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G. TSULUKIDZE MINING INSTITUTE

GEORGIAN TECHNICAL UNIVERSITY

THE DEVELOPMENT OF MINING AND GEOLOGY IS THE PRECONDITION FOR THE REVIVAL OF ECONOMY

BOOK OF ABSTRACTS

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In order to determine the physicochemical parameters of the formation and sources of matter of endogenous ore deposits, there have been established the chemical composition, concentrations, stable isotopes of hydrogen and oxygen of ore-forming fluids, as well as stable isotopes of sulfur and hydrocarbon of ore-forming minerals of copper-molybdenum-porphyry, skarn-iron ore, copper pyrite, copper-polymetallic, barite-copper-base metal, barite-base metal, gold-sulfide, gold-base metal, gold-antimony and silver deposits of the Caucasus and the Far East of Russia were established.

Research has shown the prevailing role of deep-seated solutions. The exception is the manganese-iron ores of the barite-manganese-polymetallic deposit Zhairem (Kazakhstan), which are formed by seawater mixing with hydrothermal fluids.

Table 1

Ore Deposits	Mineral association	T°C	P bar	Fluid salt composition	Fluid concent g/kg	Sulphur	Car-bon	Water
Tekhut Porphiry-copper *(Armania)*	$CaCO_3$-ZnS-PbS FeS_2-$CuFeS_2$-MoS_2 FeS_2 - MoS_2 -$CaSO_4$ SiO_2 – FeS_2	280 - 160 360 - 300 400 - 320 450 - 370	→ 100 > 1000	$\frac{Na+Ca++}{Cl-(HCO3-)}$ $\frac{Na+Ca++K+Fe++Cu++}{Cl-(HSO4-HCO3-)}$	3 → 40	abyssal	abyssal + from host rocks	meteoric + abyssal abyssal abyssal
Dashkesan Skarn - magnetite *(Azerbaijan)*	$CaCO_3$-ZnS-PbS FeS_2-$CuFeS_2$-SiO_2 SiO_2 - $Fe3O_4$ Skarns	200 - 160 320 - 200 420 – 350 > 500	→ 100 > 700	$\frac{Na+K+Ca++}{Cl-(HSO4-)}$ $\frac{Na+K+Ca++Fe++Mg++}{Cl-}$	3 → 85	abyssal + from host rocks	abyssal + from host rocks	meta-morpho genic abyssal
Madneuli Barite-copper-polimetallic *(Georgia)*	$BaSO_4$ $BaSO_4$ - PbS - ZnS ZnS - CuFeS - FeS_2 $CuFeS_2$ - FeS_2 FeS_2-$CaSO_4$ ± MoS_2	< 180 280 - 160 320 - 250 350 - 280 410 - 340	< 350	$\frac{Na+K+}{HSO4-Cl-}$ $\frac{Na+K+(Ca++)}{Cl-(HSO4-)}$	→15 30	Abyssal	-	meteoric + abyssal abyssal abyssal
Valentina Barite-copper-polimetallic *(Kuril Islands, Russia)*	SiO_2 - FeS_2 $BaSO_4$ - PbS - ZnS ZnS - $CuFeS_2$ - FeS_2	240 - 190 335 – 270 345 - 310	< 300	$\frac{Na+K+}{Cl-(HSO4-)}$	< 30	abyssal	–	meteoric + abyssal
Mutnovskoe Copper-poli-metallic *(Kamchatka, Russia)*	SiO_2 - $CaCo_3$ PbS - ZnS - FeS_2 SiO_2 - FeS_2 - fahlore $CuFeS_2$-SiO_2-FeS_2	250 – 130 315 – 230 330 – 270 370 - 310	< 300	$\frac{Na+K+}{Cl-(HSO4-)}$	< 50	abyssal	abyssal	meteoric + abyssal
Zhairem - Iron-mangan Lead-zink-barite *(Kazakhstan)*	Fe_2O_3, Fe_3O_4, $FeCo_3$ - Mn_2O_3 - $MnSiO_3$ ZnS - FeS_2 - SiO_2 - $CaCO_3$ $BaSo_4$ - PbS - ZnS - $CuFeS_2$ -	180 - 150 220 - 160 230 – 150 320 - 245	< 150	-		abyssal	abyssal	ocean water meteoric + abyssal

Filischay Sulfur-copper polymetallic *(Azerbaijan)*	SiO_2 - $CaCo_3$ ZnS - PbS - SiO_2 $CuFeS_2$ - $Fe_{1-x}S$ FeS_2 - $Fe_{1-x}S$ FeS_2 - SiO_2	< 120 300 – 180 325 – 260 425 – 375 450 - 425	800 → 150	$CO_2\frac{Na+Ca++Mg++}{Cl-HCO3-HSO4-}$ $\frac{Mg++Na+Ca++}{Cl-HSO4-}$	2 → 50		from host rocks	meteoric + abyssal
Sot, Megradzor, Tais Gold -Sulfide *(Armenia)*	SiO_2 - $CaCO_3$ ±(Sb_2S_3-AsS) SiO_2 – $CaCo_3$-Me_xTe_y SiO_2 – $CaCo_3$- Me_xS_y-Au SiO_2 – $CaCo_3$- FeS_2-FeAsS	240 – 160 320 – 230 380 – 340	< 400	$CO_2H_2S\frac{Ca++}{HCO3-}$ $CO_2\frac{Na+K+}{Cl-HCO3-}$	2 → 20	abyssal	abyssal	meteoric + abyssal?
Lukhumi Gold-antimony-arsenic *(Georgia)*	As_2S_3 - AsS ± HgS Sb_2S_3 - ($CaWO_3$-AsS) - Au FeAsS - FeS_2 - Sb_2S_3- Au SiO_2 (metamorf.)	210 – 150 300 – 220 390 – 320 250 - 100	> 1000	$CO_2\frac{Na+K+Ca++}{HCO3-Cl-}$ $CO_2N_2\frac{Ca++Na+}{HCO3-Cl-(HSO4-)}$	2 → 8	abyssal +from host rocks	abyssal +from host rocks	meta-morphogenic
Natalka, Maiskoe Gold-antimony-arsenic Kolima, (Чукотка, *Russia)*	SiO_2 - Sb_2S_3 - Au SiO_2 - FeAsS- $CaWO_3$ - Au $(Fe,Mn)WO_4$ - SnO_2 - FeAsS - Au SiO_2 (metamorf.)	230-180 340-220 380-290 220-140	140 →170	$CO_2\frac{Na+Ca++}{Cl-(HSO4)}$ $CO_2\frac{Na+Ca++K+MG++}{HCO3-Cl-(HSO4-)}$	2 → 10	abyssal + from host rocks	abyssal + from host rocks	meta-morphogenic
Dukat Silver – Argentite, (Kolima, *Rusia)*	Sulfides with argentite and native silver	350→ 270	> 250	$\frac{K+Na+}{(HSO4-)Cl-}$ $\frac{K+Na+Ca++}{Cl-HCO3-HSO4-}$	< 80	abyssal	abyssal	meta-morpho-genic
Kvaisa, Chordi Barite Lead –Zink *(Georgia)*	$CaCo_3$ - FeS_2 $BaSO_4$ ZnS - PbS- ($BaSO_4$)	340 → 60		$\frac{Na+}{Cl-}$ $\frac{Na+}{HCO3-Cl-}$ $\frac{Ca++}{HCO3-HSO4-}$		Meteoric+ abyssal(?)	abyss+ from host rocks	meteoric + abyssal

STUDY OF BLAST IDENTIFICATION METHODS IN UNDERGROUND BUILDINGS

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Protection of population and infrastructure from man-made, accidental and terrorist explosions is one of the major challenges of modernity. Statistics show that critical infrastructure facilities, such as transportation and metro tunnels, underground storages of explosives and ammunition, and other underground industrial and living spaces are at a particularly high risk of being affected by unauthorized blasts. Accidents caused by methane blast in coal mines are also a major problem. Quick identification of threats, procession of information and quick response are the only way to minimize severe consequences. Experience shows that the reliability and time characteristics of existing explosion detection systems fail to respond modern requirements.

The paper analyzes processes accompanying an explosion, along with the existing methods of blast detection. It examines methods of blast identification in underground structures, which are based on monitoring and analysis of seismic oscillations in tunnels, electromagnetic pulses, optical radiation or overpressure.

Based on the results of preliminary studies, a system for the detection of accidental explosions and wireless transmission of emergency signals has been developed. The proposed wireless system consists of transmitter and receiver modules. A transmitter module contains a sensor, a microprocessor equipped with a blast identification software and transmitter that serves to transmit an encoded signal at the 868.35 MHz frequency. A receiver module has a transmitter, which serves to receive

a signal at the 868.35 MHz frequency, a microprocessor and a decoder, which produces a starting signal for the operation of a protection device. A system prototype was manufactured and tested under real explosion conditions in the tunnel of the underground experimental base of the Mining Institute. Test results showed high reliability and speed of operation of the system. The distance between a transmitter and a receiverin the open air was at least 1000m, in a direct tunnel – at least 150m, in a tunnel with a 90^0 bending - 50m. The detection system is designed to instantly activate the explosion protection device and transmit the emergency signal to the rescue service.

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THE AGE RELATIONSHIP BETWEEN GLACIATION AND VOLCANISM (AT THE EXAMPLE OF JAVAKHETI PLATEAU)

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The correlation method is successfully applied in a set of proven methods of stratigraphic subdivision of the Late Cenozoic extrusions of the Javakheti plateau, age dating of volcanic structures and paleogeographic reconstructions. To establish age relationship of volcanism and glaciation, in parallel to studies of geomorphological structure and stratigraphy of Late Cenozoic volcanic and volcanogenic-sedimentary formations of the Samsar and Javakheti ridges, visual, aerial decoding and glacier reconstruction methods were used to clarify boundaries of old glaciation spreading and the direction of movement. The morphological and morphometric characteristics of the glaciers were also determined. In carrying out the fieldwork, we were guided by the data of the work carried out by previous researchers, and participation in the expedition together with Professor R. Gobedzhishvili. Tectonics and volcanism play a crucial role in the formation of the modern relief of the Javakheti plateau. Tectonic movements are especially strong during the Late Miocene and Early Pliocene (Attic orophase), which actually determined the features not only of the Javakheti plateau, but also of the main relief forms of the entire Caucasus.In the Javakheti region, tectonic movements of this period are connected with strong Miocene-Pliocene extrusive volcanism, the eruption of which is served by a multitude of monogenic and stratovolcanic apparatuses of various heights, sizes and shapes. The main foci of glaciation from the latter are associated with large stratovolcanoes

of the Great Abul and Samsar, currently severely eroded but having the required heights to form the Firne Valley.Glacial precipitation is also recorded in the Samsar caldera, the flattened surface of which creates favorable conditions for the accumulation of snow cover for the active development of glacial processes. According to our calculations, the total area of glaciers is 75 m^2, out of which 45 m^2 is covered by the Samsara mass. Morphologically, the glaciers of the Samsara ridge are of Corrie, Corrie-Valley glaciers (alpine glaciers) types. Moraine deposits are formed of andesite, dacite and of stone-tuff breccias of rhyodacite compositions, lava breccias, lava fragments, Lahari and pyroclastic breccias. Using of petrographic and petrochemical methods in determining these deposits made it possible to relate them genetically and physically to the bedrock of the Late Miocene-Early Pleistocene volcanic massifs of Abul and Samsar. It is noteworthy that since the Late Pliocene, intense tectonic movements and formation of heights necessary for the development of the Firne Valley were observed in the region, though the glacial process did not repeat itself here. This fact indicates that glaciation on the Javakheti plateau is of one-time nature and belongs to the time interval of early Late Pliocene- Early Pleistocene.

ECOLOGICAL MONITORING OF THE RIVER LUKHUNI

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One of the most beautiful regions of Georgia - Ambrolauri and Lukhuni river valley is the object of our research. What is the ecological condition of this river valley, why do the population complain about the impact of arsenic, whether the ecological condition is the reason for the migration of the population. Here are the issues that have not yet been explored.

The main source of heavy metal pollution in this area is the former Lukhuni deposit, where ore has been mined since 1933 and its processing began in 1937. Production has stopped ore extraction and processing since 1991. The company that won the tender in 2017 had to carry out a number of works to improve the ecological situation in the area: dismantling the buildings of former mining and chemical plants, removing contaminated soil, and more. But, unfortunately, the work was done with shortcomings. Part of the waste was left out [1].

The latest studies were conducted in 2019 by the National Environment Agency of the Ministry of Environment Protection and Agriculture of Georgia. They examined the condition of various villages in Ambrolauri Municipality, in particular, the moving form of arsenic was determined. According to the results of the research, arsenic is the most polluted soil in Uravi. The maximum content of arsenic according to the data of November 2019 is 81.35 (valid value -40.7), 45.33 (valid value-22.7) mg / kg at a depths of 0-5 and 5-20 cm,

respectively. Other villages are also polluted [2]. Such an ecological situation was encountered before the first field work in Racha. Several tests were performed to actually assess the ecological condition, to monitor the condition in time and space. We focused not only on observations but also on predicting the situation.The river Lukhun is very difficult in relief because it flows into a deep ravine and due to it we could not take a pre-planned number of samples. But to eliminate these shortcomings we used mathematical ecology, its ability to use methods of statistical analysis, probability theory, we also used data interpolation. Finally we have a mathematical model of the situation, which allows us to assess the situation, monitor and develop modern concepts of management and allow us to avoid time-consuming and costly work [3].The table 1 shows the result of the work. Only the data of the main points are presented. The data obtained by the mathematical model were also confirmed using a geo-information programs statistical analysis apparatus. There is spatial analysis in GIS. The purpose of spatial analysis is to obtain new information from existing data using mathematical, statistical and geographical operations.

With Geostatistical Analyzes we can build a thematic map based on that data. The picture shows a map showing the content of one of the elements in mg/l (Fig.1). Created with ArcMap Spatial Analyst Tools [4].

Table 1

The Content of heavy metals

Sample nomber	TDC	pH	Cu2+ mg/l	Mn 2+ mg/l	Ni2+ mg/l	As (general)	Cr6+ mg/l
1	51.1	7.15	0,03	0,05	0,01	0,06	0,08
2	99.1	7.14	0,03	0,05	0,017	0,05	0,03
3	142	6.89	0,015	0,09	0,04	0,021	0,09
4	545	4.9	0,013	1,1	0,08	0,029	0,003
5	66.8	6.39	0,006	0,05	0,03	0,08	0,008
6	139	6.65	0,082	0,3	0,015	0,05	0,001
7	141	6.75	0,02	0,9	0,09	0,07	0,009
8	160	6.8	0,02	0,19	0,001	0,071	0,005
9	139	6.98	0,038	0,3	0,032	0,009	0,05
10	139	6.92	0,15	0,3	0,044	0,003	0,006

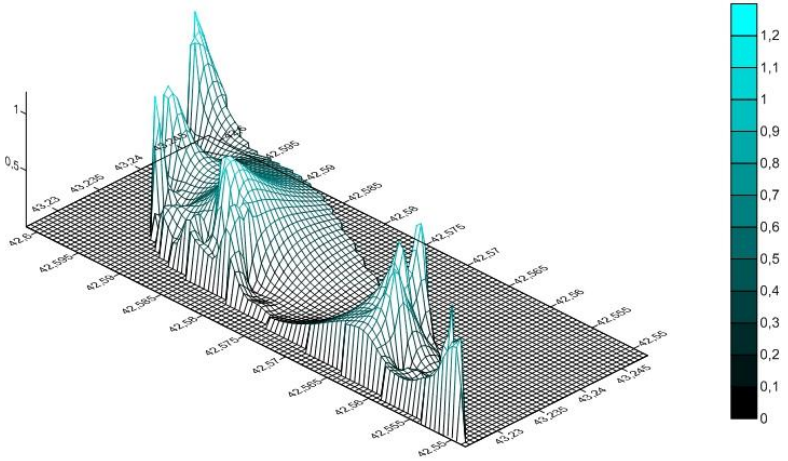

Fig.1. The content of one of the elements in mg / l

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OVERVIEW OF THE MECHANISM OF INFLUENCE OF WATER/CEMENT FACTOR ON THE STRENGTH OF CONCRETE

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The concept of water/cement factor was first developed by the American scientist Duff A. Abrams and published in 1918.

The water/cement factor is the ratio of the mass of water used in a concrete mix to the mass of cement. Its reduction increases the strength of the concrete, but makes it difficult to pump the mixture and place it in the construction formwork.

If, in addition to cement, other binders are used in the concrete mix, such as fly ash, granulated slag, microsilica, rice husk ash and natural pozzolans, the mass of the binders presenented is taken into account along with the cement.

The use of water in a concrete mix is necessary to enter into a chemical reaction with its cement, ie hydration, in order to form a cement dough-gel. At this time only the required, necessary and minimum amount of water is required. Excess, unreacted water reduces the strength of the concrete. The reduction mechanism is as follows. When water is freely in the concrete, during its solidification the water evaporates and a void is formed in its place. The void in turn is one of the weakest points in concrete in terms of strength. The water/cement factor is one of the means of making frost-resistant concrete.

There are currently a number of literary sources around the subject matter, for example [1; 2; 3; 4; 5]. A remarkable result is obtained. Nevertheless, no acceptable mechanism for

influencing the strength, corrosion resistance and other properties of concrete with water/cement factor has been established to date.

Therefore, reviewing the published papers on the water/ cement factor is one of the main, necessary and topical issues in solving the important problem of the development of concrete mechanism.

The work will result in a review and critical analysis of the current publication. In this way another step will be taken to design, manufacture and use the appropriate concrete mixture in construction.

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NEW DATA ABOUT GARTA ORE DEPOSIT

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The sample set consists of rock chips and fragments of drill core from drill holes. The samples were first macroscopically and microscopically examined with a focus of the alteration assemblage and copper mineralization, in addition to the general mineralogical composition.

The researches were carried out at the micro analytical laboratory in the Department of Earth, Ocean, and Atmospheric Sciences (EOAS) at UBC and in the Georgian Technical University (by the Department of Geology) The methodology included transmitted and reflected light microscopy, X-ray powder diffraction (XRD) analysis and scanning electron microscopy on selected samples. Furthermore, some thin sections were selected for a scanning electron microscope (SEM) study to identify submicroscopic phases and to assess the composition of the Fe-oxides and Fe-sulfides. The thin sections were carbon-coated and studied using a Philips XL30 scanning electron microscope with a Bruker Quanta 200 energy-dispersion X-ray microanalysis system (EDX) at the microanalytical laboratory in the EOAS at UBC. As a result of the research, the mineralogical composition, modal content, degree and type of alteration were determined.

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DISCONTINUITIES, DISTRIBUTION SCALES AND FORMATION CONDITIONS OF GUJARETI-TSKAROSTAVI (KHACHKOVI) ORE FIELD

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Discontinuities, distribution scales and formation conditions of Adjara-Trialeti Gujareti-Tskarostavi ore field are reviewed in the work. As known, studying ore field structures has got great significance for increasing efficiency of exploration activities. Gujareti-Tskarostavi ore field is highly complicated from tectonic viewpoint. Various type disjunctive structures and fractures are observed. The role of fold structures, Arjevani-Bakuriani fault and other geological elements in the distribution of the ore field is presented in the article. A large role is devoted to the characterization of the ore columnar structure, which is associated with magmatic formations, folded forms and rupture dislocations. Basic and specialized methods of studying structures are used in the work.

Besides, Gujareti-Tskarostavi ore field was studied by us with remote sensing method and as a result main fault and stress structures were revealed where the best conditions for the formation of ore field occur. In particular, the territory adjacent to the Arjevani-Bakuriani fault represents favorable conditions for mineralization.

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STRUCTURE AND MORPHOLOGY OF THE CRYSTALLINE SUBSTRATE OF THE SOUTHERN CAUCASUS INTERMOUNTAIN AREA (IN THE LIMITS OF GEORGIA)

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The formation of the modern structure of the Southern Caucasus (Rioni and Kura) molassic depressions is largely determined by both the meridional (submeridional) and latitudinal systems of faults covering different depths of the Earth's crust. The noted faults are often side boundaries of the blocks of the crystalline basement of the Earth's crust, creating a picture of its mosaic-block structure. The analysis of the lithofacies and thicknesses of the sedimentary cover developed within their limits, in a number of cases, indicates their autonomous and inversion nature of development. Comparison of geophysical and drilling data, as well as, the application of the method of system analysis of disjunctive structures made it possible to clarify some issues of the structural-kinematic evolution and morpho-genetics of individual blocks and faults of the pre-Jurassic crystalline basement within the limits of the Southern Caucasus.

The block diagram of the surface of the crystalline basement constructed by us within the Colkhida depression shows the spatial arrangement and the character of the inversion nature of individual blocks, indicating the manifestations of the Alpine and Late Alpine phases of tectogenesis.Thus, the Odishi block, located approximately in the central part of the depression from the western and eastern sides is bounded by

faults of a strike-slip nature, above which in the sedimentary cover supra-fault echelon folds are developed, indicating the right-lateral component of the faults. In general, the kinematics of the Odishi block indicates its shift in the southwest direction; the block is slightly inclined in the eastern part in relation to the Askhi and Okriba blocks. From the south it is bounded by the Abasha block - one of the most subsided structures of the Colkhida depression. Analysis of the actual material, geophysical and geological data for the intra-Caucasian intermountain area allows us to draw the following conclusions: the Georgian Block (a fragment of the Transcaucasian median massif, microplates, terrane) with a pre-Jurassic crystalline substrate (Dzirula uplift) exposed in its central part, is divided into the western and eastern subsidence zones, which in turn disintegrate into separate blocks. From the central zone of the uplift of the Georgian Block to the east and west, a gradual "stepwise" subsidence and tilting of the blocks of the crystalline substrate is outlined. Similar structures are known in the literature as the so-called tilt blocks. They are quite distinctly recorded on different geophysical profiles. In some cases, the transverse uplifts of the crystalline basement are recorded by drilling data.

A number of transverse faults are associated with earthquakes, the mechanism of which are characterized by tensile stress and, therefore, can have a fault character with the inclination of the shear planes towards the centers of maximum tension. As a result of gravitational modeling, it is established that the M-boundary within this profile is indicated by a local uplifting under the Central Black Sea, Agdzhabedin and South Caspian regions and a comparative subsidence under the Dzirula and Saatlinsky uplifts. From the above, we can conclude that in the modern structure of the pre-Alpine consolidated

crust of the South Caucasian median massif, two plans of structural symmetry are outlined. The first (latitudinal profile) is characterized by the existence of extensional structures, mainly in the form of stepwise tilting blocks, which subsequently transformed into listric faults. The second (meridional) is characterized by tangential submeridial compression of the region caused by the advancement of the Arabian inlier to the north with the formation of the Transcaucasian transverse uplift and other collision structures.

REVIEW OF THE GEOTECHNICAL CONDITIONS OF THE RIONI RIVER GORGE IN RELATION TO HYDRAULIC ENGINEERING

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The Rioni River is one of the major rivers of Georgia. It originates at Pasi Mountain in the Greater Caucasus and flows into the Black Sea at the city of Poti. The 327 km long river embraces 41 percent of the whole area of the western Georgia.

The Rioni is of critical importance from the point of view of hydraulic engineering; assimilation of the river for the above purposes was started in the 1930s (at present, the middle and the lower reaches of the river have been assimilated).

Within the middle-stream and downstream sections of the river, the bedrocks are dislocated, dissected by cracks and would exhibit presence of crushing and thus weak tectonic areas. These unfavourable structural-tectonic elements will predetermine further dissection of the bedrocks and their sliding down the gliding surface what in its turn facilitates activation of the geodynamic processes within the river gorge. Landslides of structural and creep nature are to be observed here rather frequently.

The above geodynamic processes predetermined in their main by moistening the bedrock as a result of frequent and abundant rainfall; that facilitates drainage of the rainwater from the dingles existing within the river gorge. According to the physical and mechanical properties of the depositional material prevailing in the gorge, the stability coefficient of the soil placed in the water environment is low; consequently, its cohesion forces are low too. As is evident from the observation data, the slopes of the gorge are really dotted with traces

of landslide movements to be observed in any place where the deposits are represented by mighty/thick deluvial-eluvial or semi-rocky series.

When hydraulic power stations are designed, evident prevalence of landslides within the gorge as well as actual potentials of their formation in future should be double checked; the risks associated with landslide formation should be ever kept in mind.

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SYNTHESIS AND BLAST TESTING OF SOME "MOLECULAR COMPOUNDS"

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Explosives have the greatest importance in human practical activities, not only at time of war, but at tranquility as well, which includes mining, engineering, arrangement of underground and surface infrastructure, etc.

Picric acid and trotyl are well-known explosives – enough strong, relatively cheap and safe – for use. There are several possibilities for the synthesis of new explosives from picric acid and trotyl. One of them is the synthesis of so-called "Molecular compounds" which is easily carried out, with a high yield of target substances.

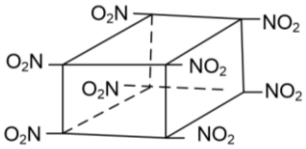
As the blast testing shows the "Molecular compounds" retain enough strong explosion nature, moreover, it is quite strongly expressed.

The article describes the synthesis of two "Molecular compounds" from picric acid and trotyl, with toluene and resorcine. The mechanism of the process is explained. The schemes of reactions are shown.

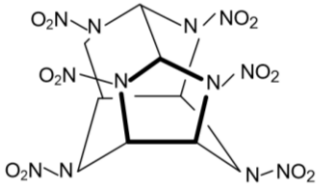
The article also includes a descriptions of blast testing of the obtained "molecular compounds".

Introduction

A vast majority of explosives are produced by the chemical synthesis, including picric acid, trotil, octogene, nitroglycerine and other well-known explosives. At the end of XX century in the USA were synthesized powerful explosives with the highest technical characteristics – octanitrocubane and hexanitrohexaazaisowurzitane - CL-20 [1-2]:



octanitrocubane



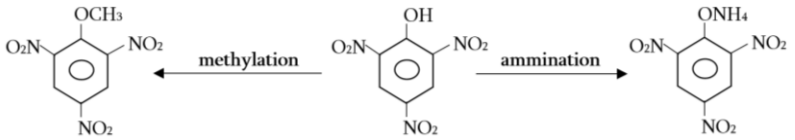
Hexanitrohexaazaisowurzitane, (CL-20)

Nowadays, thousands explosives are synthesized and used. Nevertheless, this fact doesn't exclude necessity of synthesis of new explosives for optimization of their characteristics, such as prime cost, power, safety during production, storage, transfer and so on.

The necessity to synthesize new "molecular compounds" using picric acid and trotyl is similarly motivated.

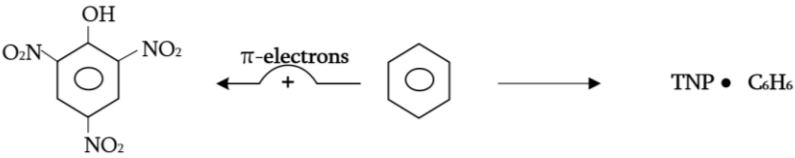
Synthesis methodology and received compounds

In general, the purpose of our investigation is the synthesis of new explosives by changing the **molecular structure** of well-known explosives, or by **chemical conversions** of them. This is a universally accepted method. It is remarkable, that in the most cases, products of such conversions maintain the same applied properties which had initial compounds. For example, by changing the chemical structure of pharmacological drugs, often, pharmacologically active substances are obtained [3]. Also, conversion products of explosives, retain their explosive ability: It is well-known, that by simple chemical conversions of picric acid, may be synthesized enough strong explosives: methyl picrate, ammonia picrate, ets.



Methyl picrate **Picric acid** **Ammonia picrate**

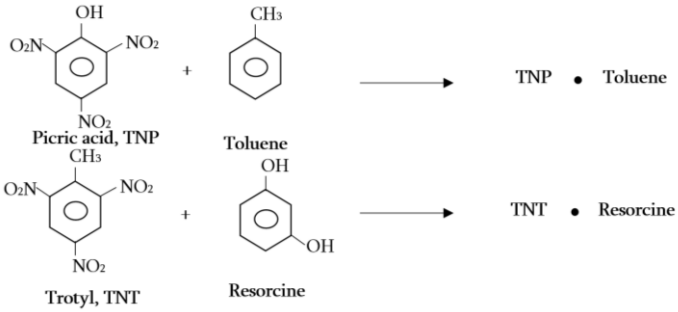
One of the examples of explosive's conversion is the synthesis of **"Molecular Compounds",** or **"Charge Transfer Compounds"** [3-5]. Such ability have picric acid, methyl picrate, ammonia picrate, as well trotyl, styphnic acid and other poly nitro aromatic compounds. It should be noticed, that the presence of three nitro groups impoverishes the π-electronic system of the aromatic nucleus of molecules and gives the mentioned substances strong **electro acceptor** properties. Consequently, their molecules arises the ability to transfer π-electrons from **electro donor** molecules to themselves. Electrostatic attraction arises, and a result of which, **bimolecular aggregates** are formed – the so-called "Molecular Compounds":



Picric acid, TNP **Benzene, C_6H_6** **Molecular Compound**

According to existent view, in the similar reactions the aromatic fragments of molecules are placed to each other in parallel planes [1].

By interaction of picric acid with toluene, and trotyl – with resorcine were synthesized corresponding molecular compounds. The synthesis' schemes are as follows:



As for the "morphology" of formulas, it is some conditional, and resembles with the rule of representation of some other formulas, such as double salts, for example silvinite – $KCl \bullet NaCl$, compound of ammonia with boron trifluoride - $H_3N \bullet BF_3$, and other bimolecular structures.

Testing of synthesized compounds on blast conversion

Primary laboratory studies were performed to determine the ability of chemical conversions by blasting of synthesized molecular compounds, to induce detonation and to assess possible workability.

Blast testing was carried out in a camera integrated into the tunnel system of an underground experimental explosive base of G. Tsulukidze Mining Institute.

The views of the base's portal and camera are shown on the figure 1.

Fig. 1 The portal of the unferground tunnel system (a) The blasting camera (b)

Two types of “molecular compounds” were synthesized for testing, each weighing 25 g. The compounds were obtained in the form of crystalline powders, in which the granulometric consist of the particles varies in the range 0-5 mm. Their microphotographs are shown in figure 2.

a b

Fig. 2 Synthesized “,molecular compounds”:
a – substance I
b – substance II

To test the ability to induce detonation, a standard test scheme localized in a solid state of charge was used, as shown in figure 3. In particular, to obtain longitudinal charges, the test substance was loaded into a low-carbon steel tube. One end of the tube is closed with a stopper of the same material, while the other side (in the area of the detonator) is not charged and is in a free state. The pipe diameter was selected conditionally, according to the analogy of the tests of brisant explosives. A capsule detonator KD-8 with a fuse was used to initiate the detonation.

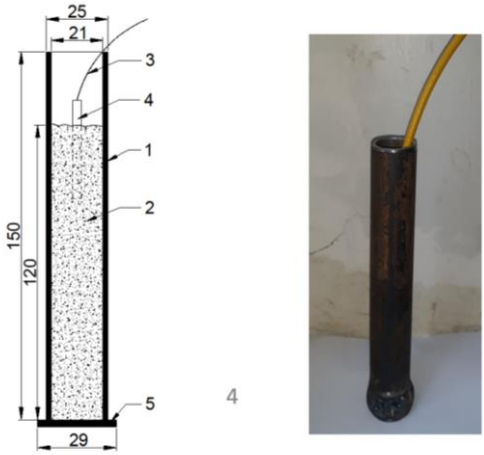


Fig.3 Diagram (a), and view (b) of testing tube of synthesized "molecular compounds"
1 - testing tube; 2 - „molecular compound"; 3 - fuse;
4 - capsule-detonator KD-8; 5 - Testing tube stopper

The results were evaluated after the experiment by analyzing the physical condition of the charge casing in the camera, assessing the degree of its deformation and fragmentation, visual inspection of the subject table, and detection to detect traces of non-detonation of the test substance. Attention was also paid to the production of possible chemical transformations to detect the acoustic effect, distinguishing it from the acoustic signal generated by the explosion of an isolated detonator.

Primary experiments confirm the explosive ability of synthesized substances. The intensity of the acoustic signal generated during the test significantly exceeded the signal of the detonator, although its instrumental confirmation was not performed.

The explosion of the I compound caused complete fragmentation of the casing, which is typical for explosives with high brisant and working capacity.

The explosion of the II substance caused a symmetrical rupture of the cylindrical surface of the steel tube. This is typical for cylindrical closed space loads with high dynamic pressures. The results are shown in figure 4.

a b

Fig. 4 Typical images of steel tube fragmentation (a) and deformation (b) after explosion
a - I substance
b - II substance

It should also be noticed that these results are primary and further studies are needed to determine the velocity and persistence of detonation in order to make complete qualified conclusions. Studies are also planned to determine the workability and brisant as well as to determine the critical diameter of the charge.

In addition, during the synthesis of new ,,molecular compounds'', in both components of them intramolecular gradation increase of oxygen atoms will occur to bring the **negative oxygen balance to zero** [6]. This, obviously, will help to release maximum energy and improve the ecology.

Conclusion

Thus, two "molecular compounds" are synthesized on the base of picric acid and trotyl. These compounds were tested using a capsule detonator to detect blast properties.

Both substances were found to have a fairly strong explosive ability.

Because the electron donor components of "molecular compounds" are much cheaper than the electron acceptor one's, in the case of their use, there may appear the **prospect of economic** effect.

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EXPLOSIVE COMPACTION OF MULTICOMPONENT POWDER MIXTURE

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Compaction of multicomponent powder mixtures is accompanied by some difficulties due to the drastically different properties of the components. Compacting powders by explosive technology method, within a few microseconds the bonding of substances takes place against the background of contact areas, interparticle boundaries and high degree of plastic deformation. When selecting the optimal parameters for powder explosive compaction, it is essential to maintain the uniformity of the load along the entire length of the matrix and not to collapse the matrix. Since explosive compaction is a high-energy process, changes in the qualitative properties of substances may occur.

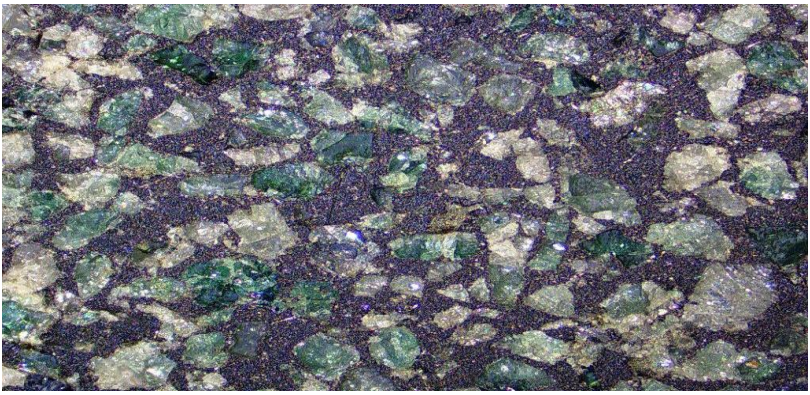
In the experiments carried out, the following explosives were used: ammonite, a mixture of ammonite and ammonium nitrate in different percentages. The detonation velocity of each mixture was determined to select the optimal shock wave parameters.

Three by three compositions, based on mixtures with different percentages of silicon carbide, in size 150-120 μ, 300-350 μ and 500-550 μ, were compacted by explosive technology. The polished sections are fabricated from explosive compacted samples (Fig. 1). As a result of appropriate processing of polished sections, the microstructure and density of samples obtained by explosive compaction were investigated. On Fig.2

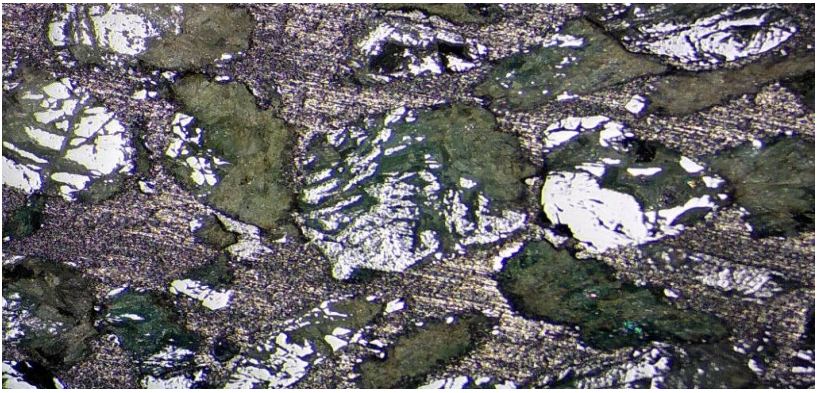
it is shown the microstructures of samples from explosive compacted silicium carbide and aluminum charge mixture, in size 120-150 μ: a) SiC 90% – 10% Al; b) SiC 80% – 20% Al; c) SiC 70% – 30% Al.

Fig. 1. Samples containing different percentage of Aluminum powder compacted by explosive technology

a) SiC 90% – 10% Al (120-150 μ)



b) SiC 80% – 20% Al (120-150 μ)



c) SiC 80% – 20% Al (120-150 μ)

Fig. 2. The microstructures of samples from explosive compacted silicium carbide and aluminum charge mixture, in size 120-150 μ

RECYCLING – A MODERN SOLUTION FOR IMPROVING THE OPERATIONAL EFFICIENCY OF THE MINING AND METALLURGICAL ENTERPRISES

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Mining and ore processing companies are increasingly using ISO 14001 certified environmental management systems (EMS), the key requirement of which is the continuous management of the operational efficiency of the enterprise at all stages of its life cycle [1]. In turn, the key criteria for assessing management efficiency include such indicators as the degree of useful (target) development of extracted resources (metals), the level of disturbance and pollution of adjacent land, the degree of safety of closing the exploited mine or technogenic deposit, the quality of rehabilitation-remediation of the technogenic-degraded environment, etc. [2, 3]. At the same time, within the framework of another concept of sustainable development of the mining and metallurgical industry, the emphasis is mainly focused to the need to expand the life cycle of developed deposits [3, 4]. This concept complements the requirements of EMS and provides for the maximum possible reduction in the amount of extracted material and preservation of reserves for future generations by maximizing the degree of extraction and useful use of ore resources, for which it is proposed to develop new, combined, environmentally friendly technological approaches for additional extraction (deep extraction) of target components [5].

The problem of maximizing the degree of extraction and targeted use of mined minerals is especially acute for Georgia in front of the Chiatura manganese mine and the Zestafoni

Ferroalloy Plant, which processes manganese ore/concentrate mined in Chiatura. The total efficiency of these enterprises in terms of extraction and useful use of manganese does not exceed 50%. Waste generated during mining, enrichment and metallurgical processing causes significant economic damage to enterprises, irreparable environmental damage is caused to the environment.

According to the concept of the United Nations Environment Program (UNEP), industrial recycling and ensuring the complete disposal of waste generated after recycling are considered as one of the main priorities for the sustainable development of the modern world economy. Therefore, in the modern world, more and more attention is paid to solving the problems of improving recycling systems.

Based on the above, there is no doubt that an increase in the recycling degree will lead to an increase in the operational efficiency of mining and ore recovery enterprises, but in practice, this will also be closely related to the need to assess the expected techno-economic-environmental efficiency from the chosen recycling strategy.

For any selected recycling strategy, the total degree of useful (target) development of the mined, processed and recyclable metal-bearing resources (ξ) can be calculated by the formula:

$$\xi = (K_{ore} \cdot K_{met} + (100 - K_{ore}) \cdot K_{orew} + (100 - K_{met}) \cdot K_{metw})/100 \quad (1)$$

where K_{ore} is the extraction of the useful component during mining and beneficiation operations, %; K_{met} - recovery of the resulting concentrate during metallurgical processing, %; $K_{ore.w}$ - additional extraction during mining waste recycling,

%; $K_{met.w}$ - additional recovery after recycling of metallurgical waste,% (values are determined experimentally).

Due to the increase in the total recovery of the target component, the rate of consumption of the extracted ore raw materials will decrease, which will lead to an increase in the operating period of the developed deposit by:

$$\Delta T_{lc} = \frac{\sum_{j=1}^{n} Q_{j\,ore}}{\sum_{i=1}^{n} Q_i N_{\Delta q\,ji}} \qquad (2)$$

Where, ΔT_{lc} - increase of life expectancy of the mine, y; Q_{jore} - resource of extractable *j*-th metal-containing raw materials, ths. t; Q_i - quantity of metal transferred to the product (i.e. reduced), thousand t/g; $N_{\Delta qji}$ - reduced consumption rate of the main *j*-th ore raw materials for the production of the *i*-th final product, ths. t.

In turn, the time during which it will be possible to fully utilize and neutralize the previously accumulated waste can be calculated from the formula:

$$T_{lcw} = \sum_{j=1}^{n} \frac{Q_{jw}}{\sum_{j,i=1}^{n} Q_i N_{ji}} \qquad (3)$$

where, T_{lcw} is the time, i.e. - duration of the life cycle of a technogenic deposit, y; Q_{jw} - resource potential of accumulated waste of *j*-th type, thousand tons; N_{ji} - the norm of consumption of the *j*-th secondary resource for the production of the *i*-th final product, i.e.

The expected economic and environmental effect E from recycling will be:

$$E = \Delta T_{lc} \cdot \Delta C + N_{\Delta qji} \cdot C_p + (T + T_{lcw}) \cdot \sum_{i=1}^{n} (D_{l_i} + D_{w_i} + D_{a_i}) \cdot (Q_{1_i} + Q_{2_i}) \qquad (4)$$

where, ΔC is the degree of reduction in labor costs for the development of new or expansion of the operated mines, $/y; C_p - the self-cost of the processed ore raw materials/ concentrate; T - the duration of the impact on the environment before the start of recycling, y; D_l - the degree of damage (pollution) of lands from mined metals, t/y; D_w is the degree of damage to water resources (pollution with water-soluble salts), t/y; D_a - the degree of atmospheric pollution (spraying), t/y; n - the amount of the type of recyclable waste; Q_1 - the total amount of the target metal in the technogenic accumulation before the start of its processing, ths. t; Q_2 - amount of residual metal after processing ($Q_2 = f(K_{ore.w}; K_{met.w})$), ths. t;

The proposed approach to assessing the key indicators of the operational efficiency of enterprises shows that the higher the degree of intensification of the in-house recycling system, the more efficient the enterprise and the less harmful environmental impact on the environment. Consequently, the proposed approach can be effectively used to organize a modern resource-saving, low-waste production.

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GEOTECHNICAL PROBLEMS OF VISCOUS-PLASTIC LANDSLIDES

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Throughout the long history of the study of geotechnical phenomena, notwithstanding the great number of scientific researches and created methods, the assessment of the stability of landslide-prone slopes is still performed under conditions of marginal equilibrium, Coulomb-Moor, and similar theories. The influence of the time factor, according to the recent studies, can only be indirectly reflected due to the rock shear strength reduction factor (SSRF).

Shear strength reduction factor is very important when calculating the stability of rocky block type landslide bodies. In contrast, viscous-plastic landslides are of more rheological properties. It may happen in rock masses virtually everywhere, and depending on what intensity active stresses are acting on a particular slide surface and what the mechanical parameters of the mass are, creep deformations can occur very rapidly or extremely slowly, over periods of time varying from several hours to centuries.

Therefore, when solving geomechanical problems, along with the rock strength parameters (cohesion, internal friction angle), it is necessary to know the deformation parameters, including the creep parameters. They can be determined by processing a large volume of geological material taken from a landslide-prone slope, through laboratory study of samples and pre-monitoring the image obtained on a rock mass by ,,back analysis" method. It should be noted that the full use of the later will be possible in the wake of the creation and improvement of a direct analytical apparatus for giving a picture of self-crawling plastic landslides, which is still a current problem.

Nowadays, the importance of rheological processes in mining geomechanical tasks for the rational solution of mineral processing problems is rapidly increasing. Similar, though much less intense

trends are observed in the field of landslide geomechanics. This mainly happens in the conditions of nature, before or after starting engineering works at the design stage, defined as potentially landslide-prone slopes according to the legal documents or monitoring . This can be explained by the fact that clear criteria have not yet been developed for the existence of rheological parameters in landslide geomechanics tasks and methods for solving them, which is related to the knowledge of the stress-strain condition of the slope.

Using the numerical methods and special computer programs developed in recent years, it is possible to assess the stress-deformed state of complex slopes and the prospect of indirectly reflecting the reduction of rock strength and deformation parameters when solving the task. The possibility of applying this to the finite element method has been called the ,,new era in landslide sustainability calculation theory'' [1].

The assessment of the stability of viscous-plastic type landslide slopes should reflect the slow rheological deformations in the rock mass and, consequently, the time factor. This problem is important and relevant both theoretically and practically in general, because there are many geological formations in Georgia, where we find "viscous-plastic" landslides. Landslides of this type, whether local or large-scale, are expected in areas of undulating relief [2] unless special attention has been paid to their avoidance at an early, design stage in the context of intensified infrastructure construction.

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PECULIARITIES OF GEOLOGY OF GOLD AND MERCURY ORE MANIFESTATION OF ORE-BEARING SITES IN SVANETI AND BOLNISI REGIONS AND PROSPECTS

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1. In the 1980s, we studied the peculiarities of the geology and structure of gold and mercury ore manifestation of ore-bearing sites in Svaneti and Bolnisi Regions. As a result of the mineralogical and chemical studies, high contents of gold, copper and tellurium were identified in the ore deposits and ore-close metasomatites. Consequently, the gold and mercury ore-bearing formation was identified [1]:
2. The ore deposit researchers paid particular attention to the gold and mercury deposits after one of the largest deposits in Nevada State, Carlin deposit, opened and was put to operation in the 1980s [2].
3. At present, quite strong gold and mercury deposits (Carlin, Cotet, Belly, New-India, Hamly, Dubaishan, Vorotsonskoe, Murzinskoe, Svetloe, Salamon, etc.) are manifested and used in the gold-bearing regions of the world (the USA, China, Iran, the Urals, Khabarovsk Krai, Central Asia, East Baikal, Mongolia, Kazakhstan, Italy, Spain, Canada, Macedonia).
4. The given type of mineralization is spatially and genetically associated with different complexes of endogenic deposits. They identify four types of gold-mercury mineralization: gold-arsenic-silver, gold-antimonite-mercury, gold -tellurium-mercury and gold-copper-mercury types [3].

5. The researchers attribute gold-mercury deposits to the low-temperature series. They are always formed in the crone of the metasomatic column, in the discharge zones of the gold-bearing hydrothermal solutions near the earth surface.
6. Two of the four types of gold-mercury mineralization are identified in Svaneti and Bolnisi Regions: gold-tellurium-mercury and gold-copper-mercury. The former is located in Gagra-Java metallogenic zone and the latter is found within the Poladauri deposit zone;
7. Gold-tellurium-mercury ore manifestations (Tsiteli-Khevi, Barjashi) are localized in the Bajocian porphyry stratum [4], while gold-copper-mercury ore manifestations (Darbazi, Vazis-Khevi, Bolnisi) are found in the volcanogenic-sedimentary rocks of rhyodacite Mashavera and Gasandam strata.
8. The content of ore manifestations is quite simple. The major minerals are: Cinnabarite, gold, copper, pyrite, marcasite, tellurium, dickite, quartz, carbonate. Getchellite, Sphalerite and galena are found rare.
9. Ore-close metasomatites are presented by: quartzites, argillizites and silicified tuffas.
10. In the future, thorough detailed geological survey and exploratory works may identify large deposits of gold and mercury in Svaneti and Bolnisi as evidenced by strong geophysical and geo-chemical aureoles and suitable geological-structural conditions.

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EVALUATION OF THE FILTERING ABILITY OF BENTONITE FROM THE VANISKEDI DEPOSIT FOR THE PURPOSE OF ITS USE IN THE PROCESS OF CLARIFYING WINE

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A study of the filtering capacity of bentonite clay of the Vaniskedi deposit (Georgia) was carried out to establish the possibility of its use in the process of clarifying white wine. In this work, the object of comparison was Askangel "B," which, as is known, is the most effective means for gluing all kinds of wine materials; in the experiments, young homemade white wine was used; transparency, stability and quality of filtered wine were evaluated.

The corresponding indicators [1] required by the industry standard [2] for the use of bentonites in the wine industry were previously determined for the bentonite under investigation. As shown by the organoleptic assessment of wine treated with taken bentonite, by this parameter it is not inferior to Askangel "B"; Vaniskedi bentonite also exhibits a good clarifying ability that satisfies acceptable standards; as expected, Askangel "B" has a very good clarifying ability. Based on all the results obtained in [1], it was concluded that Vaniskedi bentonite mainly meets the requirements of the industry standard [2] and, therefore, it is possible to use it in winemaking, along with Askangel "B.

To clarify the wine, respectively, the process instruction for processing gums and wines with bentonites, a trial treatment with Vaniskedi bentonite was carried out in advance and the necessary dosage was established. To this end, a 20%

aqueous suspension of bentonite was prepared, from which a 5% aqueous wine suspension was then prepared by adding wine. It has been found that the optimal dose at which the best brightening is obtained with the densest precipitate and with the smallest amount of bentonite taken is 0.8 ml of a 5% water-wine suspension per 20 ml of wine, which corresponds to 2 g of bentonite per 1 l of wine. Based on the fact that the doses of bentonite used in practice range from 2 to 5 g/l, we obtained a good result.

To evaluate the filtering capacity of the bentonite under study, various versions of experiments were previously used, in which the size of the fraction, the weight of the sample, the volume of filtered wine, and the temperature mode of sample preparation changed. Filtered wine was evaluated not only for transparency and stability, but also for: color, smell and volume of filtrate, filtration rate, pH value, chemical composition of the initial and filtered wine. Most subsequent experiments used a thin fraction of bentonite (- 0.08 + 0 mm); the maximum retention time of filtered wine was 114 days.

When studying the filtering ability of Vaniskedi bentonite, more than 10 versions of white wine treatment were carried out; the obtained results of the change in the degree of transparency of filtered wine over time, as well as the change in its pH value, for the last five versions showed that in these experiments the filtered wine was initially mainly transparent, very transparent and even crystal clear. But then, when held, after almost every fixed period of time, stability does not acquire and becomes turbid; in some experiments, precipitates of various types appeared: crystalline, protein, colloidal and turbid, so the filtrate was re-filtered each time; sometimes there was no precipitation at all. It should be noted that in all

preliminary experiments the filtered wine was opaque and colloidal precipitate was observed.

The best lightening effect was obtained only in experiment No. 3, where the filtered wine is not only crystal-clear, but also shows stability during the studied period of time, and retains its crystal transparency when aged. In this test, after 7 days, a crystalline precipitate appeared in the form of clear crystals of tartar, which, as is known, is absolutely harmless and indicates the naturalness of the wine, without affecting its taste. It should be noted that a thin fraction of bentonite (-0.08 + 0 mm) was used here and the contact time of bentonite with wine was minimal.

Thus, based on the results of the study of the filtering ability of bentonite clay of the Vaniskedi deposit, carried out in laboratory conditions for small volumes of wine, an optimal version of clarifying home white wine with this bentonite was established, which, apparently, makes it possible to recommend it for clarifying wine, along with Askangel "B."

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ASSESSMENTS OF THE RADIATION HAZARDS DUE TO SOIL RADIOACTIVITY ON THE EXAMPLE OF DZIRULA CRYSTALLINE MASSIF

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Natural radioactivity of the soils and ionizing gamma radiation coming from soils depend on the concentrations of natural radionuclides in it, and artificial (anthropogenic) radioactive contamination of the area. In turn, concentrations of natural radionuclides in soil depend on soil forming parent material (mother rock) and other forming factors of the soil. As a rule, relatively increased level of radioactivity is associated with igneous rocks (e.g. granitoides) and the decreased level with sedimentary rocks. Differences are also observed in igneous rocks themselves, for example, felsic igneous rocks contain a relatively high concentration of natural radionuclides than ultramafic and mafic igneous rocks [1, 2].

As it is well known, in Georgia, granitic rocks are occurred in axial region of Caucasus Main Ridge, as well as in the crystalline massifs of Dzirula, Khrami, and Loki, which represent the salient of old (Variscan) terrain of Georgian massif [3]. Our previous study was devoted to the Khrami crystalline massif [4]. At this stage of the research, the Dzirula crystalline massif (namely, its north-eastern part) was selected. During the selection of the study area, apart from the petrology, some other important factors were considered, such as the existence of populated localities, agricultural and mining (of natural industrial materials) activities.

The aim of the research was to investigate the distribution of natural radionuclides - ^{238}U, ^{232}Th and ^{40}K in the soils, taking into account the geological characteristics of the study area, as well as calculating the basic radiological parameters and estimating the radiation exposure risks of the population based on the obtained results.

Soil samples were collected and processed for laboratory works in accordance with well-proven methodologies. Using the gamma ray spectrometric method, based on the using of high purity germanium detector (HPGe), activity concentrations and content of natural radionuclides (^{238}U, ^{232}Th and ^{40}K) and anthropogenic radioisotope of ^{137}Cs were measured in soil samples. Based on the obtained results, main radiological parameters used for assessment of exposure risks to the population were determined (absorbed gamma dose rate in the air; annual effective dose rate; external and internal hazard indexes, radium equivalent activity, and cancer risk due to external gamma radiation).

As a result, the nature of the natural background radiation was identified for the study area (Fig. 1). The relationship between the radiological parameters and the geological peculiarities of the study area was determined. By the determination of concentrations of anthropogenic radionuclide ^{137}Cs along with natural radionuclides, the picture of artificial radioactive contamination (pollution) of the study area was revealed. Results were compared with similar studies conducted in other countries and other regions of Georgia, as well as with data and recommendations set by international organizations. Comparison of the results showed, that the radioactive characteristics of the study area are slightly increased, but remain within the recommended limits. The results of the

study can serve to develop an analytical information base on the radiation-ecological state of the environment.

The report is devoted to a more detailed discussion of the study and the results obtained.

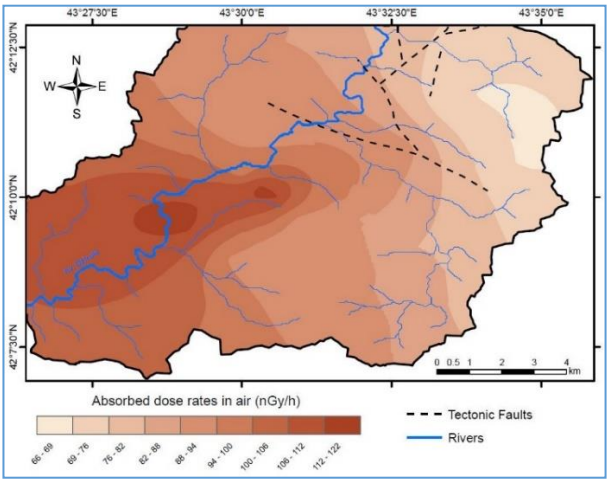

Fig.1. Spatial distribution of the outdoor absorbed dose rates in the study area

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ENGINEERING-GEOLOGICAL STUDY OF VASHLIJVARI LANDSLIDE AND ASSESSMENT OF ITS DYNAMICS

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The landslide, which occurred on the territory of Vashlijvari, on the road connecting Saburtalo and Digomi (M. Machavariani Street), caused a great resonance in the life of our city. A group of specialists was formed in connection with this issue, in which the researchers of the Institute of Hydrogeology and Engineering-Geology of the Georgian Technical University gathered. In March of this year, the group inspected the landslide area and its surrounding area several times in detail, resulting in the following conclusions:

Of course, the factors of origin of such cases should be sought in geological conditions, in particular, in the lithological structure of the mentioned slope, which is represented by alternating sandstones and argillites of the Middle Eocene. Attenuation zones are formed on the slopes, while the layers of argillite between the sandstones are directly supplied to form the flats. Added to all this is one very important circumstance: the bed shapes of these rocks coincide with the direction of the slope, which doubles the probability of landslides.

The research made it possible to identify the natural factors that contributed to the landslide, including:

1. Geological factors:
   - Sandstones with argillite interlayers take part in the construction of the slopes. The slope of these rocks is similar to the slope slope, which increases the probability of landslides several times;

- Sandstones and especially argillites - are very easily depleted rocks, due to which weak zones are formed on the slopes. Such weakening zones are easily formed on the layers of argillites.

2. To the above geological factors we must add the following natural factors:
   - Impact of atmospheric precipitation - Due to the cracking of the rocks, they penetrate smoothly into the depth of the slope and reduce the compaction between the rocks, and
   - seismic shocks, which play an important role in weakening the landslide slope stability. In the pre-landslide period, these events were quite active - during this period, several seismic tremors were recorded in Racha and Tbilisi with a magnitude of 3.0-3.5.
   - Finally, the main reason for the landslide is the road construction works, during which the slopes are improperly processed, which contributes to the emergence of driving forces.

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GLOBAL CHALLENGES AND PROSPECTS FOR EFFICIENT USE OF MINERAL RESOURCES

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1. The paper discusses the potential impact of global risks and the COVID-19 pandemic on future demand for mineral resources, development prospects for the mining industry, as well as tactical and strategic directions for the development of mining companies in the context of rapid and effective crisis resolution. The COVID-19 pandemic has made significant changes in our lives and has quite significant and different impacts on commodity markets and the mining industry around the world. Mineral companies have been somewhat hampered by coronavirus epidemics and government-sponsored demand, which has led to falling demand for many commodities. Companies are forced to upgrade and strengthen the staff sanitation organization, which incurs additional costs, hence the office staff moved to the so-called ,,On remote work".

2. The mining industry has maintained some resilience in the context of COVID-19's impact on the global economy and manufacturing, as mining companies are relatively financially strong and most continue to operate with more or less stability, although increased levels of caution and preventive control. However, the long-term consequences of the pandemic are still unknown. Clearly, in such conditions, the top-40 mining companies should take advantage of the existing financial stability and reconsider their strategy, which will increase the stability of the business in the future.

Despite the pandemic, the mining industry is relatively stable, producing minerals, and developing coal and ore deposits, but this is happening in increasingly difficult conditions – both geographically and geologically, with the abolition of tax breaks by the state leading to the development of difficult deposits, closing hundreds of mines and losing jobs.

3. The COVID-19 pandemic, which has no precedent in the past, casts some doubt on some well-established truths about mining.

COVID-19 has become a catalyst for digital growth that has enhanced sustainable development compliance, creating new trends in the areas of personnel management, delivery organization and public relations in creating a sustainable business management model.

Many mining companies, including some of them are experiencing the negative consequences of supply chain globalization for the first time, in terms of over-saving production and specialization.

The pandemic has highlighted the sustainability of the industry and the role that mining companies play in supporting local communities and the economy as a whole. While the way out of the crisis is still far away, mining companies are already analyzing the lessons they have learned from the situation they have created. Important in this regard are the key risks, opportunities and trends of 2021 for the mining industry presented in table 1.

Table 1

Mining Risks, Opportunities and Trends for 2021[4,5,7,8]

№	Risks and Opportunities		Trend
1	Commodity price risk	Innovation	**Building resilience amid volatility** - Scenarios for strategic leaders
2	Global pandemic	Digital and Data	**M&A in an altered world** - Winning back investor trust
3	Economic downturn/uncertainty	Volatility	**ESG (Environmental, Social, and Corporate Governance): Getting serious about decarbonization** - From strategy to execution
4	Community relations and social license to operate	Workforce	**ESG: Working to overcome the social trust deficit** - Linking social investments to sustainable outcomes
5	Environmental risks, including new regulations	Capital Agenda	**ESG: Corporate governance adding to competitive advantage** - Emerging risks mandate greater oversight
6	Permitting risk	Geopolitics	**ESG: Corporate governance adding to competitive advantage** - Emerging risks mandate greater oversight
7	Political instability/nationalization	Decarbonisation and green agenda	**Creating an agile supply chain** - Overcoming the Vulnerabilities exposed by global shocks
8	Access to capital, including liquidity	Productivity and rising costs	**Advancing the future of work** - Redefining leadership and adapting the workplace culture
9	Ability to access and replace reserves	High-Impact Risks	**On the road to zero harm** - Creating the next generation of integrated predictive safety systems
10	Regulatory and compliance changes/burden	License to Operate	**Meeting demand for green and critical minerals** - Mining's role in the transition to a clean energy future

4. In this regard, it is unreasonable to rely solely on traditional solutions, taking into account the world experience of increasingly expanding the key factors determining the competitiveness of mining and metallurgical enterprises – digital transformation, sustainable development and digitalisation (business transformation and tackling). Newly qualified engineering specialists in mines and shafts will be employed in the areas of information technology and software solutions, who will have the knowledge of the so-called ,,Digital Twins'' and Automated Business Project Management Systems; At the same time, the digital transformation approach is taken into account, when the technology and information environment are transformed into 4 main elements – business processes, product, company culture and customer relationship channels so that the company is in line with modern market challenges and gains competitive advantage in the fastest way.

Companies that rely on the latest digital technology tools (EcoStruxure digital architecture, digital twins, MES systems, smart mills and other technologies) to increase the efficiency of business management, as well as climate change technologies, will become the main drivers of economic development in the coming years.

5. The sustainable business management model envisages three phases of overcoming turbulence: response, recovery and further growth. The initiatives of the last three years have enabled many mining companies to optimize their asset portfolio, ,,strengthen'' their balance sheet and, as a result, respond effectively to the challenges posed by COVID-19 in order to gradually recover long-term business prospects. Who

have high sustainability standards and long-term plans to decarbonize their business.

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THE EFFECTIVENESS OF VERTICAL ELECTRICAL SOUNDING IN SOLVING ENGINEERING-GEOLOGICAL PROBLEMS

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The study area is located in Khulo Municipality, on the left side of the middle part of the Skhalta river gorge in the vicinity of the village of Kintchauri.

Village Kintchauri is located in 3 kilometers from the dam under construction. Accordingly, the influence of the landslide on the natural and social environment can be expected within the boundaries of this municipality.

From a morphological point of view, the territory is a slope of the erosive-denudation type. Its inclination fluctuates in different places from 30^0 to 50^0. Although, in some places forms of relatively low inclination are recorded. In most cases, the slopes are characterized by a pronounced wavy surface.

The purpose of the study was engineering-lithological mapping of the territory, including: establishing boundaries between Quaternary sediments and Basic rocks and identification of hazardous geological processes.

In the upper, Eastern part of the slope, at the mouth of one of the sources, a powerful landslide process is developed, as a result of which heavily depleted and highly fractured bed rocks are exposed. The upper, western part of the slope is generally represented by a paleo-landslide body. For its delineation the method of Vertical electrical sounding was used.

Vertical Electrical Sounding was carried out at 25 points. At each point, using the apparent resistivity of the medium, the differentiation of the sediments, the identification of geophysical horizons and the construction of the corresponding geo-electric columns were carried out.

Geophysical data were compared with data obtained from a well drilled in this area. The results obtained once again confirmed the effectiveness of Vertical Electric Sounding in the study of landslide zones.

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HYDROCHEMICAL CHARACTERISTICS OF NABEGHLAVI MINERAL WATERS PRODUCTION WELLS

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Nabeghlavi groundwater deposit is located in the Gubazeuli river gorge, vil.Nabeghlavi, Chokhatauri municipality, Georgia. According to the hydrogeological zoning scheme of Georgia, it belongs to artesian system of Adjara-Imereti fissure waters. Nabeghlavi mineral waters circulate in the Middle Eocene volcanic-sedimentary rocks and are met in the fissure zones of the bedrocks [1].

Nabeghlavi mineral water was discovered in 1905. Initially it was used for drinking, healing purposes and balneotherapy. Nowadays it is used for drinking and bottling.

It should be noted that in order to renew and develop the Nabeghlavi mineral water deposit, as well as taking into account a number of factors (such as yied decrease, cessation of outflow, natural disasters, inflow of substandard waters), new wells have been arranged to replace/substitute the old exploitation ones.

As of today, №2k, 17a, 66a and 67 are production boreholes, whereas the №44 and №47 are used for observation.

Resuts of chemical analysis of water from exploitation wells carried out in 2015-2020 have been analysed from hydrochemical point of view. Three groups have been distinguished: Group I (borehole №17a) – weakly mineralised (1.6-1.9 g/l) carbonic acid bicarbonate-sodium, silica mineral water;

Group II (boreholes №2k and №66a) – weakly mineralized (3.3-3.9 g / l) carbonic acid bicarbonate-sodium, boron, silica mineral water; Group III (borehole №67) - low-mineralization (5.7-5.8 g / l) carbonic acid bicarbonate sodium, boron, silica mineral water. Thus, the Nabeghlavi mineral waters are bicarbonate sodium, of weak and low mineralization. Specific components are boric acid and silicic acid.

As for the quality of water from exploitation wells - it meets the mineral water requirements set by the national standard [2] and the EC directive [3].

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DEVELOPMENT OF AN ENVIROMENTALLY FRIENDLY TECHNOLOGY FOR EXTRACTING GOLD FROM SECONDARY QUARTZITE HEAP LEACH RESIDUE WITH THE USE OF BIOTECHNOLOGY

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At the copper-barite-polymetallic ore deposit, almost half of the gold remains in the residue of the heap cyanide leaching of gold-bearing quartzites, mainly concentrated in large fractions.

The chemical composition of the secondary quartzite heap cyanidation residue is shown in Table 1.

Table 1

Composition, %									
SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	K_2O	Na_2O	S	Au, g/t	Ag, g/t
85.4	3.9	2.3	1.2	0.58	0.55	0.1	0.3	0.9	6.2

The study of the material composition of the residue showed that the average gold content reaches 0.85-0.9 g/t. Of this, the cyanidable form is 66.7%, 11.1% is encapsulated in quartz and 22.2% is covered with an acid-soluble layer. Grain-size analysis shows that the -10 + 1.0mm grade is 69.8% and contains 82.1% gold, while the fine -1.0 + 0 grade is poor in gold, indicating that during heap cyanidation the gold is mainly extracted from the material of same size. Since it is difficult to dilute the existing gold with cyanide in large grades, we used

pretreatment of raw materials (residues) with silicate bacteria (Bacilusmucilaginosus) to intensify the process.

The density of quartzite is due to its structural perfection, which is due to the abundance of strong bonds ≡Si-O-Si≡ and ≡ S-O-Al = S = in it. Silicate bacteria have the ability to break or weaken these types of bonds. The beginning of the decomposition of silicates is associated with the formation of organic compounds produced by the vital activity of bacteria on the cell's enzymatic apparatus, which dramatically changes the properties of the siloxane bond and causes the formation of cracks in the mineral, penetration to which intensively expands the inner surface in depth in all directions, mainly in the areas of localization of silicon-containing clusters, due to which the density of the ore is significantly reduced, which contributes to increasing the efficiency of processing on an industrial scale.

Laboratory studies have shown that the gold content in the solution after the cyanide treatment of quartzite residues with silicate bacteria increases by an average of 10%.

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HYDROCHEMICAL CHARACTERIZATION OF ZUGDIDI-TSAISHI-KHOBI THERMAL WATERS

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The study of the Earth's heat field began at the beginning of our era. Natural hot springs were already being used by this time. It is impossible to determine the temperature of the Earth's core experimentally and to study its heat field. This problem cannot be solved directly by geological and geophysical methods. It becomes necessary to build mathematical models of the earth and to solve the tasks posed to these models.

Geothermal observations of temperature determination in wells provide material on which to base the distribution of temperature inside the Earth. But the information obtained in this way is limited by the possibility of drilling techniques that is why the temperature distribution data are limited to a depth of 8-10 km. Information on deeper layer temperatures is virtually non-existent.

The heat field is disturbed in the aeration zone, but the impact of waters is sometimes observed even on deeper horizons. Heat field disturbance is often associated with water movement in cracks and sloping flats. Although groundwater dynamics have some influence on geothermal parameters and it is necessary to take this influence into account when determining flow, there is currently no established theory.

The history of the use of thermal water for energy purposes in Georgia dates back to the 50s of the last century, when coal explorers in the well near the village of Tsaishi in Zugdidi took water at a temperature of 80^0C.

Based on the stock materials, the thermal wells in the Zugdidi-Tsaishi-Khobi area are distributed as follows:

Zugdidi precinct: NN 1, 3 and 4 wells;

Tsaishi precinct: 1-T; 2-T; 3-T; 4-T; 5-T; 1-OP;

Khobi precinct: 1; 2 (BIA)

The total amount of mineralization in this area ranges from 0.59 (1-Zugdidi) to 2.8 (2-Khobi) g/l, while the average mineralization is 1.55 g/l. and the average temperature is 81^{0}C.

Table 1

The values given in the table give a general idea of the existing wells

N	Location	Depth	Temperature, ^{0}C	Total Mineralization	Note
1	1-Zugdidi	1743	80	0,59	
2	3 - Zugdidi	1328	70	0,97	
3	4 - Zugdidi	1060	58	1,1	
4	Tsaishi -1-T	1272	84	1,24	
5	Tsaishi -2-T	1904	84	1,25	
6	Tsaishi -3-T	1991	84	1,64	
7	Tsaishi -4-T		70		
8	Tsaishi -5-T		78		
9	Tsaishi 1-ОП	3728	65	1,57	
9	1 - Khobi	2342		2,8	
10	2 - Bia		>65	1,6	

If we summarize the data in the table, Zugdidi district is characterized by low mineralization, with this value mainly and the temperature of 80^{0}C belongs to the category of fresh water, while the wells of Tsaishi district belong to the category of brackish water with general mineralization, and the temperature is 85^{0}C.

Zugdidi - Tsaishi district occupies a prominent place among the Georgian thermal water deposits with the abunda-

nce of exploitation and wells, the amount of identified resources, the level of readiness for the development of the deposit and the existence of a large-scale user.

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ABOUT THE LANDSLIDE IN THE VILLAGE CHANCHKHALO

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Village Chanchkhalo is located in Shuakhevi municipality, on the right landsliding slope of the river of the same name (right tributary of Adjaristskali).

Here morphologically, two (maybe three) main landslide terraces (bodies) are distinguished. In each of them are developed small, local landslide bodies.

Landslides are basically developed in loose sediments of the Quaternary age: In alluvial-deluvial, possibly in elluvial formations. Which are products of weathering of Middle Eocene volcanogenic-sedimentary rocks - andesite-basalts (tuffs, lavas, tuff breccias).

The main landslide body, which is developed in the village area, is of creeping type, surface of rupture is relatively deep. It is divided into small landslide bodies of avalanche type.

The main road to the village of Chanchkhalo, crosses one of the landslide areas. This landslide is generated in the diluvion (boulder, gravel and rock debris with clay filler). Diluvion is dry, but during rains, the filler clay softens and a large fraction loses its friction.

Diluvion, as is clear from the general geological and engineering-geological maps and stock materials, is located on the Middle Eocene andesitic basalts, which is creviced.

We have identified one engineering-geological element (EGE) at the surveyed site: **EGE 1** Eluvial-deluvial rock debris– with clay filler, boulder and pebble inclusions.

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SYNTHESIS OF METHYLPICRATE AND ITS "MOLECULAR COMPOUNDS"

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N. ABESADZE, G. TKHELIDZE
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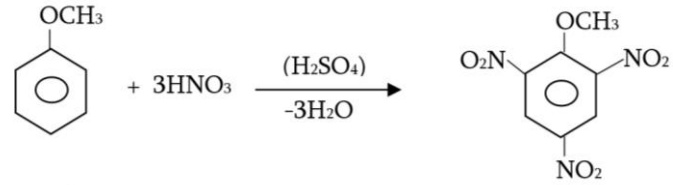
Formerly, we synthesized a well-known explosive substance - methyl picrate and for establishment of its chemical structure used the counter synthesis [1]. Concretely, we synthesized methyl picrate according to two schemes: 1. By methylation of picric acid and 2. By nitration of anisole.

Now, the synthesis of methyl picrate we realized by the second scheme:

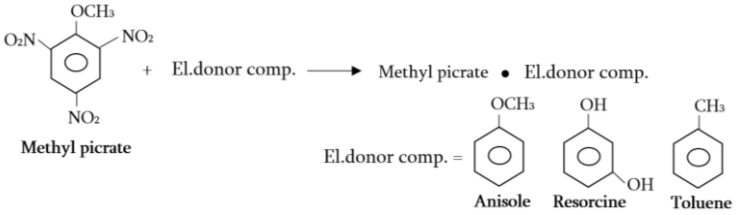


Anisole Methyl picrate

It is well-known, that in the aromatic poly nitro compounds' (picric acid, trotile, methyl picrate, styphnic acid…) nitro groups impoverish the π-electron system of the benzene nucleus, causing them to become electro acceptors and easily form "molecular compounds" or "charge transfer compounds" with electro donor compounds [2, 3].

Now, the purpose of our investigation is synthesis of methyl picrate for further conversion to several "molecular com-

pounds". Anisole, resorcinol and toluene were used as electron donor reagents. The general scheme of reactions is as follows:



It is remarkable, that corresponding reactions are going on in rather "soft" conditions, with high yields of products.

Identity of methyl picrate and reaction products – syntesized "molecular compounds", has been established by various physico-chemical methods of investigation, including IR – spectra.

In the future, we intend to accumulate synthesized "molecular compounds" primarily to determine their explosive ability. In case of obtaining positive results, their explosive characteristics will also be determined.

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MODULAR PREFABRICATED PEDESTRIAN SUSPENSION BRIDGE

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LEPL G. Tsulukidze Mining Institute

The report discusses the implementation of a simplified design scheme for a light pedestrian suspension bridge up to 120 meters long [1-3].

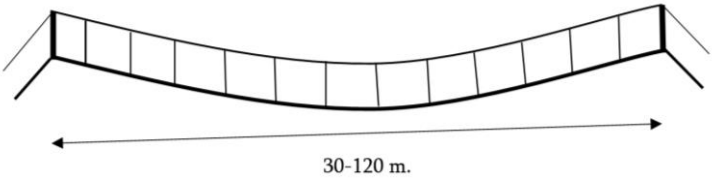

Fig. 1. Schematic of a pedestrian suspended rope bridge

The diagram of the construction of the bridge is given, taking into account the modular principle of the bridge carriageway arrangement. It is proposed to make a suspension bridge module from a standard assortment of metal material 2 m - in assemblies, in which the use of modern tiles made of composite materials together with traditional ones is provided for the construction of the roadway (Fig.2)

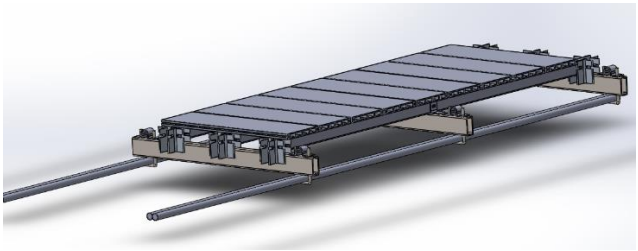

Fig. 2. 2 m. Prefabricated pedestrian bridge module

The article discusses the method of constructing the "gravitational" anchor of steel ropes of the supporting structure of the bridge in soft soils (Fig. 3).

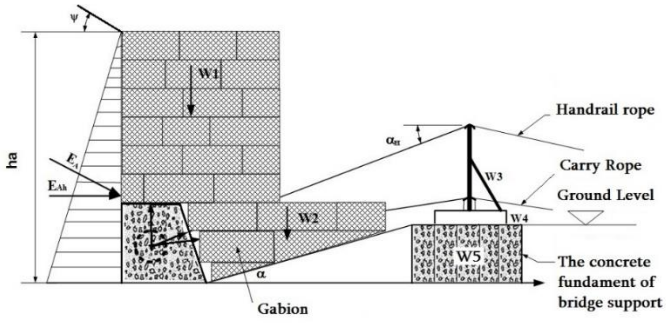

Fig. 3. The device of the "gravitational" anchor of the bearing cable of the suspension bridge using gabions.

For the construction of the ,,gravitational" anchor, it is proposed to use gabions built from inert mass in situ.

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DETECTION AND SYSTEMATIZATION OF FAULT STRUCTURES IN THE SUBURBS OF TBILISI TO IDENTIFY THE AREAS OF DANGEROUS EVENTS

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Due to dangerous geological events in different districts of Tbilisi, several catastrophes have been mentioned, which ended in casualties and huge material damage. In the forties of the last century, a tragedy caused by a flood occurred in Abanotubani, which sacrificed many people. In recent decades, several floods have also developed along the river, in the Vere Valley; the most devastating among them was in 2015, with many casualties and great material losses. Dangerous landslides occurred in 2020, on the slope of Lake Lisi, and so on.

Various special works have been carried out by local and invited specialists to prevent and predict these events. As a result, several papers have been created, which, in our opinion, contain one disadvantage - the role of tectonics in the development of these events is not properly reflected.

Dangerous geological events, floods, landslides, rock falls, etc., are mostly related to tectonic events, and most of them are caused by tectonic faults, so the main subject of the research should be the study and detection of rupture structures.

As a result of our researches, the territory of Georgia revealed the morphological features of faulty structures (lineaments) - they are linear structures and create a grid of orthogonal-diagonal systems, which consists of several (3-4) elements and usually a low-ranking structure is part of a high-ranking structure.

From the mentioned systems, the latitudinal and diagonal-northwest directions lineaments are mainly developed on the territory of Georgia. They dominate the creation of fold structures and the formation of structural-facial zones. The lineaments of latitudinal and northeast directions are intersecting in nature and usually form block structures.

Tbilisi is located at the eastern end of the Adjara-Trialeti structural zone, on the Trialeti ridge. The territory is built mainly of Eocene-Oligocene sediments and is connected with a complex tectonic node. This node is manifested by a sharp change of the flow of the Mtkvari River, which is connected with lineaments of different directions. The river Mtkvari flows in the latitudinal direction in the west of Tbilisi, which is due to the disruption of Gori-Mtskheta. In the northern part of the city, the river changes direction sharply on the meridian, and its direction near the Metekhi bridge also changes sharply on the diagonal - south-east. The abrupt change of the river is related to three strong fault structures: one is the Gori-Mtskheta regional fault, it is part of the tectonic zone that separates Adjara-Trialeti from the Georgian Belt, the second is the meridional fault, allocated by us, which is part of the Arpa-Chechnya transregional lineament that crosses the whole Caucasus and continues beyond its borders, and the third is the north-eastern direction diagonal fault, which is also part of a larger structure.

To solve this issue we believe that geological research should be carried out on the territory of Tbilisi and its surroundings, using aerospace materials. Is it clear, that in the city area itself, due to the infrastructure, the effectiveness of detecting tectonic structures will be minimal, which can be filled at the expense of studying the city surroundings. The main focus of the studies will be dedicated to detect and study

tectonic faults, their morphology, quality of activity, identification of fault crossing nodes, with which are associated areas of potentially dangerous geological events. Proper attention should be paid to hidden fault structures, which will require morphostructural analysis of the area. As a result of the study, a 1:25000 scale tectonic map of the surroundings of Tbilisi should be compiled, which will show the fault structures and the areas of dangerous geological events related to them.

ISSUES OF METALLOGENY OF GEORGIA FROM THE POSITIONS OF FIXISM AND MOBILISM

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The tectonophilic theory, which is based on the invariability of the Earth's volume, along with many other issues, fails to explain the phenomena of expansion and contraction of the Earth's crust, which is reflected in the recurrent development of riftogenic and orogenic cycles. The concept also makes it difficult to explain the existence of long-term fixed global-scale geological structures that intersect continents, multiple structural-facial zones, and are even expelled into the oceans. Along with many shortcomings, this concept also fails to predict ore deposits.

The Caucasus region, whose part is Georgia, has been considered as an active edge of the European continent for almost half a century, only according to the theory of plate tectonics. Consequently, the interpretation of the facts in this region is mainly reduced to the search for the remains of the oceanic crust and to the determination of the Benioff Paleozone, which this crust was absorbed by. There is no consensus among researchers on both the number of absorption zones and the primary source of ophiolites from which they should be derived.

In our opinion, these discrepancies can be explained by the concept of global tectonics, which is based on the idea of pulsating expansion of the Earth and attributes a leading role to the process of riftogenesis. The periodicity of these processes and their activation cycles related to the expansion of the Earth's crust has been established. During the formation of

geosynclines, it caused thinning of the continental crust (in miogeosynclines, sometimes splitting of the crust completely (in the eugosynclines) and forming of an ocean-type crust. Stretching periods were replaced by compression phases, which conditioned closure of rift structures and narrowing of geosynclinal basins; this process was accompanied by intense folding, formation of sloping structures, and horizontal movement of masses. However, this process did not have the scale envisaged by the concept of tectonophiles.

Within the Mediterranean-Himalayan fold system, the Caucasus geosynclinal area was formed mainly as a result of intersection of two global-scale linear zones. One of them is a 500 km thick, the Caucasus - Tian-Shan zone, which is stretched from Atlantic Ocean to the Pacific Ocean, between the latitudes 400 and 450, and which defines the morphology of many geostructures. It is also observed in the Sea of Japan, where it forms a system of geophysical anomalies and forms an underwater abyss.

The 200 km long linear zone of the second system intersects the Caucasus diagonally, to the northwest. It is represented by the Elbrus and Khamadan zones in the south, on the territory of Iran, and in the north by the Ukrainian shield - by the deep fault of Podolsky. These two main structures formed weakened zones in the Caucasus, along which narrow but rather deep graben-like depths were formed. The course of this process from the beginning of the Paleozoic to the Middle of Sarmatian is evidenced by paleo schemes. The lineaments, which have the northeast and meridian directions are also part of global-scale structures. They mostly form block structures, while rarely form fold structures.

The vast majority of the nonferrous, rare and noble deposits on the territory of Georgia are located in the north-west

linear zone, while the ore regions are connected to the meridian system by their crossing nodes.

Barite-polymetallic deposits are mainly found in Middle Jurassic volcanic rocks, although their Upper Tertiary age is documented by many facts. Accordingly, the spatial connection of this formation with volcanic zones requires explanation. The study of spreading zones and rifts in the oceans showed that in the active zones, hydrothermal-exhalation processes take place intensively on their seabed, with the accumulation of large amounts of endogenous substance. A clear example is the Red Sea Rift, where ore deposits are localized in the form of colloidal masses of barium, zinc, and strontium rust.

Supposedly, scattered mineralization of barium and polymetals was similarly accumulated in the Caucasus, in the Middle Jurassic volcanic zones, at the initial stage of their rift development. After that, in the upper third, as a result of tectonic-magmatic activation, these substances were recycled and concentrated along with the meridional structures, forming deposits, where there is several million tons of barite mass and its content reaches 90-95%.

Special attention should be paid to the copper-sulphide deposits of Adange and Zeskho, on which without success exploration works has been conducted for many years. These ore manifestations are related to the Main thrust zone of the Greater Caucasus and are presented in the form of ore containing blocks (sometimes colossal in size). In our opinion, the copper-sulphide mineralization of these manifestations must be related to the period when Jurassic, rift-like processes were underway on the southern slope of the Greater Caucasus, which is confirmed by the age of transformation into ore. Subsequently, the process of tectonic formation of the Greater

Caucasus destroyed these ore bodies. This process was expressed by the bringing of tectonic blocks out on the modern surface, along the main thrust. Young copper-sulphide deposits are also found in the same region, some of them are related to the structures of meridional direction, such as Shou-didi. Therefore, in our opinion, the predictive resources obtained from these ore occurrences are exaggerated and unrealistic.

Oil-gasification is controlled by latitudinal lineaments and these types of deposits are also connected to the nodes of intersection with structures of the meridian system.

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THE FIRST DATA ON Th AND U OCCURRENCES IN THE LATE OROGENIC GRANITE VEINS OF THE SHKHARA VARISCAN PLUTON, GREATER CAUCASUS, GEORGIA

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During the field research provided by the project of the Shota Rustaveli National Science Foundation (№FR-18-8122), in the Shkhara pluton of Variscan generation hydrothermal uranium and thorium occurrences were detected, about which the information will be represented in this publication for the first time. It is noteworthy that hydrothermal uranium ore deposits have an important economic value, they are consisting of 30% of global uranium reserves and therefore, approximately same percentage of global product [1].

During the fieldwork the radiation monitoring of rocks was conducted by the Portable Gamma Radiation Dose Rate Meter Type FAG FH 40 F2. Geochemical analyses of rocks were performed on ICP-MS, in MSLABS laboratory, Canada. The U-Pb zircon geochronology was conducted at the National Chung Cheng University, Taiwan, equipped with an Agilent 7500s quadrupole ICP–MS.

The Shkhara pluton crops out in the headwaters of the river Enguri and it forms ~5 m high and ~15 m long ridge. It is mainly composed of granodiorites with inclusions of biotite-bearing gneisses. This pluton is intruded by various veins

of albite-microcline series with thickness ranging between ~0.2 to 5 m [2].

In two granite-aplite veins intruding the Shkhara pluton with thicknesses of ~1.5 m and 0.7 m, high level of radiation was detected. Common radiation level measures ~1.7-1.9 Sv/h, but within some parts these values increase up to 2.7-3.0 Sv/h. This means that the radiation level in veins is ~10-20 times higher than the common radiation level in pluton. Moreover, performed analytical work showed the average concentrations of elements in veins, only uranium and thorium concentrations revealed some anomalies. Thorium content ranging between 29.5 g/t to 47.5 g/t that is almost one order higher compared to the norm. The uranium concentrations deserve particular interest that varies between 174.3g/t to 290.9 g/t that is 10-15 orders higher than the normal content. These concentrations vary between 62.4 g/t to 105 g/t in the contact areas of veins that are also high content. In all samples taken from the Shkhara pluton, the Th/U ratio is lower than two that indicates that the uranium in these veins should be represented by the mineral uraninite (UO_2). According to the modern researches the vein type hydrothermal uranium ore deposits are associated with the late orogenic phase of the Late Paleozoic and Mesozoic granite magmatism (western and central Europe, China, Canada) [1, 3].

Besides geochemical research, we performed LA-ICP-MS U-Pb zircon geochronology of the Shkhara pluton as well, that are represented for the first time in this publication. Based on the obtained data, during the Variscan orogeny (316.9±8.8 Ma) (20 grains MSWD=2.2) the Shkhara plutonic body intruded into the Late Paleozoic gneiss infrastructure (488.5±8.5 Ma) (28 grains, MSWD=2.7). The granitic vein intruding into the Shkhara pluton was dated at 310.2±7.5 Ma

(25 grains, MSWD=2.6). In these types of the late orogenic veins were detected high mineralization of uranium and thorium.

Based on geochemical and geochronological investigation it is obvious that Uranium and Thorium vein type mineralizations of the Shkhara pluton reveals full identity to the analogous deposits of Central-Western Europe, China and Canada. All of these Uranium ore deposits belong to the Late Variscan orogeny granite vein systems. Therefore, these results let us conclude that the scientific and commercial research of these ore deposits must be continued. In addition, it is advisable to check surrounding sedimentary formations of the Shkhara Pluton perhaps they are enriched with depleted uranium.

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DETERMINATION AND CONTOURING OF SPHERICAL CAVITIES IN UNDERGROUND CONSTRUCTION AND MINING BY PHYSICAL MODELING IN GPR.

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Currently, the issues of construction and protection of underground structures for various purposes, including vertical shaft shafts and underground spherical cavities, remain topical. At the same time, it becomes necessary to solve a number of related tasks, such as combating emergency consequences (rock bumps, underground explosive works, environmental protection from pollution, seismic safety problems, etc.). As a result, blockages are formed leading to the death of people and stoppages of production, which in turn requires an accurate determination of the location of underground objects for liquidation of the consequences, both for access from the earth's surface and from underground.

GPR laboratory studies [1] for a hollow sphere and a sphere with a metal cylindrical inclusion were carried out using the method of physical modeling of GPR. The work was carried out on an enclosing medium installation with a volume of 2.5mX1.5mX1.5m from the day surface [2] for a hollow spherical object with a diameter of 34 cm immersed in a sandy medium and for the same sphere, containing a vertical metal cylinder. The aim of the work was to obtain a radio image of a model of an underground object, which, in accordance with the theory of the similarity of electromagnetic fields, corresponds to a radio image of a full-scale object [1, 2, 3, 4, 5]. Model GPR works [1,2,3,4,5] were carried out using the Zond12e GPR with a 2 GHz antenna and Prism 2.5 software. We give

radio images on radarograms for the central profiles of the sphere model with a hollow and with a metal inclusion (Fig. 1-2).

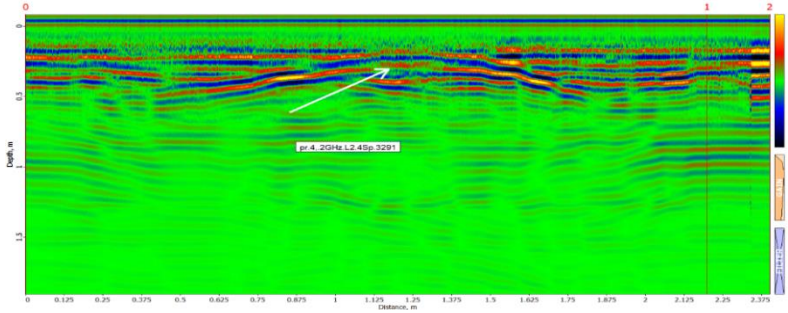

Fig. 1. Radarogram of a hollow sphere, the in-phase axes show the presence of a cavity at the upper part of the radio image with burred lines.

The paper identifies and defines the contouring criteria and features of a spherical surface in a radio image with a cavity and with the inclusion of parallel profiles above the object surface for radarograms. Thus, the possibility of recognizing a spherical cavity under the ground from the day surface during ground-penetrating radar works for the needs of mining and underground construction has been revealed.

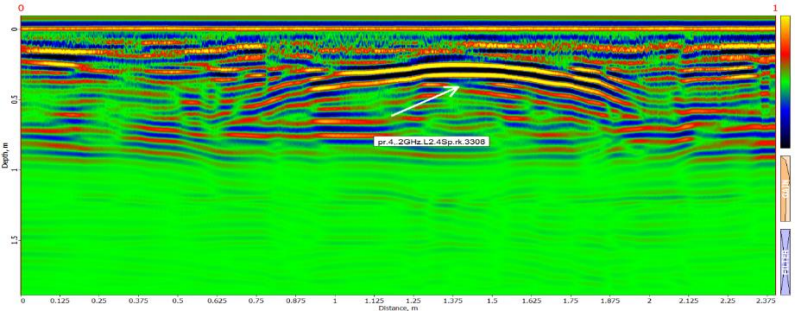

Fig. 2. Radarogram of a sphere with a vertical metal cylinder turned on, the in-phase axes show the presence of a rigidly reflecting object surface at the upper part of the radio image with clear bright lines.

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MICROFAUNA COMPLEXES OF THE MEOTIAN SEDIMENTS OF WESTERN GEORGIA (FORAMINIFERS, OSTRACODES)

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The freshening of the Late Sarmatian basin led to the impoverishment of fauna. Significant conditions for the development of microfauna occurred as a result of the restored connection with the open sea in the Early Meotian. This was well reflected in the stratigraphic sections of the Meotian sediments of Western Georgia (the rivers Tskhenistskali, Ghalidzga, Ghejiri, Kulistskali, and the villages Urta, Bia, Chochkhati, Tkhinvali) studied by microfauna. The biocenic variability of foraminifera and ostracodes over time confirms the subdivision of Meotoan sediments into two sub-stages.

According to the microfauna is possible dividing of the sub-stages into shorter units, where the tendency to gradual desalination of the basin is manifested. There are distinguished following microfauna complexes: 1) Foraminifera and ostracode species fron the following genera – *Nonion, Porosononion, Ammonia, Elphidium, Leptocythere, Cyprideis* that passedfrom the Sarmatian sediments. Genetic connections of some forms of microfauna of the Sarmatian-Meotian sediments have been established [1]. 2) Species of foraminifera of Mediterranean origin from the genera *Quinqueloculina, Miliolinella*. 3) Species of the Meotian sediments, which are widespread in the synchronous sediments of the Caucasus – *Quinqueloculina seminulum maeotica* (Gerke), *Q. bogatschovi* Bogd., *Leptocythere maeotica* (Livent.), *L. sulakensis* Suzin, *L. crebra* Suzin, *Xestoleberis maeotica* Suzin and so on. 4)

Endemic species: *Quinqueloculina disparilis galidzgensis* Bogd*., Q. iberiae* Bogd., *Q. kvezanensis* Popch., *Hauerina iljinae* Bogd., *H. tselidzei* Popch*., Miliolinella majuscule* Popch., *Leptocythere retusa* Popch., *L. chochkatensis* Popch., *L. zinae* Popch., *Loxoconcha bella* Popch., *Candona propria* Popch and so on. 5) Small amounts of foraminifera and significant amount of ostracodes continuing their existence in the Pontian sediments. Species from the following genera: *Quenqueloculina, Ammonia, Elphidium, Cytherissa, Leptocythere, Loxoconcha* are found.

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USE OF MINERALS OF THE AGATE-CHALCEDONY GROUP IN ARCHEOLOGICAL BEADS

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Semiprecious minerals or gemstones are quite widespread in Georgia. Among them, minerals of the agate-chalcedony group are of particular importance and have been mined and used for jewellery purposes since ancient times; discovered in burials numerous pieces of jewelry made of them and decorated with them are evidence of it. The reason for the predominance of the agate-chalcedony group of minerals in our artifacts should primarily be their accessibility which is due to their large spread on the territory of Georgia. These minerals are distinguished by a highly decorative appearance, great density, resistance to environmental conditions and, most importantly, good visual and attractive color.

The Samtavro Burrow ground is a colorful burial due to the carnelian beads having been found there. The beads are represented by a variety of the quartz group, here we find carnelian, chalcedony, agate, and jasper. We have raw materials of a similar type of gem stones in different regions of Georgia, including the Chokrak deposits - in the Mtskheta and Kaspi area.

Fig. 1. Samtavro necropolis beads

According to the visual description of the available beads they differ from each other in color and texture. These differences became even more apparent when studying their internal structure under a microscope. We defined form and size of each bead; we used an X-ray fluorescence analyzer to determine the chemical composition of a certain number of beads.

The results of the research carried out by the authors are the following: most beads are made of carnelian, but there also occur a relatively small number of beads made of chalcedony, agate and jasper. Their textures significantly differ from each other. In some cases, there are distinctly observed zones of growth with a circular or banded texture, sometimes in the form of impregnations or spotted texture. Most of the beads are of uneven coloration, with occasionally visible cracks and inclusions. The degree of transparency of the beads ranges from half-transparent to opaque. As for the shape and processing of the beads they are represented in various forms; there occur barrel-shaped, wheel-shaped, kneecap-shape, spherical, cylindrical, cone-shaped, drop-shaped, triangular and nave-shaped beads. The surface of some beads is represented by diverse ornaments, there are also beads with simple forms of cutting made of carnelian of dark and uniform color. The technique of making a hole through them is also interesting. In most cases, they are drilled on both sides in the opposite direction.

As for the raw material for beads the analyses carried out by optical microscope (Amscop PZ600T), X-ray fluorescence analyzer (EDEXR 3600B) and X-ray diffraction analyzer (DRON3) show that the chemical composition (both basic and admixed elements) and the crystalline structure of the beads studied by the authors and those of quartz-chalcedony-carnelian raw material, mined in various regions of Georgia, are

identical and thus it suggests the possibility of making the studied beads locally from the local raw materials by local craftsmen. We consider that different in color and relatively homogeneous beads are mainly made from the raw material extracted in the Chokrak deposits, while the heterogeneous ones - from the raw material in the Pamachi and Shurdo agate deposits of the Bajocian porphyritic series.

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INVESTIGATION OF OCHRE TYPE PIGMENT RAW MATERIAL OF NAGOMARI DEPOSIT ON ENRICHABILITY

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To study the enrichability of ochre-containing pigment raw material and the dyeing properties of the product (finished product) obtained from it, based on the familiarization with geological archive material, Nagomari deposit was selected for investigation, from which a small laboratory-technological sample was taken. According to the mineralogical analysis of the test sample, the material with thickness above 80 μm is mainly represented by transparent and milky quartz, limonitized clay particles, single earthy hematite and, rarely, magnetite and ilmenite grains. According to the chemical analysis of the initial sample, the Fe_2O_3 content in the ore is 9.78%. With this parameter in natural form it fails to meet the requirements for pigment raw materials and needs enrichment. An electrolytic precipitation method has been selected for enrichment, for the peptization of clays with the addition of sodium metasilicate. The technological scheme of the precipitation process and the optimal operating conditions were determined. The recommended technological scheme allows to obtain 461.8 kg of finished product from 1 ton of raw material with Fe_2O_3 content of 19.43%, and recovery - 91.75%. The result obtained meets the paints and varnishes industry requirements for the pigment.

From the raw materials of the deposit it is possible to produce high quality, ecologically safe, beautiful color, and high

dyeing pigments. It can be achieved by creating small manufacturing enterprises with a simple technological line, which will make a defined contribution to the development of our national economy. Nagomari deposit has favorable mining-geological conditions for development. In horizontal bedding conditions of ochre layers the opencast mining is possible.

ON THE ISOTOPE AGE OF ZIRCONS FROM THE TSKHETIJVARI BASITE INTRUSIVEOF THE DZIRULA CRYSTALLINE MASSIF (CAUCASUS)

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The Dzirula massif is the largest outcrop of the Black Sea-Central Transcaucasian pre-Alpine crystalline basement. Exposures of Early Cambrian basites are widespread within the massif, the largest of which (several km^2) are mapped in the Gezrula and Dedaberastskali river-gorges and in the vicinity of the village Tskhetijvari. Variously sized relics of the basites occurring mainly in the Variscan granites are observed as well. They are represented by gabbro, gabbro-diorite and gabbro-diabase. Their primary magmatic minerals are monoclinic pyroxene, hornblende and plagioclase, rarely biotite. Secondary minerals widespread in the rock are chlorite, actinolite and minerals of epidote group. They are the products of the Variscan retrograde metamorphism, and the appearance of quartz, albite, microcline and zircon is caused by the influence of the Variscan granites. The basites cut through Neoproterozoic (Rb/Sr – 686 ± 54Ma [3]) quartz-diorite orthogneisses, and, in their turn, are cut by granitoids of the tonalite-granodiorite series generated during the Late Pan-African (Late Baikalian, Rb/Sr – 538 ± 53Ma [3]) tectonogenesis. Thus, crystallization of basites apparently took place during the Cadomian orogeny, in the interval 650-550 Ma. The U-Pb

LA-ICP-MS zircon dating of the Dedaberastskali and Gezrula basites recorded only the Late Varician ages of 317.5 ± 6 and 323.7 ± 2.5Ma [2, 4] which reflect the influence of the Variscan granites and retrograde metamorphism.

As to the age of the Tskhetijvari gabbro, it is dated by the Sm-Nd method at 607 ± 78Ma [6]. Despite the large error, this age, in our opinion, fits the geological position of the intrusive and corresponds to the age of the Cadomian orogeny. We have performed 34 local measurements of zircons from the Tskhetijvari basites by U-Pb LA-ICP-MS method and distinguished there three age populations: I – 352-314 Ma (20 measurements), II - 445-371 Ma (9 measurements), and III - 2934-2085 Ma (5 measurements). Zircons of the first population have crystallized under the influence of Late Variscan granites; their concordant age is 329.7 ± 2.8 Ma and corresponds to the Middle Carboniferous. The endogenic process corresponding to the second population is not recorded on the Dzirula crystalline massif. The age of the third group of zircons is in the range of 2934–2085 Ma, which is probably the age of zircons captured by the basite intrusion from the mafic layer [1, 5], located under the sialic layer.

The above data indicate that zircons did not crystallize during the formation of the Tskhetijvari, Gezrula, and Dedaberastskali basites, and therefore their U-Pb LA-ICP-MS zircon dating cannot reveal the crystallization age of these intrusions. Only Tskhetijvari basites, besides the zircons crystallized under the influence of the Late Variscan granites, contain zircons of pre-Paleoproterozoic age, which, presumably, were captured by the intrusion.

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INNOVATIVE TECHNOLOGY OF OBTAINING NEW ENVIRONMENTALLY FRIENDLY HEAT-INSULATING MATERIAL

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All over the world, including Georgia, there is an acute issue of a critical increase in emissions of the so-called greenhouse gases, oxygen dioxide in the environment, as it has a destructive effect on the earth's climate.

One of the means of lowering of carbon dioxide emission in the atmosphere is the minimization of energy usage on heating of buildings, which can be achieved by using heat-insulating materials.

In Georgia construction business is continually increasing but local heat-insulating materials are not produced. The market is full of imported heat-insulating organic materials, which cannot resist high temperatures, are not fireproof materials and in the course of time they are deteriorating and decaying. Besides they cost quite high.

In Georgia the heat-insulation of residential and other buildings is disregarded, which, on its part is the reason for high energy consumption for heating and conditioning. The adoption of ecologically clean, heat-insulating material can become an important factor in order to reduce energy loss, especially when natural and mineral raw materials for producing them are abundant in Georgia.

Therefore, from this viewpoint, it becomes significant to elaborate simplified technology and new compositions in

order to get inorganic heat-insulating material, based on the cheap local resources.

One of the tasks of the project is elaboration of a new heat-insulating material on the basis of local cheap resources by the new technology as a result of self-expanding of the raw materials mixture. It will exclude boiling of the mass of the raw materials at high temperature, as well as using of swelling agents and fireproof forms, which is the scientific and technological novelty of the project.

We have developed a new environmentally friendly heat-insulating material on the basis of local cheap resources by the new technology as a result of self-expanding of the raw materials mixture. It will exclude boiling of the mass of the raw materials at high temperature, as well as using of swelling agents and fireproof forms, which will significantly reduce the cost of their production in comparison with imported counterparts.

For experiments there were chosen natural non-homogenous deposits of clay shales of the river Duruji gorge accumulated as a result of mud-flow processes. Their volume is millions of cubic meters, creating a certain danger to the local environment, particularly the vicinities of the city of Kvareli. At present they have no practical usage.

Our earlier studies found that clay shale from the Duruji riverbed can be successfully used in the production of various types of building materials [1-4].

The influence of the dispersivity of raw materials on the sintering-swelling process has been investigated; studied the influence of various melting oxides on the expansion process; the temperature regime and the expansion interval of the mixture during sintering have been established, etc.

Fig. 1 shows a laboratory sample of a new environmentally friendly heat-insulating building material obtained from clay shale using an innovative technology.

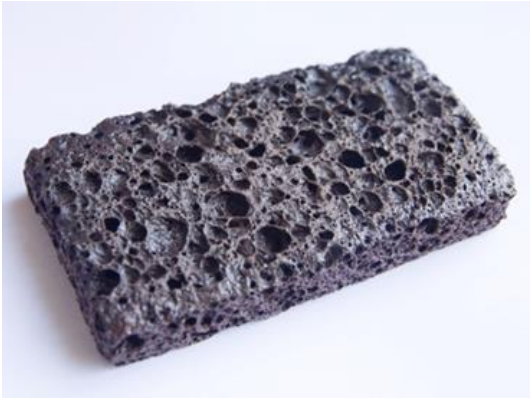

Fig. 1. Heat-insulating building material

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REVIVAL OF THE PRODUCTION OF CERAMIC BUILDING MATERIALS IN GEORGIA AS ONE OF THE WAYS TO SOLVE ENVIRONMENTAL PROBLEMS

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Ceramic building materials (ceramic bricks and blocks, ceramic finishing slabs, clinker bricks (for finishing of roads, facades, etc.) are one of the cornerstones of construction industry. Production of ceramic building materials is accompanied with less emission into the atmosphere and less heating-energy resources are consumed for their production; synthesis of ceramic bricks requires 900-1000°C, whereas synthesis of cement clinker requires 1450-1500°C. At the same time, the wall, built of ceramic bricks, can breathe and is safer for human health then that built of cement/concrete.

Presently only Metekhi brick factory operates in Georgia, which works with clay of Metekhi deposit. Metekhi clay deposit is exhaustible. The content of CaO in the remaining layers of clay is high (12-19 %), negatively affecting the quality of bricks. Brick clays of other deposits also have high content of CaO, forming white sports on the surface of bricks, lowering frost resistance. Unlike them, Kvareli clay shales are remarkable for low content of CaO (1-2%).

It is known that in Kakheti region, in the gorge of Duruji River, as a result of extensive, exogenous processes over 20 million m^3 of rock taluses have been accumulated and annual surplus makes about 500 thousand m^3. Mudflow processes of

ruinous power periodically develop in the gorge, creating risk of ecological catastrophe to the local environment and, in particular, to Kvareli and its population of 10 thousand, living in this risk zone.

There is no doubt that for the purpose of restoration of ecological balance in the region, it is necessary to remove the mass of rocks, accumulated in the outskirts of Kvareli during years. The matter is that the rock alluvium, brought by Duruji River are destroyed clay shales - natural deposit of useful raw material, in the case of rational use of which many types of products may be manufactures with considerable economic benefits, not to say anything about ecological need.

Our earlier studies have proved that the Kvareli shale can be successfully used to obtain various building materials [1-4].

The purpose of this work is to develop technologies for producing modern building ceramic materials: building bricks and clinker bricks from Kvareli clay shales, which will contribute to the revival of the production of building ceramics and a certain solution to environmental problems in Georgia.

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THE PRIMARY MINERAL COMMODITY MARKET IN GEORGIA AFTER THE PANDEMIC OPPORTUNITIES FOR SUSTAINABLE ECONOMIC DEVELOPMENT

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According to the classical definition [1], Sustainable Development is a pattern of resource use that aims to meet human needs while preserving the environment so that these needs can be met not only in the present, but also for future generations. In other words, Sustainable Development consists in synergy of three constituent parts – 1) Environmental Development, 2) Social Development, and 3) Economic Development (fig. 1). In the globalized world, involvement of primary commodities in the economic turnover implies also application of the special financial engines like ETF funds and commodity exchanges where the added value is created by intermediary derivatives contracts, which prolong the commodity chain between the commodity producer and the ultimate consumer. In 2019, e.g. the last year before the Covid-19 pandemic embraced the world, 32.95 billion derivatives contracts were signed [2] versus 7.7 billion of the world population.

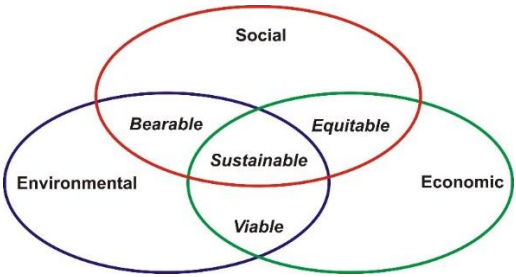

Fig.1. Model of Sustainable Development

In 2020 the coronavirus pandemic created a new economic & political reality, "pandemopolitics" [3], which consisted in governmental efforts to combat both the epidemic and the economic crisis. The latter, first of all, was determined by catastrophic crash of commodity prices at all markets and, as consequence, by withdraw of investors from basic commodity exchanges. According to our in-depth analysis [4], already in mid-summer commodity markets gained equilibrium, however, in 2020 4.89 times less derivatives contracts were signed than in 2019. Just this fact determined deterioration of the 2020 world GDP by, at least, -8% [5].

Georgia is not implied in international commodity markets, correspondingly, pandemic's impact on its economy was less vulnerable. However, the fast social & economic recovery after the pandemic seems to be impossible without application of the financial instruments and engines of the modern globalized world. Economic modelling has clearly shown that augmentation of oil and, correspondingly, of other mineral commodity prices is the best remedy for extremely fast, two-year term, regaining of the world GDP to the 2019 level.

Such accelerated economic growth is suggested to be impossible in Georgia due to lack of the corresponding economic engines. It seems obvious that modernization of the Georgian social environment and switching with the European Union will be impossible if the economic framework is not synchronized and if the commodity markets in its modern shape is not launched in the country. Economic modelling has shown that just application of these free-market financial instruments will accelerate economic development by, at least, three times.

It may be added as a conclusion that the irreversible economic reformation of Georgia must tend towards introduction of the modern free market instruments, which calls for updating of corresponding legislation including introduction of the modern Mining Code. This is the sole possibility to mobilize cheap money for huge investments in the mining sector and this way to ensure combating poverty.

If we want to have a modern state, we should have the modern mining industry.

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GEOLOGICAL STRUCTURE OF THE MUSHEVANI 3 GOLD-LOW-SULPHIDE DEPOSIT

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The Mushevani 3 gold—low-sulfide deposit is located within the Bolnisi ore-bearing region, approximately 5 km northeastward from the Madneuli enrichment plant; it occupies watershed range of sub-latitudinal strike (absolute elevation - 1009 m).

The position of the deposit is defined by the presence of junction point among latitudinal, north-western, north-meridional and close to meridional fault zones.

Host rocks of the deposit are represented by Upper Cretaceous, Senonian volcanics of the Mashavera suite.

The upper part of the deposit hosts silicified (to secondary quartzites – silicite), oxidized, weakly barytized, vitro-crystalline-lithoclastic grey-yellowish psephitic tuffs of rhyodacitic composition. The ore oxidation is met as deep as 50 m. Within strongly fractured areas, the maximum depth of oxidized zone reaches 85 m. The oxidized zone hosts mainly iron hydroxides. As for baritization, it occurs as white, unevenly distributed macrolaminar assemblages in a form of their aggregates, inclusions, veinlet-disseminations, and scarcely as veins.

The mentioned formations are underlain by crysltalline-vitro-lithoclastic coarse fragmental green-greyish tuffs of the same rhyodacitic composition. The suite also hosts scare fine grained (psammitic and aleurolitic) tuff interlayers. The tuffs are unsorted; the amount of clastic material in groundmass is about 30%.

Within the Mushevani 3 suite, there are two horizons of light greenish ignimbrite vitro-clastic tuffs – upper and lower ones. These tuffs also show mainly psephitic structure, although, in their packets some fine-fragmental tuff interlayers are observed. The thickness of the ignimbrite tuffs of the upper zone is 40-45 m, while the thickness of the lower - ranges between 120-220 m.

The deposit exhibits facies transitions of variously fragmented tuffogenic rocks both along strike and dip.

The host rocks underwent synvolcanic propylitic alteration, which is represented by chlorite-(epidote)-albite-quartz-pyrite mineral associations. Chlorite within the mentioned metasomatites has both quantitative and functional importance. In some places, the rocks along with silicification underwent argillization.

The tuffogenic rocks are cut by rhyodacitic subvolcanic bodies of various forms and sizes. Small phenocrysts in rhyodacites are represented by albite, K-fieldspar and quartzite disseminated within felsitic groundmass. Rhyodacitic bodies form distinct positive forms in the relief.

The deposit also hosts andesite vertical dykes of north-eastern strike with maximum thickness of 20 m.

The Quaternary sediments, here, are represented by eluvial, deluvial, rarely proluvial formations. Their thickness reaches some 12 m.

The Mushevani 3 deposit is hosted by weakly folded, monocline structure. Host rocks dip northward; dip angle is 20^0.

The structure of the deposit is complex and shows northeastern, northwestern, close to meridianal and sub-latitudinal disjunctive structures.The fault structures are difficult to be identified since they often are hidden below the Quaternary cover, or diguised by regional metasomatic processes. Most

disjunctives resulted mainly from pre-ore tectonic events. Apparently, during further tectonic activations, the fault structures were reorganized for several times, although, the post-ore period is characterized by the presence of fault zones without any significant deformations and displacement. Their inner structure is featured by the presence of fault and clayey zones. The fault zones and host rocks are characterized by later stage of carbonitization. Orientation of fractured system corresponds to general plan of tectonic stress.

The deposit is divided into several blocks, within which different types of voids (interlayers spaces, pores, caverns etc) in the associated with folding and faulting fractures and rocks have accumulated ores.

Within the top hypsometric horizons, the barite mineralization is accompanied by weak copper mineralization, which appear in the form of its oxidized variations, in particular, as malachite and azurite impregnations and disseminations, and rarely chalcopyrite disseminations. These hypsometric horizons show prints of gold mineralization along with quartz.

Barite concentration gradually decreases with depth increase, although, it is recorded in the boreholes as deep as 200 m, and even deeper it appears in the form of scarce small veinlets, lenses, and inclusions. Simultaneously with barite decrease in the depth, there occurs zinc, gold and copper mineralization represented by quartz-gold-sulphide (chalcopyrite, sphalerite, galena, pyrite) ores. In these ores, the overprinted quartz mineralization plays an important role in regard to gold accumulation.

About 80% of ore intersections are registered in silicified and argilized tuffs, 15% - in ignimbrite tuffs, and 5% - in oxidized zones and andesite bodies.

Ore bodies occur in form of gently dipping lenses. They also occur as pockets. The general strike of ore zone is north-eastern.

The deposit hosts veinlet-disseminated, gold—low-sulphide type of ores. Along with gold, here, very uneven distribution of silver, copper, zinc, rarely lead and barite is recorded; ore mineralization is distributed vertically as well as laterally.

The deposit is of epithermal genesis.

PRELIMINARY RESULTS OF PERFORMED EXPERIMENTS TO OBTAIN IMPACT RESISTANT ORGANOPLASTIC

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The results of the matrix material research are presented. Polyester - urea modified polyester resin is selected as the matrix material. The purpose of resin modification is to enhance the adhesive properties. It should be noted that among similar types of polymers, polyester-ureas are characterized by the highest mechanical properties (Young modulus 6.0 GPa). Akron University (Akron U., USA) is actively working on its introduction.

The principle of selection of reinforcement element of organoplastic, its input control, technological methods of fiber surface treatment to give different specific properties are also presented. The physical and mechanical properties of organoplastics and the influence of various factors on these characteristics are analyzed. Surface treatment methods for reinforcements to reduce the impact of harmful factors are discussed.

The research also refers to impact resistance and dynamic loads of laboratory-made organoplastics. Impact determination methods involve the study of the load falling on a specimen from a certain height and the impact of explosion-induced load on the specimen. Impact test specimens were 67 mm diameter discs with a thickness of 2.5 mm. Samples made of organoplastic were tested on a 3 m high impact coper at a drop load of 2 kg. A special stand mounted in an explosion chamber was used to study the impact on the material caused by the explosion. The sample placed on the stand was a 350x350x3

mm steel sheet with or without a protective layer. After the test, the deformation values (bending) of the steel sheets were measured. The result showed that protecting the steel sheet with organoplastics layer about 2 mm thick reduced the deformation by about three times.

Acknowledgment(s)

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PER FECTION OF RESEARCH METODS IN COMPUTER USING MATHEMATICAL SYSTEMS

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The high pace of development of production technologies makes it impossible to maintain the existing research mechanisms. This creates the need for developing new research methods and designing and manufacturing appropriate tools.

Modern industrial explosives are characterized by reduced sensitivity to external influences and zero or near to it oxygen balance, which results in the release of toxic gases during the chemical transformation process. Explosives are characterized by high sensitivity and pronounced negative or positive oxygen balance. Consequently, their direct use for industrial purposes is prohibited in accordance with international norms.

The manufacture of modern industrial explosive mixtures on the basis of explosives involves the introduction of various substances in their form as mixtures, which leads to an increase in the critical diameter of the charge. It's noteworthy that the critical diameter / mass is the maximum / minimum diameter / mass of the charge that causes an explosion. According to our research, the so-called "refinement" of explosives has led to an increase in the charge diameter / mass of the charge by up to one kilogram, while the current testing equipment is designed to explode a charge of 50 to 150 grams in diameter / mass. This circumstance precluded the determination of the detonation and energy characteristics of the obtained explosive mixtures using existing methods and equipment.

The need to develop a methodology and design and manufacture of equipment that will allow any crisis mass / diameter

test charge to explode has been put on the agenda. For this purpose, the Grigol Tsulukidze Mining Institute developed a device for measuring the rate of detonation working on optical transmitters, the principle of operation of which is based on the discrete registration of the chemical transformation process through ionization and optical transmission. It can measure reaction speed in both critically large (1 kg and more) critical diameter / mass as well as critically small (10-20 g) charges. In addition, the tool allows us to determine the dynamics of reaction velocity variability and to determine the forms, areas and conditions of reaction induction, acceleration, explosion and detonation. One of the disadvantages of this method is the high sensitivity to electromagnetic radiation, which leads to distortion of the signal on the recording device when testing modern explosives. In order to test the energy performance of modern industrial explosives with increased crisis diameter, the Grigol Tsulukidze Mining Institute designed a modern multifunctional calorimetric device, which will be adapted to be used both for the research of explosives produced on the basis of utilized gunpowder, as well as for testing the composition of electric / physical-chemical and reaction products of modern mass produced industrial (as well as military) explosives.

The principle of the operation of the device is based on the rise in the temperature of the calorimetric liquid as a result of explosion-induced heat release. The increase in the temperature of the calorimetric liquid equals the energy, the heat of the explosion, created as a result of the chemical transformation, which makes it possible to determine all main thermodynamic parameters.

It is noteworthy that the key detail of the modern multifunctional calorimetric device – the explosion chamber – was

designed on the basis of a computing experiment using modern research methods, specifically, computer mathematics systems. For this purpose, a computing model of an explosion chamber having parameters and form obtained as a result of analytical research was designed. In order to validate the results, the LS-DYNA software package imitated and visualized the explosion of a test charge weighing 1 kg. Based on the optimization and analysis of the results, the thickness of the blast chamber wall was selected, during which the integrity of the chamber surface was fully maintained until the chamber was fully unloaded, without residual deformation and breakage. The concurrence of the results obtained by analytical solution and computer modeling led to the reliability of the project model on the basis of which a draft project of explosion chamber was prepared and handed over to the Scientific Centre for Construction Research and Drafting for preparation of drawings. Instrument manufacturing procedures are currently underway.

Based on the above, a computational experiment based on modern research methods allows us to conduct scientific research on explosive transformation processes without any costs and risks and to "replace" the experimental research methods.

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FOLDED STRUCTURE OF THE GREATER CAUCASUS AT THE CROSSING OF THE RIVER GORGES OF THE PSHAVIS ARAGVI-KHEVSURETIS ARAGVI-TSKALSHUA-ASSA

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Annotation. The relevance of the work. The article considers the folded structure of the Greater Caucasus at the complete intersection of the gorges of the Pshavi Aragvi-Khevsureti Aragvi-Tskalshua-Assa rivers. Despite the surveys carried out in previous years, the geological study of the region, the detailed characteristic features of its folded structure are still insufficiently studied [1, 2, 3, 4, 5, 6, 7]. At the same time, the study of the folding of the Greater Caucasus is of decisive importance for the determination of the conditions of formation of the modern folded structure of the region. **Purpose of work.** The establishment of important features of the folding of the Greater Caucasus essential for identification of the reason and mechanism of its structure formation, which is not yet fully resolved problem. The **research methodology** consisted in a very detailed sketching of the folding of the region along the gorges of the noted rivers ~~on~~ with a scale of 1: 1000, which allowed to record all the features of the studied structure. The cross section compiled during field studies was reduced to 1:100,000 scale. The resulting geological-structural profile sufficiently fully and accurately reflects the main features of the structural building of this intersection. **Results**. In

the studied section, a number of important features of the folded structure of its Mesozoic-Cenozoic strata are established. First of all, it should be noted that the fold structures are multi-order and of different age and in most cases of sublatitudinal strike. The first-order structures are earlier folds and are represented by asymmetric southwardly declined, highly compressed 1-5 km wide folds. Complicating large structures, folds of higher orders are also tightly compressed and asymmetric with the axes dipping to the north and in some places to the south. Their size varies widely - from 0.5 m to several tens of meters. The sublatitudinal strike of the folding indicates that it formed in a different deformation environment than the main northwestern structure of the Greater Caucasus. The axial part of the cross-section is pierced by dikes of various sizes and diabase composition. **Discussion of results and conclusions**. The nature of folding indicates a different genesis of the structures during the two-stage diverse multifaceted deformation of the region. At the first stage of deformation (Jurassic-Middle Miocene), the Caucasus experienced northeast tangential compression caused by the horizontal advance and pressing of the Black Sea-Transcaucasian microcontinent to the Greater Caucasus. As a result, the main linear folded structure of the northwestern strike, large regional faults, and layered cleavage were formed in the region. At the second stage of deformation (Late Miocene-Anthropogene), the folded structure of the Greater Caucasus experienced oblique submeridional horizontal compression. In the southern part, the reason of the deformation was the longitudinal movement of the Zhinvali shol, the corresponding block of

the microcontinent, and their emplacement into the folded structure of the Greater Caucasus. These dislocations in the region contribute generation of the late low folding superimposed on the early structure, small shear faults and crosscutting cleavage of the sub-latitudinal direction. Thus, different mechanisms formed the modern structure of the southern slope, and also revealed a new detailed structure of northern slope of the Greater Caucasus at the intersection of the noted gorges during the alpine cycle of regional tectogenesis.

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Correction – Elene Akhmeteli