MINERALOGICAL SOCIETY
OF GEORGIA

GEORGIAN TECHNICAL
UNIVERSITY

POWER OF GEOLOGY IS THE PRECONDITION FOR REGENERATION OF ECONOMICS

BOOK OF ABSTRACTS

5th International Scientific-Practical Conference
on Up-to-date Problems of Geology

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„Technical University“

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Tbilisi
2019

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GEODYNAMICS AND SEISMICITY OF THE LITHOSPHERE OF THE BLACK SEA – CASPIAN SEA REGION

SH. ADAMIA, V. ALANIA, A. CHABUKIANI, O. ENUKIDZE, A. GVENTSADZE, N. LURSMANASHVILI AND N. SADRADZE
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The structure and geological evolution of the lithosphere of the Black Sea-Caspian Sea region are largely determined by its position between the still converging Eurasian, Indian and Africa-Arabian lithospheric plates, within a wide zone of continent-continent collision.The region sited at the central part of the collisional zone represents a collage of lithosphere fragments of oceanic Tethys and its northern and southern continental margins. Within the region, there existed system**s** of oceanic island arc, intra-arc and back-arc units. Several events of subduction and obduction of oceanic crust, lateral displacement of lithosphere fragments took place during the Neo-Proterozoic - Cenozoic. Final closing of the oceanic and back-arc basins, continent-continent collision, topographic inversion and formation of the present-day structure of the region was accomplished in the Late Cenozoic.

The Black Sea – Caspian sea region is an earthquake-prone region where devastating earthquakes have repeatedly caused significant loss lives and damage to infrastructure and buildings. Studies related to the seismicity of the region and adjacent areas started long ago. In recent years, these investtigations have been widened. Significant achievements in this field are connected with realization of several international projects; the authors of theseprojects have participated in some of them, in particular: Caucasian Seismic Information Network (CauSIN), Earthquake Model of the Middle East (EMME), International Research Group (IRG) etc. Some results of these projects have been published [1].

The Earthquake Model of the lithosphere of the Middle East is a regional project of the GEM (Global Earthquake Model). The Middle East region is tectonically and seismically very active part of the Alpine-Himalayan orogenic belt. The active tectonics of the region considered in EMME project is determined by the northward motion of the African, Arabian and the Indian plates towards the Eurasian plate. The intense tectonic deformations along the Caucasus region are also a result of the continental collision and the continuing continental convergence.

In the region, earthquake hypocenters usually are located in the upper crust (c. 5-35km). However, seismological data from the southern and middle Caspian Basin and easternmost Caucasus - pre-Caucasus reveal a deep-seated zone of stress and strain, a zone of the lower crust-upper mantle earthquake sources that dips beneath the eastern Caucasus. The most likely explanation for the subcrustal earthquakes of the easternmost Caucasus-Caspian Sea region appears interference of lithospheric folding in the region by simultaneous indentation of the Africa-Arabian and Indian plates. Submeridional trough of the Caspian Sea lithosphere (first pop-up) may be a structure located at the borderland between the Arabian and Indian plates resulted from the interference of lithospheric folding. Therefore, S-N compression of the lithosphere of the Caucasus resulted in the formation of sublatitudinal fold-and-thrust mountain belts, while submeridional trough was due to simultaneous lateral push out of the lithosphere of the Caucasus and central Asia towards the Caspian Sea [2,3] causing formation of complex knot of intersecting seismogenic structures [4].

Submeridional compression of the Caucasian lithosphere caused by Arabia-Eurasia convergence reaches its maximum within the central segment of the Caucasus, along a line running through the central part of the Transcaucasus. This line actually represents the watershed between the basins of the Black Sea and southern Caspian Sea. Westward of this line, compression is replaced by tension caused by the W-SW escape of central Anatolia, where the territory of the Black Sea is experiencing weak submeridional compression (Fig.1). Apparently, the same conditions also exist eastward of the line of maximal compression in the territory of the Kura foreland and Talysh in southeastern Caucasus.

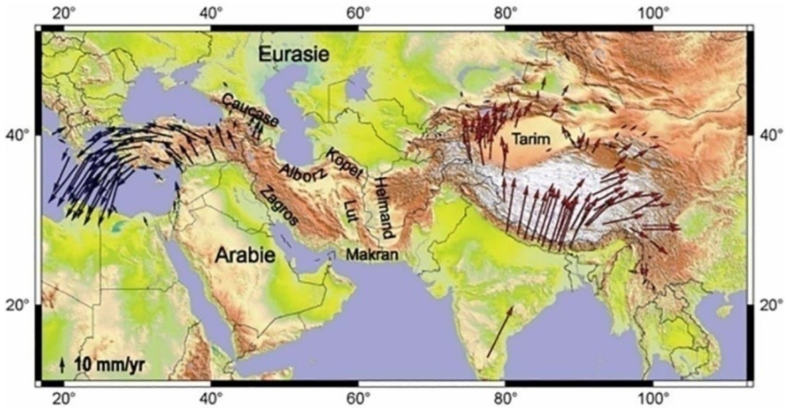

Fig. 1. GPS horizontal velocities (in Eurasia-fixed reference frame) for the eastern Alpine-Himalayan belt [5].

The Trancaucasian forelands are an active thin-skinned fold-and-thrust belt. On a regional cross section, this belt consists of upper and lower structural complexes. The upper structural complex includes south-vergent fault-related folds (fault propagation and fault-bend folds) and is made up of Cretaceous–Tertiary strata. The lower structural complex is represented by duplexes containing Middle–Upper Jurassic strata.

But the Caucasus region is subject not only to S-N but also to E-W compression, since it is directly adjacent to the eastern Black Sea on the west and the Caspian Sea on the east, both have suboceanic high-density crust that hampers lateral tectonic escape of the western and eastern Caucasus, respecttively. Therefore, the surrounding compression caused the formation of piggyback basins in western Georgia. Westward escape of the western Georgia did not occur either, because of the backstop provided by the stable crust of the eastern Black Sea Basin, so such compression led to formation of the seismoactive structure represented by the chain of Gali, Zugdidi, Khobi, Eki, and Abedati anticlines that fully delineates the Odishi piggyback basin [1].

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APPLYING GEOLOGICAL APPROACHES FOR SEARCHING HISTORIC QUARRIES OF CULTURAL HERITAGE CONSTRUCTION ROCK MATERIAL ON THE EXAMPLE OF TISELI CHURCH (AKHALTSIKHE MUNICIPALITY)

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During last decades preservation and restoration of various monuments of cultural heritage have been swiftly gaining actuality in the country. Building rocks and quarries in historic perspective, though, are rather less studied in the specific context of mining and mined resources.

As Georgian historic sources seldom mention where abouts of the quarries used for obtaining such construction material, geologic analysis of rock blocks of cultural heritage monuments is essential not only for monument conservation purposes but also for tracking and locating outcrops of identical rocks (supposed historic quarries) where new material can be obtained for future restoration of these monuments.

Applied methodology consisted of:

1. Petrological analysis of of the monument of interest (identification of different rockmaterial used for construction; sampling of used rocks of each type per monument; visual inspection of specimen; optical analysis; XRF analysis);
2. Identification of supposed whereabouts of quarry areas on the existing geologic maps (sampling of rocks from outcrops; visual inspection of specimen; optical analysis; XRF analysis);
3. Comparison of the monument rock sample analysis results with those of the supposed quarry rocks.

The methodology was applied on Tiseli Church (XIV-XV C., Akhaltsikhe Municipality). In all seven different types of rocks were identified in the monument's structure, two of which (identified as porphyritic trachyandesite and inergranular basaltic trachydacite) represent principal building material, whereas other five only occur in fragments of the structure. Results of optical mineralogy inspection (Fig. 1-2) as well as XRF analysis of major oxides and trace elements were compared through visual inspection and igneous rock discrimination diagram (Diagram 1) testing respectively.

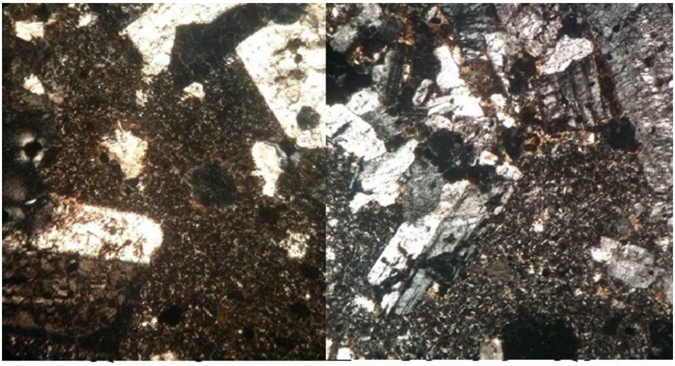

Fig. 1: Left - Tiseli porphyritic trachyandesite (XPL)
Right – Tabakhana exposure porphyritic trachyandesite (XPL)

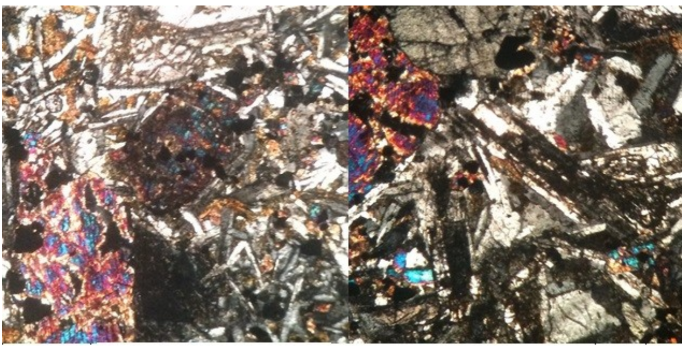

Fig. 2: Left - Tiseli intergranular basaltic trachyandesite (XPL)
Right – Columnar joiting outcrop intergranular basaltic trachyandesite (XPL)

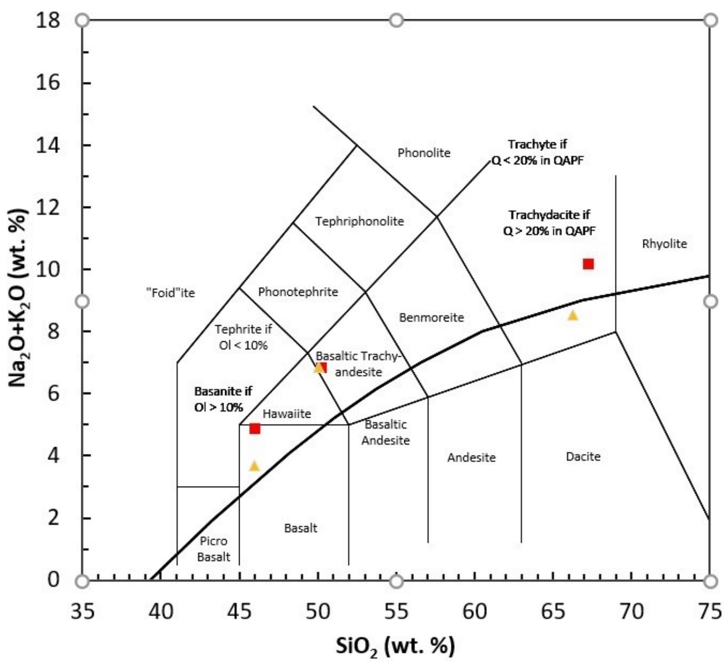

Diagram 1: Alkali-silica classification diagram(according to LeBas et al, 1986). (Right to left) red square – Tiseli church porphyritic trachyandesite; yellow triangle – Tabakhana outcrop porphyritic trachyandesite; red square – Tiseli church intergranular basaltic trachyandesite; yellow triangle – intergranular basaltic trachyandesite of columnar jointingoutcrop; red square – Teseli roof (fragmental) olivine trachybasalt (Hawaiite (Iddings, 1913); yellow triangle – talus boulder olivine trachybasalt.

Results of the analysis positively confirm identical characteristics of both of the vastly used construction material of Tiseli Church, to those of their supposed quarries, thus encouraging further application of geological approaches for determining sources for rock building material of cultural heritage monuments.

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THE LOWER -MIDDLE JURASSIC BASALTIC VOLCANISM OF THE KAZBEGI-LAGODEKHI ZONE OF THE CAUCASUS MAIN RANGE (BY THE EXAMPLE OF THE TRANSALAZANI KAKHETI REGION)

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The basaltic, andesite-basaltic magmatism in the shales series of the Lower-Middle Jurasic age at the southern slopes of the Greater Caucasus is widely presented in the form of dike and effusive facies. It is observed from the east - Transalazani Kakheti (part of the Kakheti region over the Alazani river) to the west including the Bzipi riverhead as a discontinuous strip.

The investigation of this complex started in the beginning of the last century with the study of diabases. D.S. Belyankin [1] within the Khevsureti area of the Central Caucasus distinguished diabases of albite-bearing (Kolotani river) and Labrador-bearing(Asariver)types.Later,the existence of the diabase dike complex in a series of shale is confirmed first in Kakheti, then in Racha, Svaneti and Abkhazia [2], i.e., in the entire strip of the Greater Caucasus southern slope shale series - as a diabase belt.

As a result of the later studies an actual material was accumulated according to which in the series of Caucasian shales, together with a diabase complex, some knots of basaltic effusive magnetism revealed in the upper reaches of the river Bzipi [2], Khevi - Khevsureti region [3] and in the territory of the Transalazani Kakheti [4].

The mentioned magmatic complex in the Lower-Middle Jurassic shale series is well expressed in the Kakheti region as a subvolcanic and effusive facies [4; 5]. Specifically, three stagesof the formation of effusive magmatism are established there: 1. The Sinemurian-Early Pliensbachian; 2. The Late Pliensbachian-Early Toarcian; 3. The Aalenian-Bajocian.

TheSinemurian-Early Pliensbachian volcanic complex is connected with the Stori suite. The outcrops of the series are recorded in the deep gorges of the rivers Stori, Didkhevi, Lopota, Matsimi, and on the slopeof Sperozi ridge.The total thicknesses in individual outcrops change within 15-150m interval. Volcanism starts with the quartz albitophyres and their clastolites, which, in ascending section pass into the andesite-basalts and their lava breccias, and have an antidromic character.

Late Pliensbachian-Early Toarcian basaltic volcanism is revealed in the Tsiklauri suite of pelitic composition and the Pankisi (Duruji) suite of flyschoid character. It is widespread in the region and mapped on the surface in the Kvachachala-Lamazuri, Stori, Shromiskhevi, Lagodekhiskhevi and Matsimi river basins. In Kabali-Ninoskhevi interfluve it is studied by bore holes.

The main outcrops of the volcanic complex in the extreme west are exposed on the Kvachadala-Lamazuri watershed ridge. Its thickness is almost 150 m, has a general Caucasian strike and is traced for about 3 km. It is represented by green and greenish-gray tuffites and orthotuffites, lava breccias, pillow- and massive (with uniform texture) lava sheets of basic composition that are found in the Tsiklauri suite only. The lava complex in the Stori basin is similar to the Kvachadala outcrops; the total thickness is about 500 m. It is exposed directly in the Stori riverbed and in the basins of its left and right tributaries. It extends over 3.5 km along strike. There is no magmatic complex to the east from the Stori river meridian to the Kabali river, while to the east from the Kabali river it is traced to the territory of Azerbaijan almost uninterruptedly. At the same time, volcanism in the Kvachadala and Stori areas is found only in the Late Pliensbachian Tsiklauri suite, while the magmatism is recorded in the Kabali-Matsimi interfluve even in the Early Toarcian flyschoid series.

As for the Late Aalenian- Early Bajocian volcanism, it is recorded only in the Almati series at the Shakriani ridge in the Kakheti region. A volcanic-sedimentary complex is mapped directly in the area of Shakriani Ridge (944.2 m). Its outcrops are observed on both northern and southern slopes of the ridge. The total thickness of the volcanogenic-sedimentary series is 120-130m.; it is presented by pillow- and massive texture 4 spilitic sheets traced over 3.7-4 km along strike.

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NEW DATA ABOUT KHACHKOVI PLACER GOLD

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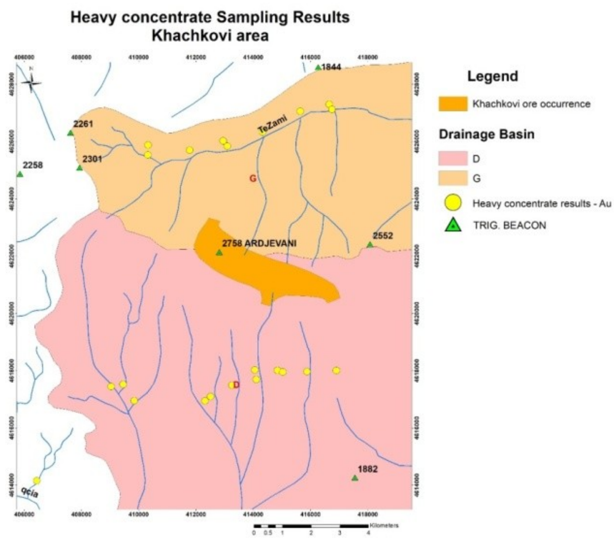
Khachkovi placer gold occurrence is located to the north from village Khachkovi. The placer has following parameters: length – 3500 m, width – 250 m, medium thickness of gold-bearing sediments – 2 m, composition – 400 mg/m^3, whereas standard – 850. According to M. Tskhelishvili [1], to the south from the village, which are covered by agricultural lands, thickness of gold-bearing placer – 1.5 m, gold composition – 300 mg/ m^3, whereas standard – 900%.

The slopes of Khahkovi gorge is built of Khachkovi suite coarse-grained blocks, clasts' sizes from 5 cm to 80 cm, redundant material is 30-40 cm sizes. The clasts are weakly cemented with fine-grained, 0.3-0.5 mm sizes material. Clastic material represented by andesites, diorites, hornblende porphyrites, diabase and basic tuffs, which are altered on different levels. Thickness of diluvium and clastic material sizes increases below, to the slope direction. Near the watershed its thickness 1.5-2.0 m, whereas down to the gorge and its slopes reaches 12 m. medium thickness of friable detrital deposits – 6-7 m. coarse-grained diluvium, which thickness is 30-40 m, changed with coarse-grained material in depth, which is often cemented with clay. Quartz enriched with silica, observed in the fine fraction, there are also pyrite small impregnations. Productive layer's thickness is approximately 3 m.

Character and features of gold mineralization is studied more detailed in the area located to the north from the village. During the time of numerous heavy concentrate sampling and mineralogical research of heavy material was established, that native gold is related to fine-grained sediments and it is quantitively more in the alluvial sediments, than in diluvial. It basically represented with proceed (60%), vein-lamellate (20%) and flattened (19%) shapes. Gold grains seldom represented with reduced crystals, where cubic and octahedral faces are badly preserved. Amount of well rounded gold is 1%, which means that gold source is near. This is confirmed by the fact, that there are gold-quartz twins in the diluvial sediments. Sizes of the grains are 0.1-1.1 mm, 0.2-0.3 mm sizes grains is redundant.

Heavy concentrate sampling in the river Khachkovi, Tedzami and their tributaries, conducted by us. Prospective areas were separated resulted in conducted works. On the base of received data, was made heavy concentrate sampling map of Khachkovi occurrence.

Resulted of the carried out works, Khachkovi placer gold mineralization contours were updated. We suppose, that our future planed works will confirm industrial status of Khachkovi occurrence.



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ECONOMIC POTENTIAL OF TSANA ARSENIC DEPOSIT RESIDUAL (LOWER SVANETI, CAUCASUS)

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At the present stage of development of the world economics and industrial development, the problem of environmental pollution by technogenic residual is becoming more acute. According to the modern researches, industrial residual per capita per year does not exceed 0.3-0.6 tons.

In total, hundreds of billions of tons of technogenic residual accumulated on the earth, causing irreversible ecological damage to the environment. Therefore, during the last decade, the modern world community intensively works on the mentioned problem and considers the safe residual recycling field as one of the top priorities..

Residuals do not represent natural mineral resources, but in spite of that due to composition of metals, they have quailtative and quantitative indicators characteristic of mineral resources and accordingly their accumulation is consider as technogenic mineral objects.

Current positive events in Georgia, widely reflected in the mineral resources exploration as well. The issue of processing small-scale mineral raw occurrences of different type becomes topical. Legislative decision gave stimulus to entrepreneurs to technogenic residuals recycling. Significant volume of residual, is alternative source of metallic raw material, because of their useful components.

Right such type of technogenic residual represents the arsenic residual located nearby Koruldashi.

Description of technogenic residual

The research object, arsenic factory residue technogenic accumulation, is located in the Lentekhi municipality nearby the village of Koruldashi.

Technogenic residual is characterized by small parameters of spreading, average dimensions (100-50-1.5m). The total area equals 0.54 hectares. It should be mentioned, that technogenic residual is weathered insignificantly and keeps its primary appearance because of surface morphology. developed In the territory of arsenic technogenic residual following mineralization groups have developed: quartz-arsenopyritic with gold and silver, quartz-tourmaline, wolfram, molybdenum and of arsenic composition, seldom antimonite-bearing, which have insignificant spread. Among the abovementioned mineralogical groups, the following main types of mineralization are distingueished: gold-quartz-arsenopyritic, gold-cassiterite-quartz-arsenopyritic and pyrrhotite-sphaleritic with gold and tin content. Among the listed mineralization types, quartz-arsenopyrite mineralization takes up 85-90% of all ores and it determines the useful components main mass spread on the technogenic residual.

Methods of Geological Research

In our case, arsenic factory residue technogenic screws presents commodity raw, with naturally exposed surface free of forest-shrubbery and grass cover. The works carried out by us, commonly had visual survey character. At the first stage of research, technogenic residual was sampled without making any mining work and sampling was accomplished subject to geological factors. When the scope of works is insignificant, the simplest and fastest methods of sampling gain actuality. In our case, at the first stage of research, relatively cheap and simple methods of sampling were used, namely, dotted and taking with oar. After visualization was decided, that sampling will be carried out in the edges and center of technogenic accumulation, using abovementioned methods. At the second stage of research, was prepare special net (8-5) and sampling was conducted through schnecke drilling.

As a resulted of the conducted works was established, that the arsenic residual nearby Koruldashi, represents a commercially interesting object in terms of gold.

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BIODIVERSITY OF THE SARMATIAN FORAMINIFERA AND OSTRACODA OF THE KARTLI DEPRESSION (ON THE EXAMPLE OF NADARBAZEVI SECTION)

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The main distribution area of the Sarmatian deposits in Georgia isthe Transcaucasian intermountain area. According to the tectonic zoning scheme of Georgia [1], Kartli depression participates in the structural-facial composition of the eastern subsidence molassic zone of the Transcaucasian intermountain area. The Sarmatian sediments widespread in this area are represented by the terrigenous deposits and are distinguished in facies diversity.

In Georgia as well as throughout the Eastern Paratethys, the Sarmatian deposits are divided into three regional sub-stages: Volhynian (lower), Bessarabian (middle) and Khersonian (upper).

In the Kartli depression, Lower Sarmatian deposits often conformably continue the Konkian deposits and are representted by the clay-sandstone facies, rarely with interlayers of microconglomerates. The exception is the eastern periphery of the Dzirula massif, where the Lower Sarmatian deposits with basal conglomerates at the base transgressively and discordantly overlie the Paleozoic, as well as the Mesozoic and Cenozoic deposits [2-3]. In ascending section the Lower Sarmatian is followed by the Middle Sarmatian, which like the Lower Sarmatian is represented by clays and sandstones comprising intercalations of limestones, marls and conglomerates [4]. In the Kartli depression the Upper Sarmatian is represented by freshwater sediments, continental clays and sandstones with intercalations of microconglomerates and conglomerates. These sediments are known as the so-called Natskhori suite [5].

The actual material for the research was collected by the authors in the Nadarbazevi section during the fieldworks in 2007-2008 and 2017-2018. The study of the collected rock samples enabled us to establish variety of Foraminifera and Ostracoda complexes in time and space. In the Lower Sarmatian deposits following complexes of foraminifers and ostracodes were distinguished: Foraminifera - *Nonion bogdanowiczi* Voloshinova, *Porosononion subgranosum subgranosum* (Egger), *Elphidium macellum* (Fichtel et Moll), *E. crispum* (Linné), *E. fichtelianum* (d'Orbigny), *E. reginum* (d'Orbigny), *E. hauerinum* (d'Orbigny), *Varidentella reussi* (Bogdanowicz); Ostracoda - *Aurila* aff. *angulatus* (Schneider), *A. sarmatica sarmatica* (Zalanyi), *A. levis* (Schneider), *Leptocythere* aff. *guttata* Suzin, *L. plana* (Schneider), *L. distincta* (Schneider), *Loxoconcha subcrassula* Suzin.

The Lower Sarmatian complex is less diversified; there prevail representatives of the genus *Elphidium,* especially abundant are species of *Elphidium macellum*and*E. crispum.*

Unlike the Lower Sarmatian, the Middle Sarmatian microfauna is more rich in species diversity and quantity. The complexes are represented by Foraminifera - *Porosononion subgranosum subgranosum* (Egger), *P.subgranosum umboelata* (Gerke), *P. martkobi* (Bogdanowicz), *P. hyalinum* (Bogdanowicz), *P. aragviensis* (O. Djanelidze), *Elphidiummaccellum* (Fichtel et Moll), *E. crispum* (Linné), *E. reginum* (d'Orbigny), *E. hauerinum* (d'Orbigny), *E. fichtelianum* (d'Orbigny), *Elphidiella artifex* (Serova), *Nonion bogdanowiczi* Voloshinova, *N.* aff. *tumidulus* Pischwanova, *Articularia articulinoides* Bogdanowicz, *Meandroloculina conicocameralis* Bogdanowicz and Ostracoda - *Aurilasarmatica sarmatica* (Zalanyi), *A.sarmatica serrata*

(Suzin), *A. levis* (Schneider), *A. kolesnikovi* (Schneider), *A. notata* (Reuss), *Leptocythere guttata* Suzin, *L. plana* (Schneider), *L. schweieri* Schneider, *L.* ex gr. *cellula* (Livental), *L. pseudoguttata* Suzin.

In the Middle Sarmatian species complex of the genera *Porosononion*, *Elphidium*and *Nonion* are dominant, though along with them miliolids are also abundant. Number of ostracodes is alsoincreased in the complex.

In the Early Sarmatian faunal complex of the Nadarbazevi section presence of euryhaline and eurythermal foraminifers and ostracodes and also morphological peculiarities of their shells (wall thickness, sculpture intensity) point out to the existence of shallow marine desalinated basin in this region. The Middle Sarmatian faunal complex is distinguished in large size fauna, species diversity and abundance. Blooming of fauna and their dimensions point to favorable biotic and abiotic environment - first of all to the abundance food, good aeration of the basin and warm climate.

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STRUCTURAL-SUBSTANCE ZONING IN BOLNISI ORE-BEARING REGION

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Bolnisi ore-bearing region is presented by lower and upper structural units. The lower structural unit is presented by the Pre-Jurassic basement with a mosaic-block structure. It was formed against the background of elevation of some blocks and subsidence of other blocks. The upper structural unit is presented by Mesozoic-Cenozoic, mostly Late Cretaceous thick (massive) formations.

During the Late Cretaceous Age, multiple intrusions of volcanic-plutonic masses occurred at different hypsometric levels. As a result, structures of various thicknesses and litho-facies composition were formed in different areas of the ore-bearing region. Late Cretaceous volcanites are characterized by a dominant distribution of pyroclastolites.

The upper parts of the fault structures in the ore-bearing region are presented as systems of branching (kinking) and joining of contraction and intense planetary fractures. Besides, at the lower hypsometric levels, mostly shear fractures are observed, while tensionalfractures are observed near the surface.

The structural position of endogenous ore deposits and ore manifestations at the upper structural unit was much determined by the north-eastern and perpendicular to it north-western faults. Ore localization took place in structural traps, in interlayer spaces, in the contact zones of the rocks with competent and screening physical-mechanical properties as well as in the areas of geochemical barriers.

As a result of tectonic-magmatic activity, the ore-bearing fluids, which were in the form of complex compounds, migrated through several deeply originated ore-pass and ore-distributing fault arteries in terms of acid media.

Ore localization was preceded by the formation of baseline synvolcanic regional propylite metasomatites, which are presented as a chlorite-hydromica-sericite-albite-quartz mineral association of different intensities, with dominating chlorite component. However, at the deep horizon of the ores, there are also epidote-(zoisite)-chlorite-albite-sericite-quartz metasomatites of the local propylite formation. In the propylitized rocks (tuffs) at the lower and ore-bearing levels of gold-sulphide ores 0.2-2cm thick gypsum veins of irregular shapes occur. At the lower levels of mineralization, there are brecciation, silicification and pyritization zones.

At the upper hypsometric levels of the ore deposits, argillizated and secondary quartzite (silicitic) ore-bearing metasomatites are formed. Argillizites are presented as a quartz-chlorite-hydromica-kaolin-montmorillonite (nontronite) mineral association. Quartzites present as monoquartzite, quartz-alunite, quartz-sericite, quartz-sericite-jarosite-pyrite, quartz-adular, quartz-hematite and quartz-hydromica-kaolin facies. The two latter quartzite facies, in respect of gold mineralization, are the external facies of metasomatites. Quartz metasomatism is developed both, on the tuffogenic rocks with rhyodacite content and on the sub-volcanic rhyolite rocks.

At the upper level of the gold-containing mineral zones, in the ore-bearing metasomatites, the geode excretions of the fine-crystal quartz are quite frequent. Sometimes, chalcedony-opal-like formations, and rarely carbonate (aragonite?, siderite) formations are grown over the geodes. The main mass of gold-containing quartzites is also latent-crystal- chalcedony-like. At the upper level where the ores are spread, zeolite (mordenite, clinoptilolite) extractions are also observed.

In addition to metasomatites, the distribution of the ore types is also different at different hypsometric levels in various blocks. At hypsometrically lower altitudes, there are signs of gold-copper-porphyric mineralization, while in the upper part, there is an ascending series of gold-copper-polymetallic, gold-polymetallic, gold-nonsulfide and barite ores. The given zoning takes different forms in different areas. In particular, the zones may overlap each other, or some zones may be missing, or they may be represented by one type of ore mineral only [1]. At some locations of the upper ore-bearing level, mercury mineralization is observed. At the upper zone of the gold-sulfide ore, there are also iron-manganese “calottes”.

The presented mineral associations indicate that the gold extraction from the residual fluids occurred in a pulsating manner, against the background of the concentration of the constituent components of the system, pressure, temperature and evolution from the acid (PH<5) to alkaline (PH=7–8) medium, for at least in two phases of the late stage of though a long, but single process of the formation. In the first phase, medium-temperature gold was extracted in association with sulfides, while in the second phase, a low-temperature gold was extracted what, among other things, was evidenced by the existence of gold in association with chalcedony, opal and others.

During the late ore-forming and post-ore processes, in the upper horizons of hydrothermal rocks, the circulation of surface waters takes place; as a result, the zones of oxidation with iron hydroxides and secondary sulfide minerals are developed.

The hydrothermal process ends with carbonization.

By considering the given structural-substance zoning, Beqtakari, Davit-Gareji, Mushevani 3, Bnelikhevi, Shikhilo-Samghereti, Kakliani, Darbazi and Kianeti-Potskhveriani deposits must be perspective in respect of development of gold and copper deposits at a great depth.

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TECHNOLOGY FOR PROCESSING OFWAREHOUSEDREMAINS OFMADNEULI ENRICHING FACTORY

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In the course of exploitation of Madneuli deposit the remains, stored in tailing dumps, may be assigned to anthropogenic raw material because of quite high content of non-ferrous and noble metals. Processing of the remains, stored in tailing dumps and extraction of rare, noble and non-ferrous metals will solve partially the problems of ecological contamination of the surrounding environment near the deposit. Rapid increase of the demand on rare and noble metals as well as of their prices at world market made profitable the elaboration of new technologies and enriching methods for processing of the remains.

Our investigations are mainly directed to extraction of useful components by mechanical (physical) methods and to minimization of supplied material on cyanidation (chemical method) or to exclude other chemical methods, which causes the minimization of ecological dangers and, correspondingly, will improve the environmental conditions [1].

At enriching of the ores, containing non-ferrous and noble metals, the use of magnetic separation is among the prospective directions. In high-frequency magnetic field the mentioned metals react with the constant electric field by the action of Foucault currents. At falling in gravitational field, they change the path of motion and the metal particles may be separated in individual fraction.

On the basis of performed investigations it should be concluded that by refinement of elaborated method not only the separation of ferromagnetic material is possible but the grains and particles of non-ferrous and noble metals may be isolated [2].

By magnetic separator, operated by the elaborated method, the obtaining of the metal products of three various types is possible:

1. Magnetic – mainly by the content of iron and other magnetic minerals;
2. Nonmagnetic - by the content of the particles of current-conducting non-ferrous and noble metals and minerals;
3. Nonmagnetic – tails (barren rock), mainly by the content of quartz and nonmagnetic minerals.

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CONCEPT OF RECOVERY OF DISRUPTED ECOSYSTEM OF MADNEULIDEPOSIT REGION BY IMPROVING OF THE TECHNOLOGYOF PROCESSING OF WAREHOUSED REMAINS

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On the basis of our researches, performed over a period of years, the concept of enriching technology for warehoused remains of Madneuli deposit obtained as a result of processing of the ores of noble metals was elaborated. The goal of mentioned technology involves a maximum extraction of noble and rare metals and complex processing of warehoused tails [1, 2]. Their processing was considered as non-profitable in the 20th century and they were stored in tailing dumps for years.

Rapid progress of digital technique and space-based technology caused the sharp increase of the demand on rare and noble metals and their prices at world market. At present the obtaining of the concentrates of rare and noble metals, cement, building materials and other products is possible from warehoused tails by adaptation of modern technologies. Processing of so-called red sludge is of significant importance, which may increase considerably the extraction of mentioned metals, will exclude the eco-harmful cyanide methods and the recovery of disrupted ecosystem and prevention of the region from eco-disaster will be possible.

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MAIN DIRECTIONS FOR THE DEVELOPMENT OF MINDELI MINE VALLEY OF TKIBULI-SHAORI FIELD

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Tkibuli-Shaori field Mindeli type mine valley and Tkibuli-Shaori coal field by their geologic conditions are one of most complicate in the world. Therefore, the introduction of high technology in the field of labor safety requires deep scientific research.

Effective processing of thick layers requires technical solutions to solve complex engineering tasks. The dense layers of great and medium thickness complicate the solution of this problem. The technologies, currently available on the Tkibuli-Shaori field have disadvantages, namely:

- It is difficult to manage gas-separation and aeration managment;
- Significant volume of exploitation losses;
- Increased risk of carbons self-ignition.

Intricate geology, geometry and parameters of seams bedding on the Tkibuli-Shaori field require detailed study of mining-geological conditions and the critical analysis of the used processing systems in order to select correctly the progressive technologies for individual fields.

On the basis of detailed study of mining-geological conditions, the shaft field was divided into blocks. Striking, preparation, processing and extraction schemes for each block were selected subject to the mining-geological and mining-technical conditions of each block. For each block schemes of block striking,preparation,processingand extraction systems were selected subject to mining-geological and mining-technical conditions. They are recommended to be implemented in the context of the existing shaft field processing technology.

Therecommended technological schemes entirely consistent with the mining-geological conditions of each block are listed below:

1) They will decrease the Block Processing loss.
2) Improve the effectiveness of mining.
3) Provides better conditions for the protection of dust-gas regime.
4) All the above mentioned will increase the value of the shaft valley and profitability.
5) The simplest scheme for isolating the blocks will enable us to ensure the quality of uninterrupted activities in other sections of the mine.

The technology of shaft field recommended by us will enable to increase the safety of mining technology. Reduction of the cost of the extraction process will result in increasing the competitiveness in the branch.

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PRESENT GEOTECHNICAL CONDITIONS OF COASTAL ZONE OF SUPSA AND GRIGOLETI CONNECTED WITH ENVIRONMENTAL PROTECTION

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The coastal zone consists of beach and a submarine slope. That is the part of land and water where lithosphere and hydrosphere undergo active interaction.

The territory under study, from the village of Grigoleti to the Supsa is one of the complicated regions. Due to activation of the Asia – Europe traffic corridor, operation of the Supsa oil terminal and its loading facility in the sea, the anthropogenic challenges have greatly increased, that makes it more urgent to study the geotechnical conditions of the region.

We accomplished some special studies under Prof. G. Buachidze's leadership sponsored by "John Brown" firm aimed at studying the geotechnical conditions of the Supsa terminal and its oil-loading facility. It is a complex a sensitive unit and in case of damage it can cause catastrophic damage to Poti – Kobuleti zone. The area from the Supsa to Grigoleti is characterizes by intensive alongshore movement of solid material.

The data of the special holes drilled within the Supsa – Grigoleti area made it possible for us to draw a border between the relatively stable and very movable sands at the intersection of the oil pipe with water line. This border is about 7.0 m that exceeded the depth of the trench provided by the project (4.0 m).

To evaluate the geotechnical conditions, it is important to identify the role of natural factors influencing the formation of the conditions. One of the main factors is coarse river drift and the sea wave conditions [1]. The data analysis revealed that the sea waves in the area are mainly of South-West (32%) and West (25%) direction. The sea waves have a great effect on the seashore lithodynamics.

Apart from the wave conditions, coarse river load, which form beaches and protect the seashore from washing away, is of great importance.

There are two groups of rivers in the region under study:

Group I - the Rioni includes river drifts exceeding a million ton;

Group II – the Supsa (0.1 million ton).

In the areas with the deficit of solid drift, it is necessary to fill it artificially. Later in the XX century due to "Sakgeology" special studies, river gorges were identified for quarries for inert material mining. At the same time, this method should be used with care not to destroy the stability of river terraces, as it can cause negative changes in geological environment.

The abovementioned indicates that at the seashore intersection oil pipeline can "hang" in the water at the place of the bend or make a subject of "excessive" load (this conclusion has been handed to a client).

We think it necessary to carry out some observations to get material for short-time prediction of development of engineering-geological conditions in this region.

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MORPHOLOGY AND ORIENTATIONS OF QUARTZ VEINS OF THE LOWER- AND MIDDLE JURASSICTERRIGENOUS DEPOSITS OF THEKAZBEGI-OMALO REGION

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Quartz veins are widespread in the principal areas of the Folded System of the Greater Caucasus and in the Lower- and Middle Jurassic terrigenous deposits of the Kazbegi-Lagodekhi zones. Quartz veins occur in sandstones on the one hand and in shales and slates on the other. They are especially common at the border between slates and sandstones.

The macroscopic-, microscopic-and growth morphology [1] of quartz veins are of great importance when studying the formation of quartz veins while the orientation reveals their relations with structures and processes.

According to macroscopic morphology quartz veins are various. They differ in length and thickness; theygenerally have the shape of lenses, planar bodies or irregular forms. The peculiarity of their forms and orientation are conditioned by the stratification of the country rocks and fractures and faults in them.

According to microscopic morphology there occur blocky (of mosaic texture), elongated (parallel lanceolate) and complex forms.

According to growth morphology quartz veins can be syntaxial (crystals grow from walls towards the center) and antitaxial (crystals grow from the center towards walls); sometimes they are complex, e.g. in some quartz-calcite veins quartz shows syntaxialgrowth but calcite – antitaxial [2].

According to relation with the country rocks the veins are parallel to bedding or crossing it; sometimes parallel veins coincide the direction and inclination of the country rocks, sometimes they coincide the direction but they are crossing towards the inclination. The contact of veins with the country rocks is distinct with even surface (sometimes slightly wavy).

In order to conduct the detailed statistical analysis of tectonics of veins and joints bed position of vein systems was measured on the territory under investigation. The statistical analysis was carried out on the Schmidt equal-area net (Fig.1).

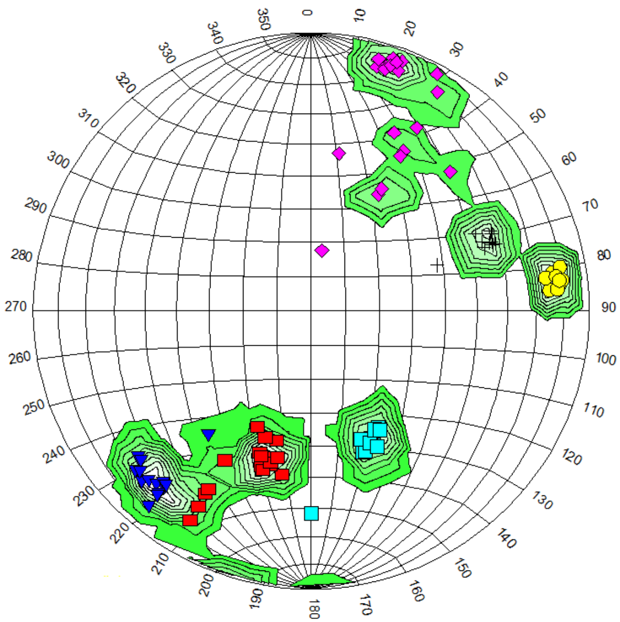

Fig.1. Composite pattern of quartz veins orientation.

For revealing the jointing of regional orientation composite patterns were plotted. Most of the veins are oriented south-westward and north-eastward. The origin of the south-west veins can be related with the systems of tensional joints. It was obvious that the veins with 360^0, $<65-70^0$ dip azimuth developed in joints parallel to bedding; as for axial plane joints, that are of great significance, they stretch north-eastward. Calcite and quartz vein strikes are very common along these joints; the veins of the aforementioned orientation cross the bedding and they are related with joints of penetrating type. The joints of such type cause fracturing and displacement of blocks.

Veins with 140^0-180^0 dip azimuth are considered to be related to joints of regional slip faults parallel to the Caucasian direction.

As the results of researches show veins of north-eastern direction developed along the strike-slip faults of the Caucasian megaanticlinorium at the final stage oforogeny as a result of spatial orientation changing of the strain ellipsoid while veins of south-western direction developed in joints conjugated with veins of north-eastern direction.

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IVESTIGATION OF RADIOACTIVE CHARACTERISTICS OF SOILS ORIGINATING FROM GRANITIC ROCKS ON THE EXAMPLE OF THE KHRAMI LATE VARISCAN CRYSTALLINE MASSIF

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As it is known, natural radioactive materials in the soil are constant sources of human irradiation (terrestrial radiation). According to periodic reports published by The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), the average part of radiation coming from natural sources equals to 2.4 mSv/y, whereas the share of radiation from artificial sources is 0.8 mSv/y [1, 2]. Thus, 75% of total radiation affecting human health falls on natural radiation sources.Consequently,thegreatimportance of studying the existing natural radiation of radioactive sources and assessment of radiation hazards is quite apparent. The major exposure to radiation caused by soil radiation comes from the upper layer of the soil [2,3],in which the sources of radioactivity are ^{238}U, ^{232}Th, their decay products and radionuclide ^{40}K. Radiological impact of natural radionuclides on humans is mainly expressed by gamma radiation affecting the body, as well as by radon (Rn) and the processes caused by inhalation of its decay products [3].

Natural radioactivity of the soil and ionizing gamma radiation coming from soil depends on the concentration of natural radionuclides it contains, while the latter depends on soil forming parent rock and other forming factors [1, 2, 4]. In general, relatively increased radioactivity is associated with igneous rocks and the decreased – with sedimentary rocks. However, there are some exceptions: for instance, some shales and phosphates show relatively high content of radionuclides. Igneous rocks, namely, sialic rocks (especially granitoids) contain a relatively higher concentration of natural radionuclides than ultramafic and mafic rocks [1, 2].

In Georgia, granitoids occur in axial part of the Caucasus Main Ridge, as well as in the Dzirula, Khrami and Loki crystalline massifs. At this stage, the Khrami massif as a study area was selected for our research. When choosing an object of study, in addition to geology, the following factors were taken into account: the existence of populated localities, agricultural and mining (of natural industrial materials) activities etc.

According to our research, the study of distribution of radionuclides naturally existing in the Khrami Late Variscan crystalline massif and soils overlapping itsadjacent territory built by Neogene-Quaternary lavas was carried out. The concentration of radionuclides in the samples taken from soils was determined by gamma spectrometric measurement. Activity concentrations and contents of natural radionuclides ^{238}U, ^{232}Th and ^{40}K were identified in the soils (Table 1). By identification of artificial radionuclide ^{137}Cs concentration revealed the character of radioactive contamination of the area under investigation. Based on the obtained results, the following parameters necessary for the assessment of radiation hazards were determined: absorbed gamma dose rate in the air; annual effective dose rate; external hazard index and radium equivalent activity that are used in the assessment of radioactive industrial materials. The difference between concentrations of radionuclides having emerged at the expense of Late Variscan crystalline substrate and recently erupted lavas was established. The results were compared with similar studies conducted in different countries and with data and recommendations published by international organizations (UNSCEAR, ICRP).

The report is dedicated to more detailed discussion of the conducted research and the results obtained.

Table 1

Concentrations of radionuclides in soil samples

Site #	Bq/kg				g/kg			
	^{238}U	^{232}Th	^{40}K	^{137}Cs	^{238}U	^{232}Th	^{40}K	^{137}Cs
1	42.50	44.4	690.6	10.6	0.00345	0.01100	0.00267	$33*10^{-13}$
2	39.40	53.8	745.80	9.60	0.00320	0.01330	0.00289	$30*10^{-13}$
3	38.70	50.7	936.00	4.50	0.00314	0.01250	0.00362	$14*10^{-13}$
4	38.30	51.4	933.00	11.5	0.00311	0.01266	0.00361	$35.9*10^{-13}$
5	39.60	50.0	867.30	5.50	0.00321	0.01232	0.00336	$17.2*10^{-13}$
6	40.67	50.5	933.00	3.75	0.00330	0.01240	0.00361	$11.71*10^{-13}$
7	43.44	56.5	1008.0	12.2	0.00352	0.01392	0.00390	$38.3*10^{-13}$
8	40.45	54.4	944.00	11.3	0.00328	0.01340	0.00365	$35.3*10^{-13}$
9	38.00	60.2	1004.8	33.0	0.00308	0.01483	0.00389	$1.0*10^{-11}$
10	33.00	48.9	956.00	8.50	0.00268	0.01205	0.00370	$27*10^{-13}$
11	41.20	59.9	768.50	10.0	0.00334	0.01475	0.00297	$32*10^{-13}$
12	35.70	52.0	784.20	10.2	0.00290	0.01280	0.00303	$32*10^{-13}$
13	29.30	50.7	778.60	13.0	0.00238	0.01250	0.00301	$41*10^{-13}$
14	36.00	54.5	957.50	10.0	0.00292	0.01340	0.00371	$32*10^{-13}$
15	48.80	63.2	954.50	8.50	0.00396	0.01560	0.00369	$27*10^{-13}$
16	44.30	53.9	837.50	10.7	0.00360	0.01330	0.00324	$34*10^{-13}$
17	42.80	64.9	975.00	8.30	0.00343	0.01600	0.00377	$26*10^{-13}$
18	34.90	51.0	918.40	13.3	0.00283	0.01260	0.00355	$42*10^{-13}$
19	25.80	39.6	722.80	7.90	0.00210	0.00980	0.00280	$25*10^{-13}$
Min.	25.80	39.6	690.60	3.75	0.00210	0.0098	0.00267	$11.71*10^{-13}$
Max.	48.80	64.9	1008.0	33.0	0.00396	0.01600	0.00390	$1.0*10^{-11}$
Mean	38.57	53.1	879.76	10.6	0.00313	0.01310	0.00340	$3.33*10^{-12}$
World's Average [1]	35	30	400	-	0.00284	0.00739	0.00155	-

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GOLD POTENTIAL OF THE SOUTHERN SLOPE OF THE GREATER CAUCASUS (GEORGIA)

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The segment selected for the research of the Alpine-Himalayan fold zone, wheregold occurrences are located, is perceived as the result of interaction of microcontinents fragments – Afro-Arabian and Eurasian lithospheric slabs.The peripheral parts of microcontinents are usually built by obducted marine or oceanic origin sediments.The deposits and occurrences occupy sharp position in space and time.The gold-ore paleosystems are found in megastructures that have undergone intense tectonic tension. Those are established in the allochthones, in activated areas of micro-slabs and suture zones of the southern slope of the Greater Caucasus.

The studied segment of the southern slope of the Greater Caucasus is constructed by Palaeozoic and Early-Middle Jurassic allochthonous carbonaceous terrigenous sediments, within which volcanic and intrusive formationsare found. Separate areas of the sediments contain gold, antimony, arsenic, mercury and tungsten. Here are known arsenic and mercury (with gold) industrial deposits, also large potential gold-ore areas, which are located within carbonaceous terrigenous suites and Middle Jurassic subalkaline granitoides. The preliminary analysis of the material from ore area, located in the northern part of Georgia, showed that there is a great probability of large gold deposits discovery in carbonaceous intervals of terrigenous suites. On the example of Lukhra (Svaneti) and Zopkhito (Racha) regions, the lithofacial composition and petrochemical peculiarities of ore bearing complexes are defined (Kekelia et al, 2016).

There are two ore regions in this segment of the southern slope: Mestia-Racha - in the north and Svaneti - in the south-west. The regions are separated from each other by natural geological borders, by large tectonic wedge, which is built by Late Jurassic-Early Cretaceous intensively dislocated formations.

The average content of gold at Lukhra occurrence amounted: in one cross-section - 8.89% g/t and in another one – 7.48% g /t. According to our data, the estimated gold resources at Lukhra district amount about 30 t.

As for the Zofkhito deposit, similar gold deposits in other parts of the world often belong to large scale ore areas with relatively low (2-5g /t) content of metal and sometimes giant (1000 tons). For example, such deposits are: Muruntau, Sukhoi Log, Olympics, Juneau etc.

A 1:200,000 scale map in Arc GIS 10.2, for gold potential assessment, was created. The map (Fig.1) is composed on geodynamical basis (lithogeodynamic complexes are shown on the map, which represent fragments of old morphostructures from the past, at the same time geological formations are involved in the complexes, part of which is orebearing). The map (Fig.1) is rich in ore occurrences and mineralization points. There are two ore regions outlined on the map: in the north – Mestia-Racha- and in the south – Svaneti regions. The regions contain potential goldbearing ore fields. The information of "TSNIGRI" was used for data on gold (Narseev, 1988, Appendix 10; Konstantinov, Narseev, 1989). At two areas (examination of surfaces and mines) gold probable resources are estimated: Lukhra – 30t, Zopkhito – 40t. The gold-quartz-low sulfide occurrence at Lukhra –, and gold-quartz-sulfide occurrence (with antimonite and needle arsenopyrite) at Zopkhito are revealed.

The following data are used for determining the gold potential of the ore fields, the area productivity for veins in carbonaceous terrigenous suites (1000 kg/sq.m)

Five ore fields are allocated in the southern slope of the Greater Caucasus:

1. Zopkhito - 0.5x1000 x 315=157500=157,5 tAu
2. Guli - 0.5x1000 x 90=4500=45 tAu
3. Tsana - 0.5x1000 x 120=60000=60 tAu
4. Kirar-Abakuri -0.5x1000 x75=375000=37,5tAu
5. Arshira - 0.5x1000 x 120=60000=60 tAu

Gold potential amounts 360 t. For gold potential adjustment the following geological works should be done:

1. A 1:10 000 scale search-evaluation works - all over the gold bearingfields in the following sequence: first at the Kirar-Abakuri and Zopkhito fields, and then at the rest areas.
2. At districts where gold probable resources (Zopkhito and Lukhra) are distinguished, prospecting should be carried out using drill holes.
3. Prospecting should be carried out on the northern slope of the Svaneti ridge for detecting gold-quartz-low sulfide type vein zones.

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CRETACEOUS PALEOECOLOGICAL EVENTS (OAE) IN GEORGIA

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Anoxic events in the ocean coincide with episodes of a rise in temperature in comparison with average rather high values of the Cretaceous period. The CO_2 level in the atmosphere at these time intervals was three to five times, and according to some estimates, even five to six times more than today. It is also assumed that the amount of other greenhouse gases (water vapor and methane) increased. Anoxic events can be classified as geological disasters, but on the other hand, the OAE contributed to balancing the ocean – atmosphere system and normalizing the global carbon cycle. Accumulation and disposal of a huge amount of $\mathbf{C_{org}}$ at that time caused a drop in CO_2 level and a relative cooling.

During the Cretaceous period, several relatively short intervals were recorded with a reduced oxygen content in the water column. They are called "Ocean Anoxic Events (OAE)". The most well-known OAEs include the following: Faraoni OAE - the end of the Hauterivian – the beginning of the Barremian (?); Selli OAE1a - Early Aptian. Three are associated with the Albian: Paquier OAE1b - Early Albian; Amadeus OAE1c - Middle Albian and Breistoffer OAE1d. The Bonarelli OAE2, the Cenomanian-Turonian boundary event, is widespread geographically and most famous.

Among the noticeable changes in the composition of the complexes of planktonic foraminifera (PF) during the Cretaceous period is the periodic increase in the number of individuals with elongated chambers of the last whorl. The elongation of the chambers was a “returning” morphological feature in the

Cretaceous and Cenozoic. This suggests that such a shell had an advantage in certain environmental conditions. One of the possible conditions for this advantage is their adaptation to the low oxygen content in the water column. This assumption was based on the factual material from a large number of sections in different regions of the world. A summarizing reporton this issue is given in the work of Italian specialists who analyzed a great deal of factual and literary material (Coccioni, Luciani, Marsili, 2006). The periodic appearance of the PF with elongated chambers was also recorded in the sections of the Crimean-Caucasian region (Gorbachik, Kopaevich, 2011). The wide distribution of these forms in both lateral and chronological aspects makes them important indicators of paleogeographic settings. They are found in sections of the Mediterranean, European and Pacific paleobiogeographic regions. Their taxonomic diversity makes it possible to judge the formation of sediments in various paleooceanic conditions: pelagic environments, epicontinental basins, they allow to establish intervals of desalination, cooling, alternating eutrophic and oligotrophic water masses.

Early Cretaceous. Analysis of a great deal of literary and factual material showed that the PF of different taxa, but having elongated chambers of the last whorl (hedbergellids, leupoldinids, globigerinelloidids, schackoinids) are timed to the events of Faraoni, Selli and Bonarelli. Each of these intervals has its own characteristics. The appearance of the first Cretaceous morphotypes with elongated chambers precedes the brief episode of the Faraoni's oxygen deficiency. Immediately after this event, short-term diversification of forms with elongated chambers (members of the genus Clavihedbergella) occurs throughout the Early Barremian (Coccioni et al., 2006; Vishnevskaya, Kopaevich, 2009; Gorbachik, Kopaevich, 2011). Anabrupt increase in the taxonomic diversity of the PF with elongated chambers is associated with the Selli event. They appear in different morphological groups: among trochoid shells (hedbergellids), planospiral (globigerinelloidids), and also with a mixed type of winding (leupoldinids and schackoinids). A generalization of the actual material showed that there was a certain sequence in the appearance of these taxa. Thus, the earliest representatives of this group are trochoid PF – hedbergellids, then follows the group leupoldinids. The last appear planospiral PF (globigerinelloidids). In many sections, a sharp increase in the leupoldinids group was noted above the interlayer with a higher content of Corg. The successive appearance of various groups of PF with elongated chambers can be explained by the degree of their tolerance to stressful environments. It is assumed that the group of planospiral PF (globigerinelloidids) was highly specialized and it took a long time for it to adapt and develop elongated chambers. At the same time, there are some differences in the taxonomic diversity and stratigraphic distribution of the PF during the Early Aptian Selli event. This is due to the regional characteristics of the parameters of water masses: stratification of the water column, seasonal fluctuation sand the intensity of bioproductivity. The materials of the Crimea and the North Caucasus demonstrate a surge of diversity and quantitative dominance of forms with elongated chambers directly in the Early Aptian. This is expressed in an increase in the taxonomic diversity of the representatives of the genera Leopoldina, Clavihedbergella, Blowiella (Kopaevich, Vishnevskaya, 2009: Gorbachik, Kopaevich, 2011). A similar picture is observed in the sections of Italy, where the taxonomic diversity of the PF with elongated chambers is higher. Along with these taxa, planispirals of PF with bifurcated chambers appear, which according to some researchers, isa reaction to OAE. In the Crimean sections, anabrupt reduction in benthic foraminifera is recorded in this stratigraphic interval, up to complete absence, and there are alsoplanospiral PF with bifurcated chambers. The Albian Paquier, Amadeus and Breistoffer events were not accompanied by a noticeable increase in the number of PF with elongated chambers. At the same time, the appearance of such forms as Hedbergella simplex and representatives of the genus Schackoina is associated with the events of OAE1b and OAE1d. In addition, the OAE1d event caused the extinction of keeled planispiral representatives of the genus Planomalina. At the same time, after the Breistoffer event, the rapid evolution of the highly specialized genus Rotaliporas.l. begins.

Late Cretaceous. The most notable impact on the morphology and taxonomic composition of the PF was the Cenomanian – Turonian boundary event Bonarelli (OAE2). It led to significant changes in the structure of the PF complexes, and had a very significant effect on the morphology of their shells. The flourishing of highly specialized Rotaliporas. l. was stopped due to oxygen deficiency, which blocked the possibility of restoring the population. At the same time, other PFs safely passed this milestone and continued their development (Hedbergella, Whiteinella, Praeglobotruncana, Heterohelix). This stage is characterized by a high percentage of PF with elongated chambers (genus Schackoina). During the Bonarellievent five phases (Coccioni, Luciani, 2006) were distinguished.Each of these phaseswas characterized by a specific composition of the PF. The composition of the complexes indicates change of stable oligotrophic conditions by the conditions of eutrophy andthen followed a gradual recovery system. In the border sediments of the Cenomanian and Turonianof Southwestern Crimea, it was also possible to single out several episodes that are comparable with the Bonarelli event. On the boundary of Cenomanian–Turonian, levels of “bloom” of radiolarians and shells of the genus Heterohelix belonging to the most cosmopolitan taxa of the PF are traced (Keller and Pardo, 2004; Kopaevich, 2011). The intensity of the impact of the OAE2 event on the morphology of PF shells, the generality of changes in large areas indicates the global nature of the event and the least influence of local features. Most likely, the morphological changes in the PF were proportional to the scale of the stress associated with OAE, and the Bonarelli event (OAE2) was the most large-scaled. The advantage of elongated chambers is to increase the surface / volume ratio and, thus, to increase the shell buoyancy. The greatest increase in this indicator in PF with elongated chambers and the holes at the ends of the chambers helped the penetration of oxygen into the shell, even with minimal contents in the water column.

The above-described processes that were recorded during of the Cretaceous period affected not only the foraminifera complexes, but also the macrofauna and vegetation. Of the belemnites, Cenomanian-Turonian species from the family Belemnopseidae were described. Starting from Early Santonian to Maastrichtian–Belemnitellidae, from the Valanginian to Aptian (during the period of the influence of the OAE), ammonites from the Ancyloceratidae superfamily appeared in the basins. Of the plants, there should be noted the Albian-Cenomanian: Tricolpites, Tricolporites, Tricolpopollenites (first stage). At the beginning of the second stage (Turonian-Maastrichtian) crucial changes in the composition of the angiosperm flora took place. Itis expressed in the appearance of the early Normapolles.

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STUDY OF THE DISPERSION OF THE BENTONITE CLAYS IN GEORGIA

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One of the important quality indicators of bentonite clays is their dispersion in natural state and easy dispersion following the treatment with sodium salts. Dispersion depends on the type and amount of exchange cations: the more the number of the exchange cations of alkaline metals in the diffusion layer of the bentonite particles, the higher the dispersion is. The amount of fine-disperse fraction in alkaline bentonites reaches 60-90%, while alkaline-earth bentonites have low dispersion [1].

Of various methods to evaluate dispersion, the best results for bentonites are obtained by using a sedimentation method, with its simplified version developed and used at the Alexandre Tvalchrelidze Caucasian Institute of Mineral Resources for many years [2].

The goal of the present study is to explore and assess dispersion, one of the technological parameters of bentonite clays. The dispersion analysis of bentonite clays from Churchuto-Chikheli and Vaniskedi deposits was done, and bentonites from the USA (Wyoming №1) and Greece were used as reference samples.

X-ray phase analysis was used to identify the polymineral structure of the presented samples: Ca-montmorillonite was identified in all samples; besides, the bentonites from Vaniskedi and Greece have a highly regular structure, while the samples from Churchuto-Chikheli show average crystallization. Quite often, the samples contain Ca-Na-feldspar and quartz as admixtures, and contain mica, α-cristobalite, calcite and kaolin as traces. As the results of the chemical analysis suggest, the content of earth-alkaline cations in them much exceeds the amount of alkaline cations.

In order to determine the degree of aggregation of the study clays and degree of their pollution with non-clay minerals, the dispersion was determined both, in the natural state and after the treatment with sodium pyrophosphate ($Na_4P_2O_7$), which, as it is known, is the most efficient peptizer for clays.

The dispersion data for bentonite clays obtained after adding different amounts of sodium pyrophosphate demonstrate that all studied samples from Churchuto-Chikheli deposit are coarse-dispersive: the yield of the I fraction is ~ 52 % on average; virtually, these samples do not contain the most important III fine-dispersion colloid fraction; the content of the II fraction in them is ~47 % on average. Following the treatment with a 5% peptizer, partial disaggregation of the I coarse-dispersion fraction takes place and as a result, the average yield of the II fraction, increases slightly as compared to the natural yield. Average yield of the III fraction increases slightly.

When clay is intensely aggregated, instead of 5%, a greater proportion of sodium pyrophosphate is added to it and optimal dose of a peptizer is identified [1]. Consequently, the study specimens were treated with 7 and 9% $Na_4P_2O_7$. Following the treatment with 7% sodium pyrophosphate, the yield of the I fraction decreased to ~36% on average; the yield of the II fraction increased respectively and was ~54%, while the average yield of the III fraction changed slightly and amounted to ~10%. Following the treatment with 9% $Na_4P_2O_7$, the dispersion of the samples hardly changed for different fractions: the amounts of fractions remained the same as they were after the treatment with 7% $Na_4P_2O_7$. Consequently, treatment with 7% $Na_4P_2O_7$ is optimal for the explored samples from Churchuto-Chikheli deposit. The gained results made it clear that the treatment of samples even with greater amounts of sodium pyrophosphate almost does not increase the yield of colloid fraction.

Purportedly, this is because the clay particles from Churchuto-Chikheli deposit are strongly cemented with the substances not easily soluble in water.

In the natural state, the fractions in the sample from Vaniskedi-1 are distributed as follows: the yield of the I fraction is ~29%, the yield of the II fraction is ~55% and the yield of the III fraction is ~16%. Following the treatment with 5% $Na_4P_2O_7$, the yield of the III fraction increases to ~33%, it is 46% following the treatment with 7% $Na_4P_2O_7$ and is 56% following the treatment with 9% $Na_4P_2O_7$. The given increase in the III colloid fraction mostly takes place at the expense of disaggregation of the I and II fractions. Thus, the obtained results evidence that optimal for the sample from Vaniskedi-1 deposit is the treatment with 9% $Na_4P_2O_7$: it results in the maximum disaggregation of the sample and in the yield of the fine-dispersion fraction (~60%) typical to alkaline bentonites.

As it was expected, in the high-quality bentonite from the USA (Wyoming №1), the yield of the III fine-dispersion fraction is high and reaches ~80% in the natural state, and is 86% when treated with the peptizer. At the same time, the yield of the I coarse-dispersion fraction, which is only 2,3% in the natural state, virtually does not change, and an increase of the III fraction takes place immediately at the expense of the disaggregation of the intermediate fraction.

So, based on the accomplished studies, it can be assumed that the bentonites from Churchuto-Chikheli deposit are intensely aggregated in their natural state and virtually, do not contain fine-dispersion colloid fraction, which hardly changes after the treatment with the peptizer (5, 7 and 9% $Na_4P_2O_7$). The bentonite from Vaniskedi, with its dispersion obtained after the treatment with sodium pyrophosphate, falls back the bentonite from the USA, but shows similarity to the bentonite clay from Greece and can be used both, to prepare clay drilling fluids and in different branches of industry.

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ENTRAILS AND MINERAL RESOURCES MANAGEMENT ISSUES

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The article discusses issues related to entrails (general) and mineral resources (specifically) management. In particular, how individual officials can disfigure the good intentions of the Georgian government, which was aimed at improving the management of mineral resources. The Government of Georgia, in its Resolution No. 565 of December 27, 2017, substantiated the National Agency [1] of Mines and obliged the control function toMinistry of Economy and Sustainable Development (Minister Mr. V. Qumsishvili) and the minister approved the documentation on the foundation of the agency in such a way that it doesnotcorrespondto and does not follow from the special law of Georgia “about Entrails” and the law that formed the basis for creating the agency; He did not declare for what purpose it was created and what it should serve with the ensuing results.

The article provides reasoned recommendations for:

1. The agency’s activities must comply with the Law of Georgia “about Entrails” and other Legislative Regulations that result from them[2], which regulate the exploration and mining of any mineral resources, use, storage and protecttion of waste mining and processing enterprises (including overburden), as well as underground structures and relationships arising in the process of their construction and operation[3].
2. We consider it expedient, first of all, that in order to manage the mineral resource fund of the ore [4], several tough and quick measures should be carried out.

In the first place, the legislation should be changed in the following direction:

a) Create a State Reserve of Mineral Resources;
b) For Mineral Resources of various categories (State Reserve, Strategic Resources, Widespread Resources) create a differ-rent legislative regime;
c) Consider and approve the rules for conducting and account-ting for geological work in order to once and finally decide on the issue of capitalization of geological work and mineral resources;
d) Establish Entrails Fund Sites;
e) Bring the law of Georgia on "Licensing and Permitting" (Article 7) into line with the law on "Entrails" (Article 6);
f) Set a fixed payment for Entrails use [5];
g) In order to assess mineral reserves,it is necessary to create and legitimize the so-called institute of "Competent Persons".

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ECOLOGICAL ISSUES OF BIOMASS OF EASTERN GEORGIA

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The problem of environmental pollution is one of the urgent problems of present Georgia. In the previous years, we conducted geo-ecological works to establish the environmental parameters of heavy and toxic elements in the soils, water, bottom sediments and biological samples of Western Georgia.The presented abstract provide data on analogous works conducted in the territory of Eastern Georgia, which can be considered as a continuation of the work performed in previous years.

The Mtkvari river valley with its tributaries is considered as an object of study to define qualitative and quantitative parameters of heavy and toxic elements (Cu, Pb, Zn, Ni, Co, Cd, Mn, etc) in soils, waters, deposits and biological samples (edible plants). The area has been studied from Akhaltsikhe-Borjomi to Gardabani inclusive where the Mtkvari crosses the Georgia-Azerbaijan border.

The abstract provides data only on bio-samples and their analysis for heavy and toxic elements. It shoud be noted, that mainly maize was sampled as it is consumed for feeding domestic animals and humans.

As it is shown in the charts, elements like Cu, Pb, Zn, their indicators fall within Maximum Permissible Concentration (MPC) norm. Only samples taken in Khashuri and Gori region show increased concentration of such elements.

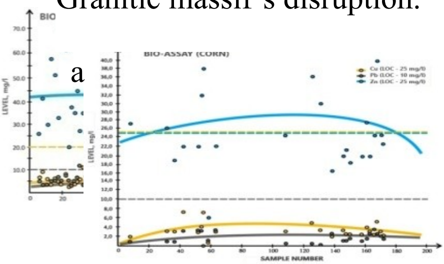
Also high concentration of Cobalt and Nickel is shown in cornfields,while Nickel concentration in straw is substantially low.

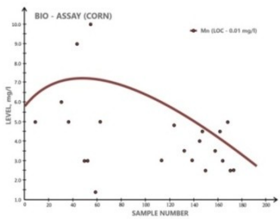
As for Cadmium, its concentration highly exceeds MPC. It is extremely high in cornfield samples of Borjomi and Khashuri regions.

Manganese concentration is high in Western Georgia but relatively low in East Georgia. Manganese concentration in maize corn bio-samples equals 5-7 mg/kg. As to straw (no MPC data available) average concentration of this element is 70-72 mg/kg.

As a conclusion, it could be said that heavy and toxic elements concentration is high in biosamples taken from both Eastern Georgian cornfield and straw. It is extremely high in Borjomi and Khashuri areas.

We consider that it may be connected with the Dzirula Granitic massif's disruption.





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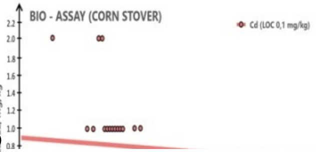

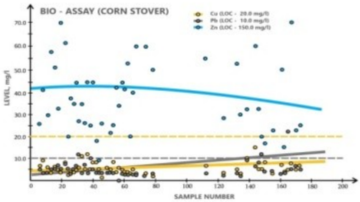

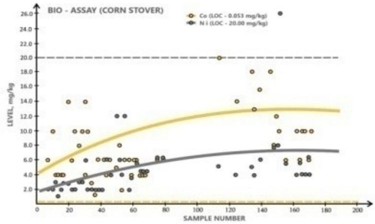

Distribution of Heavy and Toxic Elements: a) in corn b) in straw

ECONOMIC DEVELOPMENT PERSPECTIVES OF MINING INDUSTRY IN THE CONDITIONS OF GLOBALIZATION

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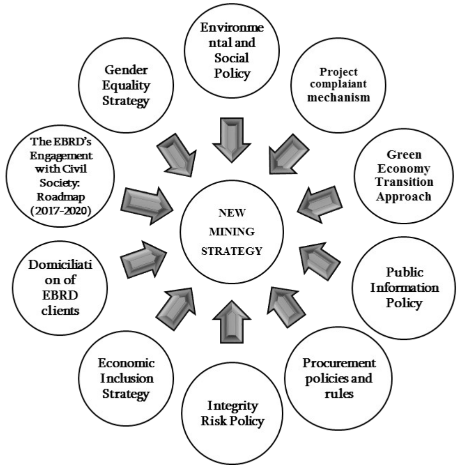

The mineral resource complex is one of the most economically sustainable and socially significant sectors of the economy, the main contributor to the country's budget system and the main source of funds for the transfer of domestic industry to a new technological structure. In the future, regardless of the change in the economy's raw model, the importance of the mineral raw materials will not decrease. With an increase in the livingstandard, the specific consumption of energy, metals and other minerals will also increase.

Natural resources, primarily mineral resources, form the basis of human existence and in many respects determine the future of world civilization. With the growth of the population of the planet and as a result of the scientific and technological revolution, the geography is expanding and the pace of involvement of the natural mineral and raw material potential in the economic circulation is growing. Over the past 60 years, more mineral raw materials have been produced and used in the world than in the entire previous history of mankind.

Everywhere in the world and in relation to all types of minerals, there is a tendency towards the exhaustion of reserves of deposits of rich and easily-rich ores, instead of exploiting deposits of relatively poor and hard-to-rich ores. The share of hard-to-recover oil reserves (in Russia it has reached 65%) and natural gas in low-permeable shale reservoirs and coal seams (in the USA – 40%) is growing. In general, unconventional types of ores and deposits, the development of which was previously considered unprofitable, are becoming increasingly popular.

The mineral and raw materials policy of the leading countries of the world can be laid in the following basic models:

• Export model ("raw materials appendages"), which allows to achieve a high living standard for a relatively short historical period on a „rental" basis;

• An import model that develops either because of the scarcity of the mineral resource base, as in the EU countries and Japan, or politically proclaimed, as in the USA;

• The model of self-sufficiency, politically evaluated as "isolationist", is possible only in countries whose mineral and raw material potential is quite large and includes a very wide range of mineral resources.

Currently, none of these models are implemented in their pure form; they stand out in the dominant direction in the mineral and raw material policy of certain countries. In general, the combined model is always preferable, since it has much greater flexibility and stability in terms of ensuring the national mineral and raw material security.

The paper will discuss the issues that mining companies will have to address in globalization. For mining companies, it is important to overcome the economic crisis and accelerate the development process. Extractive companies are trying to adapt to the existing situation in the conditions of low prices. The situation is complicated, as well as a number of unresolved problems facing the mining industry, starting with the decrease in the quality of the reserves and its demand and the increase in financing for stakeholders. In addition, the mining companies have to deal with ever-increasing requirements, such as: innovation needs, changes in the normative-legal basis and risks associated with physical and information security. It is also important, environmental and social policy, project complaint mechanism, green economy transition approach, public information policy, procurement policies and rules, integrity risk policy, economic inclusion strategy, domiciliation of EBRD clients, the EBRD's engagement with civil society: Roadmap (2017-20), gender equality strategy and etc [1, 2, 3].

Disruption and volatility have become the new constant for the mining sector − grappling with issues like rising stakeholder demands, talent shortages, tarnished reputation, an evolving threat landscape, and dwindling access to key resources such as energy and water. What leading strategies can miners deploy to succeed in this dynamic business environment?

To thrive into the future, companies must re-envision corporate strategies, boost risk management approaches, and improve relationships with stakeholders, in addition to making rapid strides in digital transformation, expanding capital spend, and to promote diversity and environmental protection.

The paper discusses the issues that mining companies should take into consideration in order to be able to focus on the future. Now in its 11th year, the 2019 tracking the trends reveals the top 10 trends (Rethinking mining strategy, The frontier of analytics and artificial intelligence, Managing risk in the digital era, Digitizing the supply chain, Driving sustainable shared social outcomes, Exploring the water-energy nexus, Decoding capital projects, Reimagining work, workers, and the workplace, Operation alizing diversity and inclusion programs, Demanding provenance) that should be on every mining company's agenda. Our global mining professionals once again share insights that miners can leverage in their ongoing pursuit for productivity, capital discipline, strategy development, and sustainable growth [4, 5].

In terms of effective involvement in international-economic relations, satisfaction of the needs of the population can be reached after the rational use of mineral resources, where the main raw material must be extracted from the rock, waste recycling, with the inclusion of „poor“ ores and complex use of raw materials, creation of waste and small waste complexes, effecttive use of resource saving technologies and improving environmental measures.

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STUDY ON THE POSSIBILITY OF UTILIZATION OF BIOREAGENT FORPROCESSING OF STORED TAILS OF COPPER-PYRITE ORE FLOTATION

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At the present moment the maximum utilization of mineral raw materials is possible in two ways: the first - to minimize the losses of useful components in the main processing of mineral raw materials, and the second – to develop and introduce advanced combined methods for the processing of waste (man-made raw materials) of mining and processing industry. Processing of technological raw material hasdouble effect: firstly, additionally marketable production required in industry is obtained, and secondly, nonrenewable nature resources are saved, life of the field is increased, anthropogenic impact on the environment is reduced, which beneficial effect on the health of future generations.

Significant supply of technological resources, containingnonferrous and noble metals, is located in JSC Madneuli area in waste heaps and tailing dumps. Since 1975 on the Madneuli copper-baryte-polymetallic field open-pit mining and processingof copper pyrite ores are carried out at beneficiating plants. Enrichment of copper-pyrite is carried out by flotation; copper concentrate is produced from the ore milled to 74 microns (50-60%) in highly acid mediausing straight selective flowsheet, in the concentrate the part of gold contained in the ore is picked out, while the remaining part follows the pyrite tail, which is storedin the tail dump.

Copper and gold content in stored pyrite tails is low (average Cu-0.22-0.24%; Au-0.61-0.65 g/t).

The goal of our research is to obtain collective sulfide concentrate with high recovery of gold and copperby flotation method.

Besides the basic aluminosilicate part, the presented sample contains 0.2% copper, 4,8% sulfur and 0.8 g/t gold.

In the course of investigation the physico-chemical and biohydrometal methods [1] for enrichment were used. For poor raw materials, althoughit theyare nothardly enriching ones, the use of only enrichment methods is economically unjustifiable. Technology that uses biohydrometallurgical methods in combination with traditional enrichment methodsis profitable. The main part of our experiments is the preparation of feedstock (raw material) for floatation process, including raw grinding, activation of hardly depressed pyrites in the selective flotation process by bioreagent (trivalent iron sulfate, which is obtained from the iron separated from Madneuliacid quarry waters and ferrous iron oxidized by sulfur-oxidizing thiobacterium *Acidithiobacillus Ferroxidans*) and at the same time leaching. For study of floatation process investigations were conducted according to the following scheme: solid-in-pulp concentration 30%.

During the pulp agitation, the dissolution of readily-solublecopper mineral by bioreagent, renewal of oxidized surface and activation of pyrite by dissolved copper ions had place. In thecourse of flotation, the butyl xanthate was used as collecting agent, pine oil – as foaming agent, and 3,5 N sulfuric acid - for regulationof pH. Better results were obtained,when pH = 3. The collective concentrate output was 6%, the gold content - 3,6 g/t, copper - 2,%, sulfur - 40%, the extraction, accordingly, was - 55.0%, 78.2% and 59,8. It is important to note the increasing of the xanthate flowrate, which is caused by xanthate decomposition at this value of pH [2,3].

When the pH=5, gold recovery significantly reduces, and accordingly, the sulfur reduces within 5-8%. In addition, at this time $Fe_2(SO4)_3$ undergoes hydrolysis and its effectiveness decreases.

At the moment, studies on determination of the optimal parameters of the flotation process are underway.

The cementation of dissolved copper by iron powder during the conditioning, whereby the bioreagent can be obtained byoxidationof ferrous iron with microorganisms,is also in the research process.

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IMPROVEMENT OF STABILIZATION MEASURES FOR THE THIRD MADE LAND OF THE MADNEULI QUARRY

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The formation of the third made land of the Madneuli quarry began in 1950s, when the placement process of different fraction and composition of refuse dumps took place.The incorrect technology of creating made land defied the decrease of cohesion forces between rock layers. All the main treads are jointed that can trigger destabilization and landslide processes, which will affect not only the territory of the made land but the whole river gorge.

The study of field characteristics have shown that the deformations are mainly caused by gravitational forces and then surface water infiltration processes. The increase of width of joints can possibly be a factor for the further landslide deformation processes. Geological, hydrogeological, climatic, seismic and mining factors have been considered during the survey of this made land. After analysing all the active factors the made land have been divided into several equal condition blocks, also astatic spots have been revealed and improvement measures for maintaining the spot stability have been planned.

Moreover, on the basis of our estimations unstable spots of potential deformationshave been identified which could be developed by the waterinfiltration causing the saturation of bedrocks and trigger landslide. Our recommendation involves filling up joints with inert materials, also known as grouting, leveling the surface of the platform and constructing surface ditches to maintain the stability of the made land slopes. Also it is important to conduct monitoring of the made land and cleaning up the drainage ditches systematically.

The surface leveling requires extremely tedious professional approach and suitable technical support. Before these activities, oversized particles should be cabbled to the dimensions that a bulldozer could level the ground and afterwards a grader gives inclination to the leveled ground. Fragmentation of oversized particles should be done by a “woodpecker” type hydro-hammer.

Another important thing is that the surface should be leveled so that surface water should be diverted into drainage ditches avoiding the slopes of the made land. From the methods of stabilization of slopes the most convenient way is removal of surface water. Well-constructed drainage ditches are believed to be a “heal” factor in rock slope stabilizing. The surface of the segment, which is headed to the slope is vulnerable and crossed by different types of imperceptible cracks and deep joints. Great amount of water volume could be drained into these cracks and joints that can cause serious negative impact in fault zones. Although subsurface drainage systems are not enough for halting slope movement but it could dry up materials composing the slope.

Considering all the factors throughout the survey, we can come to the conclusion that the obtained criteria should be generalized for other made lands with consideration of mining-geological and mining-technical conditions.

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ABOUT ONE MORE POSSIBLE MODEL OF OIL GENERATION

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Oil origination hypotheses are considered in the articl and new possible model of fossil hydrocarbons generation is proposed. According to the model at the sedimentogenesis stage on basins seafloor the sodium alkaline montmorillonite clays are produced by means of halmyrolysis of mainly volcanogenic terrigene sediments. Co-sedimented sapropel-like organic matter is emulsified by montmorillonite and soap-like substance of $C_{15}H_{35}COONa$ general formula is produced. The substance along with other contains organics of naphthenic series as well. During the katagenesis the substance is matured, hydrocarbons generated and migrate to reservoirs.

ON COLORED GLASS FROM THE TREATISE OF VAKHTANG VI "THE BOOK ABOUT OIL BLENDING AND CHEMISTRY"

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The treatise of Vakhtang VI "The Book about Oil Blending and Chemistry" has a significant cultural value as in Georgian so in the world history.

The paragraphsfrom the abovementioned treatise concerning colored glass are the most important for our research.

This issue should directly be linked to the great knowledge and tradition existing in Georgia in the form of medieval cloisonné enamel technology performed on precious metals, which ceased existence on the border of XIV-XV centuries.

The recipes by Vakhtang VI on getting colored, decorative glass for cloisonné enamel, point to the fact that the knowledge had not completely been lost and continued to exist in the XVII-XVIII centuries.

Having carried out many-sided checking, we determined that the treatise recipes fully and competently give the directions for getting colored glass.

The present research discusses the paragraphs 218 and 222 of the treatise [1]. Paragraph 218-making eastern topaz that is white (white topaz, [2]): "prepared glass…. Minium lot 14, homogenize well, put in a pot and do as mentioned above".

In this recipe, the author means the description given in paragraph 216 about processing rock crystal substance with help of tartaric acid potassium salt "Sal tartar", and in paragraph 218, he describes the process of white glass boiling with already prepared glass substance and minium.

For verification of the abovementioned data, tests have been carried out at Gori Laboratory. For getting basic glass, we have used the data protected in the geographic-ethnographic work of Vakhushti Batonishvili- “Description of Georgian Kingdom”, according to which rock crystals may be encountered in the ravine of river Chivchavi on the territory of southeast Georgia, in Samshvilde. “Here, above Chivchavi, there is a pure rock, and crystals faceted and pointed on both ends fall from it” [3]. This information has been strengthened by the recent archeological works carried out in Samshvilde. Fragments of stained glass have been discovered here, as well as significant supply of bipyramidal rock crystals described by Vakhtang VI.

Archeologists assume, this supply may have been kept here for glass production purposes. In the frameworks of specially arranged expedition to Samshvilde, we found sufficient amount of the mentioned crystals and boiled glass by the recipe in paragraph 218 of Vakhtang VI’s treatise, which has warm yellowish-greenish tone.

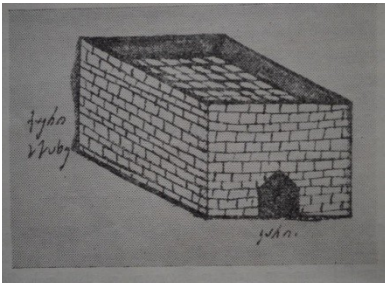

Fig. 1. Draft of furnace by Vakhtang VI

Fig. 2. Reconstruction of furnace described by Vakhtang VI (author E. Maghradze)

At the next stage we carried out a test on the base of recipe in paragraph 222: ”preparing of emerald like glass: crystal lot 4, minium lot 8, Spanish copper oxide, finely ground, grain 40, iron oxide prepared on citric acid, grain 8, mix together and leave for six-seven hours.”

We added copper and iron oxides prepared by Vakhtang VI's recipes, into the glass mixture and got green emerald glass, as described by the author.

Obtained results prove the correctness of Vakhtang VI's recipes. These data are acceptable and trustworthy for tenable scientific research.

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ON THE OROGENIC PHASES IN THE SOUTH CAUCASUS

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Considerable success has been achieved in modern geological sciences, particularly in the petrology, mineralogy, geochemistry, etc., especiallyusing the achievements of related sciences (physics, chemistry, geophysics, etc.). But in geology there are a number of issues that up to now can be solved only by geological facts and their analysis. One of such issues is the study of orogenic phases and the related events.

In South Caucasus, including Georgia all the orogenic phases (except the Savian) distinguished by G. Stille [1] and three new ones – Donetz,Chegemian and Trialetian (Ilirian) are established. All of them to various extent caused paleogeographic and structural changes affecting the character of sedimentation.

As is known the orogenic phases are mostly attended by synorogenic formations in the form of regressive sediments. Their establishment and a detailed study (stratigraphic position in the section, lithological-facial character, establishing of thicknesses, etc.) gives possibility to reveal the time of manifestation and duration of the orogenic phases.

The study of facial changes and the analysis of sediment thicknesses, especially in the areas with continuous sections, where direct signs of tectonic movements (break in sedimentation, angular unconformity) are missing, can play a decisive role in identification of orogenic phases.

It should also be noted that all regressive formations are not the result of orogenic movements and that makes it necessary for each particular case to be precisely identified the cause of individual regression (eustatics, epeirogenesis, orogenesis).

After establishing precise litho-stratigraphic boundaries of regressive formations will be possible to determine the beginning and the end of the regression that at the same time determines their exact thickness. Using geochronological scale and with due consideration of geological data the duration of time necessary for deposition of regressive formations will be established, though it will be connected with certain difficulties. Particularly, many aspects of sedimentation (considerably high speeds of regressive deposits sedimentation especially during the catastrophic events, lithological composition of rocks, processes of diagenesis, etc.) should be taken into account and due to it, obtained results may be disputable.

But there are cases, when these data are rather accurate and reliable. In such instances we have faunally well dated, completesections built up oflithologically similar rocks, where precise rock thicknesses are established.

This can be illustrated by the example of Upper Eocene sediments of Western Abkhazia [2]. We have a complete section here dated by nummulites. At the beginning of the Late Eocene, there was an epicontinental sea where the marls deposited. In the second half of the Late Eocene as a result of Pyrenean orogenic phase in the western part of the sea a piedmont trough (the Adler depression) was formed, where the sedimentation of regressive deposits began. In the eastern part of the basin deposition of the same marls continued. Thickness of the latter is 130m. If we take into account that the duration of the Priabonian is 4Ma, then rate of sedimentation of marls in Western Abkhazia is 32.5m per 1 million year. As for the western part of the sedimentary basin, the thickness of the marls deposited during the Lower Priabonian reaches 75m that corresponds to 2.3Ma. The above indicates that the formation of 475 m thick Matsesta suite took 1.7Ma, which at the same time points to the duration of the Pyrenean orogenic phase.

At the maximum intensity of tectonic movements, catastrophic events occur, during which often chaotically built "event deposits" in the form of olistostromes and a wild flysch are formed; they often occupy a significant place in the regressive sediments.

In this respect, Upper Eocene olistostromes and a wild flysch are distinguished. They are wide-spread not only in the South Caucasus, but also in the greatest part of Alpine fold strip. Their formation in time coincides with the peaks of orogeny and is connected with consedimentary tectonic movements. They are somewhat marker formations allowing the correlationof the tectonic and catastrophic processes within the Alpine fold area as well as beyond its limits.

The most important among the orogenic phases establishedin the South Caucasus were the Chegem, Pyrenean and Styrian orogenic phases.They played a major role in the formation of main morpho-structural units and determined the formationof the Caucasus modern geological structure and its character.

Due to the Chegem orogeny the Svaneti uplift was formed deviding the earlier indivisiblemarginal sea of the Greater Caucasus southern slope into two parts. Initiation of Cordilleras and sedimentary basins also associated with this phase.

In the Caucasus, the beginning of early orogenic stages is associated with the Pyrenean folding, as a result of which, first the western and then the eastern flysch basins of the southern slope of the Greater Caucasus cease to exist. V. Khain's [3] opinion on the reasons that gave rise to the Pyrenean orogenic phase is rather interesting. Particularly, it might have been a collision that formed a fold-nappe structure of the Caucasus, which started at the end of the Late Eocene and reached its maximum in the Late Miocene, when the Arabian plate detached from Africa and began its northward movement.

The Styrian folding ultimately stopped the sedimentation processes on the southern slope of the Greater Caucasus, while the Achara-Trialeti zone turned into a folded system. At the same time in the South Caucasus intermountain area partial subsidence and its transformation into a molassic depression took place.

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MANAGEMENT OF WASTE OF MINING AND PROCESSING ENTERPRISES FOR THE PURPOSE OF FORMING SECONDARY DEPOSITS VIA CREATION OF ARTIFICIAL GEOCHEMICAL BARRIERS

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The number of easily utilizable deposits of useful minerals decreases. Reserves of many of them have been exhausted.The necessity of low-conditioned, complex and secondary deposits' utilization is on the agenda.

Due to the imperfections of machinery and technologies used in obtaining useful minerals in modern conditions, the ores, the parameters of which often exceed the indicators of low-conditioned ones, go to waste in rich deposits. In addition, the level of waste usage is low and does not exceed 5-10%. [1]

Low efficiency of used machinery and technologies results in the generation of wastes' large array, which, in turn, causes an increase in anthropogenic load on the environment and therefore it becomes necessary to create such an effective machinery and technologies that provide a levelling of a negative impact on the environment.

It is necessary to develop new conceptual approaches.

Worldwide, the wastes produced during the extraction of hundreds of millionsof tons of useful minerals are stored randomly. The implementation of some order in this process will create such conditions during the formation of an array, which will facilitate the concentration of useful elements in a certain layer and accordingly the defined types of secondary deposits will be formed [2].

Basedon theabove-mentioned,it isrecommended to create such layers during the formation of tailings' arrays, for formation of which the physical-mechanical and geochemical characteristics of deposit, raw materials and wastes will be envisaged.

As it is known, theore creation depends on geochemical processes ongoing in the environment, that are developing by the influence of atmospheric, physical, chemical and biological transformations, which in turn are based on the movement of waters, physical-mechanical and chemical characteristics of the arrays therefore, the creation of ions of useful components and their movement through time and space.

The sharp change of movement speeds leads to the concentration of these ions in certain layers and ore regeneration.

The insertion of such artificial "geochemical barriers" in the tiles' arrays will facilitate the creation of sites with concentrated useful components. The barriers can be physical-mechanical, mechanical and biological.

Thecreationofphysical-mechanicalbarriers informingtailing arrays is based on the creation of the characteristics providing a sharp reduction of the speed (5-10 times) of ion migration, generated by water filtration. Biological barriers can be created in the layer by concentration of certain microorganisms or their group that work to utilize specific elements, for example, the ions of sulfur, iron, copper, gold, silver and other elements.

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ESTIMATION OFSTATE OF NOISE POLLUTION BY MOTOR TRANSPORT IN ROADAREAS ADJACENT TO SOME AVENUES AND STREETS OFSABURTALO AND VAKE DISTRICTS OF TBILISI

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By definition of UNESCO “noise is a disaster of the modern world, the undesirable product of technical civilization”. Acoustic or noise pollution is determined as physical pollution form, which consists in exceeding of noise level over natural level of noise. From the point of view of physiology noise is determined as unfavorably perceived sound and it is one of the typical ecological pollutions. High-level noises (over 80 dBA) adversely affect the biological conditions of life.

The auto transport is a main source of noise (up to 90%) in modern cities. Motor transport noise indicator L_{Aeqv}(dBA) depends on a traffic intensity, part of trucks and public transportinto the transport flow, average velocity of traffic flow, geometrical characteristics of the road, parameters of the dividing line and etc.

Present research refers to the estimation of state of noise pollution in road areas adjacent to Ilia Chavchavadze, Mikhael Tamarashvili avenues and George Tsereteli, Gigo Gabashvili streets. Studies were accomplished on working days. The main part of transport flow on researched sections was passenger cars. The number of passed motor transport in the investigated regions changed depending on time of the day and night.

The results of calculations of equivalent to noise level L_{Aeqv} during the day and night with one-hour time intervals for researched sections of avenues and streets are shown on fig. 1 and fig. 2.

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Fig. 1. Variation in noise level L_{Aeqv} (dBA) during twenty four hours with one hour time intervals in high intensity traffic intersections of Ilia Chavchavadze avenue and Giorgi Tsereteli street.

1 – The section of Ilia Chavchavadze avenue from Lado Kavsadze street to Nikoloz Berdzenishvili street; 2– The section of Ilia Chavchavadze avenue from Nikoloz Berdzenishvili street to Nikoloz Kipshidze street; 3 – The section of Ilia Chavchavadze avenue from Nikoloz Kipshidze street to Mikhael Tamarashvili avenue; 4 – Giorgi Tsereteli street.

4

Fig. 2. Variation in noise level L_{Aeqv}(dBA) during twenty four hours with one hour time intervals in high intensity traffic intersections of Mikhael Tamarashvili avenue and Gigo gabashvili street.

1 – The section of Mikhael Tamarashvili avenue from #1 to #13[a];
2 – The section of Mikhael Tamarashvili avenue from #4[b] to Giorgi Tsereteli street; 3 – The section of MikhaelTamarashviliavenue from University street to Alexander Kazbegi avenue; 4 – Gigo Gabashvili street from Alexander Kazbegi avenue to Vazha Pshavela avenue.

As the figures show, a motor transport has an important effect on eco-system of Ilia Chavchavadze, Mikhael Tamarashvili avenues and George Tsereteli, Gigo Gabashvili streets of Saburtalo and Vake districts of Tbilisi.

It is necessary to optimize noise pollution sources by restricting transport flow velocity, decreasing of part of trucks in the transport flow at a defined time of day and night, glazing of buildings with noise protection glass, arranging of noise protection shields and vegetation along the roads and etc.

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PLANKTONIC FORAMINIFERAL AND CALCAREOUS NANNOFOSSIL BIOSTRATIGRAPHY OF THE UPPER CRETACEOUS AT THE WESTERN GEORGIA

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In western Georgia, the Later Cretaceous passed a more relaxed atmosphere, but there were places where volcanic processes occurred both on the land and the basins in parallel with the sedimentation processes. Biostratigraphic study of foraminifers in these sections was very interesting. The territory of Georgia covers the northwestern part of the Caucasian segment of the Alpine fold system. The sediments are most developed in the: I. the Caucasus folded system (Gagra-Java zone) and II. the Caucasus intermountain area. Upper Cretaceous sediments are studied in the sections of the rivers Abasha, Tskhenistskali, Rioni, Kvirila, Khotevi, Tskaltsitela. The outcrops of the Upper Cretaceous deposits of the studied territory are found in the Racha synclinal, Odish and Okriba-Khreity zones. It is of interest that in these deposits, with rocks of volcanic origin, the carbonate layers play an important role.

Cretaceous volcanic activity manifested itself on the Georgian block in the time interval from Albaian to Santonian, divided into two stages. 1. Albian - Cenomanian: 30-250 m thick calcareous-alkaline pyroclastolites of theorogenic type have a local distribution 2. Turonian-Santonian, is 300 – 830 m thick.

Section of the Gordi and Tshunkuri riversare represented bythe brownish-pink tuff-gravel stone of different granulation, interlayers of pinkish limestones, brownish tuff-stones with streaks of red and grey limestones, pelitomorphic, light pink, almost white, thick-layered calcareous limestone, light grayish and white, medium - and thick-layered pelitomorphic limestones, with the interlayers of greenish-grey marls and concretions of grey flint.

We have established 5 foraminifer zones: *Marginotruncana pseudolinneiana/M. schneegansi-Eiffelitus eximius* (nannoplankton zone); 2. *Marginotruncana coronata*; 3. *Marginotruncana renzi/M. sigali –Matthasterites furcatus* (nannoplankton zone); 4. *Globotruncanaarca – Ceratolithoides aculeus* (nannoplankton zone); 5. *Globotruncana ventricosa – Uniplanarius trifidus* (nannoplankton zone).

Data on recent PF can be applied for interpretation of the obtained information concerning the fossil material for the paleogeographic reconstructions and specifying paleodepths. The appropriate quantitative calculations allow the building up of diagrams with the curves establishing in the section the changes of the P/B relation, and also the ratios of the "shallow", "transitive" and “deep-water" paleoenvironments (Caron, Homewood, 1983). The main factors that have influence on foraminifer distributions in water column are depth, temperature and salinity of the marine basin. The observations on distribution of planktonic (PF) and benthic foraminifer (BF) shells in modern oceanic silts has shown the following regularity: in areas remote from the coastal line, the PF shells make 99 % of the samples and only 1 % falls on BF. Close to the coastal line this parity gradually decreases and already in sublittoral zone, at a depth below the 50 m, BF reaches 99 %, and PF 1 % (Krasheninikov, 1960). This pattern of distribution of BF and PF (B/P relation) enables to define depths of sediment-formation. The open-sea relations of ecological types of foraminifera shows obvious prevalence of PF (70-99 %). The unstable percentage in PF and BF species quantity is characteristic of open-sea shallow sediments of the mid-shelf. Here calcareous-secretion benthos (P/B – 7/86 %, rarely 15/82 %) usually prevail. The lagoon-sea coastal sediments of the shelf are characterized with the predominance (up to 100 %) of BF. In the studied area they are missing, or sporadically distributed PF (no more than 10 %) are found.There are three associations of recent PF depending on depth of their habitation during the life cycle: 1) The "shallow-water" forms (50 м). 2-3) "Transitive" forms (50m -100m). They are represented by coarser species with spiny and smooth shell walls, sometimes with outlined keel belts. 4) The "deep-water" forms - 100м, represented by genera with thick, intensely sculptured shells having ribs, keels and spines. Thereby, with the increase of the basin depth the replacement in the following order takes place: spherical morphotype, flattened, keel-like, planoconvex "shallow-water" morphotypes: *Heterohelix, Hedbergella, Globigerinelloides, Whiteinella*, "transitive" – fine ones, and to the "deep-water" forms – all with sculptured shells *Rotalipora, Marginotruncana, Contusotruncana, Dicarinella, Globotruncana, etc*. It is assumed that the existing climatic fluctuations were expressed in changes in the winding regime of some PF species, and in relatively high-temperature conditions, the right winding shells of *Globotruncanida* propagate. A high percentage of right shells (90-95%). *Globorotalia* determines the tropical climate, and accordingly, a high percentage of left shells (75-97%) is characteristic of the subtropical climate. The PF complexes are divided into three climatic groups: warm, subtropical and tropical. The Late Turonian is represented by planktonic orictocenosis (P/B-80/20%). The left-coiling species does not exceed 10 %. All data attest to the widening (200-250 м.) and deepening of the basin down to 80 m. The intensive process of volcanic activity begins from this period. The reduction ofleft-coiling shells in the Late Turonian (up to 5%) specifies high temperature (from 22°C up to 25-27°C), that is connected with the ingress of warm waters from the Mediterranean, and activation of submarine volcanism.In the

Early Coniacian P/B ratio corresponds to 85/15%. Number of left-coiling shells does not exceed 20 %. In the second half of the Coniacian the P/B ratio decreases from 75/25% down to 70/30%. And the number of left-coiling shells does not exceed 5 %. All data establish that the depth of the basin is invariable, and water temperature declines to 21°C. At the beginning of the Santonian the PF complex practically has not changed, but at the end of this period new genera have appeared. Benthonic foraminifera make about 60 %, and the left-coiling forms reach 30-40 %. The received data specify that at this time there was an expansion of the basin indicated by the presence of the Middle European forms, and temperature of water has declined to 15-17°C. In some places it reached 20°C, and the depth of the basin amounted 150-200 m.The Early Campanian planktonic orictocenosis (P/B - 80/20 %). The Middle Campanian planktonic-benthic orictocenosis (P/B-50/50 of %), amount of left-coiling forms decreased to 5 %. And the Late Campanian benthos orictocenosis (P/B - 40/60 %). Foraminifera assemblages make it possible to assume that in the Campanian there was a shallow sea with a depth of 150-200 m. At the end of the Campanian depth of the basin did not exceed 100-120 m. The increase of left-coiling forms at the end of the Campanian up to 10 %, is indicative of the higher temperature conditions (20-20.5°C) than it was in the beginning of the Late Campanian. At the same time, horizons with volcanic material in the Late Albian, Middle Cenomanian and Middle Campanian have been dated and characterized in the South-Western Crimea. The Black Sea basin was formed as an arc basin, beginning with the Albian rifting and ending with the spreading of the oceanic crust in the Cenomanian-Early Santonian. Cretaceous appearance, during which sharp paleoclimatic events occurred, caused a significant acceleration of evolutionary changes in the composition of foraminifer complexes. It has been established that during the global events, the increase in the number of existing and emerging species is recorded just before the actual "anoxic event" of the OAE, as well as immediately after it. The most noticeable effect on the morphology and taxonomic composition of the PF was the bordering Cenomanian-Turonian event of Bonarelli (OAE2). The flowering of *Rotalipora*is stopped by conditions of oxygen deficiency. At the same time other PF safely passed this line and continued their developpment - *Hedbergella, Whiteinella, Praeglobotruncana, Heterohelix*. This phase is characterized by a high percentage of PF with elongated chambers - *Schackoina*. Forms with elongated chambers helped the penetration of oxygen into the sink, even with its minimum contents in the water column.

Thus: firstly, sections were studied in which carbonate rocks were formed with volcanic rocks. Applying a new method of material removal, five foraminiferal complexes were identified and with the help of the carried out analyses it is possible to judge that in the Late Cretaceous periodon the territory understudy a warm tropical climate can be inferred, where water temperature varied from 15°C to 27°C, and depth of the basin - from 80 m to 250 м. Troughout the Late Turonian-Early Santonian epoch in the territory of Western Georgia superficial, heatwater basin, with normal salinityexisted. The analysis of distribution of deposits and their structure allows to judge presence of three stages and three large sedimentation cycles: Cenomanian-Lower Turonian, Late Turonian-Companian. The second cycle synchronizes with the beginning of the Late Turonian and the end of the Campanian. While a regressive period comprises mainly the Santonian-Campanian, that well comports in course of time manifestation of the Laramide phase of folding.

STAGE		Zones and layers byannoplankton N. Lapachishvili (this work)	Zones by planktonic foraminifers (Kh. Mikadze)	
			Abasha block	Odishi block
MAASTRICHIAN	U	Micula murus		
	L	Litraphiditus quadraticus		
CAMPANIAN	U	Uniplanariu strifidus	Globotruncana morozovae Globotruncana ventricosa	
	M			Globotruncana ventricosa
	L	Ceratolithoides aculeus	Globotruncana arca	Globotruncana arca
SANTONIAN	U	Ahmuellerella mirabilis	Contusotruncana fornicata	
	M			
	L		Concavatotruncana concavata	
CONIACIAN	U	Marthasterites furcatus		Marginotruncana renzi Marginotruncana sigali
	M			
	L		Marginotruncana renzi Marginotruncana sigali Marginotruncana coronata	Marginotruncana coronata
TURONIAN	U	Eifellithus eximius	Marginotruncana pseudolinneiana	Marginotruncana pseudolinneiana
	M		Marginotruncana schneegansi	
	L		Helvetoglobotruncana helvetica Whiteinella archaeocretacea	
CENOMANIAN	U		Rotalipora cushmani	
	M		Rotalipora brotzeni	
	L			

Fig. 1.Correlation scheme of planktonic foraminifera and nannoplankton.

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MINERALIZATION LOCALIZATION FACTORS WITHIN THE KHACHKOVI ORE-OCCURRENCE

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Khachkovi ore-occurrence represents the peripheral part of the Gujareti-Khachkovi ore field and within its limits propylitic and gold-bearing quartz-polymetallic veins and impregnations are developed. Predominantly, the yare associated with the activation ofconvection system. It is likely that at the later stage, metamorphogenic regeneration of ores along the fault zones and fractures should have taken place. It is not excluded, that the hydrothermal solution repeatedly reacted to the ore bodies and somewhat to their assimilation and then deposited in favorable for the ore physical-chemical conditions.

In Middle Eocene tuffogenic rocks 0,5km wide ore zone of sub-latitudinal orientation is distinguished. Along the river Khachkovi it forms the area of intensive mineralization. It is represented by the host rocks, which are saturated with quartz-calcite-barite veins. They contain veins and impregnations of sulphide.

Asa result of Remote Sensing conducted by us during the research still unknown zones of mineralization at the Khachkovi ore-occurrence were discovered, where new gold-bearing areas were established applying spectrometric, principal component analyses and international standards of mathematical modeling. The results of the survey were checked at the spot and they coincided with the previous researchers' data.

MINERAL WATERS LOCATED AT THE STEPANTSMINDA-JVARI PASS OF GEORGIAN MILITARY ROAD IS THE SIGNIFICANT RESOURCE FOR THE DEVELOPMENT OF MOUNTAIN RESORTS

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Georgian military road is the international significance traffic main, on which at any period of the year the passenger and cargo transport flows permanently from the south to the north and vice versa.

Healthy air and abundance of outcrops of transparent carbonic acid mineral waters gives more charm to the territory neighboring the Stepantsminda-Jvari pass section for building mountain resorts.

With the geotectonic point of view this territory is located in the contact of two zones of the Caucasus folded system – Kazbeki-Lagodekhi and Mestia-Tianeti folded zones [1].

Abundant puncture or frontal outcrops of mineral waters of the territory under study according to spatial closeness and identity of chemical composition of water can be divided into the following groups: (from the north to the south) Pansheti deposit, Sioni spring, Kanobi well, Kobi deposit, Sadzeli gorge group, Kulagin group, big and small Mayorsha (Fig.1).

These mineral waters are impregnated with carbon dioxide air; their mineralization is within 2.0-4.0 g/l. In mineral waters spreading there is a clearly expressed regularity: waters spread in Kazbegi-Lagodekhi zone (from Pansheti to Kobi inclusive). Mineral waters of the studied territory are cold (temperature is within 7-12^{0}C) they don't contain toxic substances; they are pure, transparent, odorless, of pleasant taste, which is intensified by their impregnation with CO_2.

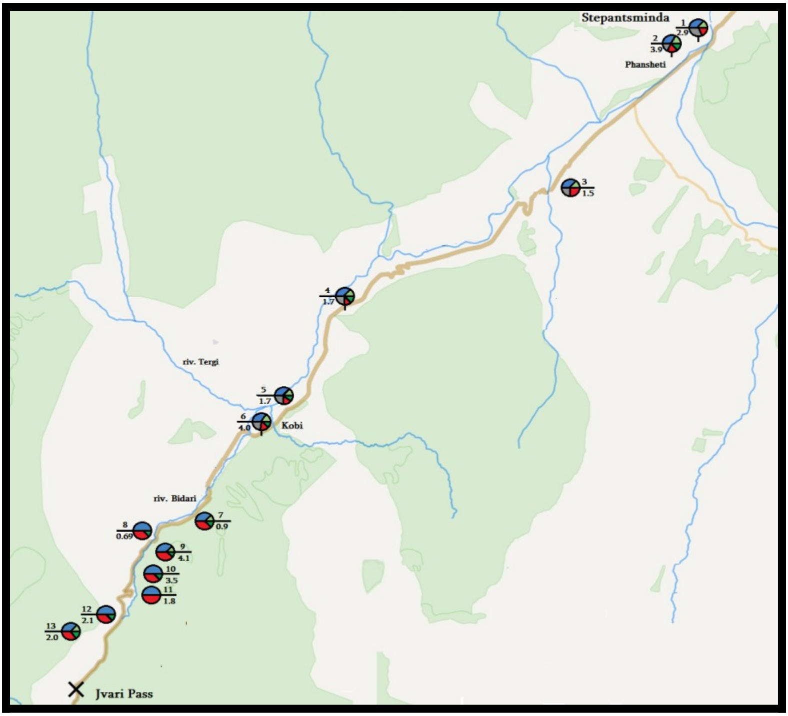

Fig.1 Schematic map of mineral waters of Stepantsminda-Jvari pass section of Georgian military road.

First of all type of carbonic acid alkali-salt waters are rather interesting (Pansheti, Sioni, Kobi well) and on the base of their resources it is expedient to create spa-climatic resorts.

Among mineral waters of the studied territory mineral water taken from Kobi well № 9 is distinguished by high soda composition, its mineralization equals to 4.0 g/l. Mineral water of Kobi well by its chemical composition resembles the world-wide known Borjomi mineral water.It has wide prospects of application, both in bottled form and for drinking at the spot – just drinking and for therapeutic purposes.

Other mineral waters belong to low and weak mineralize-tion carbonic acid hydro carbonaceous-calcium type (small and big Mayorsha, Kulagin, Sadzelis Khevi and other sources). It is profitable to organize mineral waters pavilions and screened pump-rooms on their base.

As a result of arranging not deep (100-200m depth) wells in the Bidrarivergorge, the right tributary of the river Tergi, alongside with the extraction of large capacity mineral waters, we can reveal significant resources of carbon dioxide gas.

Starting up of mineral waters drinking objects, therape-utic-healing, bottled waters and enterprises, which would ext-ract natural carbon-dioxide gas in the area of the above stated zone will undoubtedly contribute to the improvement of social-economic conditions of the mountainous region – Khevsureti.

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MUD VOLCANOES

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Great majority of the mud volcanoesof Georgia is located in Eastern Georgia – in Kakheti region. Volcanoes are interesting both visually, for example as tourist routes, also mud therapy, and most importantly, oil and gas deposits are associated with them. In Georgia and Azerbaijan, adjacent to the mud volcanoes, active oil and gas production is going on.

We are going to explore the mud volcanoes of Georgia and compare them to the Azerbaijan volcanoes. One of the reasons may be the scarcity of oil on the territory of Georgia compared to Azerbaijan and the establishment of any regularity by the variability of the components.

In 2018, in Baku, a geological excursion was arranged on the Gobustan mud volcanoes, from which we took the mud sample. We also took samples from mud volcanoes in Kakheti – Takhti-Tefa in 2019. We performed chemical, microchemical and other analyses of these samples, conducted surveying of the volcanoes of Takhti-Tefa and created a 3D map.

Unlike the Gobustan volcanoes, on the territory of the Takhti-Tepa volcanoes, fragments of calcite were found. Observations have shown us the cause of fault-formation, which generated the Takhti-Tefa volcanoes. On one side the calcite sample has the form of the slickenside surface. Calcium-rich solutionintruded into slip joints that developed due to tectonic motion and gained the form similar to the slickenside. Over time, pressure volcanic mud brings calcite to the surface. The mud consists of Maicop clays, water and gas.

GEOLOGY AND MINERALIZATIONOF THE WESTERN SEGMENT OFADJARA-TRIALETI

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The Achara-Trialeti folded structure is one of the elementsof the lineament of latitudinal direction in the Caucasus, which is formed on a solid sialic substrate.It is a 400 km long and 50 km wide linear structure built of extremely thick Cretaceous, Paleogene, mainly volcanogenic and flysch, formations. In the extreme western part the latitudinal structure abruptly changes its direction for the southwestern, which is the result of the action of the global Ponto-Caspian lineament and that is why the Ponto Mountains represent the continuation of the Achara-Trialeti folded system. According to geophysical data the lineament of latitudinal strike is established in the form of deep-seated faults on the Black Sea floor [1].

According to the tectonic tension, there are three transverse zonesin the region.In the northern and southern zones folding is weak - thereis mostly blocked folding, the fold angle does not exceed 30°. Relatively tail and steep folds are connected to the central, axial part where the rocks are more deployed and the inclination angle of the folds reaches 60-80° in the immediate vicinity of the rifts. In the northern part of the district, at the Georgian block, the folds are slightly inclined to the north and in the southern part – to the south. This phenolmenon, in our opinion, should be explained by the expansion of the dislocated and labile blocks raised between the solid blocks in its central part. The same phenomenon must be associated with the existence of gentle fault structures in the extreme northern part of the fold system.

The grid of orthogonal-diagonal system is basically created byfault structures [2]. It is difficult to identify them because of a thick soil layer and intensive vegetation, but they are well deciphered in aerospace photos. An important system of faults of latitudinal direction is connected to the central axial zone. Some of them are foundon the northern edge of the Shuakhevi syncline, while the narrow anticlines of Peranga and Khino are intensively crushed and actually represent fractured zones.

The strong fault of north-eastern strike in the north-western part of the region confines the Guria depression from the south-east. Numerous negative forms of relief occur along it, while the difference of absolute heights in the surrounding blocks is about 500-700 meters with the lowered north-western block. The fault zone in question forms the coast of Batumi cape in the south-west direction, while in the Turkish waters it causes sharp lowering of the seabed by 700-800 meters. Several faults of this system have been revealed in the district - some of them crossthe entire fold system diagonally and go even beyond it.

The faults of north-western strike are widely common. There are several important faults in Keda district, on the territory of Merisi deposits, in the southwestern limb of the Shuakhevi syncline and in the vicinity of the village of Vakijvari. The northwestern fault system is a part of the trans-regional lineament that extends to the southwest of Iran at about 1000 km and controls many minerals deposits, including gold and copper-polymetallic ones.

Meridional faults cover the entire folded system, but in this system two important zones are distinguished. One of them, which is 10 km thick is situated in the southwestern part of the region. It contains numerous faults that expand to Guria depression.This zone determines the configuration of the Black Sea basin and restricts it from the east.

The second one - 12 km thick intensely dislocated zone is deciphered in the Shuakhevi district. This zone is one step of the western depression of Achara-Trialeti and unites many parallel structures. In Shuakhevi district dikes and small elongated intrusive bodies are connected to them. In the mentioned tectonic zone, a great number of dike bodies are deciphered from Shuakhevi to the Georgian block in north, which is reflected in sharp linear positive forms of the relief. Meridional tectonic zones are the constituent parts of the global lineament, so called Shastky rise, which had originated before the Cambrian. It is functioning in modern times too, which is indicated by the drop of the relief absolute marks in the western blocks by about 400-500 meters.

Important intrusive bodies of the region are united in two tectonic-magmatic knots - Merisi-Uchambo and Vakijvari. In the trusives of average content (syenites, syenite-diorites, granosyenites, etc.) are the Upper Eocene and, according to our data, they are sheet intrusives with inclined occurrence elements. The neck raising them is steep and usually associated with the northeast faults. Wide fields of hydrothermal changes, exposuresofsulfurpyrite and alunite.Copper-polymetallic gold and gold mineralization, in our opinion, is associated with base later-age intrusives-gabro-diabases, which supposedly originated in the Upper Miocene-Pliocene, associated with the Sairme orogenicphaseandareintensivelydeveloped in the areas of mineralization. These bodies are usually connected to meridional faults.

Clay deposits, both of brick and ceramic clays, as well as of the bentonite, are associated with north-eastern fault, which borders the Guria depression from the south-east. Output of mineral and thermal waters, as a rule, are connected to the knots of the intersection of the faults of various directions.

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PRECAMBRIAN RELICTS IN PALEOGENE ACHARA-TRIALETI FOLDED ZONE, LESSER CAUCASUS: IMPLICTIONS FOR ZIRCONS U-Pb GEOCHRONOLOGY

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Adjara-Trialeti is a rift zone, formed by the end of the Cretaceous, developed during the Paleogene, by the end of which it underwent folding [1]. It is mainly constructed by trachytic and trachytic-andesitic volcanogenic-sedimentary rocks, though plutonic rocks also play an important role in the structure, which are mainly represented by syenite, monzonite and gabbro.

The zircons from ore bearing plutons of folded zone were dated by U-Pb method at National Taiwan University, Taipei, Taiwan. Based on the results of the research these plutons (Merisi, Namonastrevi, Vakijvari, Zoti, Okros Gele, Rkviana) are considered as the products of one tectonic-magmatic activity developed through the shortest period of time, specifically between 46.77±0.81 and 42.03±0.83 million years, during which they intruded into hosting volcanogenic-sedimentary rocks [2].

During the research carried out in the Adjara-Trialeti folded zone an important geological data have been obtained. In particular, during the dating process of the zircons by U-Pb method, we found the out that the Vakijvari pluton is composed of the Precambrian, namely Neoproterozoic relics. These relics outcrop fragmentally to 30 m distance and are represented by oval blocks of 0.7 – 1.5 m diameter, which are also crushed into small parts (Fig. 1).

Fig. 1. Fragment of Precambrian Relics in Vakijvari Pluton.

The Precambrian relics are represented by massive, fine-grained, dark olivine basalts with plagioclase (up to 70%), augite (up to 20%), olivine (up to 2%), epidote (up to 1%) and volcanic glass (up to 10%) composition. In these rocks zircon crystals of 50-200 micrometer have been identified, which were dated at National Taiwan University by U-Pb method on LA-ICP-MS equipment by Chew et al. [3].

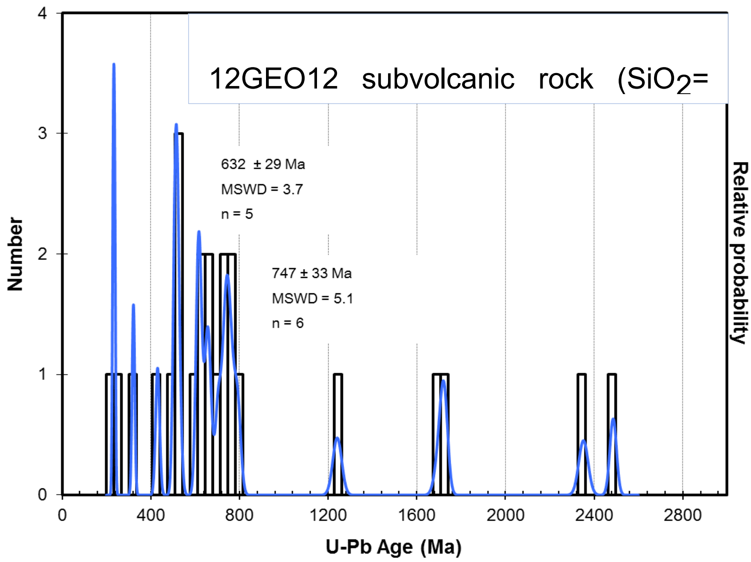

Fig. 2. Zircons Dating Hystograms fromVakijvari Pluton Precambrian inclusions (sample - 12GEO12).

The results of zircon dating were quite unexpected for us, since the average isotope age of zircons defined 632±29million years, which corresponds to the Precambrian, Neoproterozoic era. The existence of Neoproterozoic relics in the Middle Eocene (43 Ma) intrusive demonstrates the complicated geodynamic evolution of the region. It is likely that we should consider this fact as an indicator of a large volcanic explosion of the Middle Eocene.

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THE “TREATMENTS” AND “SIMULATION OF ”INCLUSIONS
THE TECHNIQUE OF 23+4 (FOR THE FIRST TIME)

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Part A: Some gemstones do not have enough quality for cutting or using in jewel making. Therefore, you have to do some process to improve color, clarity, stability etc. In fact, the quality of these gemstones must be increased or changed. This process is called treatments. The Georgian Gemstones has not enough quality and they need to color and/or clarity treatments.

Part B: After 8 years of research in the field of treatments of gemstones, the methods have been developed whereby it can be done on the gemstones in a topical and fully controlled manner, and their inclusions or blemishes can be created. I call this process a simulation of inclusions.

In this article, we will present the treatment and simulation treatment of gemstones.

Part A. Georgia (country) has more than 30 gemstones but some of them are more important than the others. Gemstones like agates, carnelian, sard, aquamarine, quartz and ..., but more of these gemstones need treatment for changing their colors and some of them for changing their quality. For treatment of these gemstones, we need acid and/or heat treatment.

Part B. The formation of internal and superficial impurities in gemstones by simulation method has different uses, but one of the most important is commercial use. It's not easy to create inclusions in the gemstones, inside them and in a controlled manner. Especially, there arise a dilemma if that gemstones is small or the purpose of the simulation is to create a particular inclusions in a particular part of a gemstone. Though initially, this research was developed in the process of PARA-ANALYS project (from the author's innovations), but later, with the focus on its business aspects, the formulas have changed, and today, using this method, it can be reconstructed or non-harmonic, Made. Even the process of eliminating a local, centralized or total inclusions can sometimes be simulated in the form of a project, until it loses its other defects, it gives a new form of a particular purpose. As the inventor of this project, I presented it in Iran for the first time, but I will present it in more detail in this article.

Before treatment or simulating, you must first examine the gemstones, which is the first step after the initial review is the Talentology [1]. This means that we must examine all the angles of gemstones to determine the talent of them in accepting treatment and simulation.

The Talentology in gemstones is done in a variety of ways, but the first and most important principles in Talentology are type and size of the gemstone, the volume of absorption changes, and the five-dimensional characteristic of the inclusions. Combining these three principles, the initial talent of gemstones in accepting treatment or simulation will be determined.

We found out in research process that all gems have the initial talent to upgrade, but they have no secondary talent to accept general changes or local changes to treatment or simulate.

Most importantly, some examples of secondary talent also exhibit unpredictable resistance when they are in the process of general or local treatments, and / or accept improvement, but more than what we need.

In this case, the changes resulting from the treatments will pass through the designated parts and enter into other parts, and this interferes, causing unwanted states. Such as changing color, color degradation, general or localized tension, cracking, burns, fractures, etc.

In the process of treatment and simulation, different modes are applicable such as [2]:

surface treatment and Simulation, treatment and simulation of uncontrolled localization, Single and Multiple Controlled treatment and Simulation (Dual and More), Color treatment and simulation, non-color treatment and simulation, liner treatment and simulation, and more …

These changes are for the following:

Color change, increase color, color reduction, cleanliness, general treatment, overall quality, making phenomenon, phenomenon removal, increased Stability, making inclusions or blemishes, weight treatment and etc.

Acid treatment is one of the main ways to change or reinforce the color of chalcedony in Georgia, but in the research process, it became clear that no desired result would be obtainned without heat. In most cases, Georgia's chalcedonies showed great resistance to the final change of color. In the sense that they have the initial talent of treatment but they have no secondary talent. This mode, in particular is for changing color showed much more than improving color. For this reason, before starting to improve the color, these gemstones should be placed in acid so that their strong structure is broken. Meanwhile, in the reconstruction of the color of the Georgian Chalcedonies, unlike the other Chalcedonies (such as the Chalcedonies of Iran-Qom, the Yemen and/or Iraq, etc.), it is not possible to obtain the desired result only with the use of acid. It is necessary to use a gentle indirect heat to gaining a better result. Meanwhile, this heat, even occasionally, must be increase at the beginning and must be decrease at the end of treatment. The acid and heat interference should also be used for fancy colors or the creation of two colors in a chalcedony.

In the simulation process, when the surface upgrades treatments are used, at least 60% of the blemishes, should be on the surface of the gem. Otherwise, they are inclusions near the surface, not the blemishes.

Acid can be used to create talent in resistant or non-talented gemstones for making primary and secondary talent. Sometimes general heat can be used to break the resistance structure.

Of course, in some cases, it is best to put the gems before surface finishes under superficial treatment for surface simulation to use surface polish to correct blemishes if left out of control.

If the purpose of topical treatment is a superficial color simulation, then two or three techniques can be used in sequence, but first of all is to create inclusions and after creation, it is possible to create techniques for creating color.

If the purpose of the simulation is to create the inclusions-analogous in certain parts, then the gemstones must be placed under the acid or thermal treatment process before being simulated. But the duration, intensity, or concentration of the acids will vary depending on whether or not the primary and secondary talents exist, but the point is that one should never simulate a gem without first testing and determining the result. In fact, must to put different gemstones with any attribute first under the simulation test, and when the outcome of the work is determined, the simulation can be done as a business order.

In the simulation of inclusions, should be insulated some parts of gemstones that do not need to localized treatment, must be insulated so that heat and acid do not damage them. The heat used to local simulation is different [3]: The general heating to create the talent for the acceptance or topical treatment, Concentrated heat/spot heat, Linear localized heat, Indirect heat (with higher pressure but less time), local or general.

An important thing in general heating is disconnect and attach in some special situations. Because this action creates tensions in depth and surface separately, these tensions help to localized simulation.

By doing this, it will prevent cracking or damaging of the gemstones in the process of localized simulation.

The simulation in Aggregated gemstones differs greatly from crystalline gems simulation. For example, simulation in opal and jade is different from Simulation in Quartz or corundum. The first difference is the concentration and shape of the use of acid, and the main difference is the shape of the heat and its degree of application.

In the simulation of aggregated gemstones [4], acid plays the role of maker of simulation, and the heat will be complementary, but in crystalline gemstones, the heat is maker of simulation and acid plays a complementary role - sometimes with colored acids and sometimes with colorless acids.

In some methods, the simulation is composed of two general stages. For example, in some gemstones, with the use of heat and acid, an impurity is created. However, in some gemstones, the impurity is created, but again they must be placed in the process of local treatment so that the inclusions created, grown, and reached the desired size, or they achieve the desired color or take on a particular shape.

The temperatures used in the simulation are different (depends on the type of gemstones) and usually vary from 250° C to 1600 °C. Generally, at a lower temperature, heat is permanent and indirect, but at high temperatures, it is indirect and occasionally interrupted and re-connected. This disconnect, other than the creation of the space required to accept stress, has another cause, and because of the difference in the coefficient of thermal expansion of the inclusions of that gemstones. Particularly some inclusions that they are small and is not easy to see them, not even under60-x magnification in microscopes.

In the world of gemstones treatment and simulation, every day, there are different techniquesin which there is a rejection of the complex research of researchers and gem-treaters. Local treatment is one of the best techniques in the world of simulation, and if the makers and scientists use this technique in the best possible way, there will be gems that will ultimately resemble natural gems, and their recognition will only be in the Modern labs or with the help of new auxiliary techniques. The simulation of inclusions and blemishes is the new technique in the world of treatments if inclusions.

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“SSPC” CLASSIFICATION SYSTEM-BASED ASSESSMENT OF SLOPE SUSTAINABILITY OF THIRD MINE TAILINGSPILE OF THEMADNEULI QUARRY

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Based on the complexmorphological, relief, hydrological, hydrogeological and engineering geological conditions of the Madneuli quarry and its adjacent area, in a number of sites (subject to geological structure peculiarities) during the quarrying as a prerequisite for ensuring normal conditions, we consider it necessary to establish systematic geo-ecological supervision of sensitive areasto be timely detected and implemented preventive measures against the development of dangerous geological processes and impending complications.

Intensive fragmentation ofquarry slope bedrocks, the existence of tectonic faults and water-bearing horizons as well asmassive explosions is the causes of geodynamic (mainly landslide) processes. During the drill-blasting disturbance of natural fissure system and new crack formation takes place, at the same time the existing fissures widen and appear additional pathways for atmospheric waters ingress into depth.

Thus, thequarry, underground mining, drilling-blasting and mine tailings change the geological environment, natural water sourceand draining scheme.Also abruptly changesthe intensity of physical-geological processes.

Assessment of slope stabilityhistorically was and still remains, one of the most complicated problems of engineering-geology.There are many methodsof calculating slope sustainability (both natural and anthropogenicones), which are divided into two main groups:

- Limit equilibrium theory, which is based on difficult mathematical calculations;

- Approximate methods, which is based on calculations of the limite quilibrium of land masseson the slope, along the alleged surface of sliding.

It is necessary to considering natural and anthropogenic factors in the concrete area.The landslide (as already happening event) hasa sliding (creeping) surface.Thoughin the case of the slope there is not a surface of sliding, it may appear, when tension will surpass resistivity.

Differ the opinions on the assessment of the causes and landslide facilitating factors. Particularly, in the question, which reason or factor has a priority? In these geological conditions, the reason for the landslide may be the height of the slopeas well as the depth of fragmentation of the area and relative height. Only in case of shallow landslide, this possibility is induced by the slope inclination, independently of its height.

There are practically some combinations of factors and reasons, which cannot be fully considered (by default of quantitative evaluation). For this reason the use of accurate mathematical calculations is limited and it is necessary to select semi -empirical techniques justified by practice.

Assessment of slope sustainability of the third mine tailingspile was accomplished with a new classification system - (SSPC – Slope Stability Probability Clasification), which concerns not only landslide slope but also generally slopes. This method was developed by Dutch scientists R. Huk, D. Prais and N. Rangers.

Due to the lack of laboratory equipment andwith limited financing, the use of this method is rational and prospective.

The solution of the issue is carried out in three stages:

- At the first stage, the mechanical parameters of the massif are assessed visually (in one or more cross sections).

Theoretically, here is admitted the continuity of the massif, which means the establishment of parameters in the massif;

- At the second stage, mechanical parameters must be studied, taking in to account the processes of natural weathering.
- At the third stage, must be estimatedthe real slope stability, with due regard to discontinuity – discreteness, which can be a normal phenomenon in nature and can appear artificeally as a result of construction activities.

The quantitative assessment of the change in the mechanical properties caused by the discretion is done on the SSPC method, which is carried out with a relatively simple field-based observation and not the laboratory tests that are often rather time-consuming and require extra finances. Assessment of slope sustainability starts with visual study and mathematical calculations as well. For example, if the angle of the inner frictionis more than slope inclination angle, which is expressed by this condition $\frac{\phi}{\alpha} \geq 1$, the slope is sustainable. If the angle of the inner frictionis less than slope gradient, in this case the next stage is calculation of maximum permissible height $(H_{\max})$. Which should be compared to the factual height of the slope (H_{fact}), in order to make the final conclusion about the slope stability or instability. In this case, the sustainability depends on the ratio of the maximum permissible height and factual height, which is calculated by the formula:

$\left\{\frac{\phi}{\alpha} < 1, \frac{H_{\max}}{H_{fact}} \geq 1\right\}$ - the slope is sustainable;

$\left\{\frac{\phi}{\alpha} < 1, \frac{H_{\max}}{H_{fact}} < 1\right\}$ - the slope is unsustainable.

Withinthe third mine tailingspilearea, according to the calculation of slope sustainability, we have distinguished four blocks, where the sustainable and unsustainable localities were identified. Issued from the e investigation data, conclusions have been drawn and recommendations developed.

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OPPORTUNITIES AND PERSPECTIVES OF DETECTING WATER-BEARING HORIZONS WITH THE HELP OF GEOPHYSICAL, REMOTE SENSING METHODS

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Demand for water has increased in agricultural sector of Georgia, in parallel to strengthening private business. Increase of demand was caused by growth of cultivated plough land areas as well as putting into operation of new enterprises for processing of agricultural products. Substantial deficit of drinking water was caused by disruption- failure of the existing irrigation network.

Thisproblemis particularlypressing inregions with semi-desert climatic conditions (Marneuli, David Gareji, Shiraki), especially for small farms and processing enterprises. In parallel to the processes of resolution of the problem of centralized water supply and restoration of irrigation system networks, there are alternative ways of reduction of demand for water; one of those is production of agricultural products by modern, cost-saving technologies and equipment of processing industry with the newest technological lines. It has become actual to create autonomous irrigation systems, operation of which will beensured on the basis of local resource–from the existing, as well as surveyed and then developed water points. Irrigation complexes,equippedwithadvancedtechnologies, provide opportunity for satisfaction of the needs of specific, individual farms and enterprises by small operational resources of ground waters (1m^3 capacity drilled well, can provide farmland (2500 m^2) with drinking and technical water if technogenic watering cycle is properly planned). For Development of local potential of ground waters, planning and drilling of individual drilled wells is actively introduced. Such works are usually offered by the representatives of small and medium business. Their financial resources are limited and the risks of unjustified expenses shall be minimized. The client required guarantees of achievementofpositiveresult: preliminary data on existence of ground water horizons, parameters of area of their spreading and depth of location. For satisfaction of these requirements, existence of solid projection basis is necessary; in the case of its absence, it shall be created. It is obvious that implementtation of survey drilling works, requiring adequate expenses is inadmissible for a client.Implementationofpreliminary survey activities using relatively cheap, remote sensing geophysical methods is a way out of situation.

Presently, methods of electrometry are approved in Georgia:electrictomography(according to "dipole-dipole" scheme) and vertical electric sensing ("VES"). As a result of surveys, it is possible to develop electric tomography and geo-electric cross-sections, reaching to the depth of 200-250 m, where ground water-bearing zones are allocated. The developed cross-sections will form basis for projection mapping of spreading of ground waters.

Projection data, obtained using these methods, are substantially cost-efficient on the basis of projection data, created as a result of survey drilling; however, field works require specialized devices, road vehicles, professional and support workforce. At the same time, for a drilled well, deeper than 100 m, due to specificity of structure, the cost of development of 1 linear meter, on average, increases by 60%. Statistical data show, that the abilities of small business is mainly limited to development of drilled wells with the depth up to 100 m. For survey of the layers, located at more shallow depth, geo-radiolocation, over ground geo-scanning technologies are currently approved in the world. Geo-scanner (GPR) represent compact, mobile device, transportation and use of which is possible in “manual” mode, as well as from any motor-car. Its principal scheme includes three basic elements: Power source (supplier), control panel, antenna (with transmitting and receiving parts) (Fig. 1.a).

Radio-locating energy impulse is formed in the power source, which is provided to the antenna, amplified and transmitted to the different environment (ground). Its reflection from the environment is recorded by receiving part of the antenna. Technical data of all the three components define value of geo-scanner – directly monetary, as well as from the viewpoint of ability of high-quality performance of the set tasks. The structure of geo-scanners provide opportunity of its non-standard completing. Antenna, working at low frequency, increases the data of in-depth reach. In-depth penetration ability of signals and clarity of the sensed image also increase in the mode of bistatic performance (with two antennas) of the geo-scanner. The structure of geological environment – lithology, metamorphism, occurrence of cracks - has significant impact on the quality of results of geo-radiolocation.

Presently, geoscanners are represented on the world market in quite wide spectrum. As a result of marketing researches and direct contact with producing companied, considering all the above-stated factors, geo-scanner Akula9000C, produces in Sweden, with antenna Gekko50, geo-scanner Phyton-3, produced in Latvia, with simpler structure, have been considered the most appropriate for Marneuli, David Gareji and Shiraki regions, for survey of ground water layers, located at the depth up to 100 m (Fig. 1 b.c).

a

b

c

Fig.1. **a**. Typical Geo-scanner; **b.** Akula9000C and antenna Gekko60; **c.** Phyton-3,with combinations of antennas.

Learning and establishment of radiolocation method in Georgia,in addition to the sciences, studying the Earth (geophysics,engineering geology), will become consumer technology for the spheres like archeology, construction, arrangement and search of underground utility systems, humanitarian mine neutralization.

PRODUCTION OF GEOPOLYMER BINDERS USING LOCAL RAW MATERIALS

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Industry of construction materials in Georgia is wholly based on the calcined hydraulic cementing material Portland cement and the concrete produced from it. Due to the lack of cement and high cost for energy supplies, the research of opportunity of receiving the alternative geopolymeric binders, produced without high-temperature burning, is very important.

One of the main components for the production of geopolymers is metakaolin, which is obtained by calcination of minerals of the kaolinite group or kaolin clays at 500-800°C. World reserves of these materials are limited and there is much interest in obtaining metakaolin from polymineral clay materials [1, 2].

Metakaolinisanen vironmentally friendly material, which is characterized by high strength, high resistance in different environments, good adhesion and heat resistance.The mechanism of action of metakaolin is based on the interaction of aluminosilicate with alkali and alkali silicates. High-quality metakaolin contains 50-54% SiO_2 and 40-45% Al_2O_3. Metakaolin is a binding material that has a good effect on the strength of concrete, its rheological properties, frost resistance and durability. Metakaolin is used in dry construction mixtures. It has high pozzolan properties. In order to obtain metakaolin and geopolymer binders from it, clay shaleswere used from the

Duruji Riverbanks, which have accumulated for tensof years due to sill-mudflows [3-5].

XR phase analysis and TGA revealed an active temperature zone within the range of 600–800°C, which is associated with the destruction of the crystal lattice of clay minerals in the shale and the formation of an active amorphous phase –metakaolin.

A calcined temperature regime was developed for modifying shale with the aim of obtaining the maximum amount of metakaolin. Binding samples were made using calcined shale, granulated blast furnace slag with the addition of 30% sodium hydroxide - NaOH solution. Samples of cubes were molded from the paste of normal density and tested for strengthafter curing in different environments (Table 1).

Table 1

The results of physical and mechanical testing of geopolymer binders

№	Specific surface,cm^2/g	Paste of normal density, %	Compressive strength after 28 days. kg/cm^2		
			Air	Water	Water-wet
1	8550	29.1	550	350	400
2	9055	27.5	228	170	185
3	8700	29.1	560	360	376
4	8050	30.0	640	440	475
5	8200	30.8	630	380	420

The obtained data prove that calcined shale, together with granulatedblast-furnaceslag, actively interact with sodium hydroxide and form a geopolymer binder, which is associated with the formation of metakaolin in calcined shale.

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DEVELOPMENT OF TECHNOLOGY FOR PRODUCTION OF AGGREGATE FOR LIGHTWEIGHT CONCRETE - CLAYDITE BASED ON THE SHALES OF GEORGIA

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Lightweight concrete is one of the most energy-efficient building materials. This is due to its high thermal insulation properties, which makes it possible to reduce the thickness of the walls and reduce the high consumption of building materials. Saving building materials is saving the consumption of fuel and energy resources for their production.

Asthe world practice of building shows, 60% of the outer walls of large-panel buildings consist of blocks of ceramsite concrete.Claydite - ceramsite itself in bulk form can be used as heat insulation of roofs - attics and interfloor ceilings.

Claydite is a lightweight porous material, which is obtained by burning clay rocks at a temperature of 1100-1250^{0}C in rotary kilns. By grain sizeclaydite gravel can be of the following fractions: 5-10, 10-20 and 20-40 mm, granules smaller than 5 mm are expanded clay sand. By bulk weight they are divided into the following grades (kg / cm^3): from 150 to 800. Water absorption of expanded clay gravel is about 8 - 20%, frost resistance - at least 25 cycles.

Depending on the type of raw materials, there are four methods for the production of claydite: wet, plastic, powdery and dry.

The most common is plastic method, because this method uses soft clays widespread in nature.When using this method, the clay is ground by a wet method in roller crushers. Then, from the plastic mass of clay (with moisture content up to 20%), granules are formed, which, after drying in a tumble dryer, are burned in rotary kilns.

Production of claydite by the dry method is possible only with the use of stone-like raw materials, such as shale. The dry method is more simple and economical, because this eliminates the stage of forming and drying the granules and the crushed raw material enters directly into the kiln.

Worldwide the demand for lightweight concrete aggregates is steadily increasing. Although this demand is satisfied only by 70-80% due to the lack of raw materials.

At the same time in Georgia, in the Duruji river valley, due to sill-mudflows, several million cubic meters of clay shale accumulated over the course of many years posing a certain threat to the local environment, especially to the environs of the town of Kvareli [1-4].

Our laboratory studies prove the possibility of obtaining claydite from shale of the Duruji river [5]. When calcining shale at a temperature of 1200-1170^{0}C, claydite granules of different fractions were obtained. The coefficient of expansion was 2.7 - 3.

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ENGINEERING-GEOLOGICAL ASSESMENT OF EXOGEODYNAMIC PROCESSES OF THE ARAGVI RIVER BASIN

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The activity of exogeodynamic processes is especially distinguished on the right slope of the river Tetri Aragvi from the village of Ganisi southwards to the village of Kvemo Mleta, where the rocks are strongly fissured and weathered, integrity of mountain massif is violated by tectonic dislocations. The rocks in the exposures are easily subject to weathering-gravitational processes. Thickness of the crust of weathering is from a meter to tens of meters.

Based on field-survey in the Aragvi river basin hazardous geodynamic events and processes were revealed, their morphological characteristics, the factors and causes that conditioned their dynamics were established. Applying aerophoto-interpretations and GPS technologies their boundaries were contoured and plotted on the relevant maps. In the selected areas the constituent rocks were sampled and their physical-mechanical properties determined.

Based on the processing and analysis of stock, literary and field materials, the electronic schematic engineering-geological map of the study area was created.

In the study area 126 mudflow canyons, 264 landslide bodies, 180 rock-fall and 76 deep and sheet erosion zones are recorder and respectively plotted on the scheme.

In the Aragvi river basin, 570 localities were distinguished by landslide-gravitational and mudflow activity and according to the zoning map data high and very high risk areas reach 47% that equals to 1275 km^2. 107 mudflow valleys developed in the fold-nappe system of the Greater Caucasus, in the mountainous Kazbegi-Lagodekhi fold-imbricate district, in the flyschoid formation of the marine-genetic type, hypsometrically are situated mainly within 1500-3800m altitude.The rest of the mudflow gorges are developed in the Transcaucasian intermountain area in the hilly-undulate subzone of Shida Kartli eastern molassic depression zone in the continental slope and shelf formation genetic types represented by molassic sediments thatcover the area mostly within 400-1500m altitudes.

218 landslide bodies (covering 348800 m^2 of total landslide area) of 264 landslide bodies (422400 m^2 total landslide area) bodies developed in the fold-nappe system of the Greater Caucasus, in the mountainous Kazbegi-Lagodekhi fold-imbricate district, in the flyschoid formation of marine-genetic type, hypsometrically are situated mainly within 1500-3800 m altitude. The rest of the landslide bodies (over 73600 m^2) are developed in the Transcaucasian intermountain area in the hilly-undulate subzone of eastern molassic depression zone of Shida Kartli plane in the continental, continental slope and shelf formation genetic types represented by molassic sediments and occupying the territory mostly within 400-1500 m altitudes.

164 stone fall areas of 180 onesspread in the Greater Caucasian fold-nappe system in the high mountainous Kazbegi-Lagodekhi fold-imbricate region in the flyschoid formation of marine genetic type. Hypsometrically they are situated with in 1500-3800 m altitudes. 16 stone-falllocalities in the Transcaucasian intermountain area, in the hilly-undulate subzone of Shida Kartli eastern molassic depression zone in the continental, continental slope and shelf formation genetic types represented by molassic sediments cover the territory mostly within 400-1500 m altitudes.

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ON PETROMINERALOGY OF METATERRIGENOUS ROCKS OF THE DZIRULA CRYSTALLINE MASSIF ALLOCHTHONOUS COMPLEX

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The metamorphites of the Chorchana-Utslevi allochthonous complex are represented in the southeastern part of the Dzirula massif within the Chorchana-Utslevi and Bzhinevi areas. Lower Cambrian, Upper Silurian (Llandoverian) and Lower- Middle- and Upper Devonian ages of the complex rocks are determined faunally. Petrographical description of the allochthon metamorphites are presented in the papers of a number of researchers. In 1980s, the detailed division of the "series" of metamorphic schists was accomplished [1]. Among the metamorphic schists two overthrust sheets of different ages were distinguished [1] – Chorchana (Lower Cambrian - Vendian?) and Ninisi (Middle Paleozoic) overthrust sheets, which are overlain by Late Paleozoic volcanogenic rocks. Three temperature stages of greenschist facies of prograde regional metamorphism are identified [2 and 3].

Metamorphites of the Chorchana-Utslevi allochthonous complex were quite well-studied geologically and petrologically, but investigation of composition of rock-forming minerals was insufficient and correspondingly the metamorphic mineral assemblages require specification. In this direction, on the basis of new rock material by the above authors additional microprobe analyses of mineral composition are conducted, a number of informative diagrams are drown and some new mineral assemblages are identified. Mineral assemblages of three temperature stages are established. In particular, in the metamorphites of the Ninisi overthrust sheet the following mineral assemblages are identified – Chl_{55}+Act+Ab(Pl2)+ +Ep[Hbl_{58},Kfs^{2-5}], Chl_{52}+Act+Act-Hbl+Ab(Pl7)+Ep+[Hbl_{59},Pl] and in the metamorphites of the Chorchana overthrust sheet– Ms-Phn+Chl_{58}+Ab^{5}+Bt-Ph_{50}+Qtz, Qz+Ms(Ph64,Ms31,Pg5)+ +Chl_{57}+Ab(Pl^{5})+Adl, Ms–Ph+Chl_{58}+Ab^{5}+Bt–Ph_{45}+Adl^{3}+Qz, Qz+Ms(Ph36-76,Ms21-60,Pg3-5)+Bt70+Cb, Qz+Ms(Ph71, Ms22,Pg7)+Pl^{18}+Chl_{59}, Ms-Ph+Bt-Ph_{45}+Ab^{10}+K-Chl_{65}+Bt_{70}+ +Qz,Ms-Ph+Bt-Ph_{69-77}+K-Chl_{66}+Sps-Alm_{93-97}+Qt; Ms-Ph+ +Bt_{74-94}+Sps-Alm_{95}+K-Chl_{76-82}+Qz, Ms-Ph+Chl_{65}+Bt-Ph_{50}+K-Chl_{67}+Qz, Ms-Ph+Ab+Qz, Ms–Ph+Bt-Ph_{69-77}+K-Chl_{66}+Sps-Alm_{95}+Qz; Ms-Ph+Bt_{84}+Sps-Alm_{95}+K-Chl_{76-82}+Qz; Ms-Ph+ +Chl_{65}+Bt-Ph_{50} +K-Chl_{67}+Qz and Ms-Ph+Ab+Qz are fixed.

Garnet exists only in the high temperature metamorphites of the Chorchana overthrust sheet. Microprobe analysis of the garnet crystals show that they are of spessartine-almandine composition, are characterized by high-manganese content and progressive compositional zoning. The obtained data were plotted on the E.H. Brown’s [4] diagram that shows that all spots of the garnets from the above-mentioned metamorphites arranged in the area corresponding to green schist facies biotitic subfacies of regional metamorphism (Fig. 1). Colorless potash mica existing in rather low temperature mineral assemblages of the Chorchana overthrust sheet mainly are representing by phengite (Ph 36-95%, Ms 0-60%, Pg 3-13%), but in higher temperature assemblages of the same overthrust sheet the content of phengite molecule decreases and of muscovite – increases (Ph 43-77%, Ms 13-48%, Pg 5-13%) [5]. Chlorite is represented mainly by pycnochlorite, but with the temperature increase ripidolite and sometimes diabantite appear. Biotite occurs rarely and is very rich in Al_2O and is poor in FeO. Hornblende from the Ninisi overthrust sheet represents the relict of the primary rock, through which actinolite develops. Potash feldspar is supplied here. According to potash micas composition and the established mineral assemblages is ascertained that the level of regional metamorphism does not exceed the garnet subfacies of green schist facies [2]. Appearance of the biotite after the chlorite and of the muscovite after the collective crystallization of sericite proves that the metamorphism of the Chorchana-Utslevi allochthonous complex is of the prograde character.

In addition, according to data obtained by the detailed microprobe analysis is stated once again that prograde regional metamorphism of the Chorchana-Utslevi allochthonous complex rocks corresponds to three temperature stages. In particular, the rocks of the Ninisi overthrust sheet belong to chlorite-sericitic subfacies, but of the Chorchana overthrust sheet – to chlorite-sericitic and biotitic subfacies of green schist facies of regional metamorphism. In the latter low- and high temperature stages are identified.

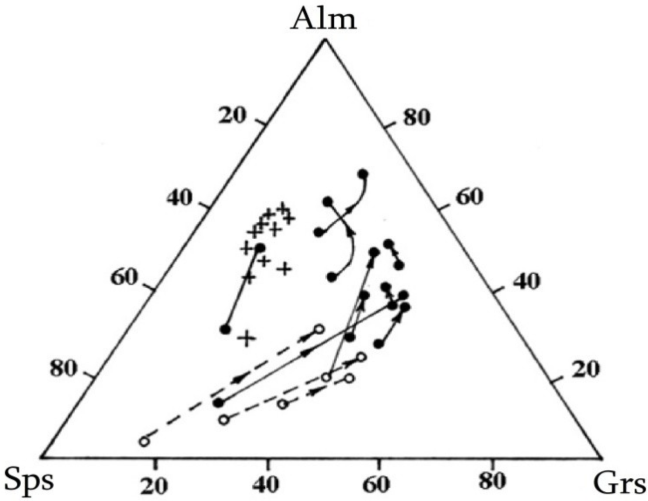

Fig. 1. Component composition of garnets (from the metamorphites of several regions, by E.H. Brown): 1 – chlorite-sericitic subfacies, 2 – biotitic subfacies, 3 – garnets from the Chorchana overthrust sheet (by the authors).

Table 1

Component composition of garnets from the Chorchana overthrust sheet metamorphites of high temperature stage of biotitic subfacies

Sample №	35-97				36-97-I				36-97-II			37-97-I						37-97-II				
	CP				C			P	C		P	C					P	C				P
Alm	51	50	54	54	55	56	57	58	56	55	56	48	49	50	53	58	60	44	44	48	55	58
Sps	38	33	35	36	34	33	32	30	34	33	33	37	37	37	34	30	27	41	40	37	32	29
Prp	2	3	3	3	3	2	3	3	2	2	3	3	3	3	3	3	4	2	3	3	3	4
Grs	9	9	8	7	8	9	8	9	8	10	8	12	11	10	10	9	9	13	13	12	10	9

C – center, P – periphery of the garnet crystal.

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GEORGIAN INDUSTRIAL MINERALS OPPORTUNITIES AND CHALLENGES: ROOFING SLATE

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Some of the first evidences of slate in constructions and other uses are found in the Neolithic in the Iberian Peninsula.The Romans also used slates for roofing, walls and flooring, but also as grinding stone or millstone – in short, for almost everything [1]. In 592, the bishop of Anger Licinius(France) ordered to use slate for building's roof, and first mines of Fumay and Rimogne were opened, which remained operational even by the end of XIX century. In 1559, the King of Spain Felipe II ordered to build the famous monastery of El Escorial with roofing slate from Bernardos Mine, which is operational even now. In British Empire, roofing slate was intensively mined in XIX century in Wales (about 500,000 tons a year) and Scotland but by 1969, all UK mines were closed due to bankruptcy caused by huge competition of the Spain slate. Today, 99% of roofing slate (slightly more than 1.1 million t per annum) is produced by Spain, China and Brazil [1, 2].

Roofing slate represents a slightly metamorphosed argillite, which is mainly composed of quartz, muscovite, chlorite and chloritoid (Table 1).It starts to form on oceanic shelf in the peripheral edges of spreading zones and terminates formation when oceans are closed in subduction zones [3]. Subduction leads to green schist metamorphism, which, according to existing data [3], proceeds in stable conditions [4] under about 300°C (Fig. 1). The determining factor in roofing slate formation is isoclinal folding, which create schistosity along the axis S_1 perpendicular to compression modulus.

Table 1

Mineral composition of leading roofing slate mines [after 1, modified]

Country	Mineral composition, %						
	Quartz	Chlo-rite	Musco-vite	Chlori-toid	Carbo-nate	Opaque	Feld-spar
Spain	20-43	12-43	29-60	0-17	0-6	1-2	0-24
Germany	24-35	19-26	41-51		0-1	1-2	
EU	20-55	10-20	25-55	2-4	0-16		5-20
UK	34-47	14-21	26-34		0-6	1-3	4-5

This feature determines easy splitting along the schistosity and practically ideal resistance of schist tiles to weathering. Such peculiarities lead to excellent technical properties of the commodity and practical perpetuity of the roofing.

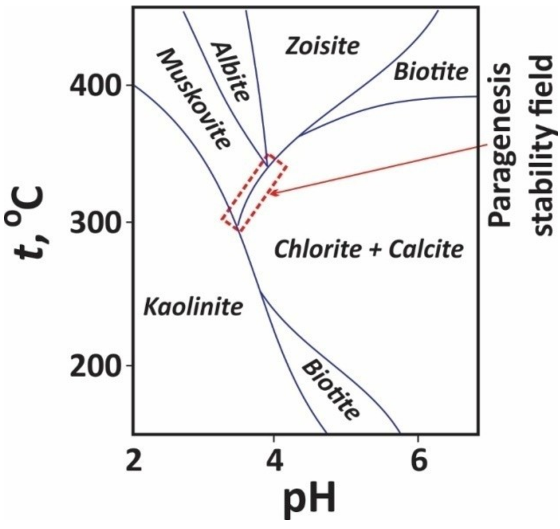

Fig.1. Stability field of the roofing slate.

The world roofing slate market is extremely tight. There are less than 50 active mines in the world, and their capacity, due to impossibility of automatic performance of slate processsing schedule, is much less than 100,000 t a year. The largest world slate pile producing company is the Spanish Cupa Pizzeras, which annually supplies about 120,000 of roofing piles to the market. The basic roofing slate consuming companies are Standard Industries Inc. (USA), Etex (Belgium), and Wienerberger AG (Austria). Tables 2 and 3 introduce basic roofing slate producing and consuming countries of the world.

Table 2

World production of roofing slate

Country	Production		Average price, US$/t
	1,000 t	US$ million	
Spain	590	380	644.07
China	400	140	350.00
Brazil	110	60	545.45
UK	8	10	1,250.00
German y	6	30	5,000.00
USA	1	5	5,000.00
Total	1,115	625	560.54

Table 3

World import of roofing slate

Import	Import		Average price, US$/t
	1,000 t	US$ million	
France	250	205	820.00
UK	190	120	631.58
USA	140	75	535.71
Germany	100	90	900.00
Belgium	50	75	1,500.00
Total	730	565	773.97

It is necessary to note that the difference between roofing pile wholesale and import prices is US$ 74.75 million or 13.23% from sales. This difference comprises an interest rate of dealer companies distributing roofing piles to ultimate consumer. No sole pile could be supplied directly by producer to a building company.

Georgianroofingslateisrelated to the Lower Jurassic minoroceanicbasinat the southern slope of the Greater Caucasus. Schistose slatesbuildupahugesequencehaving thickness from 2 to 10 km and extending from the western to the eastern border of Georgia. In this sequence, roofing slate form huge seams and differ from country rocks by technologic properties only. Resources of roofing slate of Georgia are beyond the limits [5].

Among these resources, the roofing slate deposits of Kakheti (Eastern Georgia), and namely Intsoba deposit, are distinguished by easy accessibility and perfect infrastructural features. Technical properties of roofing slate meet requirements of the EU CE Mark.

Geological investigations as well as economic modelling show that at the background of minor investments, only the Intsoba eventual mine may supply to the market more than 90,000 t of roofing pile each year.

Thus, the eventual roofing slate industry of Georgia represents a lost challenging opportunity, which could immediately place Georgian roofing pile suppliers among the leading slate producing companies of the world.

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STRUCTURAL GEOLOGICAL POSITION OF THE BEQTAQARI DEPOSIT

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The Beqtaqari gold-polymetallic deposit is located in the center of the Bolnisi Ore Region. Structural position of the deposit is induced by fault structures, which have north-west and north-east directions, also the area has favorable physical-mechanical features.

Within the territory of Beqtaqari deposit, the Tandzia suite formations are the oldest. They are represented by volcanites of andesite basaltic composition. In ascending section the Tandzia suite rocks are followed by the lower subsuite of the Gasandami suite (K_2gn_1), which starts with polymictic breccia-conglomerates, rolled and ungraded andesite-basalt and rhyodacitic fragments, then with slight unconformity follows the upper subsuite of the Gasandami suite (K_2gn_2). It is represented by alternation of psephitic, psammitic and aleuropelitic tuffs of rhyodacitic composition sometimes with lenses of thin tuff-conglomerate-breccias in the sole. Then follow rare black fine-grained tuffoceous-argillites and ignimbrite tuffs, tuff-lavas.

Structurally the whole complex of rocks is crumpled in linear and brachiform folds. Synclinal folds with flexure bends were identified. The Beqtaqari region is also affected by an important deformation that seems to be controlled by a major thrust fault and several sets of fractures and a late normal fault with a small offset. This structural feature has certainly played an important role during hydrothermal fluid migration.

The Beqtaqari deposit ores belong to the group of volcanogenic epithermal deposits and are concentrated in the rudaceous tuffs of the lower subsuite of the Gasandami Suite. There are two types of ore: gold-low-sulfide and gold-polymetallic ores. The gold-low-sulfidation ore crop out in the western part of the deposit. The gold-polymetallic ores are located in the eastern part of the Beqtaqari deposit, at the lower hypsometric levels.

Host rocks of gold-low-sulfide mineralization are secondary quartzite. The secondary quartzites are similar to products of advanced argillization. The host rock of the gold-polymetallic mineralizations is a hydrothermal breccias and argillization zones located in the apical part of a layer.

In the gold-containing ores, metallic constituents are disseminated unevenly. Gold content in the polymetallic part is higher than in the secondary quartzites. The gold-polymetallic mineralization is characterized by high zinc and lead content and insignificant amount of copper.

Based on the existing information, the Beqtaqari deposit is considered to be of epithermal gold-polymetallic type deposit with the industrial gold content.

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THE STUDY OF THE DEPOSITION CONDITIONS AND GEOTECHNICAL PROPERTIES OF LOESS-LIKE SEDIMENTS FROM THE MIDSTREAM OF THE KURA RIVER FOR THE IMPROVEMENT OF CONSTRUCTION OF IRRIGATION SYSTEMS

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Loess-like sediments are widespread through the territory of the Republic of Georgia. The main distribution zones are the latitudinal belt in the southern part of the country - the upper (Aspindza-Akhaltsikhe municipalities), middle (Shida Kartli Valley) and lower (Kvemo Kartli Depression) streams of the Kura River, also of the Iori and the Alazani rivervalleys. The sedimentary covers typically vary from 1 to 6m in thickness, but in several sites of the Kvemo Kartli Depression, the thickness reaches up to 25m. These sediments (Fig.1) by their origin are mostlydivided into three major facies: alluvial, proluvial and diluvial.

From an engineering geological point of view, the major problem concerning these areas is collapsibility of the soils, evidenced by numerous collapse processes recorded in different parts of the country. Our study area (Fig. 2) locates in the Southern part of Georgia where irrigation systems are used for agricultural activities. These systems are related to loess-like sediments.

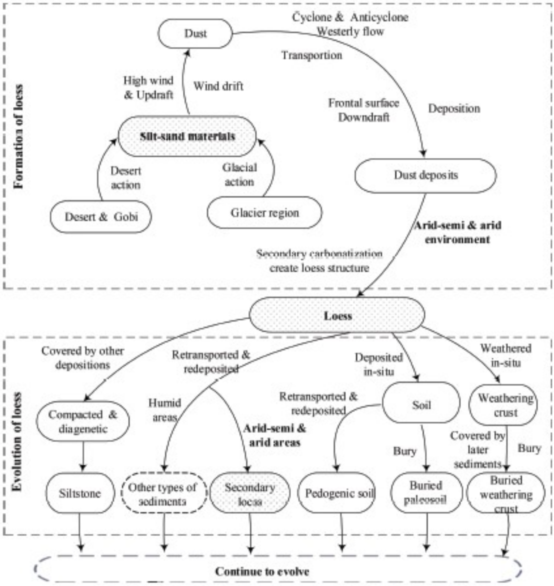

Fig.1 Schematic diagram of the formation and evolution process (Modified from Liu, 1985)

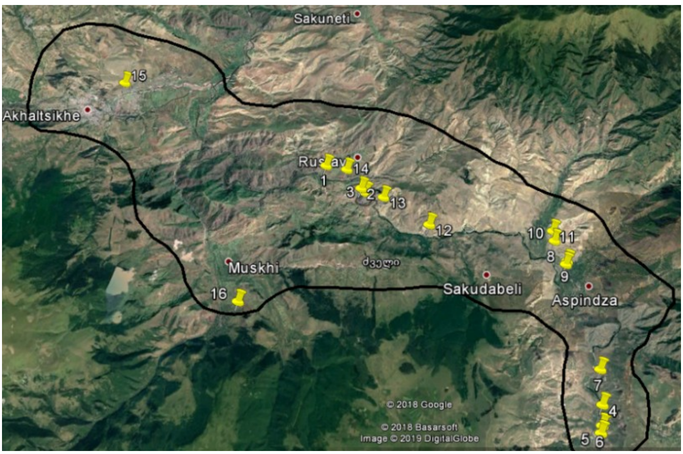

Fig. 2. Distribution of loess-like sediments through the territory of our study area. Specimens were collected from 15 different places; the places are marked with yellow tacks.

Our work describes the results of a geotechnical study carried out on block samples of intact loess. Different types of existing methods of evaluation of collapsibility of loessic soils were used to measure collapse potential for the specimens. The results have shown that most of the specimens are prone to collapse as their relative collapsible indices are > 0.02. Hence, the analysis of local engineering-geological properties, geomorphic features, and collapse potential reveals the importance of evaluating vulnerable zones of loess-like sediments from the investigation site.

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Corrections - Elene Akhmeteli