MINERALOGICAL SOCIETY
OF GEORGIA

GEORGIAN TECHNICAL
UNIVERSITY

POWER OF GEOLOGY IS THE PRECONDITION FOR REGENERATION OF ECONOMICS

BOOK OF ABSTRACTS

3rd International Scientific-Practical Conference
on Up-to-date Problems of Geology

1-2 June, 2017

„Technical University“

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ISBN 978-9941-20-832-4

http://www.gtu.ge

Verba volant, scripta manent

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EVOLUTION OF THE NEOPROTEROZOIC-PALEOZOIC CRYSTALLINE BASEMENT OF GEORGIA (SW CAUCASUS)

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Numerous blocks of peri-Gondwanan affinity are recognized in the crystalline basement of the European Hercynides, which is one of the fundamental features of the Hercynian belt. The detachment of blocks (terranes) from the northern Gondwanan margin started during the Middle to latest Ordovician, when the Paleo-Tethys basin started to open. Thus, identifycation and study of the peri-Gondwanan terranesincluded in the vast Hercynian belt reveals the evolution of active Gondwanan margin in the Neoproterozoic and earliest Paleozoic, as well as the evolution of the Proto-Tethys and Paleo-Tethys Oceans. In this respect, Neoproterozoic-Cambrian terranes and associated younger (pre-Upper Carboniferous) crystalline complexes are of special interest.

The region of the Caucasus is subdivided in two large geological provinces. The Southern Province represents a peri-Gondwanan block. Pan-African tectonic events are clearly-shown, followed during the whole Paleozoic by accumulation of predominantly shallow water marine deposits, carbonate and terrigenous clastic sediments.

The Northern Province (area of the Caucasian Hercynides) is characterized by extensive manifestation of Paleozoic (in particular Hercynian) tectono-magmatic events, suprasubduction type magmatism, strong regional metamorphism and emplacement of granites. Rocks of the Late Proterozoic-Paleozoic oceanic basins of the region, as a rule, tightly associate with granite-gneiss-migmatite complexes of Precambrian (Southern Province) and Precambrian-Paleozoic (Northern Province) age.

The boundary between noted provinces coincides with Northern Anatolian (Izmir-Ankara-Erzincan)-Lesser Caucasus (Sevan-Akera) ophiolite belt.

The Caucasus Mountains contain numerous fragments of oceanic type lithosphere, usually significantly dismembered and metamorphosed. The exposures of metamorphosed accretionary mafic complexes are known in the Transcaucasus and along the southern edge of the granite-gneiss core of the Great Caucasus.

The *Loki, Khrami and Dzirula salient of the basement* of the Transcaucasus are mainly composed of Variscan granitoids. Relatively small outcrops of differently tectonized and metamorphosed basic and ultrabasic rocks are generally associated with pre-Cambrian – Early Paleozoic gneissose diorites and plagiogranites.

The Loki basement,evidently, was formed during the Late Proterozoic-Late Paleozoic. The metabasites, apparently, represent Prototethyan fragments. The salient is composed mainly of Late Paleozoic granitoids whose ages were established by K-Ar, U-Pb and Rb-Sr methods as 320-370 Ma. The E-MORB type basalts were established in the basement of the Loki salient delineating a relatively high-Ti compositions, relatively enriched in REE and LREE. These basalts have higher Th/La, Th/Sm, Th/Yb and Zr/Y ratios in comparison with the average N-type MORB.

The *Khrami salient* is made up mainly of Late Paleozoic (Variscan) granites. Plagiogneisses and migmatites occupy a limited part and bear small bodies of metabasites and serpentinites. Samples taken from migmatites reworking a grano-dioritic protolith represent a well preserved protolith age with a ^{238}U-^{206}Pb weighted mean age of 474±3Ma. The rim analyses cluster on a concordant age of 343±2Ma. Three data points plot in between these two age groups and likely reflect an intermediate component between the rim and core ages [1,2].

The mafic-ultramafic rocks of the Paleooceanic association of the Hercynian Transcaucasian massif are found mainly within the Tectonic Mélange Zone of the Chorchana-Utslevi cropping out along the eastern edge of the Dzirula salient. Until recently, the mafic-ultramafic association of the mélange zone has been interpreted as a dismembered Late Proterozoic– Early Paleozoic oceanic complex, and the associated phyllite slices as fragments of the sedimentary cover of this Paleooceanic base. Dated paleontologically the phyllite slices show however rather wide spread of ages from Cambrian to Late Devonian. Zircons of metabasalt were studied to obtain magmatic ages and isotopic fingerprints of the source material. Two age groups of zircons were established: 460-480 Ma, and 423.7 Ma. Central parts of the analyzedzircon grains from an Underformed I-type biotite-bearing granite that intruded the Georgian crystalline basement reflect the crystallization age of the granite with an upper intercept age of 335±8 Ma. The rimanalyses cluster towards slightly younger ages (315-325 Ma), which may reflect the duration of magmatic cooling in a HT-LP [1,2].

Mayringeret al. [3] offered another new geochronological study of theDzirulagranites, tonalite-granodiorites and metapelites. In microcline granites late Paleozoic ages prevailed. However, vast variations in age values werealso observed: 2392 ± 37 Ma, 1840 ± 40 Ma, 1538 ± 26 Ma, 1441 ± 24 Ma, 804 ± 10 Ma, 691 ±12 Ma, 638 ± 12 Ma, 594 ± 11 Ma, 593 ± 11 Ma, and 584 ± 10 Ma. In some cases, thexenocrysts showed zones of differing ages (e.g., 879 ± 16 Ma vs. 313 ± 6 Ma; 816 ± 15 Mavs. 320 ± 5 Ma). Likewise, paraplagiogneisses and paraplagiogneisses intensely injected bygranites, show wide scattering in age: 1218 ± 38 Ma, 552 ± 14 Ma, and 538 ± 18 Ma; 972 ±40, 528 ± 12 Ma, and 525 ± 14 Ma; 537 ± 14 Ma and 334 ± 8 Ma; 1954 ± 34 Ma and 719 ±13 Ma.

The occurrence of the oldest xenocrystic zircons in mantle-derived igneous rocks favors the interpretation that zircon xenocrysts resided in the mantle and were entrained when this mantle was melted to form juvenile crust [4].

The southernmost strip of the crystalline core of the Great Caucasus is represented in Georgia by thrust slices of metaophiolites. Composition of the Paleozoic metaophiolitic complexes corresponds to that of oceanic spreading centers (T-type MORB) and suprasubduction zones (immature arc-back-arc associations). The presence of crinoidea and bluish-green algae in marbles of the Laba Group indicates a post-Ordovician Early-Middle Paleozoic age of the rocks. 425 Ma SHRIMP dating of zircons from amphibolites, intruded by orthogneisses, showsthat the rocks are not younger that Middle Silurian. Rb-Sr isochrone dating of potassium-spar granites (Ullukam complex – the central part of the Main Range Zone) gave values from 280 up to 300 Ma; K/Ar dating demonstrated an interval of 290-320 Ma [5].

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RESULTS OF THE REMOTE SENSING (UPPER SVANETI)

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In recent years, the advanced countries have been successfully employing the remote sensing in their scientific work. The remote sensing is a high technology method of collecting and interpreting information without physical contact with an object. Nowadays all fields of science studying the Earth use the remote sensing method. In geology this method is applied on the whole for examining structures and mineral resources of the Earth. The remote sensing of the investigated territory has been carried out according to the satellite Aster system.

Aster is an instrument for visualization with the scope of 60x60 km^2, has a spectral bands VNIR (visible near infrared-15m), SWIR (short wave infrared-30m) and TIR (thermal infrared-90m). With these spectral diapasons on the studied territory we can define structures and areas enriched with various ore deposits while consequently may become the objects of detailed geological investigation. The territory we have investigated includes the Upper Svaneti in coordinates zone 38, UTM, WGS 84, and for that we have made use of 4 Aster images. These 4 Aster images of given coordinates have been examined and several investigations have been carried out. As mentioned above, data from Aster have three spectral bands. To obtain full volume of data these spectral bands were put one over the other. Further on the data from Aster were dealt the with by means of atmospheric correlations to elicit the presence of dampness and particles which could negatively influence the analysis. Then we conducted georeferencing of the satellite images into the basic data system UTM and WGS 1984. Following the initial processing of the remote sensing, we employed concrete international standards and specific algorithms to examine the structures [1].

Conducted investigations led to distinguishing the hydrothermally altered zones and for the first time the models of fault structures were represented as single as well as entire models clearly pointing out to what structures the gold mineralization occurrences related. Besides structures, we defined geochemical anomalies and their distribution halos (fig. 1).

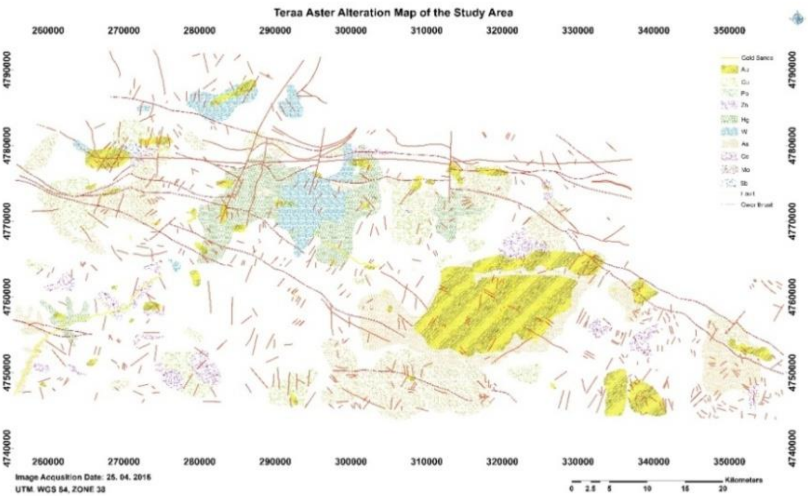

Fig. 1. Teraa Aster Alteration Map of the Study Area

The remote sensing data we have obtained and the data from the earlier investigation [2, 3] prove that in fact the remote sensing data replicate the existing occurrences contours. However, because of applying this method, we have discovered some gold occurrences unknown until now and worth attention.

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FOR THE ISSUE OF THE METALLOGENIC SPECIALIZATION OF COPPER-POLYMETALLIC PROFILE ORE BEARING MEGA SYSTEM OF THE CAUCASUS LOWER-MIDDLE JURASSIC SHALE-TERRIGENOUS BELT

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The major part of the Caucasus Lower - Middle Jurassic shale-terrigenous belt covers the territory of Georgia. In the northwest it extends to the territory of Russia, and in the southeast to Chechnya-Ingushetia, Dagestan and Azerbaijan areas.

Formation of the shale terrigenous belt is connected to the action of Caucasus Jurassic Marginal Sea. It is built of the lower-Middle Jurassic extensively deployed terrigenous rock masses, which consist of early alpine volcanism products and copper-polymetallic profile mineralization of different types which are united within the common ore bearing mega system.

Caucasian shale terrigenous belt and the ore bearing mega system related to it are divided into the western, central and eastern segments according to the tectonic and ore-geological peculiarities.

Within these segments, the mega system includes the various processing of ore bearing systems, which were formed in the in pre-collision (spreading) and syn-collision (collisionnal) periods of evolution of the Jurassic marginal sea. Correspondingly, spreading (syn-sedimentation) and collision (post-sedimentation) ore bearing systems are distinguished [1].

Process of spreading is detected with various intensity in different parts of Jurassic Marginal Sea on different stages of its development, which is caused by the transformation intensity of oceanic subducted slab and depth variation of invasion of the mantle diapir, according to the different types of volcanic activity in time and space. Three stages of formation of spreading zones and related stratiform-pyrite ore generation are distinguished: Sinemurian-Early Pliensbachian, Upper Pliensbachian-Lower Toarcian and Aalenian-Early Bajoscian, which correspond to the ore bearring series of same ages, their synchronic magmatic formations and stratiform-pyrite ores [2]. At the same time, ore formation is connected with basaltic components of the mentioned formations.

Primary stratiform ores related to the spreading ore bearing systems typically are sulfur-pyrite types. An exception is the giant pyrite-polymetallic reservoir of Philizchai deposits, where stratiformic (exhalative-sedimentary) component level in the polichronic combined ores are confirmed with the structural-geological and mineralogical-geochemical research.

Within the different segments of the mega system, different intensity of spreading ore bearing systems is detected. They are most fully represented in the eastern segment. In the central and western segments only Late Pliensbachian-Early Toarcian spreading ore bearing system is identified [1]. Besides, these systems are characterized with varying intensity of ore capacity. Spreading system of the Sinemurian-early Pliensbachian stages is characterized with only stratiformic sulfur-pyrite ores of Katsdagi deposit. Pilizchay pyrite-polymetallic ore body, stratiform-pyrite sulfur-pyrite deposits of Sagatori (Jikhikhi), Adange, Zeskho, as well as the same small orebodies in the eastern and western segments of the mega system are connected with the most abundant Late Pliensbachian-Early Toarcian Spreading system. Katekhi and Kizildere deposits, as well as stratiformic sulfur-pyrite ores of several small ore manifestation are localized within the Aalenian-Early Bajocian processing spreading ore bearing systems.

Collision ore bearing systems are revealed in most pyrite ore bodies related with spreading systems, and more broadly with the form of veinlets and veinlets-impregniated mineralization in the Lower-Middle Jurassic terrigenous rock masses. Their generation-functioning starts from the Late Pliensbachian-Early Bathonian footstep of con-sedimentation folding. Hydrothermal-metamorphogenic stage of ore generation is associated with the first generation collision ore bearing systems. At the time the metal consisting hydrothermal solutions without Sulfur (or with poor sulfur) in the earliest pyrite deposits transformed the pyrite metamorphogenically into pyrrhotite and coagulated chalcopyrite often with sphalerite. A similar process based on the pyrite veins was causing the copper-pyrrhotite vein shaped ore formation into the terrigenous and igneous rocks. A later post-Bathonian (pre-Callovian) folding process provoked new stage of the hydrothermal process – stimulation of the second generation ore bearing system, as a result of which the polymetallic sulphidisation of primary stratiform-pyrite ores, as well as formation of the pyrite-polymetallic and lead-zinc vein shaped mineralization occurred.

Earlier stratiform-pyrite deposits are transformed into polygenic and polychronic inherited stratiform-pyrite bodies as a result of the overlapping epigenetic ore mineralization. Different processing collisional ore bearing systems are detected with varying intensity in a variety of ore fields measuring their sub formational belonging and the nature of metalorgenic specialization. The table created according to the materials of Azerbaijan and Dagestan geological institutions, lists data on copper, zinc and lead reserves on the explored pyrite deposits within the study area of the eastern part of mega system. This table shows a variety of scale and sub formational belonging pyrite deposits associated with the different ages of ore bearing series. The largest is the Pilizchai pyrite-polymetallic deposit, localized in Upper Pleinsbachian-Lower Toarcialore bearing series in which copper, lead and zinc reserves in total are over 5.0 ml. t.

Table 1

Sub formation systematics of the explored pyrite ore formation of the eastern segment of Lower-Middle Jurassic shale-terrigenous belt of the Caucasus according to the Cu, Zn and Pb reserves

Deposits	Ore bearing series	Ore reserves with $B+C_1+C_2$ categories. Thousands of tons.			Ratio Cu: Zn:Pb	Sub Formations
		Cu	Zn	Pb		
Katsdagi	I_1S+P_1	17.3	99.3	36.0	0.5: 3: 1	Pyrite-pyrrhotite-polymetallic
Pilizchai	$I_1P_2+t_1$	652.6	3368.2	1281.4	0.5: 3: 1	Pyrite-polymetallic
Sagatori	$I_1P_2+t_1$	203.9	231. 0	-	1: 1: 0	Pyrite-pyrrhotite-zinc-copper
Katekhi	I_2a+bj_1	16.2	176.9	190.0	1:11:12	Pyrite-zinc
Kizil- dere	I_2a+bj_1	1312.9	131.6	-	10: 1: 0	Pyrite-pyrrhotite-copper-zinc

Uneven distribution of the main ore components in deposits draws attention, which was reflected in their sub formational systematic. In these deposits, excluding Kizildere, zinc and lead quantities usually exceed that of copper. This characteristic is most clearly expressed in Pilizchai deposit, where zinc and lead total reserve is seven times larger than copper reserve. On the other hand, zinc is almost three times more than the lead. Although the activity of collision ore bearing systems is clearly expressed on this field with copper-pyrrhotite mineralization superimposed on the stratiform-pyrite ores and seconddary polymetallic mineralization, the colossal reserves of copper, and especially lead and zinc, are mainly caused by the primary exhalative-sedimentary ore bearing processes. The gold as well probably must be associated with the primary, sinsedimentaly generated galena, which is calculatedat about 53.5 tons in the Pilizchai deposit. Gold mineralization is not revealed on the other deposits mentiond in the table.

Unlike Pilizchai deposits, on the Zeskho pyrite-pyrrhotite -copper-zinc (central segment) - and Adange pyrite-pyrrhotite-polymetallic (western segment) fields, related to the same processing ($I_1P_2+t_1$) spreading ore bearing system, the leading component is copper, so zinc and lead are subordinated components.

Within the Lower-Middle Jurassic rock masses of the Caucasian shale terrigenous belt, copper-polymetallic veinlet mineralization related to the collision ore bearing systems is widespread. The pyrrhotitic phase of the hydrothermal-metamorphogenic ore generation is related to the first generation ore bearing system, which have been revealed with productive pre-mineralization quartz-pyrite veins or cracking rocks and brecciated zones in light of the initial stages by the copper-pyrrhotite-, while on the final stages by the quartz-chalcopyrite ore formation. Polymetallic stage of mineralization is associated with a later generated ore bearing system, expressed by veinlets and stockwork pyrite-polymetallic and lead-zinc mineralization. In the case of merging this ore bearing systems and polymetallic mineralization superimposition on the copper-pyrrhotite ores, combined (polychronic) pyrrhotite-polymetallic ore formation takes place. It should be noted that the polymetallic ores are gold bearing [1, 3].

Epigenetic copper-polymetallic mineralization spreading area in the Caucasus Lower-Middle Jurassic shale-terrigenous sediments, traditionally is referred to as copper-pyrrhotitic belt, but this name does not reflect the real picture. Manifestation of this mineralization are presented by the different mineral (sub formation) types that are presented with different intensity within the separate segments of the ore bearing mega system. We have recorded 472 ore occurrences within the mega system. Out of which, 432 (91,52%) are in the most intensely mineralized eastern segment, among them 111 (25,69%) are pyrrhotitic (copper- pyrrhotitic with pyrrhotite-polymetallic).

113 (26,16%) quartz-chalcopyrite, 208 (48,15%) are pyrite-polymetallic (with lead-zinc ore occurrence). From the 25 ore occurrences of the central segment 14 (56%) are copper-pyrrhotite, 5 (20%) quartz-chalcopyrite, 6 (24%) pyrite-polymetallic type. 15 ore occurrences are accounted within the western segment. Out of them, 8 (53,33%) arepyrhotite, 2 (13,33%) quartz-chalcopyrite and 5 (33,34%) are pyrite-polymetallic type. In the eastern segment of the ore bearing mega system, pyrite-polymetallic ore occurrences prevail to the pyrrhotitic. To the contrary, within the central and western segments, pyrrhotitic ore occurrence es exceed the pyrite-polymetallic.

Veinlet ore occurrences related to the collision ore bearing systems, as well as the inhabited-stratiform deposits with spreading nature are characterized with a different substance content, different quantitative relationships of the leading ore components (Cu, Pb, Zn) both in separate segments of ore bearing mega system, as well as in various spreading ore bearing systems and even within the same system. It appears that there had been a variation of ore generating geodynamic conditions in time and space within the long-term process of formation of the ore bearing mega system related to the Lower-Middle Jurassic shale-terrigenous zone of the Caucasus.

It is important to determine the source of metals for understanding the metallogenic specificities of Lower-Middle Jurassic shale-terrigenous belt of the Caucasus. According to V. Gugushvili, [4] different types of mineralization are associated with the different geodynamic conditions. In his opinion copper source is mantle diapir, which caused spreading processes within the Caucasus Jurassic Marginal Sea; source of zinc is subducting plate and the basaltic crust blocks involved in the process of spreading, while the source of lead (together with gold) is the sial crust district covered on the marginal seabed which is diluted in the process of spreading. This explanation may be valid to the spreading (pre-collision) ore bearing systems, but can be used to solve the issue of the source of metal in the collision (and Post-collision) ore bearing systems. In this direction research should continue.

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SEDIMENTOLOGICAL-PALEOICHNOLOGICAL STUDIES IN GEORGIA

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Biogenic sedimentary structures, that we now recognize as trace fossils or ichnofossils (in Georgia mostly as ichnites or fucoids) are biologically produced structures, that include tracks, trails, burrows, borings and other traces made by differrent organisms. Owing to their nature trace fossils can be considered as both paleontological and sedimentological entities [1].

Today trace fossils have become very useful in facies analyses, including reconstruction of individual palaeoecological factors, sedimentary dynamics and documentation of local and regional facies changes. During recent decades method of ichnological analysis successfully works in ore geology and serves as a valuable cryteria in genetic interpretations of some ore deposits' host rocks. In addition one of the important uses of ichnological analysis is the recognition of key-stratigraphic surfaces (e.g. unconformities) essential in facies modeling. Such facies models could be used for guidance in interprettations of various depositional systems. Well-established are links between ichnofossil distribution and bottom water oxygenation as sediments deposited in low-oxygen setting have a high source rock potential to petroleum systems [2].

The most applied aspect of ichnological analysis involves studies relevant to petroleum industry, where accurate characterization of facies is highly important. With the increased use of reservoir modeling of sedimentary facies and highly detailed petrophysical studies of reservoir units, the need for high-quality interpretation of sedimentary facies is greater than ever. Such parameters as the porosity and permeability of potential reservoir intervals are controlled by sadimentological heterogeneity and by diagenesis, where role of bioturbation and ichnofossils is significant.

According to all above mentioned combined ichnological and sedimentological method of investigation is regarded as a powerful tool in facies analysis, reconstruction and characterization of depositional systems and palaeoecological environments. Such approach is well established worldwide, has a great scientific value and is essential and informative in solving of many problematic geological issues.

In Georgia trace fossils (ichnites) have been historically recognized by numerous researchers (Vassoevitch, TatriSvili, Varsimashvili, Beridze, Apkhazava, Zuleishvili, Magalashvili and etc.) in the Jurassic, Cretaceous and Paleogene sedimentary and volcanogenic – sedimentary suites of various tectonic units (the Southern Slope zone of the Great Caucasus FTMB, the Achara-Trialeti FTMB, and the Artvin-Bolnisi block), though their systematic study (identification and interpretation) hasn’t been conducted so far. This fact has encouraged the group of authors in establishing of ichnological studies in Georgia.

Up to now from the paleoichnological point of view the best-studied are the Paleogene deposits of the Achara –Trialeti FTMB, where following of trace fossils occurrences have been defined: Qvemo Nichbisi, Borjomi (Paleocene-lower Eocene), Akhaldaba (middle Eocene) and Lisi – Mukhattskaro (upper Eocene) [3, 4, 5]. About 35 forms of 24 ichnogenera: *Avetoichnus*, *Belocosmorhaphe*, *Cardioichnus*, *Chondrites*, *Gyrophillites, Helminthopsis, Helminthorhaphe, Megagrapton, Nereites, Ophiomorpha, Paleodictyon, Phycosiphon, Phymatoderma, Planolites, Polykampton, Rotundusichnum, Scolicia, Spirorhaphe, Spirophycus, Taenidium, Teredonites, Thalassinoides, Trichichnus* and *Zoophycos* have been recognized so far.

On the basis of the analysis of the sedimentary and biogenic sedimentary structures of the above mentioned deposits have been reconstructed depositional environments within the investigated occurrences. Similar studies have already being conducted in the Cretaceous deposits of the Southern Slope zone of the Great Caucasus FTMB (the river Aragvi basin, the Tsivgombori Range).

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PHYSICAL VOLCANOLOGY OF THE EXPOSED NEAR VILLAGE KHERTVISI (SOUTHERN GEORGIA) LAVA FLOW RELICT: THE PRELIMINARY STUDY RESULTS

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The volcanic formations of southern Georgia have a long-term study history. However in the investigation of these formations and their constituent individual lava flow units, priority has been always given to stratigraphic, geochemical, geochronological and geomorphological approach.

During past decades studies have vigorously concentrated on the physical volcanology of mafic lava flows-integral part of well-known various scale continental flood basalt provinces (CFBP) of the world. Such approach implies recognition and interpretation of major lava morphotypes on the basis of distinguishing of surface morphologies and internal structures of lava flows after their solidification. Morphotypes represent the internal parameters of: composition, temperature, crystallinity and volatile-content/vesicularity; along with such external influences as: emission mechanism, effusion rate, topography and slope control of flow velocity [1, 2].

Such type of studies has already been recently established in the Caucasus region (northern Armenia) on the example of intracanyon basalt lavas of the Debed River [3]. Our research is the first attempt to study physical volcanology of the lava flow relict exposed on the left slope of the Mtkvari (Kura) river, adjacent to village Khertvisi (south. Georgia) (Fig. 1).

Fig. 1. The lava flow relict on the left slope of the Mtkvari (Kura) river, adjacent to v. Khertvisi.

Obtained as a result of the preliminary field work rich factual data on surface morphologies and structures of the lava flow relict enable to suppose, that it is made up by pahoehoe type flows (flow lobes?). Existence of flows with features transitional between pahoehoe to ‘a’ā is regarded as well [4, 5, 3]. According to thin section petrography these lavas correspond to olivine basalts (dolerites). Development of hydrothermal-metasomatic alteration processes, such as amygdule infill with limonite, calcite, chlorite and layered minerals has been distingueshed in basalts. In some places uralitized pyroxenes are also observed. We consider that as a result of further studies of vertical and lateral distribution of alteration processes will expose their link with single morphotypes (Fig. 2).

Further detailed field- based volcanological study of the lava flow relict including specification of its stratigraphic position, exact distinguishing of flow morphotypes, stratigraphicaly controlled sampling for petrographic observations and geochemical analysis is intended. Obtained results will make the robust basis for the study of lava flows from adjacent areas using this approach.

Fig. 2. The lava flow exposure.

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GEOLOGICAL POSITION OF KHACHKOVI GOLD-ORE OCCURENCE

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The Khachkovi gold-ore occurrence is located in the Tsalka region, north of the Khachkovi village, on the south slope of the Ardjevani ridge. The 0.7 km wide hydrothermally altered zone of the sub latitudinal orientation in the Middle Eocene tuffogenic rocks generates intensively mineralized area along the Khachkovi river. The zone is represented with altered rocks saturated with quartz-carbonate-barite veins and veinlets of sulphids.

The occurrence from the North is bounded with the Ardjevani-Bakuriani sub latitudinal regional over thrust, from the South – with Neogene-Quaternary lava. From the West and East it bounded with latitudinal orientation fault structures and contacts of the sub intrusion bodies.

The endogenic mineralization structural control is determined by the Ardjevani-Bakuriani regional fault. In our conditioned, it should be ore-distribution structure and as in other ore field cases, they don't contains mineralization.

The ore controlled fault structure is observed as lateral ore zoning: in particular, the gold-sulphide mineralization is located it's proximity, whereas pyritic mineralization can be seen in peripheral part. The gold-sulphide mineralization in the other areas is observed in one or several mineralized zones consisting of splitting parts. In these mineralized zones differrent associations of ore-bearing sulphides continuation main ore minerals such as: chalcopyrite, galenite, sphalerite, pyrite. As well as vein minerals: quartz, calcite and barite can be found.

Three zones have been allocated in the Khachkovi occurrence so far. According to our data, two zone are distinguished: quartz-barytization and pyritic.

The character of mineralization and hydrothermally alteration on the occurrence together with the other factors should indicate, that it is located in the peripheral part of the magmatic system. Moreover, baritic mineralization is should indicated, that Khachkovi occurrence appears as the upper part of the Gujareti-Khachkovi ore field.

We consider, structural-geological mapping of the Khachkovi occurrence in 1:10 000 scale must be done. It's inevitable for planning prospecting and exploring works to reveal the gold-bearing areas.

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GEODYNAMIC PROCESSES HAZARD ASSESSMENT OF ZUGDIDI-JVARI-MESTIA-LASDILI MOTORWAY

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The existence of comfortable roads and their safe functioning is of the major importance for any country. In this regard the roads connecting Georgian regions, due to their multiple functionality, have to be considered separately as most of them pass through extremely roughterrain and are exposed to high-risk natural geological processes.

In this respect, countrywise the Zugdidi-Jvari-Mestia-Lasdili road (total length of 198 km) has its special place from economic and geopolitical point of view.

The road, whichbegins in the Kolkheti lowland zone and gradually moves through low-mountainous, medium and high mountain alpine zones,passes through extremely variedgeological environment, terrain and landscape-climatic conditions. In parallel with the terrain and landscape-climatic conditions there is a sharp change in the types of hazardous geological processes, the geological conditions and triggering factorswhich cause them.

To assessgeodynamic conditions and geo-ecological situationof the Zugdidi-Jvari-Mestia-Lasdili road,it has become necessary to conduct research, analyze the existing information and based on this to forecast the changes taking place in the geological environment, the trends in accelerated natural geological processes and geo-ecological risks, and to plan relevant recreational prevention activities.

In 2016 the project „Geodynamic processes hazard assessment and GIS analysis of Zugdidi-Jvari-Mestia-Lasdili motorway" was financedby the Shota Rustaveli National Science Foundation in the Doctoral Educational Prog-

ram competition (PhDF2016_44), the geodynamic condition of the road will be fully assessedwithin the framework of this project.

At the first, field-work stage of the project introduction to and the assessment of the Samegrelo-Upper Svaneti region has been conducted; potentially hazardousparts of the road have been revealed; moreover, the modern methodology of process assessment has been developed and geohazardous criteria have been established; the archived materials have been processed and generalized; the assessment of natural-technogenic factors leading to and provoking geological processes has been conducted and the Geographical Information System (GIS) databases have been filled up and the historical and statistical data have been generalised.

The research conducted and material processed at the first stageenable the identification of geohazards across the area of study, assess geoecological damage of the territory, determine the level of hazard and geohazardous zone mapping in GIS system.

A map of this type will be used as the basis for the normal and reliable operation of the major motorway in the condition of geological processes, the safety of passengers, the protection and safe display of infrastructural facilities and amenitieslocated there, and also for permanent geomonitoring activities and environmental protection events.

COMPUTER MODELING AND FORECASTING OF THE ENVIRONMENT TECHNOGENIC POLLUTION PROCESSES

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Thermodynamic analysis of heterogeneous systems "C-H-N-O" and "C-H-S-N-O" was carried out for the 101 kpa pressure gas phase using computer modeling.

The basic method to obtain similar information is to build diagrams in accordance with the experimental data. Empirical experiments require long and expensive research. Therefore, we suppose that the realistic way to build the temperature sections' diagrams of the multicomponent systems is conducting computer experiments and processing the obtained results.

Any system thermodynamic analysis, especially complicated heterogeneous, must be carried out through the appropriate software complex.

The software "ACTPA – 4" is designed to simulate chemical and phase equilibrium at high temperatures. It is based on mathematical models of complex heterogeneous systems, universal thermodynamic method for determining the characteristics of the produced heterogeneous systems, - Based on the fundamental principle of maximum entropy. This method enables the determination of all the other features of the equilibrium, transference of properties of thermodynamic parameters and the phase and chemical composition based on the parameters of two given conditions and system of initial chemical Ingredients [1, 2].

The main part of the work was to conduct series of computer experiments to determine the composition of the combustion products in the systems under study at different fuel-oxidant ratios. Since we use air as the oxidizer, where N2 ~ 78 % - for accurate thermodynamic analysis, we bring natural gas processes and combustion of fuel to the study of "C–H–N–O" and "C-H-S-N-O" thermodynamic systems, which is based on the fundamental principle of maximum entropy. During the calculation process, we took into account for the first system 63, for the second system 71, the base material and the element 1000 - 3000K in the temperature range with 50k increments [3, 4].

Based on the results, we have created diagrams of temperature-sections systems, which allow us to determine in advance the optimal conditions for the combustion processes of the corresponding fossil fuels - natural gas and oil, which is one of the basic conditions in the connection of research and improvement of the environment.

Thus, it should be noted, that the use of methods of computer chemistry not only allows us to make preliminary evaluations but also makes it possible to determine in advance the quality and quantity of anthropogenic pollution formation of the environment, their chemical composition, expected concentrations and possible changes in the environment.

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QUATERNARY ANDESITIC LAVA EXPOSURE WITHIN THE GVELETI MASSIF

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The Caucasus is situated between the Arabian and Eurasian lithospheric plates and is a part of the Alpine-Mediterranean foldbelt. In the modern structure it includes the Greater and Lesser Caucasus folded systems and the adjacent piedmont and intermountain troughs.

Within the central segment of the Greater Caucasus, on its southern slope from southwest to northeast three Quaternary volcanic districts connected with each other by longitudinal and transverse faults are distinguished: Java, Keli and Kazbegi [1].

The Kazbegi district covers the territory from the Jvari Pass till the end of the Darial river gorge. Along with other interesting and topical geological formations, it is an active center of the Quaternary volcanism. From the geologic point of view, in this part of the Caucasus the volcanism is of post-collisional origin, and it was manifested in the time of the last orogenic stage. On the territory of the district two large volcanic vents are known: the Kazbegi (Mkinvartsveri) Volcano with altitude 5047 m and the Kabardzhina Volcano with altitude 3136 m. There are numerous small flank eruption centers within the considerable area as well.

The dormant Kazbegi Volcano is located on the eastern termination of the latitudinal Khokhi ridge situated to the north of the Greater Caucasus Main Range and separated from the last by the Tergi river gorge. It is a polygenetic neovolcanic center which was active over the long timescale (Pleistocene-

Holocene). Not less than four effusive phases are established in the study area resulted in the formation of widespred volcanic sequences [2]. Forming the volcanic edifice rocks are emplaced into thick Early Jurassic sedimentary sequence represented by alternation of shales and sandstones.

From the volcanic center the lava flows travel downslope along the radially disposed gorges towards the Tergi river valley and are known as Suatisi, Mnadon, Arshi, Chkheri, Tsdo, Gveleti and Devdoraki (Chachi) lava flows [2, 3].

On the left slope of the river Tergi, to the west of village Gveleti we have discovered a new lava exposure (remnant of lava flow) of andesitic composition (42º42'44.8"N, 44º37'20.9"E). It is situated within the Gveleti massif built up of Paleozoic granitoids. The dimensions of the outcrop amount 35×25×7 m, and it is represented by the columnar-jointed lava flow. To the north and south small-size and well-developed columns are observed, but the central part is made of poorly - developed thicker columns (Fig. 1).

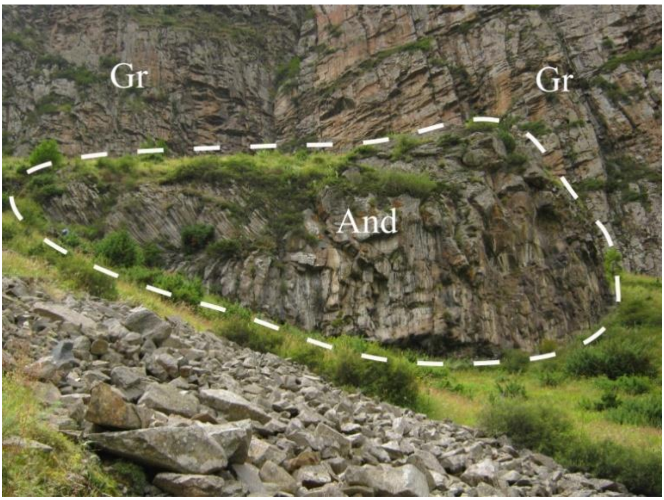

Fig.1. Andesitic lava (And) exposure within the Gveleti granitoid massif (Gr).

The rocks of lava exposure are grey and have seriate porphyritic structure. The phenocrysts are represented by plagioclase (up to 2.0 mm in size) with well expressed, rarely zonal polysynthetic twins; monocline and rhombic pyroxene (not exceeding 0.5 mm in size); partially or completely opacitized hornblende. The olivine and single diacrysts of quartz occur occasionally. The apatite and ore minerals occur as the accessories. The rock groundmass comprises volcanic glass with plagioclase laths and minor amount of mafic minerals microlites. Andesites of lava remnant contain (wt. %): SiO_2 - 60.39, TiO_2 - 0.86, Al_2O_3 - 16.39, Fe_2O_3 - 5.66, MnO - 0.09; MgO - 4.71, CaO - 5.6, Na_2O - 4.29, K_2O - 1.77, P_2O_5 - 0.25.

To the south of village Gveleti, on the left bank of Tergi river gorge another lava exposure is observed. It was earlier described in scientific literature [1-3 et al.] and well known as the Gveleti remnant. Therefore we have named the recently found exposure as the Gveleti remnant II (Fig. 2).

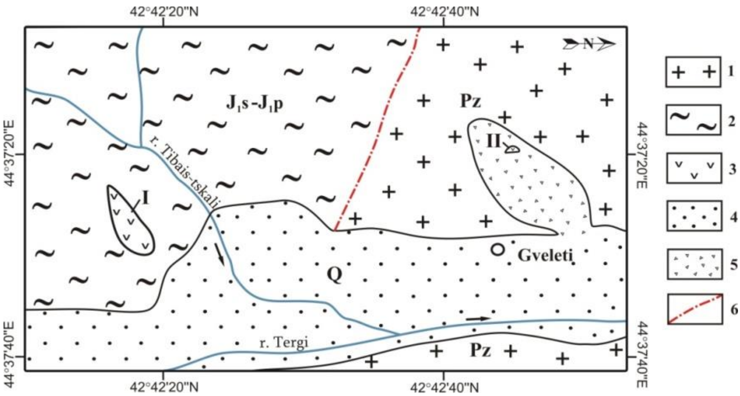

Fig. 2. Schematic map – exposures of andesitic lava remnants in the vicinity of village Gveleti.

1. The Gveleti granitoid massif (Pz); 2. The Kistinka and Tsiklauri formations (J_1); 3. The exposures of Quaternary lava: the Gveleti remnant I (basaltic trachyandesites) and the Gveleti remnant II (andesites); 4. Quaternary sediments (Q); 5. Debris; 6. Tectonic contact.

The rocks of these two exposures have noticeable difference in their chemical composition (basaltic trachyandesites and andesites). They are remnants of broken frontal part of the Tsdo lava flow erupted by Paleo-Kazbegi Volcano and related to lower and middle parts of flow section, correspondingly.

The results of K-Ar dating show that lavas of both remnants were erupted in the Middle Pleistocene (310-260 ka).

Related to Kazbegi volcanic activity lava flows mainly have contact with widespread in the region Jurassic deposits. The only exception is the Devdoraki flow termination (flow front), which overlies the Dariali granitoid massif. As for Gveleti remnant II, it is located within the Gveleti granitoid masiff boundaries.

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STUDYING OF ROCKS OF SOUTHEAST GEORGIA FOR THE PURPOSE OF RECEIVING FACING AVENTURINE GLASS TALES

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Due to the increase in rates of construction business in Georgia, also requirement on architectural and construction and facing materials including on high-decorative glass tiles grows. It is known that quartz sand, soda and alumina are generally applied to production of glass. From them in Georgia extract only quartz-feldspar sand. Therefore, for expansion of a source of raw materials and further development of branch, urgent is a studying of the local complex raw materials allowing to enter at the same time into raw mix SiO_2, Al_2O_3, R_2O. It, in turn, will allow to save on imported components and to reduce product cost.

Georgia is rich with different rocks in which joint presence of the specified oxides is noted. Studying of acid rocks of Southeast Georgia has established a possibility of their application for obtaining homogeneous glass melt [1].

Research problem is studying of the acid rocks of Southeast Georgia, in particular, the quartz-adularmetasomatites of trachyrhyolitesstructure which are overburden breed of barite ore of the Mushevani depositin Bolnisi district and also ignimbrites of the same area. The studying purpose – development of new structures and technology of receiving the aventurine glasses for production high-decorative facingglass tiles.

The studied rocks concern to high-silicate and aluminate structures, with the small content of oxides of iron and alkalis.

In the quartz-adularmetasomatites is marked out also barium sulfate availability in enough.

For researches the SiO_2-Al_2O_3-RO-R_2O system in which receiving of aventurine glass was made by additives of oxides of chrome has been chosen. Obtaining aventurine effect in glass it is based on limited solubility of oxide of trivalent chrome in glass melt.

Owing to melt supersaturation, surplus of not dissolved particles of Cr_2O_3 takes shape in melt in the form of the brilliant microcrystals giving the surfaces of dark green glass high decorative effect.

The main components were entered into raw mix by means of the metasomatites and ignimbrites corrected by additives of other natural materials and oxide of chrome.

Melting of experimental glasses was made in the laboratory electric furnace with carborundumheaters in corundum crucibles. Maximum temperature of meltinghas made 1480-1500 ^{0}C.

Experiences have established the optimum quantity of Cr_2O_3 providing aventurine effect in glass, and also, optimum ratios of the making glasses of the oxides influencing limits of solubility of Cr_2O_3.

Influence of oxidizing potential of the environment on a condition of a different valencychrom-ion for preservation of trivalent ions of chrome in melt is studied. Positive influence of an oxidizing ambient on strengthening of this process is established. Confirmation of the last is the high-decorative aventurine effect of the glasses synthesized on the metasomatites creating when cooking glasses an oxidizing ambient in a type of existence of barium sulfate in raw mix in a large number.

Thus, on the basis of the conducted researches the possibility of use of acid rocks of complex structure for receiving the high-decorative colored aventurine glasses has been established.

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NEW U-Pb ISOTOPE-GEOCHRONOLOGICAL DATA ON THE BUULGEN METAMORPHIC COMPLEX AND ON THE ASSOCIATED WITH IT PRE-ALPINE MAGMATITES OF THE GREATER CAUCASUS MAIN RENGE ZONE

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The Buulgen metamorphic complex occurs in the Pass subzone of the Greater Caucasus Main range zone (the Greater Caucasian terrane). At the base of the Buulgen complex lies the Gvandra suite composed mainly of metapelites. It is followed by a monotonous amphibolitic Klich tectonic plate (the Klich suite according to a number of authors), and then occurs the suite built up mainly of mica schists.

According to some researchers [1, 2, et al.] in the Buulgen complex two stages of regional metamorphism manifested: the pre-Variacan and the Late Variscan, while by the others [3] the regional metamorphism is monocyclic - Late-Variscan.

Pre-Alpine plagiogranites, gabbro-diorite and diorite orthogneisses, quartz diorites and leucocratic granitoids are confined to the Buulgen metamorphic complex. Biotite and two-mica bearing plagiogranites are present in the lower part of the metamorphic complex, occurring in the form of rootless lenses and concordant or crossing bodies. They belong to I type granites. Hornblende-bearing gabbro-diorite–diorite orthogneisses, known as the Klich intrusive, occur in the upper part of the Gvandra suite. Rocks of the Klich intrusive correspond to a weakly differentiated low-K series. It generated in the subduction zone of the depleted mantle or in lithosphere at a little depth of ensimathic zone [2, 4]. Zircons of the gneisses of the Klich intrusion are dated by U-Pb classical method and a concordant age - 320 Ma is obtained. Among the Late Variscan granitoids widespread in the Buulgen complex the biotite- and biotite-hornblende bearing quartz-diorite intrusive, known as the Sakeni intrusive, is the largest. The last one belongs to mantle-crustal I type low-K granitoids [4]. Leucocratic granitoids are represented by crossing or concordant bodies of plagiogranites, granodiorites, granites, garnet-bearing alaskites and aplites. They are spread in metamorphites and cut all pre-Alpine magmatites of the Buulgen complex as well. The granitoids belong to the S type granites.

The formation of gabbro-diorite - diorite orthogneisses, quartz-diorites and leucocratic granitoids, along with other factors (subduction heat, radioactive heat, etc.), is induced by the Macera nappe formed during the Saurian orogeny [1, 2]. As a result of overthrusting of the upper part of the Buulgen complex - mica schists from the Pass subzone to the Elbrus subzone of the Greater Caucasus Main Range zone, the crust was thinned out not less than by 2500 m. The above-mentioned magmatites formed during the Variscan orogeny in the relatively thinned crust of the lowermost parts of the Buulgen complex as well as at deeper horizons.

The zircon U-Pb age determination was conducted at National Chung-Cheng University of Taiwan. From all the above-mentioned metamorphites and magmatites 4 samples from each, 212 local determinations were conducted by the U-Pb LA-ICP-MS zircon method. Besides of detrital zircons, with the age interval 2685-714 Ma (29 determinations) in different zones of zircon crystals three age groups were distinguished: 1) 671-550 Ma (21 determinations), 2) 503-404 Ma (33 determinations) and 3) 351-299 Ma (129 determinations) Ma. The first age group corresponds to regional metamorphism of the earliest-Cadomian (Baikalian) orogeny, the second – to the Caledonian stage of metamorphites and plagiogranite formation, while the third group coevals with the Variscan retrograde regional metamorphism and shows the age of magmatites.

Thus, according to geological and new isotope-geochronological data the existence of three stages of regional metamorphism and two stages of magmatism in the Buulgen metamorphic complex are established.

The age interval of Variscan zircons was specified. In particular, two important facts were taken into account: 1 – in the faunally dated Upper Carboniferous-Permian Kvishi suite the Kasimovian and Gzhelian stages of the Upper Carboniferous were established [5], the age interval of which, according to the most recent geochronological scale, is 307-299 Ma. The Kvishi suite contains washed out material of the Greater Caucasus crystalline basement metamorphites and magmatites [5]; 2 - It is also taken into account that within the Greater Caucasus at the end of the Sudetic orogeny an unusually rapid exhumation of deeply submerged parts of the Earth's crust took place [2]. Therefore, the age of the above-mentioned regional metamorphism and magmatism do not have to be younger than 310 Ma. It should be noted that ages younger than 310 Ma only in the core of the zonal zircons are recorded.This indicates that some zircons were less affected by Pb-loss then core domains that is well known in scientific literature.

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MATERIAL COMPOSITION, TESTING FOR ENRICHMENT AND CERAMICS-TECHNOLOGICAL PROPERTIES OF CERAMIC CLAYS OF MAKVANETI

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Clay poly mineral raw material contains different clay minerals: kaolinite, halloysite, dickite, hydromica, montmorinolite, illite and also silty impurities: quartz, ferric hydroxide, sulfides (pyrite, marcasite), carbonates, gypsum and titanium, which adversely affect the quality of ceramic products.

We studied three Samples taken from various parts of the Makvaneti deposit (Ozurgeti, town in Guria Region, Georgia). The chemical, x-ray phase, mineralogical of the samples analysis was carried out. The results of chemical analysis are given in Table 1.

Table 1

Results of chemical analysis

№	Content, %												
	SiO_2	Al_2O_3	Fe_2O_3	FeO	TiO_2	MgO	CaO	MnO	P_2O_5	K_2O	Na_2O	SO_3	LOI
1	61,40	22,60	0,72	0,07	0,56	0,48	<0,1	0,48	0,19	8,40	0.30	0.30	4,20
2	60,50	21,50	3,00	0,20	0,22	0,50	<0,1	trace	0,30	5,00	3,20	0,28	3,90
3	56,30	26,60	0,36	0,07	0,72	0,52	trace	trace	0,10	7,20	0,40	0,07	6,12

Carrying out mineralogical-petrographic research showed that the presented rocks are of the same genesis and belongs to clay groups. Although there is a difference between them, primarily coloring; Second sample is yellow, which is caused by infiltration processes. The second sample is yellow, which is caused by infiltration processes proceeding at a various depth below the ground and near the surface. Mainly these are iron-rich solutions that determine the yellow color of clays, whitish and grayish clays are less damaged. The structural-granulometric character is also different. There are practically pure clays, also containing silty impurities. For all three presented samples the content of these impurities are different.

The main rock-forming minerals are kaolinite, halloysite and feldspar.

In Sample #1, the content of fine particles is approximately 45 % and is represented by halloysite, kaolinite, potassium – sodium feldspar and montmorilonite; Impurities: potassium feldspar (which partially transforms into kaolinite), fine quartz particles and flake hydromuscovite.

In Sample #2, the content of fine particles is approximately 70 % and is represented by halloysite, kaolinite, potassium -sodium feldspar, which ischanged to kaolinite; Silty composition - potassium-sodium feldspar, fine quartz particles, pyrite, magnetite and flake mica. The sample is intensely colored with ferric hydroxide.

In Sample #3, the content of fine particles is approximately 85 % and is represented by kaolinite, potassium feldspar (which partially transforms into kaolinite), fine quartz particles and small quantity of mica.

The silty impurities adversely affect the quality of ceramic products. Quartz sand reduces the plasticity of clays, ferric hydroxides give the product a darker shade.

To remove aleurovitic impurities and improve the quality of clays, carry out enrichments of clays. The enrichment of the presented clays was carried out with the help of the existing practice of modern methods.

The study was carried out on hydrocyclones of various types. Pulp and temperature was diluted. Hydrocycling allowed to increase the quantity of kaolinite for 2-3 times in all three samples. However removing of iron in Sample #2 is impossible.

For removing iron from Sample #2 the flotation method of enrichment was used, which did not give the result.

Chemical enrichment is the only method by which it is possible to reduce the iron content to an acceptable level. After treatment in Sample #2 the iron content was 0.4-0.5 %.

For establishment the clay fraction obtained as a result of enrichment, physical-chemical and ceramic-technological properties were defined (dispersion, whiteness,working water content, plastic, water absorption, air and fire shrinkage, sintering temperature and optimum firing temperature). The test results are shown in Table 2.

Table 2

Ceramic-technological properties

№	Firing temperature, C^0	Water absorption %	shrinkage, %		Sintering temperature, ^0C	Optimum firing temperature, ^0C
			fire	Total		
1	1250 1350	0,7 0,25	12,2 13,9	16,8 18,4	1250	1350
2	1100 1250	13,9 1,2	6,03 15,5	12,8 21,6	1250	1100
3	1250 1350	3,8 0,11	14,7 15,6	19,0 20,0	1250	1350

On the basis of the conducted research is possible to conclude:

- The Makvaneti clays represent kaolinized-feldspar raw materials, which is confirmed by chemical analysis (amount K_2O and Na_2O >8 %).
- In enrichment products of Samples # 1 and # 2 the quantity of kaolin increases three times.As a result the study showed that the water absorption of the baked tiles at a temperature of 1350^0C does not exceed 0.5%. They are white and can be used in the production of fine ceramics.

- After chemical enrichment, the content in Sample #2 of iron oxide meet the requirements for the tile production. But the use of this method we consider inexpedient, in terms of economic and ecologic.
- Tiles made of Sample #2, enriched by hydrocyclization, water absorption as of 13.9%, after firing at a temperature of 1100^0C are suitable for the production of tiles.

ORNAMENTAL STONES FOR FACING MONUMENTS OF ECCLESIASTICAL ARCHITECTURE AND ROCKS CORRESPONDING TO THEM FROM NATURAL EXPOSURES IN THE BOLNISI REGION

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Georgia is one of the richest countries in facing stones resources. These stones were applied for facing ecclesiastical and secular buildings in the past and they are applied currently in constructing monumental objects

Architectural monuments of the past centuries, especially ecclesiastical buildings are presented in large numbers in different parts of Georgia. At present most of them are severely affected and need to be restored; when restoring ancient architectural monuents, the right choice of building materials, especially of facing stones, is of great importance; it must precisely correspond to the stone applied for facing the monument as not to disturb its authenticity.

In South-Eastern Georgia for construction and facing of architectural monuments the building material was rocks of various composition and origin – especially magmatic (intrusive and effusive) and volcanogenic (pyroclastic) rocks. In the past, the sites for building of Cult architectural monument was often chosen in the vicinity of the quarries of building stones; examples of such ecclesiastical buildings are: Bolnisis Sioni (basilica of the 5th century), Kvemo Bolnisi Three Church basilica (V-VI cent.) and Tsugrugasheni Doumed Cathedral (XIII cent.); they are located between the Bolnisi town and the village Kvemo Bolnisi at a distance of 2 -2.5 km from each other.

The area where the afore-mentioned monuments are built is represented by Upper Cretaceous volcanogenic series and

Quaternary deposits. The most developed is the Upper Turonian - Lower Santonian Mashavera suite. Toward the bottom there occur layered andesite-dacite lapilli and finely segmented lithic-crystal-vitroclastic and crystal-vitroclastic tuffss and breccia-andesite layers. The upper part is mainly represented by lithic-vitroclastic and vitric-crystal bedded acidic tuffs, tuff-gravelites, tuff-sandstones and tuff-argillites. The less developed Lower Santonian Gasandami suite is represented by lava breccias, ignimbrites and ash tuffs. Volcanogenic deposits are crossed by intrusive bodies of plagiogranite-porphyry.

The researched ecclesiastical buildings were built with local material and besides, tuffs of various composition and color were used as facing stones. Bolnisis Sioni was faced with clean cut blocks of greenish tuff. Kvemo Bolnisi basilica is also dressed with green tuff and walls of Tsugrugasheni – with yellow and golden tuff.

Green and yellow tuffs are rocks of lithologically resembling psammite-aleurite rocks of rhyolite composition. In green crystal- vitroclastic tuffs crystal clasts are represented by plagioclase and quartz fragments with plagioclase in abundance. They are scattered in the mass of acidic volcanic glass where intensive processes of chloritization are observed. The yellow tuffs are of lithic-crystal-vitroclastic structure. Lithic clasts are represented by plagiophyre fragments; as for crystal clasts, quartz content prevails plagioclase; the cementing mass is devitrified, silicificated and sericitized volcanic glass that is district-by-district carbonized and saturated with hydroxides. Tuffs from the Bolnisi ore deposit (Parkhalo and Sarachlo quarries) somehow differs from those applied for facing the aforementioned ecclesiastical buildings. From petrographic viewpoint, it represents tufflava or lava of quartz-porphyritic composition; their color generally vary from yellowish through yellow shade; besides, they are characterized by good decorative properties that differ them from the above-mentioned tuffs with less pronounced ornamentality on their polished surfaces.

The Bolnisi and Tsugrugasheni churches were also faced with plagiogranite-porphyries from outcrops of the intrusive bodies presumably located nearby these churches. They are light grey medium- or fine-fragmental porphyritic rocks; on the background of plagioclase-quartz mosaic mass of granitic structure quite coarse porphyritic impregnations of plagioclase and scarce remnants of the hornblende disintegrated crystals were observed. In the samples taken from the walls of the churches the plagioclase segregations are saussuritized and sericitized.

The table provides the results of silicate analysis of stones applied for facing the ecclesiastical buildings in the Bolnisi region and of rocks from natural exposures corresponding to them.

The data presented in the table show the peculiarities of the rocks defined as a result of petrographic researches. Comparatively low content of SiO_2 and the high content of Al_2O_3 and Na_2O in the green tuffs indicate the predominance of plagioclase content. High content of K_2O in the yellow tuffs indicates the high intensity of the process of sericitization in these rocks. On the other hand, the tuffs applied for facing the ecclesiastical buildings and those from the Sarachlo and Pakhralo quarries of the Bolnisi deposit are of essentially different chemical composition; apparently, the tuffs applied for facing the aforementioned buildings had been extracted from the exposures nearby the Mashsvera suite. As for the plagiogranite-porphyries, their samples taken from the Kvemo Bolnisi and Tsugrugasheni temples on the one hand and from the exposures of intrusive bodies located in their environs, on the other hand, are identical both in chemical composition and in petrographic properties.

Table 1

Components	Samples							
	1	2	3	4	5	6	7	8
SiO_2	75.90	79.80	70.52	70.10	77.20	73.20	70.40	74.10
TiO_2	0.30	0.16	-	-	0.18	0.20	0.13	0.14
Al_2O_3	11.10	8.70	12.39	12.35	10.20	10.90	13.70	13.10
Fe_2O_3	1.54	1.01	3.68	3.81	2.59	5.35	1.78	1.68
FeO	0.14	0.21	-	0.36	0.21	0.22	0.29	0.14
MnO	0.05	0.01	0.50	0.37	-	-	-	-
CaO	0.50	0.60	1.38	4.90	1.00	0.80	2.20	0.90
MgO	0.40	0.50	0.75	0.80	1.10	0.60	1.00	1.10
Na_2O	3.80	1.20	2.10	1.00	3.30	2.40	5.00	4.50
K_2O	1.90	5.90	4.75	6.00	1.10	1.80	1.70	1.50
lost at warm.	2.01	0.85	2.96	0.80	2.07	3.20	2.35	1.62
H_2O^-	1.65	0.35	0.65	0.30	0.33	0.65	0.75	0.44
Sum	99.29	99.29	99.68	100.79	99.28	99.32	99.30	99.22

1 - Green tuff from Bolnisi Sioni; 2 - Yellow tuff from Tsugrugasheni; 3 - Tuff from Sarachlo; 4 - Tuff from Pakhralo; 5 - Plagiogranite-porphyry from the Tsugrugasheni church; 6 - The same from the exposure in Tsugrugasheni environs; 7 - Plagiogranite-porphyry from the Kvemo Bolnisi temple; 8 - The same from the exposure in in the environs of the temple.

The results of the carried out researches can be applied when carrying out the restoration works of previously mentioned monuments of ecclesiastical architecture in the Bolnisi region.

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SELLENIUM AND TELLURIUM IN THE BOLNISI GOLD-BEARING COMPLEX ORES

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The potential of mineral resources, having been created by Georgian geology for the last one hundred years, still contributes significantly to the country's economic activity.

Predatory exploitation of relatively rich deposits or of their parts, serious technical, technological and organizational lag lasting for years made the previously investigated and estimated deposits with proved ore reserves unprofitable.

One of the reasons is complete disregard for the accompanying useful components in the complex ores of the deposits in operation. Selenium and tellurium occupy a special place among them.

Selenium and tellurium belong to a group of rare elements; their clarkes are 8.10 - 5 and 1.10 – 6 respectively.

In the Periodic Table, tellurium and selenium are located in the sixth group, in the subgroup of oxygen, in the sulfur-selenium-tellurium column.

Selenium, like sulfur, has six electrons on the outer layer of atoms and represents a metalloid. Tellurium metalloid features are weakly expressed but, like selenium, with metals it gives sulfide type compositions - tellurides .

The selenides are presumably formed under specific conditions, as a result of violation of sulfur-oxygen regime when magmatic melts are unsaturated with sulfur [1].

As for tellurium, its coexistence in the crystal lattice of sulfur sulfides is limited due to the significant difference in the radii of their ions and the increase of the metal properties of tellurium.

Selenium and tellurium are representatives of trace elements group but they form a significant number of their own. minerals during both, magmatic and exogenous processes [2].

In Georgia, selenium and tellurium are mainly known in the sulfide deposits of the Bolnisi ore region where investigations have been carried out for years in order to establish the regularity of the distribution of these elements.

For instance, in case of the Madneul deposit, it is known that selenium does not form independent minerals despite its significant concentration; it is isomorphic to the sulfides in the crystalline lattice and is distributed evenly.

Selenium generally occurs in association with cerussite in the form of products of natural selenides. Its maximum content is observed in barite-lead and copper-pyrite ores and reaches 230 gr/ton in chalcopyrites and 280 gr/ton in pyrite [3].

Tellurium forms its own minerals, such as: calaverite [(Au, Ag) Te_2], petzite [(Ag_3, Au)Te_2], hessite [(Ag_2) Te], tetradymite [Bi_2Te_2S] in the form of micro-inclusions in chalcopyrite and pyrite. Besides, its existence in isomorphic form in sulfides is not excluded taking into consideration more or less even distribution of tellurium.

Calaverite occurs in the form of small segregations of 0.03-0.04 mm in chalcopyrite or pyrite and chalcopyrite contact area.

Microscopically calaveriete has the following characteristics: yellowish color, higher reflectivity (in comparison with the bordering pyrite) and comparatively lower relief.

It is anisotropic, deprived of color effects; even in immersion there were not observed double reflection and inner reflexes.

Hessite is white with evident bluish-brown tint in the reflected light; it is characterized by double reflectance with faint colors effect which is especially well observed in immersion. In crossed nicols it has quite strong anisotropy with colors effect.

Petzite occurs as intergrowths with aikinite and gold; it also makes small size independent segregations in the sphalerite mass but an intergrowth with gold occurs more frequently.

Sometimes petzite is observed in the form of small segregations together with emulsion- like gold impregnations in the alaskite mass.

Petzite certain small veinlets rarely cross the sphalerite mass.

The existence of the petzite veinlets, its penetration along the ore-forming minerals and its tight spatial relationship with alaskite, aikinite and gold give grounds for believing that petzite petzite generation of is temporally associated with the last stage of ore formation.

Tetradimite [Bi_2Te_2S] is also a rare element and it is generally localized in complex ores. Sometimes it forms small segregations [4].

Only the annually extracted ore from Madenuli deposit contains tens of tons of selenium and tellurium but it is not realized.

Selenium and tellurium occur in ores of other deposits ready for exploitation (Sakdrisi, Bneli Xevi, Bertakari etc.) that makes it indispensable to extract microelements (selenium, tellurium, cadmium etc.) together with the principal metals out of the aforementioned ores applying modern technologies that will significantly increase the economic effects of production.

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APPLICATION OF NATURAL STONES IN BUILDING AND RESTORING CHURCHES AND MONASTERIES (EASTERN GEORGIA CITED AS AN EXAMPLE)

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Georgia is a classical country of stone architecture.

History of natural stones application in building construction in Georgia goes back to remote times; for instance Armazis Cikhe castle Tsitsamuri Seri, Sarkneti etc., represent works of architectural art on the Antique Kartli land. It can be said that the material applied for construction of architectural monuments at the beginning of the Middle Ages already had several centuries-old history.

We have researched the stone material applied when building Cult architectural monuments. The following monuments were selected for research-scientific works in Eastern Georgia according to theregions: Alaverdi, Nekresi, Ikalto, Dzveli Shuamta, Kvetara, Kacareti – in the Kakhety region; Bolnisis Sioni, Tsugrugasheni, Fitareti - in Kvemo Kartli; Rkoni, Ikvi, Ertatsminda, Metekhi, Samtavisi - in the Shida Kartli region; Tserovani, Svetitskhoveli, Jvari etc. - in the Mtskheta-Tianeti region.

Besides the mineral and substantial composition of the stone material their basic physical and mechanical properties were studied as well.

In order to carry out restoration works there have been searched authentic, natural stone deposits of the studied material.

In case of churches and monasteries there were distinguished two types of construction: a) walls were built of broken stones and lime cement and then faced with the appropriate material; b) walls were built of large massive squares, considered to be facing material at the same time, cemented to each other with lime.

In all the cases the homogeneity of the building material is of great importance as the material with different characterristics differently reacts to environmental conditions, contributes to impoverishment, cracking and decreases the resistance of the building. This point must be considered carrying out restoration and construction works.

On the researched area there are monuments (Kvetera, Tsugrugasheni, etc.,) where a number of building materials were used in various architectural details so, it makes an impression that their characteristics were well known for that time. In case of such monuments generally one or two types of stone material were used; sometimes materials were not selected and their properties were not considered; therefore beside the travertine there occur cobblestones, bricks, etc. (Kacreti, Alaverdi, etc.) that is undoubtedly the reason of repeated destructions and rapid construction-restoration; in such constructions up to ten types of building materials have been applied.

The diversity of the applied building materials is in direct connection with spreading of the country stratigraphic units or with the general geologic structure of the region. The peculiarrities of the geological structure, frequency and nature of rock outcrops, the recent forms of the relief, etc. determine the predominant types of the building material.

More than one hundred deposits and ore manifestations of building and facing stones of igneous, sedimentary and metamorphic origin were revealed in the researched area. Commonly only a small part of these varieties were used - mostly easy to process and easy to extract; for today they have been time tested and they should be considered for future use.

The dominant building material for Shida Kartli is tuff, tuffstone or sandstone (arkosic, greywacke and so forth). Tuff ore-manifestations are associated with the Middle Eocene volcanogenic formations and sandstones are generally associated with Eocene, Miocene and, rarely Pliocene formations. For Kvemo Kartli such material is tuff, associated with the Late Cretaceous thick volcanogenic series. In the Kakhety region mainly travertine, cobblestones, rarely limestone or slate was applied. There are known some travertine deposits here (Orvili, Khevisckali, Khodasheni, etc).

Temples were generally built of material typical only for the same region. It is rarely observed a transfer of building material from one region to another. For example, despite the historical role of the Bolnisi Tuff and the proximity of its field to Tbilisi, only in the recent centuries this material was brought here (Sioni Temple in Tbilisi and other secular buildings).

Today in Tbilisi and other regions most of temples and churches are built and faced of the imported material. They must be replaced by Georgian natural stones; for this purpose, in our opinion, there must be created mining and processing enterprises. This will promote favorable conditions for the rapid development of small and medium-sized businesses, employment of local people and the State will receive additional income.

SVANETI GOLD DEPOSITS (KIRAR-ABAKURI ORE KNOT) AND THEIR GENESIS

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In the southern slope of the Greater Caucasus, within Georgia, two goldbearing ore districts Mestia-Racha – in the north, and Svaneti – in the south-west are allocated [1]. In the north-westernmost part of the last Kirar-Abakuri ore knot is delineated. Potential gold deposit – Lukhra from above noted area is described below. Gold-bearing quartz veins of the Svaneti region (Lukhra, Arshira, Kirari etc.) are attributed to gold-quartz-low-sulfide type [2]. There are numerous examples of deposits like Svanetian in other regions of the world. They are related to thick, weakly- and moderately metamorphosed sandstone and volcanogenic rocks stratas. Typically, the metal reserves at deposits do not exceed 30-50 tons. According to some researchers [2], deposits are characterized by a few stages of mineralization: in the early stage releases white quartz, at a temperature exceeding 300ºC. Then, from a relatively small volume of solution sulfides and gold crystallize at temperature of 150-300ºC. It should also be noted that the prime concentrator of gold appears later deformed quartz, and the main ore mineral is arsenopyrite. Within the ore knot goldbearing quartz veins are idenfied in endo- and exocontact zones of small intrusions. At Lukhra they are distributed in Middle Jurassic small intrusion near the village Dizi (Svaneti).

Geological Settings of the Lukhra deposit area. Paleozoic volcanic-sedimentary complex, hosting small gold-bearing intrusions: gold-bearing small intrusions complicate Paleozoic volcanic-sedimentary complex. In the middle reaches of the river Enguri, Paleozoic rocks compose uplifted tectonic block, on the peripheries of which outcrop Lower Jurassic shales. Uplifted Paleosoic block expresses tensed tectonic environment: abundance of small intrusions and dikes; composing rocks are metamorphosed under greenschist facies; numerous narrow fault zones are characterized by intense retrograde alteration of rocks and gold elevated content.

In the Paleosoic complex of the middle reaches of the river Enguri allocated 5 stratas [3], which successively follow each other in stratigraphic section: 1) quartz-amphibolite, quartz-biotite and carbonaceous silicified slates with volcanics of basic composition and marble lenses (Devonian); 2) mica slates and marbles (Upper Devonian-Lower Carbonian); 3) black and dark green phyllitic slates with interlayers and lenses of quartzite and marbled limestone (Upper Carbonian-Lower Permian); 4) phyllitic black slates with sandstones, gravelite and conglomerate; 5) black shales with sandstone and limestone. Later two big complexes within the Dizi series were identified [4]. The lower complex, represented by sandy-aleurolitic turbidites, includes conglomerate horizons, interlayers of chert and limestone olistoliths. The upper complex is composed of more fine-grained sediments, including tuffogenic material. At large fault zones rocks are mylonitized, boudinaged and often form near fault (or intra-fault) small folds; they experienced metasomatism and are transformed into quartz-sericite-chlorite metasomatites with sulfide disseminations. It should be noted that the intensity of greenschist metamorphism in the Dizi series rocks weakens both to the north and south.

Small gold-bearing Middle Jurassic intrusions: Intrusions of stock forms outcrop in the middle reaches of the river Enguri; they are constructed by gradually replacing into each other quartz montsonites and quartz montsodiorites. More basic and melanocratic types of intusive rocks - montsodiorites are captured at areas of xenolite accumulation and endocontacts of intrusions.

Near the Lukhra deposit, on the left slope of the r. Enguri, Abakuri intrusion outcrops at about 2.5 sq. km, which has active contacts with both the Paleozoic and Early Jurassic sediments. Intrusion is build up by pyroxenite, anorthosite, gabbro and gabbro-diorite. Radiological age of small intrusions was defined at the isotopic geochronology laboratory of the Institute of Geology of the Georgian Academy of Sciences by K-Ar- method. Age of intrusive rocks Kirar-Abakuri ore knot is 162 ± 2 - 172 ± 4 Ma [5].

Characteristics of the Lukhra Deposit. The Lukhra deposit is located on the right slope of the river Enguri, near the village Dizi, 500-600 m from the marble quarry. Gold-bearing intrusive rocks are exposed along the main road Zugdidi-Mestia, and quartz vein zone outcrops 100 m above the road. The intrusion is hosted by the Devonian Dizi series, which consists of quartz-biotite and quartz-biotite-andalusite slates. Intrusion has stock form, on the plane with ellipsoidal shape, elongated in sub-latitudinal direction at 650-700 m, exposed area of which amounts 175,000 square meters. The rocks are relatively fresh, with the exception of quartz vein zones, where they experienced nonequal silicification. Gold-bearing quartz veins are fragmented and intensely colored rusty along cracks by iron oxides. The main zone, allocated on the figure 2 as №1, is located in the south part of the outcropped intrusion and most of it likely is covered by dumped debris of montsodiorites. The apparent thickness of the zone is about 12 m. A 6-meter interval of solid milky white medium-grained quartz, fragmented and healed by more coarse-grained quartz, is distinguished within the zone. Inside the latter thin chalcedony-like veinlets are visible under the microscope. In the earliest quartz two-phase primary inclusions, with homogenization temperature of 220-250ºC, are visible.

Ten samples were analyzed on gold (in quartz) on microprobe "CAMEBAX", at six points were identified the following gold contents (in%) - 0.169- 0.343. Oxygen isotopic composition of quartz was $\delta^{18}O_2$ - 20,3 or 10,2 ‰ (analyses were carried out at the US Geological Survey laboratory in Denver). These figures are likely to show metamorphic nature of water, which is in equilibrium with ore quartz. Sampling of the main zone revealed the following metal content (10 samples, length of each channel sample was 1 m): Gold (g/t) - 19.09- 0.9; bismuth (%) - 0.9- 0.03; Tellurium (%) - 0.16- 0.0005.

The main zone is traced on the surface for 140 meters, but it seems that the major part of it is hidden under the sliderocks of intrusive rocks. In the exposed part maximal apparent thickness of the zone is 14 m. Six meter capacity ore interval is allocated on the surface within the zone, where average gold content amounts: at one section - 8,89g/t, and at the second - 7,48g/t. According to our data, probable gold resources at the Lukhra area amount about 30 tons of metal.

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GEOLOGICAL SETTING AND GENETIC MODEL OF THE ZOPKHITO PROSPECT (SOUTHERN SLOPE OF THE GREATER CAUCASUS, GEORGIA)

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In the introduction of the paper are some examples of deposits, which have similarities with Zopkhito type of deposit. Some examples of deposits resembling Zopkhito deposit type are discussed in the introduction. They are distinguished by low gold grades (2-6 g/t) and in some cases are considered as “giant” deposits (e.g. “Muruntau” deposit in Uzbekistan) in terms of ore volumes. Some common insights into the ore deposits formation conditions in carbonaceous series are presented as well. The gold manifestations have a different geotectonic position at the southern slope of the Greater Caucasus. The north extreme manifestations, represented by quarts arsenic sulfide type, associated with Neogenic tectonic-magmatic active zones and are localized in the early Jurassic flish deposits. Zopkhito potential mineral deposit reveals affinity with other hosted by carbonaceous series deposits worldwide by mineral composition of the ore, as well as by physical-chemical parameters of the ore precipitation [1]. Formation of these deposits at 3-1,5km depth is the well-established fact. The authors suggest that the primary source of gold geochemical anomaly was located in the lower part of the Early Jurassic rock packages at the Southern flank of the Caucasus or even deeper, in the similar to the Dizi series Paleozoic formations [1..3]. It should be noted, that the geological-genetic model is an important instrument used by researchers for the prognosis of some ore deposits. It is summarized, that gold accumulation is contributed by the following succession of events: 1) disintegration of the gold bearing basite-ultrabasite rock-complexes; 2) “leaching” of gold and other metals from the rock-forming minerals; 3) metals transportation to the flysch type depositional environments; 4) distribution of metals as a result of epigenetic processes; 5) the enrichment of sulfide and porous water by gold during the metamorphism reinforcement. The authors also note that during the “shock” decompression the volume of melt sharply increases – substance emission takes place as the silicate and fluid-gas phases with concurrent emission of gold bearing mobilizate (in the nature this processes expressed in the formation of quartz and quartz-feldspar veins) [4.5]. The recognition – “visualization” of such paleo-processes in the nature will facilitate to exploration conduction, which will eventually lead us to the discovery of a gold deposit.

TESTING OF ASPINDZA'S PERLITES ORE REFERENCES

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Among nonmetallic raw materials, perlite occupies an important place. Perlite is silica-rich rock; Perlite contains up to 8 % of water, which is presented in it in the form of two basic forms (1 - free, 2 - structural).

It should be noted that the practical application of perlite began after it was revealed its unique specific property - the ability to swell and at the same time multiply in volume, on which the technology of its processing is based. Parameters of perlite swelling are established experimentally for each of its varieties.

We tested the perlite samples of the Aspindza ore formation located on the territory of Samtskhe-Javakheti; Their material composition, technological parameters and the conditions of swelling are determined. 3 samples were taken for the study.

To study the material composition and structural features of perlite, chemical, mineralogical-petrographic, X-ray diffracttion and thermogravimetric analysis methods were used, as well as infrared spectroscopy.

Mineralogical and petrographic study of the sections showed that the perlite samples are represented by the acid volcanic glass (perlite) with a weak perlite structure and refer to a nonferolite-fibroplastic variety of perlite structure having a parallel-fibrous structure.

The results of the chemical analysis are given in Table 1.

Table 1

Chemical composition of perlite

Sample of perlite	Oxide components, (вес. %)							
	Moisture	П.п.п.	SiO_2	Al_2O_3	Fe_2O_3	SO_3	Na_2O	K_2O
Sample № 1	0,8	4,55	67,5	13,9	1,05	0,3	4,0	5,1
Sample № 2	1,35	5,14	65,5	13,7	1,31	0,31	3,7	5,0
Sample № 3	2,52	5,0	67,4	12,8	0,96	0,15	3,7	5,0

From the data of the above mentioned Table it can be seen that in the perlite samples studied, the SiO_2 content is ~ 70 %, the Al_2O_3 content is relatively high and varies within the range of 12.8-13.9 %; The content of alkaline cations is: Na_2O - 4.0 % and K_2O - 5.0 %; For perlite is characterized by a low content of Fe_2O_3 and alkaline earth cations.

X-ray phase analysis showed that the samples of perlite are mainly represented by the X-ray amorphous phase (perlite + obsidian), and in small quantities they contain the following minerals: sample No. 1 contains feldspar (3.21 Å); Sample No. 2 - Ca-montmorillonite (15.0 Å) and feldspar (3.20 Å); Sample No. 3 - quartz (4.25 Å, 3.34 Å) and mica (9.96 Å); On the roentgenogram clearly outlined peaks are not marked.

Analysis of the obtained differential thermal and gravimetric curves showed that perlite samples have a slight endothermic effect, which starts from 80°C and ends at 500-550°C, and is associated with the release of various forms of water. The stepped nature of the discharge of water from the perlite indicates that the water is not the same connected with the aluminosilicate skeleton. Molecular water, which is bound to the surface by a hydrogen bond, begins to be released in the low-temperature range.

Investigation by infrared spectroscopy showed that in the (1500-400) cm^{-1} region, the perlite spectrum in the infrared region is characterized by an intense absorption band of 450 cm^{-1}, which is due to valence vibrations of the Si-O bond, and an absorption band of 820 cm^{-1} is characteristic for surface Hydroxyl groups of the hydrated silicate material. A wide asymmetric vibration in the region (1000-1200) cm^{-1} relates to stretching vibrations of the Si-O-Si group.

To assess the swelling capacity of Aspindza perlite, a sieve analysis of perlite samples was carried out beforehand, and the yield of fractions was established. The main physical characteristics of perlite were determined (see Table 2).

Table 2

Physical characteristics of perlite

Sample of perlite	Bulk weight, kg/m^3	True density, g/sm^3	Average density, kg/m^3	Porosity, %
Sample № 1	1022,2	2,37	1870	21,0
Sample № 2	1127,5	2,36	1980	21,0
Sample № 3	1150,5	2,34	1870	20,0

In order to establish the parameters of swelling, both the one-stage and two-stage temperature treatments were tested, since in the perlite samples studied the loss on calcination exceeds 4.5 % (Table 1); At a two-stage temperature treatment, the primary treatment was carried out at temperatures of 350-400 °C and 400-500 °C.

Since the duration of the heat treatment, the optimal particle size and the temperature regime have a great influence on the quality of swelling, therefore, experiments were performed on all fractions of the tested samples at various temperatures (850-1150 °C) and for different time intervals ($30^{//}$ - $2^{/}$ $45^{//}$).

After each experiment, the swelling coefficient K was determined, which is the main indicator of the quality of the expanded perlite rocks, and also determined the yield of non-released particles.

It was established that Sample # 2 is extracted from the tested samples (swelling temperature 1100 °C, duration of swelling $50^{//}$, fraction -2.5 + 1.25 mm, K = 4.3, yield of unexpanded particles 20.4 %); The remaining two samples are practically not subjected to swelling (K = 1.2-2.2, the yield of unobserved particles is 75.0-99.8 %), which is caused by the dense impurities of black color present in them (mainly obsidian), Which are observed during visual observation.

In conclusion, it should be noted that the perlite of Aspindza ore occurrence refers to a variety of perlite with a slight swelling capacity.

NATURAL DISASTERSRISKS MITIGATION USING PROTECTIVE PLANTING (CASE OF BORJOMI)

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Natural disasters, related to global climate change, became more frequent in the world during last 10 years. Therefore, the important task of the urban planning is to apply such planning tools, which allows natural hazards risks mitigation as far as possible.

Positive ecological condition is noteworthy for each type of the settlement, but for tourism and recreation places this issue is most important. In this thesis we consider the example of Borjomi, which is a famous climate and balneology resort.

Objective of this research is to determine the importance of green areas in the mitigation of destructing impact of the natural hazards, in particular, stormwater streams and mudflows reduction using green areas planning.

Methods: critical analyse, cartography data processing, comparation with foreign examples.

Case study: there is no need for the extra presentation of the famous resort Borjomi. Geographical location - between the slopes of Meskheti and Trialeti ranges, in the valley of river Mtkvari and its tributaries, Borjomula and Gujareti water. Height above sea level- 800-1000 m. Peculiarities of Borjomi climate are conditioned by the locaton of the resort in moderate climate, low mountain forested zone. The average January temperature is -2,8 °C. The average temperature in July, is the same as in August, 19°C. The average annual temperature is 8,3 °C. Relative humidity is 77%. The average annual rainfall 658,6 mm. The sunshine duration is 1350-1400 hours per year [1].

According to the data of Environmental information and education center of Georgia[1], most of resorts in Samtskhe-Javakhetiand also Borjomi islocated in the danger zone of adjective geological processes. Due to the climate change-related events influence, in Borjomi heavy rains andstrong winds increased, what previously was not characteristic for this valley. It should be noted that circumstances are aggravated in last years by the reduction and degradation of forests surrounding the resort. Also green areas, located on the mountain slopes, were not systematically cared. Forests of Borjomi are damaged by:european spruce beetle; firesemerged during 2008 military conflict; in summer 2015-16sanitary cuts were implemented on the Borjomi plateau, which covered large array of forests.

Forest pest control was implemented since 60th of the last century using biological methods elaborated by Georgian scientists. For this specific case, diagnostic conclusion of Borjomi forest pathologycal condition already existed in 2011, but the implementation of sanitary measures became possible only in 5 years, when the pathological processes covered wide arrays. So, the unprecedented quantity of wood was logged at the same time.Directly after this,extremly strong natural hazard occurred in Borjomi in 4th of August 2016: heavy rainfall, hail, hurricane; as a result of soil protective function decrease of forests stormwater flowscouldn't been held – what was followed by blocking roads with brocken wood branches and mudflows, coming from mountain slopes; extremelystrongly damaged andflooded the surroundings of village Sadgeri, Bakuriani road and historic Mineral Water Park, which is located directly under Plateau. Due to the timely response these problems were solved soon. Forest restoration process is under way, however, to achieve the results many years are needed.

[1]http://eiec.gov.ge

Such heavy disasters often threatens the settlements located in mountainous gorges. As a result of decrease of forest water- and soil protective function, this problem becomes very dangerous. Due to the researches of Georgian scientists of forestry sector, protection of the nature, forests and green planting is highly important. In other case, "emerging and development of hazardous natural disasters (floods, wind- and water erosion, mudflows etc.) is not excluded" [2].

In order to reduce the destructive force of landslides and mudflows coming from mountain slopes the terraced green planting methode is suitable, which have been usedactively in our countrybefore. Recently this method is not longer used due to the high cost. Terracced planting protects the settlements located in the gorges from hazardous stormwater flows and landslides. The advantage of using this method is considered by the Japanese scientists [3].

Fig. 1. Examples of Meskhetian terraces in Samtskhe-Javakheti, Aspindza municipality.

The method of terrain terracing in form of Meskhetian "Dariji" can often be founded in Samtskhe-Javakheti. Additionally to agricultural use, mentioned method could have positive impact to reduce stormwater flows, through stepwise distribution of its force.[4].

Also noteworthy is the experience of New York City green planting recording, where the benefit of each tree brought to the city is described, which is expressed in total in impressive figures [5].

Recommendations: based on numerous expert researches, inthe planning documents of resortsshould be determined the priority of green areas and adjacent to the resorts forests planning; that the green areas planting issue should not be symbolic, and limited to single actions, but should be systematically worked out and its protective functionsshould beclearly defined: protection against wind, air pollution, water and soil protection, and especially the terraced planting of slopes, using careful correction of the terrain, what will support the mitigation of increasing natural disasters impact.

Acknowledgements:

We express our deep gratitude to Shota Rustaveli National Science Foundation for the for the implementation of grant number PhDF2016_201.

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THE CONNECTIONOF EFFUSIVEAND INTRUSIVEMAGMATISMWITH THE FORMATION OF THE DEPOSITS OF ISLAND ARC SYSTEMS

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At the end of the 20th century geology changed the paradigm. The new, existence of a large number factual material made it possible to discuss the mineralization process in the volcanic-plutonic series of island arc, as a synchronous, combined (effusive and intrusive) the whole complex of processes. It should be marked that the natural recoursesare forming in the process of its geological development, i.e. as a complicated power system, which includes an energy source, transporter mechanism, ore materials, carrying ways and accumulation ore district. By the surface of erosion levels can determine the character of the Ore-bearing systems as well. The islands arc ore-forming - this is the activity of a productive volcanic-plutonic suite as an ore-bearing system in the specific age.

As an example, some of the detailed survey of Mesozoic age island arc productive volcanic-plutonic ore districts.

Bolnisi ore district and particularly, ore field of the Madneuli relatively is a well-studied geological object in Georgia, where great attention is paid to the ore-forming materials, the physical-chemical parameters of the ore formation and the knowledge of process experimental modeling.

We can discuss the polygenic model of the formation of deposits on the example of Zagliki's alunite deposit (dashkesani ore district) in the Late Jurassic-Early Cretaceous volcanic-plutonic suits conditions of the island arc volcanism. The ores of alunite, pyrophyllite and magnetite, which are located in the area of dashkesani intrusive, are products of the complicated geological processes relative to effusive and intrusive magmatism and concomitant processes of the contact and hydrothermal metasomatism. The copper-polymetallic deposit is being processing in the lower Jurassic sediments of the south side of the Great Caucasus. The volcanism within the area is presented by the diabase dike belt.

Raised a question about the existence of the intrusive body in the Mesozoic sediments relative to Guton's anomaly detection, which is spread in the west of the anomaly.

Therefore, it is necessary to pick out optimal scientific methods for mineral resources exploration, which will be based on a complex of geological, geochemical, geophysical and remote sensing methods.

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BORJOMI MINERAL WATER NATURAL DISCHARGE ESTIMATION

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During the hydrogeological survey of the Borjomi mineral water deposit at the central site, in Likani, on the left bank of the river Mtkvari, the natural discharge source of thermal mineral water has been discovered. The chemical analysis has shown that the mineral water's total mineralization is 1.7 g/L and that it is hydrocarbonate-sodium of Borjomi type.

For the estimation of the natural discharge flow of the thermal mineral water the following preliminary data have been taken:

- discharge on the river Mtkvari bank - from 500 to 1000 l/sec, which makes 1:50 of the river Mtkvari minimum flow.
- thermal water temperature t_2 = + 25°C.
- water temperature on the river Mtkvari bank (the mixing zone) t mix = + 5.3°C.
- the river Mtkvari background temperature t_1 = + 5.0°C.

If we use the calculation formula of temperature of a mixture of different waters

$t_{mix} = (m_1*t_1+m_2*t_2)/(m_1 + m_2)$, where:

- m_1 is the river Mtkvari bank flow kg/sec - 1000 kg/s;
- m_2 is the mineral water flow, kg/s;
- t_1 - the river Mtkvari background temperature - 5.0°C;
- t_2 - mineral water temperature - 25°C;
- t_{mix} – the temperature of the mineral and river water mixture - 5.3°C;

Introducing the above-mentioned data in the formula we get that the natural mineral water discharge on the left bank is **7-15 l/sec**.

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GEO-ECOLOGICAL PROBLEMS OF THE RAVINE OF RIVER MTKVARI (BORJOMI-MTSKHETA SECTION)

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1. Caspian Sea is one of the important marine objects in the region of Caucasus. With its natural data sea is unique not only for this region but also for whole Continent of Eurasia. Caspian Sea may be considered as the object dividing Europe and Asia around which there are such states as Azerbaijan, Russia, Kazakhstan, Turkmenistan, and Iran. Due to this the ecology condition of this sea nowadays represents one of the important problems.

2. Despites the fact that Georgia has no coastline with Caspian Sea its most important river Mtkvari flows into this sea and represents one of its affluent fillers. Due to this it can be easily guessed what great importance it is given to the establishment of ecology condition of the river Mtkvari in recent years, according to the works carried out the ecology condition of the river Mtkvari is evaluated as urgent. It is flown into by not filtered industrial and being remaining, due to which the consistency of hazardous substances are much more (2-9 times) than the limited concentration.

3. In 2015-2016 we have made complex geo-ecological works on the section of Borjomi-Mtskheta where heavy and toxic elements (Cu, Pb, Zn, Ni, Co, Cd, Mn) in their regulation of allocation takes place in the water of river Mtkvari and bottom sediments. Also the number of elements named is determined in the agricultural soils across the magisterial traffics.

For bio-examination the stem of corn, its leaves and fruit was selected because it is used for feeding pets and birds as well as human ration. According to the results achieved ecologically abnormal areas are revealed where the limited concentration of heavy and toxic elements are high. The high concentration of lead is determined in agricultural soils across the magisterial traffics. From this point particular attention is paid to the section of Khashuri-Gori. Also the concentrations of lead, copper and zinc is high in stem and leaves, also fruit. The number of these elements is high in the water of river Mtkvari in the areas of c. Gori.

The average concentrations of heavy and toxic elements in soils, water, bottom sediments and plants (namely fruit and stem of corn) are given in table below.

Table 1

Average consistency of heavy and toxic elements in water, bottom sediments, soils and plants

№	Object for examination	Chemical elements						
		Cu	Zn	Pb	Cd	Co	Ni	Mn
1	Water, mg/l	0,006	0,013	0,01	0,005	0,014	0,019	0,010
2	Bottom sediment, mg/kg	38,75	69,06	17,5	10	51,25	33,88	842,5
3	Soil, mg/kg	83,19	149,17	41,39	6,06	76,67	106,11	882,22
4	Plant							
	Fruit of corn, mg/kg	3	26	1,65	1	1,5	1,5	5
	Stem of corn, mg/kg	6,47	38,53	5,02	1,05	7,32	2,53	92,26

In 2017-2019 the complex geo-ecological study-evaluation of the section of Tbilisi-Red Bridge, river Mtkvari is planned.

SEISMICALLY ACTIVE STRUCTURES RESEARCH METHODOLOGY

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The hazardous impacts on the ground surface provoked by rapid, instant deformations of the lithosphere are well known to the mankind. The several hundredth thousands of mortalities, huge material damages, devastation of the environment – these are results of such catastrophic events.

The earthquakes occur around the globe; however their sources are distributed in a clearly defined localized pattern along the boundaries between lithospheric plates (Fig. 1) [1].

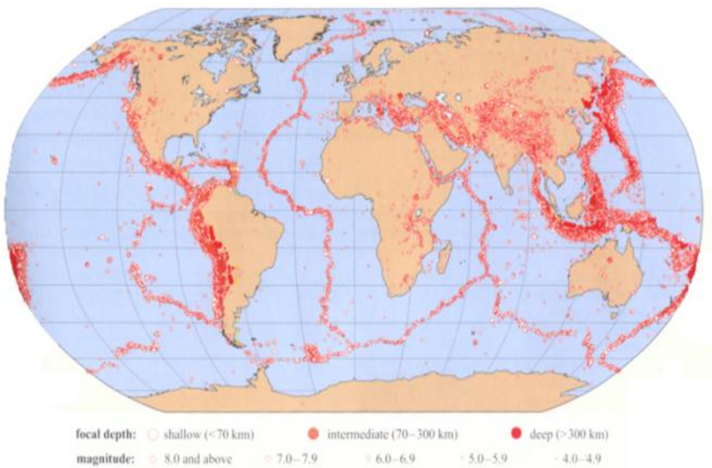

Fig. 1. Pacific and Mediterranean-Himalayan Seismic Belts

Therefore, location, investigation and adjustment of the probable earthquake sources is of both theoretical and practical importance, especially in the seismically active regions, as are the Caucasus in general and Georgia in specific. For example, this is important for seismic safety and risk assessment of reservoirs and dams (e.g. Jvari Reservoir on EnguriRiver, Zhinvali Reservoir on AragviRiver, etc.), oil and gas pipelines, settlements, etc.

The results of study clearly point to the need of comprehensiveinvestigation of any proposed earthquake source / active seismic structure to justify its actual occurrence, including geomorphological, geodetic, structural-geology, seismological, gravimetric and magnetometric (for defining the deep lithospherestructure) practices

The most effective methods for identification of the strike-slip-shaped structures comprise topographic analysis of the river network, and various scale mapping of the geological marker features (faults, fold axes, lythological boundaries, etc.), as well as the measurement of directions and values of the ground horizontal displacement using GPS technologies, anddue account of linear disposition of the earthquake epicentres and source mechanisms. (Fig.2). [2]

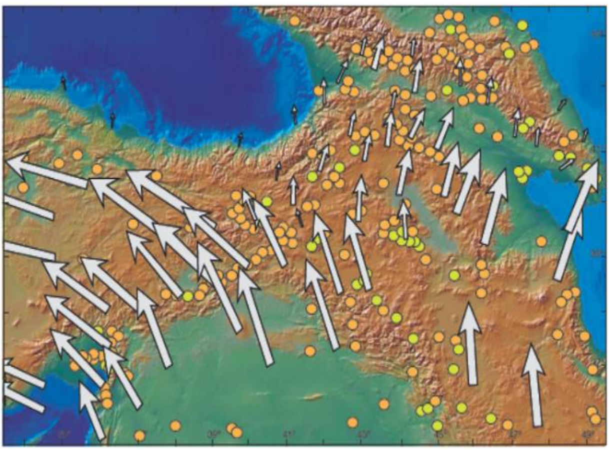

Fig. 2. GPS measurements show equal displacements of the lithosphere approximately towards the nourth.

The Arabian-Caucasian microplate moves at about 30 mm/year towards the north-east. Within the Caucasus, this rate considerably decreases towards the north. In Turkey, direction of the lithosphere movement changes to the west-north-west. Due to the plate convergence, the Caucasian plate undergoes compression and breaks provoking the earthquakes.

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THE COMPLEX RECOVERY OF GOLD AND BASE METALES FROM LOW-GRADE REFRACTORY SULFIDE ORES USING HEAP BIOOXIDATION AND "GEOCOAT" METHODS

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Flotation has been the major method for recovering precious and base metals from complex gold sulfide ores. As a rule, some part of gold is extracted with copper concentrate, but gold recovery is not high enough and therefore the recovery of gold from flotation tailings becomes necessary.

The object of this study is old gold-copper tailings of Madneuly production. The main constituents in flotation tailings are gold, silver and copper. The flotation tailings are a refractory material. Gold, as the principal metal, is fine encapsulated in sulfides, mainly in pyrite. Gold extraction from tailings is only 20-25 % by cyaniding.

In this work heap bioleaching of tailings was studied for oxidation sulfides (pyrite and chalcopyrite) using mesophilic bacteria A. thiobacillus ferrooxidanes and A. thiobacillus thio-oxidanes in sulfuric acid solution. The tailings had low filtration property (<0.3 m/day), for increasing filtration property of tailings there was used hard enrichment copper ore, in which ≈ 60% by oxidized copper and 30% by secondary sulphide were presented. Filter degree increased up to 15 m / day. Copper was extracted from sulfate solution and will be precipitated by cementation after cleaning of solution from ferric. After 97 days by leaching was extracted 89.5% copper from the solution. The bio oxidation of pyrite in tails was 52 %. Heap leaching by thiourea and cyanide were tested.

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GROUNDWATER OBSTACLES RELATED TO BUILDING FOUNDATIONS IN TBILISI

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The current day social values of geology increasingly derives from the environmental tensions created by the resource and land-use needs of an expanding population. The increase of urbanization and population requires new buildings, reconstruction and rehabilitation of damaged houses. Geology is of fundamental importanceas far as it allows wise use of urban and rural lands. As land is the surfaceexpression of the underlying geology, planning should not proceed without fully understanding geological conditions. Foundation, tunnels, transportation routes, etc. depend for their stability and performance on the geological setting.

The control of groundwater is one of the most common and complicated problems encountered on a construction site. Groundwater inflow and the presence of groundwater have an impact on the design, construction or excavation procedures, the selection of construction materials and consequently, on the overall project costs.

We discuss the process that takes place when the foundation of the buildings is interacted with groundwater. It is well known that the properties of various rocks are drastically different whether they are dry or in contact with water. Many worldwide building practices have approved that the big majority of buildings that have undergone deformation is caused by the permanent contact of the rock with groundwater. There are many preventive measures that could help constructors avoid building deformationand settling.

In this study, we represent one object, that is located in Tbilisi, Xoshtaria street. The building is planned to have a simple pad foundation, that will have 6 floors and an additional 2 ground floors. The local territory is composed of impermeable upper Quaternary formations and lower Oligocene sedimentary series. These series of rocks are characterized by low water content because of the high clay amount, however, the exogenous fractured zone and sandstone fractured layers are relatively more saturated.

The problem concerning groundwaters flowingthrough foundations is widely spread issue in Tbilisi. These groundwaters should not be considered as a natural occurring water, because in Tbilisi the precipitation is typically lower than evaporation and because of this the waters entering the excavations are more likely to be associatedwith sewage system malfunction.

When planning constructions, the hydrogeological parameters such as: groundwater level, circulation intensity, chemical composition and aggressiveness should be calculated. Although groundwater is vital in many cases, in construction works, it is considered as a drawback that could worsen working conditions and increase expenses. Two major instances should be considered:

- Obstacles in relation to groundwater flowing into excavation.
- Groundwater as a corrosive agent to constructions.

In our case groundwater is flowing from the contact of Quaternary sediments and the bedrock into the excavation and thenit seeps downward through the fracture zone, recharging and upliftinggroundwater levels. The bedrock is represented by Oligocene terrigenous flysch, that is composed of sandstone, argillite and clay layers' alteration.

The average depth of the groundwater on the represented territory is 3.5 meters, so it will be necessary to pump this water out of the excavation before starting to build the foundation. Also, the fact, that the groundwater level will be restored and the foundation will be in constant contact should be considered.

Taking into consideration all the circumstances discussed above, the foundation should be isolated by hydroisolation substances from groundwater toavoid anycomplications concerning constructions in the future. Also it is highly recommended to arrange drainage system under the foundation, from where the gathered water will flow into the well and eventually will be pumped into the sewage system.

Monitoring on the groundwater has shown that the flow is low, however, we should consider the fact that even a slight increase of the water discharge could sufficiently worsen the current situation. In addition to this problem the local territory is characterized by capillary action, what is well expressed on neighboring building walls. This process should be considered when lowering groundwater levels.

On the observed territory, the suffusion process could be developed by leaching gypsum, however we musttake into consideration the fact that the foundation will be located deep enough and quaternary sediments will be removed completely, this process will not interfere with foundation.

RATIONAL USE OF AJARA-TRIALETI MINERAL WATERS – ONE OF THE RELIABLE WAYS TO RESOLVE SOCIAL AND ECONOMIC PROBLEMS OF THE REGION

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There are many mineral waters on the territory of Adjara-Trialeti which are rich in their chemical and gaseous composition, diverse efficient medicinal and health-improving properties. Some of these resources are exploited fully or partially (Borjomi, Nabeghlavi, Sairme, Mitarbi, Flate, Nunisi, Makhinjauri, Abastumani, Akhaltsikhe, Sadgeri, Akhaldaba, Tashiskari Tbilisi et al) [1], but many outcrops of mineral waters of big or small resources are left without attention. To expose their potential in 2015-2016 the monitoring of mineral waters of the region was performed.

Monitoring revealed that majority of natural sources (springs) are small debit ones; it, at first glance is as if hindering factor to reveal interest to them, but if we consider the fact that on the spot of the currently known mineral water deposits which are distinguished by their abundant resources there were only one or two common springs, the above referred springs might be considered rather perspective. Focused capitation and prospecting boring works carried out on the section of these springs most probably will give positive results.

Thanks to their rich chemical composition most attractive are mineral waters spread in the gorge of the riv. Adjaristskali, which are presented in the form of carbon dioxide cold waters (Kokotauri, Sikhadzirim Danisparauli) and the nitrogenous subthermal waters (Tskhmorisi, Tomasheti, Bogauri, Kldis Abano and others) [2]. There is the Tbetis Tskaro, of unique chemical composition. Its chemical type resembles that of the Nunisi Therm, which is known for its healing properties. Tbeti spring has drop-wise debit but by adequately implemented geological prospecting works (by leading even a small tunnel) we can get unique natural medicinal means for treating skin diseases.

There are several thermal water outcrops in the region (Amaghleba, Zekari, Biisi et al) which are not used in fact. Only resources of the known hot waters such as Abastumani, Akhaltsikhe, Akhalkalaki and others are assimilated partially. Tbilisi thermal water deposit can serve as an example, when thermal resources of only one (Central) section is used, while potential of hot waters (37_42˚C) and ultra hot waters (> 42˚C) of Lisi and Saburtalo region is used only partially [3].

If we take into consideration the favorable climatic conditions of Adjara-Trialeti zone, its: moderate climate, diversity and abundance of vegetable cover, dense system of surface waters and others, we can state convincingly that assimilation of mineral waters will contribute to creation of wide network of spa-climatic and spa resorts and bottling of natural carbohydrate table waters. Considering the peculiarities of mineral waters as renewable mineral products, exposure and using of resources-potential of the above referred waters will contribute significantly to the resolution of social and economic problems of the population of the region.

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ASSESSMENT OF THE STATE OF NOISE POLLUTION IN SOME MAIN TRAFFIC HIGHWAYS OF SABURTALO DISTRICT OF TBILISI

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The background-parametric anthropogenic influences in Geoecology include thermal, radioactive, ionization and noise pollution. High-level noises adversely affect the biological conditions of life, shortens life expectancy and inhibits the mental activity of a person.

The main input to transport noise (up to 90%) generation in modern cities is the auto transport. Normative parameters for unstable noise are equivalent to sound levels L_{Aeqv} (dBA), which depends on a traffic intensity, part of trucks and public transport into the transport flow, average velocity of traffic flow, geometric characteristics of the road, parameters of the dividing line and etc [1-3].

Present research refers to state of noise pollution on main traffic highways (Vazha Pshavela and Alexandre Kazbegi avenues, Petre Kavtaradze street) of Saburtalo district of Tbilisi. Studies were accomplished on working days. The main part of transport flow was passenger cars. Their number was above 90 % of all the passed automobiles. The number of passed motor transport in the investigated regions was changed depending on time of the day and night.

The results of calculations for definition of noise level L_{Aeqv} of high intensive traffic intersections of Vazha Pshavela and Alexandre Kazbegi avenues, Petre Kavtaradze street (fig. 1).

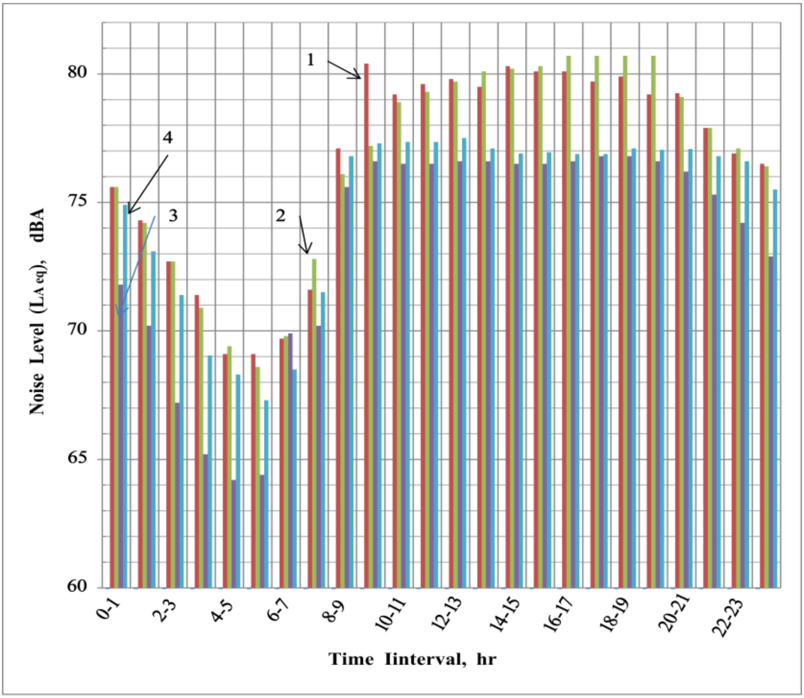

Fig 1. Variation in noise level L_{Aeqv} (dBA) during twenty four hours with one hour time intervals in high intensive traffic intersections of Vazha Pshavela and Alexander Kazbegi avenues, Petre Kavtaradze street. 1 - The part of Alexander Kazbegi avenue from Mikheil Asatiani street to Iona Vakeli street; 2 - The part of Vazha Pshavela avenue from Iona Vakeli street to Mikheil Asatiani street; 3 - The part of Petre Kavtaradze street from Marijani street to Tengiz Buachidze street; 4 - The part of Vazha Pshavela avenue from Marijani street to Tengiz Buachidze street.

On fig. 2 is shown the map of Vazha Pshavela and Alexander Kazbegi avenues (one-way traffic) with indicated maximum values of L_{Aeqv} (dBA).

Fig. 2. The map of Vazha Pshavela and Alexander Kazbegi avenues (one-way traffic) with indicated maximum values of L_{Aeqv} (dBA).

The maximum noise levels are 80-81 dBA betveen Iona Vakeli and Mikheil Asatiani intersections.

On fig. 3 is shown the map of Vazha Pshavela avenue and Petre Kavtaradze street (two-way traffic) with indicated noise levels L_{Aeqv} maximum values.

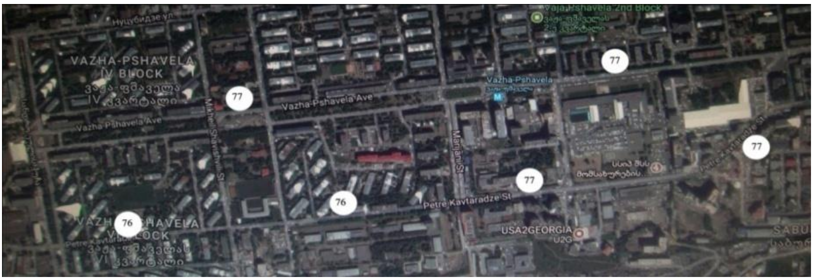

Fig. 3. The map of Vazha Pshavela avenue and Petre Kavtaradze street (two-way traffic) with indicated noise levels L_{Aeqv} maximum values.

As it is shown from the figure, in two-way traffic regions the maximum values are 76 – 77 dBA.

According to the research results, it can be inferred that a motor transport has important effect on eco-system of Saburtalo district. It is necessary to optimize noise pollution sources by restriction of transport flow velocity, decreasing the part of trucks into the transport flow at defined time of day and night.

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PLANKTON FORAMINIFERS OF WESTERN GEORGIA AND THEIR ROLE IN THE STRATIGRAPHY OF THE UPPER CRETACEOUS DEPOSITS

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The Cretaceous sediments are most developed in the Gagra-Java zone. The entire Gagra-Java zone is a part of a folded system of the Southern slope of the Greater Caucasus. It is presented by carbonate deposits that are grouped as follows: Abkhazian-Rachian and Odishi-Okribafacies types. According to planktonic and benthic foraminifera in the Abkhazia-Racha sediments have been distinguished 14 foraminifera complexes: I - the assemblage corresponding to the zone *Rotaliporaappenninica*. The *Rotaliporaappenninica* Zone is equivalent to the assemblage of *Hedbergellaplanispira* zone in Poland. Its systematic composition is close to the association of the zone *Rotaliporabrotzeni* and *Rotaliporareichel*, of the Lower Cenomanian of Western Europe. II - the assemblage with the zone *Rotaliporacushmani*. Stratigraphically it corresponds to the zone *Rotaliporacushmani*, known in the Middle- and Upper Cenomanian deposits of Western Europe and Poland. III - the assemblage corresponding to the zone *Whiteinellaarchaeocretacea*. This complex is close to those of the same zone found on the boundary of Cenomanian-Turonian sediments of Mediterranean and European areas. IV - the assemblage corresponding to the zone *Dicarinellahagni*. Analogous zonal complex is characteristic of the earlyTuronian of Southern- and Western Europe, Tethyan region and North America. This complex is found together with mollusks of the *Inoceramuslabiatus*zone and corresponds to the nannoplankton zone of *Microrhabdulusdecoratus*. The complex is dated as early Turonian. V - the complex corresponds to the *Marginotruncanaschneegansi* and *M. pseudolinneiana* zone. Stratigraphically it is the closest to the complex of the same named zone, established in the late Turonian-earlyConiacian of Algeria, Western Europe and Tethyan region. This interval is correlated with the *Tetralithuspyramidus*nannoplankton zones. VI - the complex corresponds to the zone of *Marginotruncanacoronata*. It is close to the assemblage of the zone "GrandesRosalines "from the Turonian-Coniacian boundary of Boreal Europe and also is compositionally similar to the same name zone of Poland. This zone corresponds to a nannoplankton zone of *Marthasteritesfurcatus*. VII - the complex corresponding to the zone *Marginotruncanarenzi* and *Marginotruncanasigali*. Presence of considerable quantity of plano-convex planktonic representatives of *Marginotruncana* allows to define similarity of this association to the lowermost Coniacian*Marginotruncanacoronata* zone of Poland. VIII - the complex corresponding to the zone *Dicarinellaconcavata*. In this complex, it is recorded*Archaeoglobigerinabosquensis*. Similar assemblages were established in the Paris Basin and in Algeria. The division of the late Coniacian-Santonian stratigraphic interval is connected with difficulties of morphological division of extremely similar species primitiva-concavata of the genus *Dicarinella*. IX - the complex corresponding to the zone *Contusotruncanafornicate*. Concerning the systematic composition this association is the closer to a complex of the same-named zone *Globotruncanafornicata*, distinguished in the Upper Santonian sediments in Poland and North America. A similar zone complex is established in the Upper Santonian sediments of the Paris Basin– as zone *Dicarinellaasymetrica*. X – this complex corresponds to the zone *Globotruncanaarca*. This association is close to that homonymous zone traced in the early part of the Campanian sediments in Poland. Complex

*Globotruncanaarca*corresponds to the layer with *Micraster-schroederi*and the nannoplankton zone of *Tetralithusaculeus.* It is dated as early Campanian. XI - the complex corresponding to the zone *Globotruncanaventricosa–Rugoglobigerinarugosa*. By systematic composition this association is the closest to the assemblage of the homonymous zone of the Paris Basin. Complex *Globotruncanaventricosa*corresponds to the layers with *Belemnitellamucronata*and corresponds to a zone of *Tetralithusaculeus*and a part of *Tetralithustrifidus*by nanno-plankton. The age is determined as middle Campanian. XII - the complex corresponding to zone *Globotruncanamorozovae*. Stratigraphically the given complexcorresponds to the layers with *Belemnitellalangei* and corresponds to the nannoplankton zone of a part *Tetralithusaculeus* and of *Tetralithustrifidus*. XIII - the complex corresponds to the zone *Globotruncana-stuarti*. A similar complex of the zone *Globotruncanafalsostu-arti* was established in the Lower Maastrichtian of Southern and Western Europe.Stratigraphically the given complexcorres-ponds to the layers with *Belemnitellalanceolata* and corres-ponds to the *Lithraphiditesquadratus* by nannoplankton zone. XIV – the complex correspondin to the zone Gansserinagans-seri. Similar complexes are allocated in a middle part of the Maastrichian sediments of the Paris Basin, North America, Mexico. XV complex corresponds to the zone *Abathomphalus-mayaroensis*. Complex corresponds to the layers with *Pachi-discusgollevillensis*andcorresponds to a zone of *Tetralithusmu-rus* by nannoplankton. This zone is globally usually allocated in the late part of the Maastrichtian sediments.

Upper Cretaceous sediments of Odishi-Okribafacies type are spread as a discontinuous, southward bending of bow-shaped stripe and is known as the "southern calcareous stripe of Samegrelo". The analyses made possible to establish 6 forami-niferal zones in the studied sections. I Complex –*Marginotrun-canapseudolinneiana*. Complex are found together with mollusks of the *Inoceramuslamarcki* zone and corresponds to the nannoplankton zone of *Tetralithuspiramidus*. The complex is dated as late Turonian. II Complex - at the top of the limestone layer *Marginotruncanacoronata*. This complex corresponds to a mollusks zone of *Inoceramussturmi* and nannoplankton zone of *Marthasteritesfurcatus.* The age is determined as early Coniacian. III Complex - *Marginotruncanasigali, M. renzi*. Stratigraphically the given complex corresponds to the *Inoceramusinvolutus* zone. It is dated as late Coniacian. IV Comlex - *Contusotruncanafornicata*. It is dated as late Santonian. V Complex - *Globotruncanaarca*. This complex is characterized by the abundance of index-species and it corresponds to the layer with *Micrasterschroederi*and thenannoplankton zone of *Tetralithusaculeus.* It is dated as early Campanian. VI Complex *Globotruncanaventricosa*. Complex corresponds to the layers with *Belemnitellamucronata*andcorresponds to a zone of *Tetralithusaculeus*and a part of *Tetralithustrifidus*by nannoplankton. The age is determined as middle Campanian.

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INPORTANCE OF LINEAMENTS IN LOCATION OF MINERAL DOPOSITS IN GEORGIA

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One of the most important socioeconomic development spheres for Georgia, as for a mountainous country, is the utilization of its mineral raw material potential. Geological study of Georgia commenced at the beginning of the previous century. During that time, almost all of the deposits near the surface, an important portion of which have already been exploited, have been revealed. For the development of the mineral raw material base, a question is posed regarding the exposition of more deeply located deposits, which requires a development of solid forecasting criteria. Lineament structures play an important role in the formation and spatial distribution of mineral ores.

The term "lineament" refers to a long-term deep-developed linear structure, which conditions the shape and morphology of objects on the Earth surface, as well as the structural characteristics of geophysical fields. Lineaments are unique objects of earth's crust; they, rathercredibly, relay information regarding the deep -seated heterogeneity of various scales, from the surface.The information is used in both geological theory and practice. In geological theory, lineaments, as natural indicators of deep fragmentation of earth's crust, are a reliable tool for the modern und erstanding of geodynamics. In geological practice, lineaments can point to different fluid guiding channels, thus they can become main indicators for forecasting and searching for new mineral ores. On the Earth surface, they are depicted by rift zones, linear arrangement of volcanoes, epicenters of earthquakes, fold and arch-block structures, separate ruptures of various scales, etc.

The Caucasus region, which Georgia is a part of, has for the last four decades only been considered in terms of the plate tectonic theory, as an active edge of the European continent. Therefore, the interpretation of facts in this region is reduced to determining ocean crust remains and searching for the Benioff zone, which absorbed the said crust. There is no consensus among researchers, on the amount of the absorbed zones, or the original source of opalite rock, from which they must have charriaged. It is remarcable that the theory of plate tectonics, wich is based on the permanence of the volume of the Earth, came up against the necessity of revision of many opinions and conclusions. It cannot explain a number of geological facts that have accumulated over the past decades [1,2].

Our research is based on the idea of the pulsating expansion of the earth, which places rift processes in a leading role in the development of the Earth's crust. In accordance with this process, a dominating role is accorded to lineament structures [3]. According to our data, the tectonic formation of the Caucasus region was determined by the crossing of two global lineament zones. One is the Caucasus-Tien Shan longitudinal lineament zone, which in the Caucasus region consists of six elements (subzones); they are 80-100 km apart and form a 500 km thickness zone, which, with varying degrees of authenticity, between 40-45^0 of North latitude is carried away from the Atlantic Ocean to the Pacific Ocean. The second zone has a diagonal, north-western direction, with thickness of 200 km. It is made up of two elements and is driven 3,000 km from Iran's territory, where it forms Elbrus and Hamadan facial structural zones, until the Ukraine shield, where it occurs by the Podolski depth ruptures. These two global structures created weakened zones in the Caucasus, along which initially formed deep grabenlike pits, and later rift and riftlike stretched structures. The expansion periods were substituted by contraction stages in the region, which was followed by closing of the rift zones and reduction of geosinclinalbasin area, with intense folding and formation of sloping structures.

Studies conducted on the Georgian territory reveal that rupture structures create anorthogonal-diagonal net. They are linear, each of them consists of several (mostly 3-4) elements and, as a rule, lower rank structures are a part of high rank ones. From the above mentioned systems, the ones mostly developed on the Georgian territory are the latitudinal and diagonal – lianaments of Northwestern direction. They dominate in the formation of foldsystems and structural-facial zones. Meridian and north-eastern direction ruptures are of adissecting nature and, as a rule, create block structures.

Lineaments play an important role in ore geology, as they often serve as indicators for mineral forecasting and search. In recent years a new direction, is based on the views of the piercing (Diapir) ore-concentrating structures, emerged in metallogeny. The key characteristic of these structures is their concealed character indistinct sections; they are characterized by lengthy development time, during specific periods of time they undergotectonic-magmatic activation and are conductors for mantle energy and emanations, which is a prerequisite for mineral deposit formation in the long term endogenous activity nodes. Special forecasting and metallogenic significance is attributed to lineament zones with thickness measured by initial tens of kilometers. This concept originated with the help of new approaches – morphostructural analysis and remote sensing, which is a unification of aerial and space methods.

According to our data, north-western direction and meridian systems portray the characteristics of ore concentrating structures in Georgia. The former controls the mineralization of noble, rare and non-ferrous metals, while the localization of mineral deposits occurs at the crossingknots with the lineaments of meridian direction [4].

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VARDZIA PYROCLASTIC FLOW (SAMTSKHE JAVAKHETI VOLCANIC PROVINCE): ERUPTION CENTER AND ZIRCONS U-Pb DATING

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Samtskhe-Javakheti volcanic highland (1300-2800 m a.s.l.) was formed at Late Cenozoic in the central part of the Lesser Caucasus mobile zone and it has an area more than 4500 km^2. A large part of the highland is built by the Mio-Pliocene co-called Goderzi suite with a thickness of 700-1100 m [1]. Goderdzi formation is represented by volcanic lava-breccias, pyroclastic rocks, tuffs and ash fall deposits of andesite-dacitic composition. In the construction of this formation is observed several cycles of volcanic eruptions, with a mantle source of magma chamber ($^{143}Nd/^{144}Nd$ parameter varies in the range of + 0.41703 - + 0.62304, and $^{87}Sr/^{88}Sr$ – from 0.70321 to 0.70383). The zircons U-Pb ages of upper part of this formation varies within the 5.7-3.6 Ma [2]. In quaternary period the East part of the Goderdzi formation (Javakheti bloke) has been covered with a thick continental flood basalt flow.

The question about eruption center of the Goderzi volcanic formation is still debated [1,3,4], but it is clear, that it was a huge structure. Based on physical volcanology, the analogy of such structure is considered as super/megavolcanos. The evidences of such structure are the following: a large volume of volcanic material (> 100 km^2); big thicknesses (700-1100 m in average); big size of volcanic breccias (diameter >1 m); large scales of lava flows (length 35 km, width 2-3 km; thickness 40-80 m) and big thickness of volcanic ash horizons (3m at some places). In general, the volcanic exclusivity index (VEI) of this volcano is very large, about 6 [5].

Along the Mtkvari river canyon, in the lower part of the Goderdzi formation outcrops powerful volcanic pyroclastic flow, following from the Nialla Valley till the Khertvisi castle (length is about 25 km), which is described in the literature as a Vardzia horizon [3]. It should be noted, that the 12^{th} century unique cave city of Vardzia, the most important monuments of the Georgian cultural heritage, was incaved in this volcanic flow (Fig.1).

Fig. 1. Panoramic view of the Erusheti ridge. In white color – volcanic pyroclastic flow of andesitic-dacitic composition. At the top of the flow–an upper part of the Goderdzi formation. In right – the Vardzia cave city.

Vardzia pyroclastic flow is represented by the fine-grained, andesitic-dacitic slightly welded tuffs. It is well observed in relief because of its whitish color. Its thickness in the Vardzia section is 40-80 m and is different in the northern and southern directions. It should be noted, that the flow/horizon outcropping mainly on the left benches of the Mtkvari river, while they are marked fragmentarily on the right ones. The question about the location of the magmatic centre giving the horizon of this pyroclastic flow is still debatable. It is considered, that it should be on the territory of Turkey [3].

Our field oriented detailed investigations, based on physical volcanology, allow us to conclude, that the magmatic center of the Goderzi formation was a huge volcano, which is located in Georgia and on the territory of Turkey also. One of the caldera structures of this megavolcano is located on Niala Valley (territory of Georgia) (15x 22 km, 2800-2200 m a.s.l.). Based on our field work, it should be the magmatic source for this Vardzia pyroclastic volcanic flow.

Niala Valley caldera is injected by post-volcanic andesitic extrusive domes and known as Gumbati mountains (2996 m a.s.l.). At present, the Niala Valley caldera is covered by quaternary sediments, bounded with andesitic lava flows and open to the eastern. In spite of the fact, that this areal undergoes erosion for about 7.5 million years, the identification of large caldera circle structures is still possible here.

In isotopic laboratory of the National Taiwan University, by us was dating the zircons age by U-Pb method, using LA-ICP–MS equipment, of this pyroclastic flow. The samples were taken from three main parts of the flow: in the end of the flow (at 35 km), near the Khertvisi castle (13GEO-04), in the central part of the flow (at 15 km) near the Vardzia cave city (13GEO-05) and at the beginning of the flow (at 2 km) near the Arzameti castle (13GEO-06). The results are as follows: 13GEO-04 = 7.50±0.42 Ma; 13GEO-05 = 7.54±0.21 Ma; 13GEO-06 = 7.52 ± 0.21 Ma. Thus, according to this dating, the Vardzia volcanic flow represents the late Miocene formation. The zircons U-Pb dating results of these three sections is almost the same, which indicates in very reliable data and fixing the time of origin of one volcanic flow.

Therefore, based on field, petrological and isotopic investigation we conclude, that the eruption centre (source) of the Vardzia pyroclastic flow was the first powerful eruption of the Niala megacaldera. The dating of the zircons by U-Pb method from this flow, show that this explosion happened about 7.5 Ma ago, in the Late Miocene epoch.

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NEW OPPORTUNITIES OF DIATOMITE FROM KISATIBI DEPOSIT

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The namediatomite originates from the phytoplankton group Diatomea, (in Greek it means “divided in half”, since this water plant is reproduced by dividing in half) which consists of the remains of shells of the Bacillariophyta species. It is called infusorial earth (fossil meal), kieselgur and “rock flour”. Diatomite represents a siliceous skin. It is valued not for its chemical composition, but for its physical properties. Diatomite is a very light, porous (often whole volume is 80%), has a low density (density 400-900 kg/m^3) skin. It consists mainly of opal (96%) and admixture of fragments and clayey (argillaceous) materials. It is mainly white, light gray or with yellowish tint (Fig. 1).

Fig. 1. Sea turtle petrified in diatomite skin

Diatomite has a very broad spectrum of application:

1. For thermo- and sound insulation;
2. filter for medical solutions, foodstuffs, fruit juices, beer, wine, mineral and vegetable oils;
3. light-weight aggregate for manufacture of dyestuff, rubber, paper, and plastic;

4. sorbent for purification of synthetic fibre manufacture and process water;
5. reagent for sulfate catalysts and chromatography;
6. for cement making.

Diatomite reserves are very large.Diatomite world output is rather unstable (Tab.1), but after the 2009 economic crisis, thereis a five-year period of output growth.

Tab.1

History of diatomite world output

Twenty-nine states worldwide extract diatomite. Five main countries are shown: United States 35.32 %, China 18.98, Peru 6.67, Denmark 5.21, Japan - 4.42

In southern subzone of the Achara-Trialeti folded zone, particulalry at the the Akhaltsikhe region, there is a well known Kisatibi diatomites deposit. It is in the village of Uraveli. It is associated with the Goderdzi Late Miocene- Early Pliocene volcanic or Goderdzi suite. Qualitative indicators of diatomite are high enough. Its quality is as good as that of diatomite from the world known diatomite deposits. There are 5 layers of diatomite in the productive formation, of which the lower, white one is the most qualitative. There are four kinds of diatomite represented at the deposit - striped, gray, light gray, and white. White kinds of diatomite are of higher quality. Its chemical composition in percentage terms is: SiO_2- 85.0-97; Al_2O_3 -0.9-6.16; Fe_2O_3- 0,36-3,19. Volume mass of the dried white diatomite is 0.56-0.63t/m^3, in case of natural humidity 1.18 t/m^3.

There are some more diatomite and tuff-diatomite manifestations along with the Kisatibi deposit in the Samtskhe-Javakheti region such as Chobareti, Irmis Rka, Khona (or Khvana) [2].

Diferent structures of amorphous diatomite were studied using the method of ammonium dissorption of natural and modified sorbents on acid centers of surface, as well as the methods of butylaminar titration anf spectrophotometric methods for their (acid centers) quantitave determination, rate of scattering and their type.

As a result of treatment of compounds of phosphorus and vanadium on the basis of diatomate inert liners have been got as well as sorbents capable to oxidize. Optimal conditions have been worked out for getting inert liners from diatomite with minimal quantity of iron compounds (0.02- 0.03%).

To get high quality filter powder for filtration of viscous liquids, a technological regime has been developed for making a domestic analogue and substitute of the American filter powder Celite -545- CD on the basis of diatomite of the Kisatibi deposit. The influence of grinding, thermochemical treatment, granulometric composition, chemical content of mineralizator, quality of phase transformation (quality of criystobalitization) on the speed of filtration has been ascertained. Diatomite filter powder has been got, analog and substitute of the American powder Celite -545- CD. [3]

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THE PROSPECTS OF SHALE-GAS FROM THE LOWER- AND MIDDLE JURASSIC TERRIGENOUS SHALE DEPOSITS OF THE KAZBEGI-OMALO REGION

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On the ground of microscopic, X-ray diffraction, X-ray fluorescent, chemical analyses and observations during field works there have been described and researched mineralogical, chemical and litholgic composition of quartz and arkosic sandstones (psammitic, psammitic-aleuric), aleurolites (aleuric, psammitic-aleuric) and clay shales (pelitic, aleuric-pelitic, aleuric-psammitic-pelitic) developed in the Lower- and Middle Jurassic terrigenous formations of the Folded System of the Caucasus; there were defined the conditions of their generation, types of rocks, the essence and quantity of the constituent mineral phases. Organic carbon content has been determined in certain quantity of clay shales.

From the viewpoint of shale gas generation and content, prospective ones may be clay shales of various ages and composition though sandstones and aleuolites are of definite importance too. So called black shale (carbon-bearing) formations are known almost on all continents and they are of various ages. They were formed in deep water (bathyal) sea basin and along the continents in the shelf (shallow water) seas and lagoons where the processes of biogenic sedimentation were clearly observed.

The sedimentary formations of various ages and composition, considered to be promising in terms of shale-gas content, are highly developed in various tectonic units of Georgia and comprise quite a vast area. Taking into **co**nsideration a number of significant data (maximal vertical thickness of shales, comparatively high proportion of rocks with the acceptable level of metamorphism and the total organic component, vitrinite reflectance) at this stage of researches we have chosen formations occurring in the Kazbegi-Omalo Region of the Folded System of the Caucasus where the deposits of the Lower- and Middle Jurassic terrigenous formations with dissimilar splitting are generally represented by shales (70-80%); aleuolites and sandstones (plagioclase-quartz-bearing and arkosic) occur in a subordinate amount and they are characterized by similar lithologic-petrographic and geochemical properties within the boundaries of the Folded System of the Caucasus [1, 2]. Various amount of organic carbon content in the Lower- and Middle Jurassic terrigenous formations defines their dark to blackish colors.

According to granulometric composition and data of petrographic researches shales and slates are divided into the following groups: politic - without the admixture of aleuric material, aleuric and sandstone-aleuric. Sandstones are developed in the Middle- and, especially, in the Upper Lias and in the Dogger as well throughout the Kazbegi-Lagoodekhi zone; aleuolites are less developed in comparison with sandstones and shales. Although they occur in the Early Liassic part of the section still they are more widely developed in the Middle- and Upper Lias and in the Dogger.

The complex laboratory researches of the rocks show that rocks of the terrigenous shale formation have undergone the process of catagenesis. With increasing depth, their conversion intensity increases and soemetimes the level of catagenesis takes on elements of metagenesis, accordingly the degree of recrystallization of clay minerals in the section increases from the top to bottom. In Bajocian and Upper Liassic clay shales argillaceous material is fine aggregate, pelitomorphic, feebly reacts with polarization light. In Lower Aalenian-Sinemurian shales it is recrystallized into fine-flaked mass; it is oriented perpendicularly towards the pressure stress and behaves like a monocrystal; in certain striae hydromica and chlorite are in segregation with organic material. More profound catagenetic conversions are revealed in formation of fine-flaked sericite (convertinh into muscovite), light color chlorite generation and aggregate quartz segregation. Mineral paragenesis of clay shales indicates the zones of caragenesis and metagenesis.

In deposits of terrigenous formation organic material – C_{org} (organic carbon) is presented by the scattered microinclusions in various amounts. Carbon content in the rocks are conditioned by their lithologic- granulometric composition and the degree of metamorphism. Pelitic rocks–shales - are characterized by highest carbon content while aleurolites and sandstones are considerably poorer in carbon content [3].

Based on the analysis of the results of complex laboratory tests(tectonic conditions, chemical and mineralogical composition of rocks, mineral paragenesis, organic carbon content level of catagenesis and vitrinite reflectance, environmental factor) of samples collected from natural exposures and described during our geological field-works throughout the area of the Kazbegi-Omalo Region (gorges of the rivers Tergi and its tributaries, Asa, Arguni, Pirikita Alazani, Stori, etc.) and considering the experience gained recently within the sphere of shale gas in America and Europe we managed to distinguish prospective local districts according to shale gas content taking into account the environmental and safety requirements. In case of proving the productivity of even a small part of shales Georgia will be considered among the countries rich in shale gas.

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ON THE BEHAVIOR OF GOLD ORE FORMATION PROCESSES ON LUKHUMI ARSENIC DEPOSIT

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Gold ore formation processes were studied by statistical processing of geochemical information, in multi-dimensional space of features. Spectral analyses of samples were performed in CMRI and Moscow “IMGRE” laboratories. Gold content was determined in spectral laboratory of CMRI. The results were processed by “ЭВМЕС1033” type computer. I. Bakhtadze provided consulting and support in software.

Geochemical massif was characterized by 26 informational elements: Li, Sc, Ti, V, Cr, Mn, Co, Ni, Cu, Zn, Ga, As, Sr, Y, Zr, Nb, Mo, Ag, Sn, Sb, Ba, W, Hg, Pb, Bi, Au. Geochemical selection, cleared of anomalous content, was clusterized on the basis of criterion of resemblanceto angle cosine. As a result, two groups of clusters, differentiated into classes, were pointed out: A and B. Representational connection was not established between them. Demdrogram and concentration indicators of the elements, unified in the classes, calculated against their average content in the calculated selection, are provided on Fig. 1.

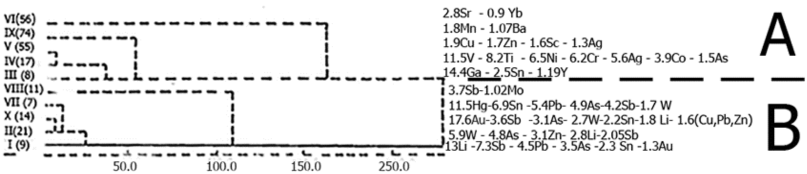

Fig. 1. Class numbers are denoted by Roman numbers, and the quantity of samples in the class – by Arabic numbers. Element concentration indicators are in the right side.

Content-wise, the results of cluster analysis was in full compliance with the schemes of performed exploration:

A group unified the samples, collected from the rocks of turbid facies, forming ore-bearing field: finely cleavaged carbonic clayshales and lime types, sequential with them. Leading classes are represented by combinations of lithophylous elements.

B group unified the results of exploration of mineralized areas: areas of spreading of arsenic (realgar-auripigment) massive bodies (VII class) and vein mineralization (X,VIII,II,I classes). Arsenopyrite- sheelite- antimonite ores (X class), enriched with gold and their zahlbands, enriched with lithium chlorites (I class).

Gold reveals inclination towards concentration in arsenopyrites. Its representational correlational connection with antimonite was not identified (on Lukhumi pre, function of arsenopyrite, as fold "host" mineral, was confirmed by researches, performed under microprobe [1]).

Sediment genesis of black shale series, in general, is characterized by correlational connection of gold and silver. Accumulation of silverabove background was noted in A lithophilic group, class IV and V. The data of the above-mentioned classes were unified in separate geochemical selection. On the basis of criterion of resemblance with it, 7 classes were pointed out as a result of cluster analysis. Accumulation of gold in two classes was as follows:

I class (4 samples): 13.9As- 4.5Cr -3.7Ti- 3.7V- 3.16Au- 2.7Ni- 1.7Ga

V class (36 samples): 1.9Au- 1.9V – 1.7Li- 1.6Ni- 1.6 Ti – 1.5Ag- 1 5Cr – 1.5Zn- 1.4- Cu.

Samples, collected in these classes, were taken from finely cleavaged clay shale series with pyrite and pin-shaped arsenopyrite impregnations, pyrite micro-concretions, limited with globular or chain-shaped quartz. This group of minerals, in black shale sedimentation basins, emerges on the stage of diagenesis. In the process of element distribution in pelite silts, in iron sulphides, in parallel with siderophilic and calcophilic elements, accumulation of gold and silver occurs [2].

Deposits on Lukhumi ore are represented by two main morphological types: massive bodies and vein mineralization. Massive depositformation of realgar- auripigment is subject to lithological control. It develops on the borders of finely cleavaged carbonic clayshales and limes. Elements of lying of bodies coincide with the bearing rocks. According to our observations, these are stratiform bodies, which should be formed on the stage of catagenesis. Lithological differences represented geo-chemical barrier, where arsenic minerals were accumulated from upgoing fluids, blown out from rocks.

Vein deposit-forming processes, which were discretely identified in time [3], are related to further stages of geological development of the region (folding, dynamometamorphism). They are developed in the zones of extensive tectonic tension and controlled by this factor.

Poly-component and poly-cyclic nature of deposit forming processes of the ore was confirmed by trend analysis. Differences of distribution of deposit-bearing elements were identified. Prognostic directions of concentrationof deposits, connected with hypsometricallylow-lying (bottom) horizons (Fig. 2).

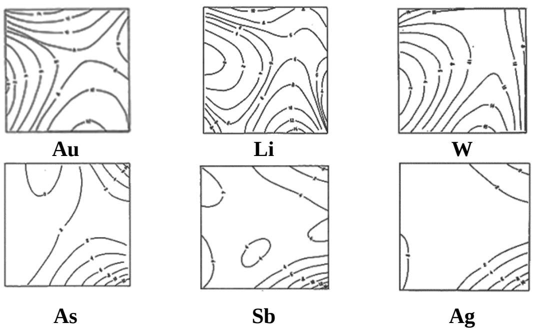

Fig. 2 – Fifth grade trends of ore-formation elements of Lukhumi ore

Geochemical researches, based on multi-dimensional analysis, revealed two generations of gold in Luckhumi ore. 1. Insignificant from quantitative viewpoint, “gold-silver”, genesis of which is conditioned by diagenetic processes. II. Projected, “gold-rare metal”, associated with vein mineralization. Gold concentration proceeded in arsenopyrites.

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MAGMATIZM AND ORE FORMATION IN THE BOLNISI ORE FIELD ON THE EXAMPLE OF BERTAKARI AND BNELI KHEVI DEPOSITS

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Based on the examples of the world's well-known deposits there is a clear evidence of the link between the mineralization and phreatic, phreatomagmatic and hydrothermal breccias associated with hydrothermal, epigenetic systems in magmatic formations. Such breccia types serve as the major pathways for hydrothermal fluids and therefore are one of the best prospecting criteria in useful minerals exploration.

The Bolnisi ore field is located within the Artvin-Bolnisi unit of the Loki-Garabagh zone (the northwest part of the Lesser Caucasus). The common consent of the researchers exists about the genetic link of the Bolnisi ore field gold-polymetallic ore-forming processes with the late Cretaceous suprasubduction magmatism. The latter is related to the north-dipping subduction zone of the Lesser Caucasus which conditioned island-arc type intrusive and effusive volcanic activity and mineralization of the late Cretaceous Tethys and its northern active margin. The Bertakari and Bneli-Khevi deposits are the parts of this island-arc [1].

Upper Cretaceous volcanic and volcano-sedimentary formations of the Bolnisi ore field are mainly represented by subaqueous dacite - rhyolite lavas, volcaniclastics and extrusives. Mafic to intermediate volcanic rocks are in subordinate amount. The rocks in places are intensively altered.

Within the Bolnisi ore field,Bertakari and BneliKhevi deposits hostrocks and spatial distribution of associated mineralization has been studied. The outcrops and drill cores visual observations as well as thin section microscopy has revealed the link of the mineralization to various types of breccias within Bertakari and BneliKhevi. Complete picture of the hydrothermal breccia evolution starts from the incipient fracturing of the rocks already influenced by diagenesis, is followed byfurther development of fracture network, fragmentation and disintegration of hostrocks into various sized clasts and finishes with generation of fluidal texture infill. Obtained data is well – correlated with the classification schemes of epigenetic – hydrothermal breccias defined in magmatic formations [e.g. 4,5].

Breccias are genetically related to phreatic/phreatomagmatic eruptions and diatrems. It is noteworthy the recognition of hydrothermal breccias with jigsaw-fit clast textures (Fig. 1A, B) and pseudobreccias (Fig. 1C, D) in the mentioned above deposits. Pseudobreccias are resulted from diffusive/selective alteration of intrusive, subvolcanic or volcaniclastic rocks. Development of jigsaw-fit clast textures in breccias is induced by hydraulic brecciation [2, 3].

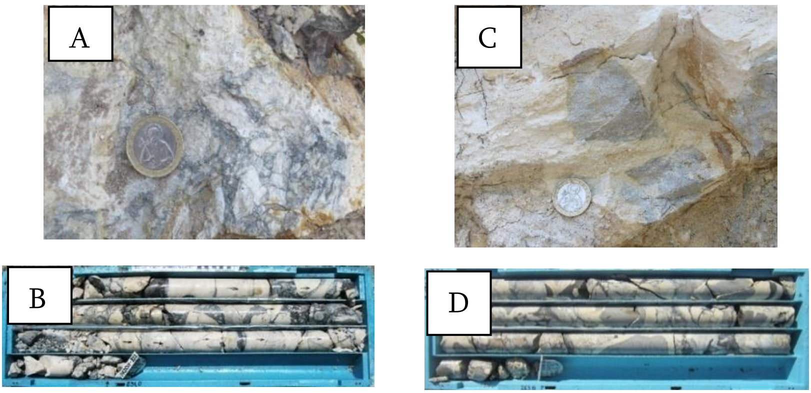

Fig. 1. A – BneliKhevi outcrop, hydrothermal breccias; B – Bneli Khevi, outcrop, pseudobreccia;C – Bertakari, KldovaniUbani, core image BK 822, 228 – 231 m. D - Bertakari, Kldovani Ubani, pseudobreccia, core image BK 875, 260 – 263m.

The existence of epigenetic hydrothermal breccias bodies is the common feature of many geodynamic setting types, especially of island-arcs and is the substantial part of the long-lasting history of magmatic-hydrothermal activity.

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USE OF WASTES OF BACTERIAL LEACHING OF TRACHYTE IN PRODUCTION OF CEMENT IN THE FORM OF ADDITIVE LIKE „MICROSILICA“

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It is known that “Microsilica” has high pozzolanic properties. His additive promotes formation of a matrix of cement with a high density. It gives the chance to increase the speed of hydration of clicker minerals and to receive the low-basehydrosilicates of calcium with high stability and durability [1, 2].

In the Caucasian A. Tvalchrelidze Institute of Mineral Resources according to the program of the of Shota Rustaveli National Science Foundation Grant №FR/431/9-220/14, the technology of bacterial leaching of trachyte has been developed [3], owing to which under the influence of special bacteria - Bacillus mucilaginosus from a crystal matrix of trachyte in solution is allocated water-soluble connection – a potassium oxide, which is applied to production of agricultural fertilizer. After extraction of potassium oxide from solution in the form of waste there is an incrustation and high-silicic gelatinous paste which on structure and contents is close to “Microsilica”.

Proceeding from the above, the idea of application of high-silicic gelatinous waste (HSGW) in the form of pozzolanic additive for cement has appeared.

In fig. 1. X-ray pictures of the raw trachyte and HSGW are submitted. At test of raw trachyte there is a mineral microcline – potassium feldspar ($KAlSi_3O_8$) – 6.56, 4.23, 3.34, 3.243, 3.003, 2.908, 2.580, 2.162, 1.795 Å.

After bacterial leaching height of peaks of a microcline has gone down that is caused by partial leaching of SiO_2 in solution and its partial transition to an amorphous state. About presence of an amorphous phase the convex form of the X-ray pictures specifies.

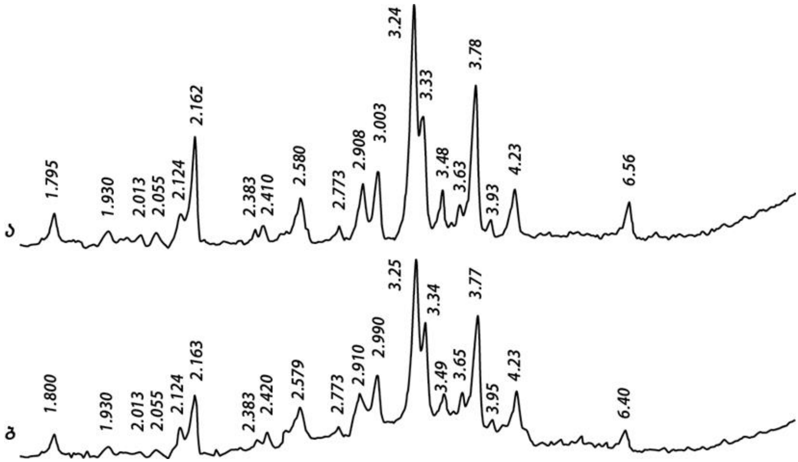

Fig. 1. X-ray pictures:a – raw trachyte, b - HSGW

The amount of SiO_2 in gelatinous paste makes 86.25% by mass.

HSGW has been tested in the form of pozzolanic additive of cement in number of 6% and 10% by mass. Results of testing of cements are given in Table 1 (No. 1 – cement without additive, No. 2 and No. 3 – with additive of 6% and 10% respectively).

Table 1

Results of the physical-mechanical testing of cements

No	No 008 sieveresidue, % by mass	Normal cement paste density, % by mass	Time of setting, h.-min.		Compressive strength, kg/cm^2		
			Initial	Final	7 days	28 days	180 days
1	3.5	33	1-20	2-55	377	633	960
2	3.5	34	1-30	3-05	392	685	1200
3	3.5	35	1-40	3-20	390	687	1180

By results of physical-mechanicaltesting of cements (Table 1) the mechanical durability of cements with HSGW additive has increased both in early terms and in late terms of curing.

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GEORGIAN MINERAL RESOURCES AS THE COUNTRY'S ECONOMIC GROWTH AND TO IMPROVE THE COMPETETNIVESS FACTOR

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1. Mineral resources represents important potential of the Industrial-economic and national wealth, which provides the country economic and defensive safety factor, for effective utilization of which it is necessary more innovation activity.
2. It is known that the mining industry is very capital intensive and labor-consuming, whichat modern period has a low level of innovative activity because of low level of production technology and scientific-technological progress. Obviously, all of these has influence on the product quality, its competiti veness and production efficiency. However, some of its sub-fields has a desired level of innovation activity. These include copper, manganese, gold and coal industry, because on their products are more or less demand on both the internal and external markets. In addition, there are legal and organizational problems in the sphere of intellectual property protection and the transfer, licensing and certification, in the part of investment mechanisms of innovative activity and so on. In Georgia is insufficient and incomplete created and developed some innovative infrastructure, which provides special conditions for news, namely: risk insurance, venture capital funds, leasing companies, which is a necessary condition, without which it is impossible to provide enterprises with innovative activities to significantly improve.Together with big companies and associations great importance has small enterprises. In developed countries they provide about

half of a whole novelty realization and small firms introduce innovations much faster than large organizations. It should be noted, that in 2016 was registered in Georgia 1 342 mining enterprise, among of them only 648 were active enterprises, most of which were small and their innovative activity is not enough.The small business has a limited finances, and because of this they can't invest significant funds in new equipment and technology, marketing, expansion productivity and so forth. Despite of abovementioned and other obstacles, Georgia owns a variety of precious and ample mineral resources, keeps some high scientific, technical and entrepreneurs potential, a qualified scientific and engineering staff, which is foundation to overcome the difficulties in the field and significantly increase the competitiveness on the base of the new production.

3. The effective utilization and development of mineral resources and mining industry at a higher level, imply to solve a number of issues and fulfillment such conditions, as:
    - technical ne-equipment, introduction and use of more modern, comprehensive, productive, powerful and of the same time, mobile device.
    - New efficient technologies in mineral extraction and their processing;
    - Mining personal training - the performance of which must be with a close relationship between science and production. For the effective utilization of mineral resources and increasing productivity in this section it is important to enhance innovative activities with the creation of corresponding infrastructure – industrial parks/clusters, business incubators, innovation centers, leasing companies, consulting and engineering enterprises and so on.
4. In condition of modern globalization the determining criteria for sustainable development is not only the rate of economic growth, but also the rate of balanced development of fields,

where on the base of the mineral resource is to foresee as a result of innovative activities development the emergence of new areas of industry, which produces innovative products and provides the labor productivity and value-added growth.

5. It is known that the international labor division forms the technological specialization, which allows each country to use its economic potential in the favorable direction, ensure the realization of his advantage, win in a difficult competition and reach to economic efficiency, it is important to determine strategic directions of innovative development and creation of the mechanisms and its implementation in mineral resources extraction and processing with implementation of high technological, legal, organizational economical managerial forms, which will be the base for new, competitive products.

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COMPARATIVE LITHOLOGY OF LOWER CRETACEOUS FLYSCH OF GEORGIA AND AZERBAIJAN

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At the current level of geological science detailed lithological study of flysch sediments widespread in geological formations of the Earth's mobile belt and in many modern geotectonic structures (epicontinental seas, deep sea depressions, mid-oceanic ridges and so on) is rather argent.

As a result of detailed lithological investigations of Early Cretaceous flysch formation of the Greater Caucasus marginal sea Eastern basin that is of geotectonic megastructure – Chiaur -Dibrari synclinorium ("Eastern flysch basin") we have established mineralogical-petrographic character of the rocks, textures characteristic of flysch sediments, structures, indicators of geochemical environment of sedimentation and hydrodynamics. In the above-mentioned megastructure lithofacies character, their vertical and lateral distribution is specified; evolution and lithogenesis of flysch sedimentation of the Greater Caucasus marginal sea Eastern basin in the Early Cretaceous age is interpreted in detail; paleogeographic situation of that time in the region is reconstructed.

Comparison of research data concerning the Lower Cretaceous flysch complex of Georgia with the synchronous data of Azerbaijan confirms that the Chiaur-Dibrari synclinorium (Eastern flysch basin of the Greater Caucasus marginal sea) began from Upper Svaneti and was traces to the termination of the South-Eastern Caucasus (to the Caspian sea on the territory of Azerbaijan).

Lithofacies schematic maps of the territory of Georgia that we have produced for separate sedimentation ages of the

Late Cretaceous time and the established regularities of sediment accumulation environment in time and space indicate that in the region under study in the sedimentary basin subsidence of the floor compensated with sediment accumulation as well as its uplifting (formation of geanticlines that at the same time underwent outwash) took place in the Lower Cretaceous [1].

It is known that the establishment of the zones of stable subsidence and consedimentary uplifting has a practical meaning for revealing zones of oil-and-gas formation and accumulation. In the Late Cretaceous subsidence and uplift zones in the Eastern basin of the Greater Caucasus marginal sea ("Eastern flysch basin") almost all the conditions (alternation of sandstones and argillites, fracturing, porosity, lithological lapouts, presence of organic residues and so on) important for oil-and-gas formation and accumulation existed. In synchronous sediments of Azerbaijan the zones of oil-and-gas formation and accumulation and the potential areas for its prospecting are already established. The comparison of above-mentioned sediments with those of Azerbaijan gives possibility for revealing not only oil-and-gas bearing areas but also the areas of mineral resources associated with flysch sedimentation basins on the territory of Georgia.

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THE METHODOLOGY OF THE RENEWED MONITORING OF FRESH GROUNDWATER IN GEORGIA BASED ON THE EXAMPLE OF A WELL IN THE VILLAGE OF VACHNADZIANI

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The monitoring of fresh groundwater in Georgia was renewed in 2013 [1]. Based on the fact that the renewed hydrogeological monitoring makes it possible to obtain information on quantitative and qualitative characteristics of fresh groundwater on a continuous basis, and based on the research results it is possible to estimate the physical-chemical characteristics of groundwater of the country and to estimate the volume of resources, this issue is a matter of national importance.

One of the wells included in the network of renewed state hydrogeological monitoring is located in village Vachnadziani, Gurjaani municipality, Kakheti region. In the work, using the example of this well, the methodology of the renewed hydrogeological monitoring study and the results obtained for the indicated period are presented.

Using the equipment installed in the well, the water discharge and water temperature are controlled in a continuous online mode. In addition, twice a year (in June and December), the staff of the Department of Geology and the Department for Environmental Pollution Monitoring of the National Environmental Agency, obtains water samples for chemical and bacterial laboratory analysis, which are conducted at the laboratory of atmospheric air, water and soil analysis of this Agency. In parallel with the analysis the following water characteristics are measured: Water conductivity, total mineralization, pH, temperature and water discharge.

Similar studies are conducted in all wells of the monitoring network [2]. Qualitative characteristics of water in cases of such changes, which can adversely affect human health, are reported to the local municipality.

Ultimately, a database on quantitative and qualitative characteristics of fresh groundwater of Georgia is being expanded based on information received online from water points, fieldwork results, laboratory analyzes (chemical and bacteriological), processing of collected actual materials, analysis and synthesis.

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THE HYDRAULIC SYSTEM BETWEEN THE NATAKHTARI AND MUKHRANI WATER INTAKE AT VARIOUS EXPLOITATION REGIME

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The purpose of this experiment was to identify the hydraulic system between the quantitative indicators of underground pressure waters developed within the Mukhrani water intake and the groundwater of the Natakhtari.

As we know, the Natakhtari water intake, in addition to the filtrates that are filtered here at Aragvi and natural outcrops of the descending sources, water is also supplied from the wells of the Mukhrani water intake, which are operating in pumping mode with high capacity (about 4500 - 5000 m^3 / day) [1, 2].

Two counters were installed separately on the Natakhtari water intake. One meter measures the flow coming from the siphon wells of the Natakhtari water intake. The second meter is designed to measure the amount of water flowing from the wells of the Mukhran water intake. Each counter, in turn, consists of two counters - the upper and lower. This is because the water comes separately from the two conduits. For the reading of the meter, there are two slots. The upper gap (the so-called "instantaneous reference") measures the flow rate in m3 /hr-ah, and the lower one - in megaliter [3, 4].

Before the experiment (11:00, August 7), i.e. Before the inclusion in the network of all 35 wells of the Mukhrani water intake, that is water from the 20 wells Mukhrani already entered the Natakhtari water intake. The description of the experiment should be clearly divided into two periods:

- the first one - from 11:00 on August 7, to 11^{00} hours on August 11, when observations were made under full load conditions of the Mukhrani water intake (35 wells were included);
- the second one - from 11:00 hours on August 11 to 11^{00} hours on August 14, when observations were made after the shutdown of 24 wells of the Mukhrani water intake, so that 11 wells remained on.

However, the above two periods of observations of duration do not coincide. In fact, the first period the number of measurements is 9, and in the second period - 6. Therefore, the first three measurements of the first period - Thursday 11:00 and 19:00, as well as Friday 11:00 in the discussion of the results do not appear. Accordingly, under these conditions, we have 6 measurements in each period, (64 hours in total), which is convenient for comparing the results.

Below is a calculation of the water discharge recorded during the experiment at the Mukhrani and Natakhtari water intake meters.

On the Mukhrani line, the readings of both meters on the measurements taken at 19 o'clock on August 8 (35 wells included) amounted to 40286.42 megaliter of water, the same meters (megalither) readings from 11 am on August 11 (35 wells included) is 40591.33.

Therefore, during the period from 19:00 hours, August 8 to 1100 hours, on August 11, while working 35 wells, 304.91 megaliter of water flowed through the Mukhrani line.

On the Mukhrani line, 24 wells were cut off and 11 wells were left in operation, the readings of both meters (megaliters) from the measurements made at 19:00 hours on August 11 are equal to 40611.41, and the same meters (megaliters) from the measurements made at 11:00 hours , On August 14 (11 wells are included) 40708.77.

Consequently, during the period from 19:00 hours, on August 11 to 11:00 hours, on August 14, while operating 11 wells, 97.36 megaliters of water passed through the Mukhrani line.

On the Natakhtari line for the time from 19:00 hours, August 8 to 11:00 hours, on August 11, for 64 hours, with 35 wells working, the difference in indications was 214.14 megalitres of water, and 11 wells, for the same period The difference in the Natakhtaro line increased to 221.31 megalitres of water, i.e. The excess is equal to 221.31-214.14 = 7.17 megaliters

Let's set the goal to determine how much would be the excess, if not turned off 24, and all 35 wells?From a simple calculation it follows that $x = \frac{35 \times 7.17}{24} = 10.5$ megaliters

Consequently, each well included for 64 hours at the Muhran water intake reduces the reading on the Natakhtar $\frac{10.5}{35} = 0.3$ megaliters

In other words, each well included within 64 hours at the Mukhran water intake well "takes away" 0.3 megaliters of water from the Natakhtar water intake, in which the quantitative influence of the Mukhran subartisian wells working in a pumping mode with a large production rate on the water discharge at the Natakhtar water intake is expressed.

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Published as represented by the authors

Given for production 23.05.2017. Signed for printing 24.05.2017. Size of paper 60X84 1/16. Approximately 8,5 pr.sh. Circulation 170 psc.

Publishing House “Technical University”, Tbilisi, Kostava 77

Verba volant,
scripta manent