellata.

The second method used to determine the absolute age of the evaporite formations is the strontium isotope dating method.

Spores and Pollens

Spores and pollens are elements of the reproductive system of plants. Acording to these elements, the plants can be devided in two main groups. The first group is represented by plants with spores as they are

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for example alga or other primitive plants with asexual reproduction The second group is represented by plants with pollens which may have covered or uncovered seeds, their reproduction being sexual .

The palinology is a branch that studies spores and pollens andt is aplicable in many other fields to clarify diffrent problems concerning the age, paleogeography orclimate etc. This method has different avantages which include the big quantity, the small size and their strong and resistent structure. But there are also some disadvantages as well, like redeposition or the easy way to confonde them with other plant parts ect.

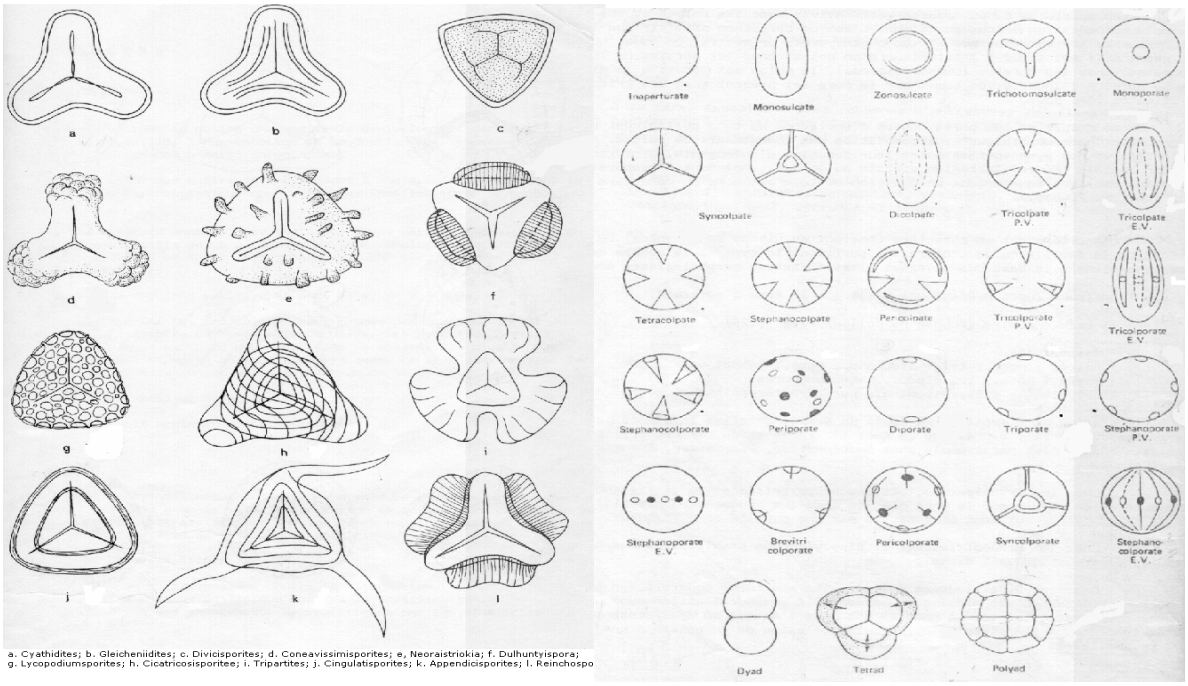


Fig. 4. Spores and Pollens

Samples processing methods

Isolated and superficial samples are collected in the field always taking care of the pollution. The samples are placed in plastic bags andclearily labeled.Then they are brought to the laboratory for palynological preparations where are washed, the surrounding matrix is destroyed with different techiques depending on its strength. They can be washed in chemical ways as well, by destroying the carbonates, phosphates, silica orthe bitum substances ect.

Strontium Dating Methods

The dating of the absolute age of the evaporite deposits by using Sr isotopes has been performed onsamples of gypsumand anhydrite fromPeshkopi and Dumre massivs.
Several samples were unapropriate for the biostratigraphic absolute dating. The sampling is realized by using calibrated Mass – Spektromet VG 354 towards NBS ^{87}Sr / ^{86}Sr , standards 0.71025.

RESULTS AND THEIR DISUSSION

Sporo-Pollen Analyses

Acording to sporo-pollen analyses, the age of the Dumre massiv is Upper Triassic.

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In Kardhiq massive we also talk about the same age, Upper Triassic (Carnian**)**. The younger forms are thought to be infiltrated. We drew the following conclusions for Delvine region as below:

1) From cronostratigraphical point of view, the age of the Bistrica section is Carnian.

2) From paleogeographical point of view , the presence of mixed elements from Laurasia and Gondwana is an aditional information for the Onslow microflora distribution, wich forms a belt along the continental margins of the southwestern Tethys.

3) From paleoclimatic point of view, the region has been under the conditions of a arid climate which can be confirmated by the presence of the evaporitic deposits.

For the Cika region we have the following facts:

a) The presence of Dacrydium which generally appears in Jurassic.

b) The lack of Cancrosporites forms and Ovalispollis, characteristic for the Upper Triassic

c) The lack of covered seeds, which usualy appear in the Lower Cretacous. Based on the above mentioned facts, the age of the gypsum is Jurasic- Lower-Cretaceous

Regarding the Peshkopi region, the general age is Triassic.

Comparing this complex with the ones evaluated in the UPA section, it results that the gypsum complexin the Kavaja section is Upper Miocene
In the Vlora region, several samples in Panaja and Qafa of Kociu were poor from the palynological point of view and we could not judge their age.

Stroncium Isotops Analyses

The below table gives the results acording the stroncium isotops analyses

Table.1. Strontium isotopes analyses

Nr	**Sample Location**	^{87}**Sr/**^{86}**Sr**	**+/- 2SE**	**Refeared Age**
1	Peshkopi	0.707092	0.000016	Medium Permian, (Late Artinskian) 266.5 mlj years
2	Grekan- Dumre	0.707954	0.000013	Late Permian (end of Wordian or Middle of Changxingian) 252.5 or 246 mil years
3	Krongj - Delvinë	0.70675 - 0.70795		Permian or Triassic(?). it can not be determined

Në proven Nr. 3 seksioni Krongj – Delvinë, përpjekjet për të dhënë të detajuar moshën absolute sipas izotopeve të Stronciumit, nuk ishin të suksesshme sepse nuk vendoset dot në mënyrë të njëanshme mosha absolute Triasik apo Permian (^{87} Sr/^{86} Sr 0.70675 – 0.70795).

CONCLUSIONS

Evaporite formation in Albania are encountered in two different morphological forms and ages.

1. Diapiric Evaporatic formations (explosive) of Triassic age, characteristic for the Ionian and Korabi tectonic zones.
2. Layered evaporate formations, Miocene age (Messinian) characteristic for the Peri-Adriatic Depression UPA

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The diapiric evaporitic formation (explosive) of Triassic age is represented in Albania by the big diapirs of Peshkopia, Dumre, Picar - Kardhiq, Delvin-Bistrica Xara - Mursisë as well as by some other small diapiric evaporites as Glina, Bashaj - Kaparjel - Vermik, Palasa, Vuno, Fterrë.

The layered evaporite formation of Miocenic age (Messinian) is represented in Albania by outcrops in Mengaj - Kavajë, Panaja - Vlorë.

Based on the spores/pollen associations and dinoflagllates, the age of the evaporite formation in the region of Peshkopi, Dumre, Picar - Kardhiq and Delvina, is the Upper Triassic. The evaporites of Çika belt (Palasë Vuno), according to the spores /pollen association are of Jurassic- Cretaceous age.

The Miocene ageof spores/pollen associations which are encountered from time to time in the Triassic evaporates should be related with karst infiltration .

In terms of the paleoclimatic conditions, the region has been under the influence of an arid climate.

The age of the evaporite deposits in the western region of UPA (Kavajë) is the same as the age of the surrounding rocks and it is admitted to be Upper Miocene.

During future studies, in addition to assessing gypsum anhydrides, the attention should be paid to the signs of sulfur, strontium, barium, potassium and magnesium salts and their accompanying elements Li, Ta, Rb, Cs, B etc..

In the regions where stone caps are encountered (Keproku) they should continue for signs of polymetals and sulphur.

Mineralised water in the the evaporite structures should be evaluated as a direct signs of the presence of soluble salts as well as hydrocarbons. The thermo-mineral waters of Peshkopia baths, Llixha-Dumre, Ishem, Mamurras Makaresh and Glina mineral waters are evaluated as so.

LITERATURE

Chateauneuf J. J. *Elements de Palynologie* 1974

Diamanti.F, Velaj. T, Gjani.E, *Formacioni evaporitik ne Shqiperi mundesia e kurthimeve hidrokarbure dhe kerkimi i mineraleve te tjere te dobishem, (Studim Monografik, Fondi i Fakultetit te Gjeologjise dhe Minierave)* 1996-1998

E.Gjani *Percaktimi i kufirit Tortonian-Mioceni i Siperm ne prerjen e Kavajes* 1978

E.Gjani & P. Muhameti *Palinostratigrafia dhe paleoklimatologjia e depozitimeve te Tortonian-Mesinianit ne UPA* 1991-1993

Harland W.B., et al. *A geologic time schale.* (Cambridge Univ. Press.) 1989

Cirilli. S, Montanari. L. *The carnian evaporite succession of Bistrica River* (southen Albany) 1994

Meco.S., Strauch.F., Kleinholter.K., Durmishi.Ç.,Gjani.E *Postorogenische Ablagerungen der Mollassen beckens in albanien* (Munster. Forsch.Geolog. palaont. 99 ,1- 101,60Abb.,3, Tab.,1 Taf.Munster) 2004

Muhameti.P, Gjani.E, Roqi.R *Palinostratigrafia e depozitimeve te Tortonian-Mesinianit ne prerjet Ndroq-Kavaje Rrogozhin*e(Nafta dhe Gazi,nr2 f 67-86) 1987

Muhameti.P,Gjani.E,Roqi.R *Zhvillimi i bimesise tokesore e ujore ne rajonin e Kavajes gjate formimit te depozitimeve te Tortonian Mesinianit dhe rendesia e tij* (Buletini Nafta dhe Gazi,nr 3,f3-11) 1987

Muhameti P. Pejo I. *Mosha e depozitimeve halogjene te zones Jonike nen driten e rezultateve palinologjike* 1974

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MIOCENE–PLEISTOCENE SEDIMENTARY CYCLES AND INTRAMONTANE LAKE SYSTEMS OF EASTERN ALBANIA

Pandeli PASHKO[1], Vesel HOXHA[1]

[1]Instituti i Gjeoshkencave, Energjise, Ujit dhe Mjedisit, UPT, Rruga "Don Bosko", Tirane, Shqiperi.

E-mail: pandipashko@yahoo.com, veselhoxha52@yahoo.com

ABSTRACT

After the main folding and thrusting Alpine phases, from Eocene to Recent two generations of molasse basins were established in Eastern Albania. The first, Albanian-Thessalian marine Basin which developed from the Middle Eocene to the Middle Miocene (Langhian) time, followed by a rapid uplift and marine regression. The second Neogene extensional powerfull period started at Middle Miocene and continued up to the end of Pleistocene results in formation of fiwe tectono-sedimentary cycles in small, tectonically controlled and gradual subsiding intramontane lake basins:Librazhdi Middle Miocene and Burreli Pannonian Basins, whereas the Ohrid-Prespa and Devolli lake basins characterized by the continuous sedimentary succession from late Miocene to Early Pleistocene and extends into Northwestern Greece and Macedonia. The Pliocene and Early Pleistocene extensions results in formation of the new intramontane lake basins.. The Miocene-Pleistocene lake basins are filled by lacustrine, lacustrine-fluvial and terrestrial sediments of the great thickness and varied lithology with the lignite seams. The molluscs, microflora and flora, ostracoda and vertebrates are the fossils found into them. During the Middle Pleistocene-Holocene gravels and sands, accumulated in the terrestrial, lateral fans, fluvial-terestrial, marches (Lake Maliqi) environements and glacial deposits were formed. Only the Ohrid, Prespa and Maliqi Lakes remain from the former extensive Miocene-Pleistocene lake systems.

KEYWORDS: Miocene-Pleistocene. Lake Systems. Sedimentary Cycles. Eastern Albania.

INTRODUCTION

During the Alpine orogenic processes, from the Eocene to Recent, the Eastern Albania was part of the South Balkan extensional region, that have conditioned the two generation of molase basins. This paper is the first presentation of an integrated study of evolution and sedimentary cycles of Miocene-Pleistocene lake systems and were compiled from previous field geological studies and drill cores. The geologic history of the lake basins and its sedimentary cycles has been detailed studied and is considerable advanced. Having a economic potential because of lignite seams its deposits has been subject of the detailet geological-stratigraphical studies. Many geologists have described and published the results of their investigations: such as Bourcart (1922, 1925), Pashko (1967, 1970, 1975, 1996), Pashko et al. (1973), Dimo et al. (1982, 1989), Aliaj (1997), Meco & al. (2004), Melo (1964), Hoxha (2000, 2001, 2003, 2005, 2011),. Biostratigraphic information derived from molluscs Pashko, (1967, 1968, 1970, 1975,1984, 1995,1996, Pashko et al. 1973, Marku 1997), palinological analyses Kumati et al. (1997), Pashko et al. (1973), Samoilovic (1958), ostracods Kumati et al. (1997), floras Kleinhofer (2004) and vertebrats Dodona et al. (1985).

GEOLOGICAL SETTING

After the main folding and thrusting of Alpine tectonic phases, from the Eocene to Recent, the Eastern Albania was part of the South Balkan extensional region that includes and Macedonia, Northern Greece, Bulgaria etc. The sedimentary and tectonic evolution of this area are characterised by two periods of regional extension:Middle Eocene-Middle Miocene and Middle Miocene-Recent and have conditioned the two generations of molasse basins. During the first, period are estabilished the Albanian-Thessalian

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(Bourcart1925) (ATHB) or in Greece Mesohellenic (Brunn, 1956) intermontane marine Basin. Its evolution ended around Langhian-Serravallian boundary, during a short compressional event and followed by rapid uplift and marine regression. The second period of extensional tectonics affected the low relief surface of eastern Albania, maynly on ATHB, from the Middle Miocene to the present, and produced mostly NNW-SSE trending, umplieft horst-grabens (-or half-grabens) structures which are usualy bounded by major normal faults, parallel tu the slowly rising Hellenide (Albanide) montane chains, corresponds to the reactivation of the basement with some direction and became filled by fresh-water. In this several, diachronically and gradually subsiding intramontane lake basins, the most important sedimentary succession have been deposited since the Middle Miocene to Pleistocene time.(Fig.1).

SEDIMENTARY CYCLES AND LAKE BASINS

The sedimentary succession of freshwater Miocene-Pleistocene lake basins (Fig. 2 and 3) are a great variety of litology and thickness reflecting synsedimentary tectonism as well as paleogeographie changes and marced by the lacustrine sedimentation of the Middle Miocene deposits, fully developed during the Late Miocene-Pliocene time. Five tectono-sedimentary cycles were documented.

First Cycle. Middle Miocene. The first, oldest known deposits related to this cycle were developed in the Librazhdi Basin, a coastal plain, and is marced by the massive influx of very coarce-terrigenous material from the horsts (ofiolites, the offiolitic weathering crust and cretasic limestone) into adjancent a coastal plain with extensive terrestrial and fluvial-lacustrine environments.

Second Cycle. Late Miocene. Pannonian. During second cycle the Pannonian Burreli Lake Basin were developed in the central part of Albania. The basin filled by 526 m thick lacustrine clays, marls with coal layers rich in molluscs and massive sandstones, conglomerates in upper part of sections. The molluscs fauna is representated mainly by *Unionidae* together with *Melanopsis, Tinnyea escheri* and are characterized by endemisms.

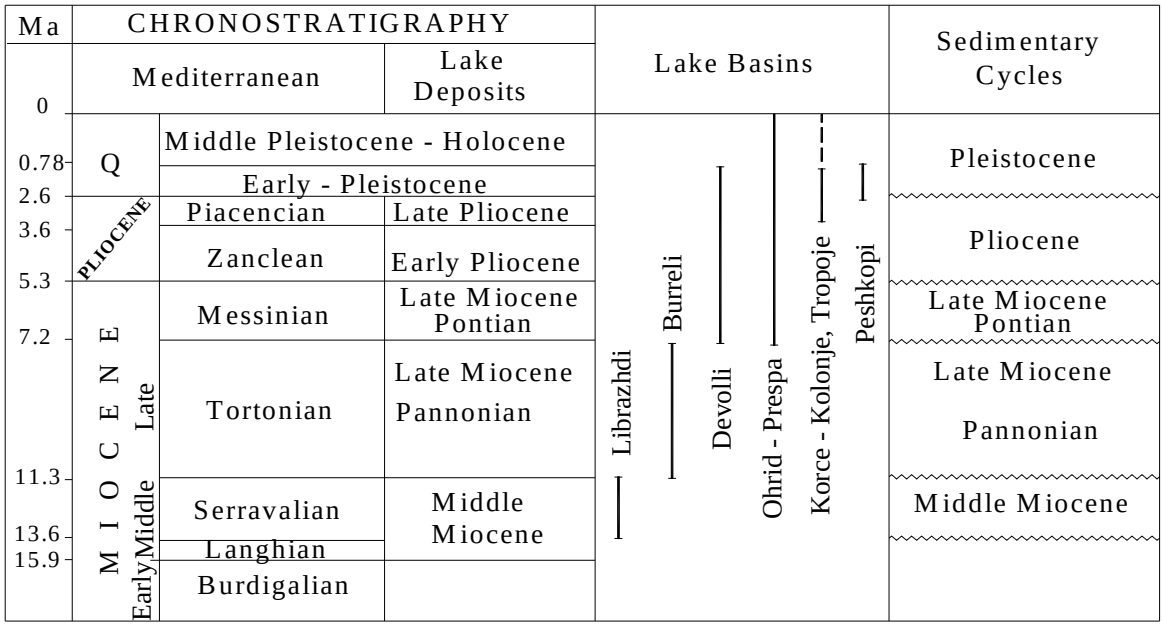


Fig. 1. Nomenclature of the Miocene- Quaternary units. Sedimentary Cycles and Lake Basins..

Third Cycle. Late Miocene**.** During this cycle the Devolli and Ohrid-Prespa Lake Basins are developed and became interconnected and extend into Late Miocene basins of Macedonia and Northern Greece. The sedimentary sections of this lakes characterized by the continuous succession a mainly lacustrine sedimentation clays, marls, diatomaceous marls, (Devolli Lake) or mostly clastic, conglomerates, sandstones (Ohrid-Prespa lake) with lignite seams. The age of this cycle was determined by the presence of *Viviparus* cf. *brussinai*, *Hipparion gracile*, leaf imprints of macroflora and microflora association.

Fourth Cycle. Pliocene. In the Late Miocene Lakes the Pliocene deposits unconformable occur the oldest deposits. Its sedimentary sequence began with coarce-grained gravel and sandstone and dominated by fine limnic sediments:clays, marls, and sands with lignite seams. At the same time, during the Late Pliocene new basins, Korca-Kolonja and Tropoja, dominated by the accumulation of fine-grained deposits with lignite seams, are formed. The age of the deposits was determined by the presence of the molluscs, ostracods, vertebrats and leaf imprints of macroflora (Kolonje).

Five Cycle. Pleistocene-Holocene. The tectonic activity characterized by a general uplift and glacyal activity. In the Southern Albania some of this lake basins interconnected, whereas the new Early Pleistocene Peshkopia Lake were formed and filled by lacustrine and lacustrine-fluviatile strata with molluscs. During the the Middle Pleistocene-Holocene, the lake system are fragmented into several sub-basins and the terrestrial, lateral fans, marches and glacially formations were accumulated. The Ohrid, Prespa and Maliqi Lakes are preserved from the former extensional Neogene Lake System.

Middle Miocene Librazhdi Lake.

The first, oldest known sedimentary cycle were developed in the Librazhdi Lake Basin. The 550-570 m thick sequence of this lake basin, transgressively on the Miocene marine molasse of the ATHB are represented by the terrestrial and fluvial-lacustrine coarce-grained clastic, mostly reddish in coleur deposits, inflowing from the horsts and deposited into adjancent coastal plain, which during the Serravalian filled by marine ingression from the Tirana depression. (A Fig.2) The age is determined by microflora associations and Serravalian lagunar deposits with *Melanopsis impressa*, folloved by marine with lithothamnium limestones deposits which occur in Golik on this deposits. (Pashko, 1973, 1975).

Late Miocene, Pannonian Burreli Lake.

During this cycle the Pannonian Burrel Lake were developed and filled by a predominantly lacustrine deposits of 526 m thickness. The basal 174 m of succession consists by conglomerates, grey sandstones, clays and reddish dolomitic limestones, overlie by 252 m thick grey and blue marls, claystones, sandstones with some scarce lignite seams, (B Fig. 2) and rich in Pannonian molluscs dominated by unionid, melanopsid fluvial *Tinnyea escheri* and scarce *Ostracoda.* The upper 180-200 m thick of sections consists of the grey to dark massive sandstones and conglomerates, grey to brown clays with unionid and vertebrate fossil fragments. (Pashko, 1967, 1968, 1970, 1996). .
After a short compressional phases in the Pannonian/Pontian boundary, the Devolli and Ohrid-Prespa Grabens became filled by freshwater and long-live, interconnected lakes are developed which extend into Northern Greece and Macedonia. Initiatet in Late Miocene, sedimentary cycle of this grabens characterized by the continuous succession a mainly lacustrine sedimentation: clays, marls, diatomaceous marls with lignite seams.

Devolli Lake is a graben established in Late Miocene, Pontian stage and is characterized by the accumulation of the ~300 m thickness of **Pontian**, predominantly lacustrine diatomaceous marls, sandstone and clays with intercalated lignite seams (Menkulas Fm.) (D Fig.3) and contains *Planorbis corneus*, unsculptured *Viviparus cf. brussinai.*

During the fourth cycle, the **Pliocene** and the new, such the **Late Pliocene Korce-Kolonje** and **Tropoje** Lakes vere formed. In the Devoll the 220-230 m thick **Pliocene** lacustrine deposits unconformable occur Pontian and Burdigalian-Langhian deposits. (D, Fig.3). The basal Zicishti sands (70-80 m thickness) with *Anancus arvernensis* and "*Mammut" cf. praetypicum*, Early Pliocene (Ruscinian) age (Dodona &

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Kotsakis, 1985), followed by the 150 m thick intercalations of the gray to blue clays, light siliceous sands, lignite seams (Kuc-Dobranji Fm.) with molluscs *Bithynia tentaculata, Planorbarius corneus*, *P. planorbis, Dreissena polymorpha*, ostracods, (Pashko, 1970, 1996) and microfloristic associations. The **Early Pleistocene**, five sedimentary cycle, are represented by the 90-100 m Vranishti fluvio-lacustrine sands and grey clays with scarce lignite seams and molluscs *Vivipara megarensis, Valvata piscinalis, V. aff. kupensis, Corbicula fluminalis* (Pashko 1996).

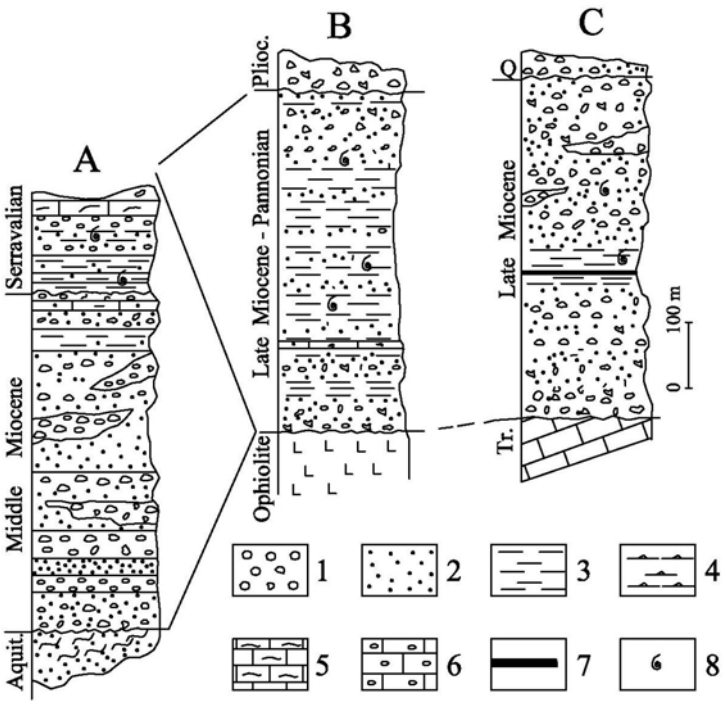


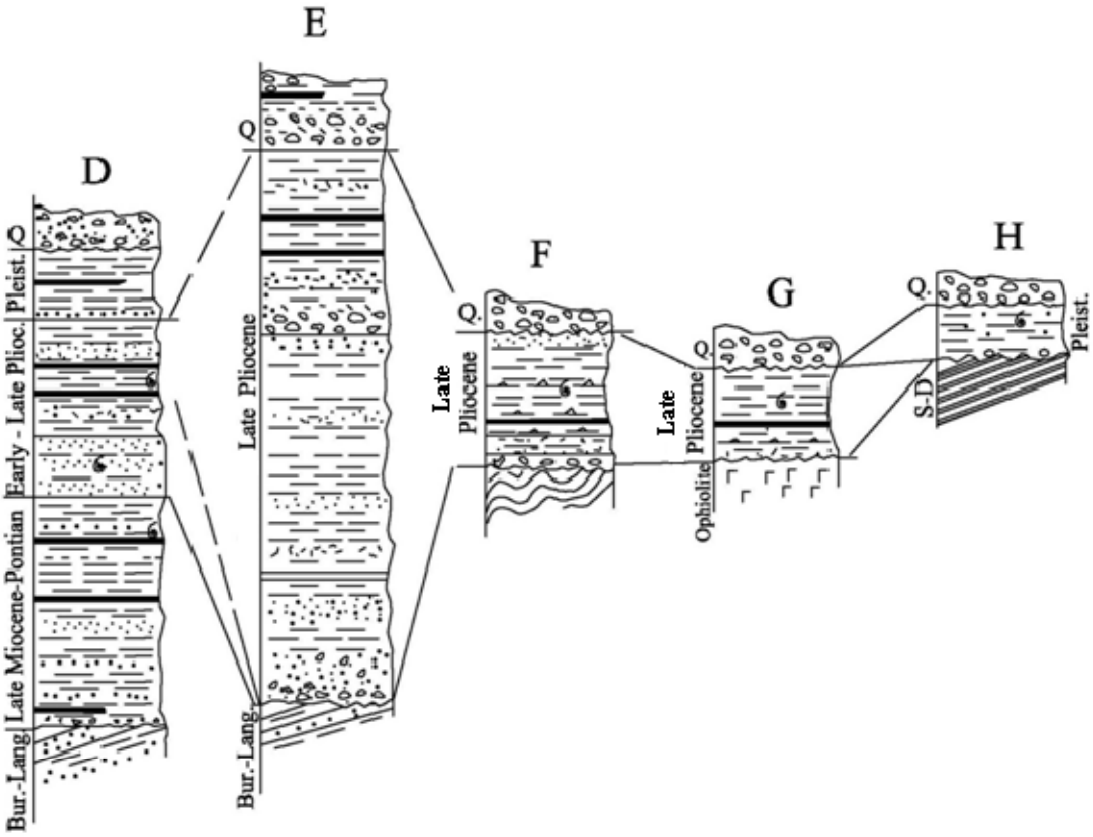
Fig. 2. Stratigraphic correlations of the Miocene freshwater deposits of the Librazhdi, Burreli and Ohrid –Prespa Lake Basins. Legend for lithological symbols used in the stratigraphic sections for Figures 2 and 3.

Ohrid-Prespa Lakes represented by grabens, limited by the normal faults. The Late Miocene sedimentary cycle ~550 m. thick (Alarup-Cerave Fm.) of Ohrid Lake consists of the 100-200 m thick bazal, conglomerates, transgressively on the Triasik limestones and folloved by ~50 m. thick grey and green clays with some lignite layers (Alarup lignites) (C Fig. 2). The upper part represented by 250-300 m thick of highly coarce-grained, characteristically jellow-brown poorly sorted, gravels and conglomerates, of the metamorphic rock (from Pelagonian massif) and localized to the southeast of the Ohrid Lake and in western side (Gorica, Liqenas) of Prespa Lake. The *Hipparion gracile* (Bourcart 1922), scarce *Viviparus* and *Psilunio sp*., floras *Quercus pseudocastanea*, *Betula sp*., *Stratiotis* etc. (Kleinholter 2004), and the pollinomorphs association (Samoillovic, 1959, Pashko, 1970, 1973), that indicate maynly Late Miocene-? Early Pliocene age. To the north of the Ohrid and around of the Prespa Lakes, in the Macedonian area, Late Miocene deposits overlie by the Pliocene-Quaternary deposits. (Pantic et al. 1973 (-1978), Dumurdzanov et al. 2004).

Late Pliocene Lakes. The Korce-Kolonje graben represents an active graben, in continuous subsidence from the beginning of Late Pliocene to present. (E-F, Fig.3) filled by the fluvial-terrestrial, lacustrine, swamps deposits, unconformable on the Miocene molasse and are evidenced from results of the core drilling. The 500-600 m thick sedimentary succession (Pojani Fm.) extended in N and NW part of the basin and represented mainly by the gray clays with many coal and claye-coal strata, with

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ostracods:*Candionella mirabilis, Illiocypris gibba, Candona sp., Cytherella sp., Xestolebris sp.* (Kumati & al., 1997). The southern part of the graben, filled up to 160 m thick succession of lacustrine sediments clays, predominantly diatomaceous marls, lignite seams and sands (Bezhani Fm.), unconformable on the Gramosi flysh (Krasta-Cukali Zone) and with plant fossils (Kleinholter, 2004), molluscs *Valenciennius*



sp., and *Vertebrata* non determined (Pashko & al., 1973).(F, Fig.3). The 250-300 m. thick Pleistocene,

Fig. 3. Stratigraphic correlatios of the Miocene-Pleistocene sedimentary cycles of the Devolli (D), Korce- Kolonje (E-F), Tropoje (G), and Peshkopia (H) Lakes.

clastic mainly coarce-grained deposits, with scarce lignites (Turani Fm.), (Korce Lake) (E, Fig. 3) extends through of the basin. The **Tropoje** Lake outcrops on the north-eastern Albania and filled by the up to 280m thicks lacustrine sedimentary succession transgresively on the ophiolites (G, Fig. 3) and yield the molluscs *Bythynia labiata, Pyrgula incisa, Vivipara megarensis, Valvata sp., Staja adiophora, Unio litoralis, Dreissena polymorpha, Congeria slavonica.* (Marku D., in Kumati & al., 1997).

Early Pleistocene Peshkopi Lake. The Early Pleistocene Peshkopia Lake represent a wide graben filled by the 50-60m typical lacustrine deposits which overlay with unconformity on Silurian-Devonian or Masozoic rocks. (Hoxha, 2001, 2003, 2005). (H Fig.3) with molluscs *Pissidium amnicum , Dreissena polymorpha f. angustiformis and f. commans, Valvata media* and *Pyrgula albanica.* (Pashko, 1984).

Finally, only Ohrid, Prespa and Maliqi lakes are preserved from the former extensive Miocene–Pleistocene Lake Systems.

CONCLUSIONS

The Neogene extensional tectonics in Eastern Albania began in the Middle Miocene, that continued to the present and resulted in the formations of some diachronically freshwater Lake basins, mostly NNW-SEE

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extending and filled by several sedimentary cycles. The first, Librazhdi Lake basin is a coastal plain with extensive sedimentation of the fluvial-lacustrine coarce-grained sediments. At the end of Middle Miocene, the new lake basins were formed, followed in Pannonian (Tortonian) Burreli and later, during the Late Miocene, Devolli (Pontian) and Ohrid-Prespa, filled by the sedimentary cycles, mainly lacustrine with lignite from Late Miocene to Pleistocene. A succession, some new Pliocene lake basins were formed into graben or half-graben structures, from the Late Pliocene Korce-Kolonje and Tropoje to the Early Pleistocene Peshkopi Lakes**.** The sediments of this lake basins consists of the highly clastic terrestrial and fluvial-lacustrine formations (Librazhd, Alarup-Cerrave), or of the less fine siliciclastic fluvial-lacustrine and lacustrine sediments with the lignites. The molluscs, flora and microflora, ostracoda and vertebrates are fossils found from them. The Ohrid**,** Prespa and Maliqi recent lakes remain from this former extensive Miocene-Pleistocene system of lakes**.** During the Middle Pleistocene-Holocene the terrestrial, fluvial-terrestrial (terrace of some rivers), marches and glacial deposits are accumulated.

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REFERENCES

Aliaj, SH.,1997. *Alpine geological evolution of Albania*. Alban. Journ. Nat. Techn. Scie. 3,68-81. Tirane.

Aliaj, Sh., 1998. *Neotectonic structure of Albania*. Alban. Journ. Natur. Techn. Scie. 4.15-42. Tirane.

Aliaj, Sh., Melo, V., Hyseni, A., Skrami, J., Mehillka, Ll., Muco, B., Sulstarova, E., Prifti, K., Pashko, P., Prillo, S. 1996. *Struktura neotektonike* e *Shqiperise dhe evolucioni gjeodinamik i saj*, 497p., Tirane. Unpublished. (In Alban.).

Bourcart, J. 1922. *Les confines Albanais administres par la France. (1916-1920). Contribution a la Geographie et la Geologie de l'Albanie moyenne.* Paris.

Bourcart, J. 1925. *Observations nuvelles sur la tectonque de l'Albanie moyenne*. Bull. Soc. Geol. Fr., (7), XXV, 391- 428. Paris.

Guernet, Cl., 1971. *Etudes geologiques en Eubee et dans les regions voisines*.(Grece) Paris.

Guri,S., Kumati, Ll., Myftari, S., Vathi, K., Marku, D. 1994. *Studim regjional mbi modelin strukturor, biostratigrafine, ambientet* e *sedimentimit dhe poitencialin gjeokimik te basenit te mbivendosur* (*Gropat* e *Brendshme*) *Albanido-Mesohelenik ne rajonin Prrenjas-Burrel*. Fier.(Unpublished) (In Alban.).

Dimo, Ll, Pashko, P., Pine, V., Petro, Th., Cakuli, A. 1982. *Rreth kushteve te formimit dhe perspectives qymyrmbajtese te depozitimeve molasike te Ultesires se Korces*. Bul. Shkenc. Gjeol. No. 4. 65-82. (In Alb. Abst. Eng.).

Dimo, Ll., Pashko, P., Vaso, P., Kita, P., Cili, N., Bibaja, P., Palko, A., Adhami, J. 1989. *Pellgjet qymyrore dhe perspektiva* e *tyre*. Bul. Shkenc. Gjeol. nr. 4. 249-257. (In Alb. Abst. Eng.).

Dodona, E., Kotsakis, T. 1985. *Premiere decouverte de Mastodontes* (*Proboscidea*, *Mammalia*) *en Albanie*. Geol. Romana,vol. XXIV. 73-78. Roma.

Dumurdzanov, N., Serafimovski, B., Clarc Burchfield, B., 2004. *Evolution of the Neogene-Pleistocene Basins in Macedonia*. Geol.Soc. Americ. Digital Map and Chart Series 1. 20 p.

Hoxha, V., 2001. *Tiparet themelore te gjeologjise dhe perspektiva* e *kerkimeve ne rajonin Kercisht-Sorokol*. Disertacion. Tirane. Unpublished. (In Alban.).

Hoxha, V., Kolgjini, E., Hysa, N., Majmari, M., Torba, Xh. 2003. Studim me titull: *Administrimi* i *territorit dhe* i *resurseve natyrore per rrethin* e *Dibres*, *Qarku Diber*, per vitet 2001-2003. Peshkopi. Unpublished. (In Alban.)

Hoxha, V., Kolgjini, E., Hysa, N., Majmari, M., Torba, Xh. 2005. Sudim me titull: *Perpilimi* i *hartes se rrezikut*

ISSN 2306-9600

g*jeologjik ne shkalle 1:50.000 per rrethin* e *Dibres, per vitet 2004-2005*. Tirane. Unpublished. (In Alban.)

Hoxha, V., Seriani A., Pashko P., Jata I. (2011). *Geological sites and landscapes in Dibra region*. Intern. Geo-Science Conf. Geo-Alb. 2011. Proceedings. Mitrovice.

Kleinholter, K., 2004. *Die Pliozanen Floren des Ohrid- und Kolonja- Beckens*. (*Sudost-Albanien*). Munster. Forsch. Geol. Palaont. 99, 103-110. 1 Taf. Munster.

Krstic, N., Savic, L., Jovanovic, G., Bodor, E. 2003. *Lower Miocene lakes of the Balkan Land*. Acta Geol. Hung. Vol. 46/3, 291-299. Budapest.

Kumati, L., Myftari, S., & Gjani, E., 1997. *The geological setting of lacustrine-marine basins in eastern Albania and their origin*. Spec. Publ. Geoinstitute, 21,107-118, 6 Abb. Belgrade

Melo, V., 1964. *Tarracat* e *vjetra te larta aluvialo-proluviale te Drinit te Zi dhe historia* e *zhvillimit Neotektonik te tij*. Bul. USHT. Ser. Shkenc. Nat. 4, Tirane. (in Alban. Abstr. in French).

Pantic, N., Dumurzanov, N., Pavlovski, B. 1973 (-1978). *Prilog za zapoznavanie na,starosta na Pliocenskite sedimenti vo Prespanskata* i *Ohridskata kotlina*. Trud. Geol. Zavod S.R. Makedonija. Sv. 16. Skopie.

Papa, A., 1975. *Suita* e *kuqerremte* e *Librazhdit eshte molase tipike*. Permb. Stud. Nr. 1, pp 127-130. (in Alban. Abstr. in French.)

Pashko, P., 1967. *Mbi depozitimet neogjenike te Gropes se Burrelit*. Bul. USHT. Shken. Nat. 3. 33-42. Tirane. (in alban. Abst. in French).

Pashko, P., 1968. *Molusqet* e *Gropes se Burrelit*. Permb. Stud. Nr. 9-10. p.15-23, fig.2, Tab I-III. Tirane. (in alban., Abst.in french).

Pashko, P., 1970. *Depozitimet miocenike te ujrave te embla ne Zonen* e *Mirdites*. Permb. Stud. 3 (16),p 12 -24. Tirane. (in alban., abst. in french).

Pashko, P., 1975. *Suita* e *kuqerremte* e *Librazhdit dhe problemi i moshes se saj*.Permb. Stud.1. p. 141-142. Tirane. (in Alban., Abst. in French).

Pashko, P., 1984. *Molusqe Plio-Pleistocenike ne Gropen* e *Peshkopise*. Bul. Shkenc. Gjeol. 2. 91-105. Tirane. (in Alban., Abstr. in English).

Pashko, P., 1995. *Tortonian molluscs of the Burreli Depression* (*Albania*) *and their affinity with the Pannonian mollusks of Paratethis*. Abst. Roman. Journ.Strat. Vol. 76, Supl. 7, 77. Bucharest.

Pashko, P., 1996. *Stratigrafia* e *gropave te brendeshme*. In: Aliaj, Sh., et al. Geology, p.1-285, Tirane. Unpublished. (in Alban.).

Pashko, P., Papa, A., Huta, B., Myftari, A. 1973. *Stratigrafia* e *depozitimeve paleogjenike dhe neogjenike ne Zonen tektonike te Mirdites*. Tirane. 564pp. (Unpublished)

Samoilovic, S.R., 1958. *K voprosu ob izmineniyah rastitelnogo pokrova Zapad*. *Balkan* v *verhnetreticnoe vremya*. Doklady AN SSSR, tom 120, nr. 3.

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SEVERAL IMPORTANT ASPECTS FOR BUILDING A NEW MAP OF TECTONIC ZONING OF ALBANIDES

Petraq NAÇO[1], Viktor DODA[1], Fatbardha VINÇANI[1], Gjon Kaza[1]

[1]*Institute of Geosciences, Energy, Water and Environment Tirana, Albania),*
E-mails: petraqnaco@yahoo.com, viktor.doda@gmail.com
bardha_vin@yahoo.com, gjkaza@yahoo.com

ABSTRACT

Albanides as regional geological notion, are part of the structural trunk Dinarides - Albanides - Hellenides - Taurid. They constitute a segment of this major Balkan unit, the tectonic structural evolution of which is part of Balkanide evolution and wider still. Thus, the tectonic structure Albanides has consistently attracted the attention of various researchers, whether foreign or native, both in terms of diversity of major tectonic units, the relationship between them, the structural features, the lithofacial characteristics, as well as of the continuity in regionality, their positioning in the framework of Balkanization. In the present paper are treated few moments, dealing with tectonic zoning of Albanides, the character of the relationship between major units struktural-facial, characteristics of longitudinal and cross tectonic contacts, etc.. Interestingly consider: spatial and positioning tectonic of structural-facial zone of Krasta-Cukali and the character of relationships that it realizes with boundary tectonic zones, its lithofacial appropriateness and distinctions and similarities that it has with neighboring tectonic zones, the existence of transversal faults and the role have played them in structuring of Albanides, the presence of tectonic windows and their meanings in terms of tectonic style and manner of placing of major structural facial units and many other problems.

KEWORDS

Tectonic zoning of Albanides, Balkanide, tectonic Window, fractured zone

INTRODUCTION

Tectonic zoning map is one of the most important studies that can be applied to any geological territory. Through its accomplished graphically, the spatial delineation of major tectonic units. Tectonic zoning map must constitute the foundation upon which to begin the building of whole series of geological maps. Specifically, Tectonic Map of Albanides in scale 1: 200 000, published in 1999, is a much more extensive map than the tectonic zoning map. It contains a synthesis of some elements, dealing with tectonics, structure, orogenic cycles, formations, etc.. While Tectonic Zoning Map should be much simplified, focusing on outlining of major tectonic units and of characterization of their main features. The construction of this map, which apparently is the first of its kind, consider a necessity, not only for the primary importance that it has, but also for solving a number of controversial issues dealing with the separation of tectonic zones, lithofacial appropriateness, their performance on the extension, etc.. Some of these problems, in the form of a discussion will try to treat below.

TECTONIC ZONES

Albanides already have a concrete definition, synthesid at the tectonic map of Albania. The problem lies at the confrontation at the time of this particular product, about the evolution of scientific thought in the field of global tectonics and the facts of the new concepts brought by observation in site, along tectonics treves of Albanides. To make it more understandable, that which will treat below, deem appropriate to give rankings of tectonic zones in Albanide.

Outer Albanides:

Tectonic Zone of Sazani.
Ionian tectonic Zone.
Tectonic Zone of Kruja.
Tectonic Zone of Krasta-Cukali.
Tectonic Zone of Alps.

Inner Albanides:

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Tectonic Zone of Mirdita.
Tectonic Zone of Korabi.
Tectonic Zone of Gashi.

Depression:

Preadriatic depression.
Among mountain depression

Obviously, the tectonic structure of Albanides until now is conceived as part of eight tectonic zones and two lowlands, which are reflected organized into three major structural facial units. So naturally the question arises, what is problematic about this tectonic zoning? Who are the facts and possibilities for the organization otherwise the tectonic structure of Albanides. Let us proceed ....

SOME PROBLEMS ABOUT TECTONIC ZONES

If take a look carefully at geological map of Albania will see that Krasta-Cukali tectonic zone separates structural trunk of Albanides in three parts: northern Albanides, that are now known by the name Albanian Alps tectonic zone; eastern Albanides, including tectonic zones of Korabi, Mirdita, Gashi and Western Albanides, involving tectonic zones of Sazani, Ionian and Kruja (Fig. 1), without speaking here to the lowlands, as the newest unit, structurally overlapping on tectonic zones.

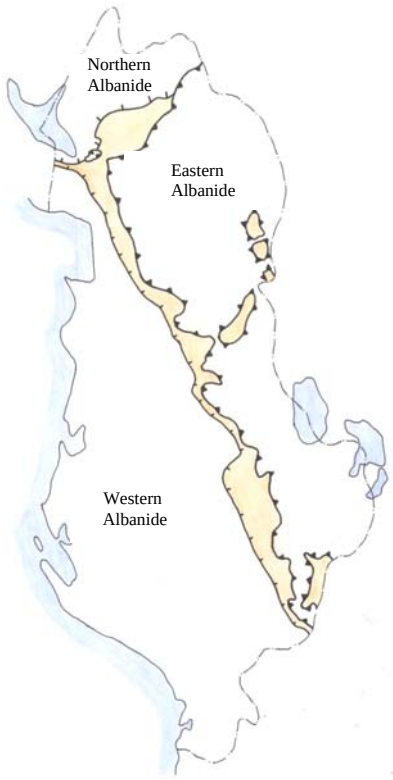


Fig. 1. Scheme of structural trunk of Albanides referred to spatial setting and relationships that offers Krasta-Cukali tectonic zone

From here be created the idea that the structural trunk of Albanides can conceive organized into four major tectonic units: eastern Albanides, including tectonic zones of Mirdita, Korabi, Gashi; Western Albanides, including tectonic zones of Sazani, Ionian, Kruja; Northern Albanides, including the Albanian Alps tectonic zone and central Albanides, including tectonic zone of Krasta-Cukali.
In the west, Krasta-Cukali tectonic zone limited to visible tectonic boundary with Kruja zone, in east with Mirdita tectonic zone, while in north its relations with the Albanian Alps tectonic zone as thought to date (Xhomo A., etc.., 2002), are unclear. Then the question arises, what stays not, what relationships and moments of development characterized these tectonic units with each other. This difficult geological situation is early noticed, by Nopça and others, who are trying to resolve under the concept attributes of Shkodra-Peja transversal fault. At first sight appears, that along the imaginary segment Shkodra-Peja, we

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have a clash of major tectonic units, where Krasta-Cukali tectonic zone put face to face with tectonic zone of the Alps, leaving the place each other to the extent unlike other areas on both sides, which follow without interruption Albanid continuity. From here arises the idea, these tectonic-facial zones are part of a larger paleotectonic unit (Fig. 2)?



Fig. 2. Outline of paleogeographical situation of tectonic zones at the time of their foundation

This reasoning also supports the existence of some unifying lithofacial horizons as between subzones of Krasta-Cukal tectonic zone, as well as between the last ones with the Alps tectonic zone and Mirdita Cretaceous structural unit (Fig. 3).

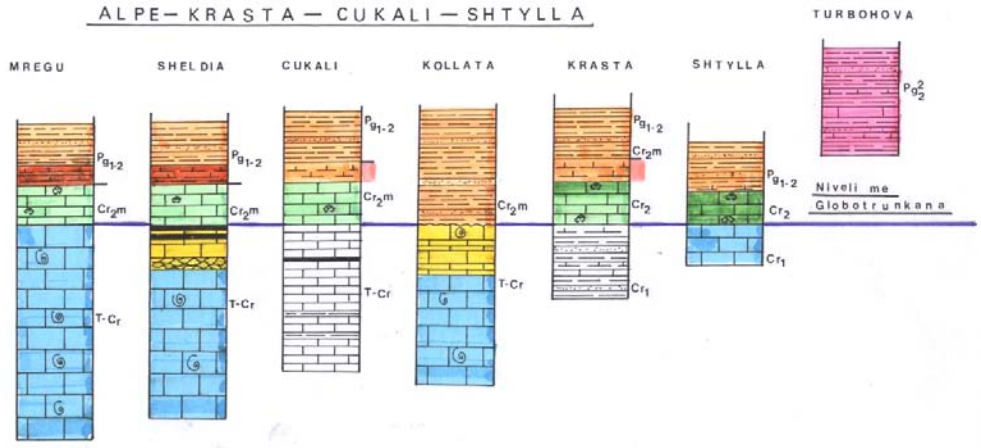
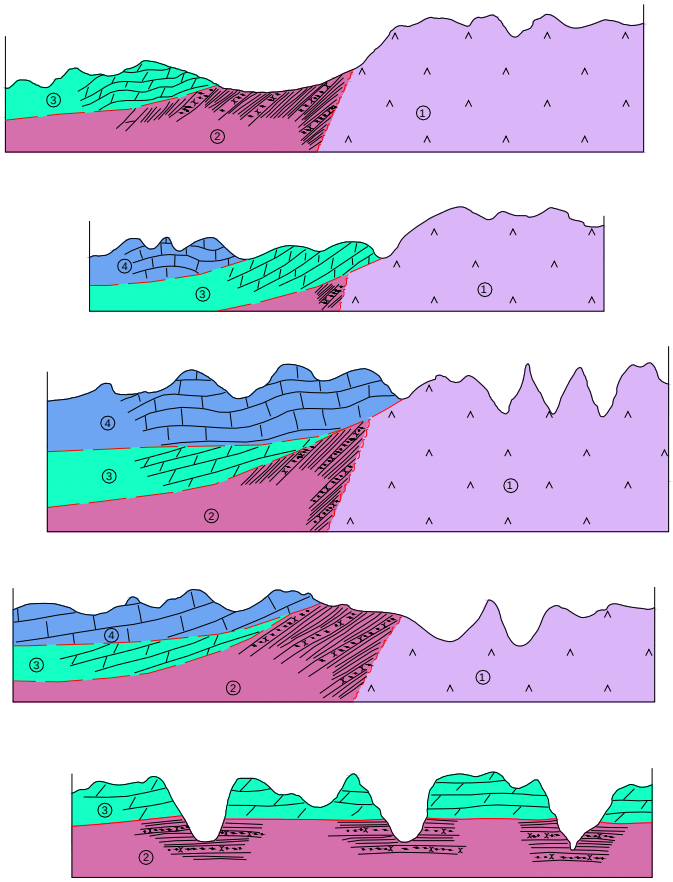


Fig. 3. Correlated scheme between tectonic zones of Alps, Krasta-Cukali and Cretaceous structural unit of Mirdita

Unifying lithofacial horizon consider new flysch of Paleocene-Eocene age, or Maastrihtian-Eocene age in some cases (Fig. 3), which shows that for this geological time the units mentioned above, have been unified, therefore experiencing the same paleotectonic story (Naço P., et al., 2011). Another unifying lithofacial horizon consider the thickness of the limestone with globotruncana of Maastrihtian age, that meets in almost all tectonic units, serving also as the reference horizon, the thickness of the neritic limestone of Triassic-Cretaceous age (Fig. 3), etc.. In consequence of this reasoning pronounce that Albanides can divided into three major tectonic units: Eastern Albanides, including zones of Mirdita, Korabi, Gashi; Western Albanides, including zones of Sazani, Ionian, Kruja and the Central Albanides,

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including zones of Krasta-Cukali, Alps and the Cretaceous structural unit of Mirdita. Distinguish the latter one, cited as central Albanides, which we consider as a major tectonic zone, with several sub-districts in its composition. This means that sub-districts Krasta, Sheldi (Spiten), Cukali, the Alps are part of the central tectonic zone, while the Cretaceous structural unit of the Mirdita represent eastern lips of this great paleotectonic area (Naço P., etc.. 2000).
Tectonic windows of Okshtuni and Peshkopi (Fig. 1), with the geological situation that offer (Fig. 4) open another controversial problem (Naço P., Reçi H., Vinçani F., 2011). New Eocene Flysch, whenever is present, is the first contact with evaporate (Naço P., 1995).



1- Evaporate, 2- New Eocene Flysch, 3- Early marly flysch, 4- Triassic-Jurassic limestone

Fig. 4. Schematic geological profiles, which express the relationship between rock complexes in the region of Peshkopi

In his absence, placed on evaporate the Jurassic-Cretaceous flysch formation and then Triassic carbonate formation, involved so far in the tectonic zone of Korabi. So as we see, have a particular placement of geological formations on each other. This situation have been reflected in Figure 5 in a wider space than Peshkopi region itself. In Zerqan area, the shale formation of Silurian-Devonian, involved in the tectonic zone of Korabi, overlayed tectonically on flysch formation of Jurassic-Cretaceous age and underlayed tectonically under carbonate formation of Jurassic-Triassic age (Naço P., Hamid S., 1998), involved so far in Mirdita tectonic zone in eastern frame unit (Shehu, R., et al., 1983). Above judge that: Peshkopi evaporate both with Eocene flysch form a tectonic unity and are part of the same tectonic zone, sub-zone Krasta; In Zerqan sector, Korab tectonic zone represented by the shale formation of Silurian-Devonian (Xhomo. A., et. al., 2002), underlayed tectonically under Mirdita zone, putting in the discussion the boundary between them, therefore, and existence as a separate tectonic zones; rocks involved in eastern Albanides, representing tectonic covers where more underlayed is flysch formation of Jurassic-Cretaceous age, on it is placed shale formation of Silurian-Devonin, then carbonate formation of Triassic-Jurassic age and the last in the form of upper cover is the unity of ophiolitic rocks (Fig. 5).

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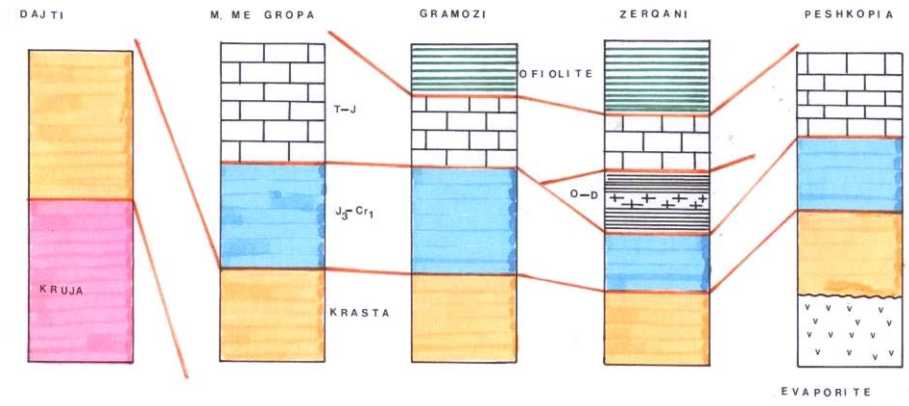
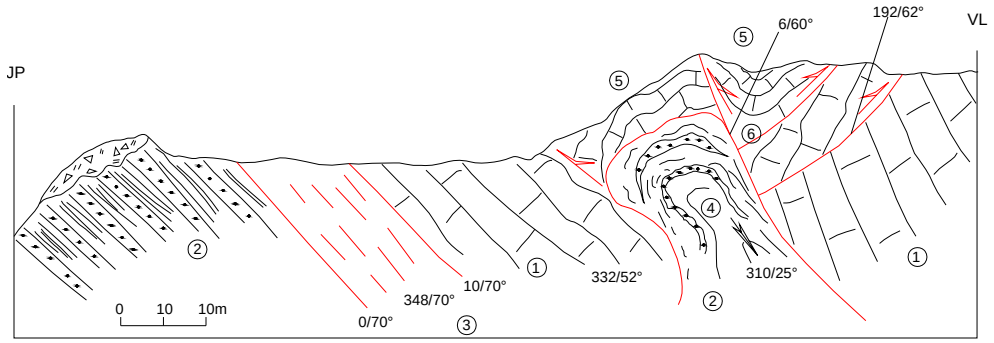


Fig. 5. Tectonic setting of the geological formations in Peshkopi-Dajti region

Shkodra-Peja transverse constitutes another controversial joints, outlined between Alps and Krasta-Cukali zones. Near the city of Shkodra, it is expressed very clearly, with all the elements (Fig. 6), where there is tectonic overthrusting of Alps zone on Krasta-Cukai zone. While, in the northeast direction becomes an unclear situation, not distincted in site the boundary between Cukali flysch formation of Eocene age and Permian formation of the Alps zone. This ambiguous situation is also noted by geological survey on a scale of 1: 25 000, carried out in the region (Qirinxhi A., etc.., 1984). More problematic still are the relationships between these tectonic units, when you think that the neritic carbonate formation is intertwined in generations shaped with terrigenous pelagic shale formation, as two very different sedimentation environments.



1. Massive limestone, Alps tectonic zone.
2. Silt- sandstone sericitic flysch of Krasta-Cukali tectonic zone
3. Tectonic boundary between Alpe and Krasta-Cukali zones, broken and brecciated, 20 m thick.
4. Krasta tectonic window, within the Alps zone, effect of flysch diapirism
5. Carbonates folds for strain effect arising from flysch diapirism
6. Thrusting and backthrusting tectonic systems

Fig. 6. Outline of the situation of tectonic relationsheep between the Alps and Krasta Cukali zones (former cement factory of Shkodra)

Fusulinid limestones of Permian, within the shale matrix, sometimes placed in the shape of chain blocks, in the form of olistolite, giving rock formation features similar with Xhani flysch, that they have under them. In sector of Shale Gates limestone Permian age have been identified of Triassic age (Kici V., 1999), while in the Plan village, within the terrigenous formation drawn as Lower Triassic (Xhomo A., etc.., 2002) met specia Pithonella ovalis, which shows a much younger age (Naço P., et al., 2012). As discussed above we think that terrigenous formation that builds oldest section of the Alps zone, to be part of Xhani flysch, therefore build the new section under Cukali zone. Then, there is the problem, who is Shkodra-Peja transversal fault, what rock formations puts it in the face, who is the origin and the role it has played

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in structuring of Albanides. These questions and other discussions made us think of this Albanid regional element as an open problem.

Lezha transversal fault can be considered an important tectonic element (Fig. 7). It is interesting in terms of concrete facts which is presented on the surface, as well as of the effects that it has had in structural evolution of Albanides. If we refer to the lowlands of under-Shkodra see that it all comes down gently toward the southeast, until it crashes into the transversal segment of Lezha. This trend is readed as in performance of hydrographic network and structural elements, where the anticline of Renci and Kakariqi, gradually decrease in height toward the south, until extinguished near the cross mouth of the Drini river. The same experience and anticline ranges of Kruja-Laç and Makareshi, but in the opposite sense, towards the northwest, leaving us to understand that the same tectonic zone, on both sides of Lezha transversal fault has experienced different tectonic regime, so there were various reaction to the main axis of strains (Naço P., et al., 2012). This is one of the facts, to understand the role of this important tectonic element in structuring of Albanides.

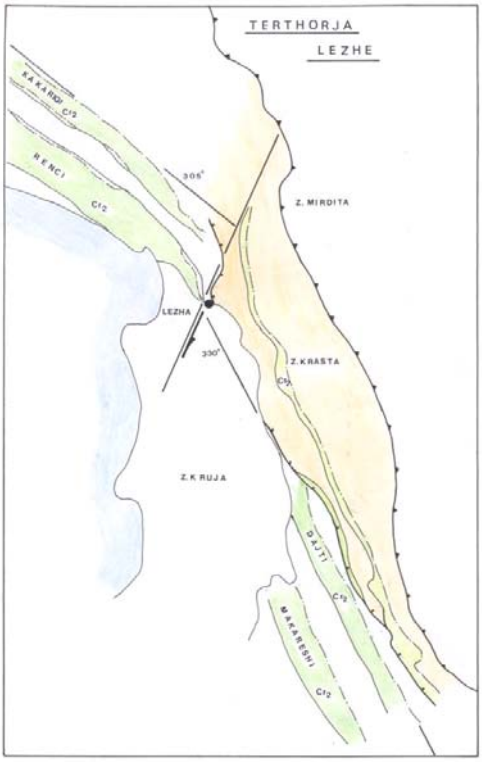


Fig. 7. Lezha transversal fault

CONCLUSIONS

- Based on the spatial position of Krasta-Cukali tectonic zone, Albanid structural trunk can conceive organized into four major tectonic units: eastern Albanides, including tectonic zones of Mirdita, Korabi, Gashi; Western Albanides, including tectonic zones of Sazani, Ionian and Kruja; northern Albanides, including tectonic zones of the Albanian Alps and central Albanides, including tectonic Krasta-Cukali zone itself.
- Based on the existence of some unifying lithofacial horizons between tectonic zones of structural units of Albanides can distinct three major tectonic units: eastern Albanides, including zones of Mirdita, Korabi Gashi; Western Albanides, including zones of Sazani, Ionian, Kruja and in central Albanides, including zones of Krasta-Cukali, Alps and Mirdita Cretaceous structural unit in the form of a transgresive tongue on eastern Albanides.
- Peshkopi evaporate both with Eocene flysch form a tectonic unity and are part of the same tectonic zone, sub-zone of Krasta.
- In Zerqan, tectonic area of Korabi represented by shale formation Silurian-Devonian, underlayed tectonically under Mirdita zone, putting in question the boundary between them, therefore the existence as a separate tectonic zones.

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- The rocks involved in eastern Albanides, representing tectonics covers, where more underlayed is flysch formation of Jurassic-Cretaceous age, on it is placed formation of Silurin-Devonian, then the carbonate formation of Triassic-Jurassic age and the latest in the shape of upper covers is ophiolitic rocks unity.
- Terrigenous formation that builds the older section of Alps zone, to be part of Xhani flysch, therefore build the new section sub-zone of Cukali. Then, there is the problem, who is Shkodra-Peja transverse, what rock formations puts it in the face, who is the origin and the role it has played in structuring of Albanides. These questions and other discussions made us think of this regional element of Albanides as an open problem.

LITERATURE

Naço P., Theodhori P., Peza E., 2000. *Krasta-Cukali tectonic zone as a key important intermediate belt of Albanides, Albania*. 8th Albanian Congress of Geosciences, p. 180.

Kici V., 1999. *Depositions of Lower Triassic in Portat e Shalës.* Bulletin of Geological Science, nr.1, f. 91-96.

Naço P., 1995. *Tectogenesis and oil-gas bearing of Krasta tectonic subzone.* Disertacion

Naço P., Hamiti S., 1998. *On tectonics of Neshte-Okshtun-Cerenec region.* Bulletin of Geological Science, nr.1, pp. 23-32.

Naço P., Reçi H., Vinçani F., 2011. *On the Vlora-Elbasan-Dibra transversal tectonic fault, as one of the earliest and most active tectonics of geological structure of Albanides*. Bulletin of Geological Science, nr. 47, pp. 32 – 59.

Naço. P., Kuliçi H., Bedini E., 2011. *A new Concept forAlbanide, Based on the Tectonic Styleof Krasta-Cukali Zone*. Proceedings of the 17th Meeting of the Association of European Geological Societies f. 264.

Naço P., Doda V., Kaza Gj., Vinçani F., Dinaj V., 2012. *Specific reaserches on some important joints of tectonic and neotectonic structure of Albanides.* Fund of Institute of Geosciences, Energy, Water and Environment.

Shehu R. etj., 1983. *Geologic map of Albania, 1: 200 000 scale.*

Xhomo A. etj., 2002. *Geologic map of Albania, 1: 200 000 scale.*

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THE MAIN GEO-ECO-SYSTEMS IN ALBANIA AND THEIR GEOTOURIST VALUES

Afat SERJANI[1], **Merita DOLLMA**[2]

[1]*ProGEO-Albania, Tirana.E-mail: aserjani@yahoo.com*
[2]*Univerisity of Tirana, Faculty of History and Philology*
e-mail: meritadollma@yahoo.com

ABSTRACT.

The geodiversity concept includes geological-geomorphologic aspect of natural heritage. Due to its geological position and mountainous relief, in Albania can be observed a lot of rare, unrepeatable, some times unique geological phenomena, most part of them represent geological sites.
Geodiversity and biodiversity there are very good base for development of geotourism all over Albania.
As geotourism destinations we recommend geosites of glacial, karst and fluvial-erosion origins, stratigraphical sections, ophiolite rocks, geoparks and forest parks, coastal and shorelines, nice Alpine and Sub Alpine grassland-pasture, landscapes.

KEY WORDS: *Albania, geo-eco-system, geodiversity, biodiversity, geotourism.*

INTRODUCTION

Albania is mountainous country, and is made up of carbonate rocks and molasse formations, while full sequences of ophiolite rocks are distributed in Mirdita tectonic zone. In Albania, there are observed special geological phenomena, representing geological sites. Superimposed there are rare, beautiful and aesthetic natural landscapes.
The complexity of Albanian geology, landscapes and water system, different soil cover and climate have conditioned a flora of more than 3250 species, which represent about 29% of the European flora; 150 species of which are considered endemic. According the Convention on Biological Diversity (1999) 540 species of flora and fauna of Albania belong to rare kind category.
In many areas, biodiversity it is intercalated and correlated with geodiversity. That is why, we think that this territories represent not simple ecosystems, as there are described up to now, but geo-eco-systems. Before in geosciences, geodiversity was included in biodiversity and in ecosystems. Here, in this paper, for the first time, there are defined and presented main geo-eco-systems in Albania.
The most distributed in Albania there are karst geo-eco-systems formed on the surface of limestone rocks and evaporites, glacial ones at high levels of carbonate and ultrabasic rocks.
Along with Adriatic and Ionian Sea coasts there located some lagoons and beaches, which represent important geoecosystems in a Mediterranean context.
Below there are described the concepts, the main geoecosystems in Albania and their geotourist values.

CONCEPTS

The geodiversity concept includes natural heritage of geological-geomorphologic origin. Geological sites represent rare, unique, and pattern unrepeatable phenomena, reflecting in separated intervals of time of the history of the Earth Crust. The first historical document concerning geoheritage it was the Digne Declaration on "Rights of Earth Memory".
Systematic works on geological heritage conservation started after the foundation of ProGEO (The European Association for the Geological Heritage Conservation). The most important, recent document on geodiversity is the Resolution of World Congress of IUCN in Barcelona, on October, 2008, where was pointed: "..That

geodiversity is a crucial factor conditioning biology, culture and landscape in their multiply forms and that geological aspect of high value must be preserved for future generations…."
Concepts of "Geological Heritage", "Geological Site", and "Geopark" after 1995 year were appeared in Albanian geological literature.
During last century, geological and geomorphological sites were treated together with flora and fauna, included in ecosystems, forest reserves, national parks etc. Last times, in European countries it widely used geopark concept, and Global Geoparks Network is found. In many areas, geodiversity it is intercalated with biodiversity. These areas constitute combined geoecosystems.
In general, geodiversity (geosites and geoparks) together with biodiversity (flora and fauna) are used for development of the tourist industry, especially geoecotourism. Geoecotourism it is strongly connected to land geodiversity and biodiversity, and it also embraces the cultural values, including together natural and cultural heritage.

Geo-eco-systems in Albania
The main geoecosystems of Albania we have grouped according their geographical position and the origin of formation of geological sites as following: -Trans boundary geoecosystems, which are considered as the most important.
-Karst geoecosystems on the surface of carbonate and evaporate rocks.
-Complex, large geoecosystems formed along with Adriatic and Ionian sea coasts.
-Glacial geoecosystems at high mountains on limestone and ultrabasic rocks.
In Fig. 1, there are shown sites of cultural heritage under the UNESCO protection:
1. Butrinti Archeological city.
2. Gjirokastra Old city and Castle.
3. Berati City and Castle.
4. Karavasta Lagoon, included in Ramsar Covention).
The main geoecosystems of Albania, there are described shortly below.

Interborder geo-eco-systems:
5. "Bjeshket e Nemuna" ("Cursed Mountains") in Albanian Alps, which represent an interborder area in Albania, Monte Negro, and Kosovo. Here is the highest peak in Albanian Alps, Jezerca Peak (2693m). We think that all northern part of Kelmendi Highland (in Albania), Rugovo Valley (in Kosovo) and Gucia and Plava (in Monte Negro) constitute a specific natural unity and can be proposed as interborder natural geopark with protection and investments by Albanian, Kosovo and Monte Negro states.

6. Shkodra Lake represents a protected (Dhora et al. (2000) interborder geo-eco-system between Albania and Monte Negro. Here are some geosites such as: Shkoder – Peja regional transversal fault, Taraboshi stratigraphical section of Triassic-Jurassic carbonate rocks with ammonites stromatolites, Involutina liassica and bauxite occurrences, Kopliku karst field, and Suka e Koplikut paleoenvironmental site full of fossils. Here, in Pleistocene and Astian sands, there are defined by Marku D. 63 species of bivalves, 90 species of gastropods, 3 species of Skakopods (dantum) and 2 species of Ekinodermates. Sferolites from cosmos are discovered as well. To south of lake is risen limestone hill full of "debris flow", where is built Rozafa Castle. Around the lake and in its bottom there are some underground karst springs.

7. Pogradeci (Ohrid) Lake. It is formed by the influence of tectonical-karst processes at the most northern limit of the long Albanian-Thessaly depression (Jozja N., Neziraj A., 1998). It is unique concerning its oval form, hydrodynamic water regimen, its fauna, high transparency (15-25m) and clean waters. Underground karst water springs in contact of molasses with limestone rocks getting their water from Prespa Lake and from Mali Thate carbonate basin supply Ohrid Lake. Driloni, Shen Naumi and Tushemishti karst springs are important geological sites and at the same time they represent very nice tourist and climate spots. From northern side of Ohrid Lake, at Struga City (Macedonia), gets its flow Black Drini River, representing a unique beautiful geological site. In Lini peninsula there are outcrops of Triassic limestone with *ammonites.*

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Concerning the unique fauna of this lake we remind especially about some mollusks, which are remained yet only in this lake of Europe. Ohrid (Pogradeci) Lake it is known since the long time before not only because of its tourist values, but also at the same time for its climate and curative features, especially for heart and blood pressure sickness.

8. Prespa lakes. Big and Small Prespa lakes are inter border geo-ecosystems between Albania, Greece, and Macedonia (Qiriazi P., 2004). On the western side of Prespa lakes Prespa, Mali Thate, and Mali Ivanit karst fields there are formed. In the southwestern limit of Small Prespa Lake is Trenit's cave, an old human settlement. A lot of karst springs are formed in Albanian, Greek and Macedonian parts of Prespa lakes.

Complex karst-glacial-erosion geoecosystems:

9. **Lura glacial lakes and pine forest.** It is located in western part of Dibra district. It was established as Lura National Forest Park since 1966. It has a surface of 1300 Ha and altitude from 1200m up to 2100m above the sea level. The ecosystem consists by pine forest, alpine pasture, and higrofile plants in 12 glacial lakes. It is located in Lura ophiolite massif, with amphibolite sequence at the bottom, as a rare geological phenomena. A lot of karst, glacial, and erosion landscapes there are formed in ophiolite and carbonate rocks around. Lura geopark has a high ecological importance and posses a significant geological and geomorphological features as well.

10. Mali me Gropa ("Honey Comb Mountain") and Dajti National Park, east of Tirana, represents a miraculous landscape of karst processes. Karst forms at 1500 – 1800 m. above the sea level on gentle slopes of mountain are of interesting views similar as honey comb. Karst holes, wells, cones, valleys are placed with a strange regularity, covered by alpine grass and flowers, by some rare kinds of plants mainly carpinus type.

11. Dumrea karst lakes in Evaporite rocks. It is a rare beauty of Albanian nature all over the Dumrea Salt Diapir. It has a surface of 270km^2, characterized by intensive development of karst processes in form of lakes holes, depressions. There are known 85 karst lakes, which cover a surface of 645 Ha or 3% of Dumrea Diapir. The deepest is Merhoja Lake (61m deep). The most beautiful is Belshi group of karst lakes, around Gradishti Hill. Here is Belshi Town, built around Belshi Lake. Biodiversity of Dumrea karst lakes is specific. Thera are evidenced 40 kind of wild birds and fowls, some kinds of wild animals and fishes.
Karst lakes together with karst geomorphology and nice hilly landscapes represent a rare natural phenomena, typically for salt rocks.

12. Drenova molasse section and Bozdoveci Forest. Bozdoveci National forest Park was proclaimed by DCM since 1966. It is a high, dense, pine forest. This forest is grown on the surfeace of molasse formation. Here is Drenova, the oldest coal mine of Albania. In molasse section was found and defined for the first time by Openheim, since 1896, **Barbatica Albanica**, the first geological site in Albania.
Just in the center of the forest it is formed "Goat Stone", an erosional geosite similar as goat head.
Thus, Bozdoveci forest together with full molasse section, coal mine and erosion geosites, constitute a nice, intersting and important geoescosystem.

13. Kurveleshi Highland as natural karst museum. Kurveleshi Highland it is located southwest of Albania. The majesty of this highland, consists in its relief, some times of fear view, but often with nice landscapes of different forms. In general, Kurveleshi Highland constitutes a large carbonate massif. Everywhere the visitor who will step in Upper Kurveleshi Highland, will see geology in all its forms, a lot of dramatic and spectacular outcrops. Deep planetary processes of mountain formation, karst, erosion and glacial forms, deep narrow canyons, and waterfalls are surprising every visitor. In carbonate rocks there are intensively developed karst phenomena, that is why this highland, is named before as karst museum of Albania.
The geodiversity and mountainous ecosystems constitute the main aspect, and the most important values of Upper Kurveleshi Highland. The most important and the most attractive there are geological sites.

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The most significant geological sites are karst fields, Gurra River canyons and waterfalls, Lekdushi erosion towers, and some erosion gorges and passes.
Concerning the biodiversity, Kurveleshi Highland is famous for typically alpine pasture with mountain tea, oregano and some other medical plants, for oak and pine forests in Llufa, Zhupenova, Zareli and Gradishta, and for hazel trees in Gusmari. In Kurveleshi Highland there are widespread those kinds of habitats, who are adopted to dry climate, to shrub forests, rocky slopes and canyons, and to nice alpine pastures.
There, near to the sky, first of all, should be interested to go researches of biosciences and geosciences.

14. Kelcyra cold water springs. It is located in Kelcyra Gorge, formed by Vjosa River, crossing Dhembel-rebeshina anticline chain.
Kelcyra cold water tourist spot is of outstanding aesthetic view. Here amongst the many nice underground springs and high old trees there are formed some geological sites such as: Vjosa river terraces formed as result of neotectonic movements, Kelcyra Gorge, one of the largest and interesting geomorphologic river erosion site all over country, "Black Eyes" spring at the bottom of Vjosa river with aesthetic view and clean water, The cave, some tenths meters above the black spring. Cold water springs and old high trees are giving a special natural and aesthetic view to this point. On both slopes of Kelcyra anticline there are outcropped fine bedded limestone rocks full of karst forms on the surface.

15. Blue Eyes springs and Muzina Mesozoic, carbonate section. "Blue Eyes" geotourist spot includes: a big artesian spring, some cold water springs, artificial lake, some old high oak trees, and forest. All springs are placed along with contact of evaporate rocks west and carbonate rocks east. "Blue Eyes", main artesian spring is getting up through a natural vertical cave-well of about 45 meters deep, where the cave is going to the east inside of Mali Gjere underground water basin.
On both slopes of the road to "Blue Eays" spot outcrop "Terra Rossa" formations with some neotectonic phenomena on the surface.
East of "Blue Eyes" springs is the slope of Mali Gjere Mountain and Muzina pass, constituted by full section of carbonate rocks from Upper Triassic in Delvina town west, up to Oligocene flysch in Grapshi village east.
Next to "Blue Eyes" springs the itinerary crosses Dhrovjani evaporate diapir, where is prospected and explored large Krongj-Dhroviani salt mine.
"Blue Eyes" spot represents an important hidrogeological site, beautiful aesthetic landscape and very nice tourist spot, especially during hot summer time.

Geoecosystems along with Adriatic Ionian Sea coasts:

16. Karavasta Lagoon and Divjaka Pine Forest.
Divjaka beach, pine forest, and Karavasta lagoon located on the Adriatic coast from Shkumbini River mouths north and Semani river mouth south. Divjaka hill to the east border them. Divjaka-Karavasta lagoon it is the largest lagoon in Albania and one of the largest and important lagoons all over Mediterranean Sea. Total surface of lagoon is of about 4200 ha. The most interesting and important geoecological values of Divjaka - Karavasta lagoon are as following:
Divjaka old coniferous forest which is national park**.**
Divjaka beach with a lot of sand dunes along the seaside.
Colonies of Dalmatian Pelican.
Karavasta lagoon is best known for its colony of globally threatened Dalmatian pelicans. The presence of these birds is one of the main reasons that Karavasta Lagoon has been designated a Ramsar Site of International Importance. At the same time over 200 other bird species have been observed in this area, including some other globally threatened species, such as Pygmy Cormorant, White-headed Duck, Spotted Eagle and Pallid harrier.
A diverse mosaic of coastal habitats exists around the lagoon: red beds, dunes, forests, tamarisks and salt marshes. On the old dunes along with the coastline, there are rich forests of deciduous and pine trees, part of which has been designated the Divjaka Forest National Park.

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The dune belt separating Karavasta lagoon from the sea forms a 100 meter wide sandy beach backed by forests. This attractive scenery is an attracted visitor. The islands in the lagoon are one of the most important features of this area for the conservation of the birds.

17. Zverneci paleoenvironment site, Narta Lagoon and forest.

To the northwest of Vlora city there are located Zverneci paleoenvironment site full of sedimentological forms, textures and structures, Zverneci Beach, Narta Lagoon, and Island, where is build an old Monastery, and Pine forest.

18. Llogara geopark and Orikumi Lagoon.

Llogara National Park, is situated in the coastal mountains 40km south of Vlora City. Llogara represents a geopark because here are some rare, important geological sites such as: Subduction of African Plate (Adria Microplate) underneath Orogen (Euro-Asian Plate; Llogara Pass of erosional-tectonical-litological origin, 1027m above the sea level; Algal fine bedded limestones of Karaborun Platform full of *rudists* and *gastropods* and with some beds of "storm deposits";Ravena karstic field, 900m above the sea level; Some underground cold water springs;

Llogara Forest of 1040 Hectares is National Park of ecological-zoological importance. The forest is placed at northern slopes of Llogara at altitudes ranging from 500m 1200m., and extending of about 2000m.

This is the best forest in southern Albania, where are widespread some kinds of wild animals and medical plants. Just at the Llogara Park there is "Flag pine" proclaimed a natural monument.

Llogara Geopark is the best candidate to be proposed for including in European Geopark Net.

To the North of Llogara Park there is located Orikumi lagoon, which represents natural reserve protected by State and Orikum antique town.

19. Borshi – Buneci Beach and cold water springs.

It represents a pearl not only in this region, but all over Albania. Borshi beach is of about 3.2km long. Along with seaside here there are formed some small "oasis" of subtropical up to tropical bio climat. Placed between short mountainous torrents this "oases" can serve as spots of rational geoecological tourism. This part together with Himara region represents the warmest "pole" in Albania. C.

Some cold water springs there are just at the rocky sea coast.

Borshi cold water spring on the travertine deposit represents a beautiful tourist place in this road. Borshi castle, is built on around hill at 303m above the sea level.

20. Butrinti Lagun-Lake and Ksamili Islands.

Butrinti Lake and Ksamili islands located on massive limestone of Lower-Middle Jurasic.

Butrinti archeological center together with forest reserve represents cultural and natural heritage under the protection of UNESCO. Butrinti archaeological and historic center and forest are a concrete example of integration of cultural heritage with natural one. Butrinti Lake and lagoon together with Bufi salt water springs east and beautiful Ksamili islands is one of the most important geoecotourist and archeological centers of Albania.

Geotourist values of natural heritage

Geoecosystems can be used for development of the tourist industry, especially last time, parallel to the civilization of peoples. Geoecotourism it is strongly connected to land geodiversity and biodiversity, and it also embraces the cultural values. The most successful tourist researches and activities, are those, which include together natural and cultural heritage.

Albania is considered as "The land of sun and hospitality". In Albanian sea coast there are of about 300 sunny days per year and of about 250 sunny days in mountainous regions. Geological sites, geoparks, lagoons, and mountainous landscapes there are a very good base for development of geotourism and ecotourism all over Albania.

As geoecotourism destinations we can recommend geosites of glacial, karst and fluvial-erosion origin, stratigraphical sections, fossil beds, petrology of ophiolite rocks, geoparks and forest parks, shoreline of Adriatic and Ionian seas, nice Alpine grassland-pasture in Albanian Alps, Korabi, Mali Thate, Zagori, Çika, and Kurveleshi highlands. Some different kinds and levels of geotourism can be developed, depending by natural conditions of regions.
New geoheritage and geotourisme information technologies, and exchange of knowledge on geosciences information system, need to apply. Description of main geotourist itineraries, exploration areas, recreation spots and new geoecotourist maps must be compiled and published as well.
Logistic information will guarantee a pleasant and comfortable geotours, establishing a complex relationship between participants and rocks, soils, geomorphology, landscapes, flowers, plants.

CONCLUSION REMARKS

- Distribution and correlation of geodiversity and biodiversity in some areas is clearly expressed and thay can be defined and named as geoecosystems.
- The most widespread geoecosystems in Albania there are those of karst origin in carbonate rocks, and in evaporates, glacial and complex glascial-karst-erosion geoecosystems in high levels of carbonate and ophiolite massifs, and lagoons, pine forests and beaches along with Adriatic and Ionian sea coasts.
- Geoecosystems there are very good base for development of geoecotourism, for exploration and education puprposes.

REFERENCES

Dragoti N., Dedej Z., Abeshi P., 2007. *Zonat e mbrojtura te Shqiperise*. Tirane.
Progni K 2 000. *Malesia e Kelmendit, vlerat e saj gjeoturistike*. Shkoder.
Rovena Hoxha. 2010. *The danger by natural and human factors to caves of Albania.* Oral presentation to Int. Sc. Con. "The role of geographer in management of natural and human dangers" (Nov. 19-20, 2010). Abstract book. Tirana.
Serjani A., et al., 2003. *Gjeomonumentet dhe Gjeoturizmi ne Shqiperi (Geological Heritage and Geotourism in Albania)*. In Albanian and English versions. Tirane.
Serjani A., Hallaçi H., Leka Gj. 2005. *The areas of karst exploration in South Albania.* Presentation to: Water resources and Environment Problems in Karst-CVIJIC-2005. Proceedings of the Int. Conference and field seminars. Belgrade-Kotor/Serbia/Monte Negro/13-19 September 2005, pp. 743-750.
Serjani A., 2009. *Geodiversity of Albanian Lakes.* Oral presentation to Int. Symposium: Lakes and their nutrients. Pogradec, Albania, 26-27 April 2009. Proceedings.
Serjani A. 2009. *Rrafshnalta e Kurveleshit te siperm, muze i Natyres Shqiptare (Upper Kurveleshi Highland, a Museum of Albanian Nature)*. Monografi (Monograph). Published in Albania and English versions in "mediaprint" shpk. Tirana.
Serjani A., Hallaçi H., Gucaj A. 2010. *Geoecotourist values of Vjosa River-Ionian Sea, south-west Albania.* Oral presentation to ProGEO WG-1 SE Europe, Elazig, Turkey (September, 15-20, 2010). Abstract Book.
Serjani A., 2011. *Limestone Aquifers and Karst GEO-Eco-Systems in Albania.* Proceedings of the 9-th Conference on Limestone Hydrogeology. Besançon, France, September 1-3, 2011.
Serjani A., 2011. *Geodiversity and Geotourism in Albania.* Proceedings of the International Geo-Sciece Conference "GeoAlb 2011": Mineral Resources and their Perspective. Mitrovica, Kosovo, September 27-30.

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GEOGRAPHICAL MAP OF ALBANIA

Cultural and Natural Heritage under the Protection of UNESCO:

1. Butrinti archaeological center and forest
2. Gjirokastra city
3. Berati City

Included in RAMSAR CONVENTION:

4. Karavasta Lagoon and Divjaka forest

GEOECOSYSTEMS IN ALBANIA:

Inter border protected geo-eco-systems:

5. Bjeshket e Nemuna -"Cursed Mountains" (Albania Monte Negro, Kosovo)
6. Shkodra Lake (Albania and Monte Negro)
7. Pogradeci (Ohrid) lake (Albania and Macedonia)
8. Big and Small Prespa Lakes (Albania, Macedonia and Greece).

Complex Karst-Glacial-Erosion Geo ecosystems:

9. Lura Glacial Lake and Forest
10. Honey Comb Mountain and Dajti National Park
11. Dumrea Karst Lakes (Salt rocks)
12. Drenova Molasses and Bozdoveci Forest
13. Kurveleshi Highland a Natural Karst Museum
14. Kelcyra Cold Water Springs
15. Blue Eyes Springs and Muzina Section

Geoecosystems along with Adriatic and Ionian sea coast:

16. Karavasta Lagoon, Divjaka Pine Forest and Beach
17. Zvernneci Paleoenvironment Site, Narta Lagoon and Pine Forest
18. Llogara Geopark , Karaborun carbonate platform and Orikumi Lagoon
19. Borshi Beach and Cold Water Springs
20. Butrinti Archeological Site, Lake, Lagoon, Forest and Ksamili Islands



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GEOMONUMENTS AND CULTURAL HERITAGE AS OPPORTUNITIES FOR DEVELOPMENT OF GEOTOURISM AND TOURISM IN HAS-LUMA-GORA ETHNO-REGIONS

Blerta Avdia[1]
[1]*ProGEO-Albania, Tirana. E-mail: blerta.avdia@ hotmail.com*

ABSTRACT
In this paper appear natural and cultural wealth of Luma-Gora-Has ethno areas and the possibility of the ways for developing of tourism. Natural heritage and treasures of minerals, and geostrategic position have played an important role in economic and cultural development of this region. The geographical position and natural conditions have affected directly in biodiversity and due to the complexity of geological construction a lot of
Geological sites there are formed in this region.
Tourist potential offered by these ethno- provinces favors the development of different types of mountain tourism (hiking, skiing, hipism etc.). This has potential benefits for local residents, but not yet to the extent that through tourism population to make a living.
Identification of cultural and natural assets and contrasts of ethno provinces, the importance of recognizing and evaluating the tourist offer in view of sustainable tourism, the problems facing the tourist offer (natural and cultural heritage), and the possibility of managing cultural and natural Heritage sustainable tourism development is the subject of this paper. This study helps to build awareness ethnographic provinces and providing alternatives to tourism development.

KEY WORDS: *Albania, Ethno, Region, Luma, Gora, Natural and Cultural Heritage, Geosites, Geotourism.*

INTRODUCTION
In this paper appear natural and cultural wealth of the ethno Has-Lumë-Gora Regions, and the possibility for developing of tourism and geotourism. This region it is located in the northeast of Albania, surrounded by high mountains up to 2000m above the sea level.Geographical position and natural conditions have played an important role in the economic development of this area. Position at the crossroads of the roads connecting the interior of the Illyrian territories, inside the Balkan Peninsula has strongly influenced the early population and the diversity of material and spiritual culture of this area. Amongst the ancient cultural objects we can mentioned the follows: ancient settlements Kolshit[1], Kënetës, Dajçi Cave, Pusi i Thatë, "Town Peak" (Maja e Qytetit), Gradishta of Bardhoci, " Tomb Hill" (kodervarre) of Kruma, Romaja tumulus in Mujaj, and the Illyrian tumulus in Qinamak, Bardhoc, Fajzat, Gradishta, "Fshej Bridge" (Ura e Fshejt), Hisarit castle. During late antiquity and the Middle Ages were built Castles in Kastoria well dried, and later was built the fortress of Alexander (Neck City, etc.). Geographical location and geological construction, together with the climate conditions have contributed to the formation of a geodiversity and colorful, unique biodiversity. In particular will be described geological sites (geomonuments) and cultural heritage sites of the provinces. This Region offers the potential development of different types of tourism: winter sports, alpine climbing and sliding in the snow, but at the same time offers the opportunity for development of tourist movements in and around the cultural and natural heritage of the regions.

GENERAL INFORMATION
Ethno provinces Has-Lum-Gore lies in the northeast of our country and goes on, and off borders in the north, where as the border of the mountain serves Junik and Erenik river flow[2], branch of the White Drin River. In the

[1] Perzita L. "Kukësi, Vështrim Arkelologjik" Dita 2000, Tiranë 2004 fq. 20

[2] Çavolli R. Gjeografia regjionale e Kosovës, Prishtina 1997.

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northwest it is separated from Tropoja district by upper flow of the Skatina river, west with Kalimash, Komi pass, Zeba mountain, Doda bridge until Draj-Rec, meeting with Montenegro (Bajrak of Puka), Mirdita, Rec (Dibra), valleys Veleshica (Korab-Black Drin) south-southeast, northeast of Poslisht valley near Prizren, including Pikëllima (Koretnik) Mountain, East Opoja hill and the Sar Mountains, Zerca mountain (1347m), Kaçina Glava (2204m), Gemitash (2118m), Mountain Kallabaku (2147 m).
Administrative boundaries: Kruma municipality, municipalities of Golaj, Fajza, Gjinaj, in Gjakova and Prizren in all Kukes district (except Municipality Malzi), some villages in the municipality of Slloves, Castle, Doda, Zall Pear, Zall Rec Field Lure, Ceren, Shishtavec, Zapod, Novosoj, Gora.
These regions differ for diversity of morphology,[3] morphogenetic and large hypsometric disparities, the latter has had a significant impact on the modeling of landscape, climate, and environmental phenomena in their entirety make more complex and interesting landscapes.
Importance it is the presence of different types of landscape: River relief (in the form of Bicaj and Vanaj canyons, some caves and a yard); glacial relief in the presence of glacial circuses in Koretnik mountain, who have given him pyramid shape, in Gjallica, Zeba, Pashtrik mountains. Karst relief it is well expressed in Arrni, and Hasi karst plateaus. All these forms have scientific, didactic, ecological, geomorphologic, and tourist values.
In geological terms this region it is constructed by from metamorphic rocks in territory of Korab zone northeast, and by ofiolite massifs covered by carbonate rocks in Mirdita zone, with some horsts and grabens filled by quaternary sediments.
This Region it has a Mediterranean climate with continental influence. Climate it is characterized by a cold and harsh winters and cool summers, with rapid variation in temperature and an irregular distribution of rainfall. These types of weather conditions have an important role in the formation of specific natural phenomena which emphasize:
- Emergence of ecosystem composed of escorts interesting flora and fauna that has scientific value, ecological deserve the status of the protected area and micro forms of relief with the value of nature monuments.
Offer real potential climatic conditions favor the development of different types of tourism: winter sports, alpine climbing and sliding in the snow, but at the same time offer the opportunity for development of tourist movements in and around the cultural and natural heritage sites.
Hydrography is represented by the surface and underground water reserves, which come to the surface in the form of water springs. Hydrography is represented by watershed joint Black Drin and White Drin into Kruma and their branches as Luma, Bushtricës, numerous streams and a large number of karst resources.
All the above element have made it possible that in these regions there are present all kinds of soils and plant cover and fauna, which presented us varied and diverse range of unique value.
These geographical features have influenced the formation of a more complex nature with rapid development, which has led to the formation of unique special values that conditioned a very rich natural heritage. It is this unique natural value, which has made this specific landscape, which has received the status of the protected zone, the category of Natural Monuments.
According the Decision no. 676, dated 20.12.2002[4], in this region, there are 25 natural monuments of Albanian nature, of which 11 geomonuments[5]: Pigeon Cave, Cave yard, Cave in Mazrek, Peak Campus (Located near Çaja of Kruma), Zeba glacial circus, Arrnit karst field, Vanave Canyon, Canyon of Bicaj, and Eagle Stone.
This natural wealth present in ethno province Has-Lumë-Gora takes even greater value if will joined with cultural heritage inherited from generation to generation and put it at the service of tourism.

Tourist offer

Ethno Region Has-Lumë-Gora has all the potential of tourism development by combining natural and cultural wealth. The varied relief, abundant water, lake, river and resources, climate and microclimate preferred

[3] Akademia e Shkencave "*Gjeografi fizike e Shqiperise*", Tirane 1991

[4] Këshilli i Ministrave "VKM nr. 676" 2002

[5] Qiriazi P., Sala S., "Monumentet e Natyrës Shqiptare" ideart Tiranë, 2006

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mountains, forests, alpine meadows, nature monuments, attractive conditions for the exercise of the different types of sports (football, wrestling, ski slide , hunting fish, birds and wild animals, etc.). Rich material and spiritual heritage, its long isolation and ignorance make the area more appealing and attractive for vacationers, tourists avanturier etc. Below there are described the main forms of tourism and geotourism that can develop in this region.

1. Mountainous Tourism

1.1 Climbing and skiing

High mountain peaks Pashtrik, Koretnik, Gjallicë, Kolesianit, Kallabakut, Tërfojës, Koretnikut, harsh climate, rainfall snow provide appropriate conditions to develop climbing in ethno-gjeographic Has-Lumë-Gora. Beautiful plateau of Novoseja and Shishtavec, Has been very suitable for the winter ski sport development. Within this sport in 2000 was organized an international championship attended by skiers from Norway and Germany.

2. Summer tourism

2.1 Hipism

It is a sport dominated province's early in the Gora area[6]. Competiting horses in Novosoja, Shishtavec, Borja. Horses for hipism housing stored regime gives a special assessment feeding schedules. Hipism developed more cases weddings and traditional holidays. Efforts are underway to organize every year horse rises, that there is a very appropriate way for horse racing by village Novosoj towards Shishtavec.

2.2 Wrestling

It is the sport that attracts not only tourists but also locals of all ages. Their uniform was special called "kysmete" and wide belt decorated with stamps lights. Wrestlers before the match coat with oil body to prevent capture by the enemy, the game followed by toys (drums).

3. Landscape geotourism

It is the most important kind of tourism. In this municipality provided the third category of protected areas, there are some geosites and biosites such as: birch of Shishtavec, stone morning, red spring, and stone eagle, oak forest in Novosej, Pigeon cave, Yard cave, and cave in Mazrek Peak Campus. Near the Kruma town, there are located Kruma Mountains, Mountain Peak of Pashtrik, Koretnik, Gof Jallica, Kolesjani mountains. All above mentioned mountains, offer good opportunities to satisfy visitors and to nature lovers and material-spiritual values they hold.

4. Cultural Tourism

4.1 Archaeological tourism

The Luma-Gora-Hasi ethno province has been inhabited since centuries[7]. I A.D. According to the data observed there are proved these historical periods: Neolithic, Bronze Age, and period. Settlmenst of antiquity of above mentioned periods there are found. The most ancient settlements there are: Kolshi Swamp, Dajçi Cave and Illyrian tuma in Qinamak, Bardhoc, and Fajzat. Some other countries can be visited as archaeological sites such as: Villa Castle, Castle peces, Hisari Domajve, Hisar Castle, Castle of Alexander, Gradishta, Bardhoci, and Bushat Castle in Çinamak. It is interesting to explain the information about the name of two main cities. Has city name emerges in search of the origin of the family document, since the year 1570. Many chronicler at the beginning of XVII century in origin argument Kastriotis mention the name "Az" or "Ass" and people like Askol indeed from lack of use (h), (s) in Latin means naming Has . In the early years of the

[6] Bala Z., *Shishtaveci, Historia dheTradita*, Erik, Tiranë 2006

[7] Perzita L. "Kukësi, Vështrim Arkelologjik" Dita 2000, Tiranë 2004

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seventeenth century has also known named Shullaa that in Latin means "dry" due to its nature has also maintained nowadays being called "Dry Hasi".

4.2 Historical tourism.

This province along with archaeological values it has a precious historical value. Most prominent is the struggle of the people of Luma against Serbs held in Kolosiani Pass, and Museum in School of Kolesianit (11 October 1911), where the first Albanian school set up in the building of former Mejtepë. This building gets value for multifunctional character both in terms of education and patriotic.

4.3 Architectural Tourism

Architectural heritage occupies a special place once stretched us and the rich heritage of the district. Architectonic monuments can be classified into two main categories: buildings where important historical events took place and memorials that dedicated to the important historical figures.

- Home-style tower (Tower Shaqir Palushi in village Bushtrice, tower Ismail Aga Luma in Bicaj village were important flats for patriots during the Albanian League of Prizren).
- Resistance Tower located in the town of Kukes, which celebrated the warm hospitality of the Kosovo citizens by Albanian brothers.
- Kurpaleve tower symbol of Albanian resistance.

4.4 Ethnographic tourism

Hasi provinces-stream-Gore has the features of different populations of two different languages: Albanian and Goran (an offshoot of the Slavic), Gorani Lumjane and represent particular with the most diverse and figurante. Large number of clothing and musical instruments, dance, songs, stories about their origin, their customs and traditions, the way of cooking, all these push tourists to visit these areas and assess the impact on the tourist economy.

5. Rural tourism

This kind of tourism is likely to evolve thanks to the many natural and cultural assets that include rural areas, where they are stored and kept alive the traditions, customs, rituals etc.. Typical areas where tourism may be developed in rural zones there are: Shishtavec, Bicaj Fierza Lake, Mount Pashtrik, Koretnik, Gjallica, Kolesian, kallabak, Pashtrik, Kruma mountains etc...

6. Gastronomic tourism

This is the element that closely touches in which the area dominated by the region's traditional dishes: fish Lake Lucipern, house brandy produced from grapes or plums, boza popular. White cheese delevev (Çaja), yogurt famous Kroi i Kuq (Red Spring), chestnut honey, dried meat, roasted, sleep, corn noodles, pie etc.

7. Religious tourism

There is a great wealth of religious sites, which explain special interest for tourists. Their greatness, legends, stories for the salvation of the people and of the element's problem's solution, which attract visitors to the following places: Masjid (teqe) of Dervish Ishmael (Buzëmadhe) in the village of the same name, Masjid (tekke) of Kadrisë (Shtiqen). On the top of Pashtrikut is "better grave" Sarisalltik Baba, where, every year in August month there are organized different pilgrims.

Identification of natural and cultural values of the region is important because it serves as:

Scientific information source for science: geology, geography, geomorphology, hydrology and hydrogeology, biology, history etc.

Promoting the values of the region turned into a tourist quality offer.

- Impact that can have the institutions responsible for taking measures for their maintain and policy in support of tourism development and geoturism in ethno province of Has-Lumë-Gora.
- Increasing and improving institutional capacity for tourism development.

- Awareness of the population in these regions as a result of natural and cultural potential to develop tourism opportunities transformed it into a tradition for these cities.
- Creates a meaningful market-resort mitigates the crisis in agriculture through its reevaluation, increase revenue, streamline territory, and precious producing agricultural consumption.
- Tourism can mitigate the unemployment crisis, especially in peak periods of agricultural work activities, by which time workforce needs of exchanges of labor relations.
- Produces determine tourist destination, which will be more qualitative.
- Leads to increased demand for products pertaining to the tourist season, prompting the farmer to cover the cost of expenses.
- Will affect tourism and infrastructure development, hotel services, restaurants, education, and health of habitants.

Stimulating the production of a group of specialists and students and other professions tourism profile in its support.

To develop tourism and geoturism is important to know all problems associated with tourism in this province. Problems encountered in the marketing and promotion of the tourism and geotourism and infrastructure, affecting decreased the possibilities for tourism development and enjoy the beauty of nature, not the development of agricultural economy, reducing the desire of the population to be educated in tourism-profile branches, depopulation of the area etc. A developed road network is after that does not work the heart of an area or a region that is its economy.

If these natural and cultural assets will be maintained, protected, studied and valued, then they can become a source of no small financial income security. Tourists are interested to know the curiosity of nature, culture, and therefore visit them, paying and fee. Cultural and natural wealth it today is faced with numerous problems and worrying related to natural factors, but an important role is playing and the human factor: the recognition of the concept of protected areas and their values; short comings in the preparation of strategies and plans for the recognition, protection, management of protected areas; feel the promotion of natural and cultural assets of the area, the lack of knowledge of the population about the possibilities of tourism development etc.

CONCLUSIONS AND RECOMMENDATIONS

• The local population aware of the possibility of natural wealth splicing (geosites) and cultural heritage for the development of tourism in the province of Luma-Gora-Has and to see it as a priority of the economy.
• Not Natural Heritage elements missing (geosites) and cultural tourist guides.
• To improve the road infrastructure that tourists have the opportunity to look closely,
• Establish appropriate symbols and posters, objects of tourism to become bilingual explanation national / international
• If properly promoted and restored historical monuments can attract a significant number of visitors, mainly from Kosovo, Macedonia and Albania.

REFERENCES

Akademia e shkencave "*Gjeografia Fizike e Shqipërisë"* Vol. I. Tiranë, 1990
Akademia e shkencave *"Gjeografia Fizike e Shqipërisë"*, Vol. II. Tiranë, 1991
Avdia B., Serjani Afat. 2010. *Geomorphologic Landscape around Shkodra Lake and Their integration with Cultural Heritage*. Shkodër.
Avdia B., Hoxha R., *"Turizmit Malor is mundësi për zhvillim të qëndrueshem në Komunën Shishtavec"* Konferenca Shkencore Nderkombetare *"Kriza e zonave malore mundësitë për zhvillim të qëndrueshëm"* Tiranë, 18-19 nëntor 2011
Avdia B. *Gjeomonumentet dhe Trashëgima Kulturore si Mundësi për Zhvillimin e Gjeoturizmit në Rrethin E Kukësit*, Mitrovicë 2011
Bala Z., Shishtaveci, *Historia dheTradita*, Erik, Tiranë 2006

ISSN 2306-9600

Dragoti N., Dedej Z., Abeshi P., *Zonat e mbrojtura të Shqipërisë (Protected areas of Albania).* Tiranë 2007
Dollma M. *"Cultural and Natural Heritage, a book for Medium School"*, Gjeografi 3, Tirana, 2006.
Doka DH, Draçi B, *"Geografia e Turizmit"*, SHBLU, Tiranë 2002
Meçaj N, Dida. M , Qarku i Kukësit, Toena, Tiranë 2004
Nazari E, Sholla A., *"Prospects of the Tourism Development Industry in Albania-(Korca)"*, Shkodra, Albania 2010.
Nokaj A. *" Novosej, Vështrim Historik, Gjeografik, Etnokulturor"*, mediaprint, Tiranë 2007
Noka H *"Një Guidë për Kukësin"*, 2004.
Qiriazi P., Hoxha G., Kola B., *"Gjeografia 3, libër për shkollat e Mesme"* Tiranë, 2007
Qiriazi P, Sala S, *Monumentet e Natyrës*, Ideart, Tiranë 2006
Serjani A., Heba G. "Gjeotrashegimia ne Shqiperi, Studime gjeografike Nr.9. Tirane 1996
Serjani A., Neziraj A., W.A.P. Wimbledon, Onuzi K., Hallaçi H., Bushati S., 2003. *Gjeomonumentet dhe Gjeoturizmi në Shqipëri (Geological Heritage and Geotourism in Albania).* In both: Albanian and English versions. Tirana.
UNDP dhe Qarku i Kukësit, *Zhvillimi i turizmit dhe Mbrotje së Mjedisit*, Shkurt 2010.

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NATURE MONUMENTS OF THE MIRUSHA RIVER BASIN

Fadil BAJRAKTARI[1], Sami BEHRAMI[2], Merita DOLLMA[3], Elez KRASNIQI[4]

[1]Kosovo Institute for Nature Protection, Prishtinë, Kosovo, fadilbajraktari@yahoo.com
[2]Kosovo Institute for Nature Protection, Prishtinë, Kosovo
[3]Department of Geography, Faculty of History-Philology, University of Tirana, Albania
[4]University of Prishtina, FNSM-Department of Biology, Prishtinë, Kosovo

ABSTRACT

Mirusha River Basin it is located in the central Kosovo, on the east side of the Dukagjini Plain. It represents the left branch of the White Drini River with the area of 337 km^2 or 3.1 % of the Kosovo area. It includes the most part of Llapusha region and is largely hilly-mountainous region. This pond is qualified with rich biodiversity as a result of geographical position, climatic conditions, geology and pedology. This area is rich in plant species important to the flora and vegetation of Kosovo. On the basis of categorization of Protected Areas, according to the IUCN, in the territory of this basin there are some nature monuments, which represent the natural, scientific, educational and geo tourist values of Kosovo. In this case we refer to caves, water sources and to old trees from species of genders Quercus (Oak) and Fraxinus (Ash), recorded in the period 2000 -2011. Geological sites of this Basin there are as following: Cave in Panorc, Cave in Dush, Cave in Zatriq and the Canyon of Mirusha River. The Hydro monuments there are: Thermo mineral water springs in Banjë, water springs in Carravranë and Mirusha River Flow with its Lakes and Waterfalls. The evaluated bio monuments ther are: Pubescent Oak trees (Quercus pubeescens Willd.) in Llazicë, Turkey Oak tree (Quercues cerris L.) in Drenoc, Turkey Oak tree (Quercues cerris L.) in Bubël, Turkey Oak tree (Quercues cerris L.) in Carravranë, Narrow Leaved Ash tree (Fraxinus angustifolia Vahl.) in Javiq, Turkey Oak tree (Quercues cerris L.) in Lladrovc and Turkey Oak tree (Quercues cerris L.) in Bellanicë.

KEY WORDS:

Kosovo, Mirusha River Basin, IUCN, Nature Monuments

INTRODUCTION

Mirusha River Basin lies in central Kosovo, respectively on the east side of the Dukagjini Plain. It represents the left branch of the Drini i Bardhë River with the area of 337 km^2 (3.1 % of the area of Kosovo). Mirusha River Basin includes the most part of Llapusha region and is largely hilly-mountainous region. On east is surrounding by the Drenica Mountain (Berishë 1025 m.), on southeast Carralevas Mountains (Gradinë 1055 m.), on southwest Gajraku Mountain (774 m.) and (Gradishtë, 1038m.), on west Kozniku Mountains (Bajraku 1006 m.) and on northwest Gremniku Mountains (732 m.).
In Mirusha River Basin outcrop different geological formations and rocks such as: ultra basic rocks, volcano-sedimentary series, diabases of the Upper Jurassic and Lower and Upper Cretaceous carbonate formation. The bottom of the section of the Senon age, it is represented by flysch and carbonate formations. Quaternary deposits there are represented by alluvium, diluvium of the Pliocene.
Mirusha River Basin, in the hypsometric terms, extends on altitude from 329 m (in the western part of the estuary of the Mirusha River) up to 1055 m on the southeast of Caraleva Mountains. Greatest height of the basin is in the south eastern parts (Gradinë 1055 m) and southwest (Gradishtë 1038 m). Lower height of the basin is presented along Mirusha river flow on the north western part of the basin. Average height of the basin is of about 700 m. The Source of the Mirusha River located in western of Caralevas Mountains on altitude of 749 m. In the upper course to the Malisheva small town, known as Banja River and after payment of the stream Stapanicë, Mirusha it is named a river. The length of the Mirusha River is 37 km, while the overall catchments area of the Mirusha River is 337 km^2. Annual average flow of water's is 1.94 m^3/sec. The

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maximum monthly average flow is presented in February with 4.36 m^3/sec. In raising the water level affect rainfall and melting snow, while minimum flow is in September (0:34 m^3/sec).

MATERIAL AND METHODS

This research was based on contemporary methodology on space research with GIS. In this case, within the inventory of the nature heritage of Mirusha River Basin, there are explored Nature Monuments, taking into account its values aspect and modern methods of research with GIS (Bettinger & Wing 2004). For identification of these Nature Monuments we are based on literature from different authors (Ahmetaj, 1989, Bajraktari & al. 2009, 2010, 2011; Krasniqi, E. 2003; Krasniqi, E. & al. 2003, Paparisto & al. 1988, Qosja et al. 1996) and on the studies from archive of Kosovo Institute for Nature Protection.

RESULTS AND DISCUSSION

Geomonuments (Geological Sites) - Mirusha River basin represents a separate space in creating values of morphological and geological processes. Among the most important values of geological-morphological heritage in this basin there are: caves, Mirusha River Canyon, ponds, bauxite, etc. Geoheritage diverse and fertile of the Mirusha River basin represents an important scientific, educational and geotourist component.

Caves on the Mirusha River basin are widespread, but little studied and exploited. The most important caves there are: Cave in Dush, Cave in Panorci, Cave in Zatriq, Cave in Lladroviqi (Bardhi), Azem Galica Cave, Bozhuri Cave, Cave at the last lake of Mirusha River Canyon etc. The Morphology of caves treated on Mirusha River Basin shows that they are in different stages of evolution. Some caves are active, such as: Panorci Cave and Cave in Zatriq. Semi-active caves there are: Cave in Dush, and Cave Lladroviqi (Bardhi). Fossilized caves there are: Bozhuri Cave in Drenoc and Cave at the last lake of Mirusha river Canyon. Also on Mirusha River basin there are found a large number of openings (holes, cavities) that communicate with gaps and underground galleries. Caves there are found mainly in the Zatriqi and Kozniku Mountain massif, in Millanoviqi Mountain (Shkoza), Drenica Mountain, Gajraku Mountain and on the slopes of Mirusha River Canyon.

Cave in Dush - located in the northern part of Mirusha River Canyon. The cave entrance is located at the bottom of a stream (temporary streams) of Dushi village. The cave is located on altitude of 516 m (Photo 1 and 2). Entrance to the cave has southeast exposition and has the dimensions: width 8.40 m and height 12.60 m. The total length of channels in this cave is of about 500 m. Is formed in Cretaceous limestone, which there is widespread all over the Mirusha River Basin. In the shower area around the Cave, there are present all forms of karst landscape surface, such as: ponds, blind valleys, karst areas and various clefts. In the area around the cave lacks permanent leakage of surface water. In this cave live bats.



Photo 1 and 2. Cave in Dush

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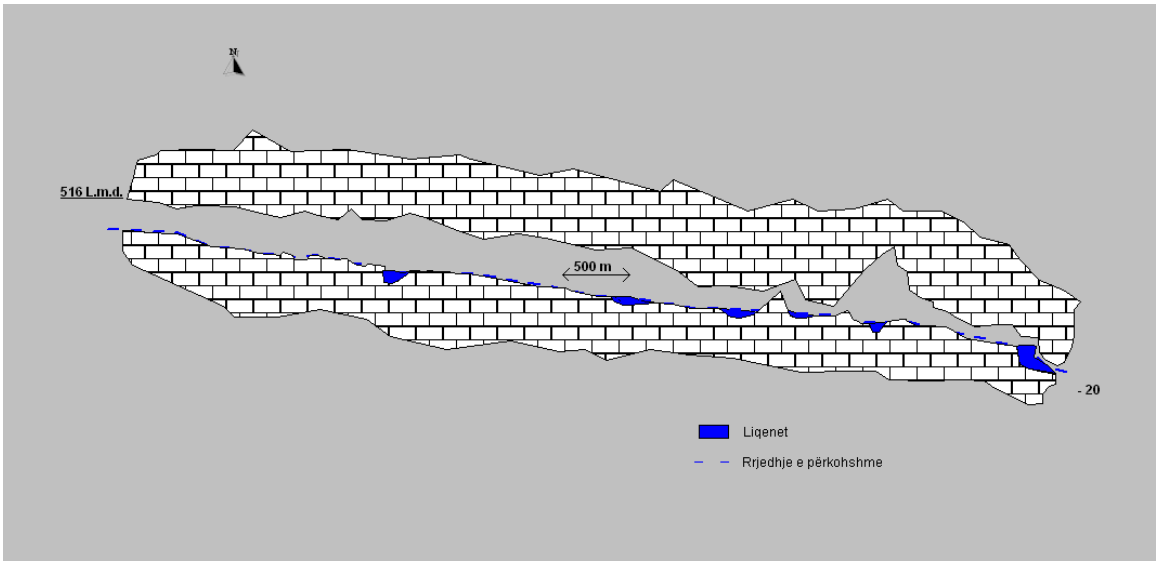


Figure 1. Dushi cave profile

Cave in Panorc – it is located about 3 km south of the Panorci village, on the northern slopes of Okovan Mountain (977 m), at the bottom of a ravine, near the valley of Panorc - Zatriq. Entrance to the cave is located in northern exposition on altitude 581 m (Photo 3 and 4). This cave has several names such as: "Shpella nën hije" ("Cave in Shadow"), "Shpella e flladit" ("Cave of refreshing,"), but the right name is "Cave in Panorci". The area around the cave is covered with oak vegetation *(Quercus sp)*. Near the entrance of the cave there are two water springs used for drinking and in all probability these springs there are related to flowing water hydrology of the cave. The cave is developed in Cretaceous limestone. Inside the cave there defined some litho logical and tectonically elements. This cave is the largest and the most interesting so far in the Mirusha Basin. Total length of passable channels, corridors and halls on the Panorci Cave it is of about 925 m. Entrance to the cave has small dimensions, with one of the transverse cut approximately 1 m width and 0.5 m. height.



Photo 3 and 4. Cave in Panorc

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Figure 2 Ponorc Cave profilet
***Source**: Bodenlos, Internationale Speläologische Arbeitsgruppe Alpiner Kars.*

Mirusha River Canyon – It is located in the lower flow of Mirusha River with a length of 2 km. The canyon starts from the Dushi village to penetrate between Grapi (546 m) and Llapqeva village. The canyon was formed in carbonate formations of the Upper Cretaceous and presents the most interesting and the most beautiful of all River flow Mirusha (Photo 5 and 6). Width of the canyon is the largest lake in the last, whereas most closely located on the fourth lake where the depth is also the biggest side slopes, which reach the height of about 200 m from the river bed. Canyon except morphological forms known with 16 lakes and 13 waterfalls of various shapes and heights, formed in the river bed, which represent the main tourist attraction. The lakes there are located along the canyon and circulation of water from one lake to another is realized through the waterfalls. Form and size of the lakes it is conditioned by the position of the canyon, and from the structure and litho logical composition of limestone rocks.

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Photo 5 and 6. Lakes and waterfalls of Mirusha River Canyon

Hydro monuments - Mirusha River Basin is characterized by a relatively poor hydro legacy. Amongst the most important values in hydro heritage of the Mirusha Basin can be noted: Thermo mineral spring in Banja village, and the water sources of Carravrana village etc.

Thermo mineral spring in Banjë - is found only a thermo mineral water source. This is located in the upper flow and is a leading supplier water of the Mirusha River. Source located on altitude at 550 m (Photo 7). The flow of water is 120 l/sec and with average temperature of 22 ^{o}C, which is constant throughout the year. Source located on the right side of the Mirusha River, 12 m near the river. Water comes from a broken dislocative fault, covered by alluvium of Mirusha River, which awaits deep under the Cretaceous limestone. Thermo mineral spring contains significant amounts of minerals and carbon and it is accumulated in the pool which serves for bathing and recreation.

Sources in Carravranë – it is found in the western part of the Carravrana village, respectively in the east of Gllavica Mountain (627 m). There are three karst springs, which are among the sources with the greatest flow of water in the Mirusha Basin. These sources are in the altitude of 452 m (Photo 8). The first source (Ahmetaj, 1989), has smaller flow of water (about 5 l/sec.), while about 15 m below, it is the secondary source, which is the most important source for the amount of water. This source has a variable flow of water depending on seasons but sometimes the exhaust for a short period especially in the period of July - August. The average water flow on secondary source is of about 9 l/sec., while in the winter and spring season water flow reaches 40 l/sec. Secondary water source comes from an underground channel length of 15 m and a width of 0.8 - 2 m. At the end of this corridor lies a lake, which is covered with water throughout the year where the water level does not change. About 10 m below the secondary source it is the third source, which right now is covered with silt, but this source has smaller flow of water than the first two sources. On the left side of these resources there are a significant number of wells that are used for drinking by the local community.

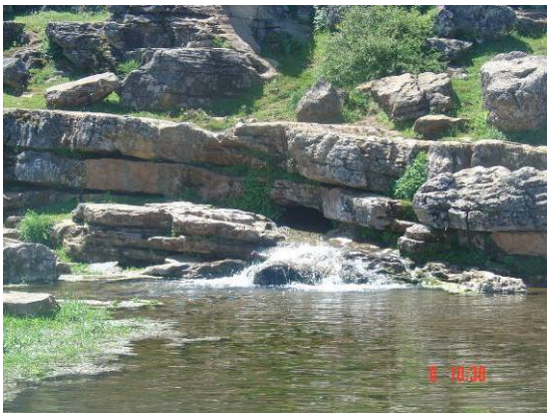



Photo 7. Thermo mineral source in the Banjë *Photo 8. Sources in Carravranë*

Bio monuments - In the territory of the Mirusha Basin there are found a significant number of older bio monuments, which represent, mainly the remaining vegetation in these areas at the past. The large number of old bio monuments represent unique natural, scientific, touristic and educational values. Overall natural status

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of the Bio monuments is good, but in some trees it is necessary phytosanitary intervention. The most important bio monuments of Mirusha Basin there are: *Pubescent Oak* trees (*Quercus pubeescens* Willd.) in Llazicë, *Turkey Oak* tree (*Quercues cerris* L.) in Drenoc, *Turkey Oak* tree (*Quercues cerris* L.) in Bubël, *Turkey Oak* tree (*Quercues cerris* L.) in Carravranë, *Narrow Leaved Ash* tree (*Fraxinus angustifolia* Vahl.) in Javiq, *Turkey Oak* tree (*Quercues cerris* L.) in Lladrovc and *Turkey Oak* tree (*Quercues cerris* L.) in Bellanicë. These bio monuments there are important due to their unique natural, aesthetic, scientific and educational values.

***Pubescent Oak* trees (*Quercus pubeescens* Willd.) in Llazicë –** there are located near the main road Pristinë - Peje (coordinates by GPS - X - 480291 and Y - 4712520), on altitude at 642 m, where the crowns of trees, very well seen from the road (Photo 9). Special feature is that both the natural trees (stalks) arise from the same root. General characteristics of *Pubescent Oak* trees are: stalk height of 20 m, trunk circumference of 3.2 m, crown diameter of 22 m and age of the tree about 200 years.



Photo 9. Pubescent Oak trees (Quercus pubeescens Willd.) in Llazicë

***Turkey Oak* tree (*Quercues cerris* L.) in Drenoc** –it is located in the neighborhood of Laci (coordinates by GPS - X - 477612 and Y - 4709214), on altitude at 650 m. General characteristics of *Turkey Oak* tree in Drenoc are: stalk height of 21 m, trunk circumference of 3.5 m, crown diameter of 27 m and age of the tree about 170 years.

***Turkey Oak* tree (*Quercues cerris* L.) in Bubël** – it is located in a place called "Shpati i Loges së Vaut" (coordinates by GPS- X - 471505 and Y - 4707361), on altitude at 643 m. General characteristics of *Turkey Oak* tree in Bubël are: stalk height of 20 m, trunk circumference of 3.5 m, crown diameter of 21 m and age of the tree about 150 years[6].

***Turkey Oak* tree (*Quercues cerris* L.) in Carravranë (Gurbardh)** - is located in a place called Kodra / Rrafshi (coordinates by GPS - X - 475038 and Y - 4703403), on altitude at 667 m. General characteristics of *Turkey Oak* tree in Carravranë (Gurbardh) are: stalk height of 25 m, trunk circumference of 3.7 m, crown diameter of 20 m and age of the tree about 220 years.

***Narrow Leaved Ash* tree (*Fraxinus angustifolia* Vahl.) in Javiq (Burim)** - is located in a place called "Zallina e Bunarit" (coordinates by GPS - X - 475384 and Y - 4702457), on altitude at 655 m. Trees located in the vicinity of a valley where there is permanent flow of water. According ecology, this type of tree found mainly along rivers and streams flow. General characteristics of *Narrow Leaved Ash* tree in Javiq (Burim) are: stalk height of 23 m, trunk circumference of 2.9 m, crown diameter of 20 m and age of the tree about 150 years.

***Turkey Oak* tree (*Quercues cerris* L.) in Lladrovc** - is located in a place called "Kodër" in the village cemetery (coordinates by GPS - X - 484108 and Y - 4706253), on altitude at 572 m, beside the road that leads to the village center. The tree has unique natural, scientific, touristic, landscape and educational values. General characteristics of *Turkey Oak* tree in Lladrovc are: stalk height of 26 m, trunk circumference of 4.3 m, crown diameter of 23 m and age of the tree about 270 years.

***Oak* tree (*Quercues cerris* L.) in Bellanicë** - is the center of the village, In the backyard of health (coordinates by GPS - X - 485215 and Y - 4700953), on altitude at 536 m. General characteristics of *Oak* tree in Bellanicë are: stalk height of 27 m, trunk circumference of 4 m, crown diameter of 20 m and age of the tree about 250 years.

CONCLUSION

Based on the research of the natural heritage values we could draw the conclusion that Mirusha River Basin is among a few river basins in Kosovo, which have geological, geomorphologic, hydrological and speleological values.

The main factors that influenced to the creation of Mirusha River Basin heritage values have been mainly physical and geographical features, geological and pedagogical diversity, climatic conditions, hydrological conditions, biological, etc.

Natural Monuments of the Mirusha River Basin have scientific, educational, tourist and geotourist values and as such they should be identified, protected and managed.

REFERENCES

Ahmetaj, I. (1989). *Ujërat termomineral në KSA të Kosovës*. Përparimi, Nr.1. Prishtinë.

Bajraktari, F., Behrami, S., Katallozi, F. (2010)**.** *Kosovo Caves*. Soros&Progeo Kosova, Prishtinë.

Bajraktari, F., Behrami, S., Zogaj, N. (2009). *Hydrological heritage of Mirusha River Basin*. UT. Faculty of History and Philology, Albanological Studies. IV Geography, 2009/4 year. XIV International Science Conference. November, Gjirokastër, 226-237.

Bajraktari, F., Behrami, S., Zogaj, N. (2011). *Geo-heritage and geo-turism of Mirusha River Minerals Resources and their perspective.* "GeoAlb 2011" (27-30 September), Mitrovicë. 416-419

Bajraktari, F., Pruthi, V., Abazi, Sh., Zogaj, N., Hajdari, R. (2010). *History of Conservation of geo-heritage in Kosovo.* 14 Internationale Jahrestagung der Fachsektion GeoTop in der DGG and 6th Internationale Symposium on Conservation of Geological Heritage, 29 May - 2 June, Hagen (Westf.).

Bettinger, P. & Michael G. Wing (2004). *Geographic Information Systems, Applications in Forestry and Natural Resources Management.* Mc Graw-Hill. New York.

Instituti i Kosovës për Mbrojtjen e Natyrës, (2005). *Studimi i arsyeshmërisë për shpalljen e e zonave të mbrojtura në territorin e Komunës së Malishevës*, MMPH-IKMN, Prishtinë.

Krasniqi.E.(2003). *Flora vaskulare e rajonit të Mirushës*, Punim i magjistraturës, Universiteti i Prishtinës, Prishtinë:4-7.

Krasniqi, F., Ruci, B., Vangjeli, J., Susuri, L., Pajazitaj, Q. (2003). *Fjalor i emrave të bimëve*, Akademia e Shkencave të Shqipërisë&Akademia e Shkencave dhe e Arteve të Kosovës, Tiranë-Prishtinë: 238-239.

Dollma M., (2011). *Natural resources use of Albania and their future problems*,"GeoAlb 2012" (27-30 September), Mitrovicë. 433-434

Dollma M., Hoxha R., (2011) *Gjeoinformacioni i shpellave të Shqipërisë,* "GeoAlb 2012" (27-30 September), Mitrovicë.

Qosja, Xh., Paparisto, K., Vangjeli, J., Ruci, B. (1996). *Flora e Shqipërisë 3.* ASHSH-Instituti i Kërkimeve Biologjike. Tiranë: 50-51.

Bodenlos, Kosovo, (2003) (Internationale Speläologische Arbeitsgruppe Alpiner Karst).

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THE NATIONAL INHERITANCE OF VLORA DISTRICT AND THE DEVELOPMENT OPPORTUNITIES OF GEOTURISM.

Fatlinda SHKURTI[1]

[1]*University "Ismail Qemali", Faculty of Human Science, Department of Education, Vlora, Albania.*
E-mail: fshkurti@yahoo.com

ABSTRACT

Vlora District, which is geographically positioned in the south west of Albania, covers a wide opening in the Adriatic and Ionian seas. This district has many naval and inland ways of traveling. It covers the area of about 2706 km^2. The land has different geological rocks, mainly carbonate of Mesozoic age, heterogeneous landscapes and colorful shapes. The climate is favorable for tourism activities during all year around. The land itself it is very rich and has plenty of water resources. This area is a mosaic of the ecologic contents and different bio geographical conditions. In this area there are formed a great number of Nature Monuments (geological sites) based on the IUCN (International Union of Nature Protection) classification, defined for the protected nature areas according to their classification.
All these nature indicators have potential values for the development of the tourist and geotourist economy, for different activities, for recreation and rest. There are also attractive important values found in this area, which can be exploited for the development of ecotourism and the incomes rise of the local economy.

KEY WORDS *Natural inheritance, nature monuments, classification, tourist economy, ecotourism.*

BACKGROUND

The tourism development in Vlora District is based on the potential tourism and geoecotourism values, which there are important in the development of the tourism offers. The natural inheritance and its use will have an impact on the economic development of the region. Vlora District has many potential tourism values oriented toward the development of geoecotourism. The rise of the investments should be, in general, in harmony with the economical development. The use of tourism potential, respectively the functionalism of the physical-geographical conditions, is the foundation of the development of tourism, and economic development. As a consequence the social productivity and the income of the population will increase not only in Vlora District, but further more. For that purpose it will be the need to put to work the tourism values of the district, thus this area will be oriented toward the function of the tourism development.
The aim of this paper it is to define the potential natural values for the development of the tourism activities, in order to classify this district among the regional areas, where the tourism development projects are conducted, and the functionalism of these natural values there are present in this geographical area.

The natural conditions as potential tourism values

Geographical position

Vlora District (including the cities of Vlora, Saranda and Delvina) is positioned in the south west of Albania, along with the Adriatic and Ionian seas. Vora City is the center of the District. It is an industrial, trade and education center and with many connections. Vlora is an ancient city and an important harbor for Albania. It holds the "Key" to the Otranto Channel (Krutaj. F, Gaçe. B, Abazi, A)
On November 28th, 1912 the well known diplomat Ismail Qemali together with the delegates from all parts of Albanian territories, proclaimed the independence of Albania and raised the Albanian flag in this city. That's why this date is a national holiday and Vlora became the first capital of independent country of Albania.

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The overall border line is around 297 km; 11 km of them are state border. Inside this border the area is about 2706 km² sorounded by land border of 129 km, river border 75 km, and sea border 144 km. The population is about 374.168 inhabitants.

Understanding the role of the geographical position goes hand by hand with the importance and the necessity of defining this role as a value in the funcion of what it offers to the population of this area. Its impact is felt in all the aspects of economic and social life of this area. This geographical position is very important in all aspects.

This position has a great impact on the main mediteranian characteristics of the geographical view of the district, expressed in the gathering of natural conditions, geological construction, landscape, climate, the defining ground caracteristics, flora and fauna.

The areas of geomorphology and its values

Vlora District, it is very valuable area regarding its geomorphological features. The landscapes with their atractive forms, present a geotourism potential which includes very special forms with special interest to be visited. The lanscape includes all forms starting from the high mountains as tourism motives, with its beautiful view and deep areas as those of Bogazi, Bistricë, Luneci and the highest mountainous areas as those of Llogara, Shëngjergji, Muzinë, Dushku, Shkallë, Drashovicë, Sevasteri, etc.

The steep slopes of the mountains and the flat and round hills as in Çika and Kurvelesh alpine areas there are the typically characteristics of the region. The carbonate mountains are almost bare, but covered by grassy pastures. This diversity of the landscape makes these areas more atractive to the visitors and it is also a great opportunity for the development of some kinds of tourism like the curative, and green tourism. In these areas there are also many geo monuments 9geological sites) with high geotourist values such as:

Sazani area. It is located in the west of the city. Sazani Island it is the only big island in our country, located in the entrance of Vlora Bay. In the west of this Island, there is the opening Xhenemi Bay. In the cliff side there are a lot of caves. The most known one is Xhehnem cave. In the east shore is located the bay of Shen Kolli, where is constructed the dock of the island and further south there is the bay of Japraku with the stony beach of Admirali.

Poria of Borsh. It is located close to the Borsh Village, within an area of 1400 m² (400 m × 350 m) and 100 m high. It has many geologic, geomorphologic, didactic and tourism values.

Saranda beach. These are located in the cost of Saranda toward the north of Cuka Channel. It is represented from a rocky seaside in the form of a very small steepy slope. These plaques are formed in those parts of the shore where the limestone falls toward the sea. In these conditions under the erosion of the waves, the shore is low, without any costal area modeled by carsticity and the erosion.

Konispoli cave. It is located near Konispoli town. It is a karst cave formed in the limestone rocks. There are some narrowing and widening with calcite microforms. It has separate areas and has to be explored. It can be visited by tourists.

The climate conditions:

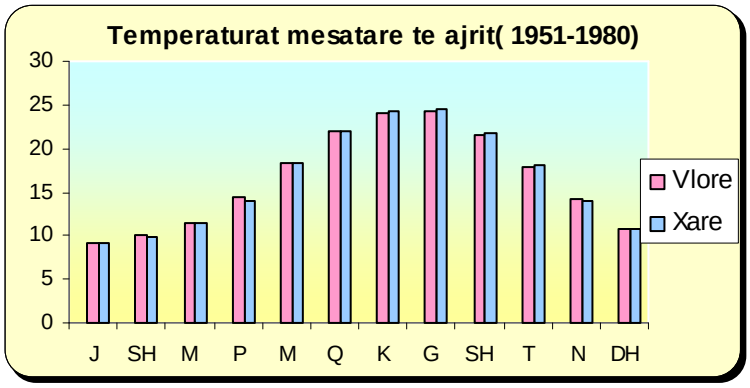
The climate conditions are the ones that represent very important factors for the development of the summer and winter tourism. Vlora District has a Mediterranean climate with a wet and mild winter and a dry summer, which stimulates the human activities in the same time as the physiologic functions. The Mediterranean climate with its appropriate temperatures and the opportunities to use the sun rays makes the study geographical area very easy to be used for tourism. According to the months of the year the daytime lasts from 115 hours in December to 340 hours in July and August. The sun time makes it possible to bathe and swim mainly on the beaches of Adriatic and Ionian seas.

To evaluate the temperature of the study area we have noticed the median yearly temperatures, the temperatures of the hotest and coldest months, and the maximal and minimal absolute temperatures taken for 29 years. The mean temperature for the total 29 years in the study area varies from 16.1ºC inVlorë to 17.6ºC in Sarandë.

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Table Nr.1 The mean temperatures for a long period of time (1951-1980)

Stations	MONTHS												Mes year	Amp Year
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
Vlorë	9.1	10.0	11.4	14.4	18.3	22.0	24.1	24.2	21.6	17.9	14.1	10.8	16.5	15
Xarrë	9.2	9.9	11.4	14.0	18.3	22.0	24.2	24.6.	21.8	18.0	14.0	10.8	16.5	15.5



Graphic Nr. 1

According to the seasons, in the winter the mean temperature has smaller values from 9.1ºC in Vlorë, to 9.2ºC in Xarrë. In the summer time the temperatures vary from 24.2ºC in Vlore to 24.6ºC in Xarrë. The hottest period of the year is the last ten days of July and the first ten days of August valuable for the tourism application in the cost and river sides.

The hydro values:

Vlora District it is characterized of a great number of hydro sources represented by various kinds of watery objects like runny surface rivers and creeks; underground water; lagoons, fountains, artificial objects, with different hydrologic, hydro chemical and thermal features. Evaluated in this aspect, the study area it is very rich in the hydro reserves.

The overall yearly mean amount for Vjosa River varies from 54.9 m³/s (Biovizhdë) to 150 m³/s (Dorëz) to 210 m³/s (in the Adriatic Sea), and for Shushica River (in Drashovicë) 23.1 m³/s. According to the size and the amount of water it carries Vjosa River it is the biggest river in South Albania. In the study area the flowing coeficient varies from 0.61 for Vjosa to 0.58 for Shushica, which means that 61 % and 58 % of all the water form the rain enters the river flow.

In Vlora District it is included one of the most important hydro geological monuments of our country: "The Blue Eye" (Syri i Kalter), categorized as a natural monument from the IUNC standarts. It has been introduced as a monument on 15.01.1996, with an area of 200 hectares, and belongs to the city of Delvina. Here, in the contact of evaporate rocks with Jurassic limestone rock there are formed a lot of karst springs. This is very nice, aesthetic tourist site.

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Amongst the hydrographic objects of high scientific, didactic and geotourist values, below we can mention the followings:

Gramata bay. This bay is called by locals the bay of Grama, and is located in the west part of Karaburun peninsula. It is not inhabited and there is a small natural beach of 50 m wide. Being the only bay in the straight rocky area, it has served as a protection area for the ships in bad weather. In the slopes of the mountain there are inscriptions chiseled by people since the third century B.C to the medieval times.

Ftelias Bay. It is a bay in the most southern Albanian cost, associated with national border of Albania and Greece. The bay enters the land by 1 km toward the north, 800 m to the east and 600 m to the south. The shores of the bay are rocky and protected from the wind.

Kakome bay. It is positioned in the Ionian Sea, west of Nivicë-Bubar Villagby tectonic processes and by krsti activity. The creek with the same name ends there. The south slope is covered by well preserved natural vegetation, while the North Slope is rocky, without trees, covered by hedges.

The Vivari Channel. It connects the Butrinti lagoon with Ionan Sea. The length of the channel is 2.5 km, the width up to 80 m and the depth 6-7 m. The flow of the water changes every 6 hours because of the tides.

The vegetation and the animals of this area

In Vlora District, there are forest complexes rich in vegetation and trees with an important role for the ecotourism. The Mediterranean vegetation is found along the rivers and lagoons and also in the slopes in the west and south west, along the sea shores. It is presented from the Mediterranean hedges of makia type and typical Mediterranean associations with early development in the spring. In this season these hedges have decorative and recreational values. The area of the study involves a rich and various ecologic gathering. The area of 1 km² is surrounded by flora and fauna which interact with the cultivated and spontaneous varieties, creating a rich variety of plants. So the vegetation is richer in variety than in quantity.

In order to preserve the plant and animal formations, IUCN has categorized special parts with the protected status of the National Park. Under this protection there are national parks of Llogara and Butrint.

Llogara National Park it is located 40 km in the southeast of Vlora City, in the space border of the Adriatic and Ion seas. The height of this park varies from 470 m up to 2018 m. This park has many beautiful areas and the fantastic zone of Vetetima Mountain with its steep slopes and a good part of Albanian Riviera. The park is well known for its wonderful climate and nice views.

KRRTRSH has approved a project for this area which is the master plan of development of Llogara–Gramë-Palasë that will develop the elite tourism with a bed capacity of 1000.

Butrinti National Park is almost 25 km in the south of Saranda City. It is a remaining from the typical Mediterranean forest; very expressed with oak trees. The maximal height of the trees is around 12 m, the diameter 80 cm and the oldest age 200 years. Inside the borders of the park there is the ancient Butrinti Archeological City, an UNESKO object. It has important national and international biodiversity.

The flag pine tree. It is located in Dukat (Orikum municipality), in the forest economy of the national park of Llogara, 900 m above the sea level. This tree has received this shape from the wind effect, taking an interesting and special shape. The height is 20 m, the diameter 0.75 m, aged 100 years old. This monument is in good condition at the present.

The animal world represents its special and attractive values. The ecologic environment full of animals is a very attractive area for the tourists. This value relates to the hunting development, the need for food but also is a real opportunity for the tourism development. It is well known that some species of the wild animals are an exclusive motive for the tourism development which is paid by high prices. The wild animals are wide spread like the wolf and the fox, (in Kuç, Kallarat, Mesaplik, and Vërmik). In the old forests of Muzinë, Kalasë, Pavllë there is the wild cat. A different kind of fox is found in the forests of Çipin, Smokthinë and Vërmik.

Some of the other animals like the rabbit are found in the lower areas, in forests and grassy areas. The wild pig lives in the oak areas, and in the corn fields of Karaburun. The deer, a very beautiful animal, is spread more in the non forest areas. In the high mountains pikes (alpine areas) lives the wild goat. There are also some other animals like the squirrels and pigs, which live in the area of Shushica, Kudhësi, Pavlla. The most spread birds are the wild pigeon, the eagle, owls, etc.

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The water fauna is very rich because the climate conditions in the ground and the water are apropriate. The long shore line makes it possible to use the space of the Adriatic and Ionian seas, and also the lagoon ecosystem of this area with 71 km² surface for fishing. The fish species are trout, gold fish, sardene, merluc, oisters etc. In this region the hunting and fishing is legal but not all the animals can be hunted, for this reason the fauna is categorized as:

1.The rare animals considered " nature jewels" of the region like the female deer is absolutely not allowed to be hunted,. Their function is only for knowledge reasons, watching, curiosity and for the pleasure of the tourists. Space viewing areas are needed to be built.

2.Dangerous species like the goat and wild pig, foxes, squirrels and pelicans should not be hunted for a certain period of time. Their zones are considered not to be hunted by law.

3.Animals that can be hunted like the rabbit, and other birds according to the hunting season and the reproductive zones.

CONCLUSIONS

- The tourism development and the use of tourism and geoecotourism potentials are of great importance.
- The potentials of tourism like the physical-geographical ones are concentrated all over the Vlora District.
- Each value has created base conditions which give to the Vlora District plenty of opportunities for the development of a lot of tourism forms like the summer one, the winter, tranzit, hunting, fishing etc.
- The natural conditions are an dominant element that gives importance to the development of the tourism activities. This way the Vlora District will be competing with other places of the region.



Photo.1 Gramë Bay



Photo.2 The cave of Haxhi Ali



Photo. 3 The flag pine tree



Photo. 4 Alpine village of Llogara

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Photo. 5 National park of Llogara



Photo. 6 Borsh coast



Photo. 7 Ksamili's islands



Photo. 8 Butrinti National Park

REFERENCES:

Abazi, H."*Të njohim vendlindjen*", SHBLSH, Tiranë, 1979
Akademia e Shkencave të RPSSH. *Gjeografia fizike e Shqipërisë*. Vëllimi I, Tiranë, 1990
Botim i Univeritetit të Vlorës: *Buletin Shkencor nr. 8,* Vlorë, 2006
Dollma. M: *Gjeografia*, Tiranë, 2006
Draçi B. *Potenciali turistik i rajonit Vjosë-Deti Jon* (Monografi). Tiranë, 1998
Fondi Shqiptar i Zvillimit; *Plani i Zhvillimit Lokal Bashkia Orikum*, Tiranë, 2009
Gjeografia fizike e Shqipërisë, Vëllimi 1. Tiranë, 1990
Krutaj. F, Gaçe. B, Abazi, A: *Vlora porti jugor i Adriatikut*,Tiranë, 2001
Meçaj N. Pellgu i Vjosës. *Pasuritë natyrore dhe veçoritë gjeomorfologjike*. Tiranë, 2004
Profili i Qarkut të Vlorës, Tiranë, 2003
Qiriazi P. *Gjeografia fizike e Shqipërisë*, Afërdita Tiranë, 2001
Saranda, *Çelësi turistik*, Tiranë, 2007

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SOME PROMINENT GEOLOGICAL SITES OF KORÇA REGION AS REAL OPPORTUNITIES FOR GEOTOURISM

Gjergji STOJA[1], Kozeta NASTO[2].

[1]*Albanian Geological Survey, Korça Geological Unit, Korça, Albania. gjergji_stoja@yahoo.com,*
[2]*Albanian Geological Survey, Korça Geological Unit, Korça, Albania. kozet.nasto@yaho.com*

ABSTRACT.

In the present paper there are described, shortly, the main geological sites in Korca district, focusing on some of them, which represent specific value for developing geotourism. The most important geoecosystem it is the transboundary Prespa Lakes. Important scientific, didactic and geotourist value represents Drenova molasses' stratigraphic section, which together with the old coal mine, "Guri i Capit" an erosion geosite, and Bozdoveci National Forest Park, constitute actually a great, important geopark. Morava molasses' section, as well as some specific geomonuments as possible, sparkling water source of Pulahës, Gjinomadhi package with macrofossils and angular discordance of Polena are described in details in this paper. We are of the opinion about large possibilities for organization and combination of the cultural tourism with geotourism in Korca Region, because there are many national cultural objects and the old historical centers.

KEY WORDS *Korça Region, geological sites, geoparks, geotourism*

INTRODUCTION

Korca district has a geological complex, with variety of rocky formations of different geological ages. Tectonic processes have been very active and powerful, by causing many of the tectonic fractures and divided this territory into multiple blocks. There are widespread molasse formations, along with lowland of Albano-Thesaliane long depression, in which some inner basins with molasse sediments were formed. Likewise Mirdita area ophiolite massifs have a considerably spreading. Triassic carbonate formations and Cretaceous, over ofiolite rocks, also have considerably spreading. In sedimentary formations there are formed classical sections, full of unique, which constitute the rare geological phenomena or geological sites.
As a result of glacial and karst-erosion processes, also numerous geo monuments were formed of the practical interest for geo tourism. An important place is occupied transboundary Prespa Park as well as the district forest parks.
This paper was devoted to some of the most important geological sites of Korca district as concrete potential for geo-tourism development, together with the usual tourism entertaining character. The city and district of Korca distinguished cultural heritage of the largest and most ancient. Evidence of this cultural and historical monuments in the city itself, but also the old centers as Sovjani, Maliqi, Voskopoja, Dardha, Vithkuqi, Kamenica, Prespa, etc., which have recently been turned into a tourist sites and pilgrimage. On the way to the city of Korca and above mentioned tourist centers, some interesting geological sites there are located. They can be visited, thus combining tourism of cultural heritage with geo-tourism. This paper was prepared to The Conference devoted to the anniversary of the Albanian Geological Service on the basis of studies and geological materials, and based on publications about Geological Heritage and geoparks in Albania.

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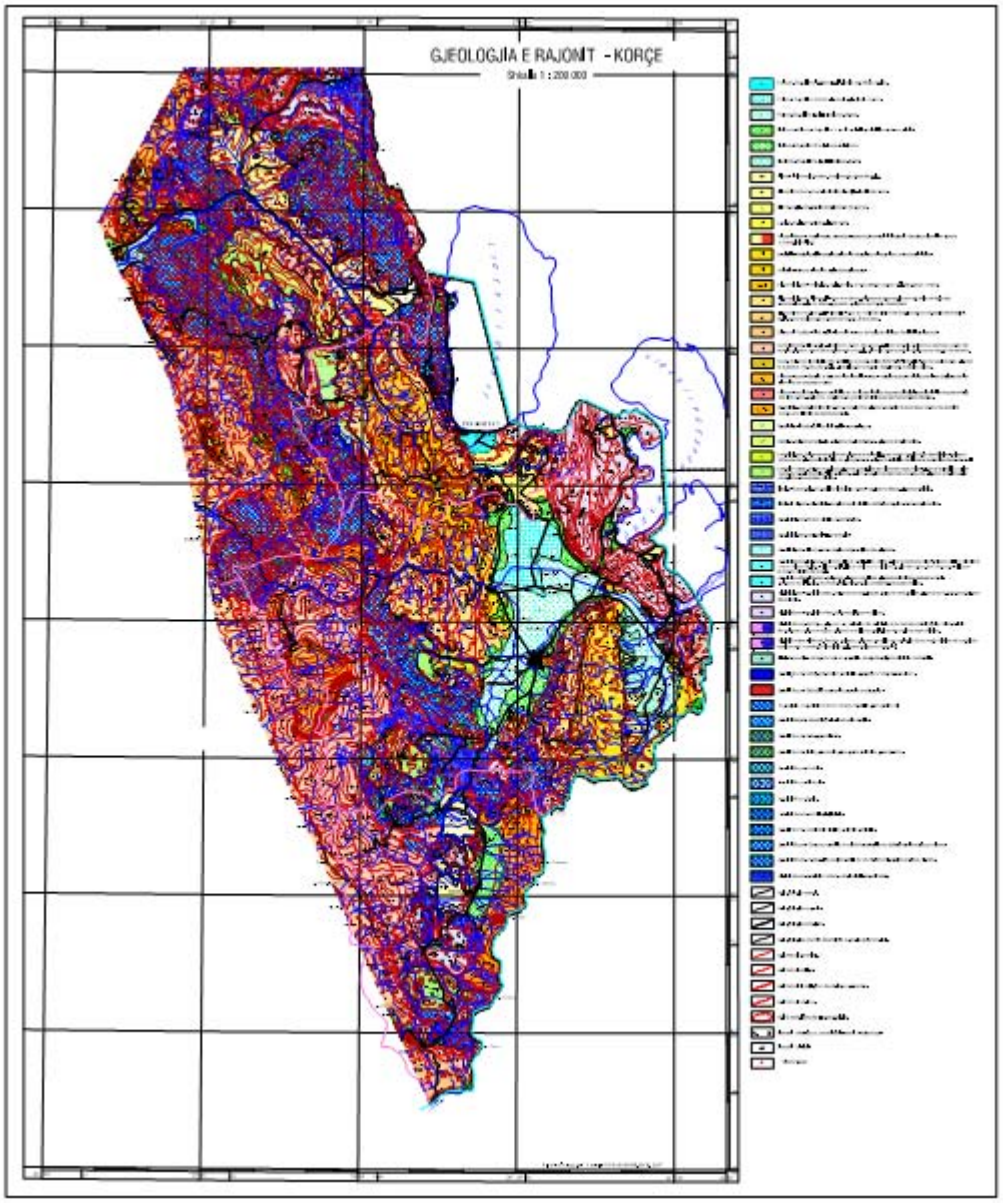


Fig. 1. Geological map of the Korca Region

SHORTLY ON THE GEO HERITAGE IN KORÇA DISTRICT

Based on the variety of geological formations and rocks which build territory of Korça Region, and on tectonic and neotektonic processes, there are formed many important geological sites of geo scientific, didactic and geotourist values.

Leading place in the list of natural heritage of the district have Big and Small Prespa Lakes of tectonical-karst origin of formation. They have been treated for a long time ago as ecosystem border between Albania, Macedonia and Greece. Korça Region it is part of Mirdita tectonic zone. Carbonate formation around the lakes have formed anticline and syncline structures. For access to great Prespa undergoing Zvezda Pass, a geo morphological erozional (Va-17) geosite. On the west side of the lakes there are formed three large areas of karst fields: karst field of Prespa (Vd-69), Mali i Thate (Vd-70), and that of Ivan Mountain. At South West of Small Prespa geoecosystem there is formed Treni Cave (Vd-20), which has been an ancient settlement. In this cave, there are leaving many hieroglyphs of ancient times. It is worth mentioning that around the lakes meet the karst multiple sources on the levels of 1400-1500m. Lake ecosystem stands for unique biodiversity, characteristic vegetation, birds, among which stands Pelican, fish etc..

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Prespa Lakes in itself constitute a large geological site and also around there are formed a series of geosites. That is why, we think that really Prespa lakes constitute a major geo park.
Among other geo-monuments of the district there are: Drenova complete molasse stratigraphic section, old coal mine Drenovë, erozionale forms as Guri i Capit, the Bozdovoci forest , angular discordance in Old Polena, earth pyramids of Zhombrit in Moglice, Guri i Kamies (Kamja Stone), Guri i Nices (Nice Stone), Guri i Prere (Cuted Stone), some erosion passes such as: Zvezda, Kazani, Qyteti, Kapshtica, Cangonji, canyons of Vithkuqi in Voskopoja, Llënga, St. Marena, Virka, Island of Maligradi, stratigraphical section of Gjinomadhi, Lenie lakes, rigid stack of Trebinje, cave St. Marene, Vromoneri thermal springs, hot baths of Postenani etc.

SOME OF THE MOST EVIDENT GEOLOGICAL SITES IN KORÇA REGION

1. Mborje Drenovë-Bozdovec geological site complex.

In the southeast of the City of Korca, on Morava Mountain slopes there are some geo monuments formed on the west flank of Devolli Syncline. Specifically here is full stratigraphical section of molasses in Morava, which has many layers of fosilifere packages, Mborje Drenovë mine, one of the oldest in our country, as well as "Guri i Capit" (Goat Stone), a residue erozionale with the shape of the head of goat. At the same time, here it is located Bozdoveci Forest, declared Forest National Park since 1966, by Decision Nr. 96. So geo monuments and bio monuments of this area altogether form a geopark of high geo eco tourist values.
Below we will describe the Morava molasses' stratigraphic section, which has an index I-13 in the first Inventory of Geological Sites of Albania (Serjani A., Neziraj A., Jozja N., 1998). In this molasse section, near there is opened coal mine of Drenova. Here, since the 1896, was found and it was defined for the first time, by Openheim species which took the denomination of the country: *Barbatica Albanica*. This is considered the first geological site in Albania. Below we are describing in details, this stratigraphical section of molasses, accompanied by a sketch.

Lower Ologocene, Lower Latorfian.

- Mborja conglomerate package

It outcrops on both sides of Mborja River, to the south of automobile road Boboshticë-Dardhe. Separate outcrops there are in the south, near Kamenica. It has a thickness of about 60m, in other sequence of Drenica 25m, sequence of Dardha 40-50m. It is represented by continental deposits, conglomerates-breccias, located transgresively on the surface of ultra basic, rinsed and meet usually surface in low relief, especially in section of Mborja the gully of the great Boboshtica and less in section of Drenica. Drillings made for prospecting of coal mining in this territory shows that they have great development eastward, under sea deposits of Oligocene.

These deposits consists of conglomerates of brecciate peridotite, irregular pieces of size from a few cm up to 10-15cm, rare to huge boulders with dimensions 50cm, while the 1cm pieces dominated by 5-6cm. Their couplings measures granule consists of peridotite.The conglomerates form lenses, often large and irregular mass located between the sandstone, but also there are met more or less regular layers of thickness 0.5-3.0 and more. There are met great granule sandstone lentiles who spend micro conglomerate.
In general, depositions of this suite have dark brown to red brown color, but in some places are made to coffee and green, especially cementing common mass. Mining region upper part of this suite, consists of a small grain of sand to the aleurolite gray-green that have separability or spherical sheathed surface sheet from a few mm to 1 cm. Often it takes the form of concretion in size from 10-15 cm up to 0.4-0.5 m. The study shows that the quartz microscope is aleurite tuffs. This rock is composed of volcanic material pieces 0.1-0.2 unit mm size represented by pieces fen crystal plagioclase, pyroxene and amphibole. The cement masse is chlorite and it is presented in aggregate form micro shavings that clearly show no traces of volcanic ash. Also there are met about 5-6% oolite (0.01-0.02mm), filled with carbonate.
At they have their typically development. There are outcropped two separated suites, which from the bottom to top have the following features: Carboniferous suite of Drenova and Suita Drenice. These two suites express the character of development of Oligocene Basin in this region, after passing through continental

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stage (coal suites holder Mborja and its analogues) were undergo to early in the lagoon conditions of coal formation and continues in typical shallow marine (Drenica suites)

- Carboniferous suite of Drenova

There is spread throughout the western slope from the Morava Stream, Mborja north to way Boboshticë-Pear, and continuing south. This suite outcrops near Kamenica, Nikolic, Red Mountain, where there are met a good enough coal layers. Section it is typically observed in the territory where the mine is described. Drenica sequence has a thickness of about 85 m.The main features of the Carboniferous suite of Drenova it is its composition litho logical dolomite with inter layers concretion, or special concretion of dolomite micro granule, and some coal layers or clay brunette coals, two of which are industrial beds, and there are subject of exploitation in mining Mborje-Drenova.
Coal clays that form thin layers are brown to black in color and with laminate fracture. Dolomite are fewer but constitute a distinguishing characteristic of this suite. They are of gray color, yellow surface and presented as a mass composition carbonate-dolomite with micro granule structure of uniformly mixed with a large amount of clay particles (2-3%), of fine clastic quartz, feldspar, mica, etc. Another feature of this suite is the presence of *mollusques fauna,* in very large amount of samples, which is placed in separate horizons (especially *Pir. plicata galeotti, Pot. Stampinoncis of T. margaritaceus*), attending layers usually coal or clay carboniferous or there are distributed throughout thickness of marl (especially *N.trassatinus, B.albanica* etc.).

-Drenica Suite

This suite includes typical marine deposits of Morava Oligocene, gradually placed on those of Carboniferous of Drenova suite and spread from Plasa north to Boboshtica-Dardha way in the south. Special outcrops there are in south to Llofka Mountaina. Typical section of this suite is described in the mining region in the Drenica stream. It is of about 190 m thick in the section with the same name.
Drenova suite depositions in this section consist mainly by massive gray sandstone or combination carbonate sandstone, and to fewer amounts from aleurolite carbonate gray clays. Conglomerates are few and there are met mainly at the bottom of the section. There are met also limestone layers crustaceans with up to 5 m thick filled by *colonial corals,* often large size and little *colony litotamniusesh.*
Conglomerates that form the entire package there are outcropped only in lower part, where the gravel is of small to medium gravel. Above there is micro conglomerate (two layers with thickness 0.5-1.3 m) and in the upper part, there is only some specific gravel or small lenses. Aleurolite outcrops at the top of the section. They have gray color, blue-gray surface, and are in very large grains. Clays form only a packet in the upper part of the section and there is gray, blue surface, overly carbonate aleourite.
As regards micro fauna in the Drenica suite depositions is found to very poor horizons, consisting only in forms of *bentonite* (those missing *plaktonite*) with bad storage, small to medium size of the mineralization. There are found very rich horizons of numulites preserved very well and defined as *numulites fichateli garencianus Joly ETLNYBIE, forms A* and **B**, with stratigraphical spreading during Middle and Upper Oligocene.

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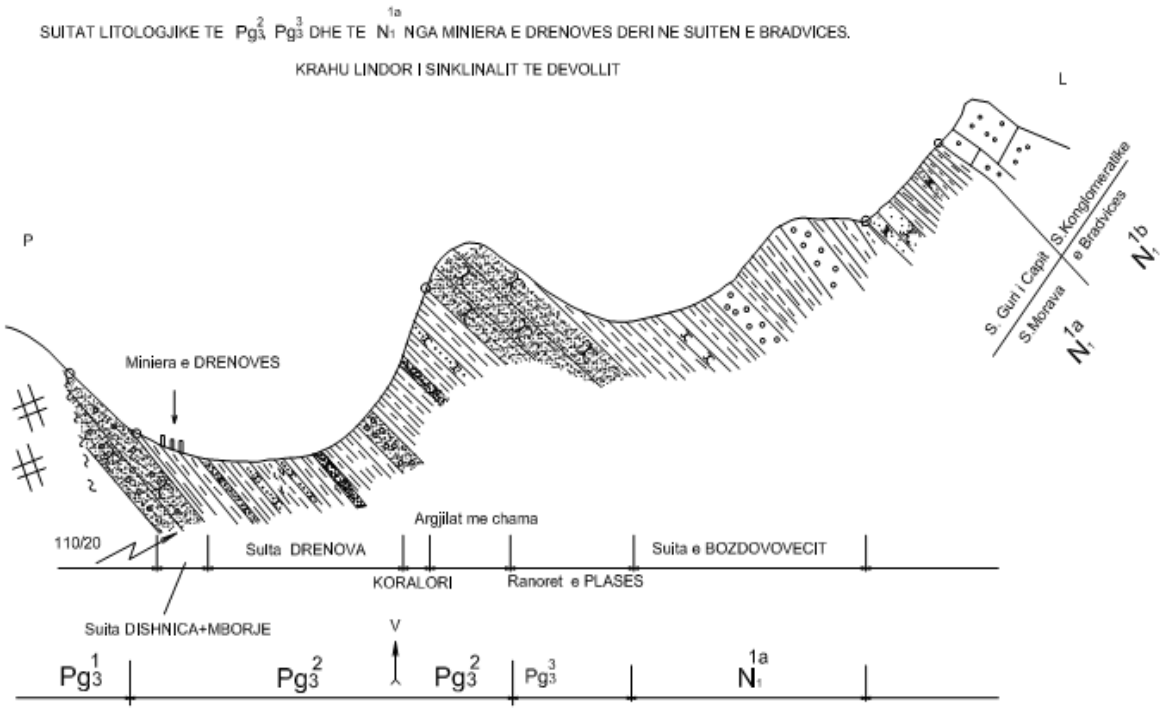


Fig. 2. Paleogene and Neogene suites from Drenova coal mine to Bradovica Suite. (Eastern Flank of Devolli Syncline)

Miocene section N_1, Lower Akuitanian N_{1a}

-Bozdoveci Suite

Denotes the beginning of the Akuitanian described section during the western slope of the Morava (Plasa, Mborje, Drenovë), where is located the Bozdoveci tourist center.
In the following **Drenica section** gradually passes to the deposits included in the Exploder suite. Suite Bozdoveci it is represented by a serie of 270m thick, which consists of sandy-clay intercalations.
The bottom part (125m thick) is represented by gray clays to blue more aleurolite, which are intercalated with rare sandstone layers of thickness (0.2-0.5 up to 1m), granule medium gray with places iron concretions. In the bottom part of the sandstone interval contains numerous *shells lepydociklina*, large plankton, especially *spondilusesh.*
Middle part of Bozdoveci section suite, it is represented by combination of high marl clay flishoide. Appear in the among-layer clays 3-5 to 10-15cm are carbonate aleurolite and spend in aleuriolite, gray with blue tinge to the surface. Sandstones there are represented by among thin layer up to 5-7cm, in small grains, poly minerals, mainly quartz, feldspate, mica, limestone. Cement is filling pores and basalt type, with rare foraminifers. Sometimes sandstone there is too much carbonate to spend on sandy limestone.
Upper part of the suite of Bozdoveci section (78m thick) is represented by clay aleurolitike passing to aleurolite of small grains with cement of clay-limestone, with rare *globigerina* that intersect among very few layers and very thin sand.
There are met foraminifers having both the number of species and individuals that represent these species. Foraminifers have sizes from small to medium, mineralized bad storage. Typical suite Bozdoveci is the presence of sandstone stoma passing in organic limestone pieces with multiple *shells lepidocyklina dephautima.*
This suite constitutes one of the most distinguishing features of the section of Miocene in Morava Mountain. In this section, it is formed erosion remains of Goat Stone, clearly distinguished in Morava highland.
This Suite is met during the western slope near the ridge of the Morava. In Drenica section, near its tip sequence suite conglomeratic Capit Stone is followed by a gradual over of Bozdoveci suite. It is represented from a conglomerate series intercalated with aleurite sandstones.

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2. Pulahe spring of combustible gas water

Is a unique and interesting geological site. It is included in the list of natural monuments of Albania, in Korca district, under state protection, according to Decision NO. 676, DT.20.12.2002. It is locates in Polena tectonic fault, in contact of ultra basic rocks, to the extreme massif's southernmost Voskopoja. On the west side, there are flysch rocks of Paleogene and molasses. To the east side it is located Korca pit field. In this tectonic fault, there is met magnesite mineralization of thickness 30-50cm. On both sides of mineralization there are getting out water springs. In the northern of magnesite mineralization get up the small artesian spring containing gas, which takes flame just putting the lighter, near the gas spring. Near there are some normal springs.



Fig.2. Pulahe spring of combustible gas into the water

3. Gjinomadhi macrofossil section

It is located in Gjonomadh Village, north of the way from Korca to Voskopoja. Is a geosite of paleo-environmental group, included in the first inventory of the geological sites of Albania (VIII-16).
A package of terrigenous-conglomerate 20-30m thick stands there far down village of Gjinomadhi. This package consists entirely of macrofossils of *gastropods* and *corals.* This Horizon consists almost fully of *Orbitolin; Orbitolina Conoidea, Orbitolina Discoidea types.* The age of this horizon it is determined in Cenomanian.

- Suite Gjonomadhit

Deposits of this suite are easily distinguished in the field by the red-brown color. They relate to a gradual way with depositions of Voskopoja suite. Gjonomadhi Suite, litologicaly consists of limestone conglomerates brecciated, *olistrostroms* and *olistolits*, and by Cretaceous limestone closed in terrigenous deposits of Oligocene. Conglomerate layers of brecciate calcareous have a thickness of about 3-6m, and a length of several hundred meters. Among them there are placed sandstone and conglomerate layers with thickness of 10-12m and numerous of Cretaceous fauna, as new depositions. At the base of the this suite to Voskopit bridge and a little above, on the left side of the river with the same name, which comes down from Gjonomadhi, there are met Gjinomadhi depositions of Oligocene and Voskop, as they belong to Carboniferous suite: *Drenova N. crassatinus, T. margaritaceus* etc.. Above this river, under Gjonomadh, on the surface are gray clays very similar to clay with *Cham granulose,* which settle down olistolite large limestone. In upper part, Gjonomadhi suite it is transgresively covered by clayey-sandy deposits of Akuitaniane, containing *Lepidocyclina* and large sea *hedgehog (Clypeaster Scutella* etc.). For this reason, its age was dated as Upper-Middle Oligocene. Gjonomadhi suite has an average thickness of about 800-1000m.

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4. The Old Polena angular discontinuity

It is a geosite of tectonically-structural group. As a monument of Albanian nature protection is included in Korca district list, attached DCM. 676, no. 20.12.2002.
In Polena region, at lower levels of flyschiode formation of Titonian Upper-Valanzhinian outcrop nodal red limestone blocks with *Ammonites, apticuse,* etc., aged to Kimeridgian. It can be assumed that they represent initially limited sectors "Sea Mount", siliceous radiolarite cover of middle and upper Jurassic age and are deposited in the new flyschoide formations of Titonian Upper-Valanzhinian, after the last tektogenese of late Jurassic.
It is represented by an alternation of limestones marl radiolarite from medium layerS to thin layerS, rarely with any layer limestone turbididite. The rocks above contain ophiolitic grains. The current position of these depositions is as that of clay package with the piece, or conglomérate-brekcciated. Ophiolite related to sedimentation processes and in sinsedimentary tectonic blocks. These deposits placed on conglomérate-brekcciae ophiolite rocks.

Lower Cretaceous deposits

These deposits are represented by terrigenous suites and by carbonates.

- Terrigenous Suite.

In all of the spreading area these deposits have special features in diverse sectors, ranging and finishing in different parts of the section. It is placed transgresivisht on different types of rock: on the ultra basic rocks in the Mali Lioves-Voskopoje-Shipckë, on basaltic rocks in Lavdar-Rock Mustafallarit, Shipckë, and on flysch Jurassic-Cretaceous in the Polen of Old-Lavdar sector Shipckë. On these deposits there is transgresive placement of Eocene and Oligocene (Shipckë region Damjanec-Polene, and Maja Rungajës).
The section begins with conglomerates basalt gray to red brown, where pieces material is represented mainly by ophiolitic material, limestone, siliceous sorting badly, of sizes from a few cm to 50cm, and rare few meters mainly of Triassic limestone. Cement is weak clay-sand composition mainly ophiolitic. The thickness of this suite oscillates from 600-800m

- Carbonate Suite

In compliance with terrigenous suite described above starts section of carbonate rock, which is represented by among knitting of various conglomeratic limestone, limestone-rich pieces of ophiolitic material, marl limestone with cement carbonate-red brown clay, which is argued as Baremian-Aptianit, based on fauna, *Nerinea Galata Radialites radrosus* etc.

SOME CONCLUSIONS AND RECOMMENDATIONS

In Korca district as a result of complex geological composition and diversity of rocks there are formed a lot of important geological sites, which constitute valuable features for scientific, didactic and geo tourism development.
Also, as a result of glacial, karst and erosion processes there are formed many geological sites of geo-morphological character.
Amongst the most important interborder geoparks, we can mention transboundary Prespa Lakes Park, karst and erosion phenomena, and karst resources with special bio diversity, as well as geo monumental complex of molasses section, and conifer forest of Morava-Bozdoveci.
Very interesting, of concrete geo tourist values there are some separated geosites such as: Pulahe Water Spring of combustible gas, breaking Polena and fossil macro packages of Gjonomadhi.
In all cases, geo tours must be integrated with visits to cultural and historical monuments as well as to traditional tourist places such as: Voskopoja, Pears, Vithkuqi, and Kamenica.
Geo tours with pupils and students or other visitors from Korca, can be organized within a day, while from other cities and regions of the country should be combined with accommodation in the ancient villages, or in Korca.

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REFERENCES

Kodra A., Xhomo A., Shallo M., Xhafa Z., (2004) - *Geological Map of Albania 1:200 000. (*SHGJSH)Tirana.
Gjeografia Fizikë e Shqipërisë *(Physical Geography of Albania),* 1990, Vol. I. Tiranë
Gjeografia Fizikë e Shqipërisë *(Physical Geography of Albania),* 1991, Vol. II. Tiranë
"Ten years geological heritage in SE Europe". 2005. ProGEO WG-1 sub regional Meeting and field trip. Proceedings. Tirana,
Dragoti N., Dedej Z., Abeshi P., 2007. *Zonat e mbrojtura të Shqipërisë (Protected areas of Albania).* Tirane.
Dollma M. 2006. Geography 3. *Cultural and Natural Heritage, a book for Medium School*. Tirana.
Pashko P. 1977. *Biometrics study of Barbatica Albanica OPPENHEIM*-1984 Bul. Shk. Gjeol. 1.
Qiriazi P., Bego F., 1999. *Monumentet e Natyrës të Shqipërisë*. Tiranë.
Qiriazi P., 2004. *Monumentet e Natyrës të rajonit të Pogradecit dhe të Prespës*. Tiranë.
Serjani A., Heba G. 1996. *Gjeotrashëgimia në Shqipëri*, Stud. gjeografike Nr.9. Tirana
Serjani A., Neziraj A., Jozja N.1998. *Preliminarily classification of the geological sites of Albania*. 8 Intern. Congress of the Geological Society of Greece. Patra.
Serjani A., Neziraj A., Jozja N. 1998. *Geomorphologic sites of Albania*. ProGEO'1998 International Meeting, Belogradchik, Bulgaria. Geologica Balcanica, pp. 129-136
Serjani A., Neziraj A., W. A. P. Wimbledon, Onuzi K., Hallaçi H., Bushati S., 2003. *Gjeomonumentet dhe Gjeoturizmi në Shqipëri (Geological Heritage and Geotourism in Albania).* In both: Albanian and English versions. Tirana.
Onuzi K, Koller F., Höck V., Stoja Gj. Kosho P., Ormeni R...-(2011)*Harta Gjeologjike 1:50 000 dhe teksti spjegues i Planshetit* 43 Korça (UTM,IGJEUM)
Onuzi K,Koller F., Höck V.,Palko A.,Kosho P.,Ormeni R..- (2010) *Harta Gjeologjike 1:50 000 dhe teksti spjegues i Planshetit* 42 Maliq (UTM, IGJEUM)

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GEOMONUMENTS IN PERMETI DISTRIC, PROPOSAL FOR NEW GEOMONUMENTS AND SUGGESTIONS FOR THEIR USE IN FUNCTION OF TOURISTIC DEVELOPMENT

Matilda DELILAJ
University of Tirana, Geography Department, e-mail: matildamati49@yahoo.com

ABSTRACT

Nowdays tourism has turned into one of the main engine for development of different countries and region in the world. Development of society as o whole has given a broader dimension to this service. In the modern world, people are eager to visit and explore new special places. Everyday more and more people want to leave urban life aiming to get closer to nature, and to the exquisite landscapes it provides. In this context, a tremendous potential in the development of tourism is offered by the specific forms of relief, scientific and aesthetic values of which they present was given the status of geo-monuments as a Natural Heritage and are protected by the law. This Heritage represents one of the most prominent values, which make many countries proud of and support the development of their tourism. On the other hand this Heritage represents a very good opportunity for scientific studies, and in the same time for recognizing and saving of the values for touristic exploitation also for a stable development. This work of mine is to support further the acknowledgement and the values of Permeti District by identifying and analyzing its geo-monuments. I've based my paper on the theoretical literature about this region and on conversations and consultations with specialists in the area. Another valuable thing that has helped me a lot about geoinheritance has been the expeditions on the ground.
Another potent tool which helped me on geo-heritage valuation was my frequent field trips in this area. In this paper are treated the geographical location and natural conditions, their role in geomonuments creation, some of the geomonuments of the district, the potential they offers in the development of geotourism, proposals for new geomonuments and the opportunities for efficient geomonuments management, especially caverns and their involvement in tourist itineraries.

KEY WORDS: *Geo-monuments, Permeti District, geotourism, cave management, all year round tourism.*

1.Geographical position estimation and its role in the development of geoturism.

Permeti District lies south-east of Albania in both sides of the middle flow of Vjosa Valley. The region is part of Outside Albanides on the Ionian Tectonic zone and partly Kruja. It is constructed from different geological formations. It is mostly hilly-mountainous relief. The region is part of Vjosa watershed and partly of that of Osumi river and it is characterized by a large hydrographic wealth.Within these borders there is an area of 929 km^2 and a population of about 20.000 inhabitants. The level of the tourism development even though it offers great potentials,it is still at an early stage.

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2.Natural conditions and their role in creation of Geomonuments.

The diverse geological composition which is widespread on the terrigenous rocks and those of limestone has characterized the special features of the relief. The composition of Trebeshin-Dhembel-Nemerck-ridge of limestone has conditioned the karstic process which together with ice activity has given relief alpine features on the Peak of Light (Maja e Drites).

The geologic construction has made possible the presence of karstic resources which give the landscape high decorative and aesthetic value. The presence of limestone has conditioned the creation of canyons such as Kamencka canyon, Langarica canyon, Bee Stone (Guri i Bletes) canyon and Zerenec canyon, which disrupt carbonate Structures creating a picturesque landscape of a great landscape value which are one of the biggest attraction of the area. Flysch materials have greatly intensified the erosion process by creating a bare relief and transforming in this way degraded landscaper some of this eroded areas such as canyon, due to their landscape features they have gain the nature geomonument status.

The geological construction has conditioned the variety of scenic landscaper, the diversity of relief forms by giving it specific combining forms such as, valley relief, hilly and mountainous relief, with distinguishing forms such as; canyons, gorges, caves, peaks which are related to the presence of limestone. The diversity of forms of relief, of those of geological formations and the climate conditions have enabled the creation of variety of natural objects with specific values, which today are described as Natural Heritage including the geomonuments too. The studies that has been done so far in the Permet District have identified 13 geomonuments. Great number of them and the values they represent are positive factors in the development of tourism in this region.

3. Some of the geomonuments in Permet region and their features.

Among the most special district geomonuments I will emphasize:

Pigeon Cave (Shpella e Pellumbave) which can be found in Langarica canyon near the village of Petran. This represents a natural karstic museum with special forms and in the same time historical museum. It has been found traces of human Neolithic period. This cave is located very close to the thermal baths and it represents one of the main objects which tourists would like to visit.

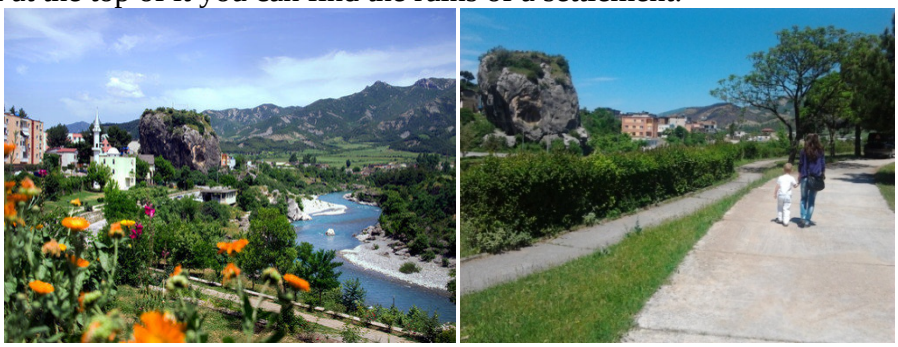
Nemercka Circus is situated between the villages of Stermbec and Dracove, 800 m above sea level. It consist of a great glacial circus created by the limestone of upper Crete. It reaches 200 m in its length and 600 m on its width.It has the shape of a giant armchair with some smaller karstic forms. This geo-monument can be easily seen along Permet –Corcove national road on the left of Vjosa flow providing a picturesque alpine landscape.



Nemercka Circus

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The City Stone is situated almost near Permeti city-center, at the banks of Vjosa River on the right of its flow. Perben nje bllok olistoliti prej gelqerori ne masen e flishit Oligocenit.It has a particular shape which rises up in a shape of a 6-story building. This stone has become a symbol of Permet and at the top of it you can find the ruins of a settlement.



City Stone

Langarice Canyon an exquisite landscape sculptured by nature. Itself represents a canyon formed by erosion of karstic activity of Langarica River. It is about 3-4 km long, 100 m deep and up to 20-30 m wide. There are steep slopes. The canyon is an interesting karst geoecosystem which it represents scientific and tourist values and it is one of a main highlights of tourism in the region. It has become one of the most visited places by foreign tourists, who prefer to walk through the canyon reaching Dashi Bridge Canyon. It is possible going sightseeing mainly in summer, when the water level falls so the canyon can be easily crossed.



Langarice Canyon

Kamencka Rock. This geomonument can be found along the national Road Permet-Hotove near the National Fir Park of Hotova (Parku Kombetar i Bredhit te Hotoves). It represents a canyon formed from limestone which are formed by the karst and erosion activity Homonim stream (Perroi Homonim). The canyon is about 600 m long, 10 m wide and 80 m deep. In the center of this geomonument, the rocks form a natural castle.

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Kamencka Rock

In Permeti region it can also be found the following geomonuments: Petrani Stone (Guri i Petranit), Atos Stone (Guri i Atosit), (Horizonte **Vidhisese),** Corcova **Olistolis** (Olistolitet e Corcoves),(**Bokerrimat** e Dangellise),God of Borocka (Perendi e Borockes),Well of Cicikojkave (Pusi i Cicikojkave) and Well of Nemercka (Pusi i Nemerckes). I can not leave without mentioning erosion-river gorge of Kelcyra, along with its cold water sources the terraces of Vjosa River, the Black Eye source and the nearby cavern.

4. Proposals for Geomonuments

Based on the studies on the ground during the study expeditions and on the basic of the existing legislation, I suggest to become known some other new geomonuments, several of which I am ranking below:

Limari Stone (Guri i Limarit). It can be found in the province of Maleshova near Limar village. It is about 12 m height. It is build of cemented conglomerates with a haystack form. The residents of the area describe it as a holy place. According to the inhabitants, this stone was carved by Illyrians as a cult dedicated to the God of Sun. Based on personal observation, this object has a unique, natural, cultural and aesthetic values. It is a creation of nature and not spoiled yet.



Limari Stone

Mertinji Plank (Derrasa e Mertinjit). It is situated in the village bearing the same name. 600 m above the sea level with an area of about 1 ha. You can notice particular stone shapes that have came up to the surface in the form of tiles as someone has laid them creating the impression of a

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mosaic. The shape and the size of the tiles are of a different format but they are located symmetrically with each other creating a very attractive and unique landscape which has grasped the passers-by attention and those who have heard of it have become more and more curious to see these particular stone. This mosaic with a carpet look like in the Orrishta Mountain, is a magnificent act of nature which has unique, scientific and aesthetic value.



Mertinji Plank

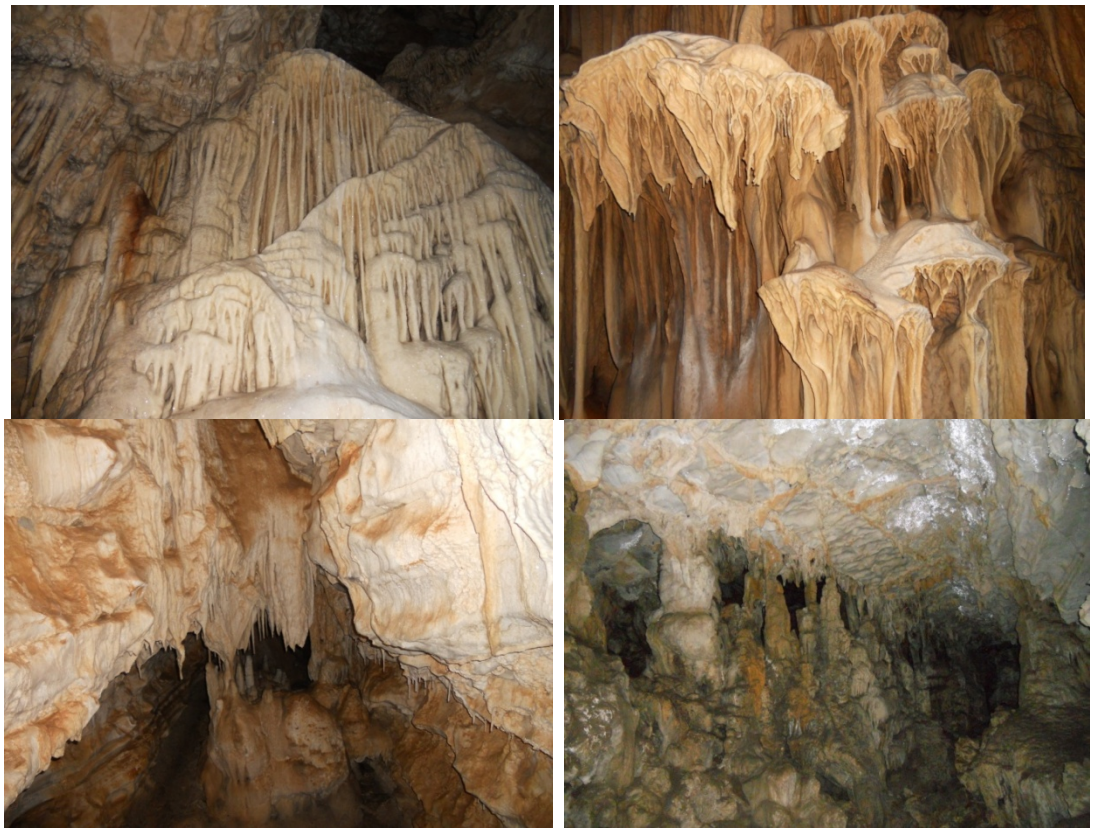
Zerenci Canyon (Kanioni i Zerencit). It is situated near the village of Benj Shqerri. It is formed as a result of the corrosive activity of Zereci stream. It has a length of 500 m, 25 m of height. Its width is relatively small. At the bottom of the canyon there are sectors close to 2 m. You can see waterfalls with a height of 5-6 m. There are also some karst caves with different shapes and sizes and a variety of specific forms engraved on both of its sides.



Zerenci Canyon

Caves of Langarica canyon (Shpellat ne kanionin e Langarices). The karst erosion activity along Langarica River has made possible the coming into existence of several karst caves in this canyon on both sides and almost in whole its length. They also can be found in different levels of its length from the bed of the river. There are over 15 caves with particular and different sizes and shapes. In each of them there are special forms of stalactites and stalacmite which somewhere come together to form columns. Beside the natural values some of this caves bear historical and cultural value because there have been found human traces. The ceramics found in 4 of this caves proves this fact. Each cave has its own features and represents a natural museum on its own.

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Caves in Langarica canyon

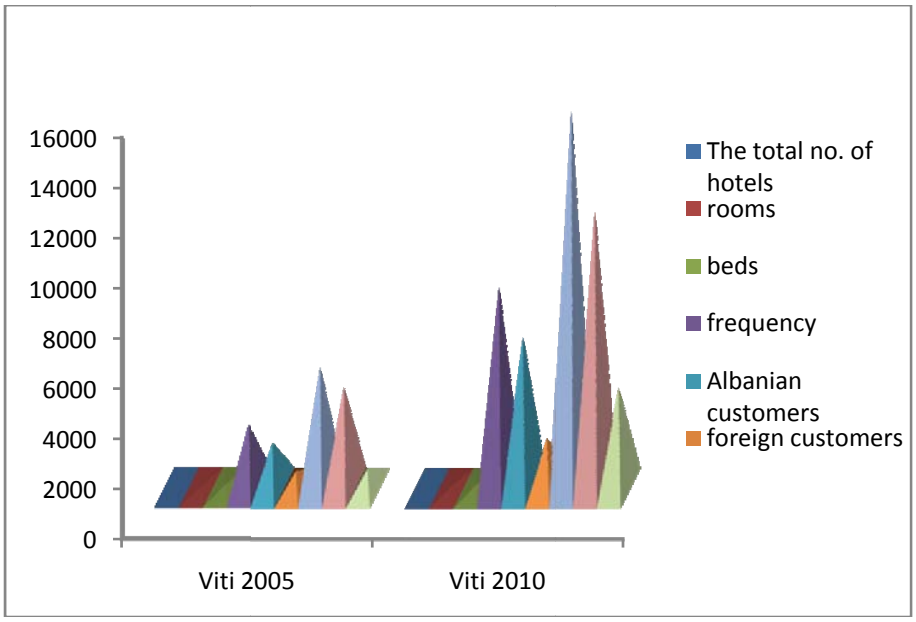
5. Current development of geotourism in Permeti Region and future perspectives.

The development of tourism in a region integrates together all the touristic elements including the natural and cultural components. In this regard Geotourism cannot be treated as something separated in relation of other forms of tourism. But we must emphasize that geotourism constitutes the main axis of tourism offer in this area. Beside the geomonuments Permeti region has another components in helping the development of tourism such are the large number of biomonuments, hydromonuments, the National Fir Park of Hotove (Parku Kombetar i Bredhit te Hotoves) and a variety of special objects like gorge of Kelcya, Vjosa valley etc. The rich and cultural Heritage has its own importance in tourism development. This is due to an early and consistent population to the development of socio-economic level in different periods. This Heritage represents a museum with architectural, historical and cultural values which combined with a reach and spiritual world offers a unique and ethnographic asset for the region.

The lack of tourism infrastructure conditions the tourist movement mainly along the valley. You can notice less tourist movement in mountainous areas. The kind of tourist who like to visit these areas are adventurous foreign ones who adore nature and camping.

The tourist potential that the region offers is relatively rich which is also reflected in the increase of tourism service capacity. Tourism seems to be a priority sector in the region today and the trends are towards its development. It is worth mentioning the fact that the region can not turned into a tourist area with mass tourism, but in an area with alternative tourism, why not even to an elite one.

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Source: Permeti District statistical Yearbook 2005,2010

6. Management of caves and their involvement in tourist itineraries.

The nature has carved for thousands of years a considerable number of karst caves in this region, most of which are found in Langarica Canyon. Despite their great number**,** cultural and natural values they bear almost none of them is easily accessible by tourists. This is due to difficult terrain in which they are found. These caves should be under goods management projects in order to make them serve the development of tourism. Firstly after they have been declared as protected areas facilities, such as building stairs on the slopes to allow safe and fast access and to create the opportunity to link cave with each other, should be offered. In the case of narrow entrances or the narrowing inside the cave, experts on the field should expand these narrow and entrances without damaging the values of the caves.

Another need for a cave management is the training of the guides who should learn very well the values of these objects to be able to show them to the tourist. It is very important to built a lighting system, the study of risks and it should be taken necessary protective measures in any dangerous cases. To visit the caves from one side of the canyon to the other, bridges or cable cars should be built. This would enable tourist to visit several caves in less time and in the same time it would increase the interest of local and foreign tourist who, despite the desire they have to explore the caves they would be put of by conditions in which caves are today.

Results

- Geographical position and natural conditions of the region offer great opportunities in development of geotourism .
- The geological build, climate and hydrography have conditioned the variety and the number of geomonuments.
- The region offers a variety of specific forms of relief (canyon ,caves, stones with rare shapes etc.) which deserve to be studied in order to be declared a protected area.
- Very good opportunities in development geotourism offer its karst caves and the values that they represent.

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- It has been made efforts by the local government to give priority to the development of tourism but tourism infrastructure does not meet the need, it is very limited.

Recommendations

To serve the development of tourism and sustainable one for the region as a hole I suggest:

- Maintaining and promoting the values of geomonuments of the region.
- Identification and declaration of new geomonuments which are not know.
- Exploring the caves by specialists of spereologise and archeology to point out their values.
- Investment in tourism infrastructure in general.
- Giving priority to the development of tourism in Permet region in all dimensions it offers.
- Training of local guides.
- Interference in Langarica canyon to enable attendance by visitors to caves. Interference should be done specifically in:
  - Building stairs on the slopes of the canyon
  - Interventions to expand the narrow entrances (of course keeping the values)
  - Building lightning system for caves
  - Study of potential hazards and protecting measures.
  - Constructions of bridges over the river or putting cable-cars .

REFERENCES

1. Adhami Stilian "Overview of folk culture of Permet region" Tirana 2000
2. Science Academy of Albania, Center for Geographical Studies "Physical Geography of Albania volume I" Tirana 1980
3. Mecaj Nasip "Vjosa Basin,Natural and geomorphological features" Tirana 2003
4. Qiriazi Perikli, Sala Skender "Nature monuments of Albania", Tirana 2006
5. Permet District Statistical Yearbook, 2005,2010.

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GEOTURISTIC RESOURCE ASSESSMENT OF HAS CROSS-BORDER REGION

Klementina NGJEÇI
University of Tirana, Department of Geography, e-mail: kngjeci@yahoo.com

SUMMARY

In this proclamation we treat Has cross-border region's natural potential role and opportunities of geoturism development in this area. Now tourism is one of the services that in recent years is growing rapidly, bringing at the same time income and life standart growth, etc. Through this work we intend to achieve awareness of the region's population, that there is no lack on geoturistic potentials which enable to develop some kind of turiam as the curative one also eco-turism, transit tourism etc. For this, tourism in the border region of Has has to be seen as one of the main branches to develop because in this area; Geographical location, beautiful natural landscapes that are created, very healthy climate combined in the best way with a rich variety of flora fauna constitute potential with great turistic value for the area.
Tourism development in this area requires greater attention of the politics and state authorities on one hand and local government on the other hand, more detailed studies to clearly define strategies and plans of tourism development of the area, etc. Once all possibilities exist to increase tourism of the area at very high levels.

KEYWORDS: *cross-border region of highlands Has, geoturism, natural potentials, transit tourism, ecotourism, etc.*

1. Geographical position and the possibilities for developing geoturism

Has border region lies to the northeast of our country and continues outside the borders of the Republic of Kosovo. On North as border serves Junik mountain and Erenik river flow, branch of the White Drin River, the northwest is separated from Tropoja district by upper flow of Skatina river, on the west is separated from the district of Puka by artificial lake of Fierza while in the south and southeast is separated from the district of Kukes by the united Drin valley, on east and Northeast as Frontier serves the White Drin River valley. Within these limits highland of Has has an area of 725 km2, of which 353km2 in Albania and 372km2 in Kosovo. The region Presents specific administrative organization terms as it works differently in the two states. In the Albanian part it works in the Has district comprising the city of Krumë and municipalities Golaj, Fajza, Gjinaj. In Kosovo operates in Gjakova and Prizren.
Has border region has been inhabited since the end of the Neolithic period. This is proven by archaeological findings, there is very clear evidence of cultural continuity from the Neolithic period (2600-2100), with residence cave of Dajç latitude 1250 m above sea level.
In ancient Highland of Has was inhabited by Illyrian tribe of Dardania, which had a broad reach, while the center of their kingdom was the territory of Kosovo. This is shown quite clear by Illyrian culture evidences such as: tombs, ruins of settlements, fortifications and many ceramic items or decorations, defined as typical Illyrian culture.
Slavic invasions, with all the social consequences on the population and the remaining few toponimive of several villages in the area, failed to change traditions, language, habits of this population, for evidence is preservation and heritageof typical Albanian elements of "Koman culture" .

functioned as a whole from the earliest periods until 1913 when it was divided into two states, and finally closed in 1949 the border with the former Jugusllav federation.
- Has Highlands region in all periods (excluding the years 19949-1990) played the role of a bridge between our country and other parts of Kosovo's ethnic and beyond in the Balkans.
- favorable geographical position, especially Expressed during the Middle Ages in the functioning of North Road which linked Shëngjin and Nis and further inside the Balkan Peninsula.
- By border separation in 1913 remained abroad two gravity centers of the region, Gjakova and Prizren, once these centers played an important role for the trade development . However, trade and economic relations continued to be guarded by Shkodra, although at low levels due to natural barriers.
- From 1913 - 1949 Has Highlands region played the role of a link but at low levels due to the political changes that were made.
- The role of the geographical position of the highlands Has ceased to exist in the years 1949 - 1990 as a result of complete isolation of the country, results of self-isolation policy that followed the communist state. This negatively affected the development of the region
- After 90 years, especially after the declaration of Kosovo as an independent state on 17 February 2008, the favorable role of geographical position is reactivated as a result of operation of the Durres-Kukes highway.
From the above analysis we come to the conclusion that geographical Has border region lying in the oldest crossing roads that connect the Adriatic with Balkans offers enormous opportunities for tourism development.

2. Has cross-border region's natural conditions and opportunities for the development of geoturism

2.1. Relief effects on tourism development

Has transboundary region's relief is hilly-mountain with heights 400-800 m, occupying 66% of the total. Highland relief is diversified both in terms of morphological and morfogenetical: mountain ridges, plateau, pits, valleys. Simultaneously in this region we can face with many beautiful scenic landscapes such as: karstic landscape of Has plateau with it's characteristic forms which together with biotic elements create variety of karst ecosystems; karstic Uvala in the village of Cahan, karst wells which among them it is worth mentioning the well of the shepherd also in the village of Cahan which some legends are connected with, karst caves that still are unexplored good (Pigeon Cave, Cave with Yard, cave with two Doors, Dajlan cave, pond of Bogdani etc.) some of these caves are hold under the status of protected areas which have great resorts, scientific, didactic values etc. Mountain loins as it of Pashtrik (1989m altitude) and the tip of Gajrep (1443m), yeast of Kunora (1512m altitude) in the village of Vlahen provide opportunities for the development of mountain tourism, and ecotourism. It should be noted that recent years have begun the first steps for investments in the tourism sector as the creation of the campsite of tourism on Mujaj village. Also the White Drin River valley and the mouth with the same name, that at the same time has the status of a natural monument, are very attractive for development of stroller tourism.

2.2. Effect of climate on tourism development

Climatic conditions are the main factors in the development of tourism, especially the curative one. The climate has transitional character from the pre-mountainous Mediterranean climate to the climate with continental influence, characteristic is the hot and long dry summer and the harsh winter with considerable snowfall, annual average temperatures reach 10-110C, rainfall 900 - 1000 mm which a part of is in the form of snow. Also the height

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above sea level of mountain ridge as it of Pashtrik, Gajrep, Maja Kunora, and the presence of mountain pastures, water resources more spread on Gajrep, all these are harmonized as well on creating a specific microclimate. In conclusion, we say that the climatic conditions in the border region of Has offers suitable conditions for the development of geoturim.

2.3. Hydrographic influence on tourism development

The presence of a number of water flows as it of White Drin River, Erenik, Kruma, Vlahn, Fierza artificial lake and karst resources that present vital importance and at one-time positive effect on developing geoturizm. White Drin river with Erenik river provide opportunities for development of strolling tourism because of having entertainment and aesthetic values. Fierza artificial lake surrounded by wreaths of green vegetation provides enough value to tourists, especially after a boating, water resources, especially karstic ones some of whom with the status of monuments of nature as it of Kruma, Vrella Domajve, Drogovodi Pashtrik, spring pf Spahia etc. in addition to the values that have, simultaneously meet the main needs of drinking water for tourist consumption. It should be emphasized that appear important supplying water to tourist clients in karst areas such as Has plateau. In conclusion we say that the presence of rivers, streams, Fierza artificial lake and a variety of water sources constitute an attraction for touristic demands.

2.4. Effect of flora and fauna in the development of tourism

Forested areas in the border region of Has occupy about 62% of the area especially in the Kosovo region, making it the most important element of the landscape. In this region meet three plant floors that of oak, beech and alpine pastures which have areal only on Pashtrik mountain, a wide spread in this region also have the medicinal plants (sturgeon, thyme, kamomilin, hollyhock etc.). Also the presence of multiple habitats such as river, lake and forestal is associated with the presence of a very rich animal world, from lower order species to mammals such as rabbit, wild boar, deer, and rarely bear constitute attraction of tourist hunters.

If to the largest natural resources, are added the cultural heritage (material and spiritual) of the population of this area, which is related to early population, the preservation and transmission of these traditions and customs till nowadays, at the same time will make enough important touristical potential. Rich is presented the area with numerous archaeological and historical objects. Archaeological discoveries made in this area have identified many objects constructed since the III millennium BC, as is "Location of Dajç cave". In the border region of Has is a considerable number of objects declared cultural monuments such as: Tuma in Kruma city, castle of Kostur, etc., same is presented also the spiritual heritage areas, such as: mountain folk dresses of Has Highland, Has Highland dances, etc.. In conclusion, we say that all of these positive elements that nature offers in this region also by attaching the cultural wealth of the population, create opportunities to reduce the difficulties and to offer perspectives for sustainable development of the Tourism in this region.

CONCLUSIONS AND RECOMMENDATIONS

Has border region has a great natural potential for developing geoturism which can appear in different forms; mountain tourism, ecotourism, curative tourism, etc.. But unfurtunately in this area tourism itself has not a Development yet, but is spoken only for touristic potential. For tourism to be seen as one of the profitable services would be important to highlight a few suggestions.

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GEOINFORMATION OF THE GLACIAL GEOMONUMENTS OF ALBANIA

Merita DOLLMA[1], Florina PAZARI[2]

[1] *University of Tirana, Department of Geography, E-mail: meritadollma@yahoo.com*
[2]*University of Tirana, Department of Geography-mail: floripazari@yahoo.com*

ABSTRACT

Albania has a great number of geomonuments due to its litho logy, various landforms, geomorphologic evolution, exogene and indogene factors impacts, etc. A major part of these geological sites of scientific, educative and tourism values are included in the list of the protected areas, in the third category so called "Monuments of nature". In this category are also included the glacial geomonuments, which are unique, rare and beautiful. Most important glacial relief forms of Albania such as glacial cirques, glacial lakes, etc, there are situated in the high mountains of the Albanian Alps and in the Central Mountainous Region of Albania. The presence of these special glacial relief forms has attracted the interest of the researchers, but unfortunately not yet the attention of the tourists, mainly due to the luck of the information.

The application of GIS will turn to digital contents the glacial geological sites data that will lead to the digital archive system development. The production of digital maps (maps showing the glacial lakes, cirques, moraines, glacial-fluvial deposits, etc.) would be the first step for the further creation of the digital atlas of the Albanian monuments of nature. This digital atlas would satisfy the need for publicly available information on the Albanian natural heritage in an easily accessible form, through the creation of a permanent digital image bank of interesting natural sites in Albania. The geoinformation of the glacial geomonuments will not only inform the tourists about their values, but also will provide geotours information based on scientific knowledge.

KEY WORDS: *Glacial relief, monuments of nature, geotours, geoinformation.*

INTRODUCTION

Glacial relief in Albania occupies a small area comparing to the other types of relief. The traces of the Vürm glacial period in Albania there are evidenced in the altitudes over 1500 m in the north and over 1800 in the south. In the valleys, the glacials got down till 300-800 m in the north and 900-1200 m in the south, where glacial moraines were formed (Gruda, 1990 a). The glacial landforms that inherited us are related to the litho logy, topography, erosion, slope processes, etc. On the loose (mostly terrigenous) formations, the glacial landforms are rarely found, mainly over 1700 m altitude in the north and northeast slopes of the Korab, Vermosh, and Gramoz mountains. They are mostly disappeared due to the erosion or degradation. Glacial landforms are well preserved in the carbonate rocks, which are more resistant to the erosion. However these landforms, such as glacial valleys, are further varied by karst processes. The most preserved glacial landforms are found in magmatic rocks, especially in ultra basic rocks, which are insoluble and resistant to the erosion. On the surface of magmatic rocks there are situated the biggest and most preserved glacial cirques and lakes of Albania.

The features and sizes of the glacial landforms are attributed to the structure, litho logy, morphological evolution of the area before and after the glacial period. Whereas their current shape depends to the altitude, erosion intensity, slope stability and climate change. The most common glacial landforms found in Albania there are cirques, lakes, valleys, glacial-karst holes, depressions, and bank of moraines.

Glacial cirques are the most widespread reliefs in Albania, which are situated in the altitudes of 1500-2400 m. They are mainly situated on the north, northeast and east slopes of the alpine crests. Their common form is that of a half circle with steep slopes. Both simple and complex cirques exist in Albania, where simple cirques are formed due to the change of the everlasting snow border. They are relatively huge and are found in the Alps and Korab mountains. Complex cirques are formed over the everlasting

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snow border, at 1700-1800 m altitude and are even bigger than the simple cirques. Complex cirques are found in the mountains of Alps, Lura, Korab, Shebenik, Jabllanica, Tomor, Valamara, Polis, Nëmërçka, etc.

Glacial lakes were formed mainly in the complex cirques (Jezercë, Balgjaj, Dhoks, Shebenik, etc) and very few in the simple cirques in the altitudes over 1500 m (Pano, 1990). Glacial lakes were formed in the glacial cirques mainly on the magmatic and terregine rocks. Most of the glacial lakes are situated in the Central Mountainous Region of Albania (52 lakes) and in the Albanian Alps (32 lakes). In general glacial lakes are small in size and they have alpine regime. Their flora and fauna is represented by some *algae's*, *hygrophilous plants* and *alpine triton.*

Glacial valleys are almost all situated in the Alps, in the upper parts of Valbona, Thethi, Boga, Vukli, Gashi and Vermosh valleys. They are all situated above 700-1100 m high and are 8-15 km long.

Glacial-karst holes of 0.5-1.7 km^2 (Gruda, 1990 b) are also widespread in the Alps mainly in Jezerca mountain (Gropat e Bukura, Gropa e Jezercës), in Bjeshkët e Namuna (Klogjen, Radohinë, Livadh i Bogës, etc) and in Kollatë, Rupë, Mijushë, etc.

Glacial depressions are other glacial relief forms situated in the Alps, Central Mountainous Region and very few in the Southern Mountainous Region of Albania. They are mostly situated in 1500-2000 m altitude and their length is 0.7-1.6 km (Gruda, 1990). Glacial depressions are found in Jezerca, Vermosh, Korab, Nëmërçkë, Tomorr mountains.

Glacial moraines are also found in Albania due to the glacial deposits in the valleys, glacial depressions and complex cirques. Glacial moraines are found in the valleys of Valbona, Gashi, Boga, and Runica and in the mountains of Korab, Balgjaj, Dhoks, Shebenik, etc.

GLACIAL GEOMONUMENTS OF ALBANIA

The Law for the protected areas has included in the third category of the protected areas, the monuments of nature that are divided in geomonuments, biomonuments and hydro monuments. In 2012 the total number of the geomonuments declared monuments of nature is 291 or 41% of the total monuments of nature. Based on the Law for the protected areas, in the category of the geomonuments are included all the geological objects that are unique such as rare geological structures, geomorphologic objects, etc. Glacial relief forms are geomonuments of complex values such as cirques, glacial lakes, moraines, glacial deposits, etc.

The most important **glacial cirques** that are declared monuments of nature there are: Glacial cirque of Zepë (Kukës); Glacial cirque of Beautiful hole of Jezerca (Shkodër); Glacial cirque of Livadhi in Boga (Malësi e Madhe); Glacial cirque of Nëmërçka (Përmet); Glacial cirques of Tomorr (Skrapar), Glacial cirques and moraines of Griba (Kurvelesh).

Glacial moraines that are declared monuments of nature there are: Moraines of Fushëlura (Dibër); Moraines of Razma (Malësi e Madhe); Moraines of Ujanik (Skrapar). Monuments of nature are also declared the **glacial-fluvial deposits** of Boga (Malësi e Madhe); Shëmtira (Tropojë); Shoshaj (Tropojë), etc.

GLACIAL LAKES

Great lake (Jezercë) is the biggest of four lakes of Jezerca trogue and over all Alps mountain's. It is situated in the altitude of 1792 m and has a prolonged shape of 443 m long, 178 m average width (maksimum width is 213 m) and 3.5-4 m depth (Gruda, 1990). This lake has been a glacial cirque and in dry season it is almost dry. In this lake has its habitat the alpine triton (Pano, 1990).

Great lake (Lura) is the biggest (12 ha) and deepest (20m) lake of all the lakes of Lura Park. This glacial lake in winter gets frozen and in summer gets covered of white water lilies. Great lake is situated in the altitude of 1550 m and is one of the most beautiful lakes of Lura.

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Black lake (Lura) is situated in Lura Park, in the altitude over 1600 m of the mountain "Kunora e Lurës". It is a glacial lake with an area of 2.56 ha and maximal depth 10m. This lake is formed on the surface of the ultrabasic rocks of Lura Ophiolite Massif, and consequently its color looks black. This lake constitutes a very interesting ecosystem of the alpine lakes with rich flora and fauna.
Flowers' lake, it is situated in Lura Park, on the altitude 1580 m of the mountain "Kunora e Lurës". This lake has covered a glacial cirque with total area of 1.44 ha. It is an alpine lake with rare beauty and rich water flora and fauna. It is well known for the big white lilies that bloom in June turning this lake to an astonishing flower meadow.
Black lake (Martanesh) is situated on the northern slope of the Mali i Lopës (Cow's mountain), in the altitude over 1800 m. This lake is formed on a big glacial cirque of 45 ha, 400 m long, 200 m wide and 60 m deep. From three sides of the lakes the very steep slopes are covered by beech and pine forests, which create a lovely landscape. Due to the depth and the deposits of chromite ore in the bottom of the lake, the watercolor seems black. This lake has rich flora and fauna and creates an interesting alpine lake ecosystem.
Lakes of Kacni are situated on the eastern slope of the mountain Balgjaj, on the southwest of Kacni village of Dibra district. In the altitude over 1700 m these lakes cover the glacial cirques of 50-100 m long, 20-35 m wide and over 5-6 m deep. The lakes and the coniferous forests around them create very attractive ecosystem of alpine lakes.

CONCLUSIONS

Glacial relief forms in Albania are several and various such as glacial cirques, glacial lakes, moraines, glacial–fluvial deposits etc.
However, although they bear great scientific, aesthetic, tourism and educative values, they are little frequented and known by the tourists.
This is not only due to the poor infrastructure to reach them but also due to the luck of information for these rare geomonuments.
Therefore the need for the geoinformation creation for the glacial geomonuments is a necessity that will serve to the researchers, managers and the public.
Geoinformation of the glacial geomonuments of Albania will not only create a detailed digital database providing geological, geomorphologic, and hydrological and tourism information, but also it will inform and increase the tourists' interest to explore them.

REFERENCES

Gruda Gj., (1990a), - *Gjeografia fizike e Shqipërisë*, 1, Akademia e Shkencave, Tiranë, 147-154
Gruda Gj., (1990b), - *Gjeografia fizike e Shqipërisë*, 2, Akademia e Shkencave, Tiranë, 68-92.
GeoAlb., (2011), *Mineral Resources and their perspective*, Konference proceedings,Kosovo, 409, 425, 426, 459, 464.
Dollma M., Pazari. F.(2010), - *Tourism potential of Dibra county, Journal Kuvendi*, 3, Michigan, 140-152.
Pano N., (1990), - *Gjeografia fizike e Shqipërisë*, vol 1, Akademia e Shkencave, Tiranë, 253-254.
Qiriazi P., Bego F. (1999), - *Monuments of nature of Albania*, ILAR, 85-86, 95-96,107-109.
Serjani A., (2009), - *Upper Kurveleshi highland*, a museum of Albanian nature. Mediaprint, 79-80,104.
Serjani A., Neziraj A., Wimbledon P., Onuzi K., Hallaci H., Bushati S. (2003) - *Geological heritage and geotourism in Albania*, ProGeo Albania, Tiranë, 32-98.

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IMPROVEMENT OF GW MONITORING SYSTEM IN ALBANIA

Arben PAMBUKU, Aranit GELAJ, Adrian DHIMITRI

ABSTRACT

Groundwater monitoring is conducted according to the methodology based on hydrogeological research and the respective laws for environmental monitoring (groundwater stocks) in water basins Drini, Mati, Erzeni, Ishmi, Shkumbini, Semani, Vjosa and Ionian Zone in space and time, today and in perspective. So, carrying out systematic monitoring of groundwater quantity, quality, dynamic, across one basin aquifer and for whole catchment's basins in total, will make possible the assessment and management for an exploitation based on criteria's without destroying the regime of exploitation in waterbearing aquifers. Monitoring is expected to place mainly in gravelly aquifers.
Whole aquifer basins are of particular importance as the quantity of reserves of GW and for their growing exploitation and especially in Quaternary gravel aquifers where water needs in the basin are increasing as well for drinking water as for the food industry and technological waters. Monitoring of all GW regime elements in time and space, especially in terms of intensive exploitation is necessary. Evaluation and implementation of an integrated monitoring system assesses and protects this national wealth as water making GW Monitoring a new scientific discipline that ensures:

- Preservation of exploitable reserves of the GW
- Ensuring the existing water deposits
- Elimination of redundant costs hydrogeological GW for exploration and exploitation.
- Definition of GW areas pollution from industrial emissions and polluting activity

Hydrogeological studies for groundwater monitoring began in 1967, with the design of the project for the stations establishment for the groundwater regime study in main basins as Korçe, Lushnje, Fushe-Kruje, later in Tirana, Fushe-Kuqe, Lezhe, Shkoder. Different project were developed mainly bu Albanian geological Survey for improvement this monitoring system of GW. In our paper we present the some results arrived for the modernization of the GW system through the data logger applying in two pilot zones in Albania. The used data loggers are them of DIVER CTD and Baro Diver. The datalogers are used for the GW water level measurements. The profited data are used for the water balance calculation.
At the framework of water monitoring system some other pilots are placed on the hydrogeological bodies separations, new monitoring integrated points and GIS development.

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HYDROGEOLOGICAL CHARACTERISTICS OF KOSHARE AREA, KOSOVE

Hazir Çadraku[1], Fidaim Sahiti[2]

[1]*Water Departament - Republic of Kosova; e-mail: hazir.cadraku@hotmail.com*
[2]*Water Departament - Republic of Kosova; e-mail: fidaimi04@hotmail.com*

ABSTRACT

"Koshare Area" is situated in the territory of of Kosova and represents a continuation of the Albanian Alps (Bjeshkët e Nemuna). It is a special interest area rich of magmatic, metamorphic and sedimentary rocks characterized by different hydrogeological characteristics, such as water reserves as well as for number and type of natural springs that emerge from these geological formations. The above mentioned rock formations are hydro-geologically divided into permeable semi-permeable and impermeable. Of particular interest for their water-bearing capacity are carbonate rocks that contain significant amounts of karstic waters. Based on the amount of water that emerges from springs, they are mostly small flow (0.1-0.9 l / s) up to moderate water flok (1.0-4.0 l / s) springs.

KEY WORDS: *Aquifer, source, water-flow, porous, karst.*

INTRODUCTION

The Koshare area is defined as an area of special interest, because it is within the boundaries of the National Park "Bjeshkët e Nemuna''. Geologically, it belongs to two tectonic areas: Alps and Mirdita. Various authors (F. Nopce, 1905; K.R. Teleg, 1905; J. Cvijic, 1901-1914; M. Donat, 1956; S. Jankoviq, 1956; M. Petkoviq, 1956; M. Kandiq, 1956; S. Karamata, 1956; A.Paviq, 1962-1968; J.Karoviq, 1962-1968; R. Antonijeviq, 1962-1968; J. Vilimonoviq, 1970; S. Popoviq, 1980; Xhomo A., 2000-2009; Mekshiqi N., 2000-2009; Hoxha J., 2009; Kodra A., 2000; Dardha M., 2001- 2009; Hysenaj R., 2009; Hoxha V., 2009; Fejza I,. 2009; Avdullahu S., 2009; Meha M., 2009; Çadraku H., 2009-2012; Sahiti F., 2009; Dardha A 2009;) have studied this area from different viewpoints: tectonic, stratigraphic, hydrogeological, etc. Vilimonoviq (1969) conducted research on the Neogene formations in the locality Piskot- Skivjan where six wells were drilled in order to study the depth. Hydro-geological researches in this area were carried out later by Popovic (1980). The resea9rchers found that gravel layer lies at a depth 30 - 40 m in the locality Piskot - Skivjan, while the sand layer at depth 49-76 m and the static groundwater level is 17.05 m below the earth's surface (Vilimonoviq, 1969; Popoviq, 1980). Popovic (1978) conducted hydro-geological and hydro-chemical research to compile a hydro-geological and hydro-chemical map for sector Starac and Koprivnik 1:25000 scale. Xhomo, 2009; Mekshiqi and Dardha, 2001; Mekshiqi, 2009, conducted geological researches for the correlation of geological formations in the Albania-Kosova border area. The rock formations of this area belong to Paleozoic, Mesozoic and Cenozoic age and are represented by, limestone, flysch and molasse, terrigenous carbonate, ofiolitic, formations, etc. Based on hydrogeologic aspects in this area are distinguished two groups of water-bearing formations: compact rocks that contain fracture water-type (Lower and Middle Triassic limestone and dolomite, Upper Jurassic silicous diabase, serpentized peridotite and serpentinite, granodiorite) and formations containing water of porous type (gravel, sand and lacustrine clay of leviathan, conglomerate, river bank gravel and sand, glacial sediments, prolluvium, alluvium). Marl and clay are classified as typically impermeable rocks. Springs emerge mainly from karst formations outcropping in southern and western part of the area. Their yields ranges from 0,1 to 4,0 l/s. There were also cases, such as cavernous limestone of Triassic in vicinity of Junik (1980), where a drilling 200m deep that found groundwater at the depth of 5 m from the earth surface gave about 10 l/s for a drawdown of 20 m. Porous alluvial formations are found in river valleys of Erenik i vogël, Gusha, etc. They have a thickness of 2 to 10 m, and are recharged by rainfalls and groundwater of the Triassic karst formations.

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PHYSICAL-GEOGRAPHICAL DATA OF KOSHARE AREA

Koshare area has an surface of 25 km^2, and belongs to the western part of Dukagjini Basin, on the border with Albania. Morphologically, the relief of the area consists of great contrasts with high mountains (Maja e Mrçaj (2250 m), Rrasa e Zogut (2104 m), Maja e Zezë (1934 m), Guri i Gjatë (1873 m), Rina (1020 m) etc.) and low terrains (the southern part of the area near Morinë e Naltë village (530 m). Climatic regime of the area is mountainous and partly continental in the southeast. Rainfall amount varies from 780 to 1100 mm. The average annual temperature is 10.3 ^{0}C, ranging from a minimum of - 23 ^{0}C in January, and a maximum of + 35°C ~~is~~ in August. Hydrographic network is highly developed and is represented by rivers and streams with both temporary and permanently flows. Hydrographic network in this area ~~has a~~ is recharged by either, precipitations and groundwater.

GEOLOGY

The geology of this area is very complex and consists of a variety of sedimentary, metamorphic and magmatic formations. Three are the main formations outcropping in this area: sedimentary ~~rock~~ formations of eastern Alps, northwestern part of Tropoja Ophiolitic complex (Mirdita Area) and Plio-Quaternary deposits of Koshare area. The oldest formations are represented by the terrigenous formations of Paleozoic (Permian) era. The most widespread formations are those of Mesozoic (Triassic, Jurassic, Cretaceous) and Cenozoic (Quaternary, Pleistocene, Holocene), represented mainly by limestone, flysch and molasses, preophiolitic sin-rift volcanic rocks and ophiolitic formations of Tropoja - Gjakova regions. The geological formations of the Albanian Alps have limited extension and are mainly represented by carbonate – terrigenous deposits. The stratigraphy of these deposits is specified by many studies carried out in this area, which have shown that it is overthrusted over Cukali subzone, while in Kosova, in the sector of Koshare, they are covered by Mirdita area. There is a gradual transition from the highly facial variable Upper Triassic formations to Jurassic ones. Generally, they have limited extension in the periphery of Shkelzen anticline up to Koshare martyrs' cemeteries. Jurassic deposits have small thickness (about 150 - 200 m) and are represented by plate and fine layer of crinoidal biomimicry limestone, with laminated texture, having included silicous lentils. Cretaceous deposits in this area have a limited extension and are represented by the alternation of clayey - sandy flychoidal formations and limestone, which are a continuation of flyschoid formation (Maastrichtian level - Cr_2^m) of Valbona subzone. *Mirdita area formations are represented by serpentinite and tectonite harzburgite*. Mantle harzburgite with rare intercalations of dunite extend at the southern part of Koshare area (Qafë Morinë). They are in contact with Pleistocene sediments which have a very large extension in the southern part of the area. They extend from Morina e Sipërme toward Qafë Morina up to the contact with serpentinite. Serpentine breccias, synrift serpentine blocks lie on the Boka hill (500 - 618 m). They are in contact with the Middle Triassic and Lower Jurassic formations. Holocene deposits are represented by river bed~~s~~ alluviums and consist of gravel and sand and rarely clay and silt and spread out along the river valleys of Erenik and Gusha rivers. Eluvial - diluvial deposits consists of clay~~s~~, silt and rock pieces. They are situated along the slopes of the valleys and on the hilly relief. Diluvial and colluvial deposits varies in age from late Pleistocene until nowadays. Alluvial, prolluvial and lake deposits up to lake-glacial ones are represented by beige clay~~s~~, silt, sand~~s~~ and gravel~~s~~ with a mixed structure. They outcrop mostly in Morina, Botusha, and their thickness ranges from a few meters to tens of meters. Tectonically - Koshare area belongs to two tectonic areas: The Albanian Alps and Mirdita zone. Geodynamic evolution and regional tectonics of the area is quite complex. General structures in this region are formed through a number of tectogenesis processes.

HYDRO-GEOLOGICAL CHARACTERISTICS

There are distinguished two groups of water-bearing formations in Koshare region: compact rocks that contain fracture-type groundwater and soft formations containing porous-type groundwater. The compact formations are represented by limestone and dolomite of the Lower and Middle Triassic, diabase - silicous formations of Upper Jurassic, serpentized peridotite, serpentine and granodiorite. The soft deposits are represented by gravel, sand~~s~~, conglomerate~~s~~, glacial sediments, prolluvium, alluvium. Finally, clay and marls are distinguished as aquitard or aquiclude formations. According to the porosity type the following aquifer formations are distinguished (Fig. 1):

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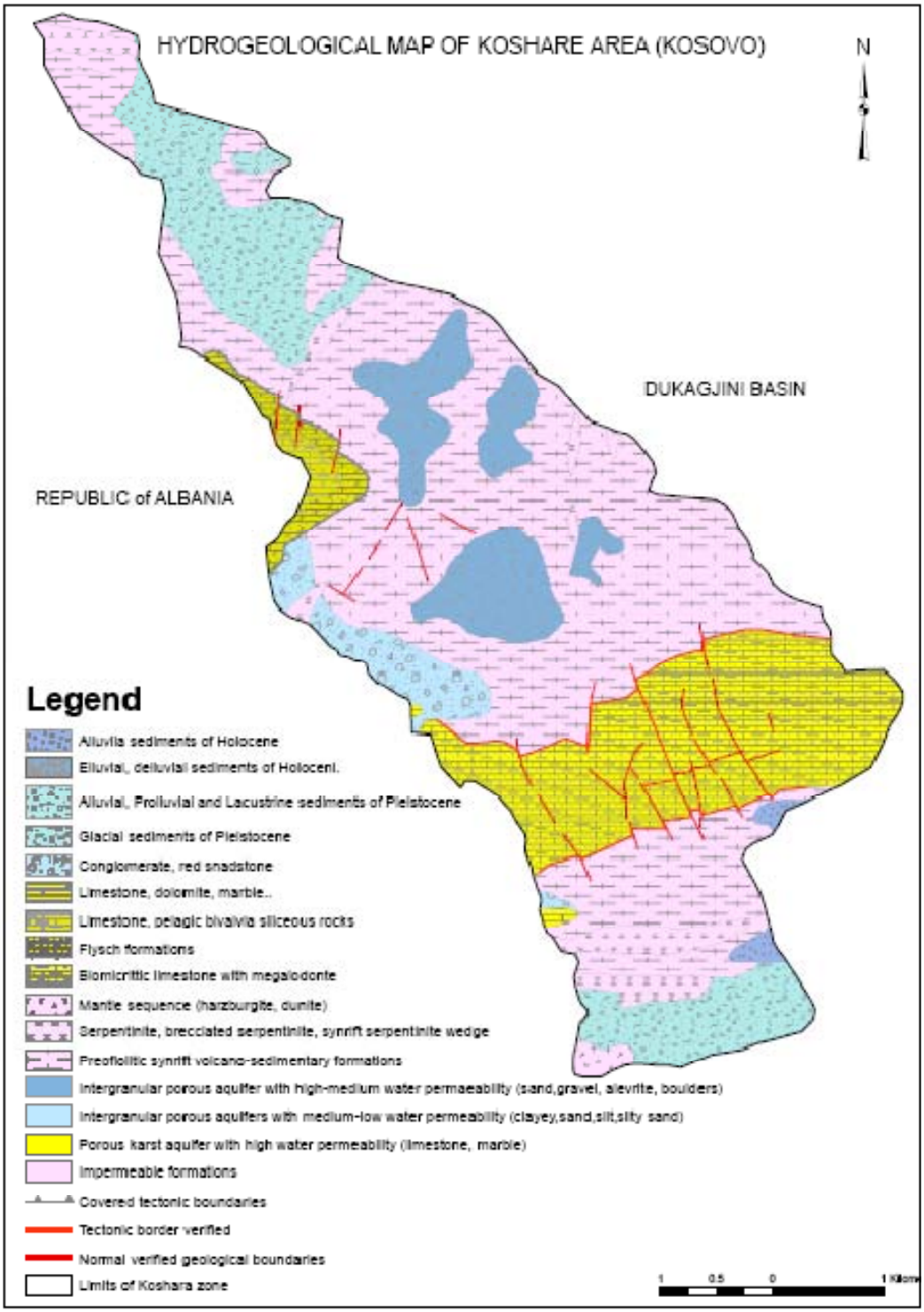


Fig. 1. Hydrogeological map of Koshare

- Intergranular porous formations (hydrogeologic formations of the first group: sand, gravel, with medium to high water permeability (Kf $> 10^{-5}$ m/s).
- Crack and fractures formations (the second group of hydro geological formations).
- Karst carbonate formations (hydrogeological formations of the third group: limestone, dolomite and marble).
- Aquitard formations (fourth group of hydrogeological formations: clay, crystalline schist with high level of

metamorphism, intrusive rocks and some effusive rocks,) with medium and low water permeability (Kf = 10^{-5} –10^{-9}).

Intergranular porous rocks

They are situated in the southern, central and northern part of the area. They are represented by sand, gravel, terrace lake and river sediments and alluviums. Intergranular porous rocks represent around 22.2% of the area and they are characterized by high (> 10^{-5} m/s) to medium (10^{-5} – 10^{-9}) water permeability. They have good hydraulic connection with the river which has conditioned variable water regime in this area. The content of the Total Dissolved Solids ranges from 0.5 to 1 g/l and they belong to calcium bicarbonate and magnesium hydrochemical type. Deterioration of their quality occurs whileflowing far from the recharge zone.

Karst rocks

Karst rocks represent around 17.4% of the area. They extend almost all Koshares area, from east to west. They are represented by limestone and marble. The presence of frequent caverns, cracks and fractures on the surface has conditioned a high water permeability Kf = 10^{-3} – 10^{-9}m/s. Intense circulation area (upper hydrodynamic area) of karst waters generally contains fresh water with content of the Total Dissolved Solids that ranges from 200 to 250 mg/l. The karst groundwaters are polluted from the surface waters so it is not recommended to be drunk directly without cleaning by chlorine.

Aquitard formations

Aquitard formations represent around 60.4% of the area. They cover the central part of the area, as well as northern and southern parts. They are represented by argillite / alevrolite, metamorphic rocks, volcanic, plutonic and pyroclastic rocks. They are characterized by low water permeability (Kf < 10^{-9}). Serpentines are of importance for their water-bearing capacity which is related with the fracture system. Natural water springs with a capacity of 1 l/s emerge from these deposits. The Lower Triassic sediments are always impermeable even when they are affected tectonically.

WATER SPRINGS

Groundwater emerges from the above formations in the form of natural springs. In this area are identified over 48 natural springs capacity that ranges from 0.1 to 4 l/s and pH values ranging from 5.5 to 6.5. According to their water capacity, springs are divided into three categories:

- 35 spring with Q = 0.1 – 0.9 l/s
- 11 springs with Q = 1.0 – 1,5 l/s
- 2 spring with Q= 1,5 - 4 l/s

The pH values of the spring water ranges from 5.5 - 6.5, thus, defining them as poor acid waters (pH = 5 - 7) (Fig. 2). According to the flow, most of the Koshare springs belong to group VI, with water flow 0.1 - 1.0 l/s, while only 13 springs belong to group V, with a flow of 1,0 - 4.0 l/s. Fluctuation of the spring water flow is determined by multi-annual variability index R. (R = Rmax / Rmin). Consequently, it was found that water springs in this area have variable flow rate (high in the November – April period and low in the May – October period), because they belong to the cracks and karst types. From May to October the precipitations are low and in this period the springs occurs under the so called characterized by a gradual reduction of their debit. Springs with greater capacity are in the lacustrine and gravels sediments. Fluctuation of regime of the spring capacity depends largely on rainfall. Limestone rocks represent the main recharge source for most of springs. Thanks to cracks, caverns and fractures they can accumulate large quantities of groundwater which emerge in the surface of the earth along the contacts of the limestone with impermeable formations. The springs that emerge from the cracked and fractured limestone have the highest capacities (30 - 40 l/s) (Vrella of Junik). Based on the geological and geomorphologic conditions the following types of springs are distinguished:

Seepage springs those that emerge from porous aquifers in contact with the impermeable layers In general, this type of sources springs have low flow.

- Fractured springs those that discharge from faults, joints, or fissures) are both descending and ascending, springs are mainly related to fracturing of carbonatic, magmatic and metamorphic rocks, due to the tectonic processes.
- Karst springs those that are primarily linked with limestone in which karst processes are intensively developed. They have a good hydraulic communication system). From the chemical composition point of

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view, the groundwater in this area mostly belongs to the bicarbonate-calcium hydrochemical type, other types (Calcium – sodium, Calcium – Magnesium, Magnesium - sodium type) are less distributed.

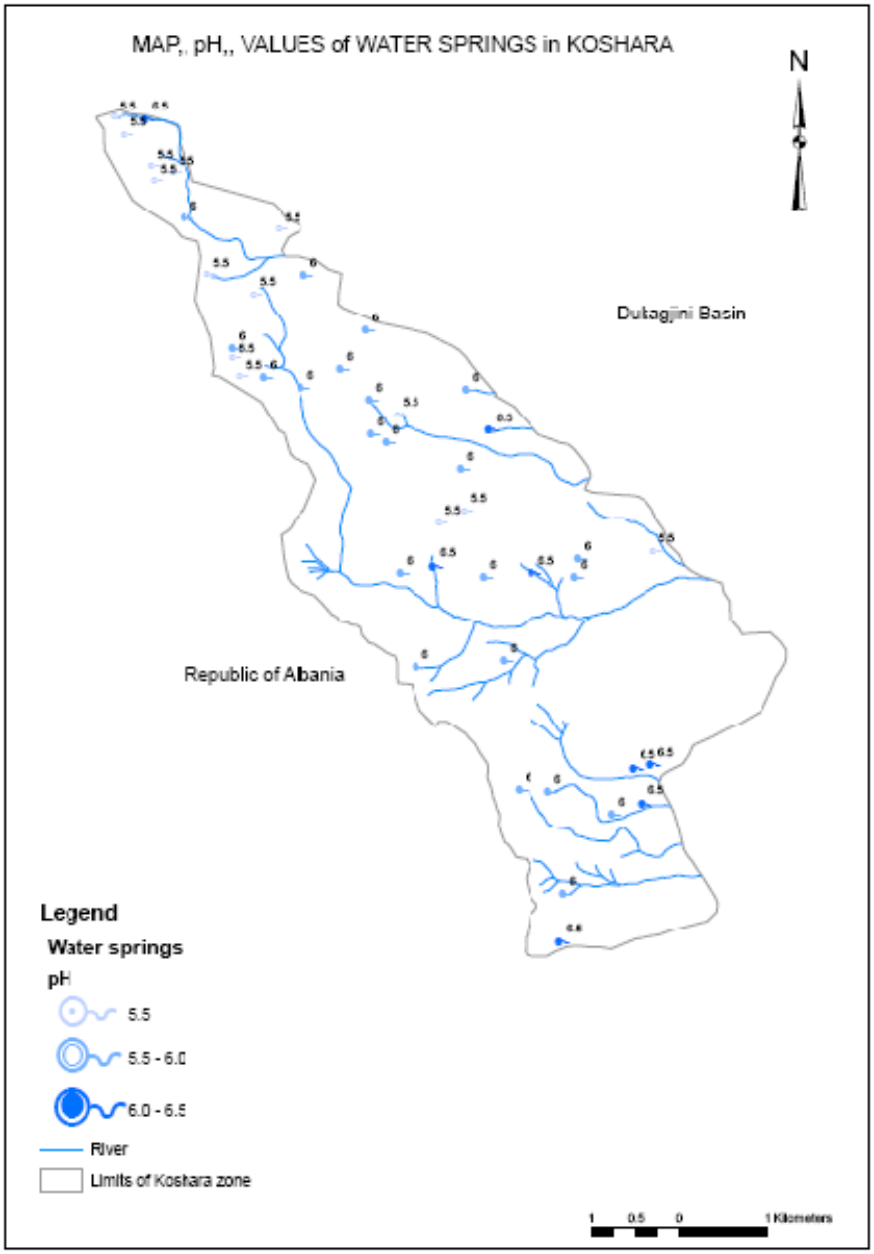


Fig. 2. pH values of the water springs, Koshare area

CONCLUSIONS

Koshare area in Kosova contains geological formations ranging in time from Paleozoic to Cenozoic and belonging to tectonic areas of Mirdita and Alps.There are distinguished two groups of water-bearing formations in Koshare region: compact rocks that contain fracture-type groundwater and soft formations containing porous-type groundwater. From the hydrogeologic point of view two groups of water-bearing formations are distinguished: compact rocks that contain fractures type groundwater (limestone, dolomite, diabase, serpentized peridotite, serpentine, granodiorite) and soft formations that contain porous groundwater type (gravel, sand, conglomerates, glacial sediments, prolluvium, alluvium). Most springs have low capacity (0.1-0.9 l/s), while those with a capacity of 4 l/s are rare. Springs with high capacity (40 l/s) emerge from

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carbonate karst formations. Groundwaters from the Koshare area are weakly acid (5.5-6.5), and they belong mainly to calcium - bicarbonate hydro chemical type.

REFERENCES

Antonijevic I., Karovic J., Pavic, 1968. *Basic geological map of Yugoslavia - Peja sheets scale 1 :100 000, Federal Geological Institute Belgrade* (in Serbian)

Cadaster of water and cadaster resource pipeline, 1985. *Institute for Hydroeconomy in Macedonian* (page 80-144, in Albanian and Serbian)

Elezaj Z., Kodra A., 2000. *Geology of Kosovo ,* Prishtina (page 393, in Albanian)

Dakoli H., 2007. *Hydrogeology part I, Tirana* (page 340, in Albanian)

Institute for Water Resources, Jeroslav Cerni, 1985. *Kosovo hydroeconomy base, 1985-2000,* Belgrade (page 5 – 35, in Albanian and Serbian)

ICMM., 2006. *Geological Map of the Republic of Kosovo, Prishtina*(scale 1: 200000, in English)

ICMM., 2006. Hydrog*eological Map of the Republic of Kosovo, Prishtina*(scale 1: 200000, in English)

Institute for Water Resources, Jeroslav Cerni, 1982, Journal 3, *Geology and Hydrogeology,* Belgrade (appendix 3, in Albanian and Serbian)

Institucional Support Project for Ministry of Environment and Spatial Planning and River Basin Authorities, *Pilot project for graundwater research in Dukagjin Basin, 2008 -2010*., Prishtina (in Albanian and English)

Institute of Spatial Planning, 2011 to 2012. *Spatial Plan for the Special Interest Area ,,Memorial Koshares,, section on of Hydrography, Geology and Hydrogeology,* Prishtina

Mijatovic B., 1980. *Report on the results of Phase I and II of hydrogeological research in the areas of Junik,* Geozavod fund, Belgrade (in Serbian)

R.O., Geozavod., Hydrogeological and Geotechnical Research Institute, 1985. *The construction of hydrogeological map sheets Peja (scale 1:100000, sections 53/2 and 54/1, scale 1:25000),* Belgrade (in Serbian)

R.O., Geozavod., Hydrogeological and Geotechnical Research Institute, 1985. *The construction of hydrogeological map sheets Peja (scale 1:100000, sections Tropoja, Ponoshec, Bec, scale 1:25000),* Belgrad (in Serbian)

Vilimanovic J., 1969. *Hydrogeological incestigations between the villages of Piskota – Skivjan near Gjakova*, Geozavod fund, Belgrade (in Serbian)

Vilimanovic J., 1973. Regional h*ydrogeological incestigations Kosova,* Geozavod fund, Belgrad(in Serbian)

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GLACIAL LAKES OF BULQIZA AND LURA OPHIOLITE MASSIFS, AS SPECIAL OFFER FOR MOUNTAINOUS GEOTOOURISM

Naim KARAJ[1], Hamit NOKA[1], Ilir ALLIU[2], Sali BUSHI[1], Sefedin SHABANI[1], Sabri HOTI[1], Afrim NELA[1]

[1]Albanian Geological Survey, Tirana, Albania.
[2]Polytechnic University of Tirana, Faculty of Geology and Mining, Tirana, Albania.

ABSTRACT

There are numerous glacial lakes in Albania, especially in northern and eastern mountainous regions of Albania.
Bulqiza ultra basic massif it is the biggest and the richest in chromate ore massif. On the surface of Bulqiza and Lurar ultramafic massifs there are formed a lot of glacial lakes. At Balgjaj Mountain, in Bulqiza massif, there are formed 22 glacial lakes; most of them are full of water during all the year. The glacial lakes of Bulqiza and Lura ultramafic massifs there are amongst the most beautiful glacial lakes in Albania... The most beautiful glacial lakes on the surface of Bulqiza ultra basic massif there are the following: Black Lake, Sopoti Lake, White Lake and Sopeve Lake.
At Lura ultramafic massif there are some glacial lakes, known under the term "Lura Lakes" ("Liqenet e Lures"). They compose a group of 18 glacial lakes, and 8 of them are permanently with water, while the others are at the eutrophism phase. Here, the most part of glacial lakes there are formed in Lura pine forest, which it is proclaimed as National Forest Park since 1962.
All glacial lakes on the surface of both Bulqiza and Lura ophiolite massifs are of distinct natural beauty, but so far they are not well estimated, especially for their geotourist values.

KEY WORDS *Glacial lakes, ecotourism, tourism, Bulqiza, Lura, Albania.*

INTRODUCTION

The lacustrine system is one of the most important elements of the hydrographic network of Albania. It is characterized by its perfect natural individuality, which it is shown by their big number, sizes, geographical distribution, origin, etc. Based on genetic criterion, there are formed different types of lake such as: Tectonic-karst lakes; glacial lakes; karst lakes, and fluvial lakes (Qiriazi, P., Sala, S., 2006).
The glacial lakes are formed during the glacial Wurm time, when the glaciers were distributed in mountainous relief of our country. At the same time there were formed a lot of glacial cirques, moraines and valleys in Albanian Alps, and in eastern and southeastern geographical units. A lot of glacial lakes there are formed in upper levels of Lura, Bulqiza, Shebeniku and Devolli ophiolite massifs. Commonly, they are placed at highest 1600 – 1800 m above the sea level. Generally, glacial lakes are of small size and there are very similar to each other. The most important feature of glacial lakes it is their aesthetic view. In the most cases they are rounded by pine forest and by specific vegetation. On the surface of the lakes there are grown, especially during the spring and summer a lot of flowers and green, typically plants.
Glacial lakes represent geological sites of very important tourist values and for mountainous climbing sports (Doka, Dh., Draçi B., 1990). Below we are describing shortly and showing pictures of some beautiful glacial lakes in Bulqiza and Lura ultra basic massifs.

Geological setting

Bulqiza ophiolite massif belongs to the eastern belt of Mirdita ophiolites. It is the biggest and the richest in chromate ore massif in Albania, where is prospected the biggest in Europe Bulqiza Chromites mine (Karaj, N., et al. 2001, 2002). According the petrological-mineralogical content, common section from east to the west it

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is as following: peridotites, which outcrop from Ternova south to Qafe Murra north. On peridotite sequence there are placed peridotite-dunite and dumite-peridotite sequences. While in the upper part of the section there are placed dunite and piroxenite sequences. Structural dipping of the rocks it is mainly to the south east direction. The most part of the glacial lakes there are placed on the peridotite sequences of petrological section, forming two large groups: one on the southeastern part, north of Ternova chromite deposit and the second group is located at northeast, to the east of Muceku Mountain. Some small glacial lakes there are formed to the west, in peridotite-dunite sequence.

Lura massif, located north of Bulqiza massif, belongs to the eastern ophiolite belt as well.

In Lura ophiolite massif, glacial lakes there are formed on the eastern slope of Lura-Deja Mountain Chain, from Krei Lura north up to the Pela Peak in the south. Here outcrops peridotite sequence of Lura ultra basic massif, with a thick amphibolites sequence at the bottom, in the eastern part of the slope. In this slope at altitudes 1500-1800m, between beautiful pine trees, there are formed 12 glacial lakes, several moraines, and complex cirques.

The glacial lakes are located on the glacial deposits, which cover the ultramafic rocks of Bulqiza and Lura massifs. The erosinal–denudation relief predominates up to the elevations 1600m – 1700 m and the glacial–frozen one at highest elevations (Pumo, E. Krutaj, F, 1990). The glacial deposits consist of coarse clastic ultramafic rocky fragments of size up to several m^3, high rounded and in a silty–gravel matrix. Glacial deposits are of about 10m – 20m thick. They are easily percolated by ground and underground waters, which is shown by numerous springs that flow at their bottom and within them. This might also suggests a possible interconnection between the lakes themselves. The surrounding relief of the lakes is various, smooth to vertical.

Geographic location

The following glacial lakes there are located in Bulqiza ultramafic massif: **Balgjaj group of glacial Lakes**. These lakes occur around of Balgjaj Mountain. This is the mountain with the highest number of glacial circuses and lakes in Albania. There are 5 big circuses with diameter 2 km to 2.5 km, where 22 glacial lakes are formed. A part of them is full of water during all the seasons of the year. The glacial lakes of Balgjaj are grouped as follows: 1.Balgjaj lakes. 2.Allamani lakes. 3. Kurdaria lakes. 4. Kasnia lakes. 5. Vali lakes. These groups of lakes are separated from each other by the watersheds flanked by the summits: Plakthi Top 2024.5 m., Kreshta Peak 2101.2 m., Gurrat e Zeza Mountain 2079.0 m., Kllogji Pass 1850 m., Allamanit Pass 2006 m., Arnishta Peak 2073 m, and Micekut Mountain 2100 m. At the eastern side, the watershed continues from Allamanit Pass, at the elevations: 2046 m., 2021m to 1960 m., in northeast, and at the elevations: 2016 m., 2019 m., and 1963 m, in east. Glacial lakes there are located at the elevations from 1650 m to 1900 m above the sea level. The biggest lake is Gropa Lake (some 8 ha), followed by Black Lake (Liqeni i Zi, 6 ha), Lower Shtrunga Lake (Liqeni i Poshtem i Shtrunges, 4 ha), Balgjaj Lake (4 ha), and so on. They can be accessed by the rural road Bulqiza – Maqellare – Kacnia, or by the forester one Qafe Murre – Balgjaj.

Lake Liqeni i Zi. This lake it is located at the northern flank of Lopa Mountain, of about 1800 m above the sea level. It has a surface of about 45 ha, within a complex circus 400m long, 200 m wide, and 60 m deep. At its three sides, it is surrounded by steep slopes with pine and beech forests. It has highly clear and cold water and typical beauty. The black color is due its high depth. During the socialist period, a dam was built and the water was used for irrigation, during the summer period. This highly damaged this lake. In the year 2004, the construction of a hydropower station began and it will use the water of this lake and its surrounding tributaries. This will have a negative effect on the lake values. This Lake, can be accessed by the rural road from Bualli Pass to Batra of Martaneshi, and footpath to Liqeni i Zi.

These are some of the main glacial lakes of the Bulqiza massif that have e distinguished natural beauty, but so far not well estimated especially for their geotourist values. Some other glacial lakes of this massif there are: Durici Lake, which due to the mining activity of the Bulqiza chromites mine have less water, Sopoti Lake, White Lake, and Sopeve Lake.

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Fig. 1. Balgjaj Lake

On the surface of Lura ultramafic massif there are formed many glacial lakes, which are known under the term "Liqenjte e Lures" ("Lura lakes"). They are a group of glacial lakes that are placed at the eastern slope of Kunora e Lures mountain (1 500 – 1 600 m) above the sea level. The biggest glacial lake here it is Big Lake (Liqeni i Madh, 32 ha). It is 425 m long and 300 m wide. Names of some other glacial lake in Lura massif there are as following: Pine Lake (Liqeni i Pishave, 13 ha), Black Lake (Liqeni i Zi, 8 ha), and Flowers Lake (Liqeni i Luleve, 4 ha).



Fig. 2. Maceku 5 Lake

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Fig. 3. Muceku 6 Lake



Fig. 4. Kasnia 1 Lake

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Fig. 5. Kasnia 2 Lake



Fig. 6. White Lake (Liqeni i Bardhe)

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- Flowers Lake (Liqeni i Luleve), some 45 ha, lies in a glacial circus in the Lura National Parkk, at Kunora e Lures, of about1 600 m above the sea level. It is distinguished for its white lily that blows in June. The lake has hydro geological, biological, ecological, aesthetical, and didactic and geotourist values.
- Balck Lake (**Liqeni i Zi)**, it has a surface of about 3 ha. It is a deeper glacial lake and so it has black color.
- Big Lake (Liqeni i Madh), **it is** of about 50 ha. It is distinguished for its clear water and various fauna and flora, and in summer it is covered by big white lilies. The high elevation above the sea level of Lura lakes, their high clearness, blue and black of their waters and their surrounding pine forests, offer a picturesque landscape of a distinguished natural beauty.

Water-bearing
The waters of the glacial lakes of Bulqiza and Lura ultramafic massifs have a high limpidity and dark blue color. They are fed by rainfalls in their areas, mainly like snow. This is conditioned by their water balance and mainly by the supply from the water of the smelted snow. Numerous torrents flow from the circuses and lakes running through the mountains slopes, which are continuously fed by the waters of these lakes. The regime of these lakes is of the alpine type with slight frequences of their level during the different months of the year. The highest levels occur in spring, after the snow smelting, and the lowest ones in winter, when they are frozen and covered by snow. The limpid water and surrounding pine forests form a very attractive ecosystem of these alpine lakes. The water of these lakes is supplied by the snowfall, rainfall, ices, and the underground waters of the winter that percolate the fissures of the ultramafic rocks. Outskirt areas of these lakes are pine and beech forests.



Fig. 7. Flowers Lake

Infrastructure

It should be mentioned that at the area of the Bulqiza ultramafic massif, at Balgjaj lakes, there is the line of high voltage that comes from Bulqiza town, passes near these lakes and reaches to Selishta. There is also a road, used for the transport of wood and chromite ore. Concerning the Black Lake (Liqeni i Zi), here it is under the construction a hydropower station and the related line of high voltage and the new road.

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To the Lura Lakes, can come by the road from Peshkopi City to Fushe Lure or from Resheni town to Fushe Lure.

CONCLUSIONS

The glacial lakes of Bulqiza and Lura ultramafic massifs are distinguished for their rare natural beauty that so far it is not estimated especially for their geotourist value.
With the further improvement of the infrastructure and especially of the road network, as well as some necessary preliminary investments, the complex of the lakes of these areas will become one of the most attractive zones for the mountainous tourist development in Albania.



Fig. 8. Big Lake in Lura

REFERENCES

Doka Dh., Draci B. *Gjeografia e turizmit*. Tirane 2002
Gruda Gj. *"Malet e Lures"*. *Gjeografia Fizike e Shqiperise*, vellimi II, Tirane 1990
Karaj N., Dhima K., Hallaçi H. (2001). *Gjendja, perspektiva e vleresimi i rezervave te mineralit te kromit ne brezin Lindor te ofioliteve te Shqiperis.* Arshiva I. K. Gjeologjike Tirane.
Karaj N., Hallaçi H. (2002). *Perpilimi i projekteve te kerkim-zbulimit per vendburimet e kromititit dhe objekteve kryesore (Masivi ultramafik i Bulqizes).* Arshiva I. K. Gjeologjike Tirane.
Karaj N., Beshku H. etj. (2005). *Studim pergjithesues mbi kromititet e Shqiperise*. Arshiva I. K. Gjeologjike Tirane.
Koçeku B., *Lura, tradita dhe zakone*
Pano N., Tirane. *Pasurite ujore te Shqiperise*.Tirane, 2008

ISSN 2306-9600

Pumo E., Krutja, F., etj. *Gjeografike Fizike e Shqiperise*, 1990
Qiriazi P., Sala S., *Monumentet e Natyres te Shqiperise* Tirane 2006
Xhomo A., Kodra A., etj. *Gjeologjia e Shqiperise.* Tirane 2008

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CAVES AS OPPORTUNITIES FOR DEVELOPMENT OF TOURISM IN LEKBIBAJ MUNICIPALITY OF TROPOJA

Jetmir DUNGA[1],
[1]*Pro-Geo Albania, Tirane. E-mail: jetmirdunga@gmail.com*

ABSTRACT

This paper will be presented as an alternative and opportunities of caves assessment for sustainable development of tourism. Emphasis is placed on the following caves: Boshi, Kakverrit, Mark Qereshit, River and Rajzës caves. These caves have a great scientific value teaching and especially for geoeco tourism. Exploring and putting into exploitation for touristic purposes, according to the concept of sustainable development would bring development to municipality Legbibaj and all Kukes district.
Although an area remote from urban centers and main streets of this municipality offers great potential for tourism and geotourism development. Caves, the natural resources of the area, ethnographic and cultural heritage should be combined in such a way to arouse the interests of others and enable the development of sustainable tourism.

KEY WORDS *Municipality Lekbibaj, caves, tourism, geoecotourism*

INTRODUCTION

In this paper we will present the values and opportunities of Lekbibaj municipality in development of tourism and geoecotourism in this mountainous, carbonate rocks area. For that purpose, here will be described some karst caves as one of the main geotourist potential of great interest for the Municipality of Lekbibaj, located in the district of Tropoja, 26 km from the town of Bajram Curri. It is part of Kukesi district. Although far from the major urban centers, this area is among the most beautiful zones in Albania.
In physical terms this geographic municipality lies in the Nikaj-Mertur Basin, the largest unit in the eastern Albanian Alps. Distinct peaks there are that of Hekurave (Iron Peak) after Jezerca, Boshi yeast, yeast of Kakais, and Toplanës. There are two large valleys named Curraj and Nikaj. In this relief is likely to develop more kinds of sports such as: the sport of skiing, hiking, hipism etc.
Municipality Lekbibaj, in geological aspect it is built by carbonate rocks, mainly limestone of Triassic Age. In some places there are flysch formations. In this area we have a large variety of forms of relief, especially karst relief with various forms such as: dolines, potholes, ridges, slopes, and caves, canyons, as well as glacial forms such as: circuses, glacial lakes, moraines etc. The climate of the area is mountainous with 8-10 º C average temperature and rain fall of about 2763mm.
Hydrography it is represented by Nikaj River (19 km long), which consists of two branches: Curraj and Nikaj. In these two rivers there are very good chances of developing water sports. Flora and fauna is rich in rare endemic plants.
In Lekbibaj municipality there are discovered 6 caves that have been explored and are in the process of exploration. According the Law No. 8906 dated 06.06.2002 and the Law no. 676, date. 20.12.2002, all these caves are proclaimed under the protection as monuments of Albanian Nature.
Below we will do the description of these caves.

Boshi Cave

This cave it is located in the Tropoja Region, in Lekbibaj municipality. This area is part of the Albanian Alps, and it is named Nikaj-Mertur Highland. To come there it is of about seven hours walking distance from the Upper Curraj village. The way to go to this cave is very difficult because it will have to follow the mountain road. This cave is named after the mountain, Boshi Cave.
It is located 1916m above sea level. The cave entrance is about 70 cm close to its end and with higher of about 1.3 m, where the top entry of the cave is going to be narrow to 40cm. Boshi Cave it is a quite nice, equipped with stalactites and seeing stalagmites, thicknesses of which there are achieved in an argument that

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this cave is not so old. Here it is seen the clear activity of water, especially in the second ceiling, where there is water into the layers of limestone. Cave presents great interest of geotourism for various scholars, especially geographers, geologists, speleologists, biologists etc.



Fig.1. Boshi Cave

Kakveri Cave

Kakverri Cave it is located in Tropoja district, in Lekbibaj municipality, which is the part of the Albanian Alps, and Nikaj-Merturi Highland. This cave is located in the Mount (Kakis), which is five hours away by foot from the Upper Curraj Village. The way to go to this cave is very difficult, because it is need to move on the mountain. Situated at an altitude of 1900 m above sea level and located on the slope of the interior of a large Dolina the cave entrance is about 20 wide and 8 m from the ceiling to the floor. Inside the cave was great where it should be said that there were many collapsing rocks. This space continues to shrink in a country barely, where only speleologists can be go inside. Then it starts to expand but not to the extent that been before. In the cave it was found water well. Cave presents an interest for tourists and researchers and because it is located in a beautiful Dolina.

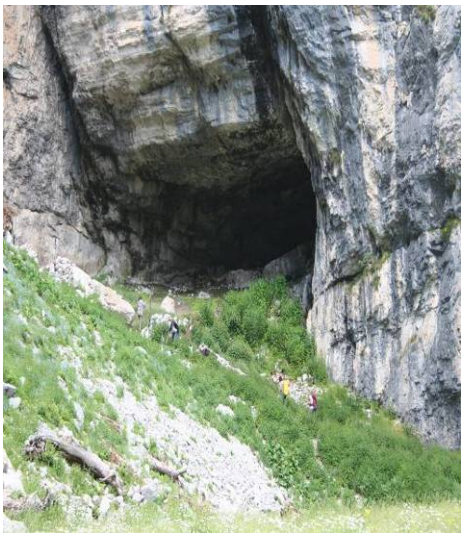


Fig.2. View of Kakveri Cave

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Black Cave

This cave is located in the Qeresh Village of Lekbibaj municipality, in Albanian Alps, in Nikaj-Mertur Highland. It is of about two hours away walking from Upper Curraj Village. It is located of about 950m above sea level. The entrance of the cave is 30 meters high and 10 meters wide. This cave is one of the caves with large spaces of the area. Regarding the geological construction is composed Triassic limestone. Inside the cave there are some water basins. The cave represents very good opportunities for tourism and geotourism, for study purposes such as: geological, geomorphologic, biological, speleological etc. This cave is continuing its exploration by different scholars.

River Cave.

River Cave located in municipality of Lekbibaj, in Albanian Alps. It is located at the bottom of the Kaki Mountain. The height is of about 900 m above sea level and 100 m above the bottom of Curraj River. This cave is three hours walking from Upper Curraj Village. It represents a great geotourist values. Inside the cave there are found stalactites which range up to several meters in waterfall shape and stalagmites at the bottom of the cave.



Fig.3. River Cave



Fig. 4. View of Marku Cave

Mark Cave

It is located in Lekbibaj Municipality, in Albanian Alps, in the area of Nikaj-Mertur, just at the Kaki Mountain. It is at the height of about 1200 m above the sea level. The cave is formed in Triassic limestone. This cave is of about two hours away by foot from the Upper Curraj Village. For the first time this cave was discovered in 2009 by Italian-Albanian Group of speleologists. This cave has a very small entrance which then is goind to expand. It has a large value, especially in scientific geological and geomorphologic aspects.

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Fig. 6: The view of Drela Cave

Dreles Cave

The cave is located in a place called Drel, two hours walking from Curaj Upper village. The cave entrance it has a diameter 4m, and widness of about 2m. This cave is located right next to the pedestrian street that leads to the mountain of Boshi. The cave represents great scientific value for geologists, geomorphologists, biologists, speleologists and tourists.

In addition to the above mentioned caves as an opportunity for the development of tourism, there are some offers and opportunities of cultural heritage in Lekbibaj area. Lekbibaj Community is an area of great wealth folk and ethnographic, which gives a great impetus to the development of potential tourism. But this should be a great attention from local and national governments to improve road infrastructure, especially that which is lacking. Also to solve the problems connected with water and electricity supply.

Intineraries to visit this area

1. The route from Tirana to Koman, to Bajram Curri town and from Bajram Curri to Lekbibaj. In addition to the main destination of Lekbibaj we suggest to visit Koman tectonical-structural geosite, and Komani Lake, traveling by boat, which is very special trip. Street from Tirana to Bajram Curri is good, while from Bajram Curri to Lekbibaj is unpaved. From Lekbibaj Center of Comune to caves, the road is very difficult and must be done on foot, approximately of about four hours through Upper Curraj.

2. Route Tirana-Reps-Kukes-Has-Bajram Curri-Lekbibaj. Even here in this route are likely to see Oroshi Mountains, protected area canyon Vanave in Kukes and Hasi karst plateau.

REFERENCES

Dunga J, 2010; *Zona e Tejdrin ne rrethin e kukesit*(Teme masteri)
Dunga J, 2011; *Disa biomonumente dhe gjeomonumente të reja në zonen e Tejdrinit në rrethin e Kukësit. GeoAlb Mitrovice* .Gjeografia fizike e Shqipërisë, Vëllimi I dhe II, Tiranë, 1991
Meçaj Nasip, *Qarku i Kukësit*, Tiranë: TOENA, 2004
Qiriazi Perikli, Sala Skënder, *Monumentet e natyrës së Shqipërisë*,Tiranë: Ideart, 2006
Serjani A, et al., 2003, *Gjeomonumentet dhe gjeoturizmi ne Shqiperi in both English and Albanian versions.*

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GEOTOURISTIC VALUES OF THE RIVER CANYONS OSUMI, LENGARICA, SKRAPARI AND GRUNASI

Edlira FILIPI[1], Florina PAZARI[2]

[1]*University of Tirana, Department of Geography. E-mail: 008@hotmail.com*
[2]*University of Tirana, Department of Geography, E-mail: floripazari@yahoo.com*

ABSTRACT

Canyons are among the most interesting geomonuments (geological sites) dististinguished for their magnificence and their aesthetic, tourist values. The presence of a great number of rivers passing through a variety of geological formations has conditioned the presence of so many canyons in Albania. The most interesting canyons there are included in the Monuments of nature list (Third Category of Protected Areas), according to the law Nr.676 on 20.12.2002 for "Protected Areas". The most magnificent and frequented canyons in Albania there are Osumi, Skrapari, Lengarica, and Grunasi canyons. Although their scientific and tourist values are so great, canyons are among the geomonuments that are still unfamiliar to tourists, because of the lack of information and because their presence into tourist guide books and guide tours is almost missing. The geo-information of the Albanian canyons would enhance their tourist use in the future.

KEY WORDS *Canyon, geo-monument, geo-tourism, geo-information, monument of nature.*

TOURIST AND SCIENTIFIC VALUES OF CANYONS

Morphological features of canyons in Albania are different mainly due to the geology, river erosion activity, rock resistance etc. Canyon's width may range from tens or more of meters to few meters, creating the view of narrow river straits with very steep, deep and spectacular almost vertical slopes of the valleys. Another distinctive feature of the canyons is the intensive erosion activity in depth of the river valleys, associated with the strength and resistance of mainly the limestone rocks. Canyons in Albania there are formed mainly in resistant rocks, with steep slopes such as the case of Valbona Canyon at the river valley sector so-called "Ura e Shoshanit" (Shoshani bridge), Grunas Canyon in Theth, Osum Canyon, Lengarica Canyon etc. There are also cases, where the canyons are formed in magmatic rocks, such is Devoll Canyon. Therefore the canyons have scientific values where the geologists, geomorphologists, hydrologists, biologists, geographers etc., may find answers too many questions in their field.
Despite that canyons represent river relief forms with specific natural values; they also offer tourist, recreational and educational values. Unfortunately so far in Albania the use of these potentials is hampered by a number of economic and social factors. The lack of tourism infrastructure to attract local and foreign visitors is the main factor of the non utilization of these geomonuments. Poor access to national roads and the presence of rural roads that are not in proper conditions make difficult to reach to the canyons. The risks that tourist may face due to lack of roads, rough terrain areas, where these geomonuments are located and lack of a tour leader is an obstacle for the development of canyon geotourism. Lack of tourist villages or houses for tourists near to the canyons as well as the lack of experience of residents to create familiar accommodation, that can be offered to tourists is another problem encountered in many areas where these geological sites are located. Also the lack of specialized travel
Agencies, that provide technical assistance to the sport with canyons or kayak is a separate issue. All these facts together with the ongoing migration of population from these areas reduce the opportunities for promotion and marketing of the natural potentials that the Albanian canyons have.

Most interesting canyons of Albania

Canyons of Osum, river valley. There are formed in limestone rock and their distinctive feature is that they are located along the geological structure, unlike the other canyons that cut athwart them that go intersection cross-line. They are distinguished for their vertical steep slopes and irregular forms of the river valley bottom.

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Gradeci canyon, which is undoubtedly the most beautiful and spectacular canyon on the valley of Osum river has a length of 4 km and it is quite narrow from place to place with only 1.5m width. Its height reaches up to 40 meters with rocky walls falling straight to the river. This canyon is the largest canyon of Albania and one of the most fantastic in Europe, according to the comments of the European researchers that have visited it. This canyon represents also an original ecosystem with Mediterranean vegetation covering its slopes and various fish species growing in the river. Some special rock forms are formed on the slopes of both riversides, which are among the rarest in the Albanian canyons.

The other canyons of Osum river valley can be reached going to the south of the valley. These canyons that are located about 3 km in the south of Çorovoda are magnificent natural geomonuments about 15 km long, 10-20 meters wide, but in specific sectors narrowed to 3 meters. Their height reaches up to 30-50 meters. In these canyons are developed water sports as rowing or kayak and some special ponds are suitable even as beaches such as Varishta beach.

Along the Osum river valley, in the northern side of the Gradec canyon, in the altitude of 450 meters is located the cave of Piro Goshi, which represents the longest cave explored so far in Albania, about 1853 m long (Dollma, 2011). The cave entrance is about 12m wide and 4-5 m high, while the most interesting part is the big hall with multiple interesting forms of stalactites and stalagmites. The cave ends with a deep well where colony of bats is found.

Osumi Canyons along with Piro Goshi cave have complex geological, geomorphologic, aesthetic and tourist values.



Fig. 1

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Lengarica Canyon. It is noted for the magnificent severe nature in a length of several kilometers. The specific relief forms of the valley, such as the different slopes in height from 80-100m, falling perpendicular to the river water surface, or the width of the riverbed that rarely exceeds 1.5-2 meters provide stunning view of the canyon. On the canyon's slopes there are numerous cavities and caves that are connected to each-other through tunnels and galleries. On the left slope of the valley is located one of the largest cave of the canyon so called "Shpella e Pellumbit" (Dove's cave). This cave is distinguished not only for natural values, but also archaeological ones, where the archaeological findings have proved that the cave has been a prehistoric settlement.

At the exit of the canyon, on both sites of the valley there are numerous thermal springs with sulfur base and large water outflow with temperature reaching 30^{o} C. These springs have great curative values. The presence of these thermal springs and those of Postenan and Vromoneri of Leskovik is connected to the presence of the deep tectonic faults in this area. The canyon is not passable throughout its length due to underground tunnels, escalation, rapids and thresholds that form a very interesting ecosystem.

Grunasi canyon. Is the monument of nature located in the southern part of Thethi Park, which is formed in massive carbonate formations. It is about 2 km long and 60 meters deep. Its width varies from 2-3 meters to 30-40 m. The canyon stands for its incomparable beauty with sufficient water to navigate the canoe lovers. The water of Thethi River is crystal clear and cold all the times. In this river sport of rowing can be done in autumn and spring seasons when the river has abundant water coming from the melting snow of the mountains and high quantity of precipitation in these seasons. The realization of this sport is helped by the river flow. What make this canyon special are also its typical ecosystem with alpine vegetation and many species of wild pigeons.

Skrapari canyons there are rare in Europe. They have a length of 10 km and depth up to 340 meters. The stunning beauty of these canyons was not used for tourism purposes until the early of 90s. Tourism in the canyon areas is being a yearly ritual of foreign tourists, mainly interested in driving the canoe or kayak. The canyon can be reached in two ways, through the river by canoe, kayak or rubber boats or overland by car or on foot. Rowing in the river is possible in every season because the river is not so rapturous but usually the period from spring to late fall is preferable.

CONCLUSIONS

Albania has a considerable number of canyons with great scientific, esthetic and biodiversity values, which offer a great chance for geo-tourism development. The promotion of the tourist potential of the Albanian canyons, water sports and ecosystem values is the immediate duty of the responsible tourism authorities and agencies. Their inclusion in tourist itineraries will increase the tourists' interests for the unique natural landscapes and the water sports that these canyons have. Also the improvement of the infrastructure, especially the roads leading to them will shorten the time and will increase their accessibility.

REFERENCES

Albanian Academy of Sciences (1991) – *Physical geography of Albania,* I, II, 41-42,318-319,338

Dollma,M. (2011) – *Albanian regions*. Dajti 2000, 78-81.

Dollma M., Hoxha R. (2011) - *Geoinformation of the Albanian caves:* Proceedings of GeoAlb 2011, Mitrovicë, 448-451.

Kristo.V. (1984) – *Gepmorfology*, II, Kombinati Poligrafik,Tiranë. 159-160

Ministry of Tourism, Culture, Youth and Sports (2007) - *Resources of natural tourism of Berat district*, 98-113.

Berat Country. (2010)- *Tourism strategy and action plan of Berat in the period 2011-2021*, 15-16.

Serjani A., Neziraj A., Wimbledon P., Onuzi K., Hallaci H., Bushati S. (2003) - *Geological heritage and geotourism in Albania*, ProGeo Albania, Tiranë, 32-98.

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GEOHERITAGE OF KORÇA COUNTY AND ITS TOURIST VALUES

Edlira MENKSHI[1], Edlira FILIPI[1]

[1]University of Tirana, Department of Geography, E-mail:
E-mail: eda_ndreko@yahoo.com efilipi2008@hotmail.com,

ABSTRACT

Korça County it is located in the southeastern part of Albania and covers an area of about 3697 km^2 at an average altitude of 850 m above the sea level. Korça Region it has a variety of landforms and geological peculiarities and consequently, a lot of interesting geomonuments (geological sites). Within Korça County there are three geoparks and twenty-eight geomonuments, which have been proclaimed monuments of Albanian Nature, according to the law for protected areas. These geological sites together with their biodiversity and hydrology of the region, constitute the complex of natural diversities with high geological, morphological and tourist and geotourist values.

Unfortunately this geoheritage is not yet known and frequented due to the poor promotion and information. Therefore geoheritage promotion, conservation and management should be part of regional and local strategic plans.

KEY WORDS: *Geoheritage, geotourism, strategic plans, promotion, geoinformation.*

GEOMONUMENTS AND GEOPARKS IN KORÇA COUNTY

Korça County has three geoparks of national and international importance, seventy-five natural monuments, twenty-eight of them are geomonuments (Qiriazi, 2008). Geological sites (geomonuments), include various lithostratigraphical sections, tectonical-structural outcrops, morphological peculiarities, karst, glacial and erosion-river processes, caves etc. The most important geoparks in Korça Region there are: Gig and Small Prespa lakes geopark, Drenova Pine forest, proclaimed as National Forest Park since 1962, and Ohri Lake, a crossborder geopark between Albania and Macedonia. Amongst the geological sites of the region we can note here Maligrad Island in Big Prespa Lake and Treni Cave in Small Prespa Lake.

Prespa geopark. It is located in three countries: Albania, Greece and the Former Yougoslav Republic of Macedonia (FYROM), (Serjani, 2009). Prespa National Park includes two lakes, Big Prespa (285 km²) and Small Prespa (44 km²), (Dollma, 2011), while the total surface of interborder geopark it is approximately 2500 km².

Prespa's lakes constitute a cross boundary geoecosystem of great importance for three states. The western part of this geopark, located in the Albanian territory, geologically it is constructed by Triassic and Upper Cretaceous limestone, by flysch of Paleogene, and by molasses of Neogene (Miocene) (Serjani, 2009). Both lakes have been originated by neotectonic-karst activity.

This geopark stands out for numerous water springs, rare biodiversity, characteristic vegetation and birds, especially Pelican. An important and aesthetic geological site (geomonument) of this geopark it is the Maligrad Island, wellknown for its natural and cultural values.

The Maligrad island it is a geomonument of 200 m length and 700-800 m width, located in Big Prespa Lake, at the height of 900 m above the sea level (Qiriazi, 2008). This island made it is up by limestone, represents the sinking residues of Prespa graben. Pelicans and snakes are the residents of this island. In the island there is also a fourteenth century church. This Island can be visited for its geomorphologic, religious and fauna values.

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Fig. 1. Prespa National Park.

Treni Cave. It is located in the Gorge of Wolf (Prespa Small lake), at the height of about 706 m above the sea level. This cave was formed by karst processes, favored by the presence of calcareous rocks. The cave is 293 m long, it has corridors, water basins, chambers and interesting forms of stalactites and stalagmites. There are also a bat colony and ancient wall drawings. The cave has geological, biological, historical and archeological values.

Drenova Geopark. It has an an area of 1.380 ha. It is proclaimed National Forest Park since 1962 for the beautiful Bozdoveci pine forest. Here, there are interesting geological outcrops, especially Drenova stratigraphical section, interesting morphology and biodiversity (Dollma, 2011). It is distinguished not only for the special natural habitats but also for the fresh air and cold curative springs. The presence of some geomonuments, such as the Goat stone, has increased the tourist values of this park.

The Goat stone. It is a geomonument (geological site) represented by forms related to rare kind of erosion. It is set in a conglomerate - sandstone rocks with a length of 25 m and of about 10 m high (Qiriazi, 2008). Its shape of a sitting camel has been created by the wind erosion in the sand stone.

The cross border geopark of Ohrid Lake. It represents a cross-border geoecosystem of a great value of both Albania and FYROM. This geopark is formed as a result of neo tectonic and karst processes in the northern part of Albanian-Thesalian depression (Serjani, 2009).

Ohrid lake is the deepest lake in Balkan with a maximal depth 295 m and an area of 363 km² (Dollma, 2011). This geopark it is rich in water springs such as Drilon, Tushemisht, and Saint Naum, which constitute hydrokarst geomonuments with tourist and geotourist values (Dollma, 2011).

The cave of Saint Marena, it is located near St. Marena monastery and the church of St. Marena in Pogradec District. It is a karst cave, formed in the limestone of Cretaceous age. The already explored part is 180 m long and is rich in karst microforms.

According to the legend, in this cave lives the miraculous Saint Marena. Saint Marena Cave, recommended to be visited for its geomorphologic and religious values.

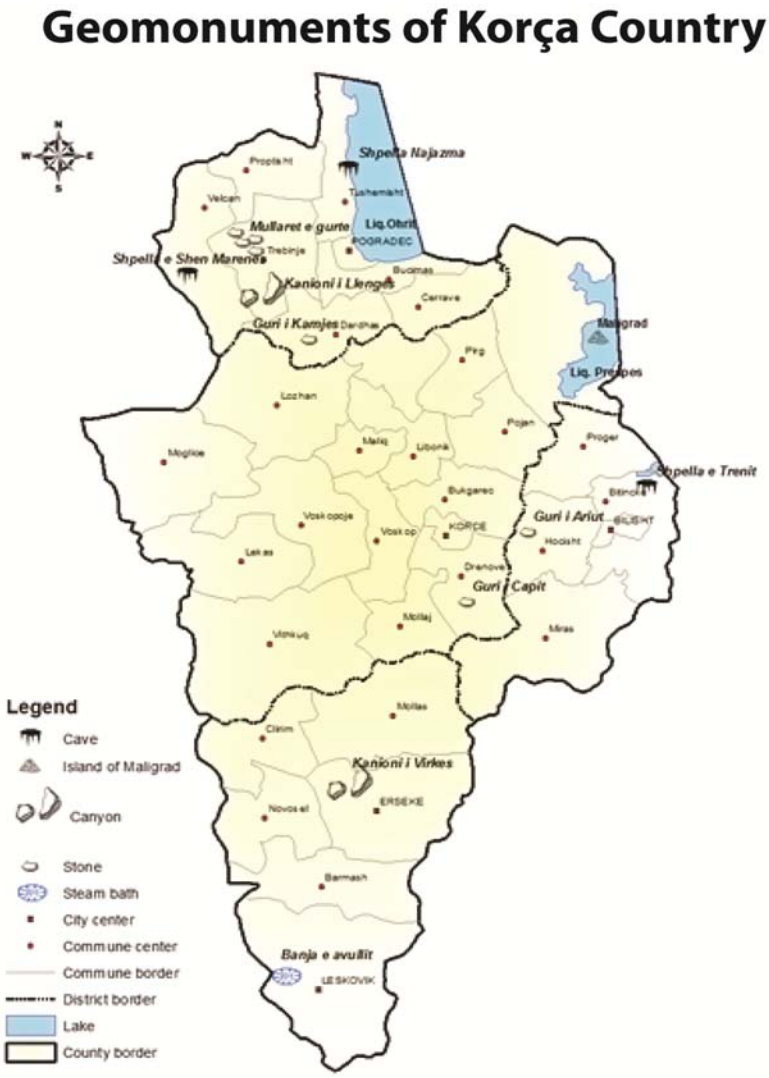
Kamja Stone. It is located in Dardhas Village, at a height of 1461 m above the sea level. This geomonument rises immediately in the surrounding territories, resembling a ship floating on a "Green Sea". With a length of 80-100 m, 70-80 m wide and 60-70 m high, this geological site represents a conglomerate rock, sculpted by the wind and water.

Virka canyon. It is located near the Gostivisht Village, 1000 m above the sea level. It is 1 km long, 2-4 m wide and 80 m deep. This gorge was formed by a stream erosion of Virka and by karst processes. It has also some karst caves in both slopes creating a karst ecosystem with geological and tourist values.

Gramoz glacial lake. It is located at the altitude of 2400 m in Gramoz Mountain, in Kolonja District. The lake (0.4 ha) is located at a glacial cirque, surrounded with dense vegetation. It has hydrological, aesthetic and tourist values.

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The Huge Mounds of stones. There are found near the Trebinja Village, in Mokra highland, 1150 m above the sea level. This geomonument it is represented by a group of stones, erosion remains, composed by conglomerate and sandstone. Their different structure and hardness is modeled by the wind and water, in the form of stone stack. Huge mounds of stones are 3-10 m high and occupy an area of 110 m long and 80 m wide (Qiriazi, 2008).



Tourist use of geoheritage

Geoheritage of Korça Region, despite the scientific, aesthetic and tourist values, it is still little known and therefore rarely visited. Unlike from the border areas of Greece and FYROM, where geological sites are included in tourist guides and tours, geomonuments of Korça County are poorly known and visited. One of the reasons for not being included in tourist tours is the lack of knowledge by the tour operators. Most of the geomonuments are not known by Albanian and foreign tourists, because most of them are located within the mountainous areas and the lack of infrastructure and signage makes it impossible to reach them.

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Existing tourist maps do not reflect their location and there is not an official inventory or geoinformation of geoheritage objects in Korça County.

GEOHERITAGE MANAGEMENT

The management of natural heritage of Korça County, including geomonuments and geoparks, is made through legal and institutional support in order to use, protect and heritage their values to the future generations.

Geoparks have the status of national parks and the geomonuments have the status of monuments of nature (the third category of protected areas). Their protection and management is done by the Ministry of Environment, Forest and Water Management and by specialized institutions. They are supported by Law Nr.8906 dated 06.06.2002 and Law Nr.9791 dated 23.07.2007 "For Protected Areas". The lists of biodiversity and geodiversity for every district of Albania, protected as monuments of Albanian Nature there are attached to the DCM Nr. 676, date 20.12-2002. Other bylaws exist to implement the previous act for protecting special areas, natural environment, flora and fauna, medicinal plants and other forest and non forest resources (Forest Directory of Korça Region). Local government has the responsibility of preserving of geomonuments situated in its territory and the regional tourism department has the duty to promote them for tourist purposes.

CONCLUSIONS

Currently in Korça County there are geoparks and geomonuments (geological sites) of great importance, but a small number of them are used for tourism. Promoting their values by the respective institutions or other interested organization, and tourist guides, through publications and scientific articles, media, etc, is a necessity, and that will affect to the development of geotourism. The involvement of geoheritage in action plans, regional and national strategy would help in the protection, management and sustainable development of the county. Scientific studies and research by experts in the field of geoheritage and other fields related to it, would influence to recognition the tourist values of them. The creation of a tourist map to locate all geoheritage objects with their values will increase the interest of tourists to visit them.

REFERENCES

Dollma M., (2011) – *Albanian regions;* Dajti 2000, Tiranë, 135-140.

Qiriazi P., (2008) - *The monument of nature in Albania;* Ideart, Tiranë, 80-92.

Qiriazi P.,Vranaj A., (1998) – *Albania physical geography.*Libri Universitar, Tiranë,186-228.

Regional Development Strategy of Korça district 2005-2015;(2005) District Council of Korça,SIDA,PNUD,
REC; Tiranë

Serjani A.,(2009) – *Geodiversity of Albanian lakes*, Int. Symposium: Lakes and their nutrients. Pogradec, Albania, 26-27 April 2009. Proceedings.

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ASSESSMENT OF THE TOURISM IN GJALLICA MOUNTAIN (KUKESI REGION)

Gladiola ISMAILI[1]
[1]*ProGEO-Albania, Tirana. E-mail: gladiola_88_@hotmail.com*

ABSTRACT

The aim of this paper it is to make a full assessment of the Gjallica Mountain for development of mountainous tourism and geotourism. Gjallica mountainous region in Kuksi District, reperesents interesting natural and cultural assets of education, exploration and sports values. The author has the opinion that Gjallica Mountain it is a priority mountain area for the development of tourist, geotourist and sport activities by local habitants of Kuksi District and by foreign explorers and tourists.
In this paper we are presenting common data about natural and cultural tourist features, which offer Gjallica Mountain. At the same time we are noting below the main efforts for attraction in the future of local, regional and foreign tourist to this interesting mountainous region.

KEY WORDS: *Gjallica Mountain, Kukes, tourism, geotourism, spring, gorges, traditional clothing, feasts*

INTRODUCTION

Kukes District it is visited for its spectacular nature, however there are many other properties that are not known or are not properly protected. In this paper will be treated exactly one of these areas, which is not known but it has potential for tourism development. The main goal it is to conduct a comprehensive assessment study on the natural and cultural assets of Gjallica Mountain, as priority area for tourism and geotourism development. Gjallica Mountain offers the opportunity to develop different types of tourism and sports such as: ski sports tourism, rest and relaxation, climbing, hunting, hipism etc. In Gjallica Mountain, there are also many places and objects of cultural heritage, which testify about a rich culture of this region. Nowadays this kind of tourism does not exist, however, with little investment in the near future can be developed.
This paper is divided into two parts. In the first part there is presented mountainous natural heritage, while in the second part it is described cultural heritage.
The most important natural beauty of Gjallica Mountain for tourism development there are the following geological sites: canyons, caves, springs, various forms of karst etc. They can establish tourist spots more attractive for tourists. In general it can be said that this mountain with its beautiful natural landscape, the presence of snow during the winter, clean air and water, represents important natural tourist potential.
In the second part, there are treated traditional festivals, that are very popular celebrations and attract not only locals but also people who have left these villages many years ago. Celebrations are mainly of pagan origin and are held every year on the same date. This is valid for tourist developments. Handicrafts products and folk costumes are objects that should be evaluated are treated with particular that characterizes them.

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NATURAL HERITAGE

Gjallica is the highest mountain (2 489m) of the elliptical shape, located 8km southeast of Kuksi City. It is characterized by a rather harsh relief. In upper levels, Gjallica ridge it is very sharp, which falls like the knife on the Vanave Gorge, in the northeast and on Bicaj canyon southwest. Northwest slope forms a magnificent fracture on Kuksi basin, with relative elevation 2 000 m, while southeastern slope falls mild depression of contact Topojan-Tërshanës, and gradually passed to Shishtavec Plateau. There is a dense vegetation with pine and beech forest at low altitudes, while at the foot of the mountain vegetation is rare, due to the emission of harmful gases. According to the geological and environmental protection studies Gjallica Mountain, represents a critical area for the display of erosion. Forests on the western slopes of Gjallica Mountain were destroyed by the gaseous emissions of the former Rexhepaj Copper Plant, which has damaged an area of about 500 ha. In winter, rain, mud slides and avalanches affect not only the land but also the settlements.
In this mountain, there are located the following villages: Shtiqen (Rexhepaj, Muja, Krenx), Nang, Bicaj (Mustafaj Mhole, Tërshen), Kolosjan, Lojme, Brekijë, Nimçë.



Fig.1. View of Gjallica Mountain from Kuksi City.

The main natural monuments (geological sites) of tourism interest there are as following:

Bicaj Canyon. It is located in the middle flow of Bicaj River (subsidiary of Black Drini River), 600 m above sea level, near the village Bicaj. It is formed by the erosive activity of Bicaj River in Upper Triassic-Lower Jura limestone. There are formed steep slopes, length of 2.5 km, depth 150-200 m, and width 4-6 m. Bicaj Canyon separates Gjallica Mountain from Kolosjani Pass. Bicaj Canyon has geomorphologic, scientific, didactic, and geotourist values. Some interesting karst caves there are formed in this canyon as well.

Vanajve's Gorge. It is situated in the middle part of Luma River flow (a tributary of the White Drin), 600 m above sea level, between Koritniku and Gjallica mountains. It has a length of about 2.7 km, a depth of over 300 m, creating a magnificent view. It belongs to Topojani Village of Kuksi District. It is formed by Vanaj River in Upper Triassic-Lower Jurassic limestone.

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In upper part of the canyon, to the east, behind the Kallabak-Tërf ridge, begins the Shistaveci Plateau, with a much softer relief of Paleozoic metamorphic rocks, mainly shales. Vanaj Canyon and Shistaveci plain can be visited along with the rural road Kukes-Topojan

Red Spring. It is located near the Dershan Village (Shishtavec), at 2200 m above sea level. This karst spring, push out to the surface through tectonic fault in limestone rock. It has clean and cool water, representing very attractive environment. It can be visited along with rural road from Kukesi to Shishtaveci.

Spring Tanzot. It is located in west of Gjallica, 2000 m above sea level, near the ruins of a cult building. Both, the Church and Tanzot springs, there are believed to have properties sourcing for various diseases. Apart from these, here are the tracks much of a dome (chapel) of the Byzantine era, about which legends circulate, that if you dig here will find golden things.

Kolosjani Spring. It is situated near the Kolesjan Village of Bicaj Comune, 430 m above sea level. The spring flows in contact of limestone rocks with terrigenous Permian formations. It can be visited through Kukes-Kolosian-Peshkopi road.
Amongst the interesting biodiversity we can note the following:

Rrobulli Laku i Topojanit. Situated near the Tërshen Village of Bicaj Commune, 1450-1600 m above sea level. This forest represents Bosnian Pine (34 ha), with height above 20-25, and the 1 m trunk diameter, aged 160-200 years. It has scientific biological values, and it is very important for ecological tourism. It can be visited through Kukes-Kolesian-Tërshen road.
In Gjallica Mountain it grows Albanian lily, one of the endemic plants of our country. Botanist who discovered called it *Lilium albanicum.* It has orange flower with unique glow characteristic, that gives beauty and seems born of Albanian rock smile.
This Albanian Lily quality is one of the unique assets of the rich flora of Kukes district to be taken under the protection.

CULTURAL HERITAGE

It is known the feast of Gjallica a yeast worship, organized on the top of this mountain, as opportunity that comes to us from prehistoric times. This day is celebrated annually the first Thursday of August. People wont have to spend the night in sheep corralled a day before the celebration. It is a traditional pagan holiday that relates to the protection of Gjallica Mountain.
The First Day relates to the exit at the top, prayers, sacrifices in honor of the summit and cleaning water fountains above mentioned those associated with toys, song and dance. Young people who are the most powerful embarking on a pilgrimage to the top of the mountain, where there is a source called "tanzot". The name is associated with the power of God, who appeared at the top of the mountain source. Later they return to the Red Spring. This spring is the place where it is prepared and served meals meal. The main menu is lamb, "flija" and Red Spring yogurt.
On the second day, commonly is going the celebration to every house. For Gjallica feast, there are not any invitations, but all those who directed to the houses, where is going the celebration are welcomed. Other feasts: Summer Day, "Shëngjergji" have been and continue to be genuine manifestations of this cultural heritage. The Day of "Saint George", is celebrated during the first half of May. It celebrates the end of winter and the coming of summer as well.
The most characteristic dance of these mountain villages it is the "Luma Danse". Is a folk dance performed in the form of a semi-circle or 'Horra". Epic dances there are typical for man; lyrical or ritual ones are the women's domain. Dancing it is accompanied by drums and curle, a wooden bugle; a tambourine and a cifteli-a tow-stringed lute, may also be used in women's dancing. Oral

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folklore is dominated by lyrical songs. Ballads and historical epic themes are also present. Anecdotes, tales, legends, puzzles and adages take up an important place.
Next to Gjallica Mountain it is Luma province, an ethnographic region, which is known for its characteristic wardrobe. Wearing popular Luma province is one of the proofs of the lifestyle of the people over the centuries. They are evidence of the level, mode of production and exploitation of environmental resources. For this purpose folk costumes bear and another aspect even more important, spiritually.

SOME RECOMMENDATIONS

Climbing up to Gjallica Mountain, we reccommend the organization of geotours setting there the small campings with the help of local authorities. Amongst the most interesting trips there are: botanical trips, cave's exploration, watching interesting mountainous landscapes, and visits to cultural sites of the region.
It would be important to rise up workshops or dairy, where tourists can see how people produce their products as cheese, brandy or handicrafts like carpets.
Should regularly organize cultural events and exhibitions, and should be advertised to attract visitors.
Tourism development to Gjallica Mountain and to the Shistaveci Plain, it is do during the hot weather of the year, especially during the summer and autumn seasons..

REFERENCES

Arkivi i muzeut lokal Kukës, *Fondi i etnologjisë, veshje e Lumës.*
Atlas themelor i gjeografisë fizike, *Tiranw: Albas, 2006*
Doka Dhimitër, *Gjeografia e turizmit, Tiranë: SHBLU, 2009*
Dokle Nasip, *Klasifikim i veshjeve popullore të Kukësit, Tiranë: Koha, 1980*
Dokle Nasip, *Emërtim i veshjes së Lumës dhe të Gorës, Tiranë: Koha, 1984*
Domi Ali, *Të njohim vendlindjen, Tiranë, 1980*
Gjeografia fizike e Shqipërisë, Vëllimi II, Tiranë, 1991
Kukësi djep i kulturës popullore, Prizren: Siprint, 2010
Qiriazi Perikli, Sala Skënder, *Monumentet e natyrës së Shqipërisë,Tiranë: Ideart, 2006*
Meçaj Nasip, *Qarku i Kukësit, Tiranë: TOENA, 2004*
PNUD, *Promovimi i Turizmit dhe Mjedisit Në Rajonin e Kukësit, Shkurt 2010*
Strategjia e Zhvillimit të Qarkut të Kukësit
www.summitpost.org/albanian-or-south-dinaric-alps

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Has cross-border region for recreation and leisure of tourist demand is still at low levels, to achieve a high level of tourism demand should be a sustainable development and a well management of natural resources.

It is important to develop guides and information brochures about the tourist potential found in the border region of has.

Must operate a collaboration between public authorities (local and central) with businesses and the public itself to achieve development of tourism (mountain, curative, ecotourism, etc.).

construction of tourist infrastructure is required based upon the potential offered by this region.

should be developed strategy for sustainable tourism development because its development is associated with a number of positive consequences as increasing the level of employment, improving the quality of services, living standards etc..

REFERENCES

1. Qiriazi Perikli. Physical Geography of Albania, Tirana 2001
2. Çavolli Riza. Regional Geography of Kosovo, Pristina 1997
3.Shtylla Walter. Old roads and bridges in Albania, Tirana 1998
4. Bogdani Ramazan. Has choreographic folklore, Tirana 1977, Kosovo's HAS based Ethnography, Tirana 2005.
5. Academy of Sciences, Institute of History, The History of the Albanian people, Tirana 2002.
6. Strategy for the development of tourism in the region of Kukes.

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GEOMONUMENTS AND CULTURAL HERITAGE AS OPPORTUNITIES FOR GEOTOURISM AND TOURISM DEVELOPMENT IN POGRADEC DESTRICT

Lorena KAZIU
"DAR" Tiranë, Shqipëri.E-mail: lorenakaziu@live.com

ABSTRACT.

This paper introduce the natural and cultural wealth of Pogradec and the possibility of developing tourism and geotourism. Natural heritage and mineral riches have played an important role in economic and cultural development of this region.

KEY WORDS: *Pogradec, cultural heritage, geomonument, geotourism*

INTRODUCTION

This paper introduce the natural and cultural wealth of Pogradec and the possibility of developing tourism and geotourism. Pogradec district lies in southeast of Albania, through southwest coast of Ohrid lake. Natural heritage and mineral riches have played an important role in the economic development of this area. The geographical position and natural resources have favoured Pogradec area to be inhabited very early, since in the Late Neolithic (6000-2000 BC), in antiquity and in medievalism there was built a number of settlements, the castle and the town of Porgradec. Important geo-strategic position, road junctions and different cultures that collide in this geographical space left behind a rich material-spiritual heritage which are represented by archaeological, architectural and ethnographic monuments. The management of tourism potentials consists in their originality and uniqueality because Pogradec is a district where are combined aquatic, forests, pastures and agricultural ecosystems. The combination of all ecosystems create a high biodiversity, very specific and characteristic for the entire country too.
Geographical location and geological construction, teamwise with the climatic conditions of the region have contributed to the formation of a geodiversity and colorful and unique biodiversity, which are mention below in this article.
In particular will be described natural landmarks that make gjeomonumente national values and beyond, as well as cultural heritage sites of this region.
Climatic potentials of the province favoured the development of different types of tourism, winter sports, alpine climbing and sliding in the snow, but at the same time offers the opportunity for the development of tourist movements in and near the cultural and natural heritage.

GENERAL INFORMATION

The current landscape of Pogradec is the result of a continuous change from the moment of exiting up the water up to the current period. The landscape is characterized by a variety of morphologically, morfogenetic and large hypsometric contrasts, where the last one has had a significant impact on the modeling of landscape, climatic, environmental phenomena that in their entirety makes the landscapes more complex and interesting. Originally came out on the water (in the Miocene) bordering mountain ranges (Dry Mountain, Stone of wealth, Jablanica) etc; in pliocen came hilly area and in Quaternary came landscape field. A really importance represent the presence of different types of relief. All these forms have scientific didactic, ecological, geomorphological and tourist value.
By the geological point of view the territory is built by magmatic rocks, terrigenous and limestone, with horste and grabene.
Pogradec's climate is mediterranean, but with features of continental climate due to the high altitude above sea level and the extent of it in the interior of the country. Our district territory, according to

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climatic regionalization of 1975, is included in the two climate sub-districts: southern pre-mountainous mediterranean sub-district and southeastern mountainous mediterranean sub-district.
In the first subzone includes Pogradec pits and valleys of Upper Shkumbini, while in the second subzone includes mountains with altitudes greater than 1000 m.
It is characterized by a cold and harsh winters and cool summers, with rapid variation in temperature and an irregular distribution of rainfall. These features play an important role in the formation of specific natural phenomena which we emphasize:

- Display of composed ecosystems with interesting escorts of flora and fauna that has scientific, ecological value that deserve the status of the protected area.
- The development of erosion processes and dynamics of exogenous processes has led to the creation of forms and microforms of relief with natural monuments value.
- Potential's climate favor the development of different types of tourism, winter sports, alpine climbing and sliding in the snow, but at the same time offers the opportunity for development of tourist movements in and around the cultural and natural heritage objects.

The hydrography is represented by the surface and underground water reserves, which come to the surface in the form of resources. The hydrography is represented by the watershed of Drini, Shkumbin and Devoll. Undoubtedly, the greatest asset of water in Pogradec the is Lake Ohrid. The main branches in this part are the brook of Dushnës, Dunicës, Radicinës, Pogradec, Vërdovës, Rrëmenjit, Çervenakës, Çërravës and a large number of underwater resources like Mullinjte e Linit, Drilon source and multiple sources that results in Tushemisht village.
The types of lands that are meeting in this district are: Mountain pastures land, which are prevalent in the Dry Mountain, Black Stone, Stone Topi and Valamarë. Brown forest lands prevalent in the western of Dry Mountain in the highlands of Mokra and Gora. Brown lands are founded in the valley of Shkumbini and Mokra. Gray brown lands are founded in the hole of Pogradec and highlands of Mokra. Aluvion lands prevalents in Buçimas field.
All the above elements have made possible to be present in the district of Pogradec all those kinds of lands, varied and diverse fauna and plant covers with unique value.
All these factors, landscape, geological construction, climate, hydrography, flora and fauna, have given Pogradec a natural asset, which is considered unique not only in the region, but also abroad. Unique natural values are preferred by domestic and foreign tourists, creating opportunities for the development of tourism in general and different types of it in particular. These natural values affect in the development of the district and consequently also in the local community.
Because of these unique nature values Pogradec has landscapes with specific values which have the status of Protected Area, Pogradec: - Protected Landscape Land/Water category and Natural Monuments category.
The decision no. 676, dated 20.12.2002, announced 17 buildings as monuments of Albanian nature, from which 10 are geomonuments: Stone of Wealth, Stone Stacks, Llënga's Canyon, Rodokali, Memëlishti, Najazma and Baribardha Cave, Drilon Source and Lukjova's Lake.
This natural wealth present in Pogradec district receives even greater value if we will be combinate it with cultural heritage inherited from generation to generation and put it at the service of tourism.

NATURAL HERITAGE (GEOMONUMENTS)

Wealth Stone, located near the neck of Lipova it has a conglomeratic composition. It is modeled by wind and erosion and the Wealth of Stone represents an interesting form of relief in the form of "a ship sailing in a green sea".
Stone Stacks with a height of 3 m to 10 m, in the vicinity of Mokra's Trebinje village, those are stone groups with conglomeratic composition, wind modeled in the form of a "stack" of the stone.
Canyon of Llënga, located near the village with the same name. It is formed in limestone by the carst and erosion activity of the river. It is about 1 km long, 60 m deep and has steep slopes. Is an interesting carst ecosystem.

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Rodokali Cave, located near the village of Upper Rodokal and it is a carst cave. Its entrance is vertical and then it continues northward with some ramifications. It has not been explored yet.
Memëlishti Cave, located near Red Stone. It is a carst cave, long up to 400 m, 10 m wide and approximately 25 m high. Inside of it there is a small lake.
Najazma Cave, located near the village Tushemisht 697 m above sea level. It is a carst cave formed in limestones of the upper triast and lower juras. Is long up to 12 m, wide up to 2 m and high up to 3 m. There is a bat colony. Legend connects it with religion.
Baribardhë Cave, located near the village Baribardhë 1052 m above sea level. It is a limestone carst cave formed in the upper Kreta. It is long up to 30 m, wide up to 4 m and high up to 3 m.
Drilon source, located near the town of Pogradec and Lake Ohrid. He is carst (flow rate 7 m^3 / sec), and it comes between limestone and terrigenous contact, clean, it has cold and pure water. Drilon Source creates a very attractive environment.
Lukova lakes, located at the border of Gramsh district, near the Bishnica village. It is situated in a great ice complex tan. It has cold water and rich alive world, which forms an interesting ecosystem of alpine lakes.
"Groom and Bride" Stones, located near Senisht village of Mokra 1000 m above sea level. They represent two stones with konglomets composition, with uneven cementation and hardness, modeled by the wind that has given to them the form of the "bride" and "groom." They are high up to 3 m.

CULTURAL HERITAGE OF POGRADEC DISTRICT

Except of natural potentials, Pogradec is rich also with cultural potentials which adds more values to tourism field . Pogradec cultural heritage is very rich and varied. With its rich history and culture, as one of the early residential areas (in the Late Neolithic 6000-2000 BC), Pogradec offers its peculiarities in the field of tourism too. Today, the evidence of this history and culture are not only language, but also a large number of historical and cultural objects with material and non-material unique importance values. The proclaimed cultural monuments of this area have archaeological, architectural, historical and ethnographic character.
Prehistoric settlement of Zagradiani, lies in east of Lin village where there was an ancient Illyrian settlement. Archaeological helleno-roman findings also shows significant influence of these cultures.
Castle in the town of Pogradec, located at the top of the hill's castle. It is set up on a Illyrian settlement of the V BC century, probably Enkelana. After the Roman conquest it collapsed and lost its significance. In the second half of the IV century it became a town and was recovered as a military-agricultural fortified settlement, to continue to live until to medievalismn (VII century), when it was lost again. In the XVII century it had about 600 houses. Life in the Castle has continued almost 1000 years before. Archaeological findings indicate the Illyrian-Albanian continuity.
Castle in Zemçë village, located in the heights of the hill near the village with the same name. It is an Illyrian fortress of the late antiquity period. For it's building is been using the same technique as for the Slabinja fortress. It got injured by barbaro-slavic attacks.
Gradishta of Lower Selca village, located on the hill on which was discovered the powerful Ilir city of Pelioni. Its beginning as a dwelling belongs to the early bronze period. In VI-V BC century Gradishta developed as protourbane center in Shkumbini's way. At IV BC century it returned into a fortified city with hewn stones walls while in the IV-I BC century it was an important Illyrian center of production, exchange and management. The construction of new paved road of Egnatia (in I BC century) with Qafë Thane – Lyhnid direction, brought the fall of the city. In the IV BC century it was walled fortified as an administrative and military center. It was destroyed in the middle of the VI BC century
Monumental tombs of Lower Selca, associated with Pelion Illyrian city and they are original creations of the ordrit ionik architecture. They belongs to III BC century, when it was engraved in the rock four monumental royal tombs, with kenotofi decorated with a colonnade of Ionic style, with helmet and shield, and also with the burial chamber.
Gradishta of Slabinjë village, located on the hill near the village with the same name. It is a wall with small stones connected with plaster that surrounds mountain heights. It has a triangulation planimetry and dates as of late antiquity.

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Rock City in the Cavern of Mokra is a large rock block in the vicinity of Shpella's village, where there is an Illyrian wall, within which is a small Illyrian town of the iron period. Underneath southeast steep slopes of this block is a large carst cave, in the walls of which, according to residents, there are early paintings, perhaps as those of Spille in the Small Prespa.

Architectural works

Bridge in the village of Golik ("Egnatia" segment's road), situated on the Shkumbin river, on the road that connects the Deep Mokra (Bishnica, Llëngë) with Shkumbini and Prrenjas valley. It is a bridge of XVII century and which continues to be used. There are two vaults and niche of high discharge and, among them, other two semi-circulars.

Terziu Bridge, bridge of the XVII-XVIII century, situated on the Velçani's Verriu stream in Proptisht of the Mokra village. She served caravan route Përrenjës - Golik - Proptisht - Bishnica - Llëngë, etc.

Nice Bridge, it belongs XVIII century, built with arc, on an old road, offshoot of Egnatia, it perlocates in Përrenjas - Wealth Stone - Nice - Llëngë etc. As Rozafa castle, this bridge shows the old ballad wall covering.

The bridge between Jolla and Llënga villages, it belongs the XVII century, on the linking road of the Cave, Llënga, Nice and Voskopoja.

Besides these bridges there are other bridges, like the bridge in Slabinjë, Cezme and Zgalle village. For the development of this kind of tourism there is a lack of projects and experience. So, it will take a long time to become efficient.

Use of natural and cultural resources for tourism development

The geographical position of Pogradec, varied relieve, different types of climate, water wealth, diverse flora and fauna and cultural potentials constitutes a complex of factors that favor the development of tourism. In addition, Pogradec offers with its culture history important historical and cultural potential in the field of tourism too.

Balnear tourism. This is the main type of tourism in the district of Pogradec. It is possible thanks to Ohrid lake, which represents the largest lake in the Balkans. Its landscape, biological and tourist values have become known a long time ago. The lake is located at an altitude of 695 m above sea level and its maximum depth is 289 m. The lake shines as an unique ecosystem because it contains many endemic species of flora and fauna. The uniqueness of this ecosystem is due to the very old age of 2-4 million years Lake (one of the four oldest lakes in the world). Not only Ohrid lake but its basin catchment is characterized by a rich biodiversity with many endemic species. The main area for the development of blue tourism is the beach of Pogradec up to Tushemisht village and Lin too. The lake creates suitable conditions for the practicability of many kinds of sports such as: diving, rowing boats with oars, fishing etc.

White tourism. Pogradec district provides conditions for the development of other types of tourism, such as white tourism, which can be developed very well in the western slopes of the Dry mountain, Valamarë etc. The ideal area for its development would be Dry mountain. Due to its high altitude, it sleets a considerable amount of snow, which has a thickness and length sufficient for the development of ski sports and other winter activities. But, because of the lack of experience and financial resources this type of tourism is not currently developed.

Mountain tourism. Due to its climate and relief, Pogradec district provides opportunities for the development of mountain tourism. Mountainous areas have diverse forms of relief, healthy climate, clean water of rivers and streams. Forests are an attractive environment for nature lovers. Tourists who choose Ohrid lake as a vacation place can plan in their tourist itinerary a trip "adventure" in the region of Mokra, where in addition to beautiful nature they can visit the Monumental Tombs of the Lower Selca, the Monastery of Saint Mary, Llënga Canyon, Bishnica forests, Wealth Stone etc. Mokra province is an ideal place for young tourists affectionate to adventures.

Religious tourism. Has a relatively large asset of religious objects which displays special interest to tourists. The presence of communities with different religious can not avoid the presence of churches (Sant Mary church, which is located in the old neighborhood of the city, a new church called

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"Resurrection", as well as other churches in the towns of Pogradec) and mosques (the mosque in the cenetr of city "Abu Beqir Esidikut", Gorica neighborhood mosque and other mosques present almost in every village in Pogradec). Religious days are traditionally celebrated with the perform of various popular devotions. These cultural values of religious beliefs and myths in Pogradec arouse tourists curiosity. They can visit the rural areas of Pogradec to hear these old legends from the inhabitants of rural areas and they also will be impressed by the harmonious coexistence of religious communities.

This region organizes cultural events during all the year (6 January: throwing the cross into the lake known as Blessed Water Day; June 21: Day of the Ohrid Lake; July 29: Feast of Sant Mërenja; December: Family Holiday Winery) different activities and festivals (June 18 the opening of Tourist Season and International Festival of Puppet Theater; June-July: Balkan Championship of volleyball in sand and Balkan Championship of soccer for children "Drilon"; July-August: Summer Nights; October: Poetry Autumn Nights)

The preparation of traditional foods give us special impressions. Pogradec is known for his unique cooking as: koran casserole, koran with nuts, belushke fried with nuts, pie with two flan baked in saci, pancakes, and family wine "Musaka", "Gems", "Tokai ", " Pamid", " Reisling "

Pogradec area has diverse popular outfits. Women's wearing of Upper Mokra, Lower Mokra and Lin, Llënga and Nice, the kilt of Dry Mountain and cladding of Gora region, etc. Dances are divided, they are playing just for men and just for women. In generally Pogradec dances are accompanied by songs. Very popular is the dance of swords and double dances.

Conclusions and recommendations

- ✓ Detailed study of the possibilities of tourism development and the preparation of a development plan that preserves the traditional elements
- ✓ Institutional improvement related to the efficiency and the strengthen of administrative structures as well as the coordination between responsible sectors for territory management
- ✓ Improving the Management Board staff with specialists who have appropriate qualifications for the relevant field, allowing in this way properly carry out of the key functions and tasks
- ✓ The development of accommodation units not only in urban areas but also in rural areas
- ✓ Admittance from the local population about the combination of natural property (geomonuments) and cultural property for the tourism development of Pogradec district and they should see it as an economy priority.
- ✓ Mitigate agricultural crises through its revaluation increasing revenues, appreciating agricultural production and consumption, which creates a tourist genuine market with a multiplication of incomes
- ✓ The presence of natural heritage and cultural heritage elements in tourist guides
- ✓ Improved information system for tourists and the location of main tourist tables
- ✓ Residents can develop projects in cooperation with local authorities for the development of rural tourism in these areas, avoiding in this way the seasonal tourism
- ✓ Professional promotion of parks in order to achieve differentiation and to enable tourist attraction

REFERENCES

Agjensia Kombëtare e Turizmit, "Shqipëria informacion i përgjithshëm", Tiranë 2008.
Agjensia Kombëtare e Turizmit, "Shqipëria natyra dhe aktivitetet", Tiranë 2008.
Dida M., Dragoti N., Kromidha G., Fierza Gj., "Zonat Natyrore të Shqiperise. Parqet kombetare", Tiranë 2004.
Dragoti N., Dedej Z., Abeshi P.,. "Zonat e mbrojtura të Shqipërisë" (Protected areas of Albania), Tiranë 2007.
German Technical Cooperation (GTZ), "Trashëgimia e Liqeneve Ohër dhe Prespë", Tiranë.
Gjeografia Fizike e Shqipërisë (Physical Geography of Albania), 1990, Vol. I. Tiranë
Gjeografia Fizike e Shqipërisë (Physical Geography of Albania), 1991, Vol. II. Tiranë

ISSN 2306-9600

Pogradeci, "Çelësi Turistik"
Qiriazi P., "Monumentet e Natyres e të Kulturës të Rajonit të Pogradecit dhe Prespës", Tiranë 2004
Qiriazi P., Bego F., "Monumentet e Natyres te Shqiperise", Tiranë 1999.
Qiriazi P., Hoxha G., Kola B., "Gjeografia 3", libër për shkollat e Mesme, Tiranë 2007
Serjani A., Heba G. "Gjeotrashegimia ne Shqiperi", *Studime gjeografike Nr.9*, Tiranë 1996.
Serjani A., Neziraj A., Ë. A. P. Ë imbledon, Onuzi K., Hallaçi H., Bushati S., "Gjeomonumentet dhe Gjeoturizmi në Shqipëri" (Geological Heritage and Geotourism in Albania). In both: Albanian and English versions. Tiranë 2003.
Vendim i Këshillit të Ministrave, Nr. 676, datë 20.12.2002

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DUMREA KARST LAKES A BEAUTY OF NATURE ON THE SURFACE OF EVAPORITES

Enkeleida GRAZHDANI[1], Adil NEZIRAJ[1], Afat SERJANI[2]
[1]*Geological Survey of Albania, , Tirana, Albania. E-mail:* enk1973@yahoo.com
[2]*ProGEO-Albania, Tirana.*

EXTENDED ABSTRACT

Dumre karst lakes are located between Lushnja and Elbasani, on the surface of Dumrea salt diapir. Dumrea is the largest salt diapir in Albania. It has a surface of about 270km2, and it is characterized by intensive development of the karst processes. In this aspect, Dumrea salt diapir, can be considered as rare example, just as "Natural karst Museum in evaporite Rocks".

Dumrea is placed in central part of Albania, representing an evaporite diapir of salt and gypsum rocks, covered in most part by "cap rock" of 200-300m thick..



Figure. Geological map of Dumrea region

Dumrea represents a hilly plateau, placed between Devolli (southeast) and Shkumbini (north) rivers. On the surface of Dumrea evaporites there are a lot of different beautiful landscapes all around, with predomination of rounded hills, karst depressions and funnels. Underground buried karst is developed as well. Dumrea diapir has tectonic contacts all around with Oligocene flysch formation.

On southwestern part, in Kuçova area some oil deposits are discovered and explorated.

In evaporite rocks are developed all karst forms, on the surface and in depth. The most widespread karst forms are funnels, depressions, caves, and wells

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Dumrea lakes are totally karst lakes, and the biggest karst lakes in Albania. Here, there are formed 85 karst lakes. Total surface covered by lakes is 645 Ha, or 3% of Dumrea diapir. Commonly they have rounded and elypsoid form, rarely they are prolongated. Their width varies from 15-20m up to 1500m. In Dumrea karst lakes predominate depths up to 10m, while the average depth is 5m. The deepest is Merhoja Lake of 17.5 m average depth and with maximum depth 61m.

The most interesting groups of karst lakes are:

Belshi lakes, where is placed Belshi tourist village, Poroske-Çeraga lakes, Seferan Ndergozhda lakes, where is Seferaj lake, one of the biggest lakes in Dumrea of surface 85.7 Ha., Moçali-Çanga lakes, Zgjanç-Çestije lakes, where is the biggest Çestije lake of surface 97 Ha., Dega-Merhoja lake, where is placed the deepest, Merhoja lake up to 61m deep.

The habitants say that some of lakes are muddy and are named Black Lake, Red Lake, or they have village's and human's name.

The waterbearing complex of evaporite rocks is widespread in this region. There are absent water springs on the surface of Dumrea. Existing springs commonly stop during the summer. The circulation of waters happened below the "cap rock".

Biodiversity of this area is specific. There are evidenced of about 40 kinds of birds, some kinds of wild animals and fishes.

Karst lakes together with nice landscapes on the surface of Dumrea evaporite are a rare beautiful natural phenomena. From tops of Destora (259.0m), Gradishta (239.2m), Faqe Madhe (233.0m), Sukubora (209.0m) hills it can be watched interesting aesthetic landscapes all around. Some of them are beautiful tourist spots such as: Belshi lakes, where is nice Belshi village, Seferani, Gradishta, etc.

Belshi lake area is the most populated part in Dumrea region. This is a geopark of rare beauty, due to the nice lakes rounded by specific vegetation with some interesting kinds of birds, good climate, fresh air and green grass all around.

Two centuries before our Great representative of Renaissance Sami Frasheri propsed Belshi region to be capital of Albania.

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GADIME CAVE IN KOSOVA, ITS GEOTOURIST VALUES AND IMPACTS

Sabri AVDULLAHI[1], Afat SERJANI[2], Islam FEJZA[3], Ahmet TMAVA[4]

[1]*Faculty Geosciences and Technology, Str. Parku Industrial, Mitrovice, Kosova, sabriavdullahi@hotmail.com*
[2]*ProGEO-Albania, Geological Survey of Albania, aserjani@yahoo.com*
[3]*Faculty Geosciences and Technology, Str. Parku Industrial, Mitrovice, Kosova, islamfejza@gmail.com*
[4]*Faculty Geosciences and Technology, Str. Parku Industrial, Mitrovice, Kosova, ahmettmava@hotmail.com*

ABSTRACT

The formation of natural caves is due to any number of processes that result in the hollowing out of rock, including dissolution, mechanical weathering, volcanic activity, or even the melting of glacial ice. Karst areas cover of about 10 percent of the land surface of the world, and there is widespread concern for the effects that human activities have upon the karst environment. The natural processes of forming of the Gadime cave have continued during whole geological periods, since 200 million years.
This paper it is focused on the human and natural impact to Gadime cave. The human activities can negatively impact karst areas, including deforestation, agricultural practices, urbanization, tourism, water exploitation, mining and quarrying. Natural hazards associated with flooding of major cave from groundwater flows to the streets of karst tectonic faults and by flooding from increasing water level in the Klysyr River and from the building the water reservoir on the top of cave area. Amongst the geological and hydrogeological data, here there are included, shortly, the results of the study about the hazards of the cave on the basis of internal structural construction of the carbonate massif, and by the degree of development of karst processes.

KEYWORDS *Gadime Cave*, groundwater, *water reservoir, impact*

INTRODUCTION

There are more people visiting caves now than at any time in history and the trend is for further increases. In recent years, interest in the underground karst environment has grown, not only from a speleological or scientific viewpoint, but also from an economic perspective (Serjani, 2011). The profits derived directly and indirectly from the tourist exploitation of caves can acquire substantial importance at local level. However, in some instances, the lack of regulation of the visits, or of an adequate maintenance infrastructure can result in a serious threat to the underground environment (Cigna, 1993). From the standpoint of the cave itself, the oldest and the most common methodological approach is based on the concept of a speleological network, which treats caves only as the mechanism of transference between the endokarst and the exterior (Trombe, 1952, Eraso, 1969). Other authors consider a cave to be a closed system (Heaton, 1986), using models based on physics to predict environmental variations induced by human presence (Villar et al., 1984, 1986; Cigna, 1987). Mangin and D'Hulst (1995) treated the problem from a larger perspective, conceiving caves within their hydrogeological context and considering them as a system in dynamic equilibrium, in which the energy inputs are equal to the outputs. Excessive human pressure upsets the balance, producing a progressive environmental degradation
The underground extent of caves is usually not apparent from the surface, and this sometimes leads to damage being done unwittingly. Since caves form a part of karst aquifers, the possibility of such damage is influenced by the hydrogeological characteristics of karst environments that are especially vulnerable to contamination (Zwahlen, 2004). An example is given by Slovenia, a country with a long tradition of karst conservation, where the first measure for cave protection dates from 1908 (Badiura and Brinšek) and in which approximately 20% of the 7405 caves recorded in the 2001 (Cave Survey) have been contaminated as a consequence of human activity (Kepa, 2001).
Gadima cave in 1969 was declared a protected area with a total area of 56.25 ha and is listed by IUCN in the third category. Total length of all channels, corridors and halls in the Gadime cave is 1.260 m. In the upper galleries, which have so far been discovered and other channels of assumed length of all rooms in the Gadime cave should be about 3 km. Ornaments inside the Gadime Cave there are so much and so aesthetic giving to this geosite an international importance.
This study it is done for determination of the impact to Gadime Cave, by the water reservoir, which is building on the top of carbonate massif above the cave (Abdullahi, S., Serjani, A., 2012). For this reason the study was focused on two main issues:

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1. Effect of the weight of the water reservoirs on Gadima Cave, on the stability of the ground where the reservoir is located;
2. Effect of the water reservoirs on the inside structure of Gadime Cave.

During this study were done new observations on geology, hydrogeology, tectonically construction of carbonate massif and surrounding metamorphic rocks. Detailed observation and documentation were done on litho logical content of the rocks and on the karst processes in carbonate rocks. Below there are presented data about regional geological position of the Gadime Cave, geological construction of carbonate massif around the Cave, morphology of Gadime Cave and impacts to this cave.

GEOLOGICAL SETTING

Study area

The cave known as Gadima cave it is located in the district of Gadima, in Lipjan, Kosova. Gadima Cave is placed in Lower Gadima village, which is located to the east of Kosova Basin. This cave it is formed in the Gllavica carbonate massif, at level 656m, on the west slope of Gadime (758m), which sinks deeper in the northwest direction in the flat valley. On the right side of the Klysyr River appear three natural cave entrances in 6-10m height above the riverbed, respectively in 576 m, 582 m and 584 m above the sea level. On the left side of the Klysyr River, there is another entrance in the Cave, but with smaller dimensions. The slope of Gllavica it is in a shape form as an isolated cone, towards the northwest is more extended, which in all three directions is surrounded by the molasses of Neogen. Gllavica is separated from the hills of Gadima with a short strait of the Klysyr River with a maximum depth at 200 m.

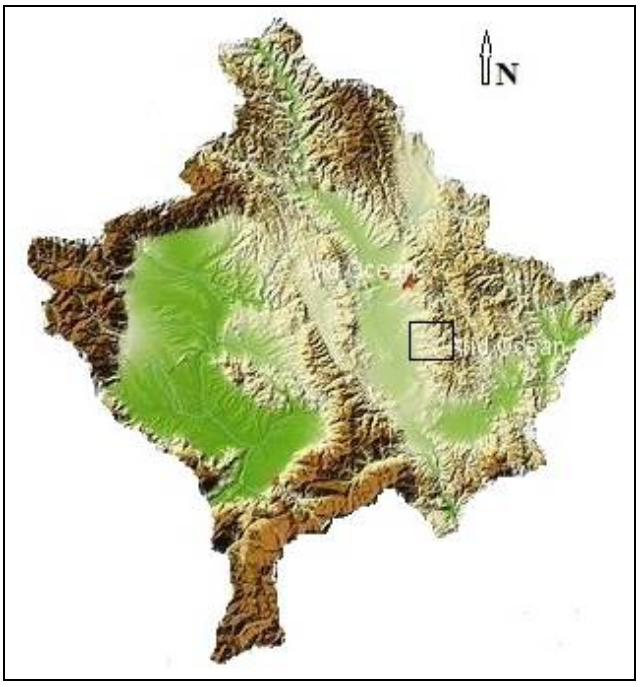


Fig. 1. Kosovo Relief Map and the location of Gadima Cave

The Klysyr River has a complex and composed valley, because after expansion in the upper Gadime entered in a narrow valley, in low and narrow Gadime, flows into the mud valley of Gadime. In the months with precipitation from the mud valley of Gadime leak large water and after 4 km discharged into the Nerodime River, near the bifurcation between the basin of Black Sea and Aegean Sea.

In the region of the Gadime cave hydrological characteristics are very different. In terrains that are built by marble rocks, as are the Gllavica and Gadime hills, there are neither springs nor surface flows. These are dry terrains. However, inside of these measures is characterized by large groundwater. In the wide region, in the terrains constituted by Palaeozoic and lake deposits of Neogen, water springs displaying often, with small outflow and temporary surface flow. Such is the largest Klysyr River which in the bottom dries.

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There is no doubt that the waters of the Klysyr supply underground flow in the leaks and in a number of underground lakes in Gadime cave. The level varies depending on the amount of water in the river bed (Avdullahi et al., 2008). However, only part of water from Gadime cave flow in the surface, in the western part of the Gllavica and Gadime valley, others probably infiltrates into different horizons of Kosova Basin.

The coldest month is January with temperature of -1-11^{o}C, while the highest temperature is in July with 19.9^{o}C. High extreme temperatures there are in summer, beyond the 34.5^{o}C, while during the winter can fall below -23^{o}C. With annual rainfall average of 610 mm the Gadima region is classified into the areas with small amounts of rainfall. The snow falls in the Kosova Basin in November, until March, but the highest quantity it is in December and January months. During the winter with strong winds in the basin snow reaches the height 1.5m.

In Klysyr River basin snow has great significance for surface and ground waters, especially for underground flow and for the lake system in the Gadime cave. Because of very steep terrain, inadequate climatic conditions, primarily small precipitation and dismantled marbles Gllavica hill is covered with a thin layer of diluvium. At the top of the hill, there are outcrops of limestone rocks, while soil is placed only on the surfaces and into the cracks. At the end of the slope the thickness of the soil cover reaches up to 25cm. Klysyr River with a numerous cracks has built a dense system of river valleys. The largest numbers of these valleys are coming from the first expansion direction of the Nerodimka erosion. In difference from the part of source basin which is built in the old Palaeozoic rocks and volcanic rocks. Valley in the upper Gadime is filled by Neogene lake sediments. This means that it is created at the same time with Kosova Basin, respectively before Neogene

Geology of the carbonate massif of Gadima area

Geological construction of Gadime cave region it is constituted by different kind of rocks of different mineralogical-petrographical content, and of different ages. The oldest rocks belong to the oldest Palaeozoic Era. They are metamorphised, transformed in schist rocks, mica schist's, phyllites and as the most important there are marbles (Petroviç, 1972). The last coverage belongs to the Quaternary Era, which consists of Klysyr stream flows and other streams nearby the mountains that brings large quantities of clay, sand and gravel. The youngest sediments there are placed on the new alluvium and lake sediments. (Fig.2). Palaeozoic series in the eastern edge of the Kosova Basin, there are composed mainly by metamorphic rocks.

Gadime Cave it is placed inside the marble limestone rocks of the Mesozoic age. The age of metamorphosed limestone, respectively marbles is not completely defined yet. There are opinions of geologists that marble rocks, where is formed Gadime Cave, may be belong to the Late Palaeozoic age.

Metamorphised limestone represents massive and compact rocks, but they have secondary cracks and there are divided into blocks by tectonic faults. Secondary cracks are often very dense, forming a dense network. Limestones there are totally metamorphosed, what seems clear from the textures of the schist rocks and from the secondary colours ingredient of rocks. In most cases observed blocks of metamorphic and volcanic rocks have clear-cut contacts with limestone and marble rocks, with irregular contour, with mutual links, but compact.

The karst processes there are mainly developed in primary system of cracks, and in fissures in the carbonate formations, while the water penetration and filtration is done through secondary fractures and through the contacts of schist rocks, especially through the disjunctive faults. The orientation of the branches in the cave in southeast-northwest direction correlates with the orientation of tectonic fracture, which are always served as a major route for infiltration of water from upper levels to depth.

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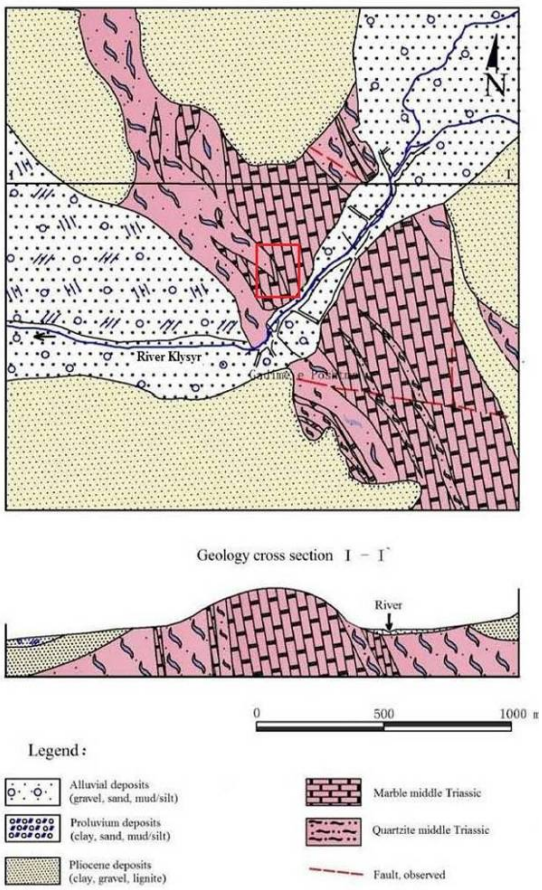


Fig.2 Geological Map of the Gadime Region.

Morphology of Gadima cave

The today's entry into the cave consists of two horizons. The lower horizon is very complex and consists of two parallel corridors, in the south-north direction, three transverse channels and curved corridors, in the west-east direction. The upper horizon consists of two linked corridors, located above 12m in the west-east direction (Muratagic, 1973). Total length of all channels, corridors and halls in the Gadime cave is 1.260m (Fig. 3).

Western gallery - with SE-NW direction, represents the essence of the discovery of parts of the Gadime Cave. It is built right along the contact between marbles and Palaeozoic schist. This gallery is consisted by main channel and several small and large rooms.

North gallery - have a big number of corridors, channels and linked halls. Three main channels which begin from the western gallery have SW-NE direction.

East gallery - in difference to the above mentioned galleries, which consist by many channels and corridors, eastern gallery is simpler. This gallery consists of two channels: the long channel and blue channel. With a length of about 95m long, this channel extends in NE-SW direction.

Exit corridor - this corridor is about 30m long and begins at deep lake and ends in one of the oldest natural exit. This corridor have direction SW-NE and is connected with the entry gallery through a support channel.

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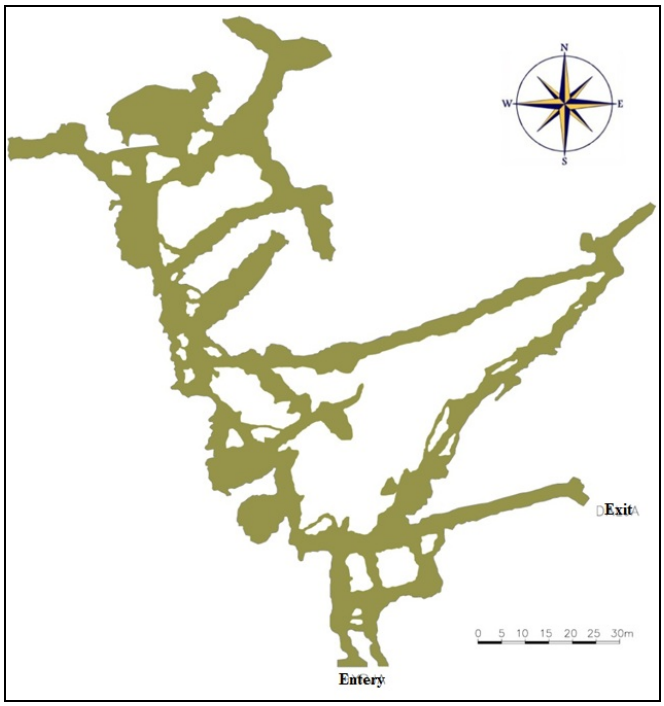


Fig 3. The Horizontal Plan of galleries of Gadime Cave

METHODOLOGY AND THE IMPACTS

This study was intended to determine the impact of water reservoir in Gadima Cave, which is building on the top of the limestone massif, above the Cave. For this reason the study was focused on two main issues:

1. The effect of the weight of the water reservoirs on Gadima Cave, on the stability of the ground where the reservoir is located;
2. Effect of the water reservoir inside structure of Gadime Cave.

The complex of the hydro geological studies is based in the geological documentation of the field data of this region with complex geological construction. During the field study following observations and documentations were made: geomorphologic, geological, hydrological and hydro geological observation of the region and Klysur River Valley.

The geodetic measurements are performed in the place (x, y, z), where it was planned to build water reservoir. Also are measured a geodetic points at the entrance of the Gadime cave in order to set absolute quotas of these two objects. At the beginning we have measured the reference point in Lipjan. From this point then we measured the position of reservoir in four points and we have determined the coordinates. We have also measured a point at the entrance of the Gadime cave (Fig. 4).

The field measurements show that the distance from where ends all galleries of Gadima Cave to the first point from where water reservoir began to be constructed is 205.50 m. The height difference between the reservoir and cave is 58.9m.

Samples of rocks have been taken in the place of construction of the water reservoir (Fig. 5). For these types of objects is important defining the general condition of the geological-engineering and determination of physical-mechanical features of rocks, involved in the active area.

The carbonate massif of Gadime forms the nearly closed aquifer, limited by the formation from metamorphic schist of Palaeozoic on the east side and west side, while on the northwest side and the north is covered by clay-sandstone and molasses, which closes the water basin in the north, not so far.

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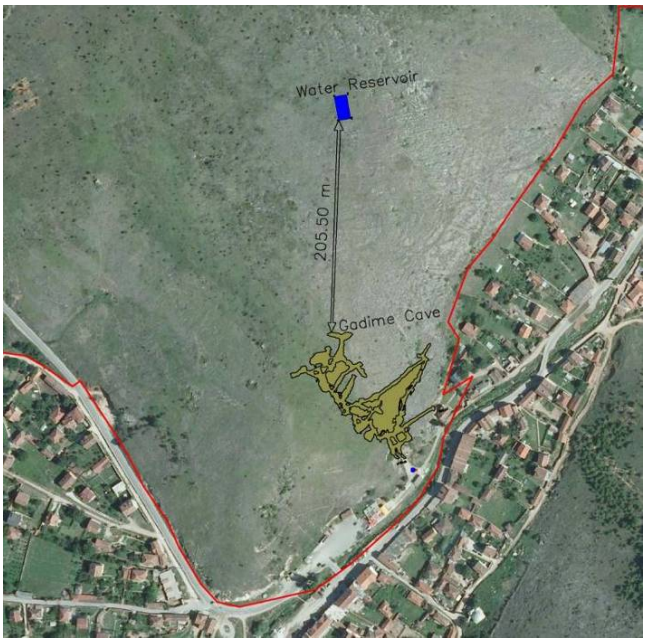


Fig. 4. The position of the reservoir and the cave galleries plan



Fig. 5. Sampling place



Fig. 6 .Samples during testing

The total loads of water reservoir filled with water and covered with soil is 83.72kN/m^2. To determine the sustainability of marbled limestone's during this field survey we took a sample. The sample was sent to the laboratory for analysis. At the beginning the samples were cut into cube shape with dimensions 5x5x5cm. The prepared sample is set in equipment to determine the pressure resistance (Fig.6). Test resulted that the pressure resistance of the marbled limestones is 81310kN/m^2.

Technical conditions of construction of the water reservoir and it's operation without leaking water on carbonate rocks of the hill above the cave, guarantees a lack of communication with the massif carbonates where is constructed and therefore there is no direct connection or influence in the cave structure.

Based on field observations, geodetics measurements and analysis of rocks samples we conclude that based on the large size of the carbonate massif north of the river, the high hardness and compressive resistance of the rock, we are of the opinion that the reservoir has no effect on the rocks where was built neither in the Gadime cave.

Natural hazards of Gadime Cave are connected by the floods from Klysyr River as has hapened in 1969 year, and by the water clay muds, which came down through tectonical faults into different levels of the Cave. While the human impacts can be happened as result of demage of ornaments by visitors, and by

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quarries on the surface of carbonate massif, especially north of Klisur River, and along with the bottom of the River.

CONCLUSIONS

The Gadime cave with large size and rare natural ornaments is formed in Gadime marble carbonates rocks.

The marbled limestones are massive and with schist-layer textures that are separated into blocks by tectonic faults, fractures and cracks.

Karst processes there are intensively on the surface of carbonate rocks and in depth.

Based on field observations, geodetics measurements and analysis of rock's samples we can conclude that the large size of the carbonate massif north of the river, the high hardness and compressive resistance of the rock, we believe that total loads of water reservoir has no effect on the rocks where the water reservoir was built neither in the Gadime cave.

Technical conditions of construction of the water reservoir and its operation without leaking water on carbonate rocks of the hill above the cave, guarantees a lack of communication with the carbonate massif, where it is constructed and therefore there is no direct connection or influence in the cave structure.

The risks for the northern part of the massif, where the main stretch of the cave is, can come from interventions in the river bed raising barrier, excavations and construction in the slope and the whole north part of the river.

REFERENCES

Avdullahi, S., Serjani A., *Repport on the impact of Gadime Cave by reservoir*. HIDROING-DK. Prishtine 2012.

Avdullahi, S., Feza, I., and Syla, A., 2008. *Water resources in Kosova*, Journal of International Environmental Application & Science (JIEAS), Turkey, 6 (3): 51-56.

Badiura, R., and Brinšek, B., 1908. *Nove jame ob Cerkniškem jezeru*. Planinski vestnik, p. 6–7, 96–99, 124–126, Ljubljana.

Cigna, A., 1987. *La capacitá ricettiva delle grotte turistiche quale parametro per la salvaguardia dell'ambiente sotterraneo-caso delle Grotte di Castellana. La Grotte d'Italia*, Serie IV, 15: 999–1012

Cigna, A., 1993. *Environmental management of tourist caves: the examples of Grotta di Castellana and Grotta Grande del Vento*, Italy, Environmental Geol, 21: 173–180.

Eraso, A., 1969. *La corrosión climática en las cavernas*. Bol Geol Miner T LXXX-VI: 564–581.

Heaton, T., 1986. *Caves: a tremendous range of energy environments on Earth*. National Speleological Society News, Huntsville, 44 (8), 301-304.

Kepa, T., 2001. *Karst conservation in Slovenia*: Acta Carsologica, 30 (1), 143–164.

Mangin, A., D'Hulst, D., 1995. Fréquentation des grottes touristiques et conservation *Méthode d'approche pour en étudier les effets et proposer une réglementation*, International Symposium on Show Caves and Environmental Monitoring, Cueno, Italy, 137-167.

Muratagic, M., 1973. *Zbulimi i Shpellës së Mermert*, Antikitete të Kosovës, V. VI-VII. Prishtinë 151-156.

Petrovic, J., 1972. *Shpella e Mermert*, Fakulteti Natyror-Matematikor. Review of Research of Sciences-University of Novi Sad 2: 187-210.

Serjani, A., 2011. *Limestone Aquifers and Karst GEO-Eco-Systems in Albania*. Proceedings of the 9-th International Conference on Limestone Hydrogeology. September 1-3 Besançon, France.

Trombe, F., 1952. *Traité de Speleologie*. Payot, Paris, 376 p.

Villar, E., Bonet, A., Díaz, B., Fernández, PL., Gutiérrez, I., Quindós, LS., Solana, JR., and Soto, J., 1984. *Ambient temperature variations in the Hall of Paintings of Altamira Cave due to the presence of visitors*. Cave Sci 11: 99–104.

Villar, E., Fernández, PL., Gutiérrez, I., Quindós, LS., and Soto, J., 1986. *Influence of visitors on carbon concentrations in Altamira Cave*. Cave Sci 13: 21–23.

Zwahlen, F., 2004. *Vulnerability and risk mapping for the protection of carbonate (karst) aquifers*, final report (COST Action 620). European Commission, Directorate-General XII Science, Research and Development. Brussels, 297 p.

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GEOPHYSICAL CONTRIBUTIONS DURING 90 YEARS OF ALBANIAN GEOLOGY, AND FACING OF THE TRANSITION CHALLENGE.

Alfred FRASHËRI[1], Salvatore BUSHATI[2]

[1]Faculty of Geology and Mining, Polytechnic University of Tirana, Albania
[2]Academy of Sciences of Albania

Abstract

In the speech are presented the development of the geophysical exploration in Albania, contribute of the geophysics and facing the challenges during the transition period toward free market economy.

Albania is a rich country in mineral resources, chrome, copper, iron-nickel, coal, oil and gas etc. The exploration for these mineral deposits is carried out successfully by using a wide and complex range of geological, geophysical and geochemical methods. There are tens of oil and gas reservoirs, tens of copper, chromite, etc. deposits that have been discovered through geophysics contribution. Gravity, magnetic, geothermal and seismic zoning maps of different scales up to 1:200.000 and 1:500.000 are important part of regional studies on the recognition of geological setting of Albanides. Geophysical studies and research are conducted in Albania for more than 70 years. The first geophysical researches have been performed during thirty years, with gravity, and magnetic survey, vertical electrical soundings, by Italian companies in the years 30-40. Geophysical research in large polygons for oil and gas reservoirs, and copper, chromite deposits explorations began systematically to 50 years period. Gradually, step by step, we have applied different geophysical methods. The successful Albanian geophysics in search for metallic deposits and oil and gas reservoirs have been published in many papers in national and international scientific press, and presented in the national and international meetings.

On shore and of shore oil and gas exploration have been performed using seismic reflection surveys, gravity mapping, and small volume of the vertical electrical soundings. Mining geophysics for copper, chromite, bauxites deposits exploration is developed through application of the gravity and magnetic mapping of different scales, induced polarization profiling and real-section surveys, electromagnetic profiling, resistivity profiling and vertical electrical soundings, self potential mapping. Radiometric and nuclear geophysics have been used for phosphorite research. Oil and gas, copper, chromite, phosphorite, coal wells have been studies using complex of the electrical, sonic, radioactive and nuclear well logging,

Important direction of Geophysics presents seismological studies in Albania. These studies have been developed to three areas: seismotectonics, seismology and seismologic engineering.

Last two decades represent the period of extension of the field of application of shallow engineering and environmental geophysical methods to solve the geotechnical tasks, hydrogeological research, the micro-zoning of main Albanian cities, the study and evaluation of geothermal energy, and environmental studies for impact evaluation and water pollution, etc.

Geophysical Branch in the Faculty of Geology and Mining, Polytechnic University of Tirana, during a half of century period from 1961 up to present have graduated 304 geophysicist engineers, and 48 doctors of sciences.

Albanian Geophysicists have established since 1989 Geophysical Society of Albania (GSA), which is part of the Albanian Association of Geoscientists and Engineers (AAGE). GSA is a member of the European Association of Geoscientists and Engineers (EAGE) and the Balkan Geophysical Society (BGS).

Key words: Albanian Geophysics, Mining Geophysics, Oil and Gas Geophysics, Engineer and Environmental Geophysics.

INTRODUCTION

Albania is rich with natural resources: oil, gas and solid minerals. Integrated geological-geophysical-geochemical prospecting have discovered and developed tens of solid mineral deposits, and oil and gas reservoirs in Albania.

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In order to demonstrate the economic capacity of the Albanian Mining and Petroleum Industries, it is sufficient to indicate that only during 1984 there were extracted 1,007,000 tons of copper minerals and processed 12,600 tons of blister copper, as well as 960,000 tons chromites. The average income from the copper and chromium extracting industries was 120 million USD. About 20 million tons of copper minerals and 21 million tons of chromites have been extracted by the Albanian Mining Industry. Oil production reached a peak of 2.250.000 tons in 1973. Up until 1990s, there were extracted 49, 5 million tons of oil, about 12 million cubic meters of natural, and 47 million tons of coils. Unfortunately, during the transition period among 1990 to 2010, the volume of extraction by the mining and oil industry has steadily decreased. According to the official statistics, INSTAT, the mining production has decreased as following*:* 88.6 in 1994, 86.5 in 1995, 75.8 in 1996, 47.1 in 1997, 74.5 in 1998, 35.5 in 1999, 31.0 in 2000, and 27.0 in 2001.

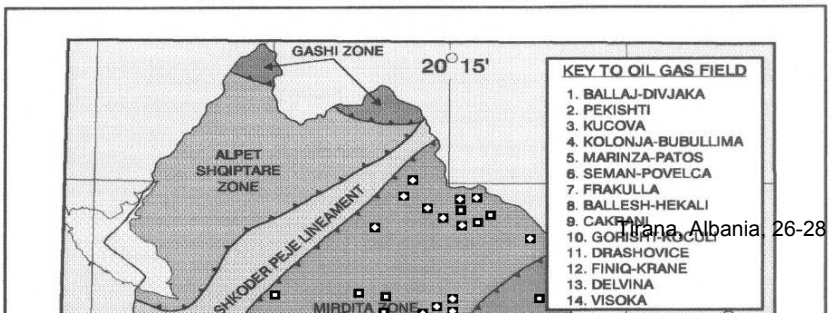
Geological prospecting have evaluated the mineral resources, capable of extraction as 31 million tons of oil, 53 million tons of cooper minerals, 40 million tons of chromites, 220 million tons of Ferro nickel, 100 million tons of nickel, 700 million tons of coil. More than twice of the extracted copper and chromites ores are estimated by geological exploration and developing statement of the resources for the future.

The Bitumen from the Selenica mines in southern Albania has been extracted since the ancient times. Illyrian tribe of pirusts was well known for copper processing. An activist of the Albanian Renaissance, the philosopher Sami Frashëri, in his book "Albania, What It Was, What It Is, and What Will It Be (1899), wrote "…it is necessary to explore all metals all over Albania … In the capital of Albania, in addition to secondary schools must be a university, and an academy….. to develop in Albania the literature, history,…. and geology, etc.". Nearly half a century later, a politician Mehdi Frashëri in his book "The Albanian Problem" (1944) wrote: "... At near future, Albanian oil in Kuçovo as well as in Patos will form a source of national wealth and a key target for state revenues " and "… in Albania there have been explored some ores, which can also reasonably be used for developing the economy and industry of the country….".

In the 1920s and 1930s, oil was discovered in Kuçova, and it was processed, also copper was extracted in Rubik, and a little later started the extraction of chromium. The programs elaborated by our philosophers and statesmen were fully implemented after the World War II. The new state took particular attention to further developing the exploration, extraction and processing of the natural

resources, and it put those industries at the cornerstone of the socio-economic development of Albania. The development of those industries went hand in hand with the formation of a new cadre of young specialists, who were able and willing to explore and to extract the mineral wealth of the homeland, and to selflessly contribute to the development of the state and economy.

Geophysical studies and research are conducted in Albania for more than 70 years. First gravimetric and magnetic surveys and electrical soundings have been performed during thirty years by Italian company. Geophysical research in large polygons has started systematically from 1950 year for oil and gas, gradually to apply different methods: Gravity survey, Vertical Electrical Soundings, and Well logging (1950), Seismic surveys (1952). From 1953 has started application of the Geoelectrical surveys for cooper exploration, magnetic surveys (1957) and gravity surveys (1958) for chromite exploration. Radiometric surveys (1959), and geothermal studies (1989). Offshore seismic and geoelectrical surveys in Albanian Adriatic Sea Shelf for oil and gas exploration have started from 1982. Geophysical research in fifty's years was performed by Soviet and German geophysicists. From 1952 he returned from overseas studies two first Albanian engineers. At that time was formed also the first geophysicist's technicians. After 1961, all geophysical surveys have been performed by Albanian geophysicists. For two years in the seventy's years, the Albanian geophysicists have worked together with the Chinese geophysicists. Today, after 60 years, there are 304 geophysicists, as well as dozens of physicists, electrical engineers, etc. that have working on geophysical surveys. Among them are 48 doctors of sciences, 7 professors, and 22 leading researchers and masters.



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Fig. 1. Important oil and gas reservoirs and solid minerals deposits in Albania.

Albanian Geophysicists have established since 1989 Geophysical Society of Albania (GSA), which is part of the Albanian Association of Geoscientists and Engineers (AAGE). GSA is a member of the European Association of Geoscientists and Engineers (EAGE) and the Balkan Geophysical Society (BGS).

Geophysical studies in Albania, year by year have been developed as complex methods, such as technological level of the surveys and interpretation, and are raised up coordination with other geological and geochemical methods. The realization of the development of Geophysics at the beginning of the period 1972-1986 is sensitive behavior of equipment and modern technologies for seismic, gravity, geoelectric, magnetic surveys, radiometric studies and well logging.

Geophysical Exploration and studies have been performed in the framework of the three Geophysical Enterprises [Biçoku T., 2004, Frashëri A. et al. 2010].

1. Oil and Gas Seismic and Gravity Enterprise in Fieri City: 70 geophysicists enginees, four seismic teams, gravimetric one, a geoelectrical team, as well as marine expedition with seismic, geological and geoelectrical teams. Enterprise has realized about 2500 km/year of seismic profiling by multiple coverage.

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2. Oil and Gas Well Logging Enterprise in Patosi City: 30 geophysicist's engineers, the electric, radioactive, sonic groups, gas logging, and perforator's groups, laboratory of physical properties of the rocks and interpretation group. Well logging groups carry integrated geophysical study of exploration deep wells for oil and gas with an annual volume of 80,000 linear meters of wells with a depth up to 6700 m, and tens of thousands linear meters of production wells.

3. Geophysical Enterprise of Tirana for mining geophysics: 106 geophysicist's engineers. Geoelectrical Teams have realized about 35-40 km^2/year mapping at the scale of 1:10 000, 1:5.000 and 1:2.000. Averagely the same area has covered also by the gravity and magnetic survey. In 2008, the restructuring of the Albanian Geological Service, the company was reformed: several specialists went to the Institute of Earth Sciences was established, some remained in the unit geophysical Albanian Geological Service.

Tab. 1 Application fields and geophysical methods applied in Albania

GEOPHYSICS	Methods	Application fields			
		Oil & gas	Mining	Engineering & Environmental	Regional
Applied	Seismic reflection	++		++	+
	Electrical	+	++	++	+
	Gravity	+	+	+	++
	Magnetic		+	+	++
	Well logging	++	+	+	+
	Radiometric		+	+	+
Seismology	Earthquakes	1. Seismological Surveys Network 2. Seismological zoning of Albania			
	Engineering	1. Seismic Micro zoning and seismic risk evaluation 2.Seismic monitoring of the hydropower plant dams			
Geothermic	1. Geothermal studies 2. Geothermal energy platform and use scenarios.				

++ *Principal method*

In Geological & Geodesic Enterprise of the Ministry of Construction and in the Hidrogeological Enterprise of Tirana have two specialized geophysical expeditions for engineering geophysics (1983) and water research (1980).

Important direction of Geophysics in Albania presents the seismological studies, which have been conducted by the Institute of Seismology, Academy of Sciences. These studies pertain to three areas: seismotectonic, seismology and earthquake engineering. The first seismic station was established in 1968, at the Chair of Geophysics, Faculty of Geology and Mining. Seismological Institute was established in 1973 at the Academy of Sciences. Has been set-up the seismological network with 13 stations in Albania. In 2008 the institute, was involved in the Institute of Earth Sciences in the Polytechnic University of Tirana

Teaching of Applied Geophysics case began in the Geological of Department of the Polytechnic Institute of Tirana (1955). The formation of geophysical engineers and their post graduate training since 1961 have been performed in the Geophysical Branch, Chair of Geophysics Faculty of Geology and Mining, Polytechnic University of Tirana. The period of study was five years for engineers [Frashëri A. et al, 2008].

Geophysicists of all generations have given outstanding contribution to the discovery of ten oil and gas reservoirs, eleven copper deposits, and many other solid minerals. They have performed geophysical regional studies of the Albanides. There are 637of papers published in national scientific journals, 33 of papers published in international scientific journals, and hundred papers that have been presented to major success in international scientific meetings [Biçoku T. 2004, Frashëri A. et al. 2010, Papa A. 2001, Rama M. 1995].

Unfortunately, during a very difficult post communist transition among 1990 to 2010, geological research and other scientific activities, including the geophysics went downhill. Geophysical companies were reformed and closed, the volume of work has fallen to the minimum possible, leading to zero discovery of

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oil and gas, as well as solid useful minerals. The geophysics branch in the Polytechnic University of Tirana was recently closed. There is only option for t Scientific Master Diploma on geophysics. Many of the best geophysicists have migrated and actually work in their specialty in France, U.S.A., Canada, etc.

Despite all these processes for geophysics and geological researches, the Albanian geophysicists currently in Albania are trying to save the geophysics in the conditions of the Albanian market economy. We have started to widen the field of the application of geophysics in other areas. We are convinced that the geophysical surveys, with modern equipment and software, are as important to geological exploration and studies as the X-ray equipment and echo-sounds are to the doctors. Therefore, geology without geophysics risks a return to the nineteenth-century level.

Last two decades represent the period of extension of application fields of geophysical methods for solving geotechnical tasks, hydrogeological research , micro zoning of the main cities of Albania, geothermal studies and evaluation of geothermal energy, geoenvironment studies and its impacts assessments, archaeological geophysics, etc. An important contribution has been given by joint projects with other institutions and academics as well as professionals from leading countries in the field. Unfortunately, Geotechnical and Environmental Geophysics surveys, there are not to the extent appropriate of modern techniques and technologies, particularly for the evaluation of natural geologic hazards.

However, in order to assess the new scientific research, inter alia, it is necessary to ask and analyze what was done, how it was done, and to determine future goals and objectives. In order to present a modest contribution in this direction, we have made a review of the Albanian Geophysics in the years 1950 to 2010.

1 THE ROLE OF GEOPHYSICAL METHODS IN THE FRAMEWORK OF INTEGRATED OIL & GAS EXPLORATION

Integrated geophysical exploration for oil and gas had the reflection seismic survey as the main method. Besides its, prospective regions for oil and gas have mapped by gravity surveys. Have been used also some vertical electric soundings. Successful experiments, but in small volume, were also made for direct search of oil and gas reservoirs by complex of methods: natural electric field, radiometric and magnetic surveys. All deep oil and gas wells have studies by integrated well logging methods.

History of the development of seismic work can share in the four main stages:

1. 1952-1970: Oscilographic recording, and manual processing and interpretation of the seismic data. The works were carried out in lowland terrains.

2. 1970 to 1978: Analog magnetic recording, multiple coverage profiling, and surveys were extended also in rugged terrain, with complicated geology.

3. 1980 to 1990: Digital recording and processing of the seismic data, the widely used multiple coverage, and improvement data processing.

4. After 1990 there were gradually declining to zero geophysical exploration works for oil and gas by Albanian geophysicists. Actually, performing of the seismic exploration there is realized by foreign companies.

Gravity survey on the scale 1:100.000, and 1: 50,000 and 1:25.000 have covered the whole perspective territory for oil and gas bearing.

In 1978 has restarted application of the vertical electric soundings with depth of investigation about 2.5 km. The object for the electric soundings have been identification of the limestone structure top, and evaluation of the sandstone content in the Neogene molasses in onshore, and in the Albanian Adriatic shelf, etc.

In the years 1978-1982 was successfully experimented direct exploration of the oil and gas reservoirs by integrates methods: natural electric field, magnetic and radiometric surveys.

Albanian Well Logging Service has celebrated 80th anniversary. The systematic geophysical study of all oil and gas deep wells was begun in 1950, with electric logging, well deflection and factice diameter measurements. The temperatures were recorded in well with electric thermometers. Were performed first experimentation of the gamma logging, and gas logging.

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The main feature of the later period, the launch of sixty years, was the step to the full quantitative and qualitative interpretation of logging data, performance of the logging in the well, and determination of the physical properties of the terigjene productive horizons.

Currently, unfortunately even this direction of the Geophysics is abolished, because there are stopped the drilling of the exploration and development deep wells by Albanian Oil and Gas Industry. There remained only a small nucleus in the oil industry, to study any of Albpetrol well.

2 THE ROLE OF GEOPHYSICAL METHODS IN THE FRAMEWORK OF INTEGRATED EXPLORATION OF SOLID MINERALS

Geophysical methods, used in the framework of integrated geological-geophysical-geochemical exploration, have an important role in search for solid minerals. The role of geophysical methods has depended on many factors such as the kind of mineral to be prospected, the stage of the search, and the kind of problems to be solved.

Application of geophysical methods has been concentrated in two major directions:

1. ***Direct search*** *for many kinds of solid mineral deposits such as copper sulphide, polymetalic, and chrome ores.*

The methodology of the geophysical exploration for copper ores deposits (from the 1930's until today) and chrome resources (from 1958 until today) in Albania was developed in conformity with the geological tasks to be solved and the scientific-technical levels of the geophysical methods.

Geophysical copper deposits search and development has high efficiency. The geophysical methods application has been depended by **ore body depth** of location, and kind of the mineralization type. Geoelectrical surveys have been main prospecting methods, through following evolution:
- **1953-1960** discovery have been based on geophysical self-potential method and resistivity profiling for massive and shallow ore bodies, where redox phenomenon is developed.

- **1973-19**89- geophysical exploration was based on application of induced polarization, which was the main exploration method at the depth, and self- potential method and resistivity profiling for detalization and selection massive ore bodies from mineralization zones.

During the **phase of detailed exploration** have been applied: the induced polarization method, EM profiling, the radio wave floodlighting method, mise a la mase method, the borehole vectorial magnetic surveys, the electrical and gamma-gamma logging. In 1978, usefully was started developing of the IP/Resistivity "Real Section".

In Albania was gained a good experience for the integrated geological-geophysical-geochemical **exploration of chrome deposits** and were set up integrated methods to be used in ground and underground surveys. The geophysical methods have an important contribution for discovery in series of chromite deposits. Only during 1989 year, in the ultrabasic massif of Bulqiza were projected 356 boreholes to verify geophysical anomalies in 35 objects. From them, 145 boreholes have discovered mineralized horizons.

The geophysical complex for direct chromite deposit search includes surface mapping by gravity, magnetic and IP methods. Underground geophysical surveys were carried out for the search surrounding space of the mine works and boreholes. In order to get the geophysical documentation of the boreholes, have been performed electrical and radiation (density/selective gamma-gamma and neutron activation) logging.

For the search of chrome deposits, a further and continuous improvement is required to improve the coordination of the direct search for ore bodies with the geophysical methods used for geophysical-structural mapping and under-ground surveys. This is connected with the fact that petrophysical properties of the ore and those of surrounding rocks vary in a wide range, sometimes overlapping each other. All this factors have their influence on the effectiveness of the geophysical search for chrome ore bodies, which is lower than for copper ore bodies.

Through the exploration activity we learned in practice that the ores and surrounding rocks are characterized by unique value of the physical properties. The inverse is not true, i.e. the same magnitude

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of a physical property or feature may be the same for several minerals and rocks. For example, good electrical conductors are not only massive sulphides but kaolin and clays as well. Therefore, a single geophysical method and one physical feature of the medium are not sufficient to solve the problem. To find the solution is necessary to know the complex of different physical properties. Consequently, exploration has been integrated, with complex of the geophysical methods**.**

Perturbations caused by the topographic effect, variation of thickness and composition of the overburden beds, should be considered carefully to avoid false signals and spurious anomalies. To solve this problem, started from 1973 the application of mathematical methods and computer's data processing and interpretation.

Heights year's period was characterized by **e**xploration of copper sulphide massive and disseminated ore deposits, which are located at the depth up to 700-800 m. The main exploration method has been induced polarization method, and underground surveys. The increase of the depth of investigation has been supported by mathematical modeling.

These achievements were based on further methodological and organizational improvements organization of the geological-geophysical surveying in Albania. Complex geological-geophysical-geochemical teams for the search of copper deposits were created to carry out mappings at scale 1:5000 and detailed studies of anomalies at scale 1:2000. **This was the key of success.** The implementation of geophysical methods in search for mineral resources, in general, and for mineral ore bodies, in particular, has been based also on methodological criteria: **moving from known areas toward unknown**, which made possible to discover the biggest copper fields in Albania, which consisted of 11 copper deposits, located at different topographic levels from surface down to depth of several hundred meters.

In the mid eighty's year's period there have been solved also two other problems:

- The discrimination of massive ore bodies in great depth, between mineralized zones.
- The discrimination of anomalies composed by the superimposed of the effect from the sulphide ore bodies and from the nearby serpentines individualization.

These complicated problems stand in front of search for all geophysicists of these days. To solve them we needed another improvement of the methodology of geophysical search, which started at the second half of the years eighty up to date.

After 1990 year up to present, geophysical exploration of the copper and chrome deposits with the minimal field volumes there are realized by foreign companies, which actually are worked in Albania.

2. ***Geophysical structural mapping*** *in the complex with geological mapping in order to recognize the geological settings of perspective zones and ore control factors.* The contribution of geophysical studies in the recognition of tectonic the zones and their relationship, is well known in Albania.

The gravity and magnetic mapping at scales between 1:25.000-1:200.000. A particular attention has been paid to petrophysical studies as well.

3. DEVELOPMENT OF THE GRAVITY AND MAGNETIC SURVEYS

The development of magnetic and gravity surveys were performed in several directions:

- Expanding the field of use of gravity and magnetic methods for solid ores deposits exploration, including copper, chromium, and iron - nickel, bauxites, asbestos, heavy mineral placers.
- Study of magnetic properties and density of minerals and rocks.
- Building of the magnetic and gravitational country networks of Albania and their connection to international ones.
- The compilation of algorithms and standard software for processing and interpretation of magnetic and gravity data.
- The major results present the Bouguer Anomalies of the Gravity Field and Magnetic Field of Albania Maps, at the scale 1:200.000.
- Performing of the paleomagnetic studies in all Albanian territory, according to the bilateral projects Albania Austria, France, and Greece.

4. RADIOMETRIC STUDIES AND EXPLORATIONS

The first measurements of natural radioactivity in Albania, carried out in 1958-1959. Until 1990, radiometric studies and research have been secret.

Ninety years brought opening of radiometric research. Radiometric researches have applied to solve many important problems, which have not the relations with the Uranium explorations:

- Implementing radiometric gamma spectrometric determinations by radioactive elements U, Th, K, in the framework of an international project, and regional survey for Geochemical Atlas of Albania.

- Regional radiometric studies according to the total gamma radiation parameter. Has been realized the study "Natural Radioactivity of Albania."

Currently, radiometric studies are oriented to solving environmental problems.

5. GEOTHERMAL STUDIES

Results of the geothermal studies and researches have been presented in the monographs: "Geothermy of Albanides" (1990), " Geothermal Atlas of Albania" (1995), "Atlas of Geothermal Resources in Albania" (, 1996, published 2004), "Geothermal Atlas of Europe" (1992) published by Geographisch-Kartographische Anstalt Gotha, Germany, and "Atlas of Geothermal Resources in Europe", European Commission (2002). Monograph "Geothermal energy resources in Albania and platform for their use", published by Faculty of Geology and Mining, Polytechnic University of Tirana, (2010).

6. SEISMOLOGICAL STUDIES

Albania's seismological network was established in the period up to 1979, with fourteen stations in major cities of the country. During this period have been making Albanian seismological network part of the European and global network through the International Central Bureau of Seismology in Strasbourg, France.

Among major seismological study was conducted "Seismic Zoning Map of Albania" (1972), "Catalog of Earthquakes in Albania" (1975), and "Seismological Zoning of Albania" (1979), published by Academy of Sciences of Albania. Eighties years were period when spread massively seismological studies for solving engineering problems, realizing complex seismological- engineering and geotechnical engineering micro zoning of leading cities of the country.

Continued high levels of international cooperation on the problem of seismic risk the corner of the Balkans, in the event of the Assembly of European Council of Seismology, as well as in projects of UNESCO. Are conducted seven joint international projects and has collaborated on eight projects under the National Program for Research and Development for the publication of seismological, seismological-engineering, neotectonic and of the geological risks maps.

7. FORMING OF THE GEOPHYSICIST ENGINEERS AND THEIR POST GRADUATE QUALIFICATION

Has given great contribution in development of the geophysics in Albanian by Section of Geophysics in the Faculty of Geology and Mining, Polytechnic University of Tirana in both directions: engineers forming, their postgraduate qualification, and scientific research.

Forming of geophysical engineers since 1961 and their postgraduate training was realized in the Branch of Geophysics, Section of Geophysics in Department of Earth Sciences, Faculty of Geology and Mining, Polytechnic University of Tirana. The period of study has been five years for engineers, taken 1-2 years (postgraduate school) and three years for doctoral studies. Current main course of applied geophysicist engineers have been exploration of the oil and gas reservoirs, other solid minerals deposits, hydrogeological research, engineering and environmental studies. During the period 1961-2008 are compiled and continuously improve the curriculum, they respond better to the requirements of time and level of scientific and technological research and geophysical studies and exploration.

In the Framework of implementing the Bologna Protocol, is closed Branch of Geophysics. Under the new curricula, after the first three years of common cycle (Diploma Bachelor for Georesources and Geoinformatics), a geophysical option is in the second year of the Scientific Master degree. With this curricula, , as have been prepared in implementation of Bologna Protocol, results level landing of the scientific and professional formation of geophysical engineer.

In the Geophysical Branch have been formed 303 of engineering geophysics, and are specialized in geophysics and were re-qualified as geophysicists many physicist. Since 1962, Geophysical Brach was also conducted postgraduate qualification of 48 doctors of sciences.

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1. Mining geophysics: Application of the new methods and technologies in Albania:

- Induced polarization method (1962 up to present)
- Micromagnetit surveys (1967)
- IP & RD Real section (1978 up to present)
- Increasing of depth of geophysical investigation (1984 up to present)

2. Mathematical and physical modeling for geoeelectric, gravity and magnetic methods, and inversion in geophysics. Compilation of the algorithms and software's for data processing and interpretation.
3. Extension of the application fields of geophysical methods for exploration of: chromite, asbestos, bauxites, heavy, rare and precious mineral placers, geotechnical and environment investigations, hydrogeological research, application of the natural electrical field for direct search of oil reservoirs.*5. Marine geophysics* (1974-1990): Design and construction of the marine geoelectrical station, marine vertical electrical sounding and profiling, and participation in performing of the marine integrated geological-geophysical studies of the Albanian Adriatic Shelf and design of deep wells for gas exploration in Durres Bay.
6. Regional geophysical studies: Geothermal (1989 up to present), Palomagnetic (1989-1997).

8. *Engineering and environmental geophysics* (1982 up to present), **Publication of the books:** The Section of Geophysics has completed all courses with textbooks, published in the period 1963-upo to present: 19 books for Branch of Geophysics, 4 books for Geological Branch and 5 monographs.

8. WHAT SHALL WE DO FURTHER - AS CONCLUSIONS

Twenty last year's represent the period of expansion in the field of application of geophysical methods to solve the geotechnical tasks: soil and bedrocks study in the construction areas, control of the dams and landslides, hydrogeological explorations, micro zoning of the main cities in Albania, the study and evaluation of geothermal energy, etc. in Albania. Actually are taken the first positive results, first experience, as well as problems of the beginning.

Currently, the geophysical prospecting of oil and gas reservoirs, copper and chromium and other solid minerals deposits are suspended entirely by Albanian geophysical teams. Cessation of work and geophysical studies extremely serious consequences for future geological researches: The geological explorations remain free modern research methods, and turn to the thirty years of the last century level. With the termination of geophysical explorations, the teams were destroyed and lost a half century of their experience, well known also from prestigious institutions of advanced countries.

Today, for Albanian petrol and mining industries are important to take the proper development and implementation of Applied Geophysics directions in accordance with the requirements of market economy, for oil & gas and solid minerals explorations, using modern methods and surveys technology. At the same time, it is necessary to begin implementation of new technologies for geophysical surveys of shallow depths for solving of the geotechnical tasks, environmental control, environmental impacts assessment, urban planning, water exploration, medical geophysics, archaeological sites searches, etc.

In response to the demands of time and development directions of the geophysics in the last two decades, there were worked successfully for the creation of Engineering and Environmental Geophysics in Albania. Geophysical methods have been applied in many fields: In-situ seismic and geoelectric topographies' for dams investigation, the slope stability evaluation and landslides study, soil and bedrocks study in construction and dam areas, of highways, tunnels, etc., for karst areas exploration, quality assessment of the concrete during construction works, and in the airport runway, water exploration, for study of the urban and industrial landfills, also for the assessment of the environmental impacts.Engineering and environmental studies are performed by the same methods, technologies, and equipments that are used for search of minerals. So, at the present, the geophysical and environmental engineering investigations are used the technology and equipment eighties years period, with exceptions when were working in the framework of European project. Albanian geophysical teams are necessary to obtain modern equipment to solve these new geological tasks, presented by today the market economy in Albania. In particular, this situation is very serious for the study of construction areas, of roads, the investigation of the hydrotechnic constructions like dams, the evaluation of the slope stability and landslides, the assessment of geological hazards, water exploration, etc.

For the forming of the yang geophysical engineers, currently the problem is the preparation and implementation of curricula and programs in accordance with the requirements of the Bologna Protocol,

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and actual scientific and technologic level of the geophysical methods. Future geophysicists should be able to realize the oil & gas, and solid minerals exploration because Albania is riche country with natural resources, in parallel is necessary to be able to solve also the engineering and environmental problems, applied surveys with modern technology and digital processing of data.

9. REFERENCES

Biçoku T., 2004. *Historic of the geological explorations and studies in Albania*. (In Albanian). Published by Academy of Sciences of Albania, Tirana.

Frashëri A., Bushati S., Alikaj P., Nishani P., Finetti I.R., A. Den Ben. 2008. *The European contribution of Geophysics in Albania in the frame work of the Bologna Protocol*. International Conference the Conference of the University Rectors in Balkan- The Process of Bologna and the Research, Embassy of Italia in Albania & Ministry of Education and Scientific Research of Albania, 28 March 2008.

Frashëri A. 2010. Albanian geophysics and facing the challenges during the transition period toward free market economy. SEG Denver 2010 Annual Meeting & Global Theater, 17-21 October 2010, Denver, USA.

Frashëri A. Bushati S., Nishani P, Liço R. 2010. *Albanian Geophysics over the years*. (In Albanian). Published by Typography KLEAN, Tirana.

Papa A., 2001. *Bibliography of the French Publications for the Geology of Albania and nearness countries*. IDSH, Tirana.

Rama M. 1995. *Bibliography of Albanian publications for Geology and petrol*. (In Albanian). Institute of Geological Studies and Projects. Publishing House «Dituria», Tirana.

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FROM GEOLOGY INSTITUTE TO INSTITUTE OF GEOSCIENCES 14. 05. 1962 – 22. 08. 2007

Jakup HOXHAJ

Institute of Geosciences, Energy, Water and Environment, Rruga "Don Bosko" 60 Tiranë, Jakuph2001@yahoo.com

ABSTRACT

Under the changes of 90 years, as the whole economy, even the Albanian geology reformations transformations began, arguably, among other things, institutions and research units. In general, unless drastic volume reduction, began a review of research and study areas and their priority within the new environmental conceptions and benefit the wider community and society in general. Work on Geological Institutes, not only would not be closed and only orjentated to research and discovery of minerals, but for all gjeoresources wider. In this context the Institute of Geological Research in addition to survey and geological mapping, stratigraphic studies of biostratigrafic, tectonic problems, geophysical studies, geochemical work and seismological studies, thematic studies summary for solid minerals, for coal research, research for chromium, studies and research for copper ore and polimetal, research and studies for precious minerals, research and evaluation of industrial minerals, was applied hydrogeological research, engineering geology and geoenvironment. The same was with the Institute of Oil and Gas, which marks stratigraphic studies and biostratigrafic, petrographic and mineralogical studies, problems of tectonics, hydrogeological and hydrochemical studies, geochemical surveys, geophysical surveys, analysis of general geological-geophysical materials, studies for oil, gas and all their derivatives, studies with bitumen and tar sands,and the studies in accordance with new priorities. As in the Geological Research Institute here start with priority batch compilation of geological-environmental maps of many target 1:50000 and 1:25000 scale. In this aspect was taken analogues experience of some institutions in the region, Europe and beyond in the World. It is important to emphasize co-4-year (1994-1998) of Geological Research Institute and the Hungarian Geological Institute.

KEY WORDS

Reformation, recreation, openness, complexity, generalization.

INTRODUCTION

Problems of recent years about reforming the Science Forum, especially its institutions, under the Academy and the Executive (ministers), not forgetting the need arise, to the traditional values of many, many years, almost all century past and ongoing. Institute so that we have today and analogues of his, in the context of high education, there are new creatures, but the logical products of reforming a range of units and research institutes across the country, which the events of the 90^{të}, current developments, according to the organization that had, went out of order and necessarily had to be changed. And so it came out pretty much as they were, remained only a few (Albanology, Geosciences Institute, Institute of Water and Environment), which, according to the specifications attached public bears high in Albania, divided by the Academy and the executive, as forms the best possible course of policy judged by consulting stakeholders. However, during this 4-year reform period (2005-2009), and in many cases had mechanical action, which created the impression of new things and forgetfulness of the basic units from being created. In this context the Institute of Geosciences as the product of institutional reform of the Institute of Geological Research, Institute of Oil and Gas and several units in the framework of the Albanian Geological Service. As understood here, and it comes to some units and institutes, not anyway, but more strategic view of economic performance of the Albanian State, almost all of his existence, from creation until today, that the geological character of institutions as the basis of all range of geo-scientific study. Albanian Geology is well before the tripartite these institutes (Institute of Geology and Institute of Geology of Oil and Gas) and the people who originated in the early nineteenth century (with office 1922) with naturalists and geologists foreign, who among others have also written to Albania, over geologic provinces in general or specific, as well as useful minerals. Then come those of the first half of the twentieth century (1952), which are characterized by more profound studies

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of more systematic and made for a relatively long time by some foreign scholars, who were later followed by some societies concessional for oil, gas and solid minerals.

REFORMATION IN THE YEARS

1952, establishment of core Geology Laboratory. 1956, Establishment of the Laboratory of Geology with 95 employees and following structure: Director of Administration, Division of Petrography, paleontology Division, Department of spectral analysis, Analytical Chemistry Division, Sector of coal mineralogy Section, Division of Paleobotany, Rare Minerals Sector. 14.05.1962, Decision nr.165 of the Council of Ministers for the establishment of Studies and Research Institute of Geological and Mining with the structure of: Director, Vice-Director, Scientific Council, Administration, Department of Mapping and tectonics, Mineralogy Petrography Sector, Sector of paleontology, Thematic Studies Division of Analytical Chemistry Division and spectral analysis. Under this decision, the Council of Ministers after the review request on the organization of the Central Geological Laboratory and Scientific-Tematic groups and their return to a Study and Research Institute of Geological and Mining notes that:

Comprehensive study of laboratory and thematic scientific and technical nature of many problemve geology and mining, in progress, it is of importance and great benefit to our country. But the solution well and a range of useful problems in this area can not be achieved without a technical and scientific treatment, required by the country today. To ensure good results in this direction and leadership for the future studies in the field of geology and mining is neccessary to create a center for scientific and technical research, which deals with carrying out of complete chemical analysis and spectral analytic for all minerals and elements, mineralogical studies, petrographic and paleontological studies of different scientific tematic conclusions increasing geological works and a fuller utilization of natural resources and studies technology to assess the cost-effectiveness and to ensure more complete utilization of useful minerals of our country.

For as above decided that, Central Laboratory of Geology and relevant Scientific Groups will be reorganized to the rank of a scientific and technical research institute, with this label: Studies and Research Institute of Geology and Mining. Studies and Research Institute of Geology and Mining has the following duties: a. Researching and refines methods for analysis of the full chemical-analytical and spectral for all minerals and elements that are in our country. b. Makes thorough study and petrographic and mineralogical composition of minerals and rocks in various of our country, to help different expeditions to draw the right conclusions for a more complete exploitation of minerals useful. c. Thematic scientific studies made conclusions increasing geological works, using new methods for detection of mineral bodies, which do not appear on the surface. d. thematic studies on stratigraphy, tectonics, the legitimacy of the spread and terms of creating useful mineral resources. d. Performs the generalization of various geological studies. dh. Prepares drafts for publication of various geological maps of our country. e. Mineral studies, using technology developed in laboratory scale, industrial and semi industrial to full utilization of the main useful minerals and accompanying elements, making the full technological projects and works for milling and processing of minerals. f. Exercises supervision and technical guidance on all laboratory methodology of the Ministry of Mines and Geology, doing analysis of case control and technical guidance issued by the general character and binding on the work in these laboratories. In terms of problems and topics of Studies and Research Institute of Geology and Mining to keep in mind not to touch the whole plan of scientific topics STATE University, accepted the decisions of the Poliburo of the Central Committee and the Council of Ministers.

????The Institute has a list of organic and organic, administrative and technical personnel of 25 men, from 6 Laboratory has today Tematic Qendrorë and scientific groups. Framework needed to meet this number be provided in the second degree, in 1962 thirteen people and in 1962, 12 people. Institute to continue carrying out the analysis for minerals export issued by the Ministry of Mines and the Mines and Geology Gjeologjisë.Ministry within the second quarter of 1962 to issue regulations with detailed tasks of Studies and Research Institute of Geology and Mining.

25.08.1963, the decision nr.81 experimental implant was set enrichment in Durres Coastal sands with 7 employees. 08.04.1966, With DCM No.12 was ba reorganization of Studies and Research Institute of Geological and Mining with 226 employees and more following structure: Director, Vice-Director, Scientific Council, Administration, Department of Geology, minerals doboshëm Cabinet, Office of paleontology petrografisë Cabinet, Cabinet of mineralogy, Map Cabinet, Division of Technology, enrichment Cabinet,

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Cabinet phosphorites technology, chemical technology Cabinet, Cabinet mining, sands implant of Durres. The industrial sector, Cabinet building materials, food industry Cabinet, Cabinet of various industrial products. Analytical Division, Cabinet metalifere analysis for export, rontgene spectral analyzes Cabinet, Cabinet of ore deposits not metalifere analysis. 1968, Technical Cabinet was formed. 1969, was reached by the Bureau of Design Technology. 1971, was established methodologies Research Cabinet. 16.12.1969, With DCM nr.186 was ba reorganization of Studies and Research Institute of Geology and Mineral separating Industry sector separately and left with the name; Studies and Research Institute of Geology and Mining of the lower structure: Director, Vice-Director, Scientific Council, Administration, Cabinet of Useful Minerals, Geology Provincial Cabinet, Cabinet of mineralogy, palaeontology Cabinet, Cabinet Drilling, Chemical Technology Cabinet, Cabinet of Metallurgy, Petrography Cabinet, Cabinet chemical Analysis spectral Cabinet Technician, Office of Mines, Bureau of Design Technology, Design Bureau of Minera, Research methodologies Cabinet, Cabinet of precious minerals, the Office of Environmental Pollution. 07.12.1978, The V.K.M nr.334. Technology sector was separated from Studies and Research Institute of Geological and Mining Institute separately and remained under the denomination; Design Institute of Geology and Mining, with 188 employees and more bottom structure; Director, Vice-Director, Scientific Council, Administration, Useful Minerals Division, Department of Geological Science, Division of Mining Research, Analytical Division and Office of Documentation. 15.04.1993, With DCM 152 was ba division in two Institutes, Research and Design Institute of Mining and Research and Design Institute of Geology of the lower structure: Director, Vice-Director, Scientific Council, Administration, Department of Useful minerals, Department of Geological Science, Analytical Division and Office of Documentation. 12.03.1992, With DCM nr.92 Studies and Design Institute of Geology passes unit depending on GJEOALBA subsidiary's 156 employees with the following structure: Director, Vice-Director, Steering Committee, Scientific Council, Administration, Department of stratigraphy , Sedimentology of paleontology, Department of Geological survey, Department of Magmatizëm-tectonics, Department of Metallic deposits, deposits Industial Department, Department of Geochemie, mineralogy of Petrography, Department of Drilling, Department of Chemical and Physical Analysis, Department of Informatics and Statistics Documentation and Evaluation Department. 15.04.1994, No. 168 In a letter to GJEOALBA's Department of Chemical and Physical Analysis was set apart as a unit in itself, passing directly dependent GJEOALBA-s, and Research and Design Institute of Geology remained with 70 employees and structure The following: Director, zv.Drejtori, Steering Committee, Scientific Council, Administration, Department of Geological survey, Department of Magmatizëm tectonics, deposits Department, Department of stratigraphy, palaeontology Sedimentologjisë the Department of Petrografisë, mineralogy of Gjeokimisë, Department of Environmental Geology, Department of Informatics and Department of Technical Documentation. 02.07.1998, approved the law nr.8366 "On the Albanian Geological Service," according to which, Studies and Design Institute of Geology at the label changes: Geological Research Institute, as part of the research unit infections. 15.04.2004, approved the law nr.9221 "On some additions and changes to the law nr.8366. According to them Geological Research Institute of remains unchanged with the same status.

22.08.2007, Council of Ministers decision nr.561, "On the merger of several institutes and researches units, their organization at the Institute of Geosciences, Polytechnic University of Tirana, and the Institute funsionimin transitional period". 21.05.2007, "On top rules for education in the Republic of Albania" and Law No.8743, dated 22.02.2002 "For movable property without the State", proposed by the Ministry of Education and Science, Council of Ministers decided: Union Institute of Seismology of the Academy of Sciences, with some of the research units of Albanian Geological Service, respectively, Department of Territory and Property Administration Mineral, Drejtorinë of Geo-informatics, Department of Applied Geophysics and Topogjeodezisë, which separated from the service and their organization: Institute of Geosciences (IGJEO) as the main unit in the Polytechnic. Both are from the government, with May 18, 1965 Geological Institute of Oil and Gas, based in Kuçova since 1971 and headquartered in Fier. His duties were carring out searching and geological survey 1:10000 scale, 1:25000, 1:50000, 1:100000 and stratigraphic studies, biostratigrafike, paleontological, petrographic, mineralogical, geochemical, geological-generalization of geophysical materials, determination of -research drilling wells for oil and gauze, tracking their results, the calculation of oil and gas reserves and prognosis, as well as studies tematiko-generalizing and synthesis of southwestern regions of the country. Director of the Institute have been: Recep Reka (September 1965 - December 1970), Bekir Alia (January 1971 - March 1975), Lucia Pleqi (1975-1979), Petraq Xhaçka (1979-

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1983), M. Mezini (1993-1991) Hasan Baqia (1991-1992), Ilia Fili (1992-1995), Stefan Baltadori (1995), Luan Zajmi (1995-1997), Fatmir Fezga (1997-1998), Stavri Dhimo (1998-1999), Snoop Nazaj (2000-2002), and then became involved in the Albanian Geological Service as a unit of infections.
In view of activity and activity recall some sezione science, scientific symposiums and consultations. In 1973 the Research and Design Institute of Geology and Mining and Geological Institute of Oil and Gas Symposium was organized in Patos first techno-scientific session of paleontology and technical-scientific view of petrografisë sediment. Subsequently, the Geological Institute of Oil and Gas, since 1974, the Faculty organized a national asset of oil and gas research. In 1976, the city of Bajram Curri, the Research and Design Institute of Geology and Mining and Geology Grejtoria General scientific session was held on the orientation and perspective of sulphide mineralization in northern Albania, while in the South conduct consultations on research work of bauxite in the area of the Alps. In 1977 he was called national attention to the asset's condition and improvement of the laboratories of geology and mining sector. In Fier, in 1978 was held scientific and technical session on the increased activity of the research methods of oil and gas. Rubik develop scientific session devoted to works works këtrkim-discovery of copper minerals. In 1979 scientific sessions were organized by the Research and Design Institute of Geology and Mining and the Faculty. Also in 1980 was held scientific session on the problems of geology and useful minerals, and the like.

ANALIZATION

At the time of reformation of the Institute of Geological Research (July 2007) had this state of scientific staff: Professor 2: Jakup Hoxhaj, Halil Hallaci. 7 associate professor: Ibrahim Milushi, Kujtim Onuzi Onuzi, Nezir Mekshiqi, Bislim Boshniaku, Petraq Naçe, Hasan Kuliçi, Veip gjoni. 2 doktor sciences: Tonin Deda, Naim Karaj. 5 Masters: Rakip Hyseni, Kristina Gjeçi, Ndoc Vukzaj, Isa Haklaj, Aslan Daci. 13 engineer geologist: Sabri Hoti Sali Imami, Ferit Ukaj, Sinan Zhupi, Adil Hakorja, Pellumb Dedndreaj, Halit Beci, Shpresa Vata, Dod Shtjefanaku, Zaim Karanxha, Stake Vukaj, Ergys Hakorja, Enton Bedini. Directors of the Institute in years: Eshref Pumo, Teki Biçoku, Hajredin Kumbaro, Sotir Dodona, Bashkim Lleshi, Aleksander Cina, Ilir Alliu, Alaudin Kodra, Adil Neziraj, Halil Hallaci, Defrim Shkupi, Ibrahim Milushi. Who worked at the Institute: Alaudin Kodra, Afat Seriani, Agron Brace, Zihni Sinojmeri, Agim Pirdeni, Agim Miftari, Arian Gjikondi, Asti Popa, Avni Meshi, Artan Tashko, Agim Tërshana, Anesti Qirinxhi Astrit Turku, Alex Vranaj, Abedin Xhomo, Avni Dibra, Burhan Kodra, Bylbyl Shehu Çerçiz Dyrmishi, Ded Marku, Defrim Shkupi, Dhimo Ikonomi, Eqerem Zhukri, Edmond Hoxha, Etleva Jaho, Fatbardha Cara, Faruk Mustafa Ferit Ukaj, Gezim Shima, Genc Tomini, Grigor Heba, Gjovalin Leka, Injac Ndoja, Islam Zyko, Ismail Turku, Ismail Hoxha, Ismail Balluku, Irakli Premti, Kadri Gjata, Kristaq Dhimo, Hamit Ndoka, Haxhi Pulaj, Luftulla Peza, Lazar Dimo, Makbul Ylli, Marie Koçi, Mehmet Spaho, Mehmet Zaçe, Minella Shallo, Myzejen Rama, Mensi Prela, Nezhat Hysi, Neki Kuka, Pandeli Pashko, Pano Çakalli, Petro Çili, Petro Kati, Polikron Theodhori, Polikron Vaso, Resmi Kamberaj, Sefedin Qorlaze, Sokol Marku, Shaban Pinari, Shaban Stërmasi, Shpresa Vata, Telo Velaj, Thanas Gjata, Vehap Bezhani, Vangjel Kici, Vasil Grillo, Vangjel Qirici, Vedat Shehu, Zef Tosca, etc.
Kondidate staff to structure the Geosciences Institute: Ibrahim Milushi, Jakup Hoxhaj, Kujtim Onuzi, Nezir Mekshiqi, Halil Hallaci, Bislim Boshniaku, Petraq Naço, Tonin Deda, Naim Karaj, Hasan Kuliçi, Veip Gjoni, Kristina Gjeçi Rakip Hysenaj, Ndoc Vukzaj, Enton Bedini, Isa Haklaj, Adil Neziraj, Vesel Hoxha, Agim Shenjatari, Arben Pambuku, Aslan Daci, gjon Kaza, Nikoll Ndreca, Idriz Jata, Safet Dogjani, Piro Leka, Fatbardha Vinçani, Gjovalin Leka, Fatbardha Cara, Ylber Muceku, Hamdi Beshku, Agim Mazreku, Aranit Gelaj, Emanuela Kiri, Rajonda Kromidha, Xhume Kumanovo, Irakli Prifti, Luan Hasani, Merit Karaj, Sonila Marku, Adil Hakorja, Ergys Sterjo, Pellumb Dedndreaj, Sabri Hoti, Sinan Zhubi, Halit Beci, Zaim Karanxha, Dodë Shtjefanaku, Dashamir Gega, Haki Sula, Ferit Ukaj, Llesh Leshi, Petrika Kosho, Sami Nenaj, Marita Dalipi, Violeta Azizaj, Shpresa Dema, Violeta Murati, Ludmidha Reso, Susana Ballushi. According to the Government decision to establish the Institute of Geosciences had to enlist the Geological Service researchers 25, among them the field of geology: 2 Professor: Jakup Hoxhaj, Halil Hallaci, 7 associate professor: Ibrahim Milushi, Kujtim Onuzi, Nezir Mekshiqi, Bislim Boshnjaku, Petraq Naçe, Hasan Kuliçi, Veip Gjoni, 2 doctor: Tonin Deda, Naim Karaj and 5 Masters: Rakip Hyseni, Kristina Gjeçi, Ndoc Vukzaj, Isa Haklaj, Aslan Daci. However unjustly dealt only: Prof. Dr. Jakup Hoxhaj, Prof.as. Dr. Ibrahim Milushi, Prof.as. Dr. Kujtim Onuzi, Prof.as. Dr. Nezir Mekshiqi, Prof.as. Dr. Petraq Nace, Dr. Tonin Deda, Dr. Kristina Gjeçi. In

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Gjeologjisë Department (Department Gjeoresurseve and Gjeoinxhinierisë) currently are: Prof. Dr. Jakup Hoxhaj, Prof.as. Dr. Kujtim Onuzi, Prof.as. Dr. Nezir Mekshiqi, Prof.as. Dr. Petraq Naço, Dr. Tonin Deda, Dr. Vesel Hoxha, Dr. Kristina Gjeçi, Dr. Ylber Muceku and Dr. Viktor Doda and as guests; Prof. Dr. Milushi Ibrahim, Dr. Fatbardha Cara, MSc. Emanuela Kiri.

Institute of Geosciences has a mission: to seek basic and applied science, university education, deepen, students and scholars, services to third in the field of seismology, and transferring knowledge and technology in the field of seismology, natural resources, gjeorisku, geoingineery and geoinformation. The main tasks of IGJEO's are: the study of geological phenomena, geophysical, geochemical, geo, etc. and construction of thematic geological maps. The study and evaluation of mineral resources, building materials, underground resources, energy and underground water resources, study geo-pedological aspect and the territory. The study of natural hazards (geo-risk, and to those of caused from human activities, slides, washouts, floods, earthquakes, pollution, deposition places, subsidencat mining, etc.). Mikrozonation study for seismic risk assessment of regional and local level. European adaptation of design standards antisizmik, in our country. The continuous study and monitoring of seismic activity and strong jolt, and real-time notification of state and public bodies. Regional and local geophysical studies in the context of geological mapping, environment studies, archeology, geothermal energy, etc. Development of models gjeoinformatice. University training, mainly in the second cycle of the third study and training of young scientists. Geosciences institute consists of the following departments: Department of Georesurses and Geoenginering, Department of Geophysics and Georisk, Department of Seismology and seismic engineering, geoinformation- technologies Department.

For basic mission: research, basic and applied, in-depth training university students and young scientists and services to third in the field of seismology and transfer knowledge and technology in the fields of seismology, natural resources, georisk, geoenginery and geoinformations) and tasks, Institute of Geosciences is required: a. human resource development and increasing the level of expertise, training of personnel appraisal of his own rejuvenation with young researchers, selected on strictly scientific criteria, to ensure continuity of research and able to face future challenges . b. Improvement and strengthening of research infrastructure and developing technology that currently does not correspond to modern standards. c. Organizational and institutional strengthening, aimed at improving management capacity, extension of autonomy to the department level, to encourage and motivate initiative and applied research activities, the construction of an adequate regulatory framework. In this context, the biggest challenge is to achieve an adequate equilibrium between development and conservation of natural resources of an optimal natural environment. So they said otherwise, the capacities required, research orientation, integration of research with university training, consulting services and transfer of knowledge and technology.

Institute of Geosciences (IGJEO) has begun its activity with 1/01/2008, Decision of the Council of Ministers no. 561, dated 22/08/2007. He is part of the Polytechnic University of Tirana, and in accordance with law no. 9741, dated 21/05/2007, "On higher education in the Republic of Albania", has the status of the main unit within the university. According to Decision no. 561, Institute of Geosciences has a mission: a. conduct research, basic and applied, in the field of geosciences, b. participate in university education, deepen, students and the training of young scientists; c. perform services for third parties and help in transferring knowledge and technology in the fields of seismology, natural resources, the gjeohazards, geoinformation and environmental. The main tasks of IGJEO's are: a. The study of geological-geophysical phenomena, etc., and the construction of maps gjeotematike b. The study and evaluation of mineral resources, building materials, underground resources, energy and groundwater resources; c. Geopedologic study of the territory; d. The study of natural hazards and those caused by human activity; of. Study and continuous monitoring of seismic activity and strong earthquakes jolt, and real-time notification of state and public bodies; f. Mikrozonation studies for seismic hazard assessment, regional and local level; g. Adoption of European standards of design antisizmik h. Geophysical surveys, regional and local geological mapping within, gjeomjedisit studies, archeology, geothermal energy, etc. The. Development of models and technologies geoinformatic and geoinformation. University training, mainly in the second cycle and third studies and scientific training of young scientists.

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CURRENT DEVELOPMENT VISION

Join Geoscience Institute (order of the Minister nr.371, dated 28.07.2011) with the Institute of Energy, Water and Environment, and formed Geosciences and Energy Institute. Water and Environment, based inter alia on the decision nr.490, dated 06.07.2011 of the Council of Ministrava "To repeal the decision nr.560 and 561, dated 22.08.2007 is the Council of Ministers". Under this order with the new name Institute mission is the same things, and the former institutes of which they formed, so and duties, except that the emphasis is on seismic and hidrometereology. As before, particularly now in the new reality created by the merger of two institutes (Institute of Geosciences and the Institute of Energy, Water and Environment at the Institute of Geosciences, Energy, Water and Environment), restructuring takes place leading integrator. In this context and Geoenvironment and Georesources Department as part of this Institute is not only reformed, but it crystallized more His own platform development, structure, object to the content. Under these new point of view department by name: "Georesurcese and Geoengineery" named: "Georesurcese and Geoenvironment" by countering the visible set and equal, in terms of Civil Geology, as the geological environment, geology, hydrogeology as well as Engineering. While the motivation for Gjeoresurset (Geological Resources) remains the same as before, due to geological resources across complex Geological Survey. Well, said the department is organized according to different research fields with three research groups, according to which the programs are përvijue works, two for each group. Programs at different times, according to the work may vary in function of solving concrete problems. The same organizational functioning is maintained for research workers under shpërndorjen of ranks and titles have, in view of the position that he possesses. Accordingly with this reasoning, discussed and accepted by almost all built structure and its contents as follows:

A. Group of Geologo-Tectonical Research Group, Prof.As.Dr. Petraq Naço,

Program 1: "Regional Studies", Prof.as.dr. Petraq Naço, Prof.as.dr. Kujtim Onuzi, Dr. Tonin Deda, Dr. Viktor Doda, Eng. Vjollca Dinaj,

Program 2: "Gjeospecialitetet" Prof.as.dr. Nezir Mekshiqi, Dr. Kristina Gjeçi, MSc. Andra Utka,

B. Georesurse Research group, Prof.dr. Ibrahim Milushi,

Program 3: "Metallic and Non Metallic", Prof.dr. Milushi Ibrahim, Dr. Vesel Hoxha, MSc. Gjon Kaza.

Program 4: "Hydrocarbon fuels", Prof.as.dr. Petraq Naço,

C. Environment Research Group, Prof.dr. Jakup Hoxhaj

Program5: "The Geohazards and Environment" Prof.dr. Jakup Hoxhaj, Dr. Fatbardha Cara,

Program 6: "Geoingineery of groundwater" Dr. Ylber Muceku, MSc. Emanuela Kiri.

Thus, the department currently Gjeoresurseve and Environment inkludon in content of his, by groups and programs out of which 15 employees: 2 professor Ibrahim Milushi, Jakup Hoxhaj, 3 prof.asoc; Petraq Naço, Kujtim Onuzi Nezir Mekshiqi, 6 dr.; Tonin Deda, Viktor Doda, Kristina Gjeçi, Vesel Hoxha, Fatbardha Cara, Ylber Muceku, 3 msc; Uta Andrea, Gjon Kaza and Emanuela Kiri and an engineer, Vjollca Dinaj, Having considered the basic status of the Institute (scientific research, basic and applied, in-depth training to university students and young scientists, transfer of knowledge and technologies and monitoring at national level in the fields of seismology, hydrometeorology, natural resources, the geohazards, geoingineery, geoinformation, climate, water resources, renewable energy, environment, etc.), the object of the Environmental and geoingineery Department is to continue to be: regional geological and tectonic studies, geological resources, geological environment and all elements of his own and geological hazards in the context of all natural hazards. More specifically delivered seamlessly included studies with regional specialties (petrography, stratigraphy, paleontology micro-macro, minerology, gjeokimy, etc.), Studies of metallic and non metallic, studies and hydrocarbon fuels, studies geological facilities along with potential risks despite the preventive measures and studies and those of waterbearing, geoingineery and hydrogeological aspects. Of course all studies, except specialized complex character involving all complex geophysical methods (elektrometry, seismic, manjetometry, radiometry and gravimetry), geochemical (rocks, minerals, waters, soils, etc.). Along with these laboratories processing and analysis, as well as all deçitalizues system and processor information. In this approach toward management stewardship all Albanian territory is undertaken study: "Albanides in Regional Map Series, scale 1:200000" (geological, tectonical, metalogenical, hydrogeological, geo-engineering, geo-environmental and geo- risk). Realization by 7 projects as follows:

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Project 1. Corrections and further improvements in terms of building the geological-tectonic and structural Albanides (for geological map of Albanides).
Leader: Prof.as.dr. Kujtim Onuzi, authors: Prof.as.dr. Nezir Mekshiqi, Dr. Kristina Gjeçi, Dr. Tonin Deda, Andrea Utka MSc, MSc. Gjon Kaza,
Project 2. Characterization of the major tectonic units on the basis of features litofaciale, structural, and tectonic (for map of main tectonic units of Albanides).
Leader: Prof.as.dr. Petraq Naço, author: Dr. Viktor Doda,
Project 3. Geological formations and features Albanides mineralmbajtëse of their metallogjenike (for metalogenical map of Albanides).
Leader: Dr. Vesel Hoxha, author: Prof.dr. Ibrahim Milushi, Prof.as.dr. Nezir Mekshiqi, Dr. Tonin Deda, Dr. Kristina Gjeçi,
Project 4. Further clarifications and improvements in the treatment of geological formations as akujfere of water Albanides nëntoksërë (hydrogeological map of Albanides).
Leader: MSc. Emanuela Kiri, author: Eng. Vjollca Dinaj,
Project 5. Evaluation and zoning Albanides geological formations on the basis of their geotechnical properties (Engineering-geological map of Albanides).
Leader: Dr. Ylber Muceku,
Project 6. Characterization of geological formations Albanides according to sensitivity and adaptability towards different types of pollution (Geological-environmental map of Albanides).
Leader: Dr. Fatbardha Cara,
Project 7. Dynamics of development in the context of occurrences Albanides and geohazard mapping out measures to prevent and relieve their consequences (geological risk map of Albanides).
Leader: Prof. Dr. Jakup Hoxhaj
These projects, and all work to design your future is a very important problem, and needed more practice in the regional context, all Albanide and perhaps wider, nationwide, which relates to the materialization of all hartografuese geological work done so far, to build a series of geological-environmental mapping, aiming to reflect the latest scientific level contemporary, unifying them under the views and options, with the sole purpose, according to them we can have in management, research and stewardship all territory and geological environment, the wider natural environment with which it connects. So, in other words, throughout the Albanian territory, first as a sum of geological formations with a spatial setting, the dynamics of the above, can be fully controlled in the scientific view, already well characterized, as a composition, placement, background, age as potential resources, as ujëmbajtje potential, potential as Infrastructure, both potential and potential environmental risk of potential geological and natural whole, including those of the universal character of earthquakes, volcanoes, tsuname, etc. However the evidence for these phenomena are kaherëshme, almost contemporaneous with man, which until recently were treated separately and not in a context, in that the geological environment, the natural environment as a whole, with all elements of infections. In geological terms, as such, observations on the types and forms of relief, on the basis of which new decoded geological formations on the surface, the surface and very close to the original observations on the geological-tectonic characterization of geological formations based, according to potencuesit përvijëzojmë which can be key to developing infrastructure and community as a whole. Well in this unity, according to these complex-type studies, we can outline the corridors of development, we can determine the nature of human relationships, can prevent risks, can ease the inevitable adversities. For example, according to these studies, orjentojmë man where he can and should affect the nature, to take its resources to the benefit of providing the goods, without prejudice to the next and future generations of his own on. Series of regional geological-environmental mapping for all Albanides, which aim, synthesized as a whole, gives a more complete information on the properties of the upper part lithosphere, expressed not only with words but with pictures of different graphs, as the most appropriate means to communicate with specialists in various fields, up to the general public. In this regard, study guides related work: the use by man of the earth's surface by physical features and characteristics, especially for expansion of urban space, the determination of factors affecting the safety and reliability of material losses and waste of all species in the rocks near the surface and in depth, with the rational use of soil and subsoil, the values that increasingly, the interpretation of links between near surface geological units and the units of agricultural land, the determination of the occurrence and nature of aquifers in depth near the surface; to the determination of geological environments

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for collecting, storing and burying the waste to determine the sources of building materials, the determination of the geological-engineering characteristics of geologic units near the surface, etc..

THE MAIN GOALS

I. Regional fundamental scientific studies, II. Regional studies applying fundamental, III. Studies on the major problems of the state, IV. Scientific activity, V. Heritage conservation,

I. Regional fundamental scientific studies: 1. Improvements and adjustments to Albanides Geological Map, scale 1:200000 (based on geological analysis formacionale). 2. Improvements and adjustments Albanides tectonic map, scale 1:200000 (based on tectonic and structural analysis of geological formations). 3. Improvements and adjustments to Metallogjenike map of Albanides, scale 1:200000 (based on analysis of geological formations metallogjenike). 4. Improvements and adjustments to Hydrogeological map of Albanides, scale 1:200000 (based on analysis formacionale aquifer). 5. Suitability map of Albanides construction, scale 1:200000 (based on geotechnical analysis formacionale). 6. Environmental geological map of Albanides, scale 1:200000 (based on analysis of environmental formacionale). 7. Improvements and adaptations of Geological Hazard Map of Albanides, scale 1:200000 (based on analysis of geological phenomena under geological formations). 8. Preparation of lithological map of Albanides, scale 1:200000 (based on analysis of lithological formations). II. Regional studies applying fundamental: 1. Geological formations (lithological) as aquifer. 2. Geological formations (lithological) suitability as construction (infrastructure). 3. Geological formations (lithological) as the fitness sensitivity Ndoja pollution. 4. Geological formations (lithological) as source, sensitivity of adaptability to the major phenomena, earthquakes, etc.. 5. Geological formations (lithological) as erozionale skills and accumulating. 6. Geological formations (lithological) as a source of geological resources. 7. Geological formations (lithological) as a source of geologic hazards. 8. Geological formations (lithological) as a source of natural hazards. III. Studies on the major problems of the state: 1. Studies on the state-level infrastructure works such as roads, railways, water supply pipelines, urbanization, etc. 2. Planning strategy for the nationwide development of river and sea erosion, floods, Deformations land, building materials, etc.. 3. Regional development strategy and planning, european and beyond. 4. Geological formations (lithological) as source, sensitivity of adaptability to the major phenomena, earthquakes, etc. IV. Scientific activity: 1. Projects and reports, 2. Publications: articles, books, monographs, 3. Participation in scientific activities, 4. Participation in teaching, 5. Participation in the knowledge transmission technologies, V. Preserving heritage: 1. Access to Central Fund of Geology, 2. Funds and the libraries of former Institutes of which are formed, 3. Electronic copies, 4. Establishment of the Institute and Museum, 5. Memorization of the electronic management, 6. Geo-scientific bulletin.

REALIZATION

1. Renovations at the facility, 2. Renovations in personnel, 3. Renovations in tools and technology, 4. Complexity of work, A. Renovations at the facility: A. Research Group Geological-tectonic Program 1: "Regional Studies", Program 2: "Geospecializations"

B. Gjeoresurseve Group.

Program 3: "Metallic and non Metallic", Program 4: "Hydrocarbon fuels",

C. environment Group, Program 5: "The Geohazards and Environment", Program 6: "Geoingineery and Groundwater"

2. Renovations to staff: Qualified new employees or justeducations inside out: a. Marine geology, b. Fuel hydrocarbons, c. Underground water study, d. Stratigraphic studies, e. Study of geological resources (mineralogy, etc..) 3. Renovations to the technology tools: a. Tools and equipment for field work: Field Teams, car transport, Individual Equipment, b. Laboratories, preparations Preparations: thin, thinsection the CC, Preparation tests with grinding, chemical analysis, spectral analysis, c. Digitization and informatization, 4. Complexity: a. Geological aspect, field survey, the sample, analysis. b. Geophysical aspects, seismic Elektrometry, Radiometry, Manjetometry, Gravimetry, c. Geochemical aspect, Gjeokimic rock soils, groundwater Gjeokimi, Ultimately the main goal is: "For a sustainable development, which means meeting the demands of today's generations, without dishonor needs of next generation, which inter alia requires natural resources management, territory management and use of land without compromising rracional natural

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balance of nature-human relations especially. Economic growth must be accompanied by rracional use of natural resources while maintaining biodiversity, ecosystems and environmental transformation avoided the wasteland ". Same thing with 7 three-year projects, which are based, respectively: geologic map, tectonic map neotektonike, metallogjenike map, the map hydrogeological, engineering-geological map, geological map-environmental and geological risk map , all in a regional context Albanide for sustainable development throughout the territory. Study as a whole is understanding and using nature as rracional man in His own good, for a better life, without sacrificing the future and ensuring sustainable development and gradual basis without compromising necessary ekujlibrat who avoid abnormalities and all subjective vicissitudes of life, they both facilitate the objective character, negative consequences for as low as possible.

REFERENCES

Hoxhaj J. 2010: From the Institute of Geology at the Institute of Geosciences. Book. Fund of the Institute of Geosciences, Polytechnic University of Tirana.