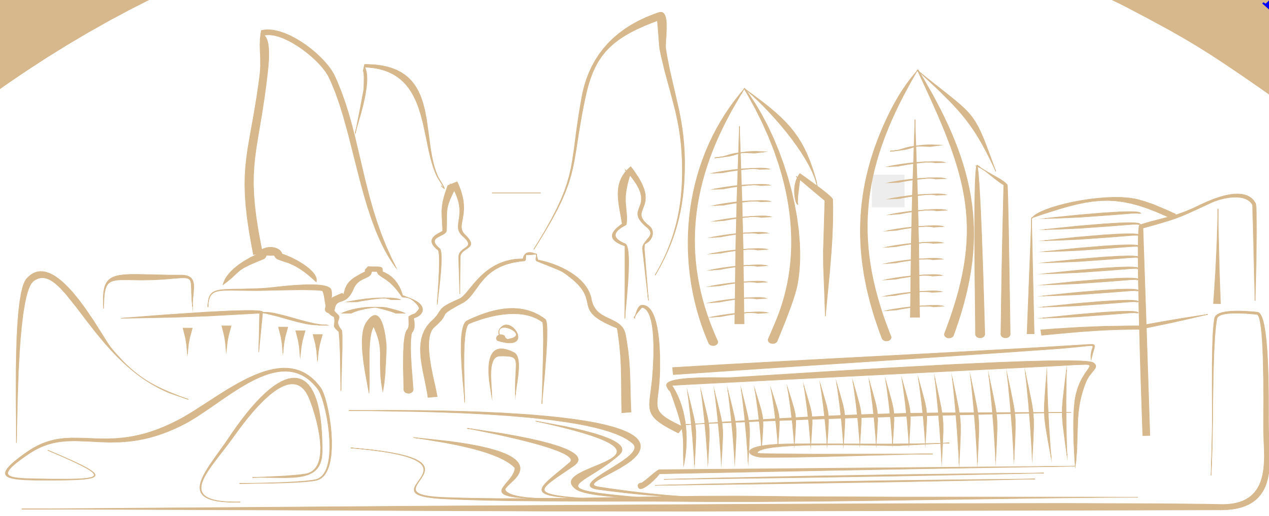
VII INTERNATIONAL CONFERENCE OF YOUNG SCIENTISTS & STUDENTS



INFORMATION TECHNOLOGIES IN SOLVING MODERN PROBLEMS OF GEOLOGY AND GEOPHYSICS

Dedicated to the 80th anniversary of
Institute Geology and Geophysics,
Azerbaijan National Academy of Sciences

BOOK OF ABSTRACTS

15-18 October, 2018

Baku / Azerbaijan

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Conference is organizationally supported by the Institute of Geology and Geophysics (GGI) and Azerbaijan National Academy of Sciences

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- New approaches and methods in investigation of the Earth's crust
- Information technologies in solving geological and geophysical problems
- Using advanced technologies in prospecting for minerals
- Geological events and processes; geological risk assessment

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CONTENT

PLENARY SESSION

NEW APPROACHES AND METHODS IN INVESTIGATION OF THE EARTH'S CRUST

INFORMATION TECHNOLOGIES IN SOLVING GEOLOGICAL AND GEOPHYSICAL PROBLEMS

USING ADVANCED TECHNOLOGIES IN PROSPECTING FOR MINERALS

GEOLOGICAL EVENTS AND PROCESSES; GEOLOGICAL RISK ASSESSMENT

PLENARY SESSION

APPLICATION OF COSMOGENIC SURFACE EXPOSURE DATING IN TECTONIC GEOMORPHOLOGY: EXAMPLES FROM OFFSET ALLUVIAL FANS, FLUVIAL TERRACES AND NORMAL FAULT SCARPS

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Cosmogenic surface exposure dating methods rely on *in-situ* accumulation of cosmic ray produced nuclides within exposed rocks and sediments. It may allow determining the timing and rate of tectonic events ranging time span from hundreds to million years. There are several nuclides but 10Be, 26Al and 36Cl are the most common cosmogenic nuclides widely employed in tectonic geomorphology. There two approaches employed to date alluvial fan and fluvial terrace surfaces with single nuclides: these are (1) surface exposure dating of boulders or cobbles and (2) depth-profile techniques. Surface-exposure dating is based on dating of multiple boulders on the surface of fan and determining the probable exposure age from the mean of the samples. Dating individual boulders on alluvial fans can be difficult because of the inherited component of cosmogenic nuclides at the time of deposition. This problem can be addressed by collecting sediments from modern river course and/or “depth-profile dating”, which relies on collecting multiple amalgamation samples in a 3- to 5 m deep profile. Dating normal fault scarps method is based on 36Cl concentration on the fault scarp surface developed within the limestone. The basic assumption is that 36Cl exponentially decreases with depth and each large earthquake exposes the buried part of the fault plane. Therefore this would accumulate 36Cl nuclides on this freshly exposed part. Measuring of 36Cl concentration from top to bottom of exposed fault scarp will display distinct exponential variations of 36Cl concentration implying timing and amount of displacement during each large earthquake. In this meeting, I will present examples of dated offset alluvial fans and fluvial terraces from Ecemiş Fault Zone in Central Anatolia and from Knidos Fault Zone in Western Turkey.

GEOCHEMISTRY AND MOBILISATION DEPTH OF MUD VOLCANO PRODUCTS IN THE KERCH PENINSULA

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Mud volcanism is a global geological event that completes multistage diagenetical alteration of soft sediments and maturation of organic matter. Mud volcanism provides transport of major and trace elements from deep sedimentary reservoirs to the surface with erupted mud masses and fluids, and thus impacts the environment [1, 2, 3, 6, 8]. In this respect, the issues of top priority are (1) constraining the geochemical specificity of mud volcanoes (MVs) that are rooted at different depths; (2) contouring geochemical anomalies of the elements specific for mud volcanism (especially, Hg, B, As, and halogens); (3) estimation of mud volcano contribution into the cycles of B, As, Hg, Cl, I, Br, heavy metals as well as quantification of their amounts in ejecta.

Our studies were performed in the Kerch Peninsula (Kerch-Taman mud volcano province, the Northern Black Sea). This province occurs on the south periphery of the Indol-Kuban Trough and connects within thick Pliocene-Quaternary sedimentary strata (3500-5000 m in total). Maykopian-facies anoxic marine mudrocks (Oligocene – Early Miocene) are the main sources of solid matter for mud volcanoes of the region. Mud volcanic activity in the Kerch Peninsula presumably began in the Pliocene and is currently decaying [5]. In 2017 sampling covered large MV edifices dormant for 50 to 100 years, active domes, gryphons and salsas. Maykopian sediments, oil shows, and waters of boreholes, springs, and saline lakes were used for comparison. Unstable water parameters (T, pH, Eh) and salinity were measured *in situ*; gas phase compositions were determined additionally in some MVs. Mud masses (40 samples) and MV waters (25 samples) were analysed by the ICP-MS, ICP-AES and wet chemistry methods.

The MV waters from the Kerch Peninsula mostly belong to Cl-HCO_3-Na type, have pH=7.0–8.7 and contain 4.5 to 69.0 g/L TDS (normally 10 to 18 g/L). The contents of Na, Cl, K, Ca, Mg, Sr, S, and Br in MV waters are much lower than in seawater, but Li and Ba are much higher (8-35 and 3-12 ppm, respectively). The dilution of MV waters expulsed by smaller edifices (salsas and gryphons) are much higher than those of large domes. Boron content is extremely high (400-1600 ppm), indicating water inputs from at least 2 km depths. Evaporation in saline MV waters is accompanied by HCO_3^-, Cl, B, Br, Na, and Li increase and Ca, Mg, Cs, and Rb decrease with growth of bulk salinity. Precipitation of halite, borates and, less often, sulfates accompanies MV water evaporation. The Li, Br and I are stored in water-soluble salts, but their exact mineral hosts were not found so far.

Temperatures in reservoirs that feed the mud volcanoes were estimated proceeding from water chemistry using hydrogeochemical thermometers: $T_{Mg/Li}$ are from 34 to 160°C (T_{av} = 88.4°C; n = 45) for the Kerch Peninsula. Taking into account the regional geothermal gradient (30-35°C/km), the origin depths of mud volcanic fluids ($H_{Mg/Li}$) can be estimated as 1.0-4.0 km, which corresponds to the depth range of the Maykop Fm.

Mud masses consist of liquefied Middle Maykop shale with low organic (≤ 0.5 wt%) and moderate sand contents. Due to high kaolinite content all studied muds are depleted in K and are commonly enriched in Na and B relative to Post-Archean Australian Shale (PAAS) [7] and in Li, Cs, U, Zn, Co, V, As, Se, Sb, Hg, Cd relative to upper crust [4]. Excess Na is manly stored by high-silica plagioclase of sand fraction and minor NaCl. Boron is mainly hosted by Na-Ca and Na borates. Variable amounts of carbonates as well as chemogenic celestite and barito-celestite are responsible for Ca and Sr variations in bulk samples, whereas cinnabar and As-bearing pyrite for increased Hg and As contents in the mud masses.

Heavy fractions extracted from mud masses became guides to solid matter sources and directions of transport into sedimentation basin and allowed to reconstruct the depth of reservoirs that maintain current MV activity. Forty minerals identifying in the heavy fractions were grouped into three assemblages. The first one mainly consists of ultra-stable high-grade metamorphic minerals (ilmenite, rutile, kyanite, sillimanite (±andalusite), and garnet) with signatures of distant transport. This assemblage is typical of the Maykop Fm. shale from the North Black Sea area and records matter transport from source areas of the southern Russian Platform and the Ukrainian shield. The second assemblage including siderite, mixed Fe-Mn-Ca-Mg carbonates and authigenic Fe (±Zn, Cu, Hg, Ag) sulfides is typical for sedimentation in stagnant deep-sea environment. These inferences are consistent with fluid generation temperatures ($T_{Mg/Li}$=110–115°C) estimated for MV waters of the Bulganak area (the largest MV field in the Kerch Peninsula) and indicating sediment mobilization from depths of 2.5-3 km. The third assemblage, with predominant Fe (oxy) hydroxides, is typical of small MVs connected with younger (post-Maykopian) synclines. Sedimentary basins of that time were shallow-water and characterized by oxygenated environments. The fluid generation temperatures inferred for their waters ($T_{Mg/Li}$=50–90°C) suggest shallower mobilization depths of MV fluids (~ 1.5-2 km).

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NUMERICAL INVESTIGATION OF THE INTERACTION OF FORCED AND FREE THERMAL CONVECTION IN BASIN-SCALES GROUNDWATER FLOW SYSTEMS

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On the basis ofearlier conceptions, water table variation was suggested as the main driving force of regional groundwater motion. Since that time it has been perceived, that furteher driving forces (e.g. density change by temperature differences, etc.) can induce groundwater flow. Foremost, *Lapwood* [1] proved analytically the onset of free thermal convection in a two-dimensional conceptual porous model, when the Rayleigh number exceeds the critical value, $Ra > Ra_{cr} = 27.1$. In their pioneering study, *Domenico* and *Palciauskas* [2] investigated the relationship between the topography-driven groundwater flow and heat transfer, however they approched negligible effect of buoyancy force. Recognizing the importance of free thermal convection, *Cserepes* and *Lenkey* [3] studied the flow pattern as a function of the slope of the topography (□<0.1°).

In this study, the combined effect of the forced and free thermal convection was investigated numerically on the groundwater flow pattern and temperature field. Continutiy equation with temperature-dependent water density, Darcy's law and heat transfer equation were solved during tha numerical calculations.A simple two-dimensional homogeneous, isotropic Tóthianmodel with constant water table slope (□=1°) [4] was applied to focus on the physics of the phenomenon. First (1) the temperature differences was increased between the bottom and the surface of the model (□$T=T_b-T_s$=0–150 °C), this range of the □T covers the values of Ra=0–3244, while the other parameters were kept constant, while the variation of the Darcy's velocity, the temperature and the hydraulic head were computed [5]. The increase in ΔT intensifies the ground water flow, heats the basin up (Figure (a)) and substantially modifies the hydraulic head (h) (Figure (b)) and the hydraulic head differecence (□h) (Figure (c, d)), inducing both over- and underpressure near and within the thermal plumes. By increasing the temperature difference, the position of head maximum (h_{max}) jumps to the thermal boundary layer, where it separates the local downflow, like a moving divergent stagnation point (Figure (b, c)). The locations where the hydraulic head is significantly affected by the free thermal convection are (1) within and around the plume beneath the recharge area, (2) in the deeper parts of the midline zone and (3) the majority of the discharge area. In further calculations studied parameters were the slope of the water table (□=0–5°), the depth of the model (d=500–5000 m) and the anisotropy coefficient of the hydraulic conductivity (□$=K_{xx}/K_{zz}$=1–100). In addition, the effect of boundary conditions was examined.

This study draws attention, that two-dimensional numerical simulations are needed to investigate the combined effect of the topography-driven forced and buoyancy-driven free thermal convectionto elucidate the physics of the complex basin-scale flow pattern in siliciclastic sedimentary basins [e.g. 6] and in carbonate sequences [e.g 7, 8], and plan more reliably geothermal energy utilization in a potential area, especially in Buda Thermal Karst, Hungary.

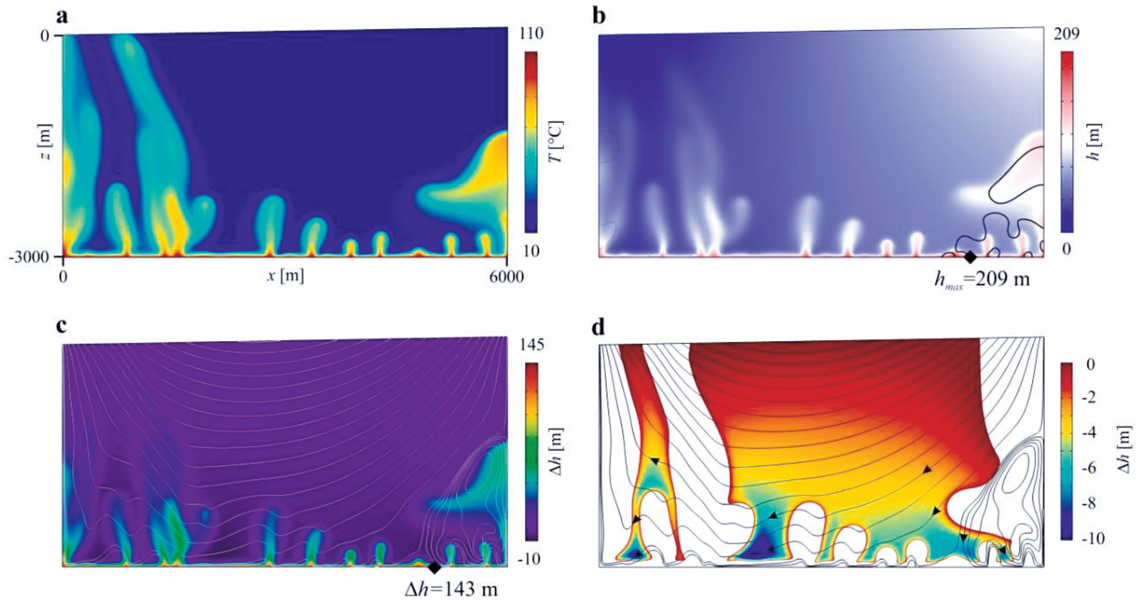

Fig. Snashots of (a) the temperature, (b) the hydraulic head (*h*), (c) the hydraulic head differeecence (□*h*) between the calculated and isoterhmal (□*T*=0 °C) head and (d) the hydraulic head decrease (□*h*<0 m) at $t=4\cdot10^6$ d and at □*T*=100 °C (*Ra*=2003). (b, c) The head maximum and the head difference is denoted by a black diamond and squere, respectively.

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ESTIMATION OF CRYSTALLIZATION DEPTH OF THE GADABAY INTRUSION ON THE BASE OF IRON-TITAN OXIDE MINERALS GEOTHERMOBAROMETRY

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As we know, the intensive exploitation of the known ore deposits leads to need of founding of new sources and expanding the resources of exploiting deposits by the prospecting and determining of new ore bodies in peripheries and in the depth of these very ore deposits. To accomplish these complex tasks, we need some ground or base, which we need to use to justify our predictions and which can be scientific proof of our future prospecting.

One of such base is understanding and revealing of an evolution of geologic unit, which the relevant ore mineralization is related. So, we can define the source of mineralization, distinguish patterns of that geological process in whole and use those patterns and marks in our tasks. To do this in the first place, we need to determine the initial magma source, its abundance or depletion in certain elements and evolutional path of the magma until the end of magmatic processes in that region. Cooling of magma in intermediate magma chambers and the differentiation of this very magma are important as well and can be reasons of the diversity in the evolutional path. As we know, cooling and differentiation of magma depend on the factors such as depth of magma chambers, P-T conditions of chambers. Titan-iron oxide minerals geothermobarometers are well-known and useful tools in such tasks.

Therefore, I have used this methodology in the estimation of the depth of crystallization of Gadabay intrusion and the temperature condition and oxygen fugacity of the crystallization as well.

First of all, it would be useful to describe Gadabay intrusion shortly, its location rock diversities and etc. Gadabay intrusion is located in the Shamkir anticlinorium of the Lesser Caucasus. It consists of two rock complexes: gabbroid and granitoid. Each complex is separated to its rock diversities. Gabbroid phase includes the rock types such as gabbro-norite, melanocratic gabbro, uralite-bearing gabbro, gabbro-diorite and plagioclase bearing pyroxenite. Granitoid phase contains quartz-diorite, hornblende bearing quartz diorite, granodiorite, tonalite, banatite, monzodiorite, monzonite and granite type rocks. Recent researches have shown that cobaltic mineralization has been caused by melting of the gabbro-norite rocks, pyritic-gold mineralization by melting of the quartz-diorite rocks and polymetallic-gold mineralization by melting of the monzonite rocks. However, here mineralization aspect of the region has not been touched, but only depth and P-T conditions of the crystallization process.

The results of the analyses of titan-magnetite and ilmenite of the related rocks and the calculated values of the aforementioned factors have been given in the Table. The results of the presented research show that, rocks of the gabbroid phase have been crystallized relatively in the shallower depth and since oxygen fugacity had higher values. Whereas, rocks of the quartz-diorite phase have deeper depth of crystallization. This obviously shows that quartz-diorite phase was not differentiation of the gabbroid phase. In addition to these fact, the instances of the cutting gabbroid phase rocks by the quartz diorite phase prove this point of view.

Table

Magnetite and ilmenite content of the rocks of the Gadabay intrusion

	5-6	7	10	11	12	13	14	15	16	17	17	18	19	21	22	23	24	25
SiO_2	0.22	0.21	0.12	0.09	0.14	0.07	0.09	0.09	0.08	0.07	0.09	0.08	0.09	0.10	0.00	0.11	0.07	0.12
TiO_2	2.75	2.04	1.66	1.38	2.38	1.15	2.66	1.62	5.20	1.30	1.30	4.46	1.16	3.64	3.66	2.46	6.38	5.38
Al_2O	1.06	3.21	1.83	1.34	1.23	1.26	1.83	1.14	0.58	1.42	0.75	1.23	0.64	1.16	1.38	0.38	0.78	0.73
V_2O_3	0.0	0.0	0.00	0.00	0.00	0.38	0.59	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cr_2O	3.65	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe_2O	58.4	60.6	63.9	64.7	63.1	65.6	61.0	64.2	58.6	64.1	65.2	58.5	65.8	60.9	60.4	63.4	55.5	57.2
FeO	32.1	31.6	30.7	31.7	31.5	30.4	32.3	30.5	33.8	31.5	31.2	34.2	31.1	33.8	33.5	32.6	36.4	35.1
MnO	0.32	0.38	0.38	0.18	0.16	0.31	0.35	0.16	0.29	0.40	0.40	0.18	0.40	0.14	0.31	0.25	0.18	0.34
MgO	0.87	0.86	1.21	0.43	1.21	1.12	0.68	1.26	1.18	0.45	0.42	0.48	0.44	0.38	0.42	0.38	0.25	0.36
NiO	0.24	0.16	0.09	0.07	0.09	0.06	0.12	0.08	0.08	0.07	0.10	0.12	0.06	0.10	0.09	0.06	0.09	0.12
CoO	0.0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Σ	99.6	99.2	99.9	100	99.8	100	99.7	99.5	99.9	99.3	99.4	99.3	99.7	99.8	99.7	99.9	99.7	99.3
Usp	8.62	6.55	5.08	4.25	7.25	3.42	7.89	4.95	15.1	3.97	4.1	13.1	3.63	10.9	10.4	7.5	18.4	15.9
İl			84.2		85.1		89.8	87.3	87.6	88.2	86.2	87.7	88.4	87.6	87.4	86.7	86.3	87.7
Tem			710		716		690	680	745	663	674	735	654	721	738	704	769	746
fo_2			-13.8		-14.4		-16.7	-15.2	-14.5	-15.7	-15.2	-14.6	-	-14.9	-14.9	-14.9	-14.0	-14.6
T_C	527	539	548	553	535	558	531	549	487	555	554	500	557	513	516	534	465	482
H	3.0	2.3	1.8	1.5	2.8	1.3	2.8	1.8	5.0	1.4	1.5	4.4	1.3	3.7	3.6	2.6	6	5.2

5-6 gabbro-norite; 7-melanocratic gabbro; 10-11,14- diorites of the gabbroid phase; 12-13,21-22 quartz diorites; 15-16 granodiorite; 17-tonalite; 18-banatite; 22-23 quartz monzodiorite; 24-25 quartz monzonite;

Summarizing all, it can be concluded that, the hydrothermal solutions of the residual meltings of each rock diversity were the source of the certain ore mineralization. It is necessary to find all relations in this process by the use of complex of methods and apply this knowledge in the future prospecting.

SEISMIC SITE CHARACTERIZATION FOR EARTHQUAKE HAZARD MITIGATION AT A PLANNED INDUSTRIAL CITY, ASWAN, EGYPT

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Due to the fact that the planning stage of the new development projects is the first step, so site characterization is one of the essential factors which should take into consideration during this step for secure project toward natural hazard and disaster. Site characterization plays an important role for sustainable development of societies in earthquake prone areas. Recently, the Egyptian government started a new plan for the sustainable development, many new development projects initiated in Egypt including many industrial cities to face the future industrial revolution. Aswan new industrial city is one of these cities, its site is very close to the main active seismic zone in Aswan region, so it became very important to perform the current such study before the construction to mitigate the future earthquake hazard on the industrial facilities. The main target of the current study is the characterization of the foundation rocks using active and passive seismic techniques (shallow seismic refraction and ambient vibration measurements). Based on the seismic measurements at 20 selected sites in the study area, the P-wave velocity, the soil lithology with the layer thickness, the resonance frequency and the amplification factor were calculated at each site. The preliminary results showed that the study area has shallow bedrock without a significant amplification which is a good foundation rocks for engineering purposes.

VERTICAL ELECTRIC SOUNDING IN STUDIES OF THE LANDSLIDE-HAZARDOUS SLOPE STRUCTURE

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In the qualitative assessment of the stability of landslide-hazardous slopes lies in the correct study of the object: in taking into account all possible properties of rocks and the state of the massif. The properties of rocks include strength, water-physical (natural moisture, water saturation, filtration coefficient, granulometric composition), elastic, plastic, deformation and rheological properties, which are required for further calculations. It is also necessary to determine the structural state, fracturing and groundwater level, which play an important role in the study. There are many methods for determining the structural characteristics of the slope: the method of measuring small deformations, the use of radioactive isotopes and radioactive radiation, vertical electrical resistance, sound metric method, and others.

The method of measuring small deformations using piezo-dynamometers refers to full-scale measurements of pore measurement and consists in converting a string into electric. To

determine the water-physical properties of rocks in the massif, a method based on the use of radioactive isotopes and radioactive radiation is used, and as a result, such parameters as humidity, groundwater level and qualitative assessment of the chemical and mineral composition of rocks are determined. The principle of the sound method is as follows.
Sound piezometers (geophones) are used that can take sounds generated by rocks in the process of destruction and allow to establish the growth or decrease of the beginning process of destruction of the onboard massif that are dangerous with respect to deformation [4]. Vertical electrical resistance is used to study rocks, without destroying the solidity of the array. The equipment, as a rule, consists of an installation comprising four electrodes: a pair of receiving and feeding electrodes. The electric potential difference between two receiving electrodes is measured, and the electric current is supplied to the supply electrodes. The current discharged from the electrodes passes through the soil, soil and rocks lying at depth [1].

In practice, vertical electrical resistance is widely used to study the structure of the slope under study. An important role is also played in the compilation of the geological engineering structure of the slope, in which not only the determination of the slope geometric parameters and the thickness of the varieties of the constituent bedrocks, but the constituent rocks, is required [3-2]. Vertical electrical sounding and electrical profiling methods are based on the principle with four electrodes as shown in Figure. *K*- Electrical current (I) refers to, *A* and electrodes B, and potential (ΔU) are measured between *M* and electrodes *N*. The specific electrical resistance of the soil (ER) is calculated by the formula:

$$ER = K\frac{\Delta U}{I} \qquad (1)$$

The geometric factor *K* can be obtained for a set with four electrodes of the AMNB configuration according to the formula:

$$K = \frac{2\pi}{\frac{1}{[AM]} - \frac{1}{[BM]} - \frac{1}{[AN]} + \frac{1}{[BN]}} \qquad (2)$$

here [AM], [BM], and [AN], and [BN] are the distances (m) between the respective electrodes. For a centrally symmetric set, when [AM] = [BN] and [BM] = [AN], formula (2) can be simplified to

$$K = \pi\frac{[AM][AN]}{[MN]} \qquad (3)$$

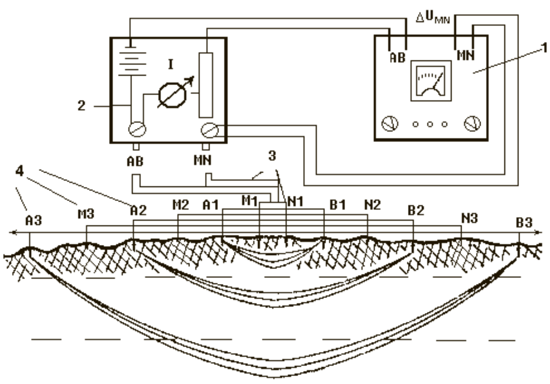

Fig. Scheme of vertical electrical sounding device: 1 - autocompensator, 2 - switch for electrodes AB and MC, 3 - composed as a result of wires for different distances among electrodes AB and MC, and 4 - electrodes.

It can be noted that the use of vertical electrical resistance is wide. This is evidenced by the results of many studies. The VES method was applied to assess the salt layers and the depths of groundwater in alluvial soils of the Volga delta, Russia. Distribution of the profile of rocks in the soils of the Crimean Peninsula, Russia was successfully investigated with the VES method. Pollution by the oil mining industry has been shown in the profiles of Gelisols in Northeast Siberia. The VES method was also used to locally control the thawing of the soil and the drying up of processes on cultural Alfisols and Histosols in the Moscow Region, Russia [1-3].

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THE SURFACE WAVE PHASE VELOCITY ESTIMATION BASED ON S-TRANSFORM

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The multichannel analysis of surface wave (MASW) [1] is a wellknown method to estimate the shear velocities through the inversion of surface wave phase velocity dispersion curves. MASW is widely applied for investigation of soil structure for geotechnical purposes. In the field of hydrocarbon seismic exploration surface wave analysis also can be used to compute receiver static corrections for body waves processing.A key step of the MASW is to transform the data from the time-space (*t-x*) domain to thefrequency-phase velocity (*f-v*) domain. The common approaches to perform this transform are *tau-p* [2] and *f-k* transforms, phase-shift method [1]. As showed by [3] these methods give equivalent results (at least for noise-free data). As a rule, all of the methods, mentioned above, provide good results for noise-free synthetic data. In practice (in the case of real data) the dispersion curves are picked manually. Often operator should empirically plot a smooth and realistic dispersion curve. Sometimes the images are so distorted that it is even hard to guess where is the surface wave.In order to increase the accuracy and ensure the unambiguity of surface wave dispersion curve picking, we introduce a new f-k spectral imaging method called slant f-k transform (SFK transform).The proposed technique is based on time-frequency analysis, utilizing a method, introduced by [4] and called S-transform. Thanks to some properties, the S-transform has been widely used in different seismic data processing applications.

The S-transform of a signal $h(t)$ is given by relation:

$$S\left[h(t)\right](\tau, f) = \int_{-\infty}^{+\infty} h(\mathrm{t}) \frac{|f|}{\sqrt{2\pi}} e^{-\frac{(\tau-t)^2 f^2}{2}} e^{-i2\pi ft} dt.$$

Let's observe a single mode of the surface wave. Consider two signals h1(t) and h2(t), recorded by a couple of receivers of a linear acquisition system (both of the receivers are located on the same source-receiver line). The S-transform of the second signal can be expressed in terms of the S-transform of the first signal [5]:

$$S\left[h_2(t)\right](\tau, f) = e^{-i2\pi k(f)l} e^{-\lambda(f)l} S\left[h_1(t)\right](\tau - k'(f)l, f),$$

where $k(f)$ is the surface wave wavenumber, $\lambda(f)$ is a frequency dependent attenuation parameter and l is a distance between receivers. Consider a non-stationary surface wave packet, composed of a series of modes with wavenumbers: $k_j(f),\ j = 0,1,...$. Let us apply the S-transform to each trace of a shot gather *g(x; t)* and cut off the frequency axis at each frequency *f.* Thus we get a series of 2D complex-valued functions of time and distance:

$$g_f(x,\tau) = S\left[g(x,t)\right](\tau, f, x),$$

called pseudo seismograms. Note, that Since the MASW method assumes a stratified horizontal homogeneous medium, the surface wave group velocity does not depend on distance x. The surface wave packet travel time curve for a fixed frequency pseudo seismogram time-distance coordinates is a slant line. In oder to pick the surface waves dispersion curves, we propose to analyze the following slant f-k transform (SFK transform):

$$P(f,k) = \max_u \left| \int_{-\infty}^{+\infty} g_f\left(x, \frac{x}{u}\right) e^{-2\pi ixk} dx \right|$$

instead of standard f-k and f-v images. The spectral peaks of the slant slices of pseudoseismograms correspond to the wavenumbers of flat waves, traveling directly from the source. All other waves are much more strongly suppressed than during standard f-k processing. The time localization of the surface wave packet at each frequency increases the signal-to-noise ratio due to an exclusion of noise at other time steps.

A field data has been acquired in vicinity of Novosibirsk, Russia. The receiver array was made up of 20 vertical 10 Hz geophones with 5 m spacing. The time domain acquisition parameters were 1 s. length and 2 ms. sampling rate. A sledgehammer was used to generate a seismic impulse. The resulting seismogram is presented in Figure (a). The f-k images are presented in Figure (b) (SFK) and Figure (c) (conventional 2D FT). One can see that the SFK surface wave spectral image is less distorted in compare with conventional 2D FT. Note, that in Figure (b) three modes can be observed.

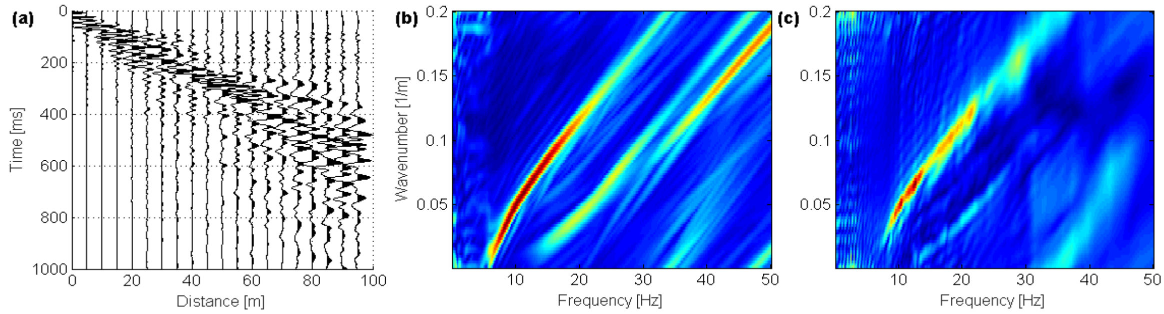

Fig. Field data processing (a) raw data (b) SFK f-k image (c) 2D FT (conventional) f-k image.

A new robust surface wave multichannel data spectral processing method, called slant f-k transformis proposed. The announced enhancement of the phase velocity dispersion curve picking has been verified on a series of synthetic and field data processing experiments.

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THRUST-TOP BASINS EXAMPLES WITHIN GEORGIAN PART OF THE KURA FORELAND FOLD-AND-THRUST BELT, GEORGIA: REVIEW

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Thrust-top basins (or piggyback basin) are key elements for unravelling the tectonic evolution of fold-and-thrust belts [e.g. 7; 4]. Our study area is the western part of the Kura foreland fold and thrust belt. The active Kura foreland thin-skinned fold-and-thrust belt, which is one of the best examples of collision-driven far-field deformations, is associated with the Arabia-Eurasia convergence [1]. The Kura foreland fold and thrust belt developed formerly as a foreland basin (Oligocene-Lower Miocene or Oligocene-Upper Miocene) and is located between the Greater Caucasus and Lesser Caucasus orogenes [2, 5, 6]. Our study area is the Georgian part of the Kura foreland fold-and-thrust belt.

Fault-related folding theories [9] were used for structural interpretation of the S-N trending seismic profiles. Identification of stratigraphic units at depth for seismic profiles was based on outcrop and deep-well data correlations. Interpreted seismic profiles across the Udabno, Tsitsmatiani, Berebisseri and Didi Shiraki synclines show that they are thrust-top (or piggyback) basins. Seismic reflection data reveal the presence of growth fault-propagation folds and duplex. The evolution of the Udabno, Tsitsmatiani, Berebisseri, Didi Shiraki basins is compared with simple models of thrust-top basins whose development is controlled by the kinematics of competing growth anticlines. Growth anticlines are mainly represented by fault-propagation folds [1, 3]. The geometry of growth strata in associated footwall synclines and the sedimentary infill of thrust-top basins provide information on the thrusting activity in terms of location, geometry, and age. Interpreted seismic profiles across the Didi Shiraki syncline is filled by the Pliocene – Post-Pliocene continental syntectonic sediments, forming a typical thrust-top basin. Double migration of Didi Shiraki thrust-top basin depocenter was connected to formation of the Zemo Qedi and Mirzaani fault-related folds and Didi Shiraki upper structural complexes have bivergent structure [1].

Analysis of growth strata geometry in seismic profiles documents the evolution of deformation, showing that it has been continuous over the last ~16-15 Ma together with the thrust system kinematics. Compressional deformation of the Kura foreland started in the Middle Miocene, initially covering the south-most parts of the area, compression reached its peak at the end of the Miocene [1]. The growth stratigraphy (Middle Miocene and Pliocene-Pleistocene) consists of shallow marine and thick continental sediments. Pre-growth strata are represented by Upper Eocene and Oligocene-Lower Miocene thick, deep, and shallow marine sediments. The Pliocene-Pleistocene growth strata are hydrocarbon-bearing, and the Mtsarekhevi oil field is located within the study area [8].

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CHANGES OF ROCK PROPERTIES DURING EXPLOITATION OF GARADAGH FIELD /UNDERGROUND GAS STORAGE, AZERBAIJAN

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In this presentation a retrospective analysis of the spatial heterogeneity of the petrophysical properties of the VII-VIIa horizons of the Productive Series (PS) of Lower Pliocene age in the depleted gas-condensate field of Garadag (Azerbaijan), used now as an underground gas storage (UGS) is given.

The Garadag field/UGS is located on the southern wing of the asymmetrical anticline fold in the far southwest of the Absheron Peninsula, 30 km from Baku. According to exploration and development data, the gas reservoir in the VII, VIIa horizons has a block structure. The gas-condensate deposit of the VII horizon of the PS differs from others deposits by high productivity. Two intervals are distinguished in section: the upper (VII hor.) and the lower (VIIa hor.) reservoirs, separated by a clay layer with thickness 16-36 m. In the south-eastern part of the southern wing of the fold the VII horizon consists of 4-5 sandstone layers with thickness 5 -10 m. These layers are separated by clayey interlayers with thickness 2-4 m. In the section of the VIIa horizon two sandstones layers are distinguished, separated by a clayey layer with thickness 5 m. The thickness of the upper sand layer is 10 m, the lower layer - 15 m, reaching up to 20-25 m in the submerged part of the southern wing of fold.

The effective thickness of the VII-VIIa horizons in the north-west is 10-25 m, and in the southeast - 55-75 m.

The gas-condensate pool with the oil fringe in the VII-VIIa horizons has been in operation since 1955. The depth of the VII horizon at the crest of the structure is 1900 m, the submerged part is at 4250 m (average depth 3125 m).

The productivity of the wells drilled into horizon VII is spatially nonuniform. The more productive wells are located in the submerged SE part of the pool.

The Garadag gas-condensate field was developed without reservoir pressure maintenance and so the deposits of the VII–VIIa horizons were depleted by the late 1980s. More than 20.5 bn m^3gaswere extracted from the horizons VII–VIIa during 1955–1978. The formation pressure dropped from 9MPa to 3.5MPa.

For the modelling of the spatial variability in reservoir rock properties and gas saturation of the productive formation (horizons of the PS) of the Garadag gas condensate field and UGS the ROXAR (Irap RMS) software was used.

The spatial heterogeneity of the petrophysical features of the VII-VIIa horizons is established, as shown in the mosaic nature of the spatial changes of the reservoir properties and gas saturation. The uneven nature of the change in the area of the reservoir properties of rocks, the formation of isolated zones in the reservoir, as well as the unpredictable directions of fluid movement is the main reasons for the decrease in operation efficiency of the Garadag field/UGS.

Thus, one has established that the volumes of injection and extraction gases at Garadag UGS are controlled by reservoir properties. In addition, in the fluid-saturation model of the reservoir, the development is seen of the process of water intrusion into the productive zone with a tendency to break into isolated gas pillars. These facts should be taken into account in the further operation of the UGS.

To monitor the dynamics of water movement, it is advisable to use the software package 'ROXAR' (Irap RMS).The pressure difference in the reservoir during the cyclic injection/extraction of gas into the Garadag UGS is more than 10 MPa (Figure). Multiple cycles of changes in loads on the reservoir during the operation of the UGS also contribute to the development of deformation changes in the rock that lead to the destruction of the rock skeleton. This effect is manifested by precipitation in the separator and in the reservoir for the liquid at the end of each season of about 10-15 tons of sand. The greatest sand lifting removal is noted in wells where the volume of extracted gas, as a rule, exceeds the volume of injected gas.

Deformational changes in the formation caused by exploitation of field and UGS lead to reduction of productivity and injectivity of wells.

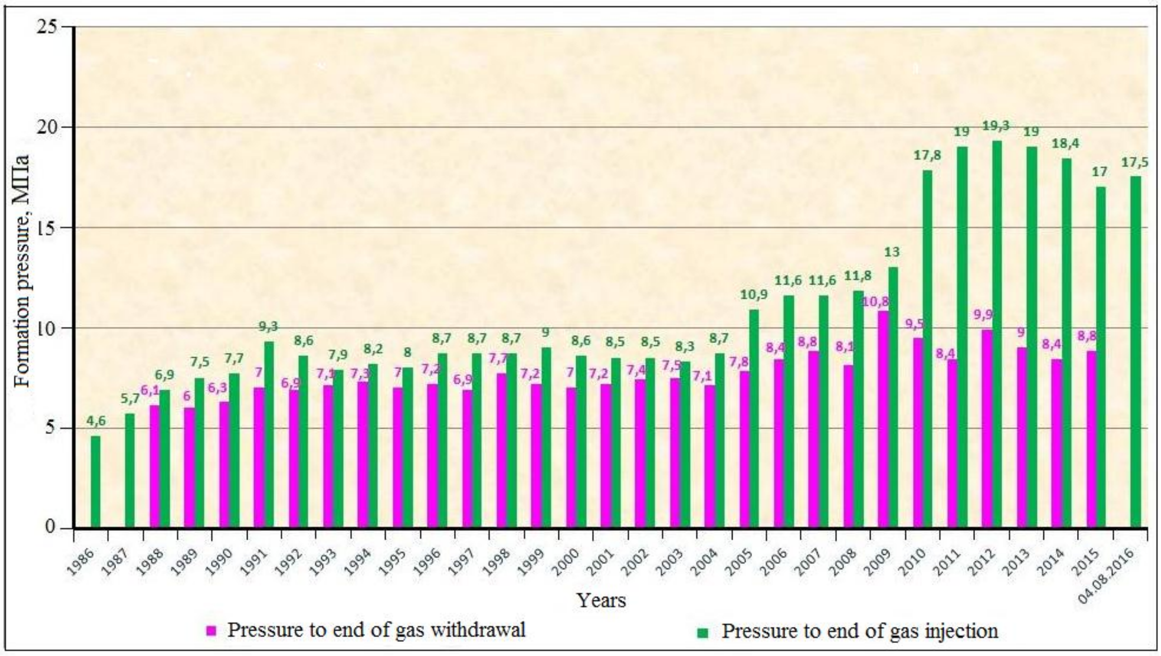

Fig. Dynamics of changes of reservoir pressures at the end of gas injection and withdrawal at UGS Garadagh, Azerbaijan.

GADIR SILICA SINTER: AN EARLY EXPLORATION TOOL AND THE DIRECT LINK TO A GEOTHERMAL RESERVOIR FOR LOW SULFIDATION DEPOSIT AROUND GEDABEK DEPOSIT

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Gadir deposit is located in the East of Yogundag, near Gedabek deposit, also, Shamkir uplift of the Lok-Karabakh structural-formation zone in the Lesser Caucasus Mega-anticlinorium. The Gadir Area has a complex geological structure, and it has become complex with the intrusive masses and breaking structures of different ages and different composition. Lower Bajocian is essentially composed of an uneven succession of diabase and andesite covers, agglomerate tuffs, tuff-gravelites and siltstones. Tuffs of the Lower Bajocian were exposed to strongly metamorphism (hornfelsed) as a result of the impact of Upper Bajocian volcanism and intrusives of Upper Jurassic age. Rocks related to the Bathonian stage have developed mainly in the top of Yogundag.

During field mapping provided around Gedabek deposit by Gedabek Exploration Group (GEG) in 2012 and discoveredsilica sinter and lacustrine siliceous deposit, also hydrothermal breccia pipes which these are an early exploration tool and the direct link to a geothermal reservoir for low sulfidation deposit (see Figure).

The Gedabek hydrothermal eruption breccia pipe (GHEB pipe) is located in the central-eastern part of the Yogundag Mountain around the Gadir low sulfidation deposit. The present shape of the pipe with about 50 m diameter resulted from both volcanic and erosional processes. Erosion has reached the deep levels of the pre-pipe stratovolcano at the bottom of the depression and the hills forming the margins of the pipe. Breccia pipe mostly consists of after Bathonian andesitic lava and tuffaceous rocks.

Gadir silica sinter observed around GHEB pipes in the central part of Yogundag Mountain.

Silica sinter layer obtained above Gadir horst. The thickness of silica sinter various from 5 m to 25 m, in average 12 m. This was one of the primary criteria indicated that Gadir horst belongs to low sulfidation epithermal deposit. The deep angle of the layers is approximately 25-30° and strike to South and South-West. Silica sinter may consist mainly of opal, but could as well be made mainly of very fine-grained quartz similar in structure to jasper. In small parts may assume an agate-like structure, but in most cases, the banding is different from that in an agate.

Gadir Silica Sinter forms from discharging alkali chloride hot springs and provide evidence at the surface of a deeper geothermal reservoir. Long after hot spring discharge ceases, sinter textures are preserved and an exploitable geothermal system may remain at depth. Therefore, sinters may be the only evidence at the surface of a hidden geothermal resource. The recognition and mapping of preserved environmentally-significant textures in ancient sinters reveal hot spring paleo-flow conditions and temperature gradient profiles from high temperature vents to low-temperature distal-apron slopes. Sinter dating reveals the timing of discharging hot springs enables the tracking of discharging fluids on a regional scale and identifies sinters that are most likely to be related to a blind geothermal resource.

Another type of silica alteration on Gadir horst is lacustrine siliceous deposit (LCD). Sedimentary sequences of the LCD basin are in East part of Gadir outcrop. The sedimentary sequences of the lacustrine basin are in East of Gadir outcrop over an approximately 85000 m2 area. The basin history was reconstructed by GEG (2012) from observations of more than 12 drill holes. The limnic sequence of the basin is cover by an andesite flow related to the intermediate volcanic activity between the fourth and fifth rhyolite tuff unit of the area. The upper parts of the lava beds show shallow subaqueous accumulation with breccia.

Thus, silica sinter textural mapping combined with sinter dating provides a simple tool that assists existing exploration techniques used in the search for hidden geothermal resources.

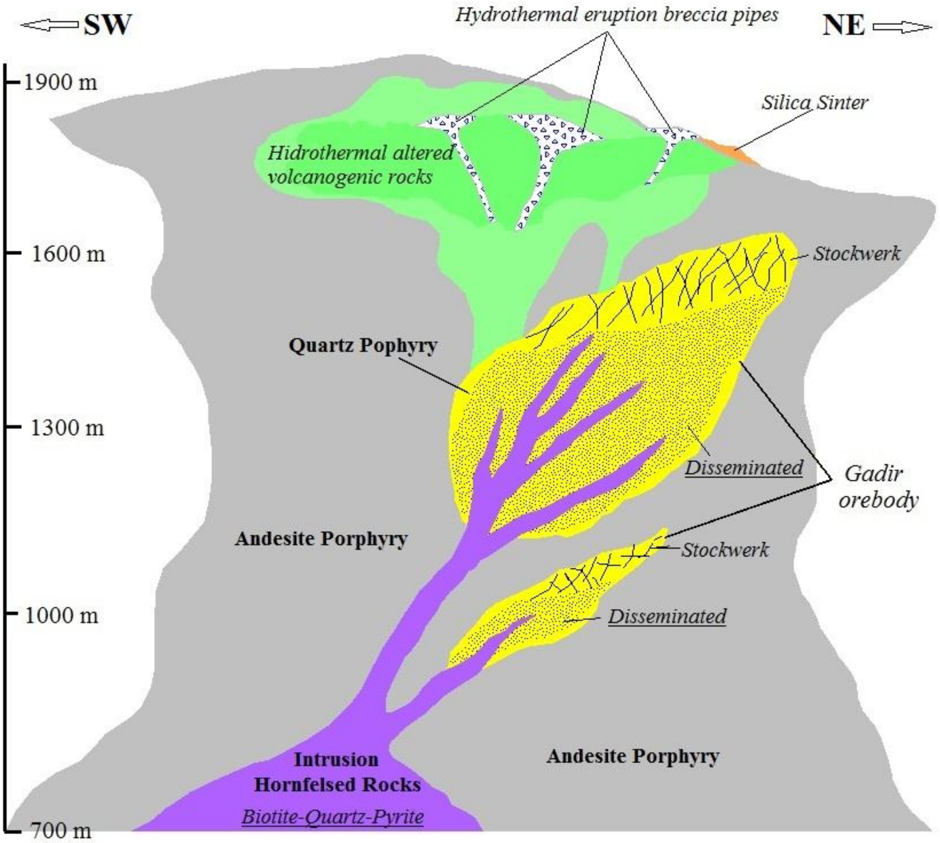

Fig. Gadir low sulfidation epithermal 2D model SW-NE direction (by GEG, 2014).

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JURASSIC ALLOCHTON COMPLEXES OF GREAT CAUCASUS (AZERBAIJAN)

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In the article, the features of the structure of the Lower-Middle Jurassic structural material complex of the Azerbaijani part of the Greater Caucasus are considered from the positions of the nappe tectonics. The conclusions and generalizations drawn are based on the prevailing ideas about the tectonic stratification of the Alpine cover and the pre-Jurassic basement of the mountain structure, which is confirmed in the materials of the latest geological and geophysical studies on its Azerbaijani part. Shahnabad-Dzhiminsky, Tufansky, Sarybashsky and Talachay-Durudzhinsky allochthonous complexes are singled out, one after another, from north to south and jointly to the northern wing of the South Caucasian microplate. The origin of allochthonous complexes is related to the subphases of late-Cimmerian deformations of tangential compression in the zone of under-thrust interaction between the South and North-Caucasian continental microplates. Studies conducted in the last quarter of the 20th century and beginning of the current century in the

Greater Caucasus found that its crust was formed by the allochthonous method, in connection with which the mountain masses composing it is tectonically stratified into uneven-aged allochthonous complexes. For the Azerbaijani part of the region, this statement is based on field observations and a large volume of geophysical information based on the results of deep sounding and interpretation of the gravitational and magnetic fields. In the composition of the Great Caucasus allochthonous massif in the North-West and Central Caucasus, a major role is played by large thrust plates (broken down into high-order digitisation) consisting of the rocks of the pre-Jurassic foundation and the overlying Jurassic terrigenous complex and forming the structure of the axial part and the southern slope of the mountain. In the east, the Jurassic complex of the hanging wing of the overthrust participates in the structure of the uplift (megazones) of the Lateral ridge, which serves as a natural extension of the elevation of the Main Ridge in the East and South-East Caucasus, and the synchronous formations of the recumbent wing are included in the Sperozo-Tufan uplift of the megazone of the Southern slope. Complex interpretation of geological and geophysical materials leads to the conclusion about the rootless situation in the South-East Caucasus of the Lias-Lower Bayosian structural-material complex of the megazone of the Lateral ridge to the south of the Akhty-Nyugiadi-Gilyazin deep fault (reflecting the position of the Main Caucasus thrust at the level of the pre-Jurassic basement), and also the Jurassic-Cretaceous complex of the southern wing of the megazone of the Southern slope, superimposed on the northern wing of Kakheti-Vandam-Gob, pushed along the Krasnopolyansko-Zanginsky fault, Oblasts megazone South Caucasus microplate. And in the west, the Mesozoic complex of the southern slope, which is part of the Sperozo-Tufan and Zagatala-Govdag areas - the eastern segments of the Goith-Tufan and Novorossiysk-Dibrar fold-cover complexes of the Greater Caucasus, completely ripped off the base and 25-30 km moved to the south with absorption of roots and pre-Jurassic basement in the sole of the Main Caucasian overthrust. All this gives rise to the isolation of Shakhnabad-Dzhimichay (as part of the megazone of the Lateral Range), Tufansky, Sarybashsky and Talachay-Durudzhinsky (within the megazone of the Southern slope) of the cover complexes, composed of the Lower Middle Jurassic sediments of the northern side and the axial part of the Early Middle Jurassic marginal sea basin of the Greater Caucasus.

The Shahnabad-Jiminsky cover complex includes Lower and Middle Jurassic structures participating in the structure of the Guton-Gonagken and Shahdag-Khyzin structural zones and is located on the natural extension of the anticlinal projections. The apparent amplitude of these covers is 10-15 km, and the true horizontal amplitude of the Major thrust is estimated at this section of 100-125 km. At the same time, in the alpine cover of the South-Eastern Caucasus, the amplitude of the nappe reaches 18-20 km.

The Tufan cover complex is the northernmost structural element of the Sperozo-Tufon zone within Azerbaijan and extends from the upper reaches of the Djurmut River in Dagestan to the Jimichai River in the South-Eastern Caucasus, tectonically wedging in both directions. To the north-west of Bazarduzi, the cover is almost completely located on the territory of Dagestan and only in certain areas (spurs of the Akhvay, Somalit, Guton) is traced to the southern slope.

The Sarybashsky cover complex, folded by the lower-middle Jurassic and bounded from the south by the Gamarva thrust, is the central element of the structure of the described region and, according to the peculiarities of its internal structure, splits into four subcomplexes: Jihih-Dindyagh, Mazym-Sarybashsky, Galal-Rustambazsky and Megikansky.

The Talachay-Durudzhinsky cover complex is exposed by two fragments (plates): the northern Talachay massif of the Toar terrigenous-flyschoid rocks with volcanomictic material lying in the sole of the transgressive (Neo-autochthon) Upper Jurassic-Lower Cretaceous series of the northern wing of the Zagatala-Govdag zone, and the southern Durudzhinsky, traced along the southern side the same zone in the form of a narrow band of outcrops of Aalenian siltstone shales, siltstones and sandstones with flows of tufflav and tuff breccia of andesite-dacite composition in the bottoms of the section. There is no spatial relationship between these sedimentary complexes on the surface, however, according to geophysical data at depth, they form a single structure that can be traced under the alluvial cover of the cones of the removal of the rivers of the southern slope into Georgia. At the same time, the Durudzhin plate is represented by a structure squeezed out from under the masses approaching from the north.

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DEEP STRUCTURE AND ORIGIN OF EARTHQUAKES IN NORTH PART OF SOUTH CASPIAN BASIN

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The modern seismicity of the South Caspian Basin, the relationship between the distribution of earthquakes in space and the depth of structure of the crust were re-investigated on the basis of actual data. Based on a map of earthquakes and seismic profiles were studied the objective laws of distribution of earthquakes along the area and depth.

In the Azerbaijani part of the Caspian basin, depth distribution of earthquakes of magnitudeml $\geq$ 3.0 occurred during 45 years was studied and high seismic activity at depths of 30-50 km was found. The analysis shows that more than 34% of the total number of earthquakes is associated with depths greater than 40 km. In the study area, about 60% of earthquakes occur at depths greater than 30 km. The northern boundary of the South Caspian basin is differed by high seismic activity. Based on depth data, we can say that this earthquake belong to the consolidated oceanic type crust and the upper mantle.

The actual data analysis shows that the strong earthquake epicenters in the northern flank of the SCB and mostly in the north from the Absheron peninsula are characteristic. The concentration of many weak and moderately strong earthquakes in the Absheron peninsula is associated with the aftershocks of the 25.11.2000 earthquake. Compiled isoseists scheme shows that the macroseismic epicenter of the strong earthquake is located in the north-east of Absheron. For this reason, it was not possible to clarify the exact location of the focus for a while. The fact that macrosysmic and instrumental epicenters do not coincide, shows that the furnace is connected to the horizontal and large volume zone.

An analysis of earthquake epidemics in the Absheron threshold shows that they are mainly associated with complicated degradation-deformation of the Mesozoic-Paleogene sediments. Analysis of the focal mechanisms has shown that earthquakes at depths of 15-25 km within the accretionary prism are mainly associated with compression stress condition and formation of thrusting-nappe structures. We can say that no strong earthquakes have occurred in the central areas of the South Caspian Basin. This fact is also a clear indication of the relationship between earthquakes and subduction phenomena. Strong (M > 5.0) and deep focus (30-80 km and deeper) earthquakes in the northern flank of the South Caspian Basin are the result from the subduction of the consolidated crust of South Caspian Basin beneath the Epihercynian platform, established on the materials ultra-deep seismometry.

ON THE ELASTIC PARAMETERS OF THE STRAINED MEDIA

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In this paper the problem of determination of physico-mechanical properties of solid media with initial strain is investigated. This type of problem has a direct relation on geophysics. The crust, mantle and the core of the Earth is generally considered as deformable solid bodies. The propagation of elastic longitudinal and share waves in geological media under compression conditions is considered. The change of velocities of propagation of elastic waves, as well as the change of the pressure with increasing of the value of the compression deformation is studied. The investigation leads to necessity to solve the nonlinear problem of mechanics for determination of dependencies mentioned above. The solution of this problem by application of the methods of the nonlinear theory presents certain difficulties. To achieve this goal, the nonclassical-linearized theory (NLT) method was used.
Various variants of the theory of initial deformations are considered: large initial (finite) deformations, the first version of the theory of small initial deformations (shifts and stretches are small in comparison with unity), the second variant of small initial deformations (in addition to the first variant it is considered that the stresses and deformations are related by Hooke's law). Processes of deformation for various types of materials were modelled with aid of quadratic elastic potential or with aid of Murnaghan’s type of elastic potential. In concrete computations, data of the following materials were used: plexiglas, steel and paleogranite.

It was revealed, that elastic parameters for the same types of medias, determined within various elastic potentials and different variants of theory of initial deformations, differs qualitatively and quantitatively among themselves. It is found that, when the certain value of compression deformation in media is reached, the propagation of elastic waves with actual velocities becomes impossible.

The obtained results have an important theoretical and applied meaning in investigation of various problems of structural model of the Earth.

TECTONIC STRESS AND GEODYNAMIC CONDITION OF ORE-GRADE GOLD FORMATION OF AUMINZATAU MOUNTAINS (CENTRAL KYZYL KUM)

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The object of research is studying of stress and a geodynamic condition of Auminzatau gold ore occurrences formation, as stress and geodynamics constant indicators of all geospheres of Earth including crust, everything without exception the geological phenomena occur against their influence. After studying tectonic stress and reconstruction of geodynamic condition of the ore formation period, it will be possible to understand principle of ore objects formation and structures that controlled ore depositionprocess. The technique of researches means the carrying out experimental works on tectonic stress modeling in crust structures [1].

The structural and tectonic base of model of Auminzatau structures is made where it is shown the main structures of the ore formation period. In model of Auminzatau structures, they imitate order fault of structural and formational zones, a series of subparallel faults of northwest bearing, which divide Auminzatau area in three tectonic blocks.

Results of works show that tectonic stress in model varies ranging from zero up to the medium value where τ_{max} reaches 16 g/cm^2. The ratio of stress value (zero, weak, and medium) in Auminzatau model makes 1:8:1 where units correspond to neutral zones and areas of medium stress, and the eight - to areas of weak stress. They are widespread extremely unevenly. The highest stress value covers the area of the northern block, a ratio of weak and medium stress value equally 1:1 here. In the central block, it is different, medium stress value covers about 4% of the space of the block, and their concentration is connected with fault junction zone. In the southern block, stress increase is not detected. Follows from the above that from the North on the South there is a gradual decrease of strain-stress distribution of Auminzatau area. Such distribution of strain-stress distribution of Auminzatau area was determined by its block structure and existence of northwest subparallel faults that did not give the chance to tectonic efforts freely to migrate in depth of model of Auminzatau structures. Overcoming by compressive force northwest structures was followed by loss of considerable compression energy. Loss of energy coming from faults activity that it was possible to observe when carrying out experiments. The similar geodynamic condition of Auminzatau area could be observed and when modeling structures of the Auminzatau-Beltau ore area. In this option of experiment, northern and southern blocks are relatively displaced in the western direction, and against these movements, the central block is displaced on the East. Divergence in shift of blocks caused to change of their strain-stress distribution of blocks and their geodynamics. As a result in the northern block local concentration of stress happened and increase deformation in its central part and in the central and southern blocks, it is just the opposite.

Variability in Auminzatau geodynamics and in its strain-stress distribution reflects the course of geological phenomena, including ore. Irregular distribution of gold occurrences on all Auminzatau area proves it. The statistical analysis of distribution of Auminzatau gold occurrences on its tectonic blocks (Figure) shows that in the southern block gold occurrences is detected in 18 areas, in the central block - 8, in the northern block - 20. Reduction of gold occurrences number in the central block is explained by that about 50% of its space are occupied by magmatic formations that for Central Kyzyl Kum are not ore - hosting breeds for gold. All three blocks uniting, form big wedge-shaped structure, which controls 80% of all Auminzatau gold occurrences.

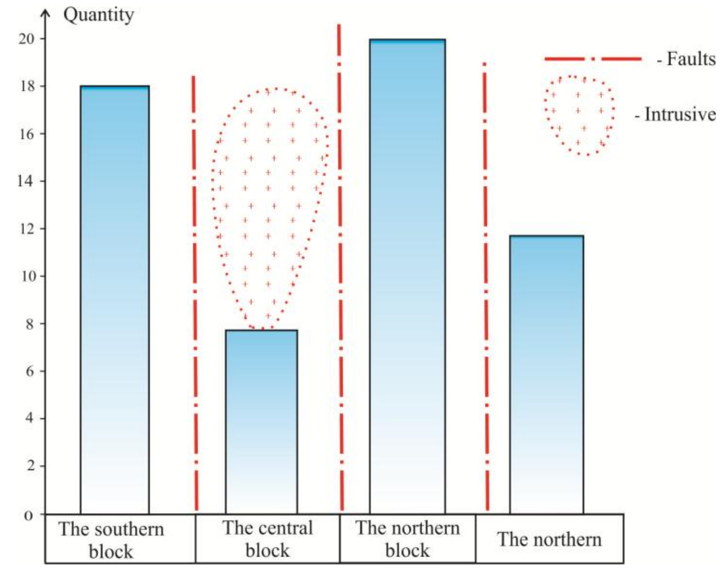

Fig. Hystogram of Auminzatau gold occurrences distribution on blocks.

The interrelation of the strain-stress distribution state of Auminzatau area with gold process is obvious. The analysis shows that more than 72 % of gold occurrences spatially are connected with fields of weak value of stress, about 10 % - with neutral zones, and the rest - with fields of medium value of stress. Existence of the favorable ore - hosting environment with its certain intensity, deformation and geodynamic condition is not enough for placement of an ore grade mineralization. Existence in areas of ore grade mineralization occurrences of ruptural and folded structures in a complex with other factors promote localizations of ore-grade gold. Thus, structures played ore - hosting or ore-distributing role.

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MOHO DEPTH DETERMINATION FROM P RECEIVER FUNCTION ANALYSIS IN THE CARPATHIAN BASIN

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We perform receiver function analysis to determine a detailed map of the crust-mantle boundary and the crustal velocity structure of the transition zone between the Eastern Alps and the Carpathian Basin. We use data from the Alp Array temporary seismic network, the permanent stations of the Hungarian National Seismological network, stations of a private network operated by Georisk Ltd., temporary stations of the Carpathian Basin and South Carpathian Basin Projects as well as permanent seismological stations in the neighbouring countries for the time period between 2002 and 2017. Altogether some 200 seismological stations are used in the analysis. Owing to the dense station coverage we can achieve so far unprecedented resolution, thus extending our previous work on the region. We apply three different quality assurance procedures for the waveforms and the obtained receiver functions. Receiver functions are calculated by the iterative time domain deconvolution approach. We present the quality controlled P receiver functions (radial and transversal component) and we conclude for anisotropy of the researched area. We show some cross sections beneath the Eastern Alps – Pannonian Basin transition zone, we concentrate major structural elements of the area. Finally, we present results for the Moho map obtained by H-K analysis. We also compare our results to previous active and passive seismological results in terms of Moho depth and crustal velocities.

PETROGRAPHIC, MINARAGRAPHIC AND CRYSTAL-CHEMICAL METHODS INTEGRATION: CHAROITITIC ROCKS OF MURUN MASSIF (RUSSIA) CASE

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The ultra agpaitic alkaline Murun massif, located in the northwestern part of the Aldan Shield, Siberia, Russia [1] and covered an area of ~ 150 km^2, represents the largest formation of alkaline rocks showing potassium enrichment and consists of the Bolshoy Murun and Malyy Murun massifs. K-Na nepheline-, alkaline- and quartz-syenites of the Bolshoy Murun massif occur in the western part of the complex, whereas the eastern part is characterized by the ultra-potassic rocks of the Malyy Murun massif. The Murun massif has an extremely complex multiphase internal structure and today there is no single generally recognized scheme for its formation. More controversy is the origin of charoitites (dominantly charoite-bearing rocks). A distinctive feature of the paragenesis of the charoite minerals is the widespread development of rare and new minerals with complex structures, which underlines the unique character of the mineralization of the Malyy Murun massif. One of the factors controlled the rarity (occurrence) and stability of minerals of alkaline rocks of the Murun massif, the “complexity” of their crystal structures, is considered here. A quantitative estimation of the complexity is established using the original method based on information theory and developed by S.V. Krivovichev [2]. To assess the complexity of structures, the parameter $I_{G,total}$ (total information content, bits/u.c.) [2] is used. Data on the paragenesis and the order of crystallization of minerals in alkaline rocks are obtained as a result of petrographic and mineragraphic study of charoitite thin sections and polished sections.

In this study, a very rare sample of charoitite from Malyy Murun with carletonite, $KNa_4Ca_4Si_8O_{18}(CO_3)_4(F,OH)\cdot H_2O$, was investigated. To date the only known locality of carletonite was the nepheline syenite at Mount St. Hilaire, Quebec, Canada [3]. Here we report a second in the world discovery of this mineral.

The carried out study has allowed to find out seventeen minerals in the polished sample. According to the mineral content, the rock can be characterized as aegirine and carletonite-containing apophyllite-pectolite-charoitic.

On the basis of mineral association, found out in the polished sample, several parageneses can be distinguished: 1) a "primary" paragenesis consisting of alkaline silicates, apatite and quartz 2) a "sulphide" paragenesis consisting of sulphides of copper and lead and 3) an "exogenous" one. The "primary" paragenesis is represented by the following minerals: needlelike black pyroxene (Ac = 47 %, Fs = 42 %, Wo = 7 %, En = 4 %), fluorapatite, microcline, greenish pectolite, blue carletonite, lilac charoite, pink apophyllite, quartz. It should be noted that fluorapatite is also found in the form of inclusions in pyroxene and in the form of flattened clusters stretched along the needle secretions of charoite. Moreover, the fluorapatite associated with alkaline leucocratic minerals has a content of Sr up to 4 wt. %. These data indicate that the grain of fluorapatite was formed during the entire period of crystallization of the "primary" paragenesis. It composition changed in accordance with the evolution of the environmental composition where the accumulation of incoherent Sr, isomorphously replacing Ca in the crystal structure of fluorapatite, occured. "Sulphide" paragenesis is represented by galena, idaite, chalcocite, digenite, native copper. Chalcocite is found in close intergrowths with digenite. The grains of copper sulphides are associated with pyroxene. On the primary mineral associations an "exogenous" paragenesis develops in local areas: on silicate minerals wollastonite and brown apophyllite develop, on copper sulphides - covellite.

Carletonite forms a close intergrowth with apophyllite-(KF), that indicates their joint crystallization, and associates with pectolite and charoite. On the relationships between grain boundaries of minerals in the studied sample, it is possible to build a distinct sequence of crystallization of minerals. Moreover, some interesting regularities of the dependence of the structural information of this paragenetic system and the results of petrography were revealed. Thus, the sequence of the crystallization of "primary" paragenesis minerals is following (the value of $\boldsymbol{I_{G,total}}$ - total information content (bits/u.c.) [2] - is indicated in parentheses):

aegirine $NaFe(Si_2O_6)$ (**50.439**) →
fluorapatite $Ca_5(PO_4)_3F$ (**111.419**) →
pectolite $NaCa_2(Si_3O_8)(OH)$ (**125.421**) →
apophyllite-(KF) $KCa_4(Si_8O_{20})(F,OH)\bullet 8H_2O$ (**359.526**) and
carletonite $KNa_4Ca4Si_8O_{18}(CO_3)_4(OH,F)\bullet H_2O$ (**923.056**) →
charoite.
$(K,Sr)_{15-6}(Ca,Na)_{32}[Si_6O_{11}(O,OH)_6]_2[Si_{12}O_{18}(O,OH)_{12}]_2[Si_{17}O_{25}(O,OH)_{18}]_2(OH,F)_4\bullet \sim 3H_2O$ (**1991.599**).

It is not difficult to see that the value of $I_{G,total}$ – total information content (bits/u.c.) [2] – increases with increasing of the crystallization queue. The use of information assessments of complexity allowed us to confirm the expected regularity of the dynamic evolution of complexity in the evolution of the crystallization of matter. Calculation of the quantitative estimation of the complexity of the associated minerals in relation to charoite rocks may allow to solve a number of issues, such as: the relationship between the complexity of mineral phases and crystallization processes, the accumulation of crystal structure information with changing formation conditions, the change of paragenetic associations, polymorphic transitions, and, finally, the identification of a sequence of crystallization.

A new approach of investigation of the paragenesis of mineral phases (especially of rare and new varieties) in rocks, represented here, is based on the integrated application of petrographic and mineralogical methods and the crystal-chemical analysis of minerals of the studied associations.

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OSTRACODS FROM THE QUATERNARY DEPOSITS OF THE SOUTHERN STRUCTURES IN BAKU ARCHIPELAGO, SOUTH CASPIAN

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Baku archipelago is one of the richest oil fields of the South Caspian. In addition to that, main offshore fields and prospects are related to this area. This is why detailed study of fauna complex, lithology, thickness and stratigraphy of the Quaternary deposits is of great practical significance to solve engineering and geological tasks related to research and survey performed here.

Ostracod fauna and its stratigraphic role in the Quaternary deposits of Baku archipelago was the study target for many scholars, including [1-3]. Over 100 specific ostracod species were described based on the study. Our research is devoted to ostracods from the Quaternary deposits in the prospects of Aran-deniz, Sabail, Inam and Lankaran-deniz. Over 300 samples were analyzed from the wells drilled in these prospects. We can draw the following conclusions from the study of lithology and fauna complex of these samples and comparative analysis with other South Caspian areas: ostracod assemblage from the Quaternary deposits in the southern structures of Baku archipelago allows breaking them down into 5 suprahorizons with distinct complexes and index species. They correlate well with similar deposits from other areas across the entire South Caspian and are widely used for practical stratigraphic purposes (Table). Note that the complex of the analyzed samples encloses many species from genus Amnicythere, Leptocythere, Euxinocythere and Loxoconcha. In our analyzed samples specimens of different variations of these species sometimes occur jointly without transition between them and sometimes a number of gradual transitions are observed. In some cases, Amnicythere, Leptocythere and Euxinocythere population, represented by variations, occurs separately. Unfortunately, nowadays ostracod composition from the Quaternary deposits of the South Caspian, and the adjacent onshore area in general, have not been studied using modern electronic microscope. In the given report we try to emphasize the necessity to solve this issue. We have photographed part of the Quaternary ostracod composition but detailed revision of their genera and species needs time and joint study assuming international taxonometric rules. This research should provide much insightful information for ostracod fauna classification, in particular for the mentioned Leptocytheridae and loxoconchidae, which are one of the governing fauna groups widely used for stratigraphic purposes.

Table

Splitting of the Quaternary deposits of the South Caspian

System	Division	Part	suprahorizon	horizon/layer	biozone	South Caspian: Ostracoda	South Caspian: Mollusk
Quaternary	Holocene	upper	Novocaspian	upper (present deposits)		*Amnicythere caspia* (Liv.), *A. striatocostata* (Schn.), *A. quinquetuberculata* (Schn.), *Euxinocythere bacuana* (Liv.), *Eucythere napthatscholana* (Liv.), *Cryptocyprideis bogatchovi* (Liv.), *Cyprideis torosa* (Jones.), *Tyrrhenocythere pseudoconvexa* (Liv.) and a lot of *Rotalia beccarii* (Linne.)	*Mytilaster lineatus* Gn., *Micromelania caspia* Eichw. ,et al.
		middle		lower			*Cardium edule* (Linne), *Didacna crassa* (Eichw.) , *D. baeri* Gr., *D. baeri* var. *alata* Gadj.
		lower	Khvalinan	upper	*Euxinocythere plicatotuberculata*	*Amnicythere cymbula* (Liv.),Euxinocythere *plicatotuberculata* (Sch.), *A. maltiosa* (Sch.), *A. modesta* (St.), *A. notabilis* (Sch.), *A. tinulla* (Step.), *A. unicornis* (Schw.), *A. lunata* (St.), *Loxoconcha unodensa* Mand.	*Didacna praetrigonoides* Nal. et Aniss., *Dreissensia polymorpha* Pall.
	Pleistocene	upper		lower			*Didacna paralella* Bog., et al.
			Khazarian	Upper (Karachukhurian)	*Euxinocythere beata*	*Amnicythere medicata* (Step.), *A. hildae* (Step.), *A. tinulla* (St.), *A. uschkoi* (Schn.), *Xestoleberis manticae* St., *Candona rostrata* (Br. et Nor.)., *C. neglegta* Sars., *Loxoconcha lepida* St., *L. lauta* Step., *Scaloconcha edita* Step.	*Didacna paleotrigonoides* Fed., *D. nalivkini* Wass., *Dreissensia polymorpha* Pall., et al.
		middle		Lower (Gurganian)		*Cyprideis torosa* (Jones.), *Tyrrhenocythere pseudoconvexa* (Liv.), *Candona elongata* Schn., *Candoniella albicans* Br., *C. subbelipsoida* Sch., *Amnicythere praeclara* (Step.), *A. cymbula* (Liv.), *A. lunata* (Step.), *A. medicata* (Step.), *A. periculosa* (Step.)	*Didacna eulachia* Fed., *D. nalivkini* Wass.
		lower	Bakuvian	upper	*Amnicythere bacinica*	*Amnicythere medicata* (Step.), *A. stepanaitysae* (Sch.), *A. periculosa* (Step.), *A. rezupina* (St.), *A. lunata* (Step.), *A. praeclara* (Step.), *Scalochoncha edita* (Step.)	*Didacna rudis* Nal., *D. carditoides* Eichw., et al.
				lower	*Bacunella dorsoarcuata*	*Amnicythere quadrituberculata* (Liv.), *A. argunica* (Suzin), *A. pravoslavlevi* (Schn.) , *A. accreta* (St.), *A. flexuosa* (Step.), *A. bacinica* (Schn.), *Loxoconha unodensa* Mand., *L. endocarpa* Schn., *Candona elongata* Schn., *Caspiella liventalina* (Evl.), *Advenocypris kurovdagensis* Kl.	*Didacna parvula* Nal., *Dreissensia polymorpha* Pall., et al.
				Turkanian		*Cyprideis torosa* (Jones),*Tyrrhenocythere pseudoconvexa* (Liv.), *Zonocypris membranae* (Liv.), *Ilyocypris bradyi* Sars, *Limnocythere* sp.	Pelecypoda and Gastropoda *Dreissensia polymorpha* Pall., representative of *Cltssiniola family.*
	Eopleistocene	Apsheronian		upper	*Caspiocypris filona*	*Caspiocypris lyrata* Liv., *C. rotulata* Liv., *Amnicythere andrusssovi* (Liv.), *A. picturata var. venata* (Liv.), *A. arevina* (Liv.), *A. cymbula* (Liv.), *Leptocythere rostrata* Liv., *Loxoconcha eichwaldi var. tuberculata* Liv.	*Monodacna bacuana* And., *Apsheronia propinqua* Eichw.
				fresh water layer		*Ilyocypris bradyi* Sars, *I. gibba* (Ramd.), *Leptocythere multituberculata* (Liv.), *Cyprideis torosa* (Jones), *Limnocythere* sp.	Pelecypoda and Gastropoda, *Dreissensia.*
				middle	*Amnicythere apsheronica*	*Amnicythere pirsagatica* (Liv.), *Leptocythere verricosa* Suz., *Amnicythere saljanica var. nostras* (Liv.), *A. palimpsesta* (Liv.), *L eptocythere chazarica* Jav. sp.nov., *Euxinocythere bacuana* (Liv.), *Loxoconcha bairdyi* Müll., *L. kaliskyi* Lüb.	*Apscheronia calvescens* And., *Monodacna beibatica* And.
				lower	*Leptocythere explicata*	*Caspiocypris rotulata* Liv., *C. lyrata* Liv., *C. filona* Liv., *Candona cavis* Mand., *Amnicythere ofortha* (Liv.), *A. bendovanica* (Liv.), *Leptocythere rostrata* Liv., *L. leonidi* Liv., *L. gubkini* Liv., *L. grandis* Kl., *Euxinocythere bosqueti* (Liv.), *E. praebosqueti* (Suz.), *Cythere lejlae* Agal., *C. azeri* Agal.	*Apsheronia raricostata* Sjog., *Adelina voluta* And.

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A STATISTICAL AND GRAPHICAL STUDY OF RESERVOIR CORE SAMPLES FROM ABSHERON FIELDS

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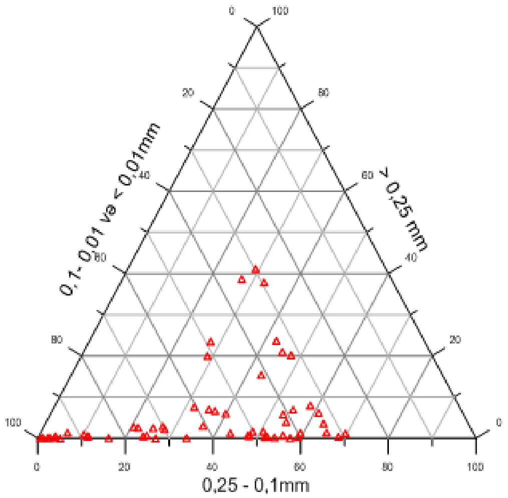
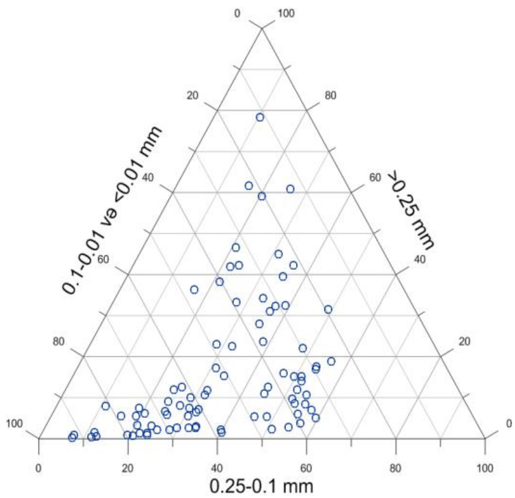
Two hydrocarbon fields in Absheron region, Hovsan and Garadagh, were selected to study granulometric composition variation regularities in the Lower Pliocene Productive Series reservoirs. A dataset of some 350 core samples collected from 30 wells were considered. The samples encompassed a depth intrerval as broad as 1100-4400 m.

To reveal regularities in granulometric composition of rocks triangular diagrams, histograms and cross-sections were drawn.

Hovsan



Garadagh



A methodological novelty – numerical ranging of granular fractions of rocks was applied to be able to compare various datasets and parameters. In practical terms comparison of the areas allowed to reveal regional scale similarities and distinctions in synchronous divisions of the Productive Series.

In addition, particle-size distribution, poroperm properties and carbonate content of rocks were comparatively studied. Well log diagrams were also involved into study to confirm outcomes made on the basis of core analyses. The study conducted allowed us to draw conclusions on regional and local pecularities of reservoir rock suites in Absheron region.

LITHOSTRATIGRAPHY AND MICROFAUNA OF BOTTOM SEDIMENTS BY THE EXAMPLE OF GUNESHLI AREA

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The Guneshli field was formed in the Southern Caspian in the Upper Neogene era (Pliocene) 25 million years ago. The incision was studied before Pontus. We conducted studies based on cores taken from a 200-meter deep well drilled in Guneshli Area. The research process consisted of the description of cores, the study of micropaleontology, and the determination of the age of the well.

In describing the cores, it was noted that the core is mainly composed of clays, with interlayers of sandstones. The thickness of the interlayers is 2-3 mm. At depths from 0.30-0.60 to 5.60-5.90 cores are represented by soft clays of olive-green color. Further, with depth, the soft clays change to more solid, and also the color changes to dark gray. In addition, in describing the cores, we tested their reaction with hydrochloric acid (HCl 10 %) to determine the carbonate content. And it was noted that with depth the reaction from normal changes to very weak. It should be noted that, at depths of 108.4-140.0, black spots were revealed in the description, which are the priceway of the plaque of organic matter. And also rust-colored spots that indicate the presence of FeO, that is, a reducing environment at these depths.

The study of microfauna (ostracodo fauna) allows us to determine the age of a given territory. When determining the ostracod fauna under a microscope at a depth of 0.30-0.60 to 199.70-200.0, *Bacuniella dorsoarcuata* (Zalany), *Caspiella acronasuta* (Livental), *Cytherissa naphtatscholon*a (Livental), *Loxoconcha eichwaldi* (Livental), *L.petasus* (Livital), *L. saluta* (Livental), *L.pirsagatica* (Livental), *L.cellula* (Livental), *L.bacuan*a (Livental), *L.qiunquetuberculata* (Livental), *L.ofortha* (Livental). Based on the available ostracod fauna, it can be said with accuracy that our well belongs to the Upper-Baku regiostage.

GOLD OCCURRENCES OF THE KIRAR-ABAKURI ORE KNOT AND THEIR GENESIS

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There is potential opportunity of gold deposits discovery on the territory of Georgia, and first of all, in the western part of the Svaneti ridge, in particular, within the Kirar-Abakuri ore knot (Fig.). Here are known ore occurrences, which by geological, mineralogical and geochemical features belong to gold-quartz-lowsulfide deposits [3]. Here, in endocontact zone of the Middle Jurassic monzodiorite body gold-bearing quartz veins are located [1]. Monzodiorite crosses sedimentary rock of so-called “Dizi series” that underwent regional metamorphism of the greenschist facies [4]. Sedimentary rocks are characterized by strong entanglement, milonitization and folding. Here also quartz-sericite-chlorite bearing metasomatites and sulfide disseminations in sedimentary rocks is observed.

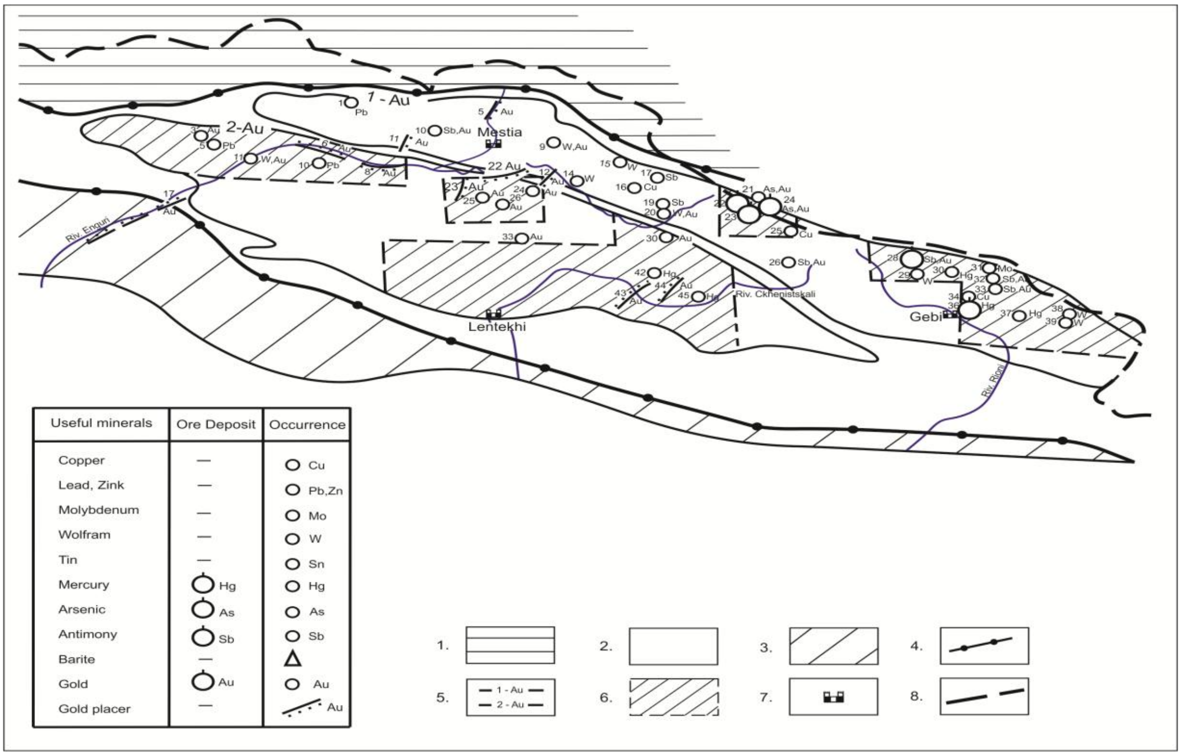

Fig. The metallogenic zoning map of the central part of the Southern slope of the Caucasus - 1. Cristalline basement of the Great Caucasus (W, Au); 2. The Southern slope of the Great Caucasus province, central subprovince, specialized on As, Hg, Sb, W, Au, Mo; 3. The northern subprovince of the Transcaucasus, specialized on Mn, Pl, Zn, Ba, Sn; 4. Boundaries between provinces; 5. The ore districts: 1- Mestia-Racha; 2- Svaneti; 6. Areas, for the exploration-assessment work (scale - 1: 25000; 1:10000); 7. Settlements; 8. Border line with Russia.

Directly in the contact zoneof the Lukhra intrusion and the Dizi series quartz-biotite and quartz-biotite-andalusite associationare established. In the apical part of the Lukhra intrusion three gold bearing zones are revealed, gold content in one of them (14 mthick main zone) varies within 8.89 - 7.48 g/t.

Gold distribution and concentration in pore waters and sulfide minerals took place at metagenesis stage. Further, under the influence of the mantle plumes (apparently monzodiorites are plume derivatives), gold-bearing environment was developed as a magmatic system. Fluid-saturated magmatic melt moves to the upper levels of the Earth's crust, where pressure and temperature drop conditioned vapor-gaseous mobilizate emission. In the result of interaction of the mobilizate and metamorphogenic waters hydrosystem evolved. Over the time, it seems, in the Midlle-Upper Jurassic, flint-containing solution and sulfides discharged from the hydro system [2].

We have conducted a complex study of the Kirar-Abakuri golden ore knot. In particular, for studying quartz veins related to intrusions and their impact on the constituent rocks field observations and petrographic methods are applied and also XRF and AAS method-based sampling on gold is accomplished.

The results of petrographic, XRF and AAS analyses of ores conducted by the author coincide with the data of the above-mentioned scientists. But there is the only difference, the amount of gold in the quartz veins according to the author's laboratory data varies greatly for some localities: in some areas gold content exceeds 9 g/t, and in the others is comparatively low 1-2 g/t.

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PECULARITIES OF THE ROCK MASSIF IN THE INFLUENCE ZONES OF TECTONIC DISTURBANCES IN THE GOLD DEPOSITS OF KYRGYZSTAN

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To date, the mining industry is one of the priority sectors of the development of the economy of Kyrgyzstan. The country is rich in minerals, has large deposits of gold, coal, mercury, antimony, uranium, zinc, rare earth metals. The deposits are mainly upland and are confined to large regional and regional faults, various faults, faults and overthrusts. The main rocks in these zones are metamorphosed rocks of shear, thermal (volcanics) and thermal-shear origin (Figure 1) Tectonic fractures and cracks are active structure-forming elements. The development of such deposits already at the design stage requires the most reliable information about the structure of the massif, the degree of fracturing and the properties of the rocks. An assessment of the stability of an array of upland quarries in the zones of influence of tectonic disturbances is one of the urgent problems in the development of upland deposits.

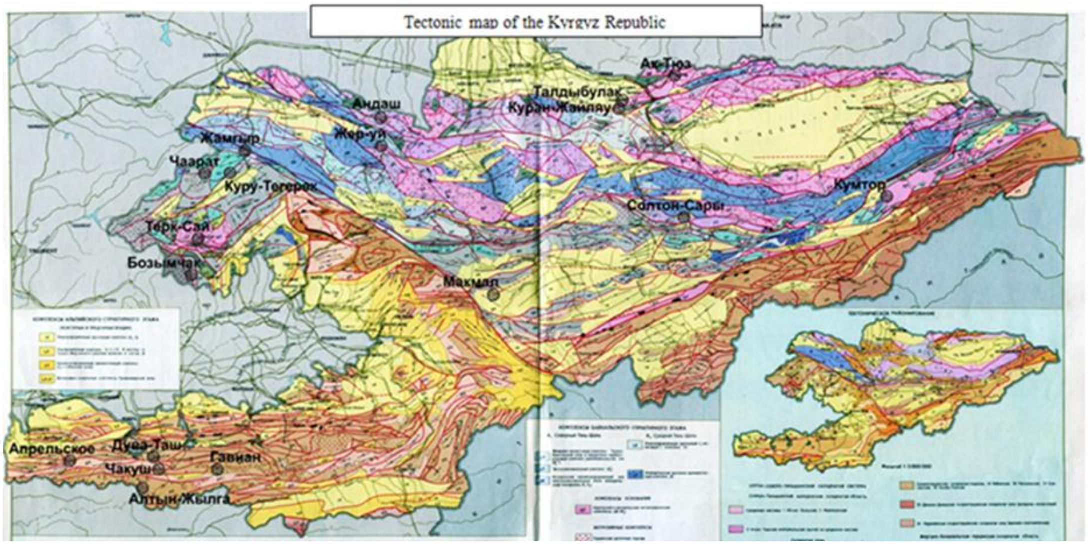

Fig. 1. Tectonic map of Kyrgyzstan with indication the main gold deposits.

Tectonic faults in the form of faults and large overthrusts, subject rocks to a prolonged displacement, pushing rocks of different ages on each other, as a result of which their structure, composition and physical and mechanical properties change, fracture of rocks increases, and the stability of geotechnical objects on the slope decreases. In order to ensure the safety of work in the extraction of minerals at the design stage, it is necessary to establish the parameters of the quarry or underground excavations, under which their stability will be ensured. Due to the fact that currently the gold mining industry occupies a leading position in the country, the study of the properties of the massif was carried out at large gold ore deposits.

As a result of the analysis of the obtained research results, it was revealed that the main host rocks of the gold deposits of Kyrgyzstan are strongly fissured metasomatites, represented by quartz-tourmaline, quartz-carbonates, quartz-sericites, gneisses, amphibole schists, silicified sandstones, diorites, etc.

A distinctive feature of the deposits of rocks in the zones of tectonic discontinuities is the fact that in the depth of the well there is a scatter in the values of the strength characteristics, and it is not possible to establish the regularity of the change in the strength characteristics of the rocks along the depth of the well (Figure 2).

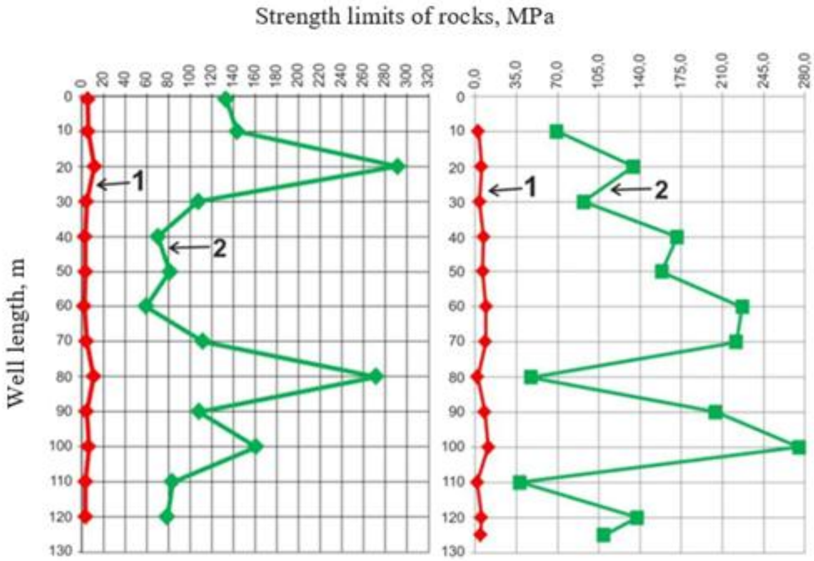

Fig. 2. The change in the strength properties of rocks with depth:
1- compressive strength; 2 – ultimate tensile strength;
a - "Chaarat" deposit; b - deposit "TaldybulakLevoberezhny".

According to the results of laboratory experiments, the authors found that these rocks are characterized by low porosity from 0.3-0.6%, low water absorption from 0.26-4.52%, rock compressive strength is an order of magnitude greater than the tensile strength of these rocks. The rocks are brittle; the brittleness coefficient of rocks is within 24-25. Strength indices of almost all rocks after their full water saturation are reduced to 30%, which indicates a decrease in the strength of rocks in the watered zones of the quarry or underground mine workings. The clutch of rocks declined by a factor of 1.2-1.3, with the angle of internal friction of rocks practically unchanged. As a result of intensive crushing, chipping and grinding of the original rocks, a friction clink is formed at the contact of the zones, the strength properties of which at natural moisture are on the average: the angle of internal friction from 7^0 to 28^0 and the adhesion from 0.001 to 0.06MPa, and at a humidity of more than 18% the connectivity of this variety of breed is disrupted.

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PECULIARITIES OF SPATIAL CHANGES OF RESERVOIR PROPERTIES OF PRODUCTIVE SERIES WITHIN GUNESHLI FIELD

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The Guneshli structure was discovered in the Caspian sea (Absheron archipelago) by seismic exploration in 1958-1963. The petroleum content of this structure, complicated by a series of longitudinal and transverse tectonic faults and having a block structure, was established in 1979 as a result of drilling of exploration well No.4. A fountain of oil with a flow rate of 230 tons per day was obtained from the X horizon of the Balakhany suite of the Production series (PS), from a depth of 3455-3423 m. Subsequently, oil deposits were also revealed in the IX horizon of the Balakhany suite and the Fasila suite, oil-gas-condensate deposits in the Nadkmarki Sand (NKP) and Podkirmaki (PK) suites, and gas-condensate accumulation in the Gala suite. In industrial development the structure was introduced in 1985. More than 220 wells were drilled in the shallow part of the field.

Several source area of sedimentary material (the Russian Platform, the Great and Lesser Caucasus, Talysh, Elburs, Great Balkhan and Kopetdag) involved in the formation of the PS (the main petroleum reservoir of the South Caspian basin), which led to its considerable facies variability. Within the Absheron archipelago, a decisive role in the formation of the PS was played the sediments carried by the Paleo-Volga from the Russian platform. The reservoir rocks of PS in this region are represented by a high content of quartz sands and favorable reservoir properties.

The analysis of microphotographs of thin sections of core samples from well No.16 of Guneshli field (shallow part) indicates that the rocks under study (with a rather noticeable inter aggregate and intergranular porosity) are poorly sorted. In these photographs (Figure) the variability along the section in the structure of the pore space is clearly visible, as well as in the forms of grains of quartz, feldspar and other clastic material. The terrigenous material is mainly represented by grains of quartz (36-70% of the total rock). Feldspars are 3-8%, and fragments of rocks - 4-8%. The sizes of grains of rocks vary in the range of 0.096-0.180 mm.

The tectonically dislocated central and southern part of folds is distinguished by the most favorable properties of reservoir rocks and their relatively higher oil saturation.

Analysis of values of the specific oil content in the rock showed their significant variations along the stratigraphic section of PS, which are well correlated with the content of the cement in the rock. The oil content in the rock is significantly reduced when the cement content in the rock exceeds 6%.

Along with this, it was also found that the highest values of the oil saturation are characteristic for rocks with large grain sizes.

At the present stage of development of the Guneshli field (shallow part) the obtained results can be used in planning its further development.

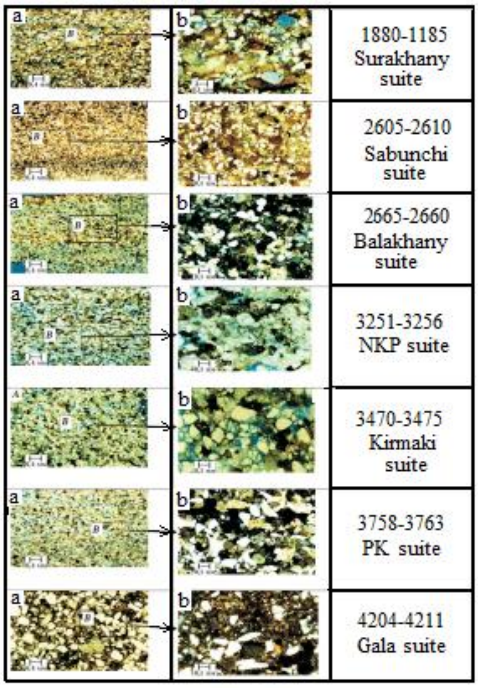

Fig. Photomicrographs of thin sections of core samples from different stratigraphic intervals PS (well No.16) of the Gunashli field. Magnification of images: scale b > a 4 times.

GRAVITATIONAL MODELING OF DEEP STRUCTURE BY MATCHING METHOD

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The matching method has been widely used in the practice of interpretation of gravitational fields. This method is used in the case when the researcher can construct the initial model of the geological structure, and it is required to clarify or determine the numerical values of the parameters of this model. The selection criterion is the coincidence of the observed and calculated fields. In this abstract, the matching method, developed by E.G. Bulakh, is used to compile a gravity model along geodynamic profil of Samur-Baku. This method reduces to the problem of minimizing multiparameter functionals,in a mathematical formulation.The initial data for compiling the gravitational model of the deep structure are the observed gravitational field and the scheme of the geological structure. When the matching methodimplement, in order to achieverapprochements of the observed and theoretically calculated fields, some geological parameters are changedin the computational process.Changes in the values of geological parameters are carried out using confidence intervals.

The geological section of the earth's crust 1: 500000 scale was compiled on the basis of available geological and geophysical data and deep drilling data. To simplify this section, many stage, epoch, sub-divisions and systems were combined. Where individual stages had a large capacity and were well studied, they are presented in the geological section independently. The following seismic boundaries are distinguished, in the initial section: 1) Quaternary sediments, 2) Neogene, 3) Paleogene, 4) Mesozoic, 5) Granite, 6) Basalt, 7) Moho boundary.

The modeling of the structure of the earth crust and upper mantle using the matching method is carried out in the following sequence:

1) collection of available a priori information on the physico-geological structure of the research area and compilation of a density model; 2) the solution of the forward problem from the compiled model in numerical and analytical form; 3) exclusion of the regional background; 4) restrictions on the choice of the geometrical and physical parameters of the density model and securing reliable data; 5) clarification of model parameters by matching method; 6)If necessary, search of new gravity sources are made.

As a result of these procedures, it is possible not only to clarify the structural maps (the configuration of isolines, the depth of the in homogeneities and density), but also to clarify the location of faults, determine the direction of the layer and the angle of fall. The described method was used for gravitational modeling of the deep structure of the earth's crust and upper mantle along the geotraverses of Europe, Central Asia and the Caucasus.

Figure shows the observed gravimetric field (from the initial and selected model), the initial geological and geophysical section along the profile, and the selected gravity model.

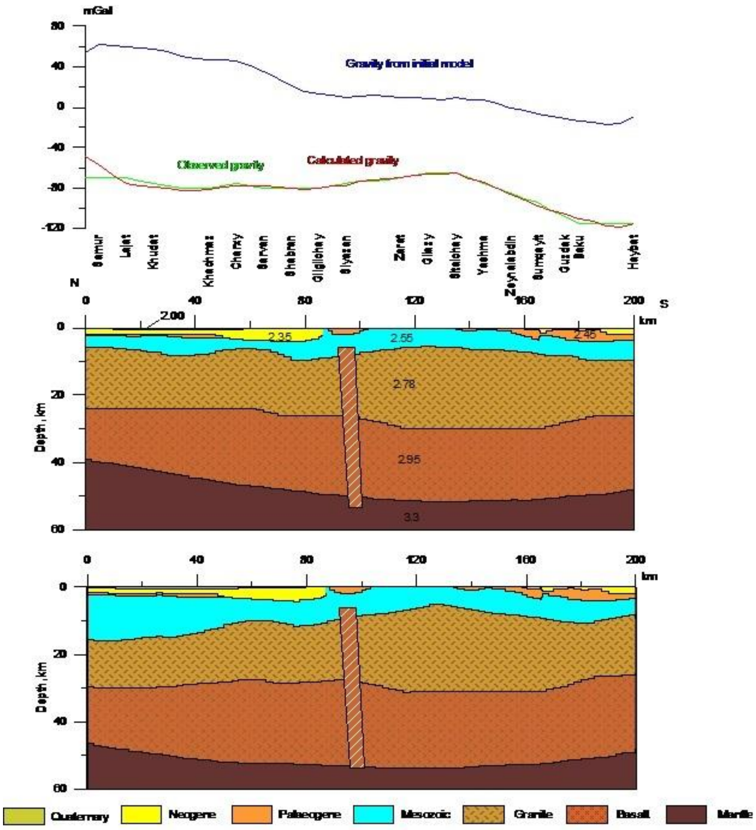

Fig. 2D gravity model along profile Samur-Baku.
The values of density differences are in g/cm^3.

Gravity modeling was developed on the basis of minimization of multi-parametric functionals with the use of the matching method. The following criteria was used to fit the observed gravity curves $g(x_i), F = \sum_{i=1}^{n}[g(x_i) - \Phi(x_i)^2]$=min, where $\Phi(x_i)$ is the estimated gravity at point i, x_i are the coordinates of observation points, and n is the number of points used at the approximation. The gravity model along the studied profile was constructed applying a forward modeling process including the fit of the initial model to the observed gravity profile, re-calculation of the anomaly, and comparison of the modeled and observed anomalies. This procedure was repeated until the calculated and observed anomalies were considered sufficiently alike (based on data uncertainties and model resolution), adjusting the model parameters in such a way in order to improve the matching between the observed and modeled anomalies.

The density values used in our model for the crust and upper mantle were selected from published data, while the mantle density was set at 3300 kg/m^3. The solution of the forward problem for the initial model shows that excessive mass is observed along the profile. Calculated values of the gravity field from the initial geological and geophysical models did not explain the observed gravity field. For compensation of the observed gravity field, a selection of density boundaries (upper boundary of granitic layer, upper boundary of basaltic layer of crust and Moho surface) was conducted until providing the least discrepancy between the observed and selected values of the gravity field.

The results of the investigation allowed us to determine the depth of the surface of the Basalt and Moho boundaries. In the northern part of the profile, where the greatest deviations in the gravitational field were observed, the surface of the granite layer was lowered by 9 km, the surface of the basaltic layer was lowered by a value of 6 km. The Moho boundary has undergone the greatest changes on the following sections of the profile: in the southern part of the profile the surface was lowered by a value of 7 km, in the central part of the profile 4 km, in the southern part of the profile by 3 km. The depth of the basalt boundary varies from 28 to 32 km, and the depth of the Moho boundary is between 47-57 km.

MINERALOGICAL, GEOCHEMICAL AND PETROLOGICAL STUDY OF MAFIC AND ULTRAMAFIC ROCKSIN NORTHEAST OF SEFID SANG AREA.

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Binalood Mountains, In northeast Iran, whose tectonic evolution is thought to be a result of the northward subduction of the Palaeotethys Ocean beneath the southern Eurasia margin [2, 8]. These ophiolitic slices comprise Mashhad and Fariman complex [2, 5, 8]. The studied area (Sefid Sang) is located in Fariman complex, between the Mashhad accretionary prism [2, 7] and the Triassic Aghdarband succession [6]. there are three diffrent idea about this area: 1) It is remnant of Mashhad ophiolite and arc-related succession but poorly known [1, 3, 6], 2) [4] suggests a different idea and he suggests basic and ultrabasic lava flows of northeast of Iran have an abyssal tholeiitic origin with the the rocks of present Mid Oceanic ridges and ultrabasic lavas are also chemically compared with the Archaean lavas (komatiites) of south Africa and Canada, 3) [9] interpreted as remnants of a magmatic arc and related basin developed at the southern Eurasia margin, on top of the north-directed Palaeotethys subduction zone long before the collision of Iran with Eurasia. Anyway there is not unanimous decision about this area.

In the present thesis we present field geological, petrographic (skeletal olivines, dendritic, skeletal and branchal pyroxenes) and geochemical data (high MgO) mainly on the these mafic and ultramafic rocks from the Sefig Sang area, and discuss these data in terms of the nature of the accreted material during the Late Paleozoic. Our data clearly indicate that the these rocks were derived from anorogenic komattite, komatiitic basalt and high-Mg tholeiitic basalt, implying accretion of a substantial material from an oceanic plateau that were delaminated and obducted over continental crust among Palaeotethys ophiolites (Figure).

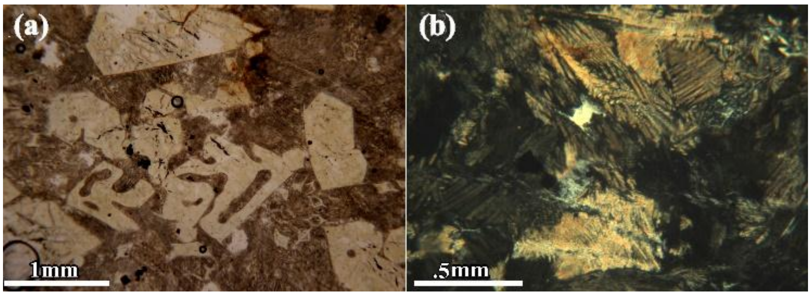

Fig. Disequilibrium texture in ultramafic rock, a. Skeletal, euhedral to subhedral phenocrysts of olivine in a groundmass of dendritic pyroxene, b. groundmass of a (dendritic pyroxene).

We note that in the Karakoram region, along the southern margin of Eurasia, high-Mg komatiitic and basaltic pillow lavas without spinifex texture are also present within Permian-Triassic argillitic-carbonated sediments and that they are geochemically and geodynamically similar to Sefid Sang komatiites.

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FEATURES THE PETROPHYSICAL CHARACTERISTICS OF TERRIGENOUS AND CARBONATE RESERVOIRS USING X-RAY TOMOGRAPHY CORE

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The essence of the method of X-ray tomography is the production of halftone images used to create three-dimensional computer models of core, with the help of which it is possible to study the filtration-capacitive characteristics of the reservoir rocks of oil and gas.

One of the main limitations of the method is the resolving power, which is determined by the resolution of the detector and by the dimensions of the spot focused by the X-ray gun. For conventional industrial tomographs, the resolution is in the range 0.01-0.05 mm, depending on the size of the test sample. This restriction introduces its own characteristics into the study of the void space of terrigenous and carbonate reservoirs.

In the case of tomography and the construction of three-dimensional models of carbonate rocks, the limitation has little effect on the accuracy of computation of the porosity coefficient from tomography, since large cavities and caverns (Figure 1), having both primary and secondary origin, form the basis of the void space of carbonate rocks.

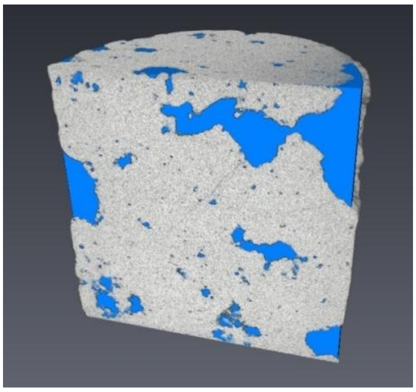
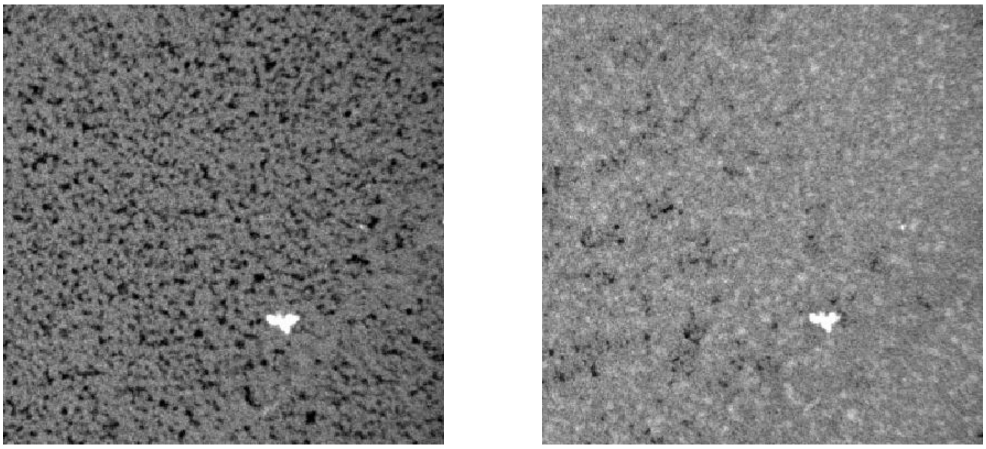


Fig. 1. Isolation of pores in a cavernous sample of a core of carbonate composition.

Modeling of porosity and other capacitive characteristics of terrigenous rocks is complicated by the fact that most of the void space is represented by pores of small dimensions, having intergranular character. To take into account this volume of pores, it is necessary to use indirect methods for estimating the porosity of a three-dimensional model, for example, an estimate for the volume filled with radiopaque material.

The wettability evaluation experiment carried out in the Petrophysics Laboratory of Perm National Research University consisted in impregnating dry samples with a model of formation water with the addition of a radiocontrast substance (sodium iodide). As a result, it was found that the distribution of the solution in the samples is uneven and strongly depends on the hydrophobicity of the sample. At the same time, a part of the samples filled with a solution makes it possible to compare the number of pores involved in the distribution of fluids (Figure 2) and, thus, determine the porosity of the sample more accurately.



Dry sample *Saturated sample*

Fig. 2. Comparison of identical core sections of terrigenous composition in a dry state and with pores filled with radiopaque solution.

According to this technology 115 and 40 core samples of terrigenous and carbonate rocks were investigated accordingly. As a result, the following differences in the application of the method to different lithologies have been established. For terrigenous rocks, a more correct estimate of the void space can be given when studying samples of millimeter-sized sizes with a high resolution. For rocks of carbonate composition, tomography of standard-sized samples and survey parameters is acceptable.

In general, a comparison of the porosity and wettability parameters obtained by standard methods and with the help of tomography showed that the joint use of standard methods and the X-ray tomography method allows to significantly improve the accuracy of the results obtained.

GRAPHIC MODEL OF GEOECOLOGICAL SITUATION

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Traditionally, the basic method of systematic and showing of geological information according to area is considered as geological maps. The mapping method for ecological geology is also optimal. So, it is important to create new grade (class) maps and they are named as geoecological. They are graphic model of ecological and geological situation and provide a generalized description of condition of lithosphere components on topographic base, represent its ecological properties (functions).

In essence, the main point is graphic description of “lithosphere-biota-human” system including the characters determining the condition of lithosphere, biota and human life. Hence, two information blocks about situation of ecological-geological condition of lithosphere and its components and ecosystem situation, the comfort and safety of human life should be represented in any ecological-geological maps.

The maps of geoecological conditions describe parameters complex or its individual characteristics of lithosphere; they characterize the influence possibility of lithosphere components to biota (to human, fauna, flora, generally ecosystem). This can be, for example, the pollution of lithosphere with toxicants, damaged by geological processes, the diversity of geophysical areas, the lack of types of different recourses. This directly or comparatively quantitative or quality information is completed by information about endemic diseases of population, degradation parameters of ecosystem and its biotic components. All the important information of these maps is represented by separate mapping method; there is no total assessment on accessibility, comfort and safety degree of population's living or on ecological condition of ecosystems. The legend of such maps (explanation on plan, map, diagram, etc.) consists of several sections, two of them are important – information about ecological-geological peculiarities of lithosphere and its components and condition of ecosystem and its biotic component (with particular emphasis on human).

All important parameters of modern ecological-geological situation are represented in maps of synthetic ecological-geological conditions by cartographic methods according to the content. Such maps are the main type of maps which describe the ecological-geological conditions of any area completely. But analytical maps of this type are carriers of characteristic, important and sufficiently spatial information representing the solution of only problem for this condition. For example, peculiarities of ecological-geological conditions can be reflected in such maps, which are associated by occurrence of only recourse or geochemical, ecological functions of lithosphere or its separate components. The same can be said about peculiarities of ecological-geological situations conditioned by occurrence of other functions of lithosphere.

So, geological basis of the ecological-geological maps should reflect such properties of lithosphere that they influence the biota by geological processes, geochemical and geophysical areas. From here it is impossible to propose single geological basis satisfying all varieties of ecological-geological maps, ecological peculiarities of lithosphere for the stated purposes. It is advisable to compile it separately for each ecological function of lithosphere: it is also possible for separate elements (geophysical areas, type of geochemical anomalies, paragenetic processes of geological processes).

GEOCHEMISTRY OF THE DIZI SERIES OF BATHONIAN INTRUSIONS

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The Dizi series of Devonian-Triasic age, located in the extreme north of the Black Sea-Central Transcaucasian terrane, is exposed on the Southern Slope of the Greater Caucasus, Svaneti (Georgia). It is built up of 1800-2000 m thick mainly terrigenous sediments: sandstones, gritstones, argillites, organic carbon-rich shales, silicites, tuff sandstones, volcanics, limestone and marble lenses, graphitized phyllites, phyllitic shales and various hornfels altered in the most low-temperature greenschist facies conditions [7].

In the series Middle Jurassic (Bathonian) intrusions, represented by pyroxenite, gabbro, gabbro-diorite, diorite, syenite-diorite, monzonite-diorite, quartz diorite and granite, occur.

Among the ten mapped exposures of these intrusions the multiphase Kirari, Abakuri and the Dizi intrusions are the largest. Under the influence of these intrusive bodies the Dizi series underwent contact (thermal) metamorphism. K-Ar age dating of the Dizi series magmatites established 176-165 Ma [1] confirming the formation of intrusives during the Bathonian orogeny.

Despite the fact that these magmatic rocks were the object of interest of many researchers, many petrological and mineralogical questions require further specification. Actually, the studies in respect of their geochemistry haven't been performed so far. Important for petrogenetic modeling trace and rare earth elements content and their distribution regularities have to be defined as well.

Integrated field, petrological and geochemical studies of abovementioned intrusions were undertaken including accurate mapping of the intrusions boundaries, standard petrography of more than 150 thin sections, identification of the intrusions effects on host-rocks and whole-rock XRF analyses on selected from intrusions 33 representative samples (pyroxenite, diorite, syenite, monzonite and granite).

According to thetotal alkali vs silica (TAS) classification diagram after [5] the larger part of the Dizi intrusions are classified as syenites. Diorites and monzonites are in limited amounts established mainly in the peripheral part of the syenite intrusions.

On the K_2O / SiO_2 diagram [2] the majority of samples from the Kirari, Abakuri and Dizi area intrusions, plot in the field of banakites and high-K andesites, rarely – in the field high-K dacites and shoshonite field. Basic rocks from Kirari and Abakuri intrusions plot in the field of basalts and low-K basalts.

In the P_2O_5% / Zr ppm diagram [3], the main part of figurative points (more than 80%) of intrusions plot in the field of tholeiitic basalt.

On the $Na_2O + K_2O$%/SiO_2 diagram [4] half of the points disposedwithin alkaline and the rest in sub-alkaline field. The rocks of basic composition are less alkaline. Rock alkalinity increases with the acidity of the rocks. Figurative points of the Kirari intrusive rock samples are evenly arranged in the alkaline and sub-alkaline fields whilefor Abakuri figurative points the deviation to the sub-alkalinity is observed.

In AFM diagram (Na2O+K2O/FeO/MgO) all the points of diorites, syenites and monzonites from the Dizi village area are plotted in the calc-alkaline field. The Kirari intrusive formations are of more calc-alkaline in composition, though tholeiitic formations are observed as well. The Abakuri intrusive formations also are of tholeiitic composition.

According to trace and rare earth element concentrations discrimination diagrams for the tectonic interpretations of granitic rocks [6] are created. As a result, syenite-diorite intrusions of the Dizi series belong to the granitoids of continental, volcanic arc and syn-collisional type.

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THE ABSOLUTE AGE OF SEDIMENTARY ROCKS: METHODS AND APPROACHES

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Sedimentary rocks are divided into two main groups: terrigenous and chemogenic-organogenic. The time of their formation can be determined from the minerals formed during sedimentation. Glauconite is one such minerals. The study K-Ar and Rb-Sr isotopic systems of glauconite to set the time of diagenesis of rocks. However, it is necessary to study their Mossbauer spectra and to verify that glauconite has not undergone post-sedimentation transformations. Only such minerals can show the correct age.

Now the study of the U-Pb age of detrital zircons from terrigenous rocks is widely used. This method helps to establish the maximum possible age of the sedimentary sequence, that is, it is a good limiting factor.

Chemogenic rocks are formed directly from the solution or colloid at the bottom and thus their composition is stored isotopic composition of sedimentation basin water. The isotope composition of C and S are fixed into the lattice of carbonates and sulfates, respectively. Strontium enters easily into the position of calcium in the crystal lattice. The Sr isotopic composition in the waters of the World Ocean is the same at every moment of geological time. However, it changes over time. To date, there is a fairly extensive database on the basis of which curves of isotopic composition variations of water in the paleoocean are constructed. Comparison of isotope characteristics of sedimentary sequences with these curves of carbon and Sr of typical sections allows us to establish the time interval for the sedimentation of these rocks.

DETERMINATION OF POROSITY OF ROCKS BY THE QUAD NEUTRON METHOD

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Borehole tool of multi-element neutron method (MNM) consists of four electrodes and a source comprising Be^{241}. When thermal neutrons radiated from a source interact with element atoms (particularly with H and Cl) atom is excited and radiates gamma-quantum (this method is called neutron-gamma log) and neutron is absorbed (neutron-neutron logging determines neutron density). A couple of detectors in a borehole tool record two curves (big and small sondes) in both loggings. The features of a borehole tool are: conditions of use– 150^0 C, 15000PSI (1PSI=6894.75729Pa) (pressure); radius of investigation– 1,2 foot (1 foot=0.3048 m); diameter of a used borehole–min:21/8$^{//}$, max:121/4$^{//}$; defined quantities: saturation, effective porosity, general porosity and relative porosity; directions of using: detection of missed layers, periodical control of quantities in a borehole, study of filtration-capacity properties in new and long-term used (low resistivity and low salinity) wells, determination of isolation intervals, determination of water-oil and gas-oil contact et al.

Values of porosity and length of a sonde influence the results. The rise of number of impulses recorded in a detector of a near sonde indicates the increase of porosity($K_p \rightarrow n$). But in far sonde the rise of impulses shows the decrease of porosity ($K_p \rightarrow 1/n$). The distance between sondes in a tool used in drilling wells is taken as a standard distance 30 sm (small sonde) and 60 sm (big sonde).

General porosity. General porosity is equal to the sum of porosities based on MNM determined by two methods.

When calculating general porosity to avoid errors due to mineralization the following formula can be used:

$$QTP = A(LNN) + B(LNG) + C(SNN) + D(SNG)$$

Here, A, B, C and D functions allow eliminating errors regarding to mineralization degree of a liquid in a pore;LNN–neutron-neutron logging big sonde; LNG–neutron-gamma logbig sonde; SNNneutron-neutron logging small sonde; SNG–neutron-gamma log small sonde. General porosity is determined according to a joint interpretation of NGL, which records gamma quanta during radiation of a medium with neutron, and NNL, which records reflected neutron density (neutron absorption), i.e.to both fields – neutron-gamma and neutron-neutron fields. The four detectors used allow the dependence on fluid in a pore to be approximated to zero, while minimizing the error in specified porosity value.

Thus, general porosity can be calculated by the following formula:

$$QTP = QEP + K_c * \omega_{g.w}$$

Effective porosity. Effective porosity is defined according to the following approaches, after lithological composition is determined:

-clay does not have an effective porosity, aleurolite, sandstone and calcium containing rock have an effective porosity. In this case the following formula can be used:

$$QEP = QTP - K_c * \omega_{g.w}$$

- clay and aleurolite do not have an effective porosity,sandstone and calcium containing rock have an effective porosity. In this case, the following formula can be used:

$$QEP = QTP - (Vsand + Vsilt) * \omega_{g.w}$$

here, $Vsand$ -amount of sand in a single volume; $Vsilt$ -amount of clay in a single volume.

- only sandstone has an effective porosity. In this case the following formula can be used:

$$QEP = Vsand * QTP$$

LITHOLOGIC-MINERALOGICALCHARACTERIZATION OF LOWER PLIOCENE DEPOSITS

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According to the mineralogical composition, the Lower Pliocene deposits (Productive Series) of Absheron region are related to Absheron type, the main source of which is the Russian Platform, derived by the Paleo-Volga from the north [3, 4]. This fact was firstly proved by V.P. Baturin [3] on the basis of the similarity of mineralogical composition of Productive Series deposits and the modern delta of the Volga River. In addition to the northern provenance area, the Russian platform, there are other source areas of terrigenous material, of secondary importance. The presence of Paleozoic pebbles in Absheron type deposits, derived from the Middle Caspian land, as well as Cretaceous and Tertiary fauna from the Greater Caucasus testify it [1, 2, 5].

The results of 173 samples investigations on the northern fold of the Pirallahi oil and gas field are analyzed in the research work [6]. The deposits of the following suites are included in the geological section: Pereriva, Postkirmaky Clayey, Postkirmaky Sandy, Kirmaky, Prekirmaky, Kala and the sediments underlying Productive series. According to the constructed three-component diagrams of distribution of the main rock-forming minerals (quartz, feldspars and rocks fragments) and the granulometric composition of rocks (Figure (a, b)) it is apparent that, sandy-clayey sediments with high content of quartz (up to 77%) are prevail in the suites (Balakhany and Pereriva) of Productive Series' upper division.

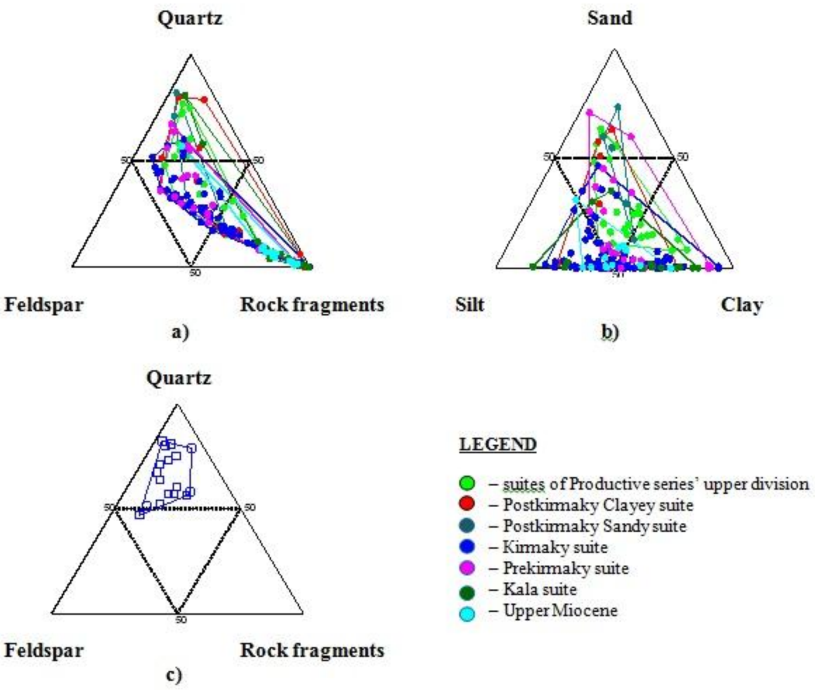

Fig. Three-component diagrams of values'distribution on: a) mineral composition (quartz – feldspar – rock fragments); b) granulometric composition (sand – silt – clay); c) mineral composition in sandy samples for individual suites of Miocene – Lower Pliocene deposits.

The silty-clayey varieties with a high content of clastic rocks predominate (up to 98%) in sediments of Postkirmaky Clayey suite. Postkirmaky Sandy suite is characterized by an increased amount of sandy-silty fraction with quartz content up to 82%. Silty-clayey sediments with a high content of rocks fragments are predominant (99.5%) in Kirmakysuite. Prekirmaky suite is characterized by a high amount of sand fraction, in the light fraction of which quartz and clastic rocks predominate up to 92%. Also, of all the samples, only samples with a sand fraction above 40% were defined, the analysis of which indicated a predominance of quartz in the light fraction (Figure (c)).

In the studied Lower Pliocene deposits, the content of ore minerals ranges from 25 to 94.5% of the heavy fraction weight, the content of stable and less stable minerals (tourmaline, zircon, garnet, epidote) varies between 4-11%. According to the constructed histograms of highly stable and stable minerals, the most frequently encountered zircon values range from 2-3%, garnet 0-1%, tourmaline 1-2%, epidote 4-7% and muscovite 5-8%. According to histograms of ore minerals, the most frequent values of pyrite vary within 0-5%, leucoxene 0-7.5%, limonite 0-10% and magnetite 20-26%.

As a result of the studies, the following conclusions are made:

– the significant presence of ore minerals is, probably, caused, from one hand, by their presence in all possible provenance areas and from another hand – by the syngenetic (authigenic) formation of pyrite directly in the sedimentation basin (in situ). The number of stable minerals (disthene, mica, etc.) and glauconite is very limited. The first, probably, is explained by the remoteness of the provenance area and the loss of these minerals in the transportation routes and the latter one depends on the depositional environment of glauconite;

– increased content of quartz (up to 82, 33% in an average) and vice versa, the reduced content of feldspars (up to 45, 26% in an average) in the light fraction of Productive Series deposits of the Pirallahi field indicates their addition from the territories located in the north, with the influence of provenance area from Greater Caucasus.

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STUDY OFRESERVOIR PROPERTIES OF MIOCENE DEPOSITS WITH THE APPLICATION OF SCANNING ELECTRON MICROSCOPE

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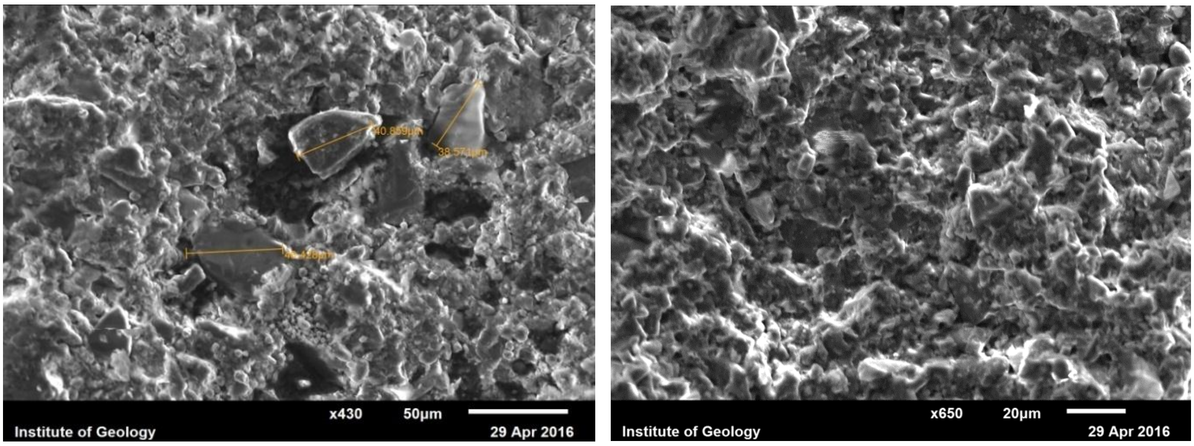
A scanning electron microscope (SEM) is used for observation of samples surfaces. When the sample is irradiated with a thin electron beam (electron probe), secondary electrons are emitted from the surface of the sample. Surface topography can be studied by using a two-dimensional scanning of the electronic probe over the surface and obtaining of an image from the detected secondary electrons [4].

The samples were analyzed with the JEOL-JSM 6610LV scanning electron microscope in the laboratory of Geology and Geophysics Institute of ANAS. At the beginning the rocksamples were grinded, dried and also the platinum was sprayed over the samples'surfaces. The application of SEM made it possible to observe images of samples'surfaces with a high resolution and obtain more detailed information about the morphological structure of minerals in the studied rocks. The use of an energy dispersive spectrometer had allowed to study qualitatively and quantitatively the elemental composition of mineral particles at a micron level.

Figure shows scanning electron images of Miocene rocks samples, obtained from wells №1200, 1201 of the Pirallahi field, with an indication of grain size (in µm).



a) b)

Fig. SEM images of Miocene deposits: a) sample № 2 – calcareous-silty clay; b) sample № 21 – dolomite.

To study the morphological parameters of microscopic images, the samples' quantitative analysis was carried out by using the "STIMAN 3D" software, developed by V.N. Sokolov, D.I. Yurkovets and O.V. Razgulina [1, 3].

The main advantages of this method application is the possibility to use for analysis a very small sample (less than 0.5 cm^3) that can be obtained without distortion of its natural structure, as well as analyzing images, obtained not for one fixed magnification but for a series of magnifications, that display structural elements of all sizes. Unlike the standard technique, the advantage of the present one, is a high rate of obtaining of the studies'results [2].

The simple type of binarization, applied for stationary images, had been used when analyzing the pore space in the "STIMAN 3D" software package. The operator sets the binarization interval in each studied SEM image; after obtaining the binary image, its statistical processing is performed, indicating the total number of defined pores, as well as the number of large, boundary and small pores. The obtained results of samples'investigations indicate the predominance of mainly small pores of an elongated anisometric shape with an average porosity of about 12% for calcareous clay and 14% – for dolomite rocks.

By comparison the morphological parameters of the investigated samples with the values of porosity, a certain regularity had been established: the greater the roundness, circularity and sphericity of mineral particles, the higher the total porosity of the rock. To obtain more accurate and reliable dependencies, it is necessary to conduct studies with greater number of samples.

Taking into account the presence of sandy-silty and dolomite layers, as well as calcareous-clay rocks with some reservoir properties, it is possible to predict the gas saturation of some intervals of the Miocene sediments.

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ARCHITECTURE OF THE UPPER MIOCENE-LOWER PLIOCENE GODERDZI SUITE (GODERDZI PASS AREA, SOUTH GEORGIA)

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The region under study is administratively part of the municipalities of Khulo and Adigeni /South Georgia/ and located on the Arsiani ridge, the watershed of the rivers Dzindza /to the east/ and Acharistskali /to the west/, at the height of 2025 meters. The region was distinguished by strong volcanic activity during the Mio-Pliocene, the products of eruption of which are referred in geological literature as the Goderdzi suite [4, 5].

The geological studies of postcollisional volcanic formations of Southern Georgia go back to the very beginnings of the last century and have been highlighted in numerous publications so far. Nevertheless, some issues still remain questionable and need further detailed investigations and up to date interpretations.

The main goal of the performed research is to assess the impact of the volcanic processes on the biotic and abiotic components of Paleoecosystems on the example of Upper Miocene-Lower Pliocene Goderdzi suite. For this purpose the representative cross-section was studied in the Goderdzi Pass area, in the rivers Dzindze and Adjaristskali headwaters. In this location Goderdzi suit lies unconformably on the middle Eocene and younger volcanic formations. According to available data [4, 5] two distinct parts - lower pyroclastic and upper lava flow units could be distinguished in the Goderdzi suite section here (Figure).

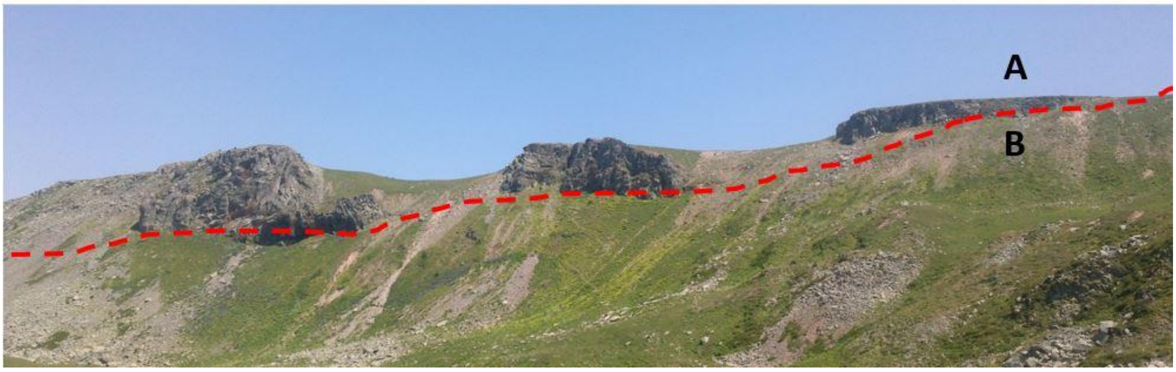

Fig. The studied cross-section of the Goderdzi suite. The dashed line indicates the boundary between the two parts of the suite: upper lava (A) and lower pyroclastic (B) flow units.

Accurate specification of facies is the key to understanding of eruption style and emplacement environment of volcanic products. Based on available data interpretations and our field observations and laboratory studies, several lithofacies have been identified within the pyroclastic flow unit, which was considered to have a uniform character until now: massive lithic breccia and conglomerates, crystal-rich tuffs, lithic-rich tuffs, crystal-lithic rich tuffs and vitroclastic tuffs [1, 2, 3].

It is well-known, that Goderdzi suite hosts numerous remnants of fossil plants which are of great ecological significance suggesting that palaeoenviroment could be deduced through their precise identification. Two horizons of rich in fossil plants tuffs (mainly leaves) were distinguished during the field work. 12 taxons were identified and described from the lower horizons. It should be emphasized, that only plant species of the Lauraceae family were known within the suite. The rest 11 fossil plant species have been found and described here for the first time. Recently found new flora species, confirm the previous researchers' opinion about the subtropical character of Goderdzi suite fossil flora.

Palaeoenvironmental reconstructions through further detailed study of volcanic, volcanogenic-sedimentary and sedimentary facies, post-volcanic alterations, and permineralized flora will enable us to determine the combination of biotic and abiotic factors affecting ecosystems in the process of formation of the Upper-Miocene lower-Pliocene Goderdzi suite.

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ZIRCON AGE DETERMINATIONS OF THE SCHISTS FROM THE KOYANDY COMPLEXES (THE ZHELTAU TERRANE, SOUTHERN KAZAKHSTAN).

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The Central Asian Orogenic Belt (CAOB) represents the largest contractional orogen and is framed by the Siberian, North Chinese and Tarim cratons. The formation of continental crust in the CAOB took more than one billion years from the Neoproterozoic to Mesozoic [2]. A significant volume of continental crust of the CAOB was produced during the Late Precambrian-Early Palaeozoic at the expense of juvenile crust transformation.

In the western part of the CAOB, the terranes comprise thick terrigenous, quartzite-schist, felsic volcanic and igneous complexes [2]. The data obtained in the last several years on the ages of detrital zircons and Sm-Nd whole-rock isotopic compositions of Meso- to Neoproterozoic quartzite-schists, granitoids and volcanic rocks indicate that their formation was related to the intracrustal recycling and reworking of older continental crust [2]. Hence, the overwhelming volume of continental crust in the terranes of the western part of the CAOB was formed in the pre-Mesoproterozoic. However, in the modern erosion zone, the pre-Mesoproterozoic complexes are poorly developed [1], which may have been related to either their complete erosion or their placement in the structure of the deeper horizons of continental crust of the terranes in the western CAOB

The new results of U-Th-Pb geochronological studies of metamorphic crustal complexes of the Zheltau terrane (Southern Kazakhstan) are provided

Within the Zheltau massif metamorphic formations are subdivided into Anrakhai and Koyandy Complexes (after [2]). The Koyandy complex formations have been overthrust from the SW by the Anrakhai complex and are characterized by considerably less distribution within the Zheltau terrane. Metamorphic lithologies of the Koyandy complex are composed of strongly retrogressed garnet-kyanite-phengite paragneisses, which contain pods of garnet amphibolites, eclogites and spinel peridotites. Subordinate muscovite-clorite schists, associated with marbles, amphibolites and quartzites, are also present among the formations of the Koyandy complex.

We analysed detrital zircons from the garnet-mica schist and muscovite-chlorite schist. from the Koyandy Complexes. They are typically characterized by well-preserved magmatic zoning in the cores and variable in size light-grey rims. These features suggest primary magmatic origin of zircon cores and rather metamorphic origin of the rims.

A total of 133 zircon grains from the garnet-mica schist were analysed and 106 concordant age estimates were obtained. Obtained zircon ages are mainly in intervals of the ranges of 667-834, 868-1051, 1087-1220, 1296-1378 and 2464-2539 Ma. The single grains have Ediacaran to Ordovician (632-460 Ma) and Palaeoarchean to Neoarchean (3582-2612 Ma).

A total of 129 zircon grains from the muscovite-chlorite schist were analysed and 112 concordant age estimates were obtained. The Concordia age estimates vary mainly in the intervals of 590-672, 695-790, 905-1332, 1427-1491 and 1991-2023 Ma. Concordia ages of ca. 2.13, 2.32, 2.50, 2.55, 2.81, 2.96 and 3.09 Ga have been determined for the single zircon grains.

A comparison of the obtained geochronological data showed general similarity between age data from both the observed garnet-mica and muscovite-chlorite schists. These results imply quite similar sources of detrital zircons for the different types of metasediments of the Koyandy Complexes.

Combined U-Th-Pb on zircon data for the garnet-mica and muscovite-chlorite schists, plotted as probability density curves, demonstrate age peaks at 604, 635, 672, 726, 749, 991, 1082, 1211, 1272, 1320, 1459, 1604, 1720, 1843, 1882, 2014, 2311, 2506, 2819 and 2819. The youngest peak age of 604 Ma defines the maximum age of deposition for metasediments of the Koyandy Complexes. Our data indicate that Archean to latest Neoproterozoic rocks were sources of the metasediments.

Apart from the Zheltau terrane, the Early Precambrian formations are solely known within the Naryn-Sarydzhaz (Central Tien Shan) terrane, where they comprise the Kuilu complex. It comprises Palaeoproterozoic orthogneisses with ages of 2320 – 2333 Ma and ~ 1850 Ma [1].

The studied detrital zircons from the schists of the KC displayed another stage of magmatism at the Meso- to Neoproterozoic boundary (~ 900 – 1100 Ma) during the Precambrian evolution of the Zheltau terrane. The formation of granitoids and felsic volcanic rocks of Precambrian terranes in Northern (~ 1200 – 1100 Ma) and Central (~ 920 Ma) Kazakhstan as well as Northern Tien Shan (~ 1150 – 1100 Ma) is thought to have been due to this stage [1, 2]. It has to be noted that within the Ulutau-Moyunkum group of terranes, magmatic complexes of the indicated ages have not been found. At the same time, detrital zircons with similar ages (970 – 1090 Ma) have been identified in the paragneisses of the Aydaly complex in the Chu-Kendyktas terrane [2].

Late Mesoproterozoic – Early Neoproterozoic magmatic complexes are present within the Tarim craton to a limited extent. The granitoids of this age are known within the NE (Quruqtagh) and eastern (Altyn-Dunhuang) parts of the craton [3]. An inferred proximity of the tectono-magmatic evolutions of the Ulutau-Moyunkum group of terranes with the Tarim craton [2] allows the suggestion that the formation of the sources of detrital zircons from the schists of the Zheltau and Chu-Kendyktas terranes may have been related to magmatism in the Late Mesoproterozoic – Early Neoproterozoic, as identified within the Tarim craton.

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EVALUATION OF ENVIRONMENTAL DAMAGE CAUSED BY THE EXTRACTION PLACER IRON DEPOSITS USING REMOTE SENSING TECHNIQUES IN SANGAN KHAF AREA, IRAN

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The Sangan iron mine which contains various iron anomalies and placer deposits is located 300 km southeast of Mashhad and 40 km of Afghanistan border. The study area has a soft topography (lowland and hills) and the placer deposits have been developed in an area with about 30 km length and 20 km width and its depth is to 14 meters in some areas. Owing to the high economic value and easy extraction of placer deposits, exploration and extraction of these deposits have been carried out extensively at the study area. For extraction of placer deposits a considerable amount of soil surface is dug out at the area. Consequently, it causes soil erosion, severe geomorphologic changes (creation deep pits and huge depoos in the area) and loss of the drainage system, vegetation and animal life. The focus of this study is to investigate environmental damage caused by mining activities and placer extraction using remote sensing data for the first time in Sangan area. For this purpose, the satellite images (Landsat 7 and 8) of study area before and after the extraction iron placer deposits have been processed to investigate morphological changes (Figure (a, b)), Also from DEM data were used to extract the stream of region and identify the direct effect of mineral activity on the drainage system (Figure (c)). The results showed that the extraction of placer deposits over a period of 11 years causing severe environmental damage (Including 37 km^2 morphologic changes and destruction more than 50 km of drainage systems) in the study area (Figure (d)), which its compensation and rehabilitation require the time, long-term planning and management.

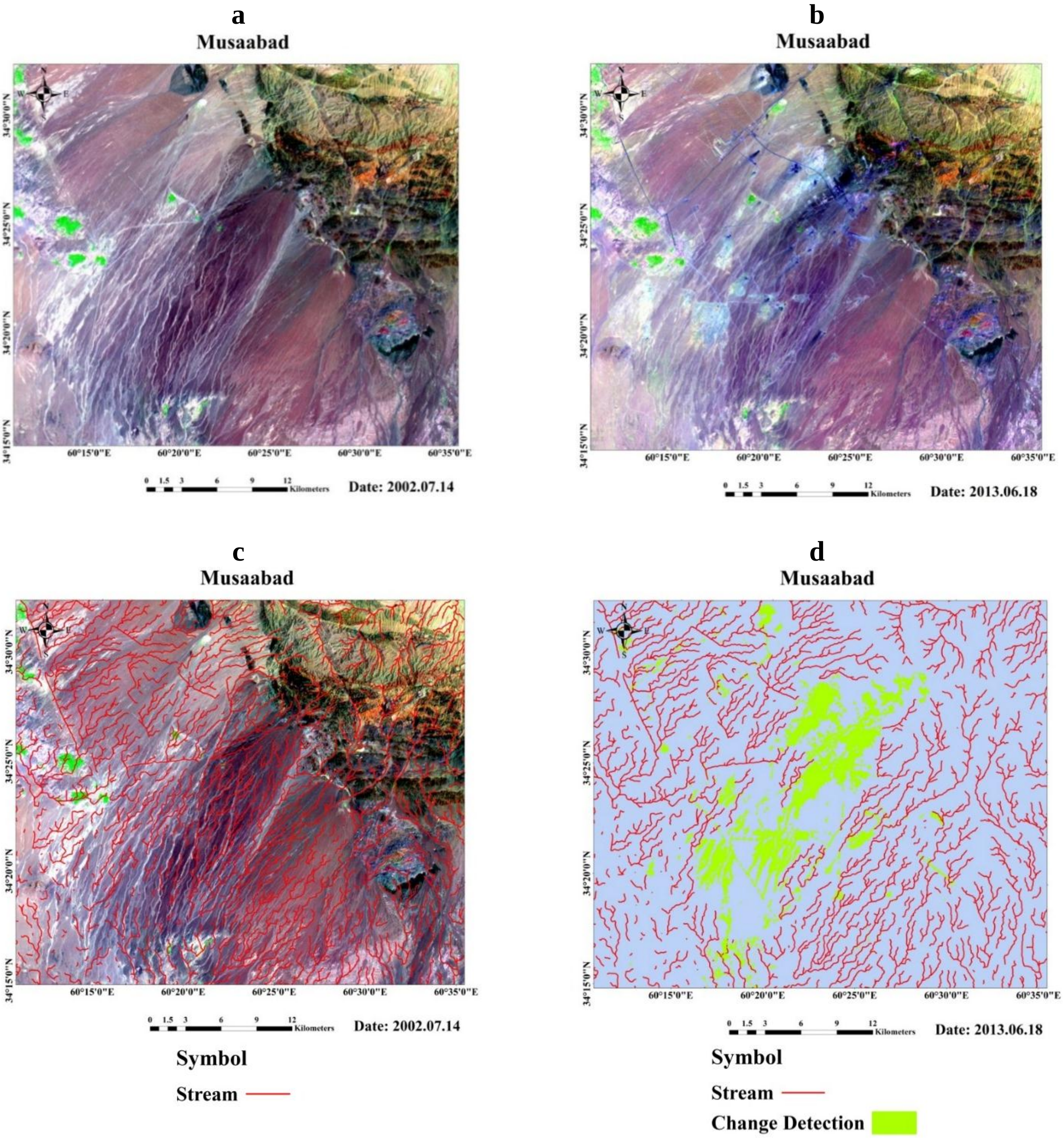

Fig. The Landsat 7 (ETM+) satellite image before mining activity (a). The Landsat 8 (OLI) satellite image after mining activity (b). Drainage system of study area was extract by DEM (c). Change detection of study area, Including 37 km^2 morphologic changes and 50 km destruction the drainage systems (d).

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REFLECTION OF THE STRESSED STATE OF THE GEOLOGICAL ENVIRONMENT OF THE TERRITORY OF AZERBAIJAN IN SEISMOLOGICAL FIELDS

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Characteristics of the rates of velocity and wavelength velocities (Vp / Vs) recorded at seismic stations during earthquakes were analyzed on time and space.

It has been revealed that the Vp / Vs parameter time scale, based on the data of separate seismic stations in Azerbaijan, shows abnormal changes before strong earthquakes. These abnormal changes show up to 10 to 15 days depending on the location of the stations and the epicentral distance of the earthquake. According to researchers, these changes are due to changes in the physical and mechanical properties of the environment through the deformation processes in potential burner zones [1].

Analysis of Vp / Vs curves based on data from various seismic stations revealed that some of the abnormal changes were observed only at local and nearby earthquakes at some stations (Saatli, Kurdamir s/st) and other (Ismayilli, Shaki s/st) stations - before local, near and remote earthquakes shows.

Maps have been set up to determine the Vp / Vs spatial distribution capability. The analysis shows that the mean values of the Vp / Vs ~ 1.73 in Azerbaijan with the mean values ofVp / Vs 1.73 and the negative (Vp / Vs<1.73) values in the built-in maps are not always strongly potentially strong (M≥5.0) zones [2].

Continuation of these studies can give significant results in solving the problem of determining geodynamic-tension zones of Earthquakes and earthquakes in the territory of the Republic based on the Vp / Vs kinematic parameters of time and space.

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THE ROLE OF NEAR-SURFACE GEOPHYSICAL METHODS IN SEARCH OF ARCHEOLOGICAL OBJECTS

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The application of geophysics in archeology is actual and can be used primarily to search for important archaeological sites and to develop preventive measures. "Preventive Archeology" is a special area of archeology, based on the pre-identification and investigation of important archeological objects that can be damaged by construction facilities. Over the past 20 years, preventive archeology has developed rapidly in many countries around the world (France, Spain, Turkey, etc.), the methods in accordance with the geological and tectonic conditions of the area were modified and it has been possible to detect objects that play an important role in clarifying the history of the country. Up to date, no archeogeophysical methods have been applied in Azerbaijan territory. The study of archaeological sites along the route of oil pipelines and at the areas where buildings and oil terminals planned to build are of great practical importance in Azerbaijan. Near-surface geophysical methods will provide information about the features of the various elements of the cultural layer. The acquired geophysical field data will help to explore the subject of the research from the historical-cultural context, which will give a comprehensive insight into the living conditions of ancient societies. Since most of the archeological monuments are covered with soil, various geophysical methods are used in their search.

Application of geophysical methods during search of archaeological sites reduces the volume of drilling works several times. On the other hand, unlike traditional archaeological methods, search of archaeological objects by geophysical methods is carried out within a short period of time. In addition, the preventive detection of underground monuments, the predetermination of the area, type, depth, structure and other characteristics of the object will allow planning the volume of archaeological surveys to be undertaken in any specific area and will increase the quality and shorten the duration of these works.

The application of these methods in Azerbaijan will first of all enlarge the search opportunities of archeologists, while on the other hand; will allow to take into account archeological monuments existing in the area of planning and to make the necessary adjustments to the projects.

The geophysical research methods used in archeological practice depend on the type and character of the monument, its geological and ecological environment. Therefore, each monument must be studied by geophysical methods appropriate to its location. In other words, new localized modificated methods must be developed. The experience accumulated in the study of archeological objects creates the need for complex research in this direction.

Taking into account the above mentioned difficulties in the archeological researches, the application of geophysical methods in the search of archeological objects is of great importance.

DISTRIBUTION OF PALEOGENE MIOCENE SEDIMENTS AND THEIR COMPARATIVE ANALYSIS IN GOBUSTAN

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Paleogene-Miocene sediments are widely spread in Gobustan, and dominate in the mud volcano breccia. There are more than 100 mud volcanoes in the region. These sharply differ on their structural position, morphological features and the thickness of sediments. In northern Gobustan, mud volcanoes are located in a cover zone which buried under the Cretaceous aged rocks under the rocks, and the thickness of Paleogene Miocene sediments is less than 2,000 meters. Mud volcanoes in the area are smaller in size than others. The thickness of sedimentary rocks in Central Gobustan (Boyanata microblock) varies from 2.5 to 4.5 km, and in the geological sections of the Southern Gobustan (Toragay microblock) aboute 11-12 km. Mud volcanoes in this zone are differ on their some features, as well morphological characteristics, bigness, activity and complex folding and tectonics positions.
In addition, the lithofacies and mineralogical features of Paleogene and Miocene sediments vary from north to south. It was obtained oil from Maikopian sediments in some fields, for example Gizmeydan, Ombaki and Chokrak (Dashgil).

The study provides detailed information on the geological structure and tectonics of Gobustan, as well as distribution of mud volcanoes, lithology, mineralogy and oil and gas potential of the Paleogene-Miocene sediments.

ORE DISTRIBUTION, TYPES, PARAGENESIS AND SULFIDATION STATE EVOLUTION OF THE ORE FLUID OF THE GEDABEK DEPOSIT

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The Gedabek deposit is one of the main producing mining of the Gedabek ore district of Azerbaijan and is the largest porphyry-epithermal ore field of the country. It belongs to the Lesser Caucasus, located in the central part of the Tethys metallogenic belt. It is emplaced within the Jurassic-Cretaceous Lok-Karabakh magmatic arc, resulting from the subduction of the Tethys Ocean along the Eurasian margin.

Underground mining activity at Gedabek started about 200 years ago and is more recently exploited for copper, silver, and gold. The deposit was previously described as a porphyry of the Cu or Cu-Au type, and, more recently, as a high-sulfidation epithermal deposit. The ore mineralization is hosted by a large body showing an upper flat-lying contact with Bajocian-Bathonian andesitic tuff and located above a Kimmeridgian diorite intrusion. The ore body has a porphyritic texture formed by quartz eyes in a microcrystalline matrix.

The field study in the open pit reveals a pervasive propyllitic alteration of the andesitic tuff and a pervasive quartz±adularia±pyrite alteration which forms the ore body. Field observations also reveal a strong lithological control of the propyllitic and the quartz±adularia±pyrite alterations, within sub-horizontally bedded volcanoclastic rocks. The central part of the open pit is characterized by the intersection of two main fault structures spatially associated with a late argillic alteration extending vertically, and small semi-massive sulfide mineralization.

Metal content analyses of the quartz±adularia±pyrite alteration and mineralizations indicate a large low-grade ore body associated with the pervasive quartz±adularia±pyrite alteration and high-grade semi-massive sulfur mineralizations associated with the central part of the deposit. Variable but high contents of volatile elements (Te, Se, Hg, Sb, As) indicate a shallow epithermal environment of formation.

A petrographic study of mineralization describes a paragenetic sequence subdivided in four stages: (1) an early quartz-adularia-pyrite assemblage, forming a pervasive alteration of the andesitic tuff and a localized mineralization occurring as semi-massive sulfide lenses, followed by (2) a chalcopyrite-sphalerite-dominated mineralization occurring as localized semi-massive lenses and veins; (3) a late copper stage characterized by the replacement of chalcopyrite and sphalerite by chalcocite, covellite and enargite; and (4) a finely disseminated galena-tennantite dominated mineralization, with an ambiguous timing of formation.

The galena-tennantite-dominated mineralization is arbitrarily placed after the chalcopyrite-sphalerite-dominated mineralization. This is suggested by rare occurrences of fahlore in equilibrium with Fe-poor sphalerites. However, galena-tennantite-dominated mineralization is observed in spatial association with the “stockwork-like” structure, and no relationship with other mineralization is observed. Therefore, this stage might also represent a spatial zonation of the mineralization, as well as a more oxidized fluid.

No chalcocite nor covellite is observed replacing the galena-tennantite-dominated mineralization. However, the late copper stage was later after in the paragenetic sequence, because its mineralization represents a higher oxidation and sulfidation state.

No visible gold is reported at Gedabek. However, rare tiny electrum grains are microscopically observable. Electrum was only observed in samples from the galena-tennantite-dominated mineralization. It indicates deposition of electrum together with hessite, chalcopyrite, galena and tennantite. This electrum is observed together with large galena and tennantite crystals, which are relatively larger than the usual smaller disseminated crystals from this sub-stage. Analyses of electrum by SEM indicate an Au/Ag ratio of about 3 (qualitative estimation).

The galena-tennantite-dominated stage has the highest content of gold measured in this study (~20g/t Au). Despite the possibility of a nugget effect, it is consistent with microscopic observations of electrum in this mineralization only. Furthermore, analyses indicate a strong correlation between Au and Bi, Te, Pb and Ag (respectively 0.98, 0.91, 0.89 and 0.87). These correlations are consistent with the observation of gold occurring as electrum in association with galena, and tellurides.

Microprobe analyses, undertaken on sphalerite from the chalcopyrite-sphalerite-dominated mineralization, indicate a general intermediate-sulfidation state of the system, with large variations between the low-intermediate limit and the intermediate-high limit of sulfidation state suggested by Einaudi et al. (2003 year). The detailed petrological study indicates a general increase of the sulfidation state of the system with time, from a low-intermediate-sulfidation state toward a high-sulfidation state.

Sulfur isotope data obtained for sulfides and sulfates from the Gedabek mineralizations indicate a magmatic source of sulfur precipitated in a general reduced environment. A preliminary oxygen isotope study of the Gedabek ore body is consistent with a quartz±adularia±pyrite alteration of the andesitic tuff.

The superposition of these two distinct groups of epithermal systems are possibly formed by unrelated hydrothermal events. However, a model of formation by a single continuous hydrothermal system cannot be discounted and is also discussed.

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PALEOMAGNETIC RECONSTRUCTION OF THE VARTO FAULT ZONE, EASTERN TURKEY

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Collision between the Arabian and the Eurasian plates started after the total consumption of oceanic lithosphere of the southern branch of the Neotethys Ocean in Late Serravalian. After the collision, Anatolian plate started to extrude westward, along the dextral North Anatolian Fault Zone (NAFZ) and sinistral East Anatolian Fault Zone (EAFZ) [4] (Figure). NAFZ and EAFZ intersect at the 10 km northeast of the Karlıova district and make a junction with the Varto Fault Zone [8]. This junction is called Karlıova Triple Junction (KTJ) and characterised by transtensional tectonics.

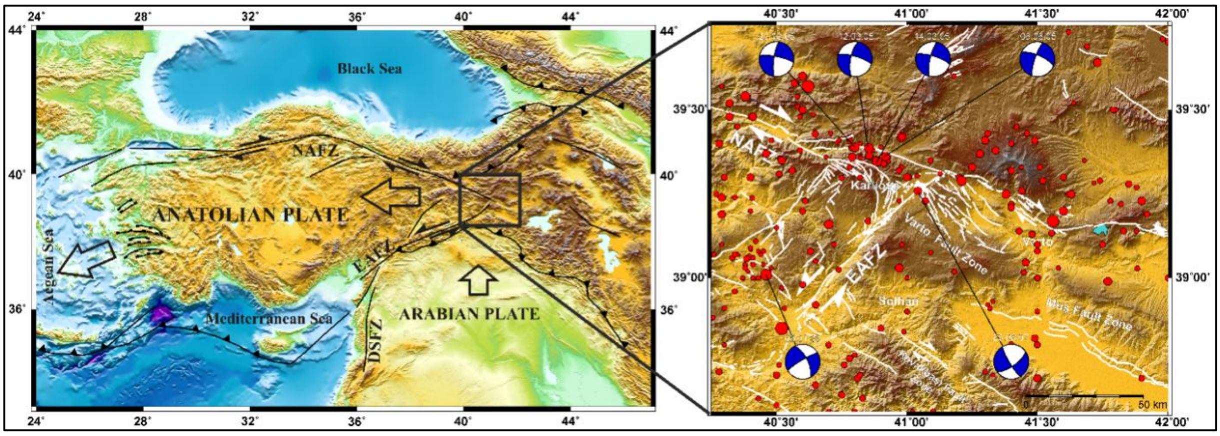

Fig. a) Tectonic map of the Anatolian, Eurasian and Arabian plates, North Anatolian Fault Zone (NAFZ), East Anatolian Fault zone (EAFZ), Death Sea Fault Zone (DSFZ) **b)** Seismicity of the KTJ and its aruond (M > 4.0 Earthquakes between 1900-2017 and focal mechanism solutions of M >5.8 Earthquakes). Figures were generated using the Generic Mapping Tools [9].

Varto Fault Zone is at the eastern end of the NAFZ, which is located at the east of the Karlıova Triple Junction. The VFZ lies roughly ESE trending, begins at the KTJ in the west and continues eastwards with a length of about 30 km along a widely distributed deformation zone [5]. Maximum width of VFZ reaches up to 12 km. VFZ can be divided into three segments from north to south; Varto, Leylekdağ and Çayçatı respectively [1]. The interpretation of the tectonic structures in the VFZ is controversially discussed. To explain the mechanical behavior and/or initiation of the VFZ, several models have been proposed. Some of these models are "the eastern continuation of the NAFZ" [2]; "a separate fault system" [7, 6, 5] "the whole zone developed as a result of distributed continental transpression" [5] and "the VFZ consist of at least four sub-parallel segments and fault kinematics indicate a range of shortening and extensional regimes" [3].

In order to determine the tectonic evolution of the Varto Fault Zone, oriented paleomagnetic samples from 24 paleomagnetic sites were collected from the Pliocene volcanic rocks. Paleomagnetic samples, whose orientations were determined using both magnetic and sun compasses, were collected using a portable motorised core drill. Paleomagnetic laboratory studies have been done in KANTEK Paleomagnetism Laboratory.Standart paleomagnetic demagnetisation tests have been applied to all of the samples. Demagnetisation steps of paleomagnetic samples are shown on Zijderveld and Stereographic projections. After demagnetisation procedures, site mean magnetisation directions have been calculated and shown on maps. Our results indicate that western part of Varto Fault Zone rotated counterclockwise (CCW) and eastern part rotated clockwise (CW).

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PALEOMAGNETISM OF THE MIOCENE QUATERNARY VOLCANIC ROCKS OF THE LAKE VAN, EASTERN ANATOLIA

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To study the North of the Lake Van in terms of tectonic evolution, oriented paleomagnetic samples were collected from 145 sites of Miocene to Quaternary volcanic rocks (Figure). Ages of these volcanic rocks has already been known from radiometric aging methods [3, 1]. The origin of the collected paleomagnetic samples from different volcanic series are related to the volcanic centers in this region such as Tendürek, Aladağ, Etrüsk Mountain, Pliocene plateau basalts, Girekol, Yüksektepe and Karnıyarık Hill. Paleomagnetic laboratory studies and rock magnetism studies have been performed in KANTEK Paleomagnetism Laboratory and Istanbul University Doç. Dr. Yılmaz İspir Paleomagnetism Laboratory respectively. Rock magnetic experiments, including high temperature susceptibility measurements and acquisition of isothermal remanent magnetization (IRM), were carried out using the samples of some sites in order to identify the magnetic remanence carriers and origin of the volcanic rocks.

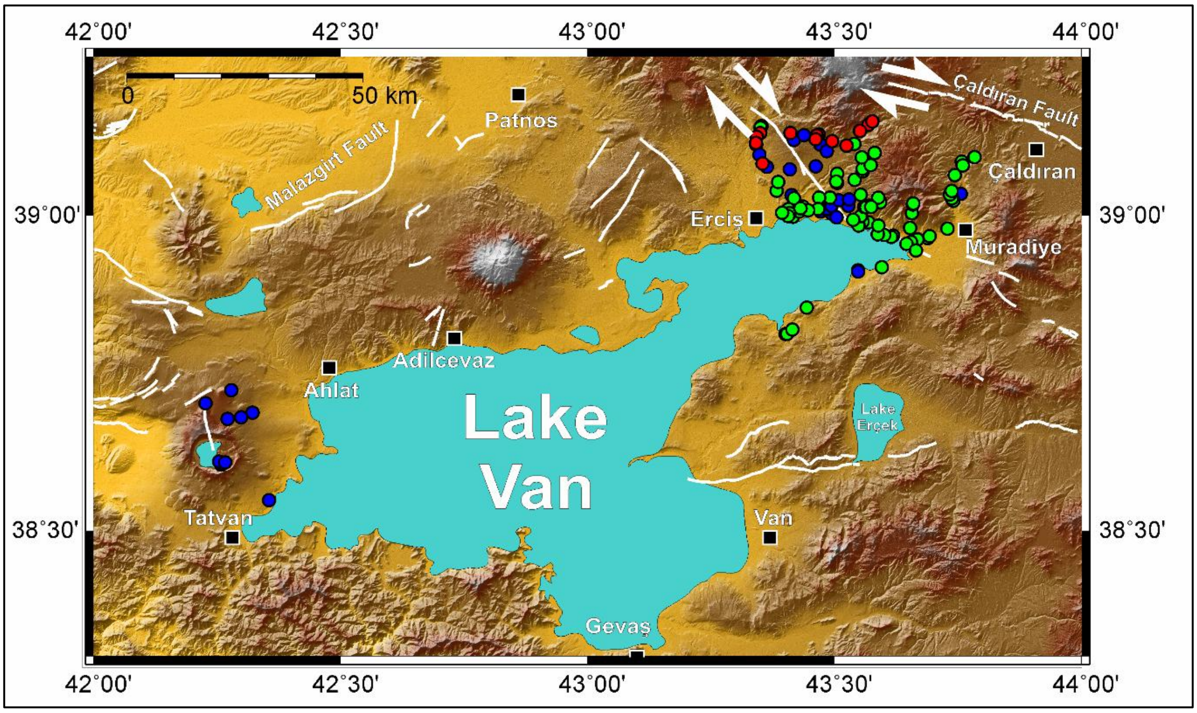

Fig. Distribution of the paleomagnetic sampling sites. Blue circles represent Quaternary, green circles Pliocene, red circles Miocene aged volcanic rocks.
(Figure was generated using the Generic Mapping Tools [6].

High temperature susceptibility measurements of most samples show a strong decrease in susceptibility between 500°C and 600°C, typical of Ti-poor magnetite. Generally, IRM curves show rapid acquisition of magnetization about 200mT.

Our paleomagnetic results suggest that there are not any considerable rotations at the

Holocene and the Upper Pleistocene volcanic rocks around the Nemrut Volcano. However, significant differences are observed between both sides of the Erciş Fault in Pliocene. There are mostly counter-clockwise (CCW) rotations in the western/southwestern part of the Erciş Fault and there are not any considerable rotation in the eastern part. Furthermore, there is a considerable difference in rotations of northern part and western part of study area. Our results are consistent with previous paleomagnetic studies [2], seismological studies [5] and GPS data [4] in this region.

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APPLICATION OF U-PB DATING OF DETRITAL ZIRCON IN RESEARCHES OF PRECAMBRIAN SEDIMENTARY COMPLEXES

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The Precambrian or Phanerozoic volcanogenic-sedimentary complexes are important objects for scientific interest due to large and giant metallic deposits of gold, platinum, copper, nickel, iron ore and others that are related to them. Type of deposit depends on mineral composition, occurrence and preservation of ore-hosting rocks. Formation of mineral deposits are timed to defined timeframe in geological history of orogenic belt evolution and are related to defined rock associations.

It is important to understand sequence of evolution of volcano-sedimentary complexes of volcanic rocks primary mafic-ultramafic composition mostly by using petrological and geochemical analytical studies. Different interpretation of analytical data can lead to disputable models of formation and evolution of volcanic-sedimentary structures that cause uncertainties in defining of them metallogenic potential. But sedimentary rocks in complexes typically remain away from geodynamic reconstructions although by informational content about evolution of structures them can exceed volcanogenic rocks. Particularly relevant sedimentary formations acquire in the light of the recognition of the analysis of detrital (clastic) zircons separated from terrigenous deposits. Investigation of their uranium-lead isotopic systems makes it possible to determine the denudation sources of clastic material and to establish the upper age limits of its accumulation. Composition features and structure of sedimentary strata together with isotope-geochronological data allow to restore possible conditions for the formation of volcanogenic-sedimentary complexes.

The attention of the authors of this work is directed to the study of the Paleoproterozoic structure Vetreny Belt located in the sourthern part of Fennoscandian shield. Vetreny Belt extends from north-west to south-east for about 250 km, with a width of 15-85 km. Currently structure is unexplored due to remote location and low level of outcropping. Volcanogenic-sedimentary Vetreny Belt is relating to Paleoproterozoic Sumian suprahorizon and representing narrow elongated greenstone belt structure. It is on the border of Belomorsky mobile belt along regional thrust fault in the north-east that clearly fixed by gravitatational folding in geophysical maps. In the south-west border Vetreny Belt is thrust on Paleoarchean grey gneiss complex and Mesoarchean greenstone belts of Karelian granite-greenstone region. The maximum thickness of the sedimentary-volcanogenic greenstone complex in belt reaches 3,5-4 km.The rocks of the belt are metamorphosed in the prehnite-pumpellyite subfacies of the greenschist facies.

The following distinguished suites are outlined in Vetreny Belt (from below upwards): 1 – terrigenous-sedimentary Tokshinskaya suite, composed of various quartzites and quartz gravelites; 2 – Kirich suite, represented by and esibasalts, andesites and their tuffs; above there is a number of terrigenous sedimentary suites. Above the last there are number of terrigenous sedimentary suites: 3 – conglomerates Kalgachin suite; 4 – Kozhozersky suite of limestones, dolomites, marlstones; 5 – Vilenga suite of sandstones, siltstones and shales; 6 – Vetreny Belt suite completed by komatiitic volcanites and mafic tuffs.

The purpose of this work was to determine the conditions for the deposition and the time of formation of the sedimentary-volcanogenic complex of the Vetreny Belt according to the analysis of the isotope systems of detrital zircons. There were accomplished several tasks: were specified petrographic and geochemical features of the Tokshinskaya and Kalgachin suites, was determined the time of their formation by uranium-lead dating of detrital zircons, was made the comparison of the isotope-geochronological data obtained by the Vetreny Belt with other similar Paleoproterozoic structures.

Studied detrital zircons were from the quartzites of the Tokshin suite, that located at the base of the volcanic-sedimentary complex. Petrography and geochemical results showed that the suite is composed of terrigenous sediments with high maturity index (like ultra siliceous rocks) and formed at the border of the littoral and sublittoral areas.For the first time ever U-Pb isotope analysis for the detrital zircons as well as study of their morphology and internal structure allowed to establish Vetreny Belt reliable age of 2.6-2.4 bln years that formed under long-term continental conditions. Also were established possible denudation sources during the formation of the Tokshin suite which were lithotectonic complexes of the Karelian granite-greenstone region.

At the middle part of the cross-section of Vetreny Belt are deposited by Kalgachin suite rocks presented by pebble conglomerates. Zircons were separately sampled from the pebbles and separately from cement. Analysis of the total age spectrum of detrital zircons in the suit showed that there were no grains with ages less than 2.81 bln years and older 2.99 bln years. So, the age spectrum of the Kalgachin suite zircons is significantly different from the age spectrum of the Tokshin suite zircons that lies at the bottom of the Vetreny Belt structure (from 2.65 bln years to 3.36 bln years).The distribution of rare and rare-earth elements in zircons as well as their morphology and internal structure in cathode rays and petrography and geochemical analysis of isolated pebbles clearly indicate its source from diorite-granodiorite rock massive.The possible denudation source of clastic material could be Shilos plagiogranite massif or granite complexes of the Vodlozersky block located in the neighborhood areas and have age of formation relatively equal to majority of the dated zircons.

Comparison between obtained isotope-geochronological characteristics of the Vetreny Belt with data of others Paleoproterozoic structures made possible to establish significant differences of their denudation sources of detrital material in spite of the similarity of the conditions of formation and the proximity of dating.

Thus, the analysis of detrital zircons from the cross-section of the Vetreny Belt sedimentary-volcanogenic complex made possible to determine the conditions for its formation and subsequent development that previously could not be determined from the petrological and geochemical features of the volcanic rocks in the complex.

Comparison between previously and present geochronological dating results data of the Vetreny Belt with others Paleoproterozoic structures made it possible to establish significant differences of their denudation sources of detrital material in spite of the similarity of the conditions of formation and the proximity of datings.

This conclusion make it possible to carry out a qualitative comparison of the Vetreny Belt with similar structures of the Fennoscandian shield and allow to make a rational forecast of metallogenic potential on a poorly studied territory. This, in turn, will allow us to make a probable forecast of minerals on a poorly studied territory.

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INVESTIGATION INTO THE IMPACT OF GAS COMPONENTS IN GAS-CONDENSATE SYSTEM ON PHASE TRANSFORMATION IN RESERVOIR CONDITION

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The systems of the gas-condensate reservoirs consist of gas components as well as liquid (C5 +), which have an important role in the exploitation of this kind of fields [2,3]. According to field reports, the amount of gas components, such as methane (40-95%), ethane (up to 20%), propane (up to 15%) and butane (up to 12%), can fluctuate from 50 to 95%. In addition, non-hydrocarbon components such as nitrogen, sulfur dioxide, mercaptane and helium are also, found in the reservoir system and their total quantity can be up to 80% in some fields. For example, the amount of carbon dioxide in the Russian Semividovskoe field is up to 79.79%, in the Tuymazinskoe field is up to 15.2% and Astraxanskoe field is up to 22.5% [1].

Thermodynamic researches of the methane mixtures with various groups of hydrocarbons show that if the system consists of a mixture of liquid components (paraffin) where this gas can dissolve better, the dissolution of the liquid in the gas improves [3,5], the same time saturation and retrograde condensation pressures decrease. In other words, increasing methane in the system improves the ability of gas components to disperse in the liquid phase. When the system consists of components in which methane is poorly soluble (naphthenic and aromatic,) depending on pressure and temperature, the two-phase interval of the mixture is prolonged and the dispersion of liquid into gas phase is deteriorated [5].

In general, nowadays studies have confirmed that the mutual solubility of liquid and gas components is one of the leading parameters that significantly impacts on the phase transformation of multi-component systems [3-4]. Thermodynamic studies have shown that nitrogen is considered a poor soluble element in a hydrocarbon liquid, and carbon dioxide is considered highly soluble in a hydrocarbon liquid. Thus, increasing the nitrogen content of the gas mixture should worsen solubility, but increasing the carbon dioxide content of the gas mixture should improve the solubility. From this point of view, our experimental studies concluded interesting results. During experimental investigation, various gas mixtures with different compositions have been used. The composition of the mixture was sorted by changing the amount of nitrogen and carbon dioxide in the system.

Experiments have been carried out in accordance with the general methodology of contact condensation. With the use of different gas mixtures and the liquid with the same density (748.6 kg / m^3) and compositions (45.9% of the gasoline, 17.4% of the aromatic; 36.7% of the naphtha fractions) were used for composing 7 different gas-condensate systems with 200 g / m^3 of condensate/gas ratio. The content of these systems is kept unchanged in all cases. Experiments were performed at constant temperature of 100 ^{0}C. At first stage, the fog up (formation of fog in the system before retrograde condensation) and retrograde condensation pressures were measured, and then by taking samples from the liquid and gas phase at the same constant temperature and pressure (12MPa) the dissolved liquid per gas volume and dissolved gas per liquid volume were determined.

In accordance with analyses of obtained experimental data the following conclusions have been made.

It was confirmed that the presence of the highly soluble components in the reservoir system reduces its fog up and retrograde condensation pressures. In addition, this effect reduces the difference between these pressures. In other words, the period of the system staying in a single-phase state is enlarged.

Increasing the nitrogen content in the reservoir system increases the retrograde pressure, but the increasing carbon dioxide causes these pressures to be decreased. A similar trend was observed with the fog up pressure however, it has been found that increasing carbon dioxide results in enlarging the difference between the fog up and retrograde condensation pressures. Also, this increases the stability of the aerosol state to the hydrocarbon system during depletion regime.

The analyses some of the physical properties of these 7 different gas mixtures confirmed that an increase the critical temperature and decrease the critical pressure of the gas mixture in the gas-condensate system would lead to improve dissolution capability of the gas in the hydrocarbon liquid. This also increases the condensate/gas ratio of the gas phase and increases the stability of the liquid components to remain in the dispersed phase. It was found that an increase the coefficient of the compression of gas components, that is, the increasing the differentiation of the physical properties between natural and ideal gases, improves the dispersion process the liquid components in the gas.

Based on the obtained results, it should be noted that the use of these gas component properties could contribute to the efficiency of reservoir development process. Also, it can be effectively used during projecting and selection of working agent or “vaporizer” for the re-vaporizing and extracting the remained retrograde condensate from the reservoir.

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FRAGMENTS OF THE OCEANIC CRUST IN THE REVDINSKY MASSIF OF THE URAL PLATINUM BELT (MIDDLE URAL, RUSSIA)

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Revdinsky massif is one of the Ural Platinum Belt massifs. It located at the Middle Urals 40 km west of Ekaterinburg. Fragments of the oceanic crust presents by the root zone of the sheeted dyke complexes are exposed on the day surface at the Western part of the Revdinsky massif. In the outcrops we observe the gabbro intruded by a two dolerite sheeted dyke complexes, these intersects at angles 40-70°. Veins diorite-tonalite-plagiogranites intruded gabbro and sheeted dolerite dyke of 1st generation.

The host rocks are gabbro and gabbro-diorite and quartz diorite. Gabbro is characterized by a smaller f 0.24-0.44 and a lower Sr content (185-263 ppm) from the typical gabbro of the Platinum Belt massifs (Figure (a)). Gabbro contains REE 12-89 ppm, La_n/Yb_n=0,8-4,9. Initial lead isotope ratios in the gabbro by age 426 MA are $^{206}Pb/^{204}Pb_i$ – 17.902, $^{207}Pb/^{204}Pb_i$ – 15.523, $^{208}Pb/^{204}Pb_i$ – 37.871. Sheeted dyke dolerite and host gabbro correspond to low-potassium tholeiitic basalts and andesibasalts of normal-alkaline series. sheeted dolerite dyke of 2nd generation varies from picrobasalts to andesidicocytes (SiO_2 – 43,1-63,1%).

Sheeted dolerite dyke of 1st and 2nd generations has clined trend of REE and minimum by Ta, Nb, Th, Zr, Ti and high peck by Sr, K, Ba, Cs. Thus, these rocks are close to basalt zones of back-arc spreading. Dolerite point are in the space between oceanic and island-arc basalts near field of back-arc spreading basalts (BABB) at the plot Nb/Yb–Th/Yb [5] (Figure (b)). Sheeted dyke dolerite of 1st generation are enriched of Ti, Mg и Ni compared with sheeted dyke dolerite of 2nd generation. Later dolerites of 2-nd generation dykes characterized by greater iron content f – 0,23-0,72 compared with all rocks infiltrated previously.

Diorite-tonalite-plagiogranites has fine grained or coarse grained texture and consist of plagioclase (An 0.01-0.20), amphibole, chamosite, quartz and accessories minerals. Veins diorite-tonalite-plagiogranites has SiO_2 46-73% and belongs to the low-K normal-alkaline series. The rocks has inclined trend of REE, La_n/Yb_n 1.5-3.6. Tonalites has minimum by Rb, Zr, Ti. Tonalites and plagiogranites belongs to calcic series by [2]. Tonalites belongs to magnesian series by [2]. Plagiogranites are metaluminous and ferroan by [2]. Initial lead isotope ratios in the sample of vein tonalite by age 426 MA are $^{206}Pb/^{204}Pb_i$ – 18,055, $^{207}Pb/^{204}Pb_i$ – 15,569, $^{208}Pb/^{204}Pb_i$ – 37,707. It most closely matches the “orogenic” reservoir by age 426 MA by [7]. However by geochemistry composition diorite-tonalite-plagiogranites are similar by plagiogranite series of the mid-ocean ridge [3].

Thus, we studied fragments of the oceanic crust (the upper part of the ophiolite section) in the structure of the Revdinsky massif of the Ural platinum belt. This fragments of the oceanic crust was formed by a back-arc spreading. The spreading axis rotation by 40-70º and the change any geochemical characteristics of magma occurred in the interval between the intruding sheeted dykes of the 1st and 2nd generations.

New data on the problem of the relationship between ophiolites and concentrically-zonal massifs of the Ural-Alaskan type in folded belts were obtained in these studies. The joint presence of these two formations in one massifs imposes some limitations on the existing models for the Ural Platinum Belt formation. According to Prof. V.N. Puchkov (oral report) fragments of back-arc spreading ophiolites are the host rock roof for concentrically-zoned gabbro-ultramafic massifs of the Ural-Alaskan type.

The massifs of the Ural Platinum Belt are sources of the platinum group elements (PGE) and are promising for the discovery of new ore occurrences of PGE. Its economic importance may increase in the future. The delineation of the ophiolites and concentric-zonal formation rocks in massifs of the Ural Platinum Belt will allow localizing the regions for the exploration of platinum ore occurrences.

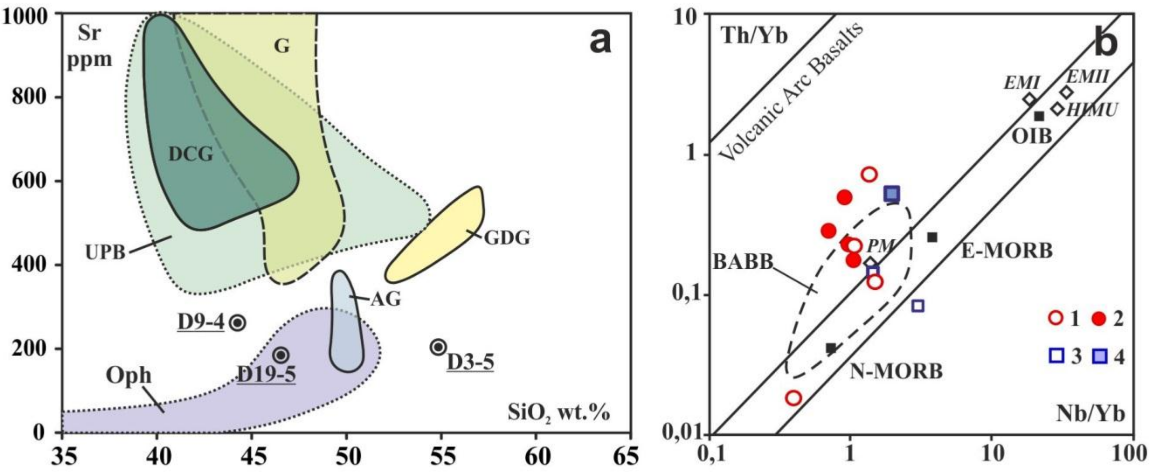

Fig. a – Plot SiO_2 – Sr for gabbro of the fragments of the oceanic crust from Revdinsky massif. Ural Platinum Belt: DCG - dunite-clinopyroxenite-gabbro series, G - gabbro series, GDG - gabbro-diorite-granite series, AG - amphibole gabbro by [1]; UPB – rock of the Horasyursky massif of the Ural Platinum Belt and Oph - ophiolites by [6]. b – Plot Nb/Yb–Th/Yb [5] for 1 – sheeted dolerite dyke of 1st generation, 2 – sheeted dolerite dyke of 2nd generation, 3 – host rock gabbro, 4 – host rock quartz diorite.

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ACCESSORY MINERALS TRACE ELEMENT GEOCHEMISTRY AS A TOOL FOR CARBONATITES GENETIC FEATURES STUDY

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Precambrian shields alkaline rocks are important objects for abyssal Earth processes study despite on their low prevalence [1]. There are near 40 alkaline rocks massifs studied to varying degrees within Ukrainian Shield [4]. Genesis of most of them is not fully explored and geochemical features of rocks are different. In this paper the attempt to investigate the cause of such difference for carbonatite massifs was made by mantle sources for their formation geochemical differences estimation.

Proskurovka (PM) and Chernigovka carboantite (ChCM) massifs (Dnister-Bug and West Pre-Azov Regions respectively) [2, 4] were chosen as objects of study. Low indicator elements (P, LREE, Sr, Ba, Nb) contents for alkaline rocks are observed in PM unlike ChCM [2-4, 7].

PM belongs to central structural-morphological type. It’s composed of ijolite-melteigites, alkaline pyroxenites, alkaline and nepheline syenites and surrounded by fenitized rocks and fenites formed on Chudnov-Berdichev granites and Bt-Pl crystalline shale host rocks [10]. ChCM is stretched along the Chernigov fault zone and represents linear structural-morphological type. It’s composed of carbonatitic dykes, and some nepheline syenites and alkaline pyroxenites bodies. Massive is surrounded by wide fenite halo developed on amphibolites, gneisses and granites [5, 6].

Metasomatic columns of host rocks alteration were formed for fenitization process investigation in both massifs. Geochemical research on the rock level has shown [5-7], that contrast types host rocks compositions converge during fenitization process. At the same time final products of PM and ChCM fenitization significantly differ between themselves and with alkaline rocks and carbonatites. It can be traced distinctly on trace-elements content. The leading role in fenitization belongs to so-called «forward wave» metasomatic fluids which were preceding of alkaline rocks and carbonatites intruded the fenite halo. In general, such fluids composition apparently carries information about mantle source for each massive forming. It can be assumed accessory apatite of different generations (corresponded to fenite halos zones) is sensitive indicator to fenitization fluid trace element composition [9]. Trace element composition alterations of accessory apatite [9] in formed PM and ChCM metasomatic columns were traced to confirm this suppose.

PM. Because of the basic host rocks limited distribution the metasomatic column for them is a two-member: 0 – initial host rocks, 1 – fenitization rocks. Unfortunately, the apatite is not observed in last one. For granites the metasomatic column is a three-member: 0 – initial host rocks, 1 – fenitized rocks; 2 – apogranitic fenites [6].

ChCM. For different composition host rocks (basic, intermediate, felsic) three-member columns were formed: 0 – initial host rocks, 1 – fenitized rocks; 2 – fenites [5, 7, 9].

Obtained data are represented on Figure. Arrows show trace elements composition alteration trends of apatites during different host rocks fenitization. The plots show, that apatite from ChCM fenites has higher indicator trace elements content (in particular Sr) compared with such PM rocks. It allows suggesting the different fluid composition for both massifs.

Apatite composition from the most altered rocks will allow obtaining more precisely trace elements composition of fenitization fluids if apatite-fluid distribution coefficients for trace elements will be known. These estimations are the task for further research.

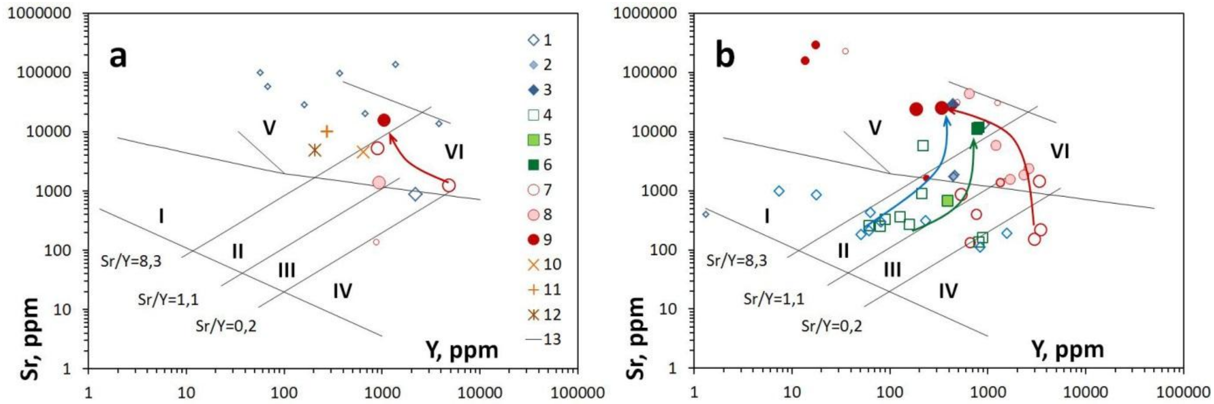

Fig. Composition variations of accessory apatites from PM (a) and ChCM (b) fenite halo rocks [9]. 1-3 – basic (1), intermediate (2) and felsic (3) host rocks; 4-9 – their metasomatic alterated products (4, 6, 8 – fenitized rocks; 5, 7, 9 – fenites); 10 – alkaline syenites; 11 – nepheline syenites; 12 – ijolites; 13 – apatite composition fields boundaries. Arrows show composition alteration trends of apatites from fenite halos rocks. Statistic justified fields of apatite compositions are marked by roman numerals (from [8]): *I* – metamorphic carbonate and silica-carbonate rocks; *II* – calc-alkaline ultrabasic, basic and intermediate rocks; *III* – the same for moderately felsic rocks; *IV* – high-felsic granites; *V* – carbonatites, alkaline rocks and associated metasomatic rocks (together with mantle xenolithes lherzolites); *VI* – alkaline metasomatites (including fenites).

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3D DYNAMIC EARTHQUAKE FRACTURE SIMULATIONS CONCERNING THE NONPLANAR FAULT GEOMETRY AND HETEROGENEOUSSTRESS STATES IN THE SEA OF MARMARA

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Located around the western section of the North Anatolian Fault Zone (NAFZ), Marmara Region of Turkey is seismically an active area with the occurrence of earthquakes M>7 and a population over 15 million and the analysis of it is of significant importance. Despite earthquakes larger than 7 has occurred during 20^{th}& 21^{st} century to the west and east of the Sea of Marmara, there were no large earthquakes along NAFZ in this region, so making the analysis of possible earthquake scenarios even more crucial.

The main objective of our study is to determine 3D dynamic earthquake rupture scenarios, considering non-planar fault geometry and heterogeneous stress structures based on the recent studies on the interseismic strain accumulation on various segments of NAFZ and historical earthquakes in the Sea of Marmara. A Finite Element Model (FEM) via PyLith

Codeis used to achieve the goal. Tetragonal meshes are generated to decrease in accuracies at the fault bends.

In this study, due the requirement of high computational demand, the most accurate and largest mesh size (300m) and the time step (0.015s) values are verified for planar (simple) and non-planar (complex) test geometries. In addition, despite the complexity of our model and high computational demand, creeping and locked parts of the fault geometry in the Sea of Marmara are considered. In addition, the most reliable frictional parameters are adapted with the help of results from the latest geodetic studies to decrease assumptions. The most probable scenarios are created in terms of results from locations and extensions of historical large earthquakes, latest seismicity maps and recent GPS displacements.

As a result of this study, we expect to obtain reliable and accurate 3D dynamic earthquake rupture scenarios for the non-planar and heterogeneous fault structure in the Sea of Marmara. We will consider under what conditions can whole of the unruptured segments of the NAFZ can rupture and which scenarios are more realistic.

ON PETROLOGY AND GEOCHEMISTRY OF THE JALOVCHAT INTRUSIVE (CAUCASUS)

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The Caucasus situated between the Eurasian and Afro-Arabian plates is a central link of the Mediterranean (Alpine-Himalayan) mobile belt. One of the most important components of the Caucasus is the Main Range structural zone of the Greater Caucasus. The zone thrust over the fold system of the southern slope of the Greater Caucasus by the Main Thrust. With the above thrust a number of Jurassic intrusives of basic and acid composition are associated. One of the intrusives of basic composition is the Jalovchat gabbroic intrusive (Figure 1). It covers the area of about 25 km^2 with 10 km of length and with a maximum width of 3.5 km. Moreover, its thin (0.3-2.0 m) concordant or crossing bodies occur in host metamorphic rocks. The K-Ar age dating of the intrusive shows 176±20 Ma [2].

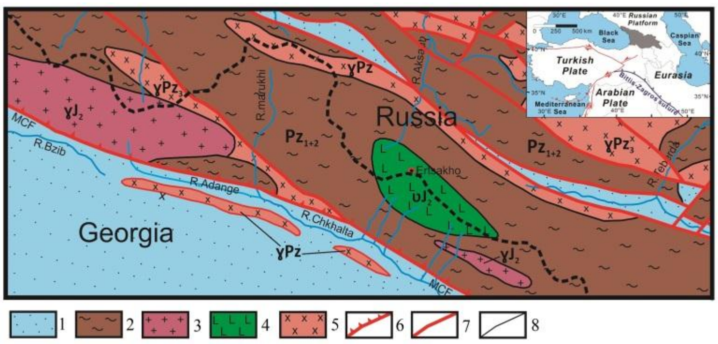

Fig.1. Schematic geological map of the Greater Caucasus Main Range zone in the area of exposure of the Jalovchat intrusive.
1 - Jurassic sedimentary rocks; 2 - Pre-Alpine metamorphic complex; 3 - Middle Jurassic granitoids; 4 - Middle Jurassic gabbroids; 5 - Paleozoic granitoids; 6 - MCF- Main Thrust of the Greater Caucasus; 7 – Ruptures; 8 - Geological boundaries.

The intrusive is built up of hornblende gabbros, gabbro-norites and norites. There hornblende-bearing gabbro-pegmatites are widespread. That is a coarse-grained rock with gigantic hornblende crystals. Sizes of hornblende prisms amount several centimeters, sometimes reaching gigantic sizes of 30-50 cm [2]. By its unusual composition, the Jalovchat intrusive has no analogue in the Caucasus. However, petrologically and geochemically, the intrusive rocks were studied insufficiently. For comprehensive investigations, the authors applied appropriate methodologies: microscopic study of thin sections, petro- and geochemical analyses of the samples and also different petrogenic, rare and rare earth elements diagrams and spidergrams [1, 3, 4, 5, 6]. On the basis of analytical data and their interpretation it is established that the Jalovchat intrusive by its composition corresponds mainly to the mid-ocean ridge basalts and according to geodynamic type belongs to the subduction type. In general, it is an anomalous phenomenon, as in the rocks of such composition crystallization of hornblende and especially of its gigantic crystals is atypical. The authors believe that the water-rich magma reservoir, which was necessary for the crystallization of gigantic hornblende crystals, appeared as a result of melting of water-rich mid-ocean ridge basaltic rocks during the subduction process in Bajocian time (Figure 2).

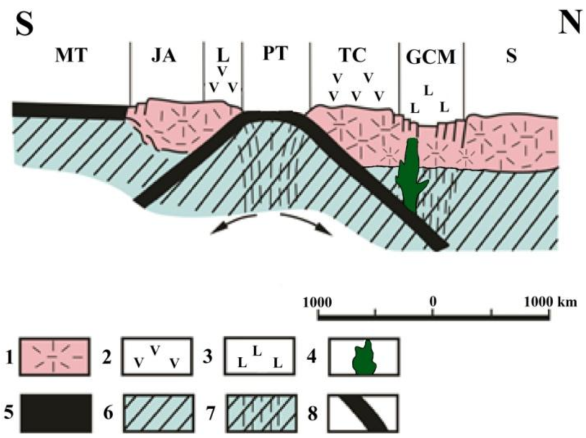

Fig. 2. Palinspastic reconstruction of the Caucasus segment of the Mediterranean belt along N-S profile for Jurassic time.

1 – consolidated continental crust; 2-3 – manifestation of volcanism: 2 – calc-alkaline, 3 – basaltic, 4 – gabbro of the Jalovchat intrusive; 5 – newly formed oceanic crust and ophiolites; 6 – upper mantle; 7 – heated upper mantle; 8 – subduction zones; Oceanic areas and small sedimentary basins: PT – Paleotethys, MT – Mesotethys (Neotethys), GCM – Greater Caucasus marginal sea. Continental plates and microplates: TC – Transcaucasian island arc, L – Lock-Karabach Zone, S – Scythian Plate, JA – Iran-Afghanian Plate.

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LANDSAT IMAGE ENHANCEMENT INTEGRATED WITH SAR IMAGE FOR GEOLOGIC STUDIES

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The present investigation deals with the resolution enhancement of multispectral image for better identification of High Aswan Dam region that specific important part of Egypt. Preprocessing of both SAR and Landsat images has been carried out to obtain the best Enhancement. Concerning the SAR image, the utilized information for terra-SAR-x getting backscatter image is the main goal of the investigation. Calibration has been performed first then de-speckling to evacuate dot happened in accumulation. The present system as established by different methods of filtering, after that an appraisal as carried out to get the best image from all strategies done. Then, the image, for doing a combination with Landsat image in the wake of doing subset for our region of the hobby, has been utilized. The outcomes demonstrated that utilizing mean with (7*7) portions issuing us great results instead of different systems. Fusion of Landsat image by SAR data was performed using the principal component method. A geologic interpretation is applied to the processed image.

ELECTRICAL RESISTIVITY TOMOGRAPHY AND 3D NUMERICAL MODELING FOR AQUIFER MAPPING IN NOVOSIBIRSK REGION

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Underground aquifers are the main source of fresh water in Novosibirsk Region. Typical depths vary from 30 to 200 meters, depending on the exact area and its prevailing geological conditions. There are two major types of aquifers here: those exploiting water that is contained in weathered bedrock layer and those that utilize ground waters captured in sand pockets of various size. Both are not reliable in terms of possible water yield: weathered bedrock can be without water or its thickness might be insufficient. Whereas sand pockets are very hard to find without proper geophysical studies. Luckily, we possess such methods (ERT) and as of now, we also have sufficient experience and unique software solutions [1] that help us perform reliable studies on the matter.

Since year 2011 we have worked on numerous sites across the Novosibirsk Region and in this text we would like to present the results of one such study.

The area of study was located 45 km East of Novosibirsk – a small village called Lekarstvennoe. Initial data suggested complicated groundwater patterns and uneven geological structure of bedrock. Previous attempts to drill a water well were partially successful: a well back from Soviet era showed moderate yield (5 m^3/hour), whereas new well was almost completely dry. This case demonstrated the complexity of geological structure in the area: the new, almost dry well was drilled only 20 meters from the old one, which normally promises identical yields.Our objective was to determine an optimal place for the water well near the village by means of ERT.

Geophysical survey was performed using following parameters: distance between electrodes – 5 m, number of electrodes – 48, number of electrical lines – 2 consequent lines in roll-along pattern, maximum depth of investigation – 45 m, survey scheme – Schlumberger array.

Resulting geoelectrical cross section showed more or less two-layered structure (Fig.).

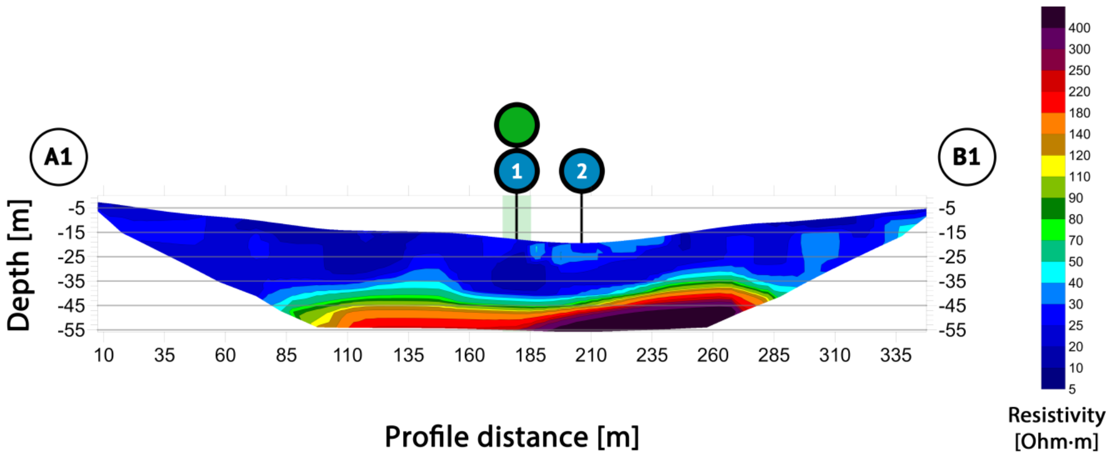

Fig. Resulting geoelectrical cross section. Blue areas stand for sediments (clay loam), purple and red are attributed to bedrock (red - shale rock, purple – possibly diabase). Green-yellow layer – weathered bedrock.

However, as expected, the second layer – bedrock was complicated by low resistivity region, that was interpreted as fault or strongly weathered bedrock. Such areas in Novosibirsk region are usually best in terms of fresh water yield.

To make a more valid interpretation we performed a 3D numerical modeling using our own unique software that allows calculation of forward problem on GPU, thus providing very fast solution. Modeling results showed, that with high probability the fully known interval 85-185 meters is represented by low resistivity bedrock – either weathered or faulted. Which means this layer of bedrock is saturated with water.

Therefore, the recommended interval for the water well was situated around the 170 m point along the profile (see Figure).

Drilling at recommended point showed excellent results: yield value was 8 m^3/hour. Which is a very high volume for this area. Furthermore, drilling showed that ERT helped us determine layer thicknesses for this object of study with high precision.

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INVESTIGATION OF FRACTURING USING SEISMIC DATA FOR GEOLOGICAL MODELING OF BASEMENT ROCKS

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As a basis for geological modeling, the results of processing of 3D-seismography materials are widely used to date. At the same time, study of the fracturing of natural oil and gas reservoirs using seismic data is quite a difficult task. The scale and size of the majority of fractures, involved in the filtration of reservoir fluids (meters and centimeters), are beyond the resolution of standard 3D surveys with the recording of reflected waves. A seismic inversion can be singled out to a group of direct methods for fracturing investigation. Its main purpose is to transform the initial kinematic parameters of seismic traces into a set of quantities characterizing the physical properties of the rocks in the section.

The object of the study is one of the oilfields of the Krasnoleninsk arch (Western Siberia). The subject is represented by a Proterozoic-Paleozoic complex composed of metamorphic rocks, which is described in more detail in [1, 2].

As a basic tool for analysis, 3D seismic data, which completely covered the area of the study, were used. After standard correction procedures, making corrections to the initial seismic traces and temporal migration, the final seismic cube was obtained. Structural interpretation for the target horizons was carried out in the "Petrel" software complex (Schlumberger).

To isolate zones of heterogeneity (fracturing) along the "A" reflecting horizon (the top of the basement) at different time intervals a set of structural (geometric) seismic attributes was used: "Variance", "Chaos", "Ant Tracking", "Local Structural Dip", "Local Structural Azimuth", as well as "3D Curvature" and a number of its varieties – "Most negative curvature", "Most positive curvature" and "Gaussian curvature" [3, 4].

Based on the maps of mean values and interval slices of the "Ant Tracking" attribute, a overall picture of the development of small tectonic disturbances were obtained. In addition, the assumed orientation of the associated fracture systems in the region of the deposits under consideration was determined. To assess the reliability of the chosen approach to determining the direction and orientation of the fractures, a number of reports on the use of the FMI ("Formation Micro Imager") [5] for fracture evaluation of the basement in several wells located in one of the neighboring areas were analyzed.

Despite the fact that the lithology of the rocks varies significantly, the orientation of the fractures intersected by the wellbore has a high convergence with the network of faults identified using the "Ant Tracking" attribute. Thus, it has been confirmed that seismic attributes can be used to map the sections with the highest fracture density. Moreover, obtaining information about the changes in the basic properties (direction, intensity) of the entire fractures system in the inter-well space was confirmed.

A review of laboratory studies and a detailed macro- and micro-description of the core suggest that a decrease of the initial high bulk density of metamorphic rocks of the Paleozoic complex is due to the presence of open fracturing. This is a direct indicator of the presence of hydrocarbons.

In the process of work, a relationship between the results of the exploratory wells testing and their position relative to the zones of reduced density on acoustic impedance maps was established (Figure).

Main conclusion. The comparison between oilfield and seismic data showed that the sharing use of the "Ant Tracking" seismic attributes and acoustic impedance makes it possible to identify promising areas in the upper part of the Paleozoic basement associated with increased fracturing.

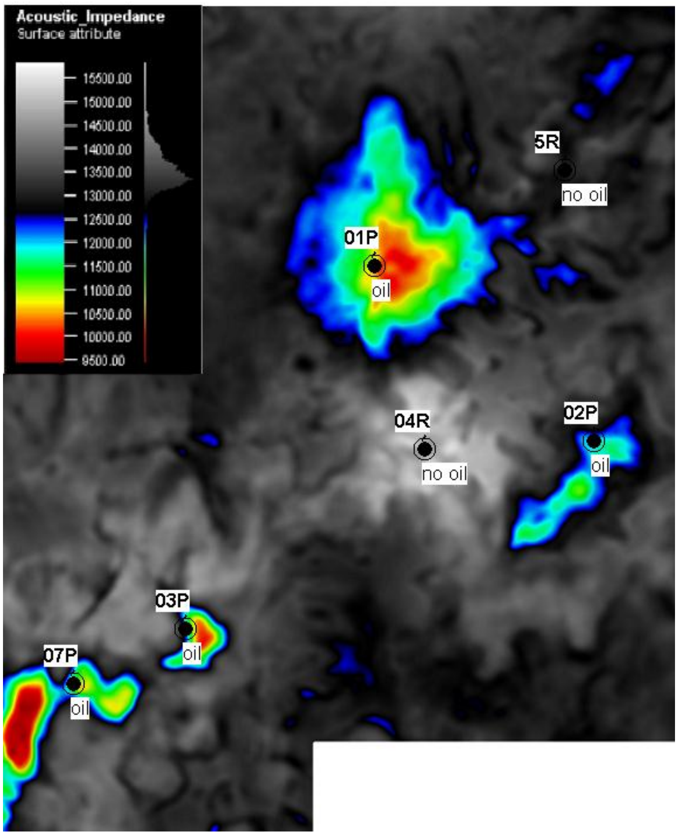

Fig. A map of average values of acoustic impedance in a time window (0-70 ms) below the "A" reflecting horizon.

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PRODUCTION OF LANDSLIDE SUSCEPTIBILITY MAP OF VEZİRKÖPRÜ DISTRICT, SAMSUN (NORTH TURKEY)

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According to the disaster pattern of Samsun, the landslide areas are respectable extensive. Landslides in Samsun have generally creep characterism. However, some landslides were caused loss of life after rapidly moving due to the excessive. Landslide-sourced disaster prone areas, which have totally 3.110.500 square meters, have been determined by technical staff between 2010 and 2016 in Samsun.

Vezirköprü, the study area, located in 115 km south of Samsun, has 1.597 square kilometers and population of 97.815. It has also wide forested areas and canyons. Besides, the North Anatolian Fault extends from southeast to southwest of the district.

On the purpose of the collecting landslide inventory of Vezirköprü, processing of the digital datas, known as inventory source, sent by Prime Ministry Disaster and Emergency Management Authority (AFAD), have been completed. In office and field studies, 1:25.000 scale topographical maps, 1:25.000 scale geology maps, 1:5.000 scale orthophotos, MTA (General Directorate of Mineral Research and Exploration) landslide inventory maps, notebook, portable charger, GPS, camera, smart phone, GoogleEarth, ArcGIS 10.2, and the other mobile geographical softwares have been used. Four different squads have been assigned in field studies. Paleo-landslides and active landslides, which were not indicated in landslide inventory source, have also been recorded in the landslide log sheets. 159 landslide photos have been taken in situ with the aim of advanced field surveys in the future. All field studies were successfully completed between September 2015 and November 2015.

Observed landslide datas from the study area have immediately been digitized by office staff in same day using with ArcMap. These landslides have been drawn as polygon and added on the inventory. Before the analysis, it is possible that the patterns of elevation, slope, and aspect have been reviewable. Digital Elevation Model (DEM) has been produced as 25x25 pixels size helping with number of 20 1:25.000 scale topographical vector maps of Vezirköprü. Slope, aspect, and curvature parameters have been produced by using with this DEM. Geology and proximity to fault parameters have also been produced by way of converting from vector map to raster map.

Frequency ratio method, which is the ratio of occurence probablity to non-occurence probablity [3], has been used in the study. Several studies were also used frequency ratio for landslide susceptibility [1, 2, 4]. Reclassified elevation, slope, aspect, geology, curvature, and proximity to fault parameters have been used in the landslide susceptibility. All parameters have been collected in CAD media and the landslide susceptibility map has been produced (Figure).

The areas in the produced landslide susceptibility map have been classified into 5 groups as very low, low, moderate, high, and very high susceptible. 30 landslides, which separated to control, located in the landslide inventory have been compered to each other with a view to test the reliability of the produced map.

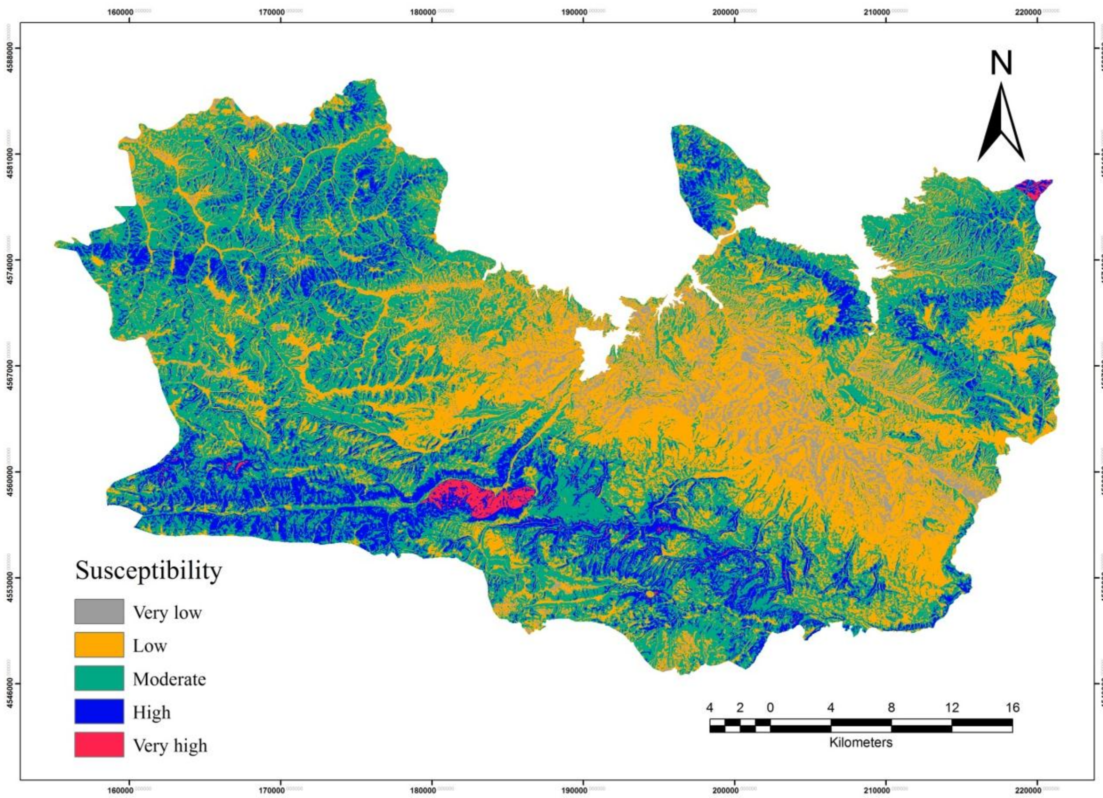

Fig. Landslide susceptibility map of Vezirköprü.

It has been determined that the produced landslide susceptibility map is compatible with the control landslides in a ratio of 80 % in terms of the very high and the high susceptible areas. It has been thought that the high susceptibility in south and southeastern part of the district arises from techtonism based on the North Anatolian Fault. This study is the first comprehensive landslide susceptibility work for Vezirköprü district, carried out by Governorship of Samsun Provincial Directorate for Disaster and Emergency Management (AFAD Samsun) resources.

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ANALYSIS OF HYDROCARBON SYSTEMS OF SEDIMENTARY BASINS IN EASTERN SIBERIA: CAPABILITIES AND PRACTICAL EXPERIENCE

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Basin modeling is dynamic modeling of geological processes in sedimentary basins over geological time spans. The most important processes are deposition, compaction, heat flow analysis, petroleumgeneration, expulsion, phase dissolution, migration, and accumulation. Basin and petroleum system modeling makes it possible to study the evolution of these basins during geological time, the generation and migration of hydrocarbons. Modeling includes three types of numerical models: one-, two- and three-dimensional.

One-dimensional (1D) models are also called "maturity models". Well data are needed for simulation: stratigraphic picks with thicknesses of each sediment layer, lithology and rock physics data. The subjects of analysis at this stage are subsidence of a basin, temperatures and source rocks. Results of modeling are: burial history of a basin; quick estimation of source rocks which implies an assessment of the thermal maturity of rocks and the determination of the stage of catagenesis; time of entering the "oil window". 1D models are used for calibration two- and three-dimensional models.

Two-dimensional (2D) models (Figure) are based on 2D seismic profiles, well data and regional geological profiles. This type of models is more detailed, than 1D. Subjects of analysis at this stage are migration paths, phase composition of hydrocarbons, pressures (geostatic, hydrostatic). Results of the simulation are assessment of phase composition of HCs and hydrocarbon migration along profile, pressure predictions and estimation of faults permeability. We can also give a rough quantification of emigrated and accumulated HCs along the profiles.

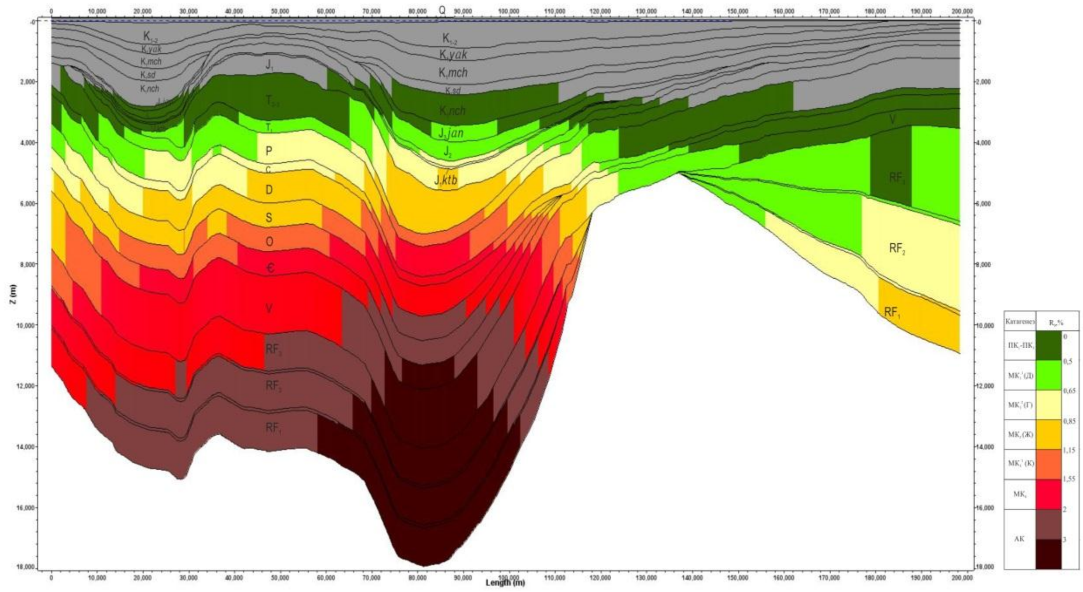

Fig. 2D model of catagenesis of the organic matter along profile located in the Yenisei-Khatanga regional depression.

Three-dimensional (3D) models are the most informative and the most difficult in creating. Creating three-dimensional models requires a large number of maps: structural, lithofacies, maps of the distribution of any properties by investigated area. The modeling is also based on 2D seismic profiles, well data. It also requires a lot of computer resources which makes it difficult to use 3D models in practice. The subject of analysis is all parameters of hydrocarbon system. Results of modeling are quantitative evaluation of any parameter of the hydrocarbon system, estimation of pressures, zones of abnormally high reservoir pressures, estimation of volumes and masses of hydrocarbons in oil and gas accumulation zones and deposits, selection of oil and gas accumulation zones. With the help of modeling, a risk analysis is carried out with the allocation of the most prospecting sites for further exploration.

Experience of using basin modeling includes creating 1D and 2D models of sedimentary basins in Eastern Siberia: Anabaranteclise, Yenisey-Khatanga regional depression. Based on the results of modeling, we give an assessment of the catagenetic transformation of the parent rocks along the studied profiles; we make a quantitative assessment of the emigrated hydrocarbons, trace the migration paths. Also, the sedimentary basin is studied at any stage of its evolution, for example, at the time of maximum subsidence of the sedimentary basin. The results of modeling are used in planning geological prospecting.

In conclusion we note that as a result of complex modeling, it is possible to reduce risks in geological exploration, analyze the prospects for licensing blocks, monitor regional projects with new data, add and change model parameters, and make a transition to local models of deposits.

THE RELATIONSHIP BETWEEN SEISMIC LINES, GRAVITY, MAGNETIC MAPS AND HEAT FLOW IN WESTERN ANATOLIA

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In this study, by the comparison between seismic lines, gravity, magnetic maps and heat flow values obtained from Western Anatolian region the variation in the tectonic and geothermal aspects of this region will be examined. Western Anatolian is an orogenic jam following the continental expansion and that make it one of the world's active seismic zones. The basins developed during the neotectonic period in the region [1] are caracterized in a wide scale by the Western Anatoliahorst-graben system’s East-West extensional faults, slope normal faults which limits the basins [2] approximately in NE-SW and NW-SE direction and strike-slip faults. In the literature there are four different point of view on the expansion of Western Anatolia. The first one of these point of view is the model of tectonic escape; The collisions of the Arab and Eurasian plates along the BZSZ produces, the Anatolian plate movements along the NAFZ and DAFZ in the direction of the west and these movements causes the N-S expansion of Western Anatolia. The second is the spring back opening model; Migration to the south and southwest of the Aegean arc is the starting point for this model. The migration of the Aegean arc, is the main cause of the N-S expansion which occurs in Western Anatolia. The third one evaluate an orogenic downfall model; according to this model, the thickening of the continental late Oligocene crust caused by the compression of the Late Paleocene and a spreading thinly in early Miocene is resulting a N-S oriented continental expansion. Finally, the fourth opinion illustrate a Two-stage grabenation model; In this model, the orogenic settlement forming the basins of Western Anatolia occurs in two phases. In the first phase (Oligocene-early Miocene) normal faults with small angles (detachment) is associated to orogenic collapse, in the second stage (Plio-Quaternary), it is associated to the deplacement of the Anatolian plate to the west in te N-S directionstress and rifting are controlled by high angle normal faults.

In some tectonic zones the heating flow produced in the crust are caused by tectonic movements and a part of this heating flows are radiogenic. The component of heating flows is related to the geological, in the Precambrian age the heating flows are absent. In young folds such as Cenozoic high heat flows are seen. It gives high heat flows in parallel to the mountain formation zone. In the places of formation of the island arc, the heat flows are high in the grabens. Young basin formations are important play an important role in the presence of the heating flows. In the places of formation of the island arc, the heating flows are high near the plate collision zones, in the subduction zones, and deep fault zones. Depending on these, we can see that the places with high heating flows show fault systems and opened geothermal wells. From that we can say that in the areas with high heating flows, if fault systems are present, the geothermal systems are alimented by meteoric waters. The presence of hot water resources in a region is related to the thermal structure of that region [4].

The distribution of hot water springs in Western Anatolia is very important sign of the presence of important geothermal resources. Western Anatolia is formed mainly by graben-horst systems. Higher values of heating flows are observed in the grabens compared to horsts. The reason of the difference between, these structures is the opening tectonics and the presence of normal faults in the area. The heating flows seen on the graben boundaries is high due to the magma approaching to the surface. From the first look at the gravity maps in Western Anatolia, it is observed that the shell structure thickness is decreasing as a result of the opening mechanism. When we compare these maps with all the maps in the places where these curves coincide, it is observed that the curie depth is low, the heating flows are high, the geothermal wells and fault systems are present [3]. In this study, by using the seismic, gravity and magnetic maps and cross-sections, the tectonic and shell relation with the heating flows system in Western Anatolia will be examined.

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MAPPING OF THE FAULT SYSTEM OF NORTH ANATOLIAN FAULT IN THE SOUTH SHELF OF MARMARA SEA

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Researched by many scientists active tectonics of the Marmara Sea which is formed under the effects of the North Anatolian Fault Zone (NAFZ). 3000 km of high-resolution multi-channel seismic reflection data and the CHIRP data were collected onboard K.Piri Reis within the scope of the TAMAM project in the summer time of the years of 2008 and 2010 in the Marmara sea. In addition, 800 km of high-resolution multi-channel seismic reflection data were acquired with 1500 m of streamer and seismic records of 240 channels within the scoop of European Seas Observatory Network (ESONET-Marmara DM) project being supported by the EU's sixth framework program in June 2010. These data have been added to the other present multi-channel seismic reflection data to create a database. Chirp and multichannel seismic data in the study area which is between Gulf of Gemlik and the Kapidag Peninsula on the southern shelf of the Marmara Sea, are processed for the investigation of the continuity of the middle splay at the southern shelf of the NAF and its fault geometry.

The direction shown on the fault map, created as a result of step-over faults which are thought to affect the North Anatolian Fault dextrally. However these faults cannot be traced back to the Holocene unit which was active in previous years, but it was observed that their recent activity reached to the Holocene unit. There are active faults present in Holocene between the southern Armutlu Peninsula and Northern Mudanya. It has been reached to the conclusion that when all the faults are reviewed and examined at the fault structure of South Marmara; it is punctuated (step-over) and has transition structure. It has been observed that faults with the right lateral step-over faults and normal faults occur on the north side of these faults.

As a result, in the created fault map of Edincik Fault as shown B2 fault is the continuation of it in the sea, fault indicated by B4 is a part of Armutlu Bandırma Segment, fault indicated by G1 is the continuation of the fault's new segment and moreover this fault is considered to be Gemlik Fault. G2, G3, G4, G5 and B4 north of the fault are shown by the black color of the normal faults with the effects of the step-over faults are shown behind to be normal faults. The step-over faults which are shown at the faults map are considered to be the right directional effects of the North Anatolian Faults. However, it was observed that these faults could not reach to the Holocene unit but were active in previous years yet its activity could not reach the Holocene unit. The faults between Southern Armutlu Peninsula and Northern Mudanya area are active in Holocene. It has been reached to the conclusion that when lines in the study area interpreted and all the studies are observed the shape of the Southern Marmara fault structure's shape is step-over and has transtention structure. Faults were observed with right lateral skid-slip faults and the normal faults on the north of these faults. When previous years seismic activities and the history of its earthquakes were observed , it was found that they were the cause of large and destructive faults and therefore it is thought that it would be beneficial when preparing this map with potential earthquake risks analysis kept in consideration (Figure).

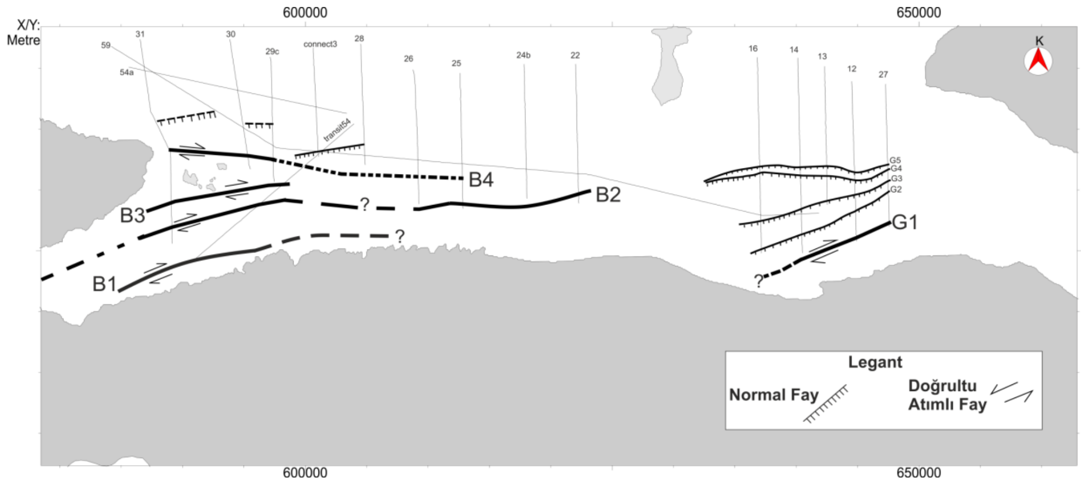

Fig. Fault map.

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CREATION OF THE DATABASE AS THE FOUNDATIONS FOR STUDYING THE CORK OF THE DEPOSIT ON THE FIELDS

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The implementation of databases in engineering geology, is in great demand, because it is necessary to store and process large amounts of information, the use of which is made difficult by the fact that most of it is stored on paper. Especially it concerns the formation of a data bank on weathering crusts, since they are different from each other in different geographic and geological conditions. Such a database is capable of providing up-to-date verified information about weathering crusts in the fields.

The creation of a weathering crust database at various fields would contribute to the accumulation of knowledge about the conditions for their formation, mineral composition, physical and mechanical properties, as the main factors affecting the economically profitable and at the same time safe mining of the deposit.

We suggest the following database structure created in the ArcGis system.

At the initial stage, a permanent engineering geological model is built, designed for input, storage, processing and analysis, coming from the regime data network, in order to timely estimate and forecast the change in the weathering crust condition. The model includes: factual, conceptual-factographic, cartographic and attributive database.

Any engineering-geological process (for example, weathering, karst, landslide, etc.) is represented by a set of observation points, each of which is expressed by a table. The process of ordering information for processing and converting it into data is reduced to the formalization of the subject area, which is similar to the organization of a system of forms.

The structure of the cartographic database is as follows:

1. The elementary layers form a single package, structured according to scale levels, but in the same geographical projection.

2. Thematic layers are analyzed in a series of packages based on the sources and time of integration of elementary layers.

3. Cluster layers form the main value packets and are the documents regulating the processes of estimating, forecasting and designing the process of crust formation.

The primary information involved in the process of engineering-geological research is formatted in tabular formats and loaded into a preliminary database in the form of a file system. Next, in the geographic information environment ArcGIS 9 elementary layers are formed: 1f – relief contours, 2f – hydroset, 3f – observation points, 4f – wells with engineering and geological documentation, 5f – lines of engineering geological sections, 6f – stratigraphic-genetic types, 7f – lithological composition of rocks, 8f – the boundaries of the weathering crust development, 9f – the power of the ave, 10f – the zones of the azu, 11f – the deformation properties of the rocks. The next step is the formation of geoinformation packages in the ArcGIS environment, each of which contains a set of thematic layers in accordance with Table.

Table

Thematic and cluster layers

THEMATIC LAYERS		
№ of the thematic layer	Number of elementary layers	Function of the layer
1t	1f, 2f, 3f, 4f, 5f	Map of the actual material
2t	1f, 2f, 4f, 9f, 10f	Map of the thickness of the weathering crust
3t	4f, 5f, 6f, 7f, 8f, 9f	Engineering geological columns of wells
CLUSTER LAYERS		
№ of the cluster layer	Number of thematic layers	Function of the layer
1k	1t, 2t, 3t	Map of engineering-geological conditions
2k	1t, 2t, 3t	Map of geotechnical zoning

Map of thematic maps is the fundamental basis for implementation everyone is needed mathematical functions that provide objective control and forecast changes in the parameters of engineering-geological conditions in the field.

The final stage on the basis of a series of thematic layers is the development of a series of target cartographic products (cluster layers) presented in Table.

Figure shows an example of a query such as "Show the Engineering Geological Column with weathering crusts," etc. (basic inquiry requests of the type "Show").

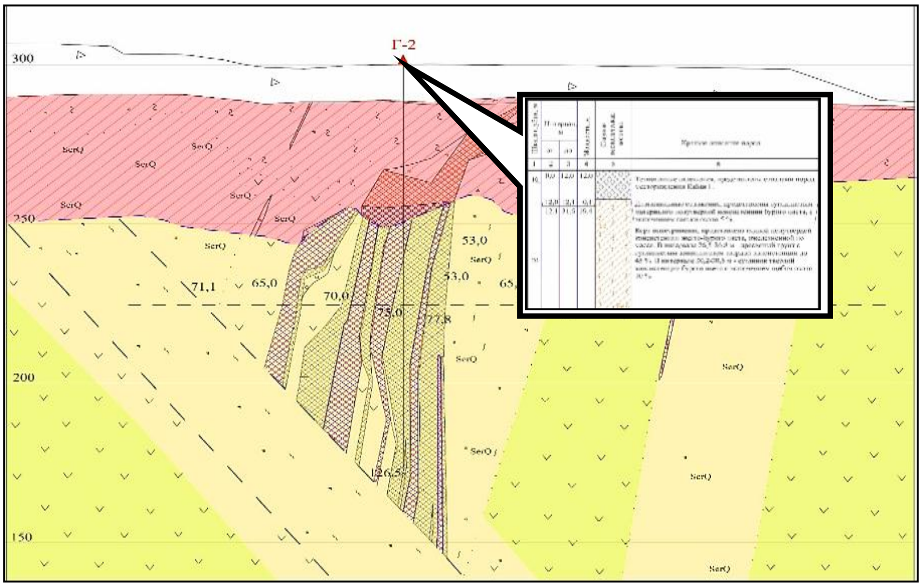

Fig. Fragment of the engineering-geological column along the G-2 well (Kaban-I deposit)

Thus, the database will allow to obtain the accumulated information on the weathering crusts, which will make it possible to form an objective opinion on the conditions of their formation and structure, and influence on the formation of engineering-geological processes.

GPR AND SEISMIC CHARACTERIZATION OF SUBSURFACE HEAT GALLERY AT THE ITU AYAZAGA CAMPUS,ISTANBUL

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Using geophysical methods has gained crucial interest for delineation of natural or man-made cavities such as subsurface heat galleries, in the past few decades. In this study, high resolution geophysical methods were performed for graduation project to investigate the distribution of the subsurface heat gallery in the front of the Central Hall Building of Istanbul Technical University in Ayazaga Campus, Istanbul (Turkey). For this purpose, Ground-Penetrating Radar (GPR), Multi-channel Analysis of Surface Waves (MASW) and Seismic Refraction data were collected on the gallery area.

The GPR data were collected by using GSSITerraSIRch SIR-3000 acquisition system with 200MHz and 400 MHz antennas. Reflex W software was used for GPR data processing and three-dimensional depth-sliced views were generated for better interpretation of the data Processing steps were data import, editing, Dewow filtering, static correction, gain, band-pass and f-k filtering [1]. We prepared a 3D cube with GPR data collected with very frequent line spacing of 0.25 m. Figure 1 gives four depth-slices obtained from this 3DGPR cube data. According to the interpreted depth-slice maps, the gallery starts from 5 m inside from the south to the north and extended in E-W direction at about 4.5 m wide. The depth of the gallery cannot be determined from the GPR data because electromagnetic signals in the concrete confining the gallery are attenuated and/or the day when the data is collected is saturated with the heavy rain before 3 days.

The MASW and seismic refraction methods were used also in this study for determining the depth of the heat gallery. The MASW acquisition is faster with multi-channel coverage and easier method of identifying higher modes of Rayleigh waves to show the detection of subsurface cavities at shallow depths [2]. The seismic data were collected using a SARA DOREMI seismograph system with 12 vertical 4.5 Hz geophones. SeisImager2D^{TM} program which is licensed for ITU, Geophysical Engineering Department was used for seismic refraction and MASW data processing. MASW solutions include interpreting dispersion curve and S-wave velocity section. S-wave velocity model, which was obtained by inverting the dispersion curves from the MASW technique, leads us to determine the depth of the heat gallery, as described by a low-velocity zone (Figure (b, c)). The gallery depth can be determined as 3.7 m from MASW data. Seismic refraction technique was preferred as auxiliary method to get low velocity zone that specified from MASW method under 3-4 meter depths. Thus, we collected the seismic refraction data by choosing 1m of geophone spacing and offset and using 12 P-geophones. Low velocity zone related to the gallery cavity could be seen as delay times of direct arrivals on seismic refracted data.

The integration of both P-wave seismic refraction and MASW data confirm low velocity zone (i.e., gallery) and MASW gives better results for the depth of the existing gallery. GPR method is very efficient tool for mapping shallow targets for these kinds of applications with regard to seismic methods.

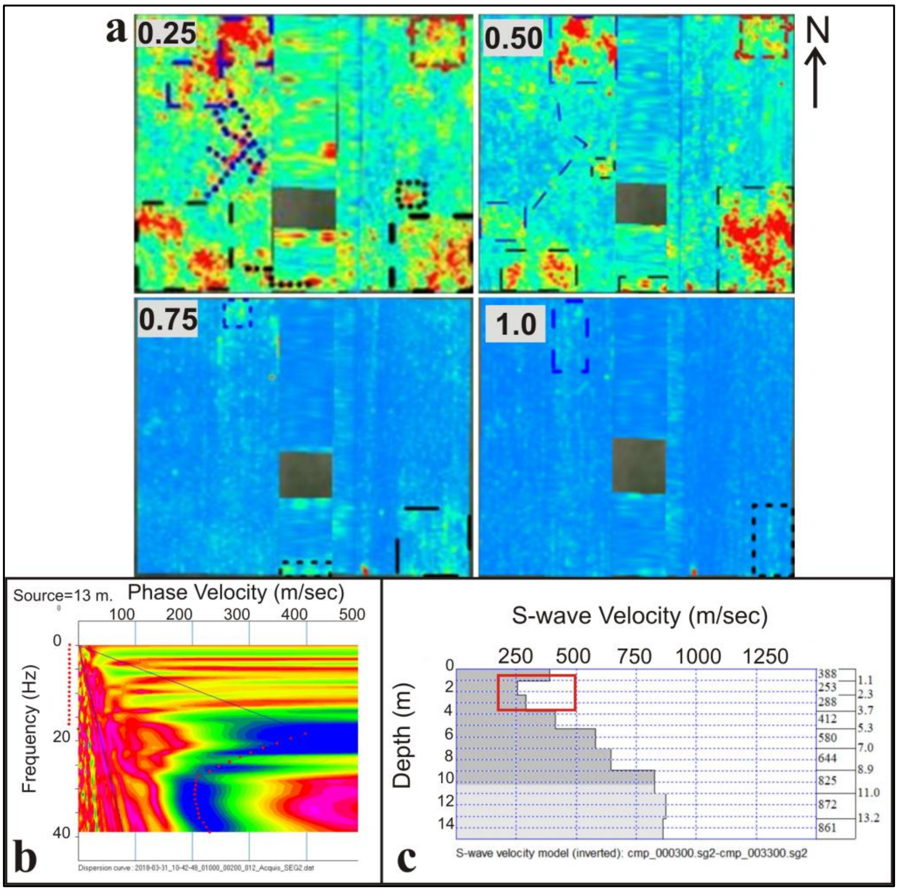

Fig. a) Four depth-slice mapsfrom 3D-GPR cube for 0.25 m, 0.50 m, and 0.75 m, and 1 m. Black dashed lines show gallery cavity, blue dashed lines point to irrigation pipes and unknown anomaly represented by red dashed lines. **b)** Interpreted dispersion curvedetermined in high frequencies low phase velocity. **c)** S-wave velocity-depth model. Note that between depths of 1.1 m – 3.7 m, low velocity zone (red rectangular area) can be interpreted as the depth of gallery.

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THE PERSPECTIVITY OF THE ELEMENT MIXTURES OF CASDAG COPPER-PYRRHOTINE-POLYMETALLIC DEPOSIT

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The presence of a great deal of the element mixtures have been revealed in the ore minerals of Casdag copper-pyrrhotine-polymetallic deposits, like in other pyrite formation deposits of the southern slope of the Greater Caucasus. The components with industrial value for copper-pyrrhotine-polimetallic deposits ore minerals are lead, zinc and copper, but mixed elements are silver, gold, selenium, cobalt, cadmium, bismuth and tellur in small quantity, tallium and others. Some of the mentioned element mixtures are observed only in form of isomorphic mixtures (cadmium, indium, tallium, celenium and etcetra) in basic sulphides. The other group of the element mixtures-isomorph form their individualized minerals, too (gold, silver, bismuth, cobalt, tellur and etc.). A series of accessory and rare minerals belong to the latter in the deposit: joseite, free bismuth, freibergite, cobaltite and etcetra. These elements, particularly cobalt are typical mixtures of copper-pyrrhotine ore mineralization. The problem of cobalt and nickel distribution in stratiform pyrite deposits of the eastern slope of the Greater Caucasus has been illuminated in some authors' works differently.

Amongst element-mixtures, cadmium attracts attention with its high concentration in the ore and sulphide minerals. It was determined that, zinc sulphide (sphalerite) is both assemblage and carrier mineral of cadmium. Like in other pyrite deposits, the maximal concentration of indium element has been collected in the sulphides with quadruple coordination (sphalerite and chalcopyrite). Besides it, the high concentration of cadmium has been noted in the sphalerite which contains small amount of iron, but indium, on the contrary has been noticed in the dark colour diversity species of the mineral (marmatite). The concentration level isn't high in the sulphide minerals of tallium, gallium and germanium.

One of the typical mixture components of ore minerals-celenium has three assemblage minerals: pyrrhotine, pyrite and galenite. It has been determined that, out of copper-pyrrhotine ores chalcopyrite is the only leading sulphide mineral in which composition the quantity of tellur exceeds celenium.

Though galenite (200 g/t) and chalcopyrite (120 g/t) play the role of assemblage minerals for bismuth, the carrier mineral of the element is considered pyrrhotine.

In the wallrocks of pyrite-polymetal and copper-zinc-pyrrhotine deposits of the southern slope of the Greater Caucasus the chemical elements typical for the ore mass have been determined, it means that, the unified (a single) geochemical spectrum exists.

The geochemical research of Casdag deposit ore minerals has been carried out for the purpose of metallogenic and geochemical specialization of wallrocks. These researches define the perspectivity of pyrite, pyrite-polymetal, copper-pyrite, copper-pyrrhotine ore deposits of the Yurassic formation and their manifestations by giving geological mapping and planning information. The geochemical research of Casdag deposit ores allowed to specify the location areals of ore bodies. During these researches clayey shales, sandstone areas and their enrichment with pyrite porphyries have been detected. Rarely, pyritized quartz veinlets, ceritized fields with several cm. thickness have been found.

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GEOPHYSICAL METHODS FOR DETERMINATION PROPERTIES OF FROZEN SOILS

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Mechanical characteristics of soils – one of the most important parameters of the properties of soils used in the design and construction of buildings and engineering structures. Traditional types of tests are labour-consuming and time-consuming (one test can take one month), so a reliable and rapid determination of the parameters of the mechanical properties of frozen soils is a relevant area of research. In connection with this promising direction, it seems possible to use indirect geophysical methods to determine the properties of soils. The evaluation by geophysical methods of the physical and mechanical properties of frozen soils is indirect and less accurate than direct testing, but despite this, it allows us to characterize the massif in natural occurrence and provide long-term monitoring of changes in its stress-strain state.

Advantages of geophysical methods are the simplicity of the experiment and small time costs (measurement is not more than 1 minute). Many scientists were engaged in assessing mechanical properties of frozen soils with the help of geophysical methods.

There are four main geophysical methods for assessing mechanical properties of frozen soils: seismic-acoustic methods, methods of electrical prospecting, the method of georadiolocation and the radioisotope method. And the last two are used only to evaluate physical properties. The main methods are seismic-acoustic and electrical prospecting.

Electrical and seismic exploration are most widely used methods for assessing physical and mechanical properties. This is explained by the fact that it is during freezing that the physical properties of soils change sharply, and together with them the values of the specific electrical resistance and the speed of longitudinal waves [2].

Special experimental studies were carried out for investigation the correlation between mechanical and geophysical properties.

The electrical resistance was measured by the micro-VES method. Velocities of longitudinal waves are determined with the help of the UD2N-PB defectoscope. Spherical template indenter test was used to determine the equivalent cohesion.

Plots of the relations between geophysical characteristics and equivalent cohesion showed a good correlation. The greatest relationship is established between the electrical resistance and the equivalent cohesion for loam (correlation coefficient = 0.89) (Figure).

Regression equations are compiled to determine the equivalent cohesion, depending on the geophysical and physical properties of the soil.

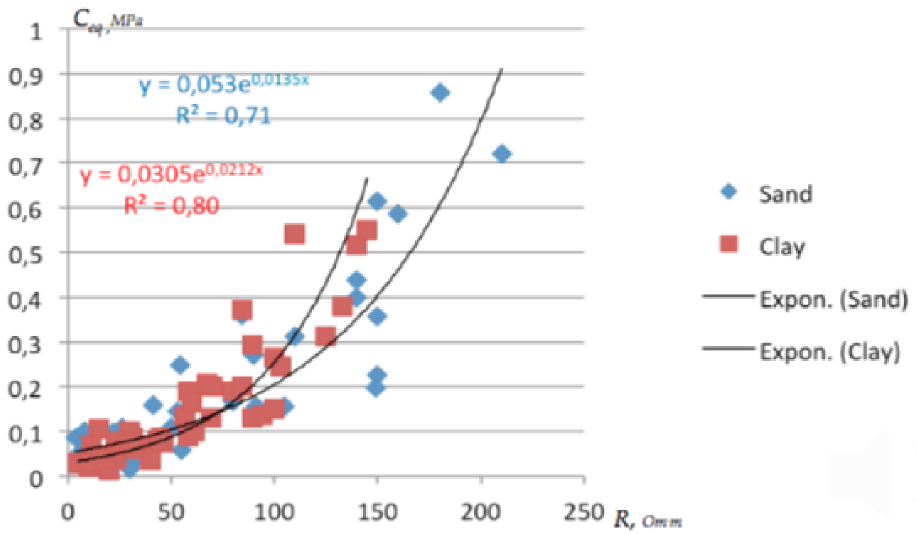

Fig. Relations between equivalent cohesion and electric resistivity (R) in sand and lean clay.

Thus, the evaluation of physical and mechanical properties of frozen soils by geophysical methods is possible and it is a promising scientific direction.

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THE BASIN MODELING RESEARCHES APPLYING IN THE KURA BASIN

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In recent years, basin modeling plays an important role in the study of oil and gas formation processes, their migrations in the sedimentary basin and their accumulation in the deposits.

The basin modeling is used for practical issues of petroleum geology such as to predict accumulations of oil and gas, to analyze anomalous pressure before drilling, to prognosis the composition of hydrocarbons, as well as to solve a number of fundamental issues of geology.

The oil and gas resources of industrial significance of the near future are located at great depths (6 km or more). Reducing costs for opening sediments in the depths requires the improvement of research methodology and minimizing the number of exploration wells. This is directly related to the acquisition of more detailed and accurate information about the geological structure and lithic-geochemical properties of oil-and-gas horizons at depths. In this regard, modeling studies have been selected for their relevance and have been found their application in oil and gas geology as in other areas. The results of the modeling allow for the study of being economically efficient and important to the industry during the evaluation of oilness and gasness at depths. Such modeling programs, they have been found their use in studying the oil and gas geosystems of the Kura basin with complex geological structure and in solving other issues.

1D, 2D, 3D modeling of the hydrocarbon system in the Kura basins made imagine about the evolution of the generation, migration and accumulation of hydrocarbons, gave an opportunity to determine reservoirs and traps with oil and gas, to prognosis the spatial condition of hydrocarbons and to estimate of their resources.

2D modeling of oil and gas complexes is designed to work with profiles; it is applied in which areas primary information is less; allows to evaluate the oil and gas complex using different types of kinetics, depending on the volume and quality of the initial geochemical data;the use of different algorithms in the modeling of thermodynamic processes in a layer has been enabled the detection of hydrocarbon migration paths and accurate estimation of possible hydrocarbon potential.

3D modeling of the oil and gas complex is determined by using structural maps and well data; according to data from mining geophysics and rock samples, the change of collector characteristics allows modeling of the distribution of facies in the terrigen cross.

It should be noted that the basin modeling researches in the Middle Kura basin was accomplished by M.A.Abrams and A.A.Narimanov. As the result of their researches was got information about geochemistry of source rocks, temperature of rocks and rock kinetics.

So that the thirty one Cretaceous to Middle Miocene conventional core samples were analyzed for total organic carbon. Total organic carbon values ranged from 0,08 % to 2,74 %.Samples with TOC values greater than 1.0 % were then analyzed with Rock-eval pyrolysis. Twelve samples contained sufficient total organic carbon for Rock-eval pyrolysis. Only the Oligocene-Miocene (Mykopian) core samples contained sufficient quantity and type of organic matter to generate large volumes of liquid hydrocarbons.

Level of organic maturity (LOM) is based on examination of T_{max} and vitrinite reflectance. Measured T_{max} values for Miocene core samples from the Evlakh-Agdzhabedi depression are between 420^0 C and 426^0 C, Oligocene-Miocene between 415^0 C and 432^0C, Eocene core samples between 426^0 C and 438^0 C.

The researches shows that Mykopian source rocks in the study area will behave like "average" type II marine source rocks, although no analyses on source rock kinetics were performed to determine the exact levels of maturity needed to transform kerogen into petroleum for Mykopian source rocks. For average marine source rocks, oil generation begin at a vitrinite reflectance of 0,5 % and reaches its maximum between 0,7 and 1.0%.

When analyzing the basin modeling results in Azerbaijan, it can be said that oil-gas formation processes cover a wide stratigraphic interval (including Jurassic-early Pliocene) and characterized by variability in space. The main factors that determine the processes of oil-gas formation are the history of development and the geological structure of the basin, its temperature regime and so on.

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4D SEISMIC TIME-SHIFT ANALYSIS

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Time-lapse of 4D seismic is widely used in oilfield industry to obtain dynamic response in the reservoir through time. Two (or more) 3D surveys are taken at different calendar times over the same reservoir to construct time-lapse result. The base survey is the initial survey and is usually before production starts in the field, and monitor survey is after years of production. By obtaining and processing base and monitor surveys in usual way, and accounting for differences between them production related changes in pressure thus saturation can be obtained. 4D seismic interpretation is an interesting integrated discipline of geophysics and reservoir engineering and is becoming progressively more popular. 4D seismic can be used to identify a variety of engineering related features and can thus help constrain the reservoir model. Here is a selection of possibilities:

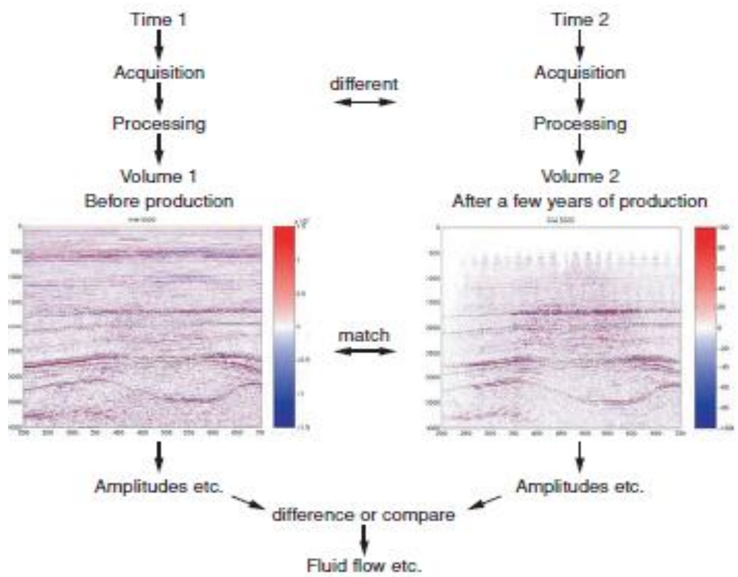

Fig. Description of base and monitor surveys in 4D seismics.

- Assessing zones of undrained or bypassed oil
- Defining barriers to flow or compartments
- Monitoring the movement of the oil-water contact or gas-oil contact
- Monitoring pressure depletion

• Assessing possible water encroachment or breakthrough
• Identifying high permeability channels
• Optimizing well placement
• Optimizing injector profile management

Rock and fluid physics models for stress dependency in the reservoir are important for interpretation and quantification of 4D signatures through depletion and injection schemes. These models re constructed by attributes obtained through processing. One of those attributes that are mostly used in analyzing 4D signatures is the time-shifts and its derivatives occur during depletion and injection. A time-shift is defined as:

$$\Delta TWT = TWT_{monitor} - TWT_{base} = 2Z\left[\frac{1}{V_{p.monitor}} - \frac{1}{V_{p.base}}\right]$$

where TWT is two-way time, Z is depth and Vp is velocity of a compressional wave.
To detect the time-shift, a baseline survey will be compared to one or more monitor surveys by detecting seismic attributes changes, such as travel-time differences of seismic waves, differences in acoustic impedance, reflection amplitude, and changes in seismic velocity. The real-life field study will be analyzed using Petrel, Raphson Russell, and Matlab software packages to build model and synthetic wavelets to prove theoretical research.

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ANALYSIS OF TECTONIC AND GEOMORPHOLOGICAL VARIATIONS USING GIS

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The SE-Carpathians are of a great interest to the geoscientists on the Eurasian plate. Firstly, the youngest volcano in the Carpathian Basin can be located here. The name of this volcano is the Csomád (Ciomadul). Secondly, the largest seismically active region is the Vrancea-zone in Europe. These areas are indications of the still ongoing subduction.

More geophysical and geodetic measurements were carried up in these regions (e.g. seismic, magnetotelluric, GPS-measurements, etc.) [1, 2, 3, 5]. We have decided to create a so called Seismotectonic Information System using GIS. For this reason surface deformation velocities of interferometric synthetic aperture radar (InSAR, e.g. ENVISAT), focal mechanism solutions (FMS), stress data derived from FMS and thematic maps (e.g. tectonic map) have been collected.

Quantum GIS (QGIS) was used in order to illustrate and analyse the data. Recently, we have tectonic maps, SRTM, focal mechanism solutions from 1979 until now, principal stress data derived from FMS [4] and archive ENVISAT-images. The figure presents the Seismotectonic Information System in QGIS.

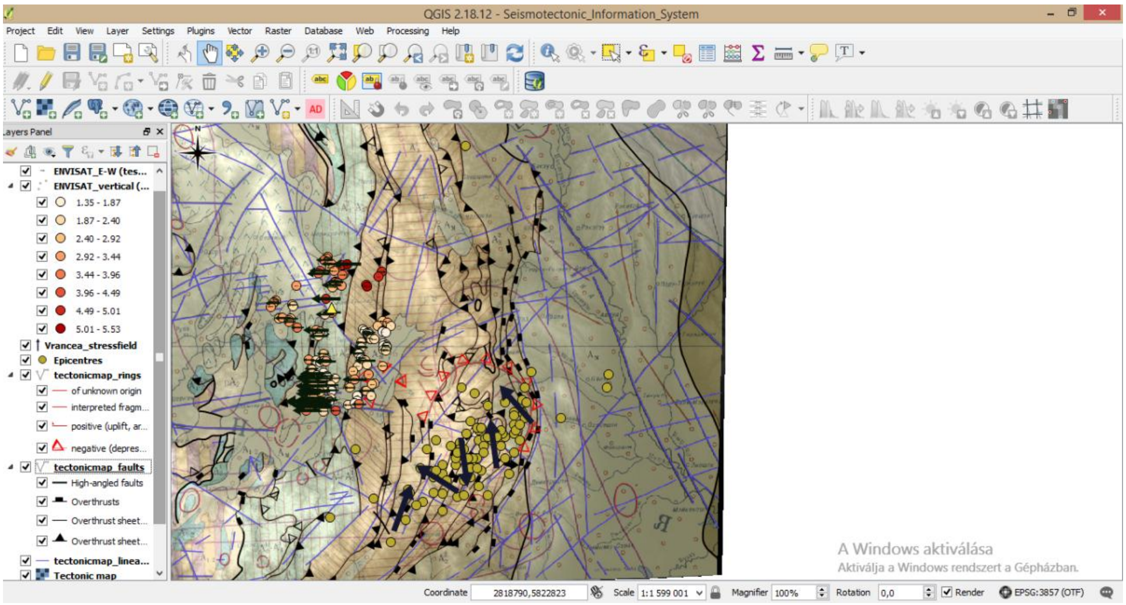

Fig. The current Seismotectonic Information System in the South-eastern Carpathians. The Csomád (Ciomadul) volcano is on the western part (yellow triangle). In the vicinity of Ciomadul, there are vertical- (red scale bar) and E-W (black arrows) velocities from ENVISAT-images. On the eastern part, there are epicentres (brown circles) and main stress field orientations (bold dark blue arrows) in the Vrancea-zone. The black lines with the black triangles indicate the overthrusts, violet lines present the lineaments and red curves illustrate the tectonic ring structures (anticline, syncline).

The aims of this information system are on the one hand to analyse simultaneously the different information of this area saved in the different thematic layers of the GIS and on the other hand to understand the surface deformation due to crustal-mantle processes comprehensively. Based on the data, it can be verified that the subduction is ongoing but the tectonic and geomorphological situation is complicated. Therefore, we need more measurements, more seismological data, more geomorphological information and other thematic maps (e.g. topographical maps, DEM, map of Neogene Quaternary Formations). Moreover, we have to control the quality and reliability of current data. We hope that this information system help us to comprehend the different processes and the surface deformation due to them in the SE-Carpathians.

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APPLYING OF SPECIAL SOFTWARE FOR INTEGRATED INTERPRETATION OF SEISMIC DATA (CDP) AND WELL LOGS AT EXPLORATION OF HC FIELDS

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In exploration of hydrocarbon (HC) fields a wide range of problems is solved through a comprehensive data-interpretation of seismic (CDP) and wells logs. There is a large number of interpretation applications in the software market. Each of them has its advantages and disadvantages, but most of them are oriented either to work on oil fields under production, or they include overabundant functionality, which makes software very cumbersome and unfriendly, and requires long training and the use of large hardware capacities.

A complex of proprietary software tools was developed at IPGG SB RAS (the authors have a direct relation to the development of them), adapted for the tasks of geologists working at the stage of prospecting and exploration of hydrocarbon fields. The application has module system including three main blocks: 1 – well logs interpretation, 2 – wave field simulation, 3 – seismic interpretation. All three modules are linked, however each one can function as a separate app.

This paper shows some capabilities of this software tools on the example of Ostanin oil and gas field located in the southeast of West Siberia. In the section of the West Siberian plate two structural levels are distinguished: a heterogeneous basement and a sedimentary cover. On the Ostanin field, hydrocarbon pools are confined to three stratigraphic complexes: 1 - basement rocks (Paleozoic Era) and weathering crust developed along them, 2 - sand layers of alluvial genesis (Middle Jurassic Epoch), 3 - sand layers of shallow-marine genesis (Upper Jurassic Epoch).

The Figure A shows a lithological-stratigraphic column of the Upper Jurassic deposits for the well№3, constructed in well logs interpretation module. A set of logs such as self-potential log (SP), resistivity log (GZ3), gamma-ray log (GR), neutron gamma log (NGR), acoustic transit-time log (dT), induction log (IL) were uploaded into the app. According to the logging interpretation four stratigraphic horizons (T, V, G, and B) are reliably distinguished in the Upper Jurassic deposits of the research area (see Figure (a)). There is a range of sand reservoirs with in the horizon V, in which a significant part of hydrocarbons in this field is concentrated. To assess the distribution of sedimentary bodies through the area, lithological-stratigraphic columns were constructed for all wells in the field and then combined into a series of correlation patterns. These patterns show correlation of stratigraphic units and sedimentary bodies from well to well.

On the next stage of the research using a step diagram of P-waves interval velocities constructed from the envelope curve of dT (acoustic transit-time log) and data of vertical seismic profiling (VSP), a stratified model of Upper Jurassic deposits was constructed.

These model was upload to the wave field simulation module, where a seismic signal the most similar to the field signal (the impulse from SEG-Y) was calculated and a full wave field was simulated for this part of the section (see Figure (b)).Comparison of the synthetic time section with the real one makes it possible to link reflective horizons to stratigraphic units reliably and to assess the influence of lithology on the parameters of the wave field.

The main purpose of seismic (CDP) data interpretation module is to trace reflective horizons and faults on time sections got from SEG-Y files and to construct two-dimensional numerical models of geological and geophysical data. At the loading stage, various special processing filters are used to normalize seismic data by amplitude and geometric parameters. Different methods of special processing of sections are also used to identify any local features or to improve the overall visualization of the wave field during interpretation.

Jurassic deposits in the southeast of Western Siberia are limited by the reflecting horizons II^a (top) and F_2 (bottom) [1]. The reflector II^a is confined to the bottom of the Bazhenov formation - the most reliable seismic marker in West Siberia. There for it becomes possible to apply a special procedure for minimizing the parameters of wave field inconsistencies in the intersecting sections. The horizon F_2 is formed on a rough, acoustically in homogeneous boundary between the pre-Jurassic basement and sedimentary cover and is complex for determination on the time sections. It requires the support of VSP data and scrupulous manual correlation. In addition, the horizon F_2 is intensively broken by faults, which were identified on sections. Constructing of surface gradient maps and rotating pallets approach available in the app were used to trace the faults through the area.

In Ostanin field in the basement deposits, hydrocarbon pools are confined to fractured reservoirs. There is an approach to use the effect of changing the spectral characteristics of a seismic impulse to detect zones of increased attenuation of certain frequencies in time sections undergone special processing [2]. It was found that on the research area the waves of frequency spectrum in limits of 30 Hz fade out in the zones of increased fracturing.

Structural maps were also constructed for the reflecting horizons of the sedimentary cover and then structural and paleotectonic analysis was carried out. As a result the thickness maps of each sand reservoir of the Upper Jurassic deposits were constructed in the grid calculator, integrated into the app, using thickness maps, structural maps, stratigraphic picks and statistical analysis.

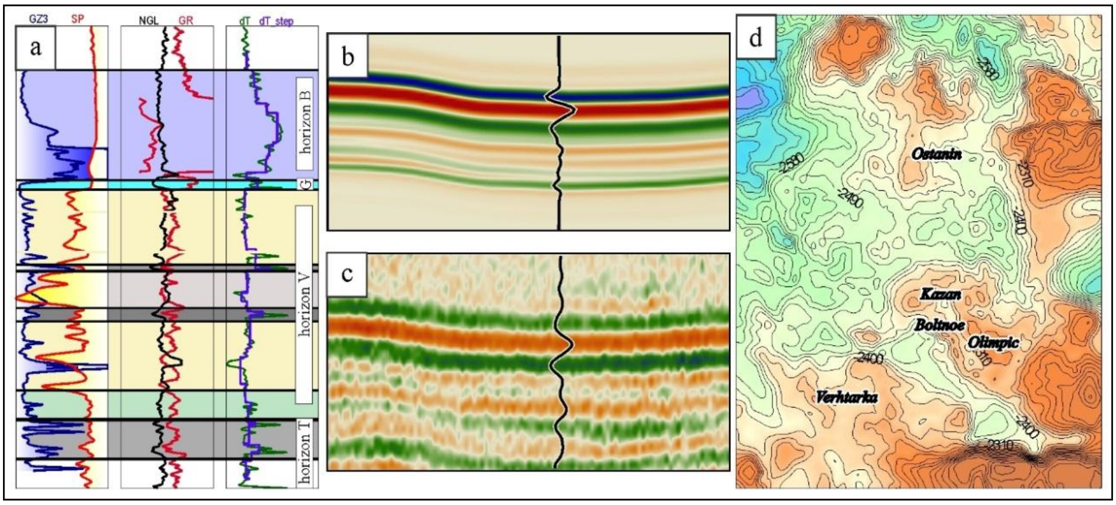

Fig. Well log pattern (a), synthetic (b) and real (c) time sections and structure map (d).

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CONTRIBUTION OF NMR TECHNOLOGY TO PETROPHYSICAL EVALUATION OF THE NEZZAZAT RESERVOIRS IN CENTERAL PROVINCE, GULF OF SUEZ, EGYPT

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The Gulf of Suez is considered as one of the most important petroleum provinces in Egypt and contains the Edfu and Saqqara oil fields located in the Central province of the Gulf of Suez. The Nezzazat reservoirs in the Gulf of Suez basin are well known for its great capability to store and produce significant volumes of hydrocarbons.

Nezzazat group was deposited in Cretaceous age and is subdivided into four formations named Raha, Abu Qada, Wata&Matulla. It consists of intercalations of shale, carbonates, sand and siltstone. Sandstone is glauconitic and pyritic in some intervals which have significant impact in reservoir properties. Carbonates are mainly limestone with minor percentage of dolomite and with high probability of iron carbonates minerals such as siderite ($FeCO_3$) or ankerite ($Ca(Mg, Fe)(CO_3)_2$), which gives very high peaks of density (> 2.87 g/cc).

Spectral gamma ray and photo electric logs indicate that shales of Nezzazat are consisting mainly of mixed layer, illite, in addition to some montmorillonite, chlorite, glauconite and mica. This reflects the complications in such shaly sand reservoir.

Two water saturation models (Archie and Dual Water models) were used to calculate water saturation. Where, in shales and shaly sand intervals within Nezzazat group; there are significant differences between the two models as Archie don't consider for shale effect.

The permeability of the Nezzazat reservoirs is evaluated using the Nuclear Magnetic Resonance (NMR technology) and formation pressure data in addition to the conventional logs and the results were calibrated using core data.

In this work, the Nezzazat reservoirs was investigated and evaluated using completesets of conventional and advanced logging techniques to understand the reservoir characteristics which have significant impact on economics of oil recovery.

GROUND-PENETRATING RADAR AND GEOELECTRICAL NUMERICAL MODELLING

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In this study a numerical modelling of a variety of geophysical problems will be realised. These models are high lighting the anomalies caused by the subsurface heterogeneities.

Geophysical modelling is a description of the response of a hypothetical geological structure by numerically calculated mathematical relations and a prediction of the expected values to be measured [3].

In the study, a comparison between the obtained results from the application of the ground penetrating radar and direct current resistivity methods on theoretical models will be realised.

In the ground radar method, modelling is a process of obtaining the electromagnetic wave field cross section (radargram) of an underground model defined by physical (dielectric coefficient, electrical conductivity and magnetic permeability) and geometrical parameters (Table) [2].

Table

Dielectric constant, conductivity and velocity values of some geological materials [2]

Material	Relative Dielectric Constant (ε_r)	Conductivity (σ S/m)	Velocity of Propagation (V, m/ns)
Air	1	0	0,3
Fresh water	80	0,5	0,16
Clay	5-40	2-1000	0,06
Silt	5-30	1-1000	0,07
Calcite	7,8-8,5	$5x10^{-10}$	0,11
Quartz	4,2-5	$3x10^{-4}$-$5x10^{-12}$	0,13-0,15
Limestone	4-8	0,5-2	0,12
Basalt	12	$8x10^{-6}$-0,025	0,09
Granite	4,6	0,01-1	0,13

In the direct current resistivity method 1-D modelling, according to the conductivity distribution, it is supposed that the underground is homogeneous and isotropic. For 2-Dmodelling, the conductivity distribution is supposed to be varying in x and z directions and to be constant in y direction. In 3-D modelling, according to the conductivity, it is supposed that the model is formed by homogeneous and isotropic cubes (Figure (a, b, c)) [1].

The realisation of the modelling for the direct current resistivity method it is needed to use a mathematical relation defining the model. In 1-Dmodelling this relation is

$$\emptyset = \frac{I}{2\pi}\int_0^{\infty} T(\lambda)J_0(\lambda a)d\lambda \quad (1)$$

Here, I is the current applied to the ground, T(λ)is the resistivity function, $J_0(\lambda a)$ is the first kind of Bessel Functionand∅ is the current intensity [1].

In this work, by using CST(Computer Simulation Technology) and MATLAB programs the application of Ground Penetrating Radar (GPR) and the direct current resistivity methods on different underground structure models will be realised. The models will be created similarly to geological structures. For this purpose, the underground layers, the faults and the anomalies that the ground waters can show will be observed in different models (Figure (d, e)).

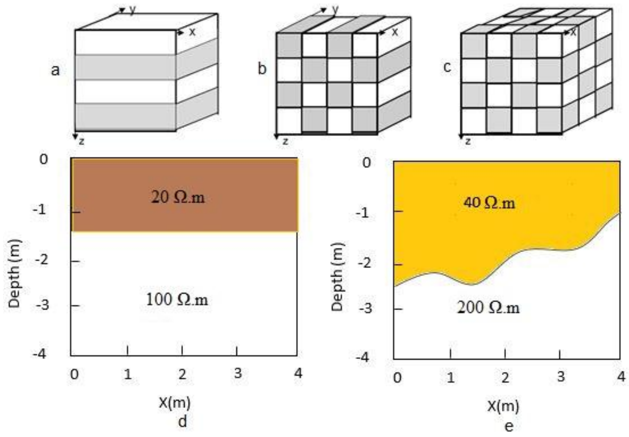

Fig. 1-DConductivity model (a), 2-DConductivity model (b), 3-DConductivity model (c), Example of underground models (d) and (e) [1].

Figure d shows a two-layered environment. The thickness of the top layer is 1.5 m and its resistivity is 20 Ω.m. The thickness of the the bottom layer is 2.5 m and its resistivity is 100 Ω.m.

Figure e shows a two-layered environment. The interfaces of the layers are inclined. The resistivity of the top layer is 40 Ω.m and the resistivity of the bottom layer is 200 Ω.m.

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STATIC RESERVOIR MODELING TO EVALUATE RESERVOIR QUALITY OF SAMANA SUK FORMATION OF MIDDLE INDUS BASIN, PAKISTAN

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Reservoir modeling is a typical job in developing and producing hydrocarbon fields as properties vary spatially due to number of geological heterogeneities. However, it is much important to do a comprehensive reservoir characterization to overcome the heterogeneities and take a clear insight of the area of petroleum interest. This study constructs a 3D static model for Samana Suk Formation, which is a hydrocarbon producing carbonate reservoir in various fields of Middle Indus Basin, Pakistan. To evaluate the reservoir, complete structural and petrophysical model is proposed using seismic volume, well logs and petrophysical core data. From seismic data structure is marked and horizon grids and polygons are created for 3D grid construction. Petrophysical properties are evaluated in detail from well log data which includes litho-facies analysis, calculation of shale volume, porosity and water saturation.These properties are upscaled and their spatial distribution between the wells in 3D grid is estimated using Sequential Gaussian Simulation (SGS) and Sequential Indicator Simulation (SIS) algorithms. SGS and SIS are commonly established stochastic simulation tools to obtain variogram reproduction.

Reservoir structural model shows that a dome-like structure is present which is a result of Indian Plate’s collision with Eurasian Plate and constant movement of Indian Plate towards the North. Hydrocarbons are trapped in this outward dipping dome-like structure. Reservoir petrophysical and litho-facies modeling revealed the Samana Suk Formation as a good to moderate reservoir. In interested zones, reservoir has high hydrocarbon potential having low volume of shale, high effective porosity and low water saturation. The results suggest the economical presence of hydrocarbons in the study area.

The 3D modeling of the reservoir illustrates petroleum prospect of the reservoir and it will assist to boost the hydrocarbon production. On the basis of the results, strategy should be planned for new well locations and maximum recovery of hydrocarbons from the field. This work proves the efficiency of the 3D static model for better understanding of spatial distribution of the properties in the field. Hence, it provides a framework for estimation of reservoir performance and production capabilities of Samana Suk reservoir in Middle Indus Basin, Pakistan.

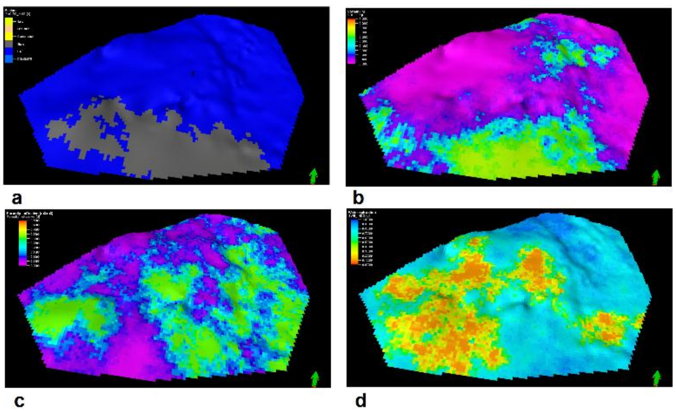

Fig. Facies analysis and petrophysical results of reservoir model (a) Facies (shale and limestone) (b) Shale volume distribution (c) Effective porosity (d) Water saturation.

MATLAB BASED GRAVITY DATA PROCESSING GUI: GRAVPACK

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Bouguer anomalies are achieved after applying certain corrections to the raw gravity data and represent gravitational attraction variations occurring due to density or shape differences within the Earth's crust. Since the anomalies are directly related to mass' properties, it is possible to make rough interpretations; however, Bouguer anomalies require numerous processing steps to extract desired information, most of the time. Filtering and analytical continuation processes are used to separate shallower and deeper bodies' anomalies from each other. Spectral analysis of Bouguer anomalies yields estimations about possible body depths from radially averaged power spectra. Boundary analysis techniques provide information about the extent of the bodies causing the anomalies. It is also possible to put the information from these steps together to create an underground model using various forward or inverse solution techniques.

GravPack is a Matlab based gravity data processing pack that is capable of applying all the processing steps mentioned above. The pack is put together with a graphical user interface (GUI) that is easy to use and operable by all levels of geophysical knowledge (Figure).

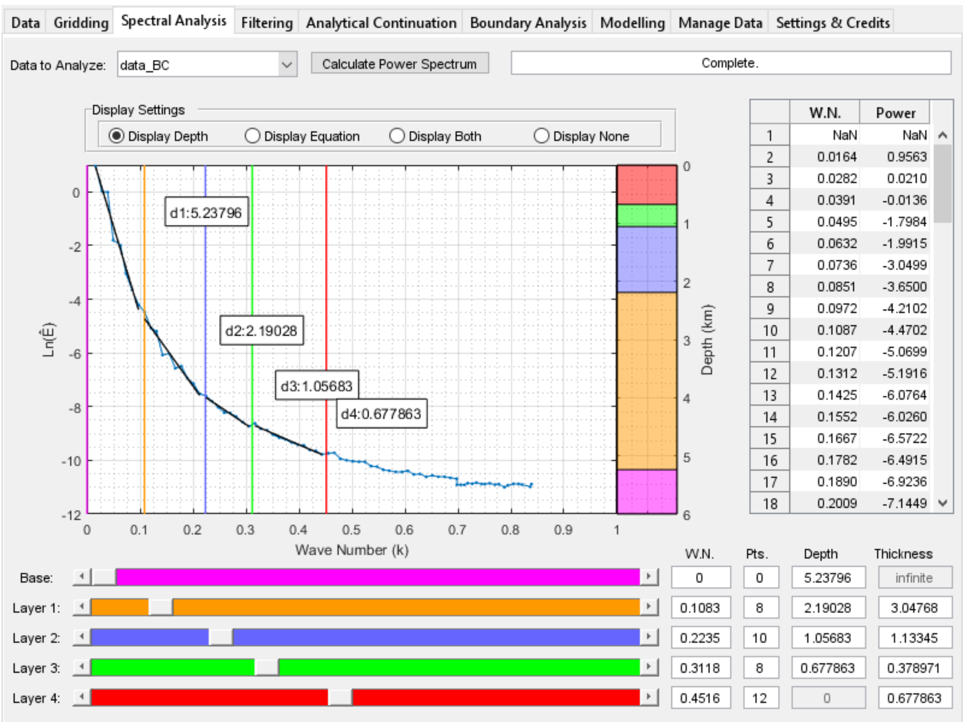

Fig. A screenshot from the GravPack GUI, presenting Spectral Analysis tab with depth estimations from Menderes Basin Bouguer gravity anomalies [4].

GravPack can read data from DAT files in which the data is separated in columns as coordinates and gravity data. Upon loading a data set into the program in Data tab, it is possible to convert decimal degree coordinates into UTM and raw data to Bouguer anomalies if altitude and terrain correction values are also present in the file. Gridding tab allows user to crop data from defined coordinates, define a sampling interval, resample the scattered data into a matrix and display these data. Spectral Analysis tab is used to calculate radially averaged power spectrum of the gridded Bouguer gravity data and calculate mean depths using [5] approximation (Figure). It is possible to filter the data using six different wavenumber intervals in Filtering tab. Analytical Continuation tab uses analytical continuation function written by [1] to apply upward or downward analytical continuation. Boundary analysis tab can be used to apply derivative related boundary analysis methods, [2] method and various image editing techniques in order to assess the extent of the bodies from the anomalies. If mean depth and approximate density differences are known for a body, Modelling tab can be used to calculate underground model of desired body using Vertical Prisms Method [3] within Modelling Tab. All the results from all the tabs can be saved in various file formats or deleted from Manage Data tab. GravPack also have translation support, which allows users to translate the application into desired language simply by translating an external XLSX file.

In this brief presentation, we used Bouguer gravity anomalies from Menderes Basin (Western Anatolia) which we sampled from Bouguer gravity anomalies prepared by [4] in order to show the capabilities of GravPack.

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PROCESSING BOUGUER GRAVITY ANOMALIES OF MENDERES BASIN (WESTERN ANATOLIA)

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Menderes Basin is exposed to strong tensional stress since the North Anatolian Fault (NAF) force the oceanic lithosphere at the north of the African Plate to subduct beneath Anatolian Plate. This tectonic setting led the formation of numerous grabens and large swarms of normal faults that still produce tectonic activities over the Western Anatolia. The grabens are now filled with alluviums carried by the rivers and the surrounding hills are made of igneous and metamorphic rocks [2], which create density variations throughout the area that are useful for gravity studies.

In this study, the Bouguer gravity anomalies retrieved from [3] are processed with GravPack; a gravity data processing pack based on Matlab which is developed by the authors (Figure).

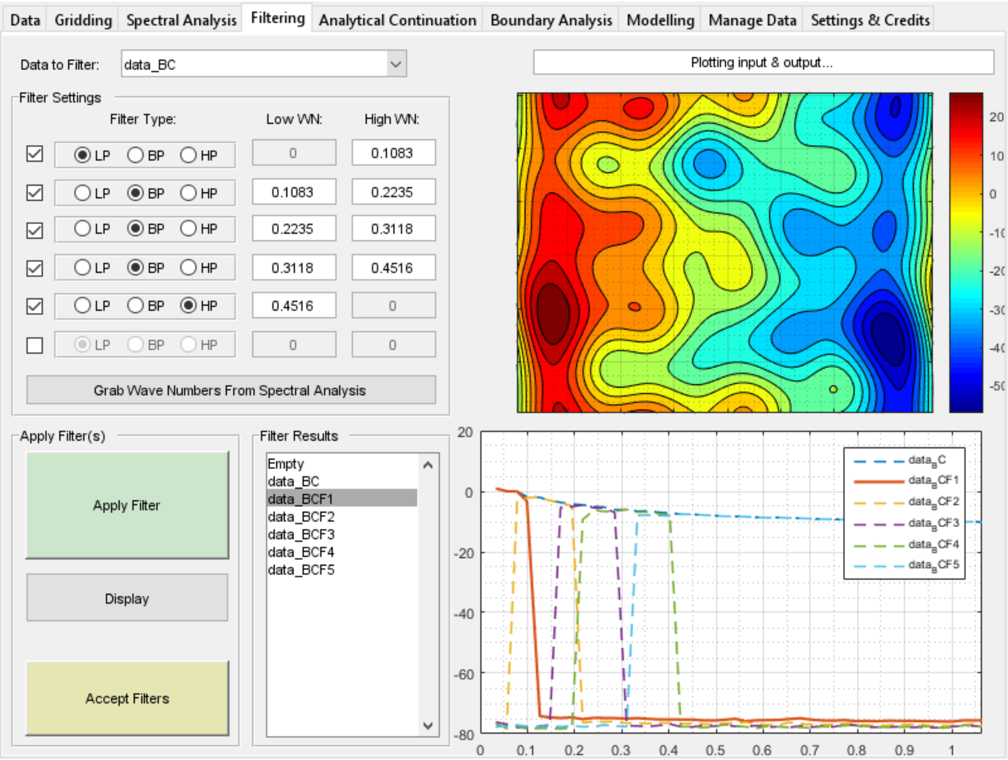

Fig. Results of low pass filtering process for cutting wavenumbers of deepest layer depth estimated by spectral analysis of Menderes Basin Bouguer gravity anomalies [3].

There are a total of 765 points picked from the Bouguer anomaly map of Turkey printed by [3] and the data is loaded into GravPack. First of all, the area of interest is selected from the Bouguer anomaly contours and the points fall within the boundaries of the area are gridded with a sampling interval of 1 kilometer. The gridded data then is used in spectral analysis process to estimate mean depth of layers using [4] approximation. The depths that are deeper than the sampling interval calculated to be about 5.24, 2.19 and 1.06 kilometers. Next, the cutting wavenumbers used to split the power spectrum to estimate layer depths are used in filtering process to separate the components of each layer from the total Bouguer anomaly. Analytical continuation and boundary analysis processes are also applied as a side study to examine the effects of shallower bodies and extent of anomalies. Finally, the input Bouguer anomaly data and filtered data are used in Modelling process using Vertical Prisms Method [1] to calculate approximate geometry in case of the source body being a homogenous layer boundary.

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FREQUENCY-DEPENDENT P WAVE ATTENUATION AND DISPERSION TO ASSESS THE LOW GAS SATURATION IN THE UPPER INDUS BASIN PAKISTAN

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The renowned theory of poroelasticity presented by [1] presume the mechanisms of P wave dispersion and attenuation in partially saturated reservoirs because of wave induced fluid flow (WIFF) at macroscopic scale. The macroscopic sacle is defined by the central wavelengths. However, there arescientific studies to exhibit that this phenomenon is unable to account the frequency dependent seismic attenuation- dispersion in partially saturated clastic reservoirs [4]. Remarkably, there are variouse evidences that the fluid heteorgeneties at mesoscopic scale are capable to demonstarte the phenomenon of seismic attenuation-dispersion at seismic frequencies range. These heterogeneities at mesoscopic scale are linked with the pore fluid (liquid/gas) composition [3].

The prime aim of recent modelling is to analyse the outcomes of horizontal distribution of immiscible binary phase fluids patterns and their saturations in the sedimentary rock. The phenomenon of velocity dispersion and wave dissipation is investigated at mesoscopic scale in the Cambrian Khewra Sandstone because of WIFF.

In this study we have considered a periodic layer of sedimentary media (two layer case 1 and 2) and composed of thickness (d) and period (d_1+d_2). We have used the complex modulus given by [5] for a compressional wave travelling perpendicular to the sedimentary strata. This complex modulus is given by the relation:

$$E = \left[\frac{1}{E_0} + \frac{2(r_2 - r_1)}{i\omega(d_1 + d_2)(I_1 + I_2)} \right]^{-1} \tag{1}$$

The phase velocity (υ_P) and attenuation (Q^{-1}) are measured by using the following mathematical relation and given by Carcione and Picotti (2006).

$$\upsilon_P = \left[\mathrm{Re}\left(\frac{1}{\upsilon} \right) \right]^{-1} \tag{2}$$

and

$$Q^{-1} = \tan\theta = \left[\frac{\mathrm{Im}(\upsilon^2)}{\mathrm{Re}(\upsilon^2)} \right] \tag{3}$$

where the real and imaginary parts are represented by Im and Re respectively.

The case study taken for this analysis is partially saturated with bi-phasic fluids and is commonly dispersed in the Upper and the Central Indus Basin of Pakistan. First the petrophysical evaluation carried out to characterize the reservoir features of the Cambrian rock and then equation [2] is used to find the seismic parameters as a function of fluid saturation. The phase velocity and attenuation also called inverse quality factor (Q^{-1}) curves for selected frequencies are plotted as a function of gas/water saturations are described in Figure.

These attenuation and dispersion curves behave in a same manner as saturation of gas changes. It can be depicted (Figure) that the maximal compressional velocity dispersion (increase of seismic velocity as a function frequency) and attenuation due to WIFF happen at low gas saturation (13 %).

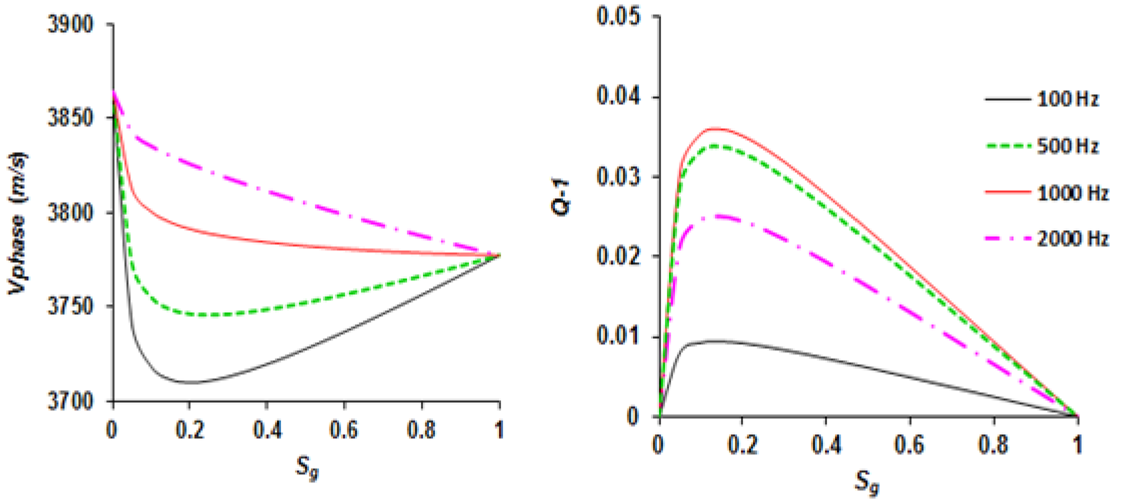

Fig. The Phase velocity and inverse quality factor (attenuation) are plotted versus gas saturation at different frequencies. It is noted that the maximum change in velocity and inverse quality factor is at small gas saturation (about~ 13 %). Thus these two attributes can be used at potential indicators to indicate the low gas saturated reservoirs.

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USING GOOGLE EARTH IN NEOTECTONIC STUDIES

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To create a GIS-project for geological research, an alternative program in addition to ArcGIS, MapInfo, etc. Google Earth may be used. The main technical advantages of the program are open access of software, cross-platform KMZ file format, its compactness. So, information exchange with colleagues can be easier and faster, and this contributes to improving the quality of scientific communication in general.

As in other GIS-systems, in Google Earth it is possible to use thematic layers with coordinate referencing which allows to make regional geological interpretations geographically. Figure 1 shows a map of gravity anomalies of the Crimean-Caucasus region).

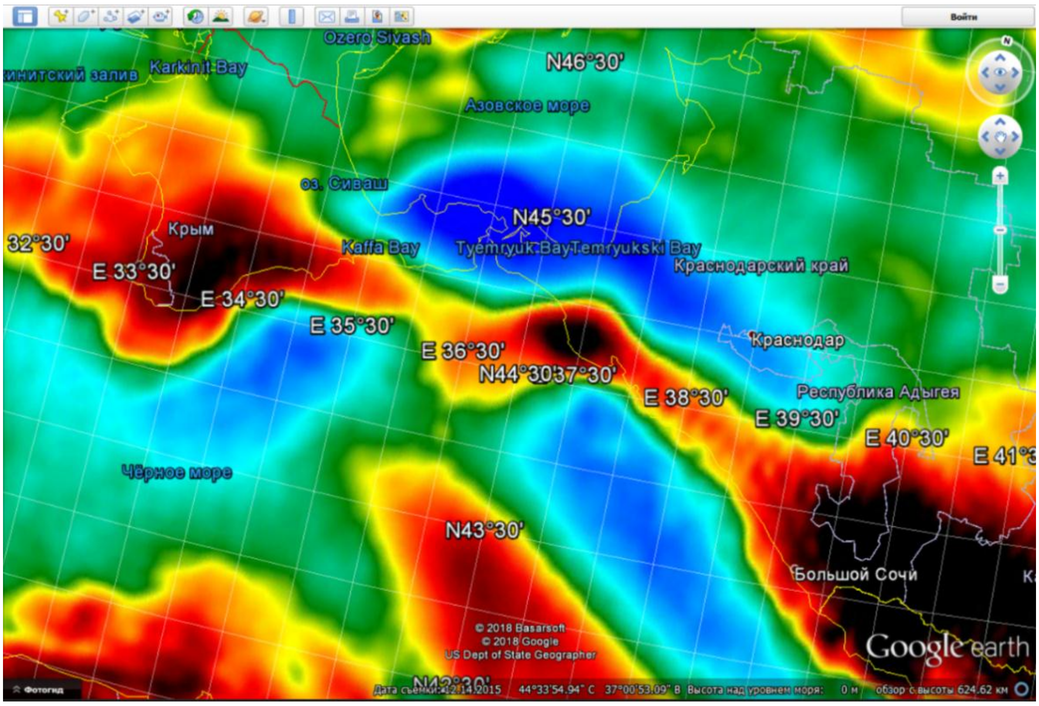

Fig. 1. Map of gravity field in the Crimean-Caucasus region (work space of the program).

One of the most important advantage of the Google Earth program applying directly to geology and particularly to structural geology is a high accuracy of the data as well as possibility of online zooming. As an instance, it is possible to trace a fault very precisely, and dynamically zoom an area of interest if needed.

Another advantage of Google Earth in neotectonic studies is using relief tool as well as imposition of geological and other rasters on the topography. This advantage is directly related to making geological-geomorphological profiles. A classical method in geomorphology is creating of longitudinal profiles of river terraces. The use of the 3D survey allows geologists to make effective cross-sectional profile lines. Creating of series of profiles which cross a valley makes possible an identification of the terrace edge with high accuracy. Another application of Google Earth relief tool in geomorphological studies is a reconstruction of hilltop surface. In this case, a scientist draws profile lines along the adjacent ridges. It makes possible to reconstruct ancient surfaces which were uplifted due to tectonic movements and are now separated by scarps from each other. A magnitude of an uplift may be estimated on the basis of a magnitude of erosion. This idea could be illustrated with the profile of the ridge in the North-Western Caucasus (Figure 2), where the blue line is the profile along the thalweg as the local basis of erosion, the red lines are the profile along the ridge. On this profile three hilltop surfaces separated by scarps are clearly distinguished. They can serve as an evidence of different rates of uplift of these ridge sections.

Thus, in this short review some features of Google Earth applying to neotectonics are demonstrated.

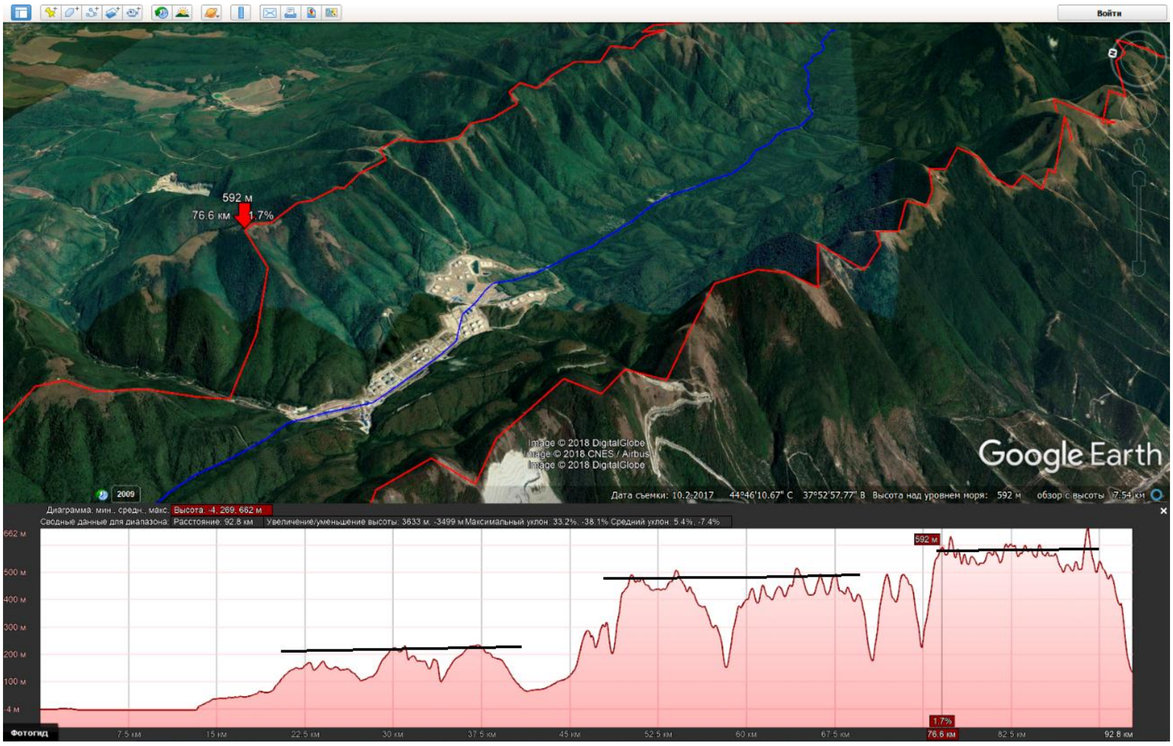

Fig. 2. Profile of dividing surfaces in the North-Western Caucasus.

STUDYING OF EXOGENIC GEOLOGICAL PROCESSES IN THE COASTAL ZONE OF LAKE GYRMYZY BY THE METHOD OF ELECTRICAL PROSPECTING

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The Lake Gyrmyzy is located in a southeast part of Baku. In order to study the exogenic geological processes (EGP) in the coastal zone of the lake, electric prospecting works was carried out by the method of Vertical Electric Sounding (VES) in scale 1:5000. Preliminary for Geophysical research was selected profile (I-I), in the northeast direction

The geological tasks set for geophysical surveys:

- Detailed separation of the geological cross section to a depth of 40 m;
- Identification of alleged discontinuous violations;
- Determining the thickness of lithologic layers;

Field geophysical works were carried out with the of geophysical equipment ERA-MAX. As a result of field works the estimated litological-geophysical cross section on a profile I-I was structured. In the structured cross section layers of different lithologic structure and thickness are revealed, their angle of incidences and also electrical resistivity are determined (e.r) (Fig.). In the upper part of the cross section identified deluvial sediments, lithologically composed of clays and clays with sand, of thickness 1-6 m, with, electrical resistivity 10-20 Om•m. The prevalence of this layer in the study area is intermittent. The second layer in the lithologically, presumably consists of clays. Layer thickness along strike changes frequently in the range of 2-7 m, electrical resistivity, with

2-5 Om•m. Identified the third layer with a capacity of 2-8 m, composed of clay alternating thin layers of Sands with.uh.20-25 Om•m. This layer in the cross section is intermittent, sometimes represented by separated lenses.

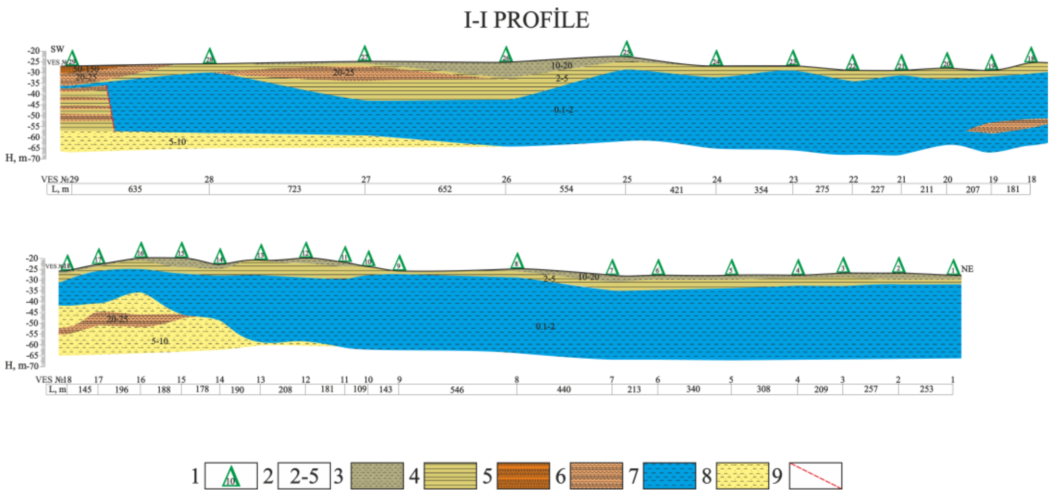

Fig. Based on the results of geophysical studies, the proposed lithological-geophysical cross section of the profile 1-1 is structured. (horizontal scale 1 : 5000) 1-VES Points and their Numbers; 2-The electrical resistivity of the lithological layers; 3-Diluvial sandy-clayey sediments of the cover; 4-layer of clay; 5-alternation of clay with thin layers of sand; 6-alternation of clays with sandstones; 7-clay layer with high level of mineralization and humidity; 8-clay layer with sand content; 9-discontinuous violations revealed by the results of geophysical studies.

In the South-Eastern edge of the profile revealed a layer thickness of 0.5-3 m, with electrical resistivity 50-150 Om•m, presumably composed of clays alternating with sandstones. In the context of continuously traced clay with high humidity and salinity with, electrical resistivity 0.1-2 Om•m. The thickness of this formation varies in the range of 20-32 m. the last layer identified in the South-Western and Central part of the cross section, in lithologically presumably consists of clays with Sands. The thickness of this layer varies in the range of 1-9 m, electrical resistivity 5-10 Om•m. It should be noted that, in the Central and South-Western part of the cross section, the power of this layer is greatly increased. As can be seen from the proposed lithological and geophysical cross section, sedimentation of deposits is complex and intermittent. In the South-Western part of the cross section, the alleged rupture was revealed. Or it is a lithofacial frontier.

Short results of geophysical studies:

-as a result of geophysical studies it was found that the geological cross section of the area of work is mainly composed of clays, clays with layers of sand and clay Sands

-it is assumed that the exogenous geological processes will expand in the range of the profile, where discontinuous violations are revealed;

-it should be noted that the accumulation of sediments in the sediment study area is rather complex and intermittent.

On the area of research it was found that the layers of the composing geological cross section are mainly located, horizontal. Based on this, it can be assumed that in this area there is a favorable environment for the development of pseudo karsts.

DIGITAL CORRECTION OF GEOPHONE RECORDS FOR RECOVERY OF THE SIGNAL LOW-FREQUENCY COMPONENT

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Lately the range of seismic applications is rapidly expanding. In addition to traditional areas - seismology and exploration seismic surveys, seismic measurements are increasingly used in the field of monitoring systems of industrial facilities [1] (including reservoir monitoring), in security systems and many other applications. In this case, there is a trend to use low-frequency information in seismic data processing [2].

At the moment, the most common sensors used to record seismic signals are geophones (electrodynamic seismometers with one signal coil). Due to the simplicity of the construction and well-established production technology geophones are extremely reliable and provide high metrological characteristics. In addition, they are significantly cheaper than other types of seismometers which is important when using a large number of registration points. Because of this, in addition to seismic exploration, geophones are increasingly used in tasks related to seismic and microseismic monitoring. The main obstacle for using them in many areas is a relatively high natural frequency (about of 10-15 Hz).

However, the situation began to change dramatically in recent years. First, there has been a huge progress in the development and production of geophones: modifications have appeared with frequencies of the natural frequency up to 4.5-5 Hz, and also have an increased sensitivity of about 100 V/m/s. Secondly, in most applications of local microseismic monitoring we have signals with frequency rabge above 0.5-1 Hz (for example, reservoir monitoring). At the same time, the required low frequencies are still below the working bandwidth of the standard geophone.

In this situation one can use low-frequency deconvolution method (LFD) [3], which allows recovering the signals with frequencies below the sensor working bandwidth. Digital signal processing can be used for this purpose. In this case, the record of the high-frequency geophone is converted into a record of a "virtual" low-frequency seismometer with naturalfrequency being 1-2 orders lower. To implement the procedure it is necessary to know only two dynamic parameters of geophone (natural frequency and a damping coefficient), which can be taken from its technical description, or obtained by calibration.

The main limitation of the method is the presence of instrumental noise (first of all, the amplifier's noise) which prevents recovery of arbitrarily low frequencies. At very low frequencies the sensor sensitivity becomes to small so that the signal is completely covered by instrument noise. Thus, the problem arises of dividing the recovered useful low-frequency signal and parasitic low-frequency instrument noise, which increases with the virtual decrease in the natural frequency of the short-period seismometer.

Figure (a) shows an example of recording a distant low-frequency earthquake by a geophone (red line), as well as the result of its processing by the LFD-algorithm to a frequencyvalue of 1 Hz (blue line). Figure (b) shows the corresponding amplitude spectra.

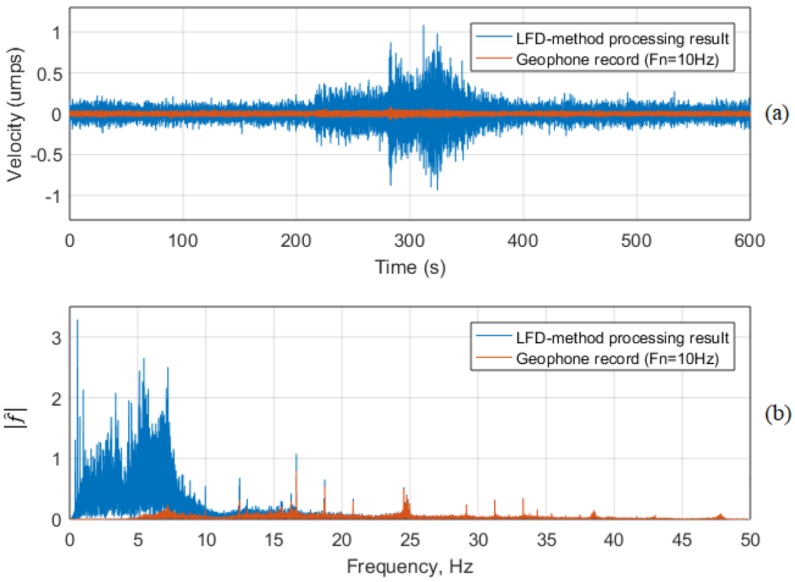

Fig. Example of recording a low-frequency earthquake (b) by a geophone (red line), as well as the result of its processing by the LFD-algorithm to a frequency value of 1 Hz (blue line). The corresponding amplitude spectra (b).

This example illustrates the operation of the LFD-algorithm. It should be noted that the result of processing the geophone record by the LFD-algorithm is identical to the recording of "control" seismometer with natural frequency 1 Hz installed at the same registration point.

In this paper, an improved low-frequency deconvolution algorithm implemented in the frequency domain is described. Results of its approbation on synthetic and real data, as well as comparisons with other existing implementations, are presented. In addition, the accuracy of the method is considered depending on the error in setting the factory characteristics of geophones.

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THE GEOCHEMICAL FEATURES OF THE BLACK SHALES OF DURUJA ZONE OF THE GREATER CAUCASUS AND THEIR PERSPECTIVITY OF THE ORE MINERALIZATION

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A number of geochemical anomalous zones with heavy metal (manifestations, ore mineralization and etcestra) have been found in the black shales along the Duruja structure and the properties of the gathering mechanism of metals have been defined in the zones. Their gathering is explained both by the sorbtion process of rock forming minerals and organic matters together with iron sulphides. On the other hand, it is explained by the oxidation-reduction activity and acid-alcaline barriers.

At the same time, the manifestation of the ore concentrations in the black shales can be based as a result of interactivity of surface and underground waters in the eodiagenesis and catagenesis stages.

Ore-forming solutions compose heterogenous system in reality, being accompanied by the solution and gas solvents are considered the universal solvent in the extraction of metals from their primary source, in carrying them and in the formation of anomalous zones, more correctly, ore containing layers.

The experimental researches of the testing samples taken from Duruja zone indicate that, black shales have strong sorbtion features and this is accompanied by the fact that, sorbtion power is different to various elements. But, sorbtion properties of the black shales show diversity in every respect, depending on the geological condition of the region where it has spread, mineralogical and chemical composition of shales and the type of compounds which it had contained.

Out of clay minerals the montmorillonite dominates in the black shales and it has the highest sorbtion capacity (volume) (80-150 mgekv/100 q).The high sorbtion capacity of mortmorillonite is explained with the fact that ion exchange in its crystals occurs not only through the exterior surface, but also in the cavities between tetraedrical layers of silicium oxide within the crystalline grid.

These peculiarities in the formation of elements' concentration in black shales leads to the differentiation of elements and this can be estimated as a leading geochemical criterion in the investigation and exploration work. The mixtures of the elements such as Mo,Se,Te and Ln which are higher than their clarks (percent abundance of elements) have been found out in the ore minerals of the studied zones.

As the specific mineral of these elements haven't been defined in the ores, their presence in the ore samples can be explained with the fact of their substituiting sulphur in the composition of sulphide in a form of isomorph.

The detection of the indicated element mixtures is of great importance from the point of view of the possibility of using ores in the future, considerably increasing their price.

So, the detection of the high concentration of the above-mentioned element mixtures in the zones accompanied by the impregnated and veinlet-impregnated type textured mineralization where the minerals with epigenetic nature developed is of great importance from the point of view of conducting investigation and exploration work for the purpose of increasing perspectivity of these zones.

IMPROVING METHODS OF RESERVOIR PARAMETERS DETERMINATION WITH HYDRODYNAMIC ANALYSIS

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It is known that for the construction of accurate 3D hydrodynamic models at the design stage and further development of reservoir, reliable input data are required. In particular, the issue of obtaining information on the value of formation permeability in vertical direction (perpendicular to the bedding) remains topical.

One of the promising methods of hydrodynamic well testing for evaluating vertical permeability of beds and layered heterogeneity of filtration properties are 3D profile interference test and vertical interference test.

The 3D profile interference test procedure uses two horizontal wells – one at the top of the formation, other at the bottom, with disengagement of horizontal well bores. Any of the wells can be regarded as both injection and responding.

Profile interference test data is processed with the help of graphical-analytical technique based on improved analytical and numerical methods.

Vertical interference test procedure involves creating response in formation and recording it within a single vertical well, creating two intervals of perforation – at the top and bottom of formation. Perforation intervals are isolated from each other by packer, fluid production is operated from the lower interval. Pressure change over time is measured in active and reactive intervals.

Vertical interference test data is processed by solving inverse problem – problem of determining formation filtration properties by using obtained well test data. The inverse problem is formulated in optimization formulation, and solved using methods of optimal control theory. For vertical interference test, the goal of solving the inverse problem is to determine the values of vertical and horizontal permeabilities of the formation or of its part zones.

Features of inverse problem solution are studied, with the help of developed and software-implemented algorithm.

The presentation will demonstrate possibility of combined determination of the lateral and vertical formation permeability for a different configurations of layered and zonal heterogeneity of formation, taking into account skin zone effect.

IMPROVED RESERVOIRS ZONES DETERMINATION IN PALEOZOIC FORMATIONS OF NUROL DEPRESSION (TOMSK OBLAST)

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Currently in the Western Siberia both search and evaluation of oil and gas promising Paleozoic formations is a very urgent problem due to necessity to increase the potential of the Cretaceous and Jurassic fields by deeper sources of hydrocarbons.

The main reason of this interest is to increase number of oil and gas Paleozoic fields discovered annually. They are confined to rocks of a wide stratigraphic range.

Therefore, the purpose of the research is to determine improved reservoirs zones in Paleozoic formations of Nurol depression [1].

The object of the research is located in the Parabelsky District of Tomsk Oblast. Pre-Jurassic deposits are the main development objects with high operational parameters. There are two lithological objects: carbonate-clay-siliceous deposits of crust of weathering (M pay) and Devonian rocks of the carbonate basement (M1 pay).

Locally, there is absence of impermeable barrier between M and M1 pays according to available data. Thus, the reservoir of these pays is united, hydrodynamically joined.

The complex structure of the area is the result of active tectonic evolution on which the Hercynian cycle of tectogenesis and the early Triassic riftogenesis were reflected.

The deposits are composed of Devonian organic limestones and terrigenous-carbonate rocks. The second rocks were forming in shallow and marine conditions.

Carbonate rocks are one of the most difficult to model. Seismic attributes are used to predict improved reservoirs zones distribution. Attributes are directly connected with the seismic parameters V_s, V_p, ρ (primary wave velocity, secondary wave velocity, density respectively) [2].

Petro-elastic modeling is one of the most relevant methods to establish a connection between attributes and predictive parameters. This method allows to determine the dependences between petrophysical properties of rocks and parameters obtained from seismic survey, geophysical well logging and laboratory study [2].

The results of interpretation of seismic data were provided for the research. The Authors of the work carried out the analysis of the obtained information and well data (core description, geophysical well logging and well test results).

The seismic pulse configuration was predicted according to seismic data. The shape of the reflected wave describes integral characteristic of geology rock-layer associations. Considering this, it is possible to establish a correlation between seismic attributes (energy, dispersion, coherence, etc.) and productive parameters. From seismic survey, vertical and lateral waveform changing have to reflect not only the variability of the facies and tectonic environments, but also have to indicate the spatial position and reservoir influence boundaries.

Reference wells were used according to seismic data. These wells entered M and M1 pays to assess reservoir rocks qualitatively.

Seven types of rocks of reservoir with gas, oil, gas and oil saturation were identified according to seismic data and core description. Considering this, the rocks distribution map through the territory of the object was constructed.

The obtained results were compared with the results of the previous research of facial relationship. In deposits of lithofacie of progressive bank there is absence of oil inflow, but there are high indicators of the gas and condensate influx. In deposits of lithofacie of barrier reefs there is anhydrous hydrocarbon saturation with relatively high gas and condensate productive rate. In deposits of lithofacie of reef platform there is oil and gas saturation.

In conclusion, the conducted researches confirm that combined researches of well data and field geophysical survey allow to get the concept of the geological structure of the territory and to predict the most promising zones of improved reservoirs.

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INTRODUCTION OF METHODS FOR DIGITAL PROCESSING AND INTERPRETATION OF WELL LOG DATA AT THE DEPARTMENT OF APPLIED GEOPHYSICS AND GEOINFORMATICS OF THE GROZNY STATE OIL TECHNICAL UNIVERSITY

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Any sphere of activity in modern society is difficult to imagine without information technology / technology and information systems.

The technology of geological prospecting, and in particular geophysical methods of well research, is closely connected with modern geoinformation technologies.

In Russia, the peak in the development and implementation of geoinformation systems in the recording, processing and interpretation of geophysical survey data occurred in the mid-1990s and early 2000s. The Grozny State Petroleum Institute at that time, because of the well-known events that took place in the country, did not have the opportunity to introduce modern computer technologies into the educational and research process.

But with the restoration of the university, the Department of Applied Geophysics and Geoinformatics began to look for ways to solve this problem and fill the gap.

The management of the university bought software and hardware, as well as former graduates of the department were transferred to the department on a no-cost basis Automated systems for use in research and teaching and educational process.

One of which is an automated system for processing and interpreting the results of geophysical well studies (ASOIGIS). Gintel - development of graduates of the STI Afanasyev Vitaly Sergeevich and Sergei Vitalievich [1]

With the help of this software product, materials from the geological information base on the Lower Cretaceous sediments of the Tersko-Sunzhenskaya oil and gas area (TSNO) were processed.

This system uses fundamentally new approaches to the implementation of automated interpretation of GIS data, including the principles of visual processing of information, a generalized algorithm for assessing the properties of rocks in the borehole section and interpretation modeling.

The results of the laboratory analysis of more than 1000 core samples from hundreds of wells drilled on the bottom chalk of TSNO were digitized and curves of dependences were plotted according to the proposed method and the location of points on the planes along theoretical curves indicated the applicability of these dependencies for our rocks [2, 3].

Analysis of the results and evaluation of reliability showed high efficiency of the method and reliability of the results.

In the following years, a system of automated visual interpretation of Gintel well logging results was also used to process and interpret GIS data in the mining geothermal well DGT 1. Speaking about the technology itself, the interpretation of GIS data from such non-deep deposits settled on TERRA technology.

The basis of TERRA technology is a method description file compiled by the user on specialized panels, and a software module compiled in LC language. The method description file specifies the interpretation scheme and its tuning to specific geological conditions, and the software module describes the complete algorithm for interpreting the GIS data on a separate depth quantum along the wellbore.

TERRA technology allows to perform batch processing of a given array of wells taking into account a new view of the deposit formed during the refinement of petrophysical models used in interpretation schemes.

The interface of TERRA technology actively interacts with the "Chart Wizard". This allows, for example, in the process of refining the reference strata, to focus not on numbers, but on the visual "removal" of the reference stratum.

Based on the interpretation, gamma methods were used to calculate the double difference parameter iGR = (GR-GRmin) / (GRmax-GRmin).

After the program has correctly passed the processing phase, the final result was generated ie. a results processing board with a geological model and a lithologic column along the entire treated area.

The evaluation of the reliability of the results of the interpretation of the GIS obtained using the chosen technique was also carried out by comparison with laboratory analysis data, and in particular with the results of the well testing, as a result of which an industrial inflow of thermal water was obtained opposite the proposed productive formation. Based on the achieved result, it can be concluded that the TERRA processing technology used as a basis gives reliable results and is recommended for further use in such cases [4].

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ANALYSIS OF SEDIMENTATION-DIAGENESIS OF PRODUCTIVE AND RED SERIES BY GEOCHEMICAL CRITERIA (CASE STUDY THE ABSHERON-PRIBALCHAN UPLIFTS ZONE)

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In presentation on the example of Absheron-Pribalkhan tectonic zone of uplifts attempted paleo-reconstruction of conditions of forming of low Pliocene sediments in the

South Caspian basin (SCB) - Productive (PS) and Red (RS) series, using the complex is well known geochemical criteria: the ratio of the oxides (Fe_2O_3/FeO, CaO/MgO, Na_2O/K_2O, SiO_2/Al_2O_3, TiO_2/Al_2O_3, Fe_2O_3/MnO, K_2O/Al_2O_3) and trace elements (Sr/Ba, Mn/Ni, Ti/Mn, V/Ni и U/Th).

Absheron-Pribalhan tectonic zone of uplifts is the eastern extension of the Greater Caucasus Orogenic Belt. This zone stretching from the Absheron peninsula in the west to the Cheleken peninsula in the east for a distance of about 275 km is the main structural element of the northern part of the South Caspian basin that separates the Middle and South Caspian.

Acording to results of analyses of the formation conditions of PS and RS its common and distinctive features were identified.

The generality of the conditions of sedimentation and subsequent diagenetic processes in PS and RS is confirmed by comparing the mean values in the oxides (Figure (a)) and trace elements (Figure (b)).

It has been established that PS has a relatively limited source of nutrition, characterized by zircon, rutile and quartz, whereas heavy mineral association in rocks of RS is more diverse and is usually represented by zircon, titanium, garnet, tourmaline and amphibole.

One of the obvious signs of differences between PS and RS rocks is their characteristic red-brown coloration. It was justified diagenetic nature of brown-red colour of RS. The relatively more oxidizing conditions of sedimentation PS compared to RS was established.

Geochemical parameters of rocks are in good agreement with the geochemical characteristics of their organic constituent. So, in the complex of geochemical parameters (Fe_2O_3/FeO, Fe_2O_3/MnO, V/Ni), the PS basin was characterized by more oxidative conditions, in comparison with the basin of the RS, which is confirmed by the values of the corresponding geochemical parameters (S_3 and OI) of core samples pyrolysis (Table).

The obtained results are confirmed the existing ideas about the conditions for the formation of the Lower Pliocene deposits in the SCB as a whole. In particular, the existence of unfavorable geochemical conditions for the formation of high hydrocarbon potential of rocks in the Lower Pliocene basin has been confirmed (see table).

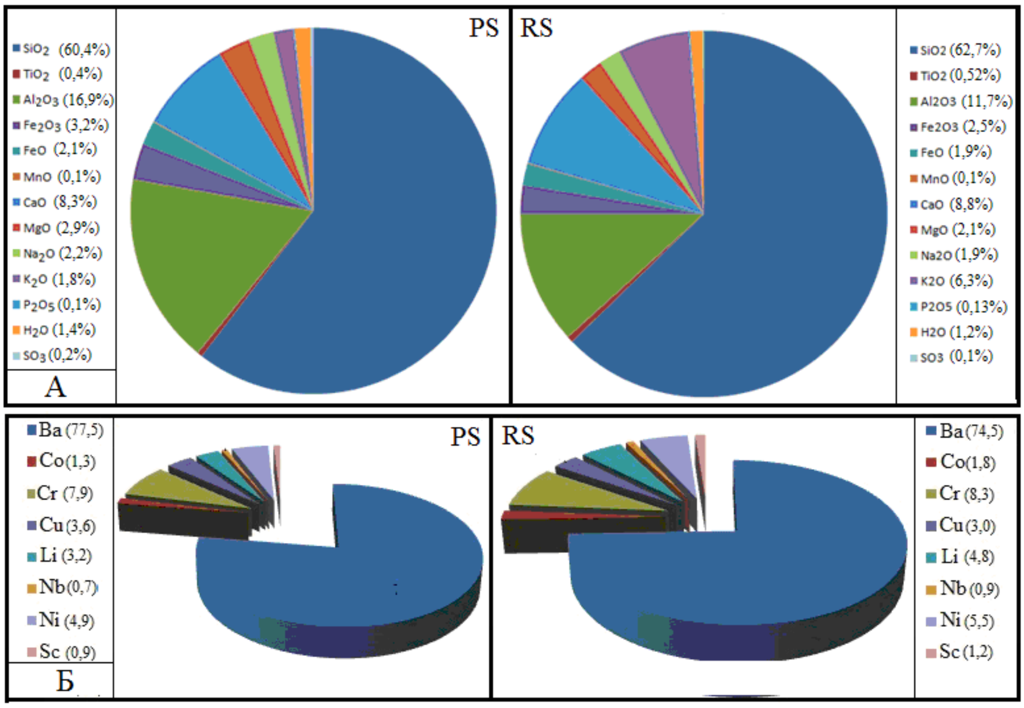

Fig. A circular diagram of the content in the rocks of PS and RS of the average values of oxides (a) and microelements (%) (b) within the Absheron-Pribalkhan threshold

Table

Statistical data of pyrolysis of rock samples of PS and RS

Object	**TOC*, (%)**	**S_1+S_2, (mgHC/g rock)**	**S_3, ($mgCO_2$/g rock)**	**HI, (mgHC/g TOC)**	**Ol, ($mgCO_2$/g TOC)**
PS	0,14-0,93 **0,44** (33)	0,16-2,28 **0,60** (29)	0,02-2,18 **1,03** (33)	21-180 **90,4** (29)	2-990 **295** (33)
RS	0,16-0,54 **0,28** (16)	0,13-0,51 **0,29** (14)	0,26-1,81 **0,70** (16)	32-119 **69,1** (14)	98-513 **271** (16)

* In the numerator, the limits, in the denominator the average value, in brackets the number of analyzes.

SEISMOGEOLOGICAL CRITERIA FOR UPPER JURASSIC RESERVOIR PREDICTION OF THE SOUTHEAST REGIONS OF WEST SIBERIA

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The paper is devoted to the Jurassic deposits of the southeast of Western Siberia, with which more than 100 oil and gas fields are associated in this region. In administrative terms, the study area is confined to the Tomsk region and the northern part of the Novosibirsk region.

The goal of the research is to develop seismogeological criteria for identifying and mapping distribution zones, facies replacement and cheking-out of reservoirs, evaluating the reservoir properties of sandstones and identifying complex structure objects in the sediments of the J_1 horizon on the basis of a complex interpretation of geological and geophysical materials.

Callovian-Upper Jurassic deposits in the southeast of Western Siberia are characterized by facial heterogeneity.According to the scheme of facial regionalization, the research area is located in the regions of marine, transitional and continental sedimentogenesis [1]. The Callovian-Upper-Jurassic deposits are represented by Vasyugan, George and Bazhen regional horizons.

From the west to the east, the marine deposits of the Vasyugan formation are transferred to the Naunakformation of transitional sedimentogenesis, and then to the Tyazhin formation of continental sedimentogenesis. The George and Bazhen formations pass first to the Maryanov and further to the Maximoyar formation.

The entire complex of the Upper Jurassic is displayed on time sections by one interference wave (wave packet II^a), the main "contribution" to the energy of which is made by reflections formed on the top and the bottom of the Bazhen formation [2]. In the analysis of acoustic characteristics it has been noted that coal layer U_1has abnormal velocities of longitudinal seismic waves distribution, and on this border the high-amplitude reflected wave capable influence significantly the nature of seismic recording of a wave package of II^a has to be formed.

Let us consider what effect on the nature of the wave field will have a change in the thickness of the deposits lying between the coal layer U_1 and the Bazhen formation (supracoal pack).

Figure shows a synthetic section calculated using the mathematical modeling apparatus for the case where the thickness of the supracoal pack is reduced from 35 to 5 m. In addition, graphs of the amplitude characteristics distribution of the wave packet are given, as well as a fragment of the real time cross-section characterizing the structure of the Callovian-Upper-Jurassic sediments.

Analysis of the obtained materials makes it possible to note that a decrease in the thickness of the stack is accompanied by a decrease in the energy level of the wave packet II^a;frequency of seismic recording;the duration of the negative phase II^a; duration of phase II^{U1} (top of coal layer); dT between the horizons II^{KR} (the top of the supracoal pack) and II^a; dT between horizons II^{KR} and II^{U1}, etc.

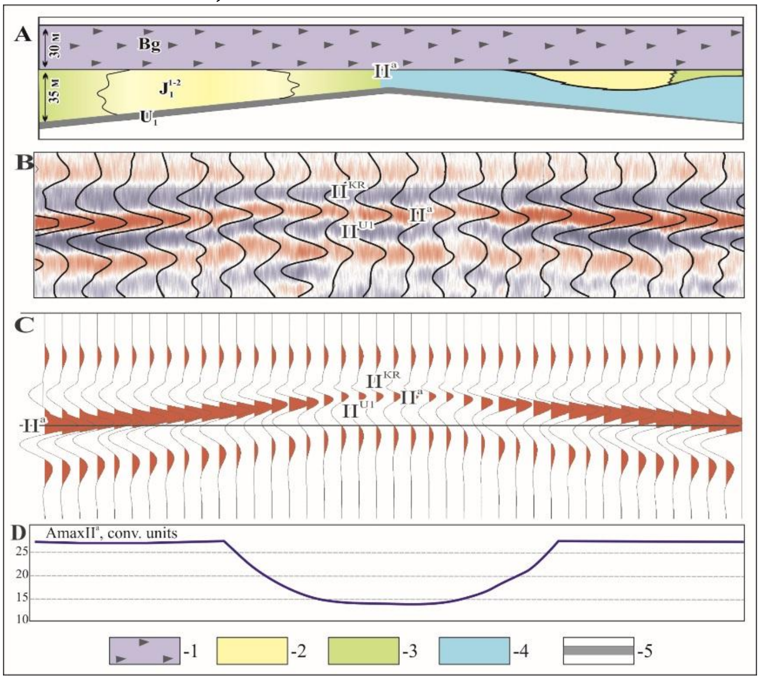

Fig. Seismogeological characteristics of the Upper Jurassic complex.

A – geological model, B –real cross-section, C – synthetic cross-section, D – graphs of the wave package amplitude characteristics on thickness of supracoal pack. Legend: 1 - siliceous-argillaceous rocks of the Bazhen formation (Bg); 2 - sandstones, 3 - siltstones, 4 - argillites of supracoal pack (J_1^{1-2}) of the Vasyugan formation, 5 - coal layer (U_1).

Along the seismic composite profiles based on seismic and deep drilling materials, a series of geological sections was constructed that crossed the southeast of Western Siberia in a sublatitudinal direction.

The analysis of geologic-geophysical materials has shown that mainly marine deposits of the Vasyugan formation located in the west of the territory are replaced by deposits of Naunak formation of a transitional sedimentation, and then mainly continental deposits of Tyazhin formation.

Accounting for the whole set of geological and geophysical information, a comprehensive approach to the interpretation of seismic materials, deep drilling data, mathematical modelling of wave fields allow us to solve subtle tasks of forecasting the geological section and mapping complex oil and gas perspective objects.

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BIOLOGICAL MINERAL POTENTIAL OF SEA-FLOOR

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In order to **definition** of sea floor, most of the oceans have a common structure, created by common physical phenomena, mainly from tectonic movement, and sediment from various sources. The structure of the oceans, starting with the continents, begins usually with a continental shelf, continues to the continental slope – which is a steep descent into the ocean, until reaching the abyssal plain – a topographic plain, the beginning of the seabed, and its main area. The border between the continental slope and the abyssal plain usually has a more gradual descent, and is called the continental rise, which is caused by sediment cascading down the continental slope. The mid-ocean ridge, as its name implies, is a mountainous rise through the middle of all the oceans, between the continents. Typically a rift runs along the edge of this ridge. Along tectonic plate edges there are typically oceanic trenches – deep valleys, created by the mantle circulation movement from the mid-ocean mountain ridge to the oceanic trench. Hotspot volcanic island ridges are created by volcanic activity, erupting periodically, as the tectonic plates pass over a hotspot. In areas with volcanic activity and in the oceanic trenches there are hydrothermal vents – releasing high pressure and extremely hot water and chemicals into the typically freezing water around it [(1)].

Benthos is the community of organisms which live on, in, or near the seabed, the area known as the benthic zone. This community lives in or near marine sedimentary environments, from tidal pools along the foreshore, out to the continental shelf, and then down to the abyssal depths. The benthic zone is the ecological region on, in and immediately above the seabed, including the sediment surface and some sub-surface layers. Benthos generally live in close relationship with the substrate bottom, and many such organisms are permanently attached to the bottom. The superficial layer of the soil lining the given body of water, the benthic boundary layer, is an integral part of the benthic zone, and greatly influences the biological activity which takes place there. Examples of contact soil layers include sand bottoms, rocky outcrops, coral, and bay mud.

The sediments in the ocean, which consist of three major components of detrital, biogenic, and authigenic origins, contain direct and/or indirect evidence of chemical and material inputs to the ocean and recycling within it.

Deep sea mining is a relatively new mineral retrieval process that takes place on the ocean floor. Ocean mining sites are usually around large areas of polymetallic nodules or active and extinct hydrothermal vents at 1,400 to 3,700 metres (4,600 to 12,100 ft) below the ocean’s surface. The vents create globular or massive sulfide deposits, which contain valuable metals such as silver, gold, copper, manganese, cobalt, and zinc. The deposits are mined using either hydraulic pumps or bucket systems that take ore to the surface to be processed. As with all mining operations, deep sea mining raises questions about its potential environmental impact. Environmental advocacy groups such as Greenpeace and the Deep sea Mining Campaign have argued that seabed mining should not be permitted in most of the world's oceans because of the potential for damage to deepsea ecosystems and pollution by heavy metal laden plumes.

Biogenic Minerals. Dissolved weathering products constitute most of the salt in the sea. The major- and minor-element chemistry of biogenically produced minerals, most importantly calcite, aragonite, and opal-A (amorphous silica) reflect the geologic processes and rates that control the chemistry of seawater, ocean circulation, and biologic evolution. The less reactive, long residence time elements such as Cl, Na, K, Mg, Ca, and Sr do not vary throughout the ocean. Others vary with depth and between oceans because of biological cycling and scavenging by particles. Plants and organisms preferentially extract some elements, primarily C, N, P, Ca, and Si, from seawater to form soft tissues and minerals. Some of these elements are consumed by other organisms or redissolve, thus they are internally recycled. The rest reach the seafloor mostly as calcite and opal-A [(2)].

At the seafloor, the rather segregated distribution of calcite, formed by coccolithophores (phytoplankton) and foraminifera (zooplankton), and of opal-A formed by diatoms (phytoplankton) and radiolaria (zooplankton), are important indicators of the history of productivity and ocean circulation. The trace element chemistry and isotopic compositions of these skeletal components are the most powerful tools available to unravel the effects of the interplay between tectonic and surficial processes on the chemical history of seawater. In addition to calcite and opal-A, aragonite is an important indicator of chemical paleoceanography. Corals form aragonitic skeletons. Because of their seasonal growth bands and formation near the sea surface, the isotopic and trace element compositions of coral heads are important as recorders at high resolution (decadal or longer) of late Quaternary sea level fluctuations, sea surface paleo-temperatures, and rainfall data. Another important mineral is celestite, which forms biogenically by acantharians (zooplankton); however, its high solubility prevents its preservation as fossils [(3)].

Despite the absence of celestite from the geologic record, its importance lies in the influence on recycling of Sr and Ba in the uppermost km of the ocean, with important implications for chemical paleoceanographic interpretations of Sr/Ca and Ba/Ca ratios in corals and planktonic foraminifera. Fish-teeth apatite is highly useful for both stratigraphy and chemical paleoceanography, especially in red clay deep-sea sediments where biogenic calcite and opal-A are absent because of dissolution. Magnetite bio-mineralization first was identified in chiton teeth, as it hardens their surface. The geologically important magnetite consists of the morphologically distinct single domain crystals formed by magneto-tactic bacteria. This magnetite is responsible for much of the stable magnetic remanence in many marine sediments, which is valuable in paleo-magnetic studies [(4)].

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DEVELOPMENT GEOGRAPHY OF ZEOLITES IN AZERBAIJAN

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It is commonly known that the value of minerals resides not only in their dazzling glare and transparency, but also in their formation diversity, valuable element content and the variety of applications. Supposedly, it will not be a mistake to endow zeolites with all of the cited exceptional qualities, including variety of uses.

Environmental protection is the one of most critical challenges the contemporary world. With this consideration in mind, it is deemed appropriate to use zeolites in such important areas as the air and wastewater decontamination, agriculture, oil-gas industry, etc.

Widespread occurrence of zeolites at the territory of Azerbaijan together with a number of areas in which these minerals might be applied, make it beneficial to continue efforts in this area.

Zeolites belong to a class of framework hydrous aluminosilicates. Some cations and H_2O molecules move freely along inside voids in the silicate frameworks (Figure). Different type of zeolites are known to have differently sized voids. Depending on dimensions, some parts of the molecules can pass through the mineral’s voids while the larger molecules cannot. Due to these properties, zeolites are often called molecular sieves.

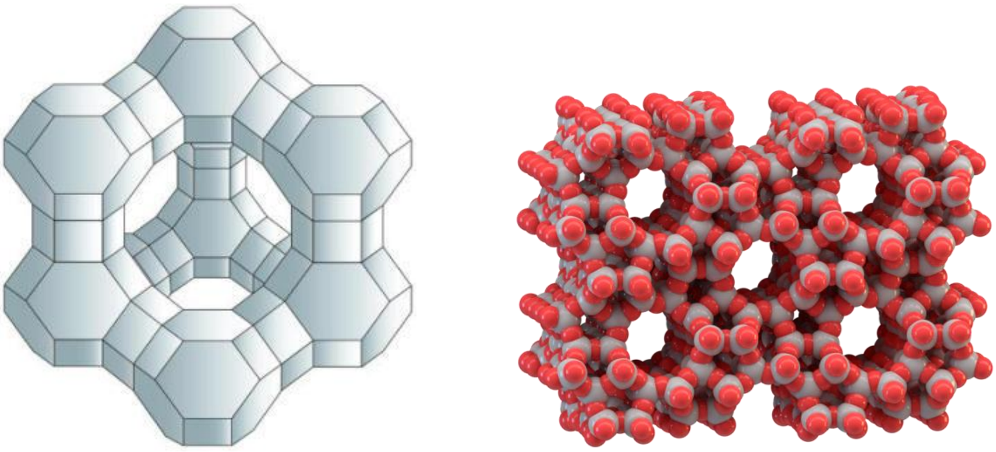

Fig. Location of voids in a zeolite framework.

Confinement of zeolites to the different volcanic formations, lithofacies peculiarities of zeolite-bearing volcanosedimentary rocks, associations formed by zeolites with the other minerals as well as the mineral's morphological properties allow dividing the country's rich zeolite deposits into hydrothermal, magmatic, volcanosedimentary and sedimentary types.

In Azerbaijan, most developed occurrences of zeolite are detected within Late Cretaceous and Paleogene formations of Lesser Caucasus and Talysh.

Using the outcomes of studies implemented by various domestic researchers, we developed the following table that summarizes the development geography of zeolites within the territory of Azerbaijan (Table).

Table

Development geography of zeolites in Azerbaijan

Seolitlər / Rayonlar	Natrolit $Na[Al_2Si_3O_{10}]\cdot 2H_2O$	Mezolit $Ca_{16}Na_{16}Al_{48}Si_{72}\cdot 2H_2O$	Skolesit $Ca[Al_2Si_3O_{10}]\cdot 3H_2O$	Tomsonit $NaCa_2[Al_5Si_5O_{20}]\cdot 6H_2O$	Qonnardit $(Na_2,Ca)_4[Al_2Si_3O_{10}]_4\cdot 12H_2O$	Lomontit $Ca_4[Al_8Si_{16}O_{48}]\cdot 16H_2O$	Mordenit $Na_8[Al_8Si_{40}O_{96}]\cdot 24H_2O$	Heylandit $Ca_4[Al_8Si_{28}O_{72}]\cdot 24H_2O$	Stilbit (desmin) $Na_2Ca_4[Al_{10}Si_{26}O_{72}]\cdot 28H_2O$	Stellerit $Ca_8Al_{16}Si_{56}O_{144}\cdot 56H_2O$	Epistilbit $(Ca,Na_2)_{3.5}[Al_7Si_{17}O_{48}]\cdot 15H_2O$	Klinoptilolit $CaNa_2K_2[Al_6Si_{30}O_{72}]\cdot 24H_2O$	Analsim $Na_{16}[Al_{16}Si_{32}O_{96}]\cdot 16HO$	Şabazit $Ca_8[Al_{12}Si_{24}O_{72}]\cdot 39H_2O$
Tovuz	■					■	■					■	■	■
Qazax	■	■	■	■		■	■	■				■	■	■
Naxçıvan M.R		■	■	■		■	■		■			■	■	
Dağlıq Talış		■	■	■		■	■	■	■				■	■
Goranboy	■	■	■	■		■		■	■				■	■
Göygöl	■	■	■			■	■		■	■			■	
Xocavənd	■		■	■	■			■					■	■
Şuşa							■		■					
Laçın	■	■	■	■		■	■		■				■	
Kəlbəcər				■		■		■						
Ağdərə						■	■					■	■	
Qubadlı		■												■
Sərsəng		■									■			
Daşkəsən	■					■								
Gədəbəy						■			■					■

Out of the regions cited in the above table, richest zeolite deposits are located at the territories of Tovuz, Gazakh and Nakhchivan AR. In these regions, zeolite development areas have been thoroughly studied in order to identify a distribution regularity of deposits and forecast their commercial significance. In many countries, natural zeolites, especially clinoptilolite and mordenites are currently used for their efficiency.

Within the territory of Azerbaijan, clinoptilolites are most widely developed in the Gazakh depression (Lesser Caucasus), where they are confined to complex volcanosedimentary series of the Upper Cretaceous volcanic formation. The area's zeolites form associations with montmorillonites, calcites and field spars.

Mordenite has been detected in a number of areas within the Lesser Caucasus region, and its' richest deposits is observed in the Ordubad district of Nakhchivan AR, where the mineral is mainly associated with quartz and field spar. The area's zeolite bearing layer of tuffs and tuff-gravelites had formed between the deposits of Lower Eocene.

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THE REMOTE SENSING RESULTS OF BERTAKARI-BNELI KHEVI DEPOSITS AND THEIR HOSTROCKS (BOLNISI ORE FIELD, SOUTH GEORGIA)

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The Study area (Bertakari-Bneli Khevi deposits) is located in Bolnisi ore field in southern Georgia which is part of the globally significant Tethyan-Eurasian Metallogenic Belt.

The Bolnisi ore field is well known for the existence of both Kuroko-type volcanogenic massive sulphide and volcanogenic epithermal ore depositsprimarily associated with hydrothermal processes. Despite the economic and strategic importance of such occurrences, the detailed geology of this particular region is poorly known and it obviously lacks geological mapping at an adequate scale. Remote sensing techniques were applied in order to increase current geological understanding of the Bertakari and Bneli Khevi deposits area and to find future target locations for exploration.Digital imageprocessing algorithms, such as RGB color composites and band ratios, were applied to ASTER imagery. Lineaments were extracted relying on geological photointerpretation criteria in order to identify new geological–structural elements. It is well-known that remote sensing as one of the cutting-edge technologies currently supporting the geosciences (among others), may have a significant role in mineral exploration works, effectively decreasing initial investments and saving time by clearly targeting the most suitable locations for the occurrence of ore deposits [3].

The Bertakari and Bneli Khevi deposits are host by Upper Cretaceous Gasandami suite which in the Bertakari area is subdivided into two-the lower Gasandami and upper Gasandami subsuites [1]. Gold-base metals mineralization within the lower Gasandami subsuite is related to pervasively hydrothermally altered rocks – hydrothermal breccias [4]. The upper Gasandami subsuite postdates mineralization and does not contain any of significance ore occurenses. It is introduced by volcanogenic, magmatic and normal marine rocks [2].

The lower subsuiteof the Gasandami suite, (K2gn1) is constituted by the altered rocks with diverse textures, chemical and mineralogical compositions and mechanic propertiesmainly formed after ryolite-dacitic lavas, volcaniclastic and extrusives rocks. The upper Gasandami subsuite breccia-conglomarates are affected by quartz-sericite, adularia, argillic and propylitic alteration (Figure).

In the study areathe satellite imagery used was clipped from the ASTER scene

AST_L1B_00304092004080704_20180110171001_32359 (available at: earthdata.nasa.gov) and have been analyzed. The anomalies of hydrothermal, propylitic and argillic alteration have been identified. The images underwent atmospheric correction and were processed using Band Rationing Algorithm. (B7 + B9) / B8 combination was applied to propylitic alteration, B5 / B4 to the hydrothermalalteration, (B4 + B6) / B5 to argillic alteration and B7 / B8 combination for gold.

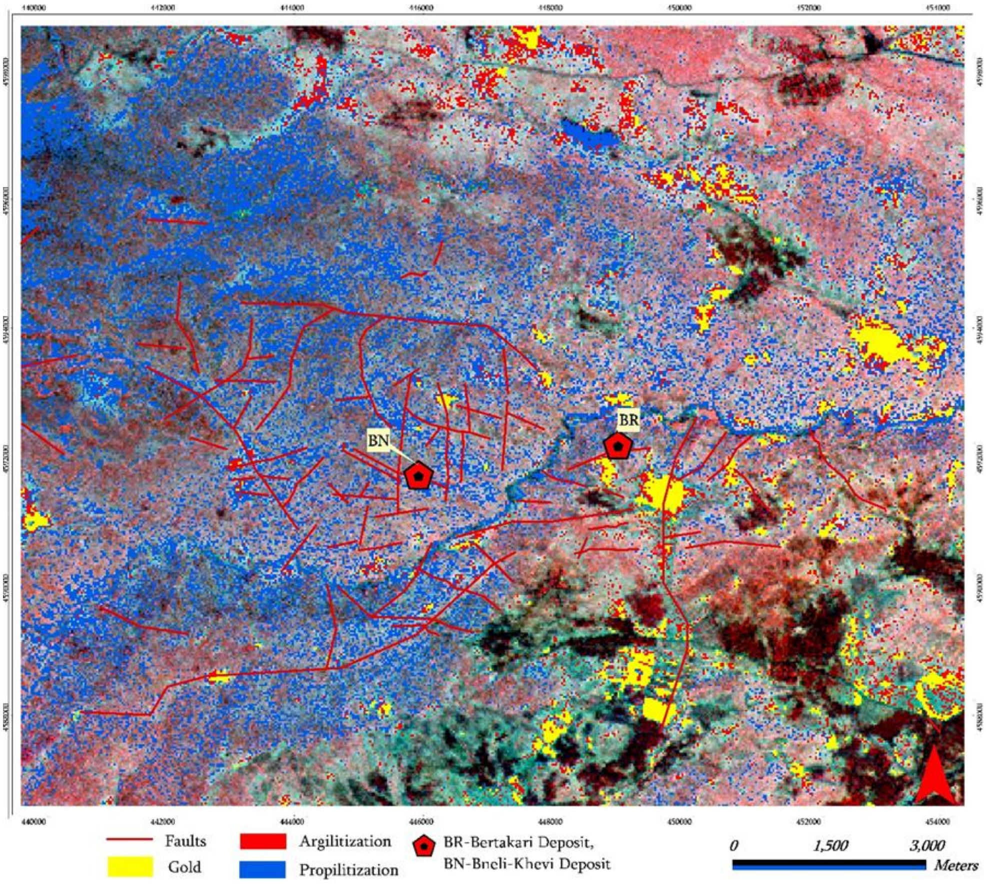

Fig. Faults and Alteration Zones Map of Bertakari and Bneli Khevi Deposits Area.

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TECTONIC EVOLUTION HISTORY (ASSOCIATED WITH PETROLEUM POTENTIAL) OF YAMAL PENINSULA

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The article presents a reconstruction of Yamal peninsula tectonic evolution history and determination of the influence of the tectonic processes on the petroleum potential, based on complex interpretation of seismic exploration data, well logging and deep drilling.

The study area is located on the north-west of the West Siberian Plate - Yamal peninsula (Figure (A)).Plate consists of two parts: heterochronous (from the Precambrian to the Late Paleozoic), heterogeneous basement, unconformably overlying Mesozoic, and Cenozoic sedimentary cover.

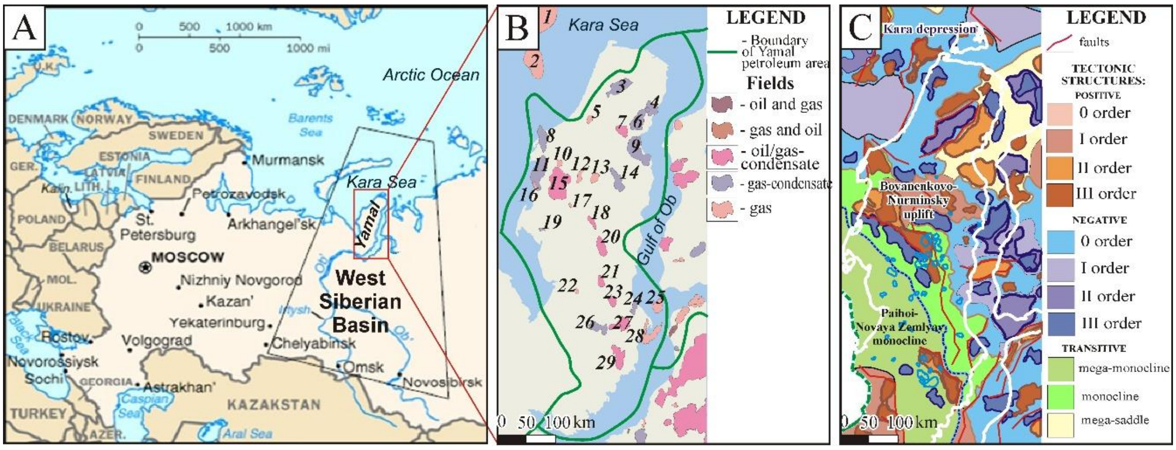

Fig. A - location of the research area; B - oil and gas fields (1-Rusanovsky, 2-Leningrad, 3-Malygin, 4-Tasia, 5-Syador, 6-North Tambey, 7-West Tambey, 8 Kharasaveyskoe, 9 South Tambey, 10 North Bovanenkovo, 11-Kruzenshtern, 12-East Bovanenkovo, 13-Verkhnutudei, 14-West-Seyakhin, 15-Bovanenkovo, 16-South Krusenstern, 17-Nerstinsky, 18-Neytinsky, 19-Baidaratsky, 20-Arctic, 21-Middle-Yamal, Ust-Yuribeyskoye, 23-Nurminskoe, 24-Khambateiskoye, 25- North -Kamennomysskoye, 26-Maloyamalskoye, 27-Rostovtsevo, 28-Kamennomysskoye, 29- Novyi Port); C - part of tectonic map of West-Siberian basin.

The Yamal basement features are large linearly extended uplifts and submeridional and northeastern strike depressions. The structure of the sedimentary cover largely inherits the structural features of the basement.

Yamal continental part is rich in dry gas reserves of the Cenomanian-Aptian complex, lying at 700-1700 meters, and the combination and condensate gas of lower Cretaceous-Jurassic deposits lying at 1700-3200 meters depths.

32 hydrocarbon fields were striked on the study area such as South Tambey, Bovanenkovo, Kharasaveyskoe, Krusenstern, Arctic, etc (Figure (B)).

Seismic markers and seismogeological sequences.

Five seismic markers controlling basic seismogeological sequences are indicated in sedimentary cover of research area: A - a borderline between preJurassic basement and Mesozoic-Cenozoic sedimentary cover, Kt - a top of Kiterbut Formation (Lower Jurassic, Toarcian), B - a top of the Bazhenov Formation (Lower Cretaceous, Berriasian), M - the

Neitin shale unit of the Tanopchinskiy Formation (Lower Cretaceous, Aptian), G - the Kuznetsov Formation (Upper Cretaceous, Turonian). Reflectors are associated with transgressive clay beds with stable areal thickness, formed during the era of calm tectonic, have spread over large area of the WS basin, and can be used as peneplanation planes. Construction of structural maps by the reflectors and thickness maps of the basis sequences (Jurasic, Berriasian-Aptian, Aptian-Turonian, post-Turonian) (Kontorovich, 2009).

Structural characteristics and tectonic evolution.

Modern relief of all reflectors are significantly similar on the study area, it is a monoclyse complicated by high-amplitude positive structures of 2 and 3 orders (Figure (C)).All positive tectonic structures are associated with the hydrocarbon fields. For instance, the Neytinskoye field is confined to the North-Arctic uplift; the Arctic field - to the South-Arctic uplift; the North-Bovanenkovo, Bovanenkovo, East-Bovanenkovo, Verkhnetuteyskoe, West-Seyakhinskoye fields are confined to the Nurminsky uplift; the South-Tambey field – to the same name uplift;West-Tambeyskoye, North-Tambeyskoye, Tasia Fields are confined to the North-Tambeyskoy uplift.

Positive tectonic structures amplitudes increase upsection; from A to G marker.

It was Cenozoic tectonic stage resulted in the formation of uplifts – structural traps for hydrocarbon fields.

According to the formation time and character of growth, all positive structures were divided into three types. The first one is structures formed above the basement uplifts, these structures had already been formed to the Aptian, in post-Turonian its amplitudes could increase or decrease. For instance, North-Tambey and Bovanenkovo-Nurminsky uplifts, South-Tambey dome. The second one is structures formed above the basement uplifts too, but in post-Turonian its amplitudes increased several times. For example, Malygin, Kharasaveyskoye, Bovanenkovo, North-Arctic, Novoportovskiy uplifts. The third one is structures developed mainly in post-Turonian, which didn`t form above the basement uplifts (rootless structures). Such as South-Arctic uplift.

Paleotectonic analysis revealed thatYamal Peninsula positive structures have tended to grow during Mesozoic-Cenozoic tectonic history, while the intensive growth of positive structures was in Berriasian-Aptian and especially in Cenozoic when they acquired a modern appearance. Interesting that almost all these structures have basement«roots».

During the Mesozoic-Cenozoic tectonic processes analysis the authors identified four main stages of tectonic activation, accompanied by the faults formation: pre-Jurassic, Early Jurassic, Early Cretaceous and post-Turonian (Cenozoic), which allow us to distinguish five main classes of faults:

• Faults separating blocks of basement that penetrate the deposits of the sedimentary cover, but do not cut Jurassic deposits (the time of formation is pre-Jurassic, presumably Permian-Triassic);

• Faults penetrating into the Jurassicsediments (the time of formation is Hettangian-Aalenian);

• Faults penetrating into the Cretaceous sediments (the time of formation is Berriasian-Valanginian);

• Faults penetrating in to the Cenozoic deposits (the time of formation is mainly Late Paleocene) - cutting the entire sedimentary cover.

The last type of faults is important in terms of oil and gas potential, since they could be the channels for migration of hydrocarbons from oil and gas deposits upwards the section.

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THE EXPLORATION OF NAMEGH PROSPECTIVE AREA BASED ON GEOLOGY, ALTERATION, MINERALIZATION, GEOCHEMISTRY AND FLUID INCLUSION STUDIES

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Namegh area is located northeastern Kashmar, Khorasan Razavi province, and central part of Khaf-Kashmar-Bardaskan magmatic belt. Geology of the area is covered by Eocene volcanic rocks [4] having andesite to rhyolite composition, which are intruded by sub volcanic intrusions having monzodiorite composition. All of units are affected by well development alteration, which are silicified, silicified-sericitic, and argilic-propylitic alteration zones. Mineralization is occurred as Vein mineralization type trending NW-SE and 75°NE inclination hosted by trachyandesite and trachyandesitic tuff. Primary minerals include specularite, chalcopyrite, and magnetite with waste quartz. Secondary minerals include goethite, hematite, and malachite. Silicification is the most important alteration (Figure 1).

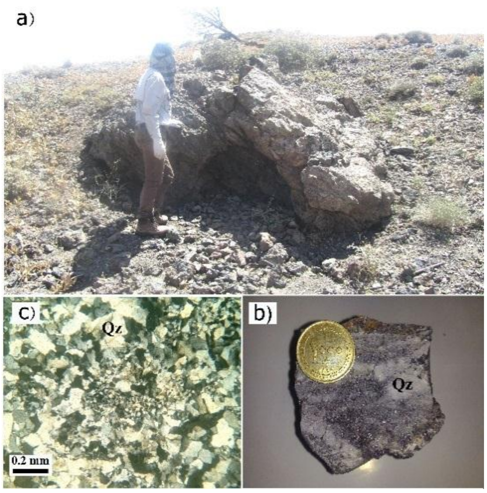

Fig 1. A distant view from vein IOCG mineralization (Qz=Quartz, [3]).

High anomaly of Fe (up to 9%), Cu (up to 2%) and low values of Au (maximum 20 ppb) are present in the vein. Based on fluid inclusion studies, formation temperature of mineralization is between 300 to 496 ºC and it is occurred from NaCl- and $CaCl_2$-bearing fluid having 11 to 22 wt.% NaCl equivalent salinity. Temperature and salinity is decreased and dilution occurs due to mixing of two high temperature-salinity and low temperature-salinity fluids resulting Fe oxide and copper is deposited from chloride ligands (Figure 2).

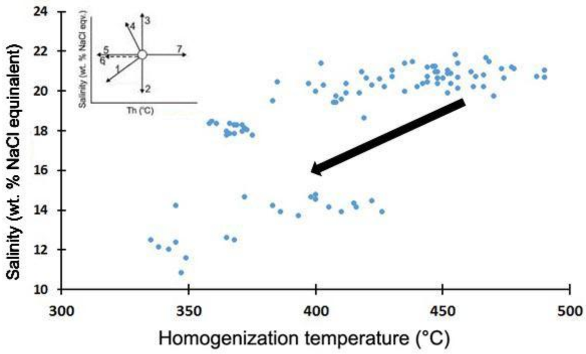

Fig 2. Possible trending for fluid evolution on Homogenization salinity-temperature diagram [2].

Mixing of magmatic and meteoric waters model is the best model for generation of Namegh copper-gold enriched in Fe-oxide vein. This mineralization is occurred at 10 to 60 Mpa pressure and 0.5 to 2 Km depth (assuming lithostatic pressure) (Figure 3). Mineral paragenesis, host rock, alteration, structural control and nature of ore fluid indicate mineralization is copper-gold enriched in Fe-oxide (IOCG) hydrothermal type.

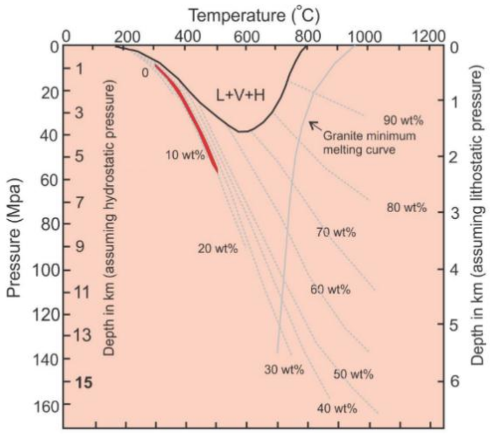

Fig 3. The location of potential IOCG fluid on tempearture-pressure-depth diagram in H2O-NaCl system [1].

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IDENTIFICATION OF IRON ANOMALY AND LINEAMENTS USING REMOTE SENSING (ASTER & OLI DATA) IN HAJI-GAK AREA, AFGHANISTAN

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The Haji-Gak area is located in the Bamyan, Wardak, and Parwan Provinces in central of Afghanistan (Figure (D)), which is approximately 2,079.29 km^2 and have Elevations range from 1,900 to 4,962 m. This area is the best known and largest iron oxide deposit in Afghanistan, iron mineralization type is Algoma and mineralization controlled by structurally phenomena, because The study area are present along a tectonized zone (Har-i-Rod Fault zone) in central Afghanistan and this subject created numerous faults and fractures of different orientations and extent occur in area (Figure (A)). Generally Haji-Gak area contains metavolcanic and metasedimentary rocks (Figure (B)) and iron ore deposits are hosted by this geological unites. In this study used remote sensing methods for exploration iron deposits. Spectral reflectances in the visible and near-infrared bands are used as a rapid and inexpensive technique for determining the mineralogy of samples and obtaining information on their chemical composition. The use of satellite images for mineral exploration had been very successful. The images of Operational Land Imager (OLI) and Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) sensors according to have a sufficient number of bands in the ranges of visible near infrared (VNIR) and short wave infra-red (SWIR), have high ability to identify iron mineralization, lithological units, alteration zones and fracture systems (faults). Remote sensing is central component of this study and main aim of this research is to discriminate alteration minerals and lineaments by processing of ASTER and OLI data and find their relationship with iron mineralization to produce Iron anomaly map of study area. To achieve these objectives different sensors and techniques have been evaluated. Satellite data were analyzed using various methods such as Spectral Angel Mapper (SAM), Matched Filtering (MF) and Directional Filter techniques to identify the alterations, Iron anomaly and faults - lineaments. Characteristic absorption features (absorption bands) in the OLI and ASTER data were compared with standard spectral library (USGS Spectral Library of Minerals) for detect minerals. Spectral map of Iron minerals show associated with iron mineralization and host rocks in Haji-Gak deposit. The results of remote sensing studies indicate high potential iron mineralization is in the study area (Figure (C)), also this results show potential areas of mineralization outside the Haji-Gak region that needs to be investigated further.

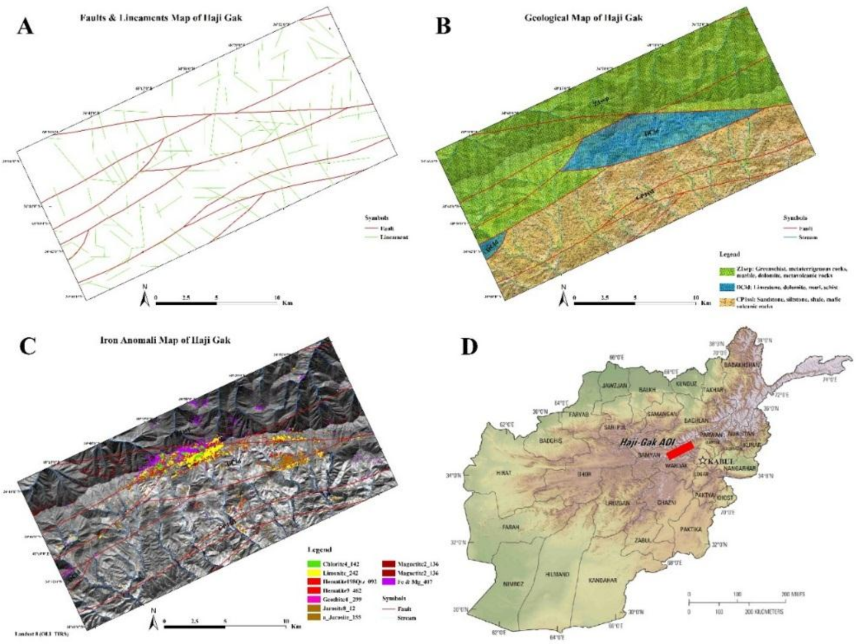

Fig. Fault & Lineaments map of study area (A), Geological map of study area (B), Iron oxide Anomaly map of Haji-Gak Area (C) Location of Haji-Gak ore deposit in Afghanistan (Red Rectangle) (D).

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SEISMOGEOLOGICAL METHODS FOR IDENTIFYING PALEOZOIC OIL AND GAS PROSPECTS IN THE SOUTHEAST OF WESTERN SIBERIA

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For more than 50 years in Western Siberia, hydrocarbons have been extracted from the Mesozoic deposits of the sedimentary cover, but the growth of reserves in traditional oil and gas bearing complexes is gradually decreasing.

The Paleozoic oil and gas complex is increasingly attracting the attention of researchers. More than 50 oil and gas fields have been discovered in Paleozoic deposits on the territory of the West Siberian Province. Noncommercial hydrocarbons flows are recorded in more than 100 areas. The Paleozoic oil and gas complex is increasingly attracting the attention of researchers.

In the central and southeastern parts of the West Siberian oil and gas province, pre-Jurassic formations are represented by rocks of different composition and age.

Outstanding interest in the formation of reservoirs and the oil and gas potential of the Paleozoic formations is represented by organogenic limestones and dolomites of the indigenous Paleozoic and argillaceous-siliceous rocks of the weathering crust. These rock formations have good filtration-capacitive properties [1]. The weathering crusts developed on granites and acidic effusives are also promising.

In the central and south-eastern parts of the basin, a series of oil-and-gas-promising macroblocks. These macroblocks are largely composed of argillaceous-siliceous and carbonate rocks. The largest number of Paleozoic oil and gas fields is concentrated in the southern part of the Pudinsko-Aleksandrovsky block. This zone of oil and gas accumulation covers the south of Tomsk and the north of Novosibirsk regions. The Verkhtarskoye, Vostochnoe and Maloychskoye oil fields are the most southerly in this oil and gas zone and in the Paleozoic of Western Siberia.

Reservoirs in the formations of the indigenous Paleozoic and weathering crust were formed in different tectonic conditions.

The most oil-gas-promising formations of the indigenous Paleozoic are the low-contrast erosion-tectonic protrusions, which are composed of organogenic limestones and dolomites and have an increased capacity (Figure). In these low-contrast protrusions, a cavernous-fractured reservoir was formed as a result of exogenous processes. The Verkhtarskoye and Maloychskoye oil fields are confined to such type of reservoirs.

The greatest interest in the oil and gas content of the weathering crust is represented by contrast erosion-tectonic protrusions composed of silicate-bearing rocks. In the first place, siliceous limestones and siliceous argillites subjected to intensive processes of disintegration. Within these massifs, thik weathering crusts of argillaceous-siliceous composition were formed, which have good reservoir properties. The Vostochnoe oil field is confined to such type of reservoirs.

An analysis of seismic sections and results of mathematical modeling of wave fields was carried out. As a result, it was concluded that the oil and gas prospects associated with the formation of the indigenous Paleozoic and weathering crust are displayed differently in wave seismic fields. Zones that are promising for the formation of reservoirs in organogenic limestones and dolomites are characterized by increased values of reflected-wave amplitudes. A sharp decrease in the amplitude-energy characteristics of a seismic record is characteristic of siliceous erosion-tectonic protrusions. A similar sharp decrease in the amplitudes of the wave fields is fixed within the oil and gas promising blocks of the pre-Jurassic base, composed of granites and acid effusives.

This is due to the fact that the formation of the weathering crust is composed of rocks that are close in acoustical characteristics with overlying Jurassic deposits. While the difference in the velocities of longitudinal seismic waves distribution at the boundary between Jurassic and indigenous limestones exceeds 1000 meters per second.

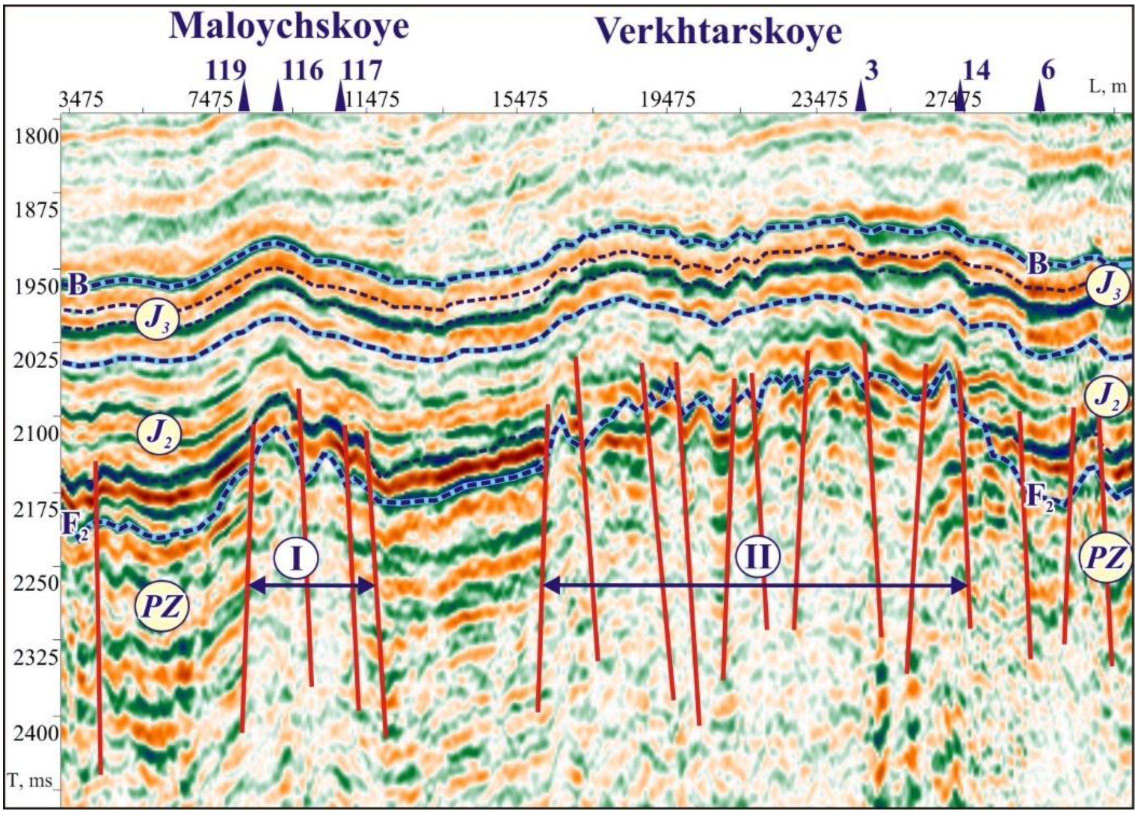

Fig. Time cross section.Carbon-bearing: I - Maloich block, II – Verkhtar block.

Based on the results of a complex analysis of seismic, gravity and magnetic data, a map of the material composition of the Paleozoic was constructed. Oil-and-gas-perspective objects were also identified within the area of the Paleozoic deposits distribution in the territory of the Novosibirsk Region.

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ORIGIN OF ORE-FORMING FLUIDS OF TEPEOBA Cu-Mo DEPOSIT, NW TURKEY

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The Tethys metallogenic belt in western Turkey has a variety of types of mineralization such as Au-Ag, porphyry Au-Cu-Mo, Fe-skarn and epithermal Pb-Zn-Cu-Au. The Tepeoba Cu-Mo deposit has a total reserve of 26 million tons averaging 0.33% Cu and 0.041% Mo.

Mineralization is hosted by Permo-Triassic metamorphic/sedimentary rocks and Oligocene-Early Miocene granites. The deposit is typical of porphyry systems in terms of mineralogical, textural and geochemical characteristics in the nearby area. Mineralization is mainly in breccias and veins/stockworks in the host rocks consisting of chalcopyrite, pyrite, molybdenite, sphalerite, pyrrhotite, limonite, malachite and azurite. On the basis of the petrographic and microthermometric behavior of fluid inclusions assemblages (FIA) hosted in quartz, liquid-rich (liquid c.70%), vapor rich (vapor c. >70%) and multiphase inclusions (mostly halite, sylvite, hematite) were identified, and the results show that the ore-forming hydrothermal fluids are enriched in NaCl+KCl+FeCl2. Th of vapor-rich inclusions are c. 370 ºC and c. 1 wt.% NaCl equiv. salinity, L+V inclusions have Th c. 300 ºC and c. 9 wt.% NaCl equiv. salinity. Halite-bearing inclusions have high Th up to c. 500 ºC (hematite? bearing inclusions c. >600ºC) and high salinities of c. 35 wt.% NaCl equiv. Combining fluid inclusions with cathodoluminescence of the veins, different vein filling events and associated fluids were identified. This allows a better time evolution of the fluids and mineralization to be determined. The measured homogenization temperatures and salinities are compatible with porphyry copper deposits and consistent with the other porphyry copper deposits and prospects in western Turkey.

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GEOLOGICAL MODEL AND OIL-GAS-POTENTIAL OF THE LOWER AND MIDDLE JURASSIC OF THE UST-TYM MEGADEPRESSION

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In the Tomsk region since 2012, there has been a steady decline in oil production which is mainly due to the long development of active reserves in the Upper Jurassic and Lower Cretaceous complexes and, as a result, their depletion.

The need to build up hydrocarbon potential in new stratigraphic horizons for areas characterized by falling oil production is topical. The southeastern part of the West Siberian Plate is one of such areas within which the hydrocarbon potential of the Lower Jurassic and Aalenian deposits of the Ust-Tymmega depression has been estimated.

An integrated approach using all geological and geophysical materials makes it possible to detail the geological structure of the Getang-Aalenian deposits, which corresponds to the present-day degree of study, and makes it possible to allocate perspective objects. The presence of seals, reservoirs and source rock (the Togur Formation) makes it possible to consider the Gettang-Aalenian complex as an oil and gas perspective.

To recovery the conditions and time for the formation of uplifts - potential traps, a "thickness method" was used. Calculative experiments on the reconstruction of sediment deposition processes and processes of naphthidogenesis in this work were carried out in the Temis Flow software package developed by Beicip-Franlab.

The Lower Jurassic and Aalenian deposits overlap the rocks of the pre-Jurassic basement and are distributed practically throughout the entire study area, except for the most elevated areas represented by the protuberances of the pre-Jurassic basement, the complex's thickness reaches 440 m. The full section of the lower Jurassic and Aalenian can be detected in the most submerged parts of the megadepression and contains the Urman, Togur, Peshkov Formations and the lower member of the Tyumen Formation.

The Gettang-Aalenian sediments can be divided into three oil-and-gas bearing subcomplexes: the Gettang–EarlyToarcian ($U_{16\text{-}17}$), the Late Toarcian -Aalenian (U_{15}) and the Aalenian ($U_{11\text{-}14}$).The main source of hydrocarbons is the Togur Formation, which contains mixed and aquatic organic matter [1].

Formation of the sedimentary cover in the pre-Jurassic time was preceded by Early Triassic rifting, as a result of which the Ust-Tymmega depression was formed. In the Hettang-Aalenian time, the Ust-Tym periphery depression was submerged in relation to adjacent major uplifts and was filled with sediments carried by them. The main uplifts were formed over the erosion-tectonic protrusion of the basement. Ust-Tymmega basin and adjacent major uplifts finally took shape after the Turon-Cenozoic times. The formation of local uplifts in the structural plans of the Getang-Aalenian stratigraphic levels occurred most intensively in the Jurassic and Early Cretaceous.

In the process of determining the prospects for oil and gas, promising objects were identified in the Gettang – Early Toarcian, the Late Toarcian – Aalenian and the Aalenian subcomplexes using structural surfaces along the roofs and maps of their effective thicknesses.

To assess the oil and gas potential by the method of comparative geological analysis, a resource estimate of category $D_0$was carried out. Taking into account the success rate, the total geological resources of category D_0 of the oil of the Gettang-Aalenian complex amounted to $805*10^6$bbl, the total recoverable resources –$182*10^6$ bbl.

For a more correct assessment of the prospects, the scale of generation and the time of submergence of the sourse rock (the Togur Formation) in the oil window were determined.

In the most depressive parts of the Ust-Tymmega depression the rocks of the Togur Formation began to sink to the oil window about 115-110 m. a. ago (at the end of the Aptian), the rocks in the instrument parts of the megadepression plunged into the oil window about 5 m. a. ago (the Pliocene). The output of rocks from the oil window began about 48 m.a. (the early Eocene) and continues to this day.

The history of generation of liquid hydrocarbons was traced for the II and III types [2] of kerogen. For type II, the generation began about 94 m. a. ago at the beginning of the Late Cretaceous (Cenomanian), for type III kerogen - in the Turonian time (89.8 m. a.). The maximum volumes of generation fall on the last 5 m. a. (Figure (a, b)).

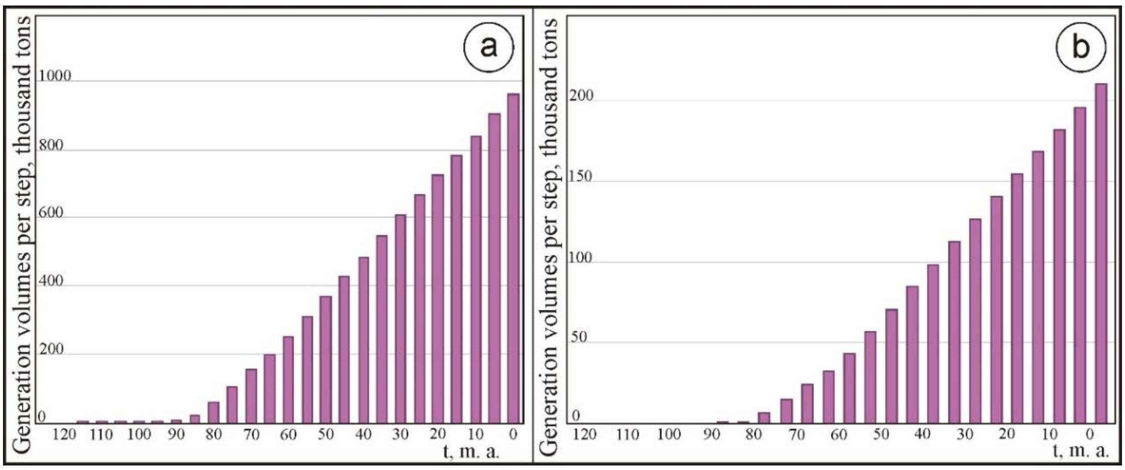

Fig. Diagrams of generation of liquid hydrocarbons by the organic matter of the Togur Formation for kerogen of type II (a) and kerogen of type III (b) over time.

By the time of intense oil generation, anticlinal structures, potential traps for hydrocarbon deposits, existed in the Gettang-Aalenian complex and could have accumulated hydrocarbon deposits.

According to the results of basin modeling, the total volumes of liquid hydrocarbons generated by the aquatic (kerogen of type II) and mixed (kerogen of type III) organic matter of the Togur Formation amounted to 6094*10^6bbland 1327*10^6bbl, respectively. At present, the generation of hydrocarbons in the Lower Jurassic oil-producing stratum has not reached the maximum level.

At the same time, when comparing estimated D_0 oil resources in the Hettang-Aalenian complex traps (805*10^6bbl) with the volumes of hydrocarbons generated, it can be concluded that the existing generation volumes are sufficient to allow many of the allocated traps to concentrate the oil deposits.

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FLUID INCLUSION STUDIES OF TRAVERTINE. A CASE STUDY: DENIZLI-HONAZ-GÜRLEK TRAVERTINE FORMATIONS

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There are many horst-graben systems related with KB-GD extention at Upper Miocene in Western Anatolia and Denizli graben is one of them. Travertine of Honaz-Gurlek, south-east part of Denizli, district can be classified into five groups:Vein type travertines, Ridge type travertines, Terrace type travertines, Channel type travertines and Lacustrine travertines. This works focus on the microthermometric analysis of the travertine samples from the Honaz-Gurlek district. Inclusions can be seen mainly liquid-vapour and just vapour, with different size and shapes. Microthermometric studies showed that homogenization temperatures are relatively higher than earlier studies, between 200°C-330°C and salinities between 0,5 and 1,25 wt.% NaCl equiv.

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GEOELECTRICAL INVESTIGATIONS IN THE UKRAINE

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As a result of experimental studies of the electromagnetic methods, interpretations, construction of geoelectric 3D models on the territory of Ukraine within the geological structures of different ages from the Precambrian Ukrainian Shield (USh) to the Carpathians - the north-eastern branch of the alpine folded geosynclinal region of Europe, revealed anomalous areas of increased electrical conductivity in the earth's crust and upper mantle. Their nature is different and the possible causes of education are just as different.

On the western slope of the USh in the depth (H) from 3 to 6 km lies Volynian conductive anomaly (CA) with specific resistance (ρ) of the order of 10 Ohm·m. Chernovtsy-Korostnian CA outside of USh was found on the southern part of Volyn-Podolian plate (H=6-15 km, ρ=10 Ohm·m). The anomaly gets deeper in the north (H=15-30 km). Section of the anomaly with ρ=5 Ohm·m is located within the borders of Bugsko-Rosinian and Podolian megablocks (Mb) and contains objects with ρ=1000 Ohm·m. Western part of CA (ρ=20 Ohm·m) stretches outside of the USh in two directions – south and southwest, along Podolian deep fault zones (fz) till Golovanian seaming zone (GSZ). On the northwestern part of USh on the border of Volynian and Bugsko-Rosinsky Mb in the Earth Crust (H=15-30 km) lies Korostenian CA (ρ=30 Ohm·m).

Anomalies of high electrical conductivity with ρ=2-250 Ohm·m in the Earth Crust of GSZ have been revealed, which coincide with deep fz: Talne, Pervomaisk, Vradievka, Gvozdavka, Zvenigorod-Bratsk, Smila, Subbotsko-Moshorinka; which are represented up to the depths of 2,5 km by sub-vertical structures and deeper – mainly sub-horizontal layers. The low resistivity CA are confined to the alongated strips and areas of the spread of the graphitized rocks and metasomatic zones extended along the fz. In its boundaries there is a large amount of the ore deposits of the region. Outside the GSZ heterogeneous Earth`s crust and upper mantle are observed as Chernovtsy-Korostnian and Kirovogradian CA.

Full scale Kirovogradian CA of isometric shape H=20-25 km is fixed by two contours with different ρ – 10 and 50 Ohm·m. CA extends over almost all of the eastern part of Ingulian Mb and Ingulets-Krivoy Rog SZ and western part of Middle Peridneprovian Mb of USh. In the interval of 25-30 km CA (ρ=50 Ohm·m) in the Earth Crust stretches far beyond central part of USh north into the Voronezh massif and south under the Pre Black Sea depression.

In the east USh is fixed by Periazovian CA (ρ=10-100 Ohm•m, H<10 km) which covers almost all of West Periazovian massif (the southern part of the Orekhovo-Pavlogradian SZ, the Gulyai-Polish and Andreevsky blocks) and the deep (10-50 km) low-resistivity (ρ up to 100 Ohm·m) in the area of the Gruzsko-Elanchik region.

Within USh (of Middle Peridneprovian Mb and massifs of crystalline rocks Uman, Korsun-New-Myrhorod, New-Ukrainion) and a part of folding Donbass were found regions of anomalously high resistivity of rocks in the Earth crust.

Geoelectrical parameters are also observed to be considerably non-uniform in the USh mantle. In the southwestern part of USh was found a conductor with the cover at 70 ÷ 120 km with ρ=25-50 Ohm·m. Its boundaries lie at: the northern is along $50^0 \div 48^0$ northern latitude, the eastern is along 30^0 eastern longitude, the southern is Chisinau fz, southen from $47^0$20`northern latitude. In the west the conductor deepens to 90-100 km and is galvanic connected with the anomaly in the upper mantle of the Carpathian region. We can assume the existence of a mantle conductor in the depth interval 50-120 km in the southern part of the

Ingulian Mb. Its northern border should pass south of $47^0 20`$ northern latitude. To the east of $32^0$ eastern longitude it reaches to $47^0 40`$ northern latitude. The maximum distribution to the north is observed along the Kirovogradian CA, in the deep fz - West-Ingulian and Kirovograd. And also the existence of several local upper-mantle heterogeneities in Kirovograd ore area.

The nature of the anomalies of increased electrical conductivity at depths of up to 2.5 km can be due to the presence of the association of electrically conductive minerals (sulfides, graphite) in the zones of metasomatic mining of rocks leading to the formation of ore mineralization (uranium, gold, rare metals). Anomalies of increased electrical conductivity in the Earth's crust at depths of 5-30 km and tops of the upper mantle 50-120 km, most likely reflect the traces of the impact of modern mantle fluids.

Anomalies of high electric conductivity on the territory of PeriDobrudga depression and North Dobrudga from the surface of the Earth crust to the upper mantle are identified. Stretched for hundreds of kilometers conductors are associated with deep conductive fz of different ranks and with their intersections: Frunze, Saratsky, Bolgrad, Cahul-Izmail, Chadyrlungsk fz and others. A highly conductive layer is identified on the southern side of PeriDobrudga depression which lies at the depth corresponding to the lower crust and the top part of upper mantle. North side of PeriDobrudga depression is characterized by the distribution of electrical conductivity in the upper mantle which is the same as that of EEP, while presence of conductive structure at the depths of 110 to 160 km differs the southern slope from the northern one. Without a doubt, there is a relationship between seismicity and geoelectric parameters that reflects the current state of the Earth's interior. The origin of high electric conductivity anomalies may be the result of geodynamic processes on the boundaries of regions characterized by various manifestations of these processes. Earthquake sources as well as anomalies of high electric conductivity are mainly correlated with active deep tectonic fz and juncture zones of geological structures such as different age zones of Precambrian EEP and Cimmerian Scythian plate on the territory of PeriDobrudga depression and North Dobrudga.

Results of the quasi-3D film modeling of the data of magneto-variation profiling of Carpathian region showed that an anomaly in the Western Carpathians is related to the juncture zone of Flysch Carpathians and Inner Covers, including Pennenian and Marmarosh zones. An anomaly in the Southern Carpathians is related to the juncture zone of Inner Covers, separating Pannonia and Transilvania, and the Southern Carpathians; it is not related to Pericarpathian depression. An anomaly of the western part of the USh and Volyn-Podolian plate (Tchernovicko-Korostenian) is galvanically connected to Flysch zone of the Eastern Carpathians and Marmarosh belt. Western branches of the anomaly are located in the zone of deep Podolian fz and the juncture of the South-Western border of East European platform and Sciphian plate. Juncture of Sciphian, Mosean plates and Dobruja forms separate conducting body. Trans-European seaming zone is correlated to a set of anomalies of high electric conductivity in the Earth Crust of the Eastern Carpathians and Dobrudga. Geoelectrical model of the crust electric conductivity does not always correspond to the surface geology. Pennenian and Marmarosh belt as well as Flysch Carpathians are not a continious zone of high electric conductivity in the Earth Crust. Anomaly of the Precambrian USh and East European platform wedges into Alpine-Carpathians. High electric conductivity of the Earth Crust at the depth of 5-15km does not extend to the Eastern Alp and Dinarides. In other words, not the whole region occupied by intensive epigeosynclinal orogen regime is characterized by high values of electric conductivity at the Earth Crust depth.

CHEMICAL SEPARATION OF CHEMICAL ELEMENTS DURING PROCESS ORE PROCESSING

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During the processing of ore deposits in the composition of processing solutions other than the target production components normally present a number of other valuable components from the solution compartment which can have a commercial interest and improve the profitability of the process. One of the methods that make it possible to separate the necessary elements is electrodialysis. The electrodialysis method was used by us to extract a number of elements during processing of alunite ores. In addition to the main components - Al, K, Na, S, there are other univalent, divalent cations and anions. As we used a multi-chamber electrodialysis electrodialysis installation PC CELL 64004 and the installation of their own making. The electrodialyzer used cation exchange, anion and bipolar membranes of general purpose, as well as monovalent cation exchanger and anion exchanger membranes. According to our method, we can separate monovalent from two or more valence elements. The remarkable feature of this scheme is that many elements that are contained in very small quantities and at first glance are not of interest, with multiple turnover cycles, these components are summarized as a result of attaining the concentration of interest. This method is quite economical and completely ecological and can be successfully applied for various processes during ore processing. The application of this method is especially effective for deposits with small reserves when extraction of the main components may not be profitable, the complex extraction of other valuable elements may be attractive for the processing of similar ore objects. With the same success, the electrodialysis method can be used to extract different elements from natural waters and wastes of various types of production.

GEOLOGICAL EVENTS AND PROCESSES; GEOLOGICAL RISK ASSESSMENT

SEISMOTECTONIC EVALUATION OF THE EARTHQUAKE DATED AT 12 NOV. 2017 AT IRAQI-IRANIAN BORDER

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The northern east areas of IRAQ consider as one of the most important areas geologically, because these areas have different geological structures with very complicated morphology and because also situated near to Zagros thrust belt (collision zone between Arabian and Eurasian plates). Therefore, these areas are very active seismically and tectonically. From this point this study has been focused on the geological interpretation and seismotectonic analysis of the last major earthquake at the Iraqi-Iranian border near to Halabja town\Iraq.

According to that, a seismotectonic analysis has been conducted for the earthquake dated in (12 Nov 2017) and its epicenter located at the geographical coordinate (34.902°N 45.952°E) with a magnitude (7.3) at Depth (19 km).

The purpose of this study is to explain the sources and reasons of this earthquake and to determine the geological structures (fault), which is the seismic activity released on it to produce this earthquake. This study refers to Mountain Front Fault (MFF) as a surface plane for this seismic activity, because this fault considers as one of most effective fault in Loristan promontory within Zagros zone. This study refers to the reason of the majority of this earthquake, and why the shaking intensity of this earthquake was strong.

Remote sensing data, USGS, GFZ, and other international seismological institutions data have been used as database in this study to locate the earthquakes epicenters in the study area and to prepare morphotectonic analysis of the earthquake source and the mechanism of this earthquake.

As a final result a tectonic model has been produced to demonstrate the source and the mechanism of the tectonic activity for this earthquake.

THE STRUCTURE OF THE POROUS SPACE OF THE RESERVOIR INTERVALS OF THE BAZHENOV FORMATION OF THE PRIOBSKOYE FIELD OF WESTERN SIBERIA

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Bazhenov formation is one of the most promising sources of shale oil and gas. Its structure has not been fully studied yet, and wells with industrial inflows of oil from the Bazhenov formation are alternating with "dry" wells. Therefore, the question of studying the structure of the Bazhenov formation is particularly acute.

Previously [1, 2], it was shown that the structural arrangement exerts a significant influence on the porous characteristics and reservoir properties of the rocks of the Bazhenov formation. The paper is devoted to the investigation of the rocks of the Bazhenov formation of three wells in the Priobskoye field located in different structural zones: wells A and B, according to the structural map on the top of the Bazhenov formation, are at different depths in the basins, while well C is higher along the isohypses, in the slope of the elevation to the west of it. It is of interest to study the change in reservoir properties and lithological composition over the area of the deposit, to search for a possible relationship between them, and to assess the influence of structural features and secondary processes on the formation of reservoir properties.

In the framework of the paper, a study was made of the reservoir properties, the description of the core and the rock sections, the determination of the mineral-component composition (by mass and volume), and the geophysical studies of the wells, on the basis of which a number of conclusions were presented below.

In the wells studied, the values of the reservoir properties of the Bazhenov formation samples range from 0% to 7% for porosity and from 0.001 (detection limit of the device) to 1.360 mD for permeability.

The reservoir properties of core samples and the lithological composition differ depending on the location of the wells in the area of the deposit and the flow of various secondary processes. It is established, to which group of lithotypes each reservoir interval is confined.

In wells A and C, silicite-radiolyte is isolated as reservoir interlayers, the pores of which are mostly isolated from each other, the reservoir is technically stimulated.

In well B, the reservoir is represented by a kerogen-clay silicite and kerogen-clay-siliceous rock, the porosity of which is formed as a result of transformation of the organic matter and the formation of voids between the kerogen and the mineral matrix, probably as a result of local heating.

Thus, the main pore forming processes in the Priobskoye field in the studied wells are the leaching and recrystallization of the siliceous substance (wells A and C), additional local heating (well B). A more detailed study of the core material of the rocks of the Bazhenov suit in these and other wells is needed, as well as the identification of signs of secondary processes and their search criteria using well log data and seismic investigations.

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OIL AND GAS PROSPECTIVITY OF NEOGENIC SEDIMENTS OF WESTERN ABSHERON

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The prospect of oil and gas in Western Absheron can be evaluated in several ways: tectonic, geochemical, temperature and litofacial. Complex analysis of all these aspects characterizes the prospect of oil and gas in the region.

Tectonic aspect. Miocene sediments in Western Absheron are considered promising for the formation of oil and gas production and industrial significance. The high prospect of the complex has been confirmed in the production of oil-extracting oil-gas fields of industrial importance. Thus, Garadagh, Suban, Binagadi, Masazir, Sulutepe and others. oil and gas were extracted from the various horizons of Miocene sediments.

Local oil and gas collections can also occur in tectonic fractures and fragmented tectonic zones, where clay rocks are tightened, shattered and collapsed. The existing cracks, hydrocarbons located in areas, fill the layers and shell blanks under high altitude pressure.

The southern and central part of the Pliocene sediments of the Western Absheron Miocene sediments is considered to be the most promising. The discovered and exploited beds in this zone confirm their high prospects. The prospect of oil and gas in the Miosen sediments in the northern part of Western Absheron is sluggish, as the thickness of the tiosides decreases to the ground surface and is strongly washed in some places.

Geochemical aspect. According to the geochemical parameters, the prospect of oil gas is mostly monitored from the marine area of the study area to the western part of the area. The decrease in the thickness of sediments (Maykop, Oligocene, etc.), which gradually reaches the dry part of the field, is accompanied by a decrease in its organic residues. As a result of the researches, it was determined that the amount of organic matter in the rocks decreases from 0.6% to 0 in north-west and west from the south-east and 0.6% to the north.

Temperature aspect. It should be noted that thermobaric and hydrogeological conditions play an important role in identifying promising areas. The temperature regime has a special role in determining the oil and gas status of each region. Thus, the thermobaric conditions of the region should be high for transformation of scattered organic matter into hydrocarbons, as mentioned in the geochemical aspect. From this point of view, according to the researches carried out, the depth corresponding to the starting temperature of the oil formation here is 3.5 km.

DISTRIBUTION OF QUATERNARY TECTONIC DEFORMATION ALONG THE COAST OF THE GULF OF GÖKOVA: INFERENCE FROM UPLIFTED SHORELINES

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Gulf of Gökova is located soutwestern part of Turkey. This region is an extentional region characterized by horst and graben structures delimited by normal faults. The gulf is one of the most seismically active region in the Agean Sea. Recently occurred 21 July 2017

Bodrum Earthquake Mw:6.6 is the latest example of this activity. We observed 20-25 cm uplift of tidal-notches along the coast of the Karaada Island as a result of coseismic deformation. This was the first coseismic coastal deformation observation along the Turkish part of the Agean Sea. Based on these observations we enlarged the study area and investigated whole coast of the gulf from Bodrum to Akyaka and Akyaka to Knidos antique city. We found uplifted tidal-nothces at several places along the coast. These notches are very selective to lithology and structure of rocks. Limestone rocks without steep beddings are prefereable for notch formation. In the southern coasts of the Gulf especially in the Mersinlik and Merdivenli coves. and around the Körmen Bay, we observed several levels of uplifted tidal-notches up to 1 m above sea level. Unfortunately these tidal notches are dissappeared when lithology of rocks change from limestone to ophiolitic rocks at the southern part of the gulf. The most uplifted and also preserved uplifted tidal notches are located between Ören town and Akbük Cove. These tidal notches has four distinct levels that rise up to 1.5 m above sea level. They are carved into the massif limestone. There also uplifted tidal-notches toward the Bodrum town indicating uplift of the northern part of the Gulf. We collected lithophaga samples to date tidal-notches by using 14C radiocarbon dating method.

As a conclusion our findings imply presence of active submarine faults very close to shoreline. Several levels of notches indicate co-seismic uplift of the shoreline by several large earthquakes that gave rise to relative sea level change.

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HISTORY AND FORMATION CONDITIONS OF NAKYN PLACERS CONTAINING KIMBERLITE INDICATOR MINERALS

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The Nakyn kimberlite field is located in theSrednyayaMarkha diamondiferous district (eastern part of the Siberian Craton, Markha-Tyung interfluve). There are three diamondiferous kimberlites (Nyurba, Botuobaand Maiskoe) on this field. Kimberlite indicator minerals (KIMs) in this bodies are presented mainly by pyrope; picroilmenite and chromite are almost absent.

More than 250 kimberlite indicator minerals from Nakyn placer, which located in the Nakyn kimberlite field, were studied. Kimberlite indicator minerals in placers are presented mainly by pyrope,as well as in known Nakyn kimberlites pipes. The main methods of investigation are typomorphic and ontogenetic analyzes [1], realized by optical and electron microscopy, and microprobe analysis. Ontogenetic analysis is reconstruction of individual development history of grain or placer, as a sequence of morphogenesis stages (i.e., those periods of mineral evolution when it acquired the certain characteristic morphological features because of condition changes of the geological environment). Typomorphic analysis is reconstruction of geological conditions, which are associated with various stages of morphogenesis.

Most of pyropes from the Nakyn placer are slightly rounded and have signatures of chemical weathering in Middle Paleozoic laterite profile (Figure (a)). Pyropes are dissolved in different degrees. Mainly pyropes have weak tracers of chemical weathering, so grains is seen to be slightly rounded before dissolution, that is typical feature for transport in continental conditions. Often pyropes with signatures of chemical weatheringare characterized by polished surfaces (Figure (b)) postdating dissolution. Polished surfacesare associated with the ingression of the sea basin. There are single grains with medium and strong degree of roundness.

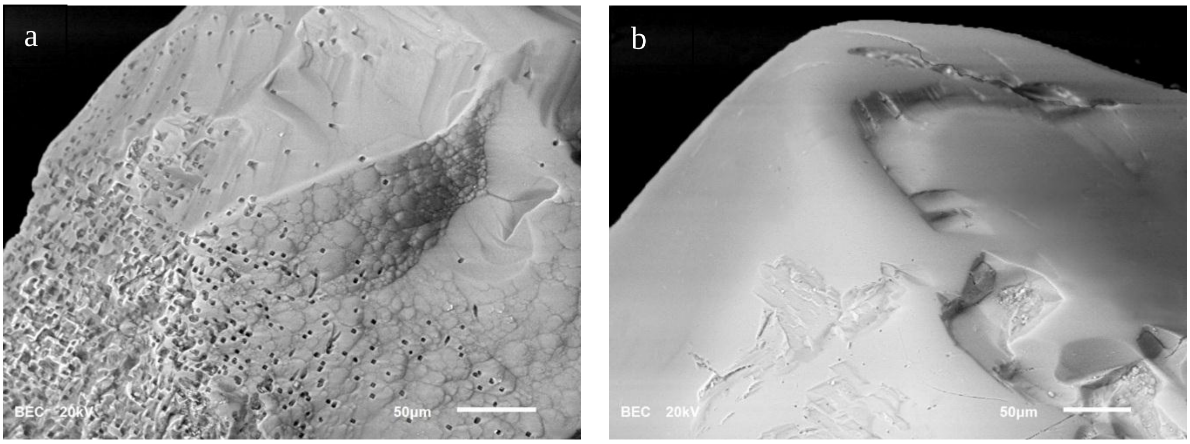

Fig. Pyrope morphology from Nakyn placers: a - pyrope with weak wear postdating dissolution, b - pyropepolished surfaces.

Based on morphological features of the pyropes, it is possible to reconstruct the history and formation conditions of the Nakyn placers [2].

Nakyn kimberlites were formed in the Middle Paleozoic (Late Devonian, early Famennian) [4]. At that time the territory was elevated, that caused active kimberlite erosion. Thus, continental sedimentary hosts of KIMs were formed. Under such conditions kimberlite indicator minerals experienced only weak wear. In the latest Famennian-earliest Early Carboniferous the Siberian craton was exposed to lateritic weathering in a tropical climate [5]. Minerals, especially pyropes, acquired signatures of supergene alteration (dissolution) in laterite weathering profiles (Figure (a)) [1, 2]. It was the only event of laterite formation in the Phanerozoic geological history of Siberia, whereas later weathering events did not cause dissolution of minerals. Therefore, traces of dissolution reactions on pyrope grain surfaces can have appeared in the Middle Paleozoic only, which places rigorous constraints on the age of the primary kimberlites that originally hosted these minerals.

In the Upper Paleozoic ingression flooding after laterite weathering took place. KIMs experienced only weak wear in the ingression settings, and hard minerals, such as pyrope, acquired polished surfaces [3]. The second stage of abrasion was superposed on earlier dissolution of grain surfaces and in rare cases traces of chemical weathering werecompletely destroyed (Figure). Later the Upper Paleozoic deposits were completely eroded, and indicator minerals, including pyrope, were redeposited in the Lower Jurassic deposits, which are currently the main sedimentary hosts of KIMsand diamonds.

Chemical composition of pyropes from Nakyn placers corresponds to diverse parageneses, including those of diamond assemblage [6]. Such pyrope composition is typical for the Middle Paleozoic diamondiferous kimberlites.

According morphological features and chemical composition of pyropes from the Nakyn placers, the Middle Paleozoic diamondiferous kimberlite sources, which are not known yet, can take place. The history of the Nakyn placer development completely corresponds to the history of Yakut diamond province development.

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SEDIMENTARY MODELLING USING DIONISOSFLOW SOFTWARE: PROGNOSIS OF RESERVOIRS DISTRIBUTION

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DionisosFlow modeling is based on the deterministic reconstitution of the depositional processes in a sequence of time steps from the past to the present (“Forward Stratigraphic Model”). Built and calibrated on well data and seismic surfaces as well paleobathymetric data, it relies on a dynamic-slope approach which allows an average geometry of sedimentary units and their average facies content to be quantified (sand-shale ratio, depositional water depth, etc.). Furthermore DionisosFlow results can be dragged automatically to Basin models (TemisFlow) through the OpenFlow platform, ensuing enhanced Petroleum System Assessment to be achieved.

DionisosFlow is 3D stratigraphic modeling software developed by Beicip-Franlab and IFP Group in order to:

• Quantify basin geometry from a static view of past geometries and paleobathymetry (key geological markers) to a 4D geological movie (evolution of 3D stratigraphic mesh through time),

• Test and quantify the role and interaction of several large scale sedimentary processes,

• Predict the location and quantification of sedimentary volumes (siliciclastic and/or carbonate reservoir) in unexplored areas.

The basic workflow for DionisosFlow modeling implies four main stages:

1. The 3D model building based on available data of the study (input data),

2. The definition of environmental parameters within DionisosFlow (sediment source, sediment supply, transport parameters, eustasy, subsidence, erosion rate, etc…),

3. The qualitative and quantitative calibration of simulation results. Simulation results are compared with well data (1D control – comparison of simulated/calculated shale volume), seismic/stratigraphic sections (2D control), and by thickness maps (3D control of sedimentary volumes),

4. The transformation of shale/sand ratio into lithofacies on the base of environmental criteria and the interpretation of reservoir, seal and source rock distribution in the project area (Figure).

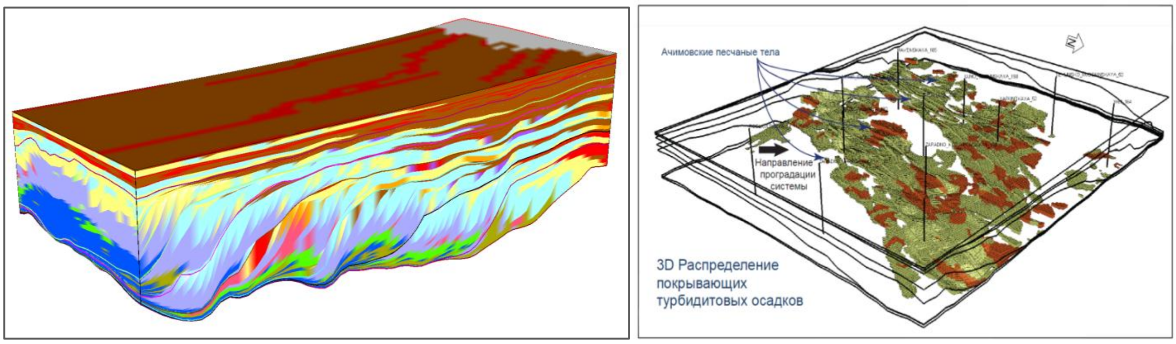

Fig. The model of facies distribution taking into account physical parameters and lithostratigraphic traps prediction based on sedimentary modelling.

The main objective of this paper is to evaluate a high-resolution prediction of facies distribution (potential reservoirs and seals) through the Late Jurassic-Early Cretaceous interval over the central part of West Siberian basin using 3D DionisosFlow depositional model. It allows:

1. The validation of regional sedimentary concepts, and the checking of facies interpretations obtained though alternative methods (petrophysics and geophysics);
2. The prediction of facies distribution in poorly-explored areas;
3. The definition at regional scale of facies maps and net-sand / net-shale maps for all the stratigraphic intervals (and not only for reservoir layers), which will serve as inputs for the basin model using TemisFlow software.

Finally, the distribution of potential reservoirs, seals and source rocks are analyzed in order to identify potential prospective areasover the central part of West Siberian basin.

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EFFECTS OF THE OPERATING REGIME OF RESERVOIRS ON THE STATE OF LOCAL SEISMICITY

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In the zones of large reservoirs, there is a threat of increasing seismic activity with unpredictable consequences. The solution to this problem is possible on the basis of a comprehensive study of the processes occurring in the bowels under the influence of the unstable exploitation of the technogenic object [1]. Cognition of these processes will answer many questions to improve the geodynamic safety of their operation and its activities in the region. The possibilities of formation of induced or induced seismicity are considered here by the examples of comparison of the operation regimes of the Gissarak, Tupalang (Southern Uzbekistan) and the Andijan (East Uzbekistan) reservoirs with the level of local seismicity [2].

As a result of carrying out full-scale experimental seismic surveys on the localization of local foci for the zones of the reservoirs of Uzbekistan, we have created a seismometric database on the body of the dam and the sides of the reservoir. It includes synchronous recording of earthquakes and microseisms on the crest and base of the dam. Possible accelerations are determined.

A package of accelerograms of a possible strong earthquake in **ASCII** format (no less than 7 points) is compiled according to calculations of accelerations on the basis of a dam with a catalog of earthquakes within a radius of the reservoir up to 150 km with a magnitude of more than **M≥2** and from 150 to 350 km with a magnitude of **4≤M≤6**.

It was revealed that for a higher reliability of materials, a sufficient number of the same records for strong earthquakes (more than 6 points) occurred in potentially dangerous focal zones. As a result of modernization and ensuring the stable operation of seismic stations in the territories of the Gissarak and Tupalang reservoirs of South Uzbekistan, it is determined that the maximum possible seismic acceleration is in the range **0.24-0.32 g**, or in the range of 8.0-9.0 points.

The number of earthquakes for the last 2014 and 2015 is quite small, and this is possibly due to the continuation of the seismic calm in this region. As a result of seismogram analysis, the following has been established: seismic vibrations on the crest of the dam are enriched by harmonics associated with resonant phenomena, which must be investigated within the framework of separate, maybe innovative programs.

Currently, a network of local and regional seismic stations is working around the Gissarak and Tupalang reservoirs of Southern Uzbekistan for the possibility of recording earthquakes with the energy class **K≥7**. The operational regime from 2010 to mid-2016 and the time of earthquakes with different energy classes in the near zone of the reservoir for 2010-2015 according to the catalog of local earthquakes is shown in http://isas.uzsci.net/last-earthquakes-ru.php?language=ru.

Each peak of the water column corresponds to an earthquake of certain energy classes. If they are accepted as reservoirs induced from operation, then the energy distribution ***lgE***, the values of the total voltage drops from these earthquakes $\Delta\sigma$ and the variation of this strain $\delta\varepsilon$ must be linearly coordinated. The graphic dependencies shown by the graph below show the above assumption (Figure).

Spectral analysis of earthquake records with equal epicentral distances has shown that the spectral diagrams are characterized, basically, by one maximum and by a comparatively smooth decay of the high-frequency part of the spectrum. This is probably due to the "hard" seismic properties of the focal environment of seismogenic faults. The maximum values of the gain in the frequency range in which the spectra were calculated vary from 1.02 to 6.8 and, in most cases, from 1.3 to 3.7.

Analyzing the general and background seismicity within a radius of up to 50 km from the Gissarak and Andijan reservoirs of Uzbekistan, it was revealed that the seismic regime for materials for the period from 2010 to 2015, with the energy class ***K≥9.0*** and in recent years - from 2014 to June 2016 , with ***K≥8.0*** shows that the number of earthquakes and the density of epicenters in the area under study in different years are different.

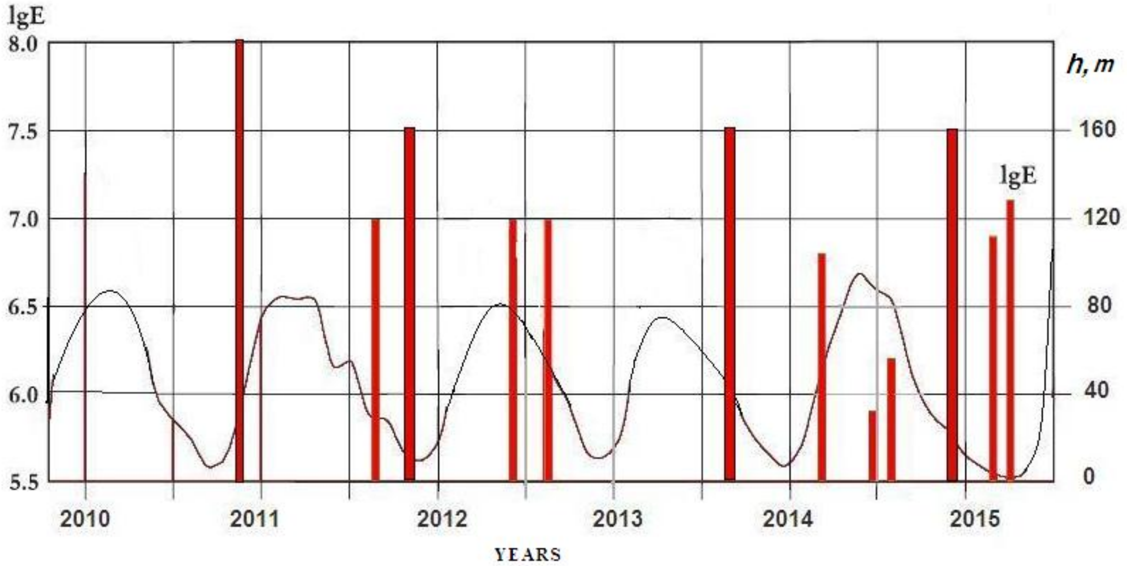

Fig. The test averaged operating mode of the reservoir and earthquakes with different energy classes in the near zone for 2010-2015.

At the end of 2015 and in the first months of 2016, there was a sharp increase in the intensive fall in water volume in the Gissarak reservoir. At 12 km from its alignment in the western region from it and 14 km east of the city of Kitab (coordinates λ=67.24, φ=39.06), on April 15, 2016, a tectonic earthquake with a magnitude M = 4.9 and energy class K = 12.5. The intensity of concussion in the epicenter was I = 6-7 points (MSK). In December 2015, the Gissarak facility was informed about the possibility of an earthquake with an energy class above K≥11 in the near zone of the reservoir. This earthquake can be attributed to the induced.

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ABOUT STRUCTURAL TECTONIC PROPERTIES OF MESOZOIC SEDIMENTS OF SHAHDAG-KHIZI SINKLINORIUM

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The southern part of Shahdag-Khizi sinklinorium includes Khizi (Kashchay, Tegchay, Shurabad, Beyimim, Sitalchay, Yashma areas) and Dibrar-Yashma zones (Gadisu and East Gedi areas).

Here are some of the many signs of the Mesozoic sedimentary tectonics, which are under the bedrock cover, which have not been perfectly studied and have serious interest and controversy.

Discovered thickness of Mesozoic sediments in deep wells drilled at Yalama, Shirvanovka, Imamqulukend, Khudat, Khachmaz, Gusar, Talybi and Agzibekala. At the same time, Triassic and Lower Jurassic sediments, which form the sub-divisions of Mesozoic sediments, have only been discovered in Agzibekala. Middle Jurassic sediments discovered in wells in Yalama, Khudat, Khachmaz, Gusar and Agzibekala. Finally, the top of Jurassic was only opened in Achzıbirchala. In Gusar, the Jurassic is directly transposed with the Pont sediments in the Sarmat, Khachmaz and Talebi areas, and in the Agzibekala area. Apart from the Yalama and Khudat ridges of the Gusar-Devechi sediments, the Chaldean sediments were removed in the hilltop part of the other ridges. As a result, the asymmetric Mesozoic age braxianiclinians in the Yalama, Khudat and Imamqulukand fields are observed in the Paleocene and Eocene sediment complexes. These ridges are also reflected in the Paleogene sediments. Thus, in the Samurian zone, the local rhinos are embedded and Meso-Cenozoic sedimentary complexes have been subjected to various degrees of aggression throughout the sedimentary complex.

The Gusar-Khachmaz Ridge Zone, which is 15-20 km wide in the center of the Gusar-Devechi subsidiary, extends southward to the west and 75 km to the west. Here, a number of local climbing (Gusar, Khachmaz, Carkhi, Aghzıbirchala and others) were identified on the Paleozoic aged base.

Miocene deposits lie in monoclinal layers, which are incompatible with the local junctions formed by the Middle Jurassic sediments in the Khachmaz and Tsargi areas. The Middle Jurassic sediments are covered transgressively by Pontian layers. Therefore, most of the Cretaceous, Paleogene, and Miocene do not participate in the formation of the wrinkles.

Mezozoy and Cenozoic at the local rises (at the crossroads of West Winery, Qaynarca, Gizilburun), located in the south-eastern slope of the southern east of the Tala-Qaynarca anticline zone in the center of the Guba-Davachi (Qaynarca) depression, separated from the Gusar-Khachmaz Ridge Zone Stratigraphic units are marked. The characteristics of these ridges are the absence of periclinal shocks. With high hipsometric condition, the Maykop sediments lie in the middle of Jurassic uncomformable.

According to geophysical data, sharp decrease and thickness of the thicknesses of separate stratigraphic units of the upper Cretaceous and lower Miocene in the passage areas of the Guba-Khachmaz ridge of the north-eastern slope of the Guba-Devechi basin is noted.

Here, the Siazian monklinic narrow stripe and upright sedimentary sediments (up to Barrema) comes in contact with the Paleogene-Miocene and Pliocene layers. These sediments are embedded in the center of the sediments in the north-east direction and are involved in the formation of local rhinoplasty. In some places (Siyazan-Nardaran, Saadan, Amirkhanli) these sediments were overtaken by the Chaldean sediments. The thickness of the Paleogene sediments decreases, with the right wing.

The Meso-Cenozoic sediments of the Caspian basin, Devechi basin, Tangi-Beshbarmak anticlinorium, Khizi region) and local rocks found there. Since the Upper Jurassic sediments were washed away, the Lower Cretaceous layers laid transgressively on the Middle Jurassic, and the Titan limestones, which were just above the Gilgilcay, were south-east. Mesozoic ridges in northern and north-eastern parts are quite epiphany, monoclinal, pliocene, and modern sediments. The closeness to the Greater Caucasus is intensified. Comparison of these seismic data with seismic geological data and deep drilling data shows that most of them are not reflected in the above-mentioned stratigraphic units. Compared with the Mesozoic sediments, there is a totally different idea, as the Jura sediments have fully controlled the formation of Mesozoic sediments [1, 2, 3].

By summarizing it, it can be noted that the Cenozoic sediments covered the Mesozoic and deepened in the north-east direction towards the Caspian Sea and widely spread. Recall that until the 1980s, the Chaldean sediments had inherited the plains of the Caspian-Quba NKR. However, drilling of Agzibirchala well No.1 revealed that not only the Cretaceous.

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RELATION OF SEISMIC ACTIVITY WITH TECTONIC STRUCTURES IN SOUTHERN SLOPE OF THE GREATER CAUCASUS (WITHIN AZERBAIJAN)

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The stress-state of the Greater Caucasus’ lithosphere is a consequence from compression of the Alpine-Himalayan orogenic belt, located between collision zone of Eurasian and Arabian plates, towards north-west. Based on detailed analysis of historical and recent seismic data, the southern slope of the Greater Caucasus depicts the long-term and high-level magnitude seismicity in this region. Our current study is inspired by a series of strong earthquakes that occurred in the studied area in 2012, 2014, 2017, 2018. Here, we have employed a technique which allows analyzing the foci zones of these earthquakes in terms of correlation of focal mechanisms with the fault zones. We used different approaches based on clustering and focal mechanisms to analyze and differentiate various earthquake groups as well as different tectonic regimes with distinct characteristics. Further, on the basis of the spatial and in-depth distribution of the earthquakes within the studied area, we defined areas and "geological levels", which mean the boundary between sedimentary layer and consolidated basement, with different seismic activity.

It is known that, during the continental stage of Alpine tectogenesis (starting from the end of Miocene), the process of intensive lateral compression was caused by an intrusion of the frontal wedge of the Arabian indenter into the buffer structures of the southern frame of Eurasia. This is particularly evidenced by data produced by GPS monitoring of modern geodynamic activity, which demonstrates the Southern Caucasus block's intensive (up to 29 mm/year) movement toward northern direction as compared to relatively stable indicators for the Northern Caucasus microplate (0-6 mm/year). This, in turn, is a reflection of the ongoing pseudosubduction regime in a band of collision junction of these microplates. This process is admitted as a reason for the described region's historically observed seismic activity, which is spatially confined mainly to the Southern slope's accretionary prism area and the adjacent strip of the Southern Caucasus microplate.

The results of this study demonstrate mainly thrust faulting focal mechanism with a number of normal faulting and strike slip component. Mainly western and central parts of Greater Caucasus are characterized by north-eastern-south-western (NE-SW) tension. In the eastern part, the tension reverses into intensive compression.

GEOECOLOGICAL RISKS OF THE FUNCTIONING OF AUTO TRANSPORT SYSTEMS IN UKRAINE

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Auto transport systems (a combination of highways and the flow of vehicles that moves on them) are a significant source of negative impact on the components of the environment at all stages of their life cycle.

There are a lot of scientific studies are devoted to the study of the influence of motor transport systems on atmospheric air, surface water and roadside soils. At the same time, an analysis of the current ecological researches shows that insufficient attention is paid to the study of geoecological problems arising in the course of their functioning. Environmental risks of impact on the geological environment are the possibility of the emergence and activation of exogenous processes (linear and planar erosion, landslides and crumbling when cutting slopes and forming embankments, subsidence of the surface, flooding, development of karst and so on).

Geoecological problems associated with the functioning of the auto transport complex are very relevant for Ukraine, since the total length of highways in the state is quite large and amounts to 169,495 km, they pass through flat, mountainous, arid and marsh ecosystems. In addition, Ukraine has a high transit potential, and it is also planned to actively develop it until 2030 by new construction and an increase in the length of highways. This causes the urgency of the study of this problem.

Let's consider features of influence of auto transport systems on a geological environment at stages of its life cycle construction and operation.

Analysis of the regulatory and technical base of Ukraine regarding the minimization of geoecological risks associated with the construction of highways has made it possible to single out the normative document SBC B.2.3-218-007: 2012 "Ecological requirements for highways. Projecting", which most fully reveals the problem.

The construction of highways in areas with complex geological and hydrogeological conditions (60% of the highways planned for the construction of Ukraine are inherent) can cause a negative impact on the geological environment. The main factors of this impact are dynamic loads on the roof of rocks and reformatting the relief due to their displacement during excavation.

The direct impact of highway construction on the geological environment is manifested in the activation of exogenous and endogenous processes, which can lead to disruption of the stability of the highway being built, artificial structures and other natural and man-made objects in the zone of its influence.

Indirect influence of construction and reconstruction of highways on the geological environment is manifested in the activation of dangerous natural processes, which leads to the transformation of ecosystems. The main forms of impact on the geological environment of technological processes of highways construction include the following:

1. Development of quarries and reserves for the extraction of soil – leads to increased erosion; shifts; changes in the conditions of local water flow and surface flushing; biotope change; disturbance of biocenosis.

2. Clearing the right-of-way, removing the fertile soil layer – erosion, deflation of the soil surface; violation of the biotope and biocenosis.

3. Construction of embankments and depressions – processes of denudation, shifts; change in conditions of surface runoff and surface washout; biocenosis partition:

– in wetlands – a change in the water supply system, a different level of groundwater from both sides of the mound;

– in the highlands – shifts, shedding; change in surface and underground runoff.

4. Regulation of riverbeds near the bridge crossings – a change in the shape of the riverbed and the flow velocity; abrasion.

When the highways are operated, the impact of the auto transport system on the geological environment is the occurrence of fluctuations. They are caused by road irregularities, as well as unbalanced engine and transmission forces. These vibrations are transmitted to the frame through the car body and the road surface to the elements of roadside space. In this case, the impact of vibration is considered in two aspects: the impact on the driver and passengers of the car and the impact on surrounding objects (buildings, structures, soils and biological objects in the affected area).

The result of studying regulatory and legal documents on the regulation of vibration effects (BS 2.2.4 / 2.1.8.566-96 "Industrial vibration, vibration in residential and public buildings", OSSS SS 12.4046-78 "Methods and means of vibration protection. Classification") showed almost complete absence in Ukraine of normative documents of the road industry on rationing and minimizing the influence of vibrations from highwys on the roadside space with the exception of the normalization of the impact on buildings in localities – protection consists in isolation from the source of vibration by the distance (Table).

Table

Ways of minimizing the vibration impact from highways of different categories

Type of building	Residential		Hotels			Administrative	
Category of highway	I	II, III	I	II	III	I	II, III
Distance from the edge of the roadway, m	30	20	30	20	15	15	<15

This significantly increases the geoecological risks associated with their operation.

Thus, it can be concluded that the functioning of auto transport systems creates geoecological risks of different origin that lead not only to changes in the parameters of geological systems, but also to changes in ecosystems as a whole in the zone of their impact. The study of this environmental problem is an urgent task for Ukraine, taking into account the great variety of geological conditions of the territories along which its highway pass, and also in the aspect of developing its transit transport potential.

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STRUCTURAL FEATURES AND GENESIS OF KHACHKOVI GOLD-ORE OCCURRENCE

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Khachkovi gold-ore occurrence is located in Tsalka region, on the South slope of Mount Arjevani, in 4-km. north of Khachkovi. From the Northern part it is bounded by Arjevan-Bakuriani subdivision regional over thrust, from the South with Neogene-Quaternary lava flow. From the West and the East, the distribution of the ore field isdetermined by neo meridional directions faults structures and area of sub intrusive concentration bodies. The endogenic structural control of the ore field is determined by Arjevan-Bakuriani regional fault. In our opinion, it should be represents ore distributing structure and as in most cases of other mineral fields, it does not contain mineralization (Figure).

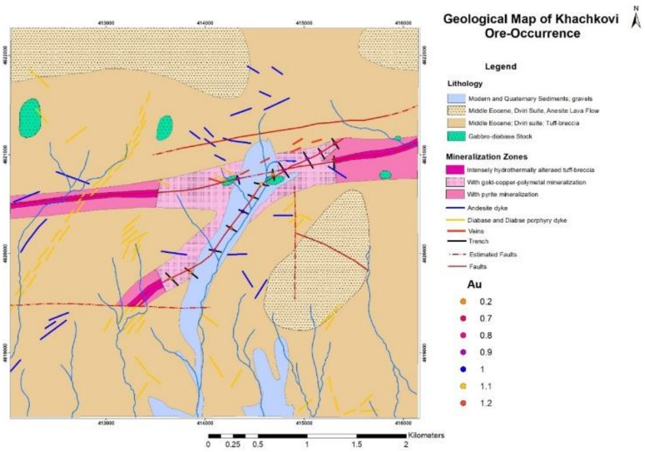

Fig. Geological map of Khachkovi Ore-Occurrence (According toM. Ckhelishvili).

Khachkovi gold ore occurrence is represented by hydrothermally gold-sulfide and pyritic types and is located in the top blocks of the abovementioned regional fault and is localized on its parallel, steeply plugging down fracture zones.

Between middle Eocene tuffogenic rocks are allocated subdivision orientation mineralization zones of 0,5 km width, which creates intensively mineralized zone along the river Khachkovi. It is represented by alteration rocks, which are saturated with quartz-calcite-barite veins. They contains veins and impregnations of sulphide. The quartz-baritization zone №1 is located in the source of the river Khachkovi gorge, on its right side. 70 samples were obtained from this zone, from where 58 channel sample were analyzed on gold, in 29 sample gold composition is more than 1g/t.

The Pyritization Zone №2is located on the first left tributary of the river Khachkovi. It is represented by a 50-70 m. mineralized and hydrothermally ferruginous altered zone. Were taken 90 samples, from where 55 samples were analyzed on gold. Gold content varies from 11g/t to 3,2 g/t.

The Pyritization Zone №3 is located on the left tributary of the river Khachkovi. It is presented with irregular pyritization, hydrothermally altered Andesite rocks. Alterations are mainly represented by silicification and kaolinization. 50 samples were taken from this zone, 30 of them were analyzed on gold. Gold composition varies from 0.8g/t to 1,7g/t.

On the based of available materials analysis and conducted works by us, provides to express opinion about genesis of Khachkovi ore-occurrence. It represents an apical part of magma system, where are developed propilitic and gold-bearing barite-polymetallic seam and impregnated mineralization, which is related to action of conventional system.

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UNDERGROUND WATER RESOURCES AND GEOLOGICAL PROBLEMS OF NAKCHIVAN REPUBLIC

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As in many regions of Azerbaijan, Nakchivan has freshwater resources, and surface water is uneven distributed. Hydrogeological studies conducted on the territory of Republic, by considering the quality of underground water resources distribution and which also uses the result set. The exploitation and prognosis resources of mineral and thermal water resources, if possible, their individual areas, it was for a horizontal water and industrial water, sweet. Problems in the supply of the population with water from water showing the amount of each specific area and hydro dynamic parameters, use the appropriate hydrochemical reflected on them this. The weathering of rocks, a thick layer of sediment alluvial plains are characterized by the presence of numerous river valleys filled with sharp relief the territory of the Republic of Nakchivan, the great thickness of a separation zone.

In the region, sweet and low mineralized groundwater are mainly concentrated in the fourth quarter of the Nakchivan sediment, while natural and thermal waters the rocks.The climate and relief forms of the mountanious areas of the area the distribution of surface water and the diversity of geological structures have led to the complexity of hydrogeological conditions here. Territory of the region is divided into zones in Karabakh and Zangazur and Daralayaz ridge is a major factor in the geological structure and its characterictics taking into account covering Arazyani responding to natural hydrogeological right.

Since the 2nd half of the XX century as a result of intensive exploitation of underground water resources and irrigation networks through process of changing the level, groundwater level in the field of reduction is changing, the hydrogeological conditions in the country. The particular foothill region as a result of long-term research, hydrogeological conditions and exploitations resources of underground water balances of learned.

Hydrogeological conditions of creation of underground water resources and natural areas layer type is represented by a hydrogeological conditions, hydrodynamic paranmeters according of distribution of allocated within the boundaries of the mountains hydrogeological identity, similar:

1. High porridge- crack water basin;
2. Sadarak pond- water of basin;
3. Sharur porridge- pond water basin;
4. Nakchivan pond- lay water basin;
5. Culfa-Ordubad porridge- lay water basin.

Nakchivanchay, Arpachay and Araz with his left arm, Alinjachay, Qaradere, Gilenchay, Venendchay and other small areas of a horizontal landscape of rocks and water, special role played by East, groundwater important source of nutrition, Ordubadchay.

Sadarak and Sharur plain in watery horizon is gaining momentum and pressure of the groundwater in the intermountain almost all areas of Nakchivan. The structure of relevant structures have their own characteristics, water flow and empty condition of the aquifer.

Groundwater depth of 0.9-3.4 m revealed as noted where in the area, and their bed of the Araz in the area, including the ford were among the horizon. Wet rocks, sand and water, and clay layer between the thickness of a growing movement toward change. Water depth of 6-181 m and 15-90 m along very often is between a rock. The absolute price level is 630-1320 m. Water taken from wells during water consumption was 0.15-20m, 0.01-15.8m.Wet rocks at odds of 0.2-15 m/day is usually between 100-400 and 3155, some 60 m/day. The wet field and this figure is manifasted in the central part of the plain where high.

Water has different properties on the terrain for quality. The total mineralization of groundwater ranges from 0.2 to 21 g/l grows to the Araz River. In the Kangarli Plateau, in many areas of the Sadarak and Sharur plains, they are sweet, some areas have less mineralization. Groundwaters in the Nakchivanchay plain are only sweet in the Nakchivanchay and Ceyirchay, their mineralization is increasing (3-5g/l)and increases to 10-21 g/l near Nehram and Guzgunt villages. Underground water flows along the Araz River plains, Kangarli and Sadarak plain with fresh water intake line designed for plateau. Julfa-Ordubad and Nakchinvanchay for the course: 52, 111, 72, 34, 49 and 318 m/day. Nakchivanchay and Ordubadchay mineralization less 14,2 and 26,4 42 m/day.

In plain areas Boyukduz and Nakchivanchay, between 2-3 and 1-2 along. In Sadarak, Sharur plain in 2-5 varies between 2-3 and 3-7 have less exploitation of water resources of the module in the Culfa-Ordubad2-5 l/km^2.

İt is advisable to continue the study of natural and age-related of the underground water resources, chemical and gas composition their impact in the environment by taking into account the natural and artificial factors.

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GEOLOGICAL PROCESSES RELATED TO VAKIJVARI ORE FIELD

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Guria ore region unites Vakijvari (70km^2) and Zoti (20km^2) ore fields. Within their boundaries are present more than 20 gold-bearing occurrences, which could be united into three groups according to their spatial position and composition. In particular, Vakijvari ore field comprises: Shemokmedi (Gonebis-kari, Jakhua, Gvarda ore occurrences), Pampaleti, (Pampaleti, Tsikhisubani, Lashigele occurrences), Vakijvari (Chachuasgele, Chkhikva, Nasakhlebi, Koris-bude occurrences) groups. Zoti ore field includes Zoti (Zoti, Charkhi, Tsiskvilistskali, Grdzeligora occurrences) and Surebi (Sanisgele, Sadzrokhia, Baramidzeebis-tskali occurrences) groups [1].

As a result of analyses of conducted geological activities in Vakijvari ore field, which comprises more than 10 gold-bearing ore occurrences, are singled out quartz-copper-polymetallic, iron ore-pegmatitic, sulphur-pyrite, copper-molybdenum-porphyry and low sulfidation ore occurrences.

In the ore-bearing field was held complex geological field, geochemical and geophysical survey. Is determined, that all ore occurrences in this ore field are spatially and genetically related to endo- and exocontact areas of syenite-diorite Vakijvari intrusive. These areas are represented by hydrothermally intensively altered and mineralized rocks. Ore bearing are as ore bodies, so adjacent metasomatites. Is determined that from the point of view of gold content, the most prospective are low sulfidation and copper-molybdenum-porphyry ore bodies.

Based on above discussed data, Vakijvari ore field could be estimated as prospective for gold (Nasakhlebi), molybdenum (Nasakhlebi), copper (Madnis-gele) and iron (Chkhikva, Chachua), from the point of view of resources. In our opinion, the most prospective among them is Nasakhlebi gold bearing copper-molybdenum ore occurrences, where we suggest conducting of further prospecting – estimation activities, which will be based on modern analytical basis. Besides, are worth of interest high grades of iron and rare metals in the ore occurrences of this group in general. In order to determine their long-term significance, we suggest to carry out new large-scale geological, geochemical and geophysical survey [2].

Aside from discussed ore occurrences in Vakijvari ore field are also known several ore occurrences (Tskhinkula, Gomi, Lashis-gele), which contain useful metal components of commercial value, which are very poorly studied. In the 60-ies of the previous century, prospecting drilling was carried out here when were cross-cut sulfidized mineralized zones with gold grade 1 g/t. According to existing in the Soviet Union demands, this was insignificant result and further investigations were stopped. In 2011, were collected 10 point test samples from the sulfidized area of apical part of Vakijvari intrusive (near the entrance of the head office of Bjuja hydroelectric power station) and in three samples gold grades varied within the limits 1.1 – 1.75 g/t (analyses were made in laboratory "Gamma" by means of atomic absorption method).

Besides, in the ore field were determined numerous geochemical, geophysical, heavy concentrate and etc. anomalies, which point out the great scales of mineral resources (gold, copper, lead, zinc, molybdenum and other metals). They represent not only already known ore occurrences, but those, which are still not discovered. Attention should be paid to high concentrations of thorium in the ore field, which correspond to commercial parameters of this element. It's determined, that to carbonate hydrotherms of mantle genesis is genetically related thorium mineralization, as for uranium, such kind of hydrotherms aren't able to transport it. If we take into account the geological history of the region and its genesis, than its obvious that here rather significant accumulations of thorium could be expected, especially that modern analysis of this element in this region haven't been, carried out so far [3].

In the end, we state that if we consider economic potential of Vakijvari ore field with complex factors than it should be estimated as prospective mining object. These factors are: complex character and scales (70 km^2) of metal resources of the ore field, developed and favorable infrastructure (high way (motor way), railway and marine sailing, cheap electric power (nearby the ore fields operates Bjuja hydroelectric power station), favorable geographic environment (subtropical climate, low hypsometric position of the object), cheap labour cost and etc. Should be taken into consideration the fact, that analytical studies of Vakijvari ore field were carried out 20 years ago, by the Soviet devises of low sensitivity and precision. If analytical study will be held in the ore field by means of modern, high-tech equipment, there's a great chance that mentioned reserves of the mineral resources here will significantly increase and even new commercial concentrations of metals will be defined.

Besides, in Vakijvari ore field are estimated only prognostic reserves of gold, silver, copper, lead and zinc; and on the contrary are not studied at all grades of platinoids and of such rare metals as cadmium, selenium, tellurium, gallium, germanium and etc. In the ore field, according to its genetic type, concentrations of these very elements should be studied in order to increase the chances to find out commercial reserves of new ore elements in it.

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PETROPHYSICAL CHARACTERISTIC OF ASMARI FORMATION AND DETERMINATION OF POROSITY TYPES IN WELLS NO. 2 AND 5 OF THE EAST PAYDAR OIL FIELD

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Petrophysics is the science of studying properties of rocks and their interaction with fluids. Porosity, permeability, degree of saturation, geometric shape of pores and radioactive properties are the most important petrophysical properties of rocks.Zagros Folded-Thrust Belt of Iran is as a part of Alp-Himalayan system in the north-eastern edge of the Arabic Plate. Zagros Mountain in southwest of Iran is one of the richest oil field in the world with %8.6 oil and %15 gas of world's proven reservoirs. There is no igneous activity and very rich in organic matter in source rocks and porous reservoir rocks and cap rock with suitable conditions for the production and accumulation of hydrocarbons in the unique Zagros folded belt. Asmari formation is the richest oil and gas reservoir in Iran and the Middle East and one of the richest carbonate reservoirs in the world. Asmari Formation is the youngest reservoir carbonate rock in Zagros zone with Oligocene-Miocene age. This oil field located in the Zagros sedimentary asymmetric anticline in the west of the country, north of Dezful and 110 km northwest of Ahwaz. The asymmetric anticline shows saddle form with NW-SE axial trend, 27.5 km length and 5.7 km wide.

The main objective of this research was to study the distribution of petrophysical parameters, determination of porosity and contact surfaces of fluids using well-logging data. The reservoir layers of the Asmari Formation were petrophysically evaluated using data from two oil wells located in the Zagros zone. For this purpose all available information were used including petrophysical log, geological reports, drilling and reservoir experiments. Petrophysical parameters calculated such as shale volume, total porosity and effective in determine and multimin sections, as well as the effects of shale on calculated porosity, water and hydrocarbon saturation, and the volume of minerals by well logging charts. To determine lithology, porosity graphs (neutron, density, and sonic), with photoelectric (PEF) charts, were used. Limestone, dolomite and sandstone can be detected using different cross-plot diagrams including neutron-density, neutron-sonic, density-sonic and density-photoelectric. Gamma ray log in sedimentary rocks somewhat reflects the volume of clay. According to the evaluations, the lithology of this formation consists of anhydrite, limestone, dolomite, sandstone, and also with varying percentage of shale. According to the thorium-potassium cross-plot, most of the clays are montmorillonite in well No.2, and illite in well No. 5. The average effective porosity and water saturation in well No. 2 are 21% and 24% respectively. In well No. 5, the average effective porosity was 19% and the mean saturated water was below 22%. Finally, using the velocity deviation log, the type of predominant porosity are fractures, channels and vugs. In this research, the sequence of the Asmari Formation was evaluated in two wells p-2 and p-5. In these two wells, a total of complete logs of the reservoir (full set conventional log) were taken. Figure shows the petrophysical parameters calculated in the sequence of each well in the Asmari Formation in the East Paydar oil field.

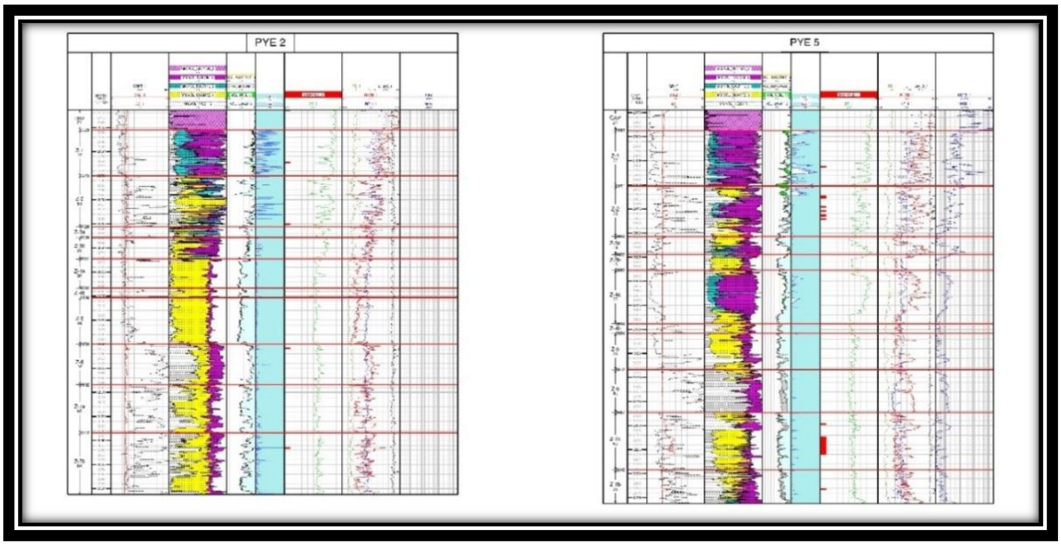

Fig. petrophysical parameters calculated in the sequence of both wells.

Acknowledgments. *We thank the oil company of the central regions of the Islamic Ripublic of Iran for providing the necessary information and data for studying the petrography and petrophysics of the Pydar oil field.*

MICROFACIES AND DOLOMITIZATION OF THE ASMARI FORMATION IN THE EAST PAYDAR OIL FIELD, SW OF IRAN

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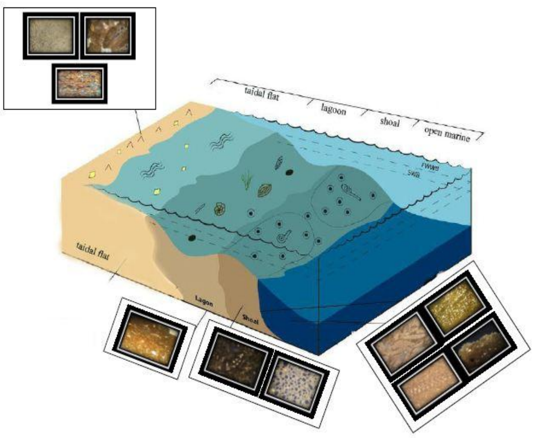
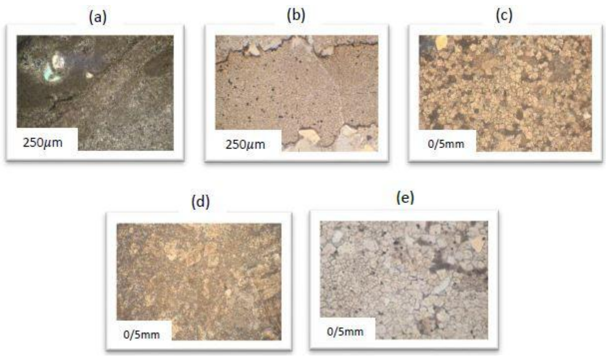
Zagros Zone in southwest of Iran is one of the most richest folded belt in the world. Asmari Formation is the richest oil and gas reservoir in Iran and the Middle East and one of the richest carbonate reservoirs in the world. Asmari Formation with Oligocene-Miocene age in the East Paydar oil field in the Zagros sedimentary zone is an asymmetric anticline with a northwest-southeast axial trend in the western part of the country, 110 km northwest of Ahwaz city.

The microfacies and sedimentary facies of the Asmari Formation were identified on the basis of the quantity and type of constituent grains (skeletal debris, ooid, peloid, intraclast), cement and matrix. Number of 200 thin sections was studied to identify the microfacies and sedimentary facies. Based on petrographic and facies studies, 12 microfacies were identified in the Asmari Formation such asanhhydrite, quartzarenite, mudstone-dolomudstone fenestral fabric, dolostone, peloidal intraclast packestone to grainstone in tidal flat facial belt. bioclastpeloidal benthic foraminifera packestonefacies are formed in the lagoon facies belt. Benthic foraminifer peloidal packestone facies, Ooidgrainstonefacies are formed in the facies belt of Shoal. Large foraminifer bioclast wackestone, coral bindstone, echinoderm packstone, argillaceous mudstone facies are deposits in the open marine facies belt. Investigation of facies and comparison this facies complex of facies with Flügelfacies belt showed that the AsmariFormation was precipitated in a carbonate ramp with an even slope. Due to the lateral changeof facies to each other, isolated reef barrier, no presence of cortoids, ancoids, pisoids and aggregate grains that are specific to carbonate shelf and or are rarely found in carbonate ramps and also lack oftalus facies and slip facies that show high slope of sedimentation facies during sedimentation. Sedimentation model of Asmari Formation is carbonate platform type ramp with even slope, includes subenvironments external ramp, mid ramp and inner rampwithin4 facies belt tidal flat, lagoon, shoal and open marine (Figure A).

To identify dolomite from limestone, the thin sections were stained with a alizarin red solution. The study of petrography of thin sections show that this Formation consists mainly of carbonate rocks. The dolomitization process mainly affects this Formation and causes changes in the porosity of the Asmari Formation. Since porosity and permeability of dolomite retains better than limestone due to its chemical stability and strength to pressure dissolution during burial. This process has played an important role in increasing the quality of the reservoir. Types of dolomites observed in the study area were: A-Dolomicrite: very fine to fine crystalline dolomite with a size of 5-16 microns, amorphous to euhedral with a planar cristalline boundary to a slightly curved shape and as primary dolomite in the early stages of sedimentation. B- Dolomicrosparite: these types of dolomite are mainly mosaics of the equant, compact and subhedral to amorphous planar boundarys, and their size is between 16-64 microns. Dolomicrosparite is the result of recrystallization of dolomicrites, and in the studied sequence, these dolomites have a significant frequency. C- Dolosparite: This type of dolomite is an equant mosaic crystal, compact, and has a subhedral to amorphous palanar boundary, with a crystalline size of 62-250 microns. In the studied sections in the field, this type of dolomite can be seen in two forms in the specimens: 1- anhedral phenocrystal and compaction with sutured boundary and amorphous. 2- rombohedral and euhedral phenocryst, straight boundary, transparent and light with intercrystalline porosity.Dolosparite in the studied field is observed in most facies (Figure B). Three models of dolomitization can be provided for this Formation : 1- sabkha model 2- neritic burial model 3- seepage-reflux model. Dolomitization in the Asmari Formation in the studied area is one of the most important diagenetic processes. This process has affacted more than 65% of the secuence in the reservoir rock and, as a result of dolomization, has increased the reservoir quality of the oil field in question.



(A)



(B)

Fig. A three dimensional design of the sedimentary environment of the Asmari Formation with identified microfacies.

Fig. B Types of dolomites observed in the study area: A dolomicrite and dolomicrosparite (a); dolomicrite (b); dolomicrosparite (c); dolosparite with coarse-shaped crystals and rhombic shape (d); dolosparite with large, shapeless and compact crystals with xenotopic and anhedral borders (e).

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USING THE DIGITAL ELEVATION MODEL FOR STUDYING WATER BALANCE OF THE TERRITORY

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The water regime of the territory is considered as the determining factor for many components of the landscape. It largely influence the change in thickness and humidity of the humus horizon of soils, the state of vegetation and geochemical processes in the soil and lithosphere. Relief controls the water balance and determines area of waterlogging and insufficient moisture through surface irregularities, valley-girder network and closed depression.

The combination of a space survey and a digital elevation model provides a good basis for determining areas with disturbed water change and their mapping.

First of all, the moisture content in the soil depends on the relief of surface and climatic conditions of the territory. The increased humidity of the territory corresponds to its lowest areas. Due to the subsidence phenomena that characterize the forest-steppe and steppe zone of Ukraine, there are microdepression forms (also can be call ponds, vernal pools, seasonal wetlands, sors).

Microdepressions can have a depth of 0.5 m to 3 m, and diameter form 10 m, to several kilometres [1]. As a rule, soil degradation due to subsidence phenomena extends to leoss rocks [2]. For research study was selected area that contains microdepressions with a diameter of 150-200 m, located on the agricultural fields of the Baryshivka Raion, Kiev Oblast of Ukraine.

The surface of relief was taken as a basis for the investigation of the microdepressions Based on digital elevation model SRTM, a relief map was compiled (Figure).

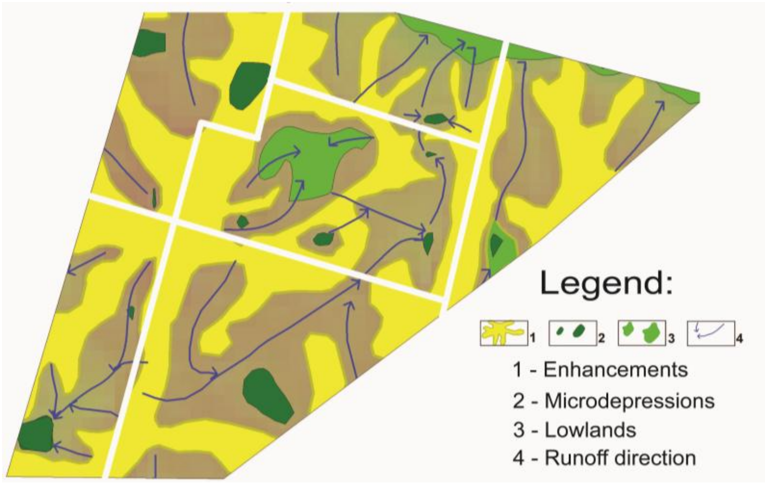

Fig. Map of relief plastics.

On the map (Figure) the territory of the conditional line with a zero morpho-isograph is divided into depressions and elevation of the relief [3]. The enhancements correspond to the watersheds which marked by yellow colour. The vectors in Figure 1 indicate the direction of the surface runoff. Precipitation from elevated areas due to surface and ground runoff moves into depressions, which are depicted light and dark green colour.

Discovered water exchange, excessive watering characterized by accumulation and stagnation of water in the lowered areas without further drain can lead to a change in the type of soil cover and species biodiversity in the centre of the microdepressions, bringing them closer to the waterlogged landscapes [4, 2]. The most wet period for the territory of Ukraine is spring-autumn. In spring, the wet period coincides with the vegetative period of the plants. Disturbance of the water regime in spring leads to a slowdown in the growth of crops and their soaking [5].

The combination of space survey data and the method of relief plastics make it possible to determine lowered areas with a stagnant water regime, the direction of flat flushing of the upper soil layers, which can be successfully used for precision agriculture within one or more crop fields.

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MODERN GEOLOGICAL PROBLEMS OF GROUNDWATER OF GANJA-GAZAKH PLAIN

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In the territory of the Republic of Azerbaijan, 18 of the underground water located in the Greater Caucasus and the Small Caucasus mountainous-zones and the Kur-Araz plain between them, there are 14 transboundary water basins. he Ganja-Gazakh underground water basin is located between the North-East foothills of the Small Caucasus and the Kur chay and the Ceyrangol Plateau, a state border with Georgia in the north-west, and in the south-east, it borders with İnjachay with the Karabakh plain. The area of territory is 3737 km^2, and the absolute level is 700 m in the south-west and 30 m in Kurekchay.

The climate of the plain characterized by climate-warming, weak-hot desert and dry-winter (Kur zones) climates that are accompanied by climate in the dry winter (along the mountain-bound areas). The rains is mainly fall in summer.

Geological structure of the research area is include Jurassic, Chalice, Paleogene, Neogene and Quaternary sediments. 5 watery horizons (groundwater and 4 pressure hollow horizons) were discovered and studied in the plain area at the depth of 300-400 meters [4].

Potable pollution sources of underground waters are the areas where various pollutants are discharged, collected and stored in warehouses or areas (lubricants, crushing areas, filling pools, basins, filtration areas, etc.), which may include pollutants in the aquifer, and agricultural irrigation fields (used in fertilizers and pesticides), mining and geological exploration, and so on. the areas where it is taken.

Pollutants are divided according to their origins and quality indicators:

- household (farm-phenol);
- industry (manufacturing);
- agriculture;
- floods.

The pollution of groundwater chemical composition and species occurs by chemical, bacteriological, radioactive and thermal pathways. There is an underground water pollution in each of these ways. But chemical pollution is a very frightening and difficult disassembled feature [1].

Human activity affects not only the amount of water in the rivers, but also its quality, and as a result, the quantity of these elements in the water increases in the region. It poses a threat to human health and the environment [2].

Based on the above, it can be influenced that human activity has a significant impact on quantitative and qualitative water resources. As a result of the removal of water, flow decreases considerably and even in many cases the rivers dry up. Establishment of security posts at the settlements, river banks causes significant changes in river beds. Household Wastewater, solid waste, chemical and industrial waste cause water contamination. Analysis of available observation data shows that the amount of water contained in many chemical elements is higher than that permitted. As can be seen, pollution of underground waters occurs with various natural and technogenic factors. In our opinion, the following scheme should be taken into account in all cases: atmospheric precipitation - upper waters - vegetation cover - soil layer - aeration zone - groundwater. Implementation of groundwater protection measures should first of all be carried out in parallel and in conjunction with environmental protection [3].

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THE ECOLOGICAL CHARACTER OF IRON AND ALUNITE ORE WASTES

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The process of the gradual reduction of proper metals, metallurgy raw materials take place during the exploitation all over the world, as well as in Azerbaijan. In this case, the need for the application of deep technological processing method grows, to be precise, it is needed to increase the complex level of usage, to minimize the losses, to prolong the exploitation of ore minerals mines and to improve ecological-economical efficiency of mines. We should also note that, the reserves of mines remarkably decrease during the exploitation, even in most of them, they are exhausted. In most cases, during the inefficient exploitation process, great part of raw material reserves remain on the ground, is mixed with soil and is lost indispensably. Such raw materials turned into the wastes are scattered, spoil the air, soil, water, gives damage to the forests and vegetation cover, pollutes the environment, the ecological balance is disrupted. This process is still continuing today.

As a result of rapid development of mining and metallurgy industry, the production of new chemical substances and their wide usage in the agriculture, the biosphere, especially the ground is affected anthropogenically. In a result, their pollution gets a wider range. Nowadays, the environment pollution is the most topical and global ecological problem. It is characterized with bringing biological systems by new chemical compounds and making physical and anthropogenic effects. The pollutants are divided into physical, chemical and biological types for their properties, gas, liquid and hard wastes for their aggregate condition, fragmented and non-fragmented wastes for their sustainability, lithosperic, hydrospheric and atmospheric for the medium and global, local and regional types for the distribution area.

Generally, all types of pollutants are the factors which spoil the ecological situation, affect negatively the dynamics of natural processes taking place in the biosphere uncharacteristic for the nature, as well as human health and the whole living world. The level of the ecological safety of the society is defined by the pollution degree of the environment.

The ecological balance of the world forms a very significiant unit with the rapid growth of population-demographic explosion. As the population is growing, his interference to the nature, agriculture and industry, as well as biosphere, his pressure to the environment is increasing, too.

The total amount of the iron with 10 cm thickness gathered on the upper layer of the ground cover of the earth is measured by billion tons. The amount of the used iron is plenty, too.The amount of iron in the soil causes the reduction of the activity of organic acids, effect on the substances in the ground composition and its weakening. Along with iron, mercury and lead also have a significiant role in the technological pollution of the ground. As the consistence of mercury is slight in the nature, particularly in the lithosphere, its assembling on the ground affect negatively on the environment. In this case, as the roots of plants are away from water, they're deprived of the water and food items in the soil composition. Thus, not only their productivity decreases, but also danger of destruction appears. The pollution degree of the ground don't only depend on the input elements, but also it's associated with its physico-chemical properties, especially the reaction that occurs on the ground.

The application of chemical substances in the agriculture and mining are of great importance in the soil and water pollution. During the mining work, technogeneous faults often occur in the natural medium, as well as, geomechanical and hydrological, chemical, physico-mechanical and thermical faults can be noted too. Just for this reason, the pollution of soil and iron with other elements is growing and rich soil is spoilt. Nowadays, a great deal of chemical substances-mineral fertilizers and pesticides are given to the fields and plantations in the agriculture. Soil and water sources are polluted due to the chemical poisonous substances used for medical, veterinary preparations and scientific-research work. The soil pollution causes the air and water pollution and air and water pollution cause the reverse process. By entering into the reaction, the chemical substances fell to the ground change its structure and chemical composition, make it useless and weaken or cease the microbiological processes. In a result, due to these cases, humans and animals are poisoned, plants become underdeveloped and productivity is reduced. The pollution of soils with acids is a factor that make it low-qualified and useless for agriculture. Such kind of pollution occurs both by the natural way and anthropogenic effect. The growth of acidity in the soil by the natural way is observed during the formation of humus. As the acids are absorbed into the deep layers, the root system of plants can't be fed and the productivity is reduced. The continuation of acidity is defined by the reduction of Fe^{2+} and Mg^{2+} ions in the soil. But, hard domestic wastes are of great importance as a basic type of wastes which pollutes the environment. Wastes are the main source of pollution of lithosphere, hydrosphere and particularly the World ocean and air layers of the Earth. Wastes are considered the main factors which disrupt the ecological balance of our planet. In the developed countries, as well as in Azerbaijan wastes have been neutralized in a number of plants and recycled. After the domestic wastes are sorted, fertilizer and liquid fuel are obtained from them. The other part of the wastes is removed from the accommodations and is used for filling the stone, sand quarries and ravines.

Hard domestic and production wastes differ greatly from each other for their compositions. Nowadays, the formation of technological processes in the direction of unpolluted environment using the raw materials without wastes is considered a radical crucial issue of the modern ecology. The efficient usage of natural products means the improvement and stabilization of environmental quality. The protection of natural products is a crucial source in the sphere of meeting the increasing demand of agriculture.

STRUCTURAL-GEOLOGICAL POSITION AND GENESIS OF UPPER SVANETI GOLD OCCURRENCES

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As it known, magmatites have important role in formation deposits,they are not only potential ore-bearings, but also warm-bearings, which has ability of repeated activation of hydrotherms. In all cases, when is spatial contact between magmatic rock and mineralization, we should note positive role of magmatites with other factors.

The fact is known, that there are several classification of hydrothermal mineralization nowadays. According to the newest classification [1], three type of mineralization is separated from these mineralization, they are:

1. Hydrothermal mineralization, which is closed to magmatic chamber with spatially and, accordingly, temperature regime and forms around it. The classical example of this type of hydrothermal mineralization presents porphyritic mineralizations, almost 95% of Mo, Cu more than 65%, significantly amount of Au and also Ag and Re as accompanying production,obtained from the world, is related to them.
2. Hydrothermal mineralization, which is also forms in regional tectonic and magmatic activation period, but some distance away from magmatic chamber. The classical example of this type of hydrothermal mineralization presents orogenic mineralizations, which forms in actively evolutional orogenic systems. This type of mineralization occurs under the high pressure (1.5-5kb) and temperature (300-450^{0}C) terms, on the depth 4-15km. Ore bearing rocks are: metamorphic rocks, migmatites and magmatites. The main product of this mineralization is Au, whereas, Sb and As are accompanying products. As usual, hydrothermal mineralizations characterized with small scales, but also there are large scales of mineralization.
3. Hydrothermal mineralizations, which forms in sedimentary cover, but they are related to nearest magmatic chambers with temperature regime and source of material. These type of deposits give Pb, Zn, Co and U, whereas partly Ag and Au reserves. During formation of this type of mineralization, transportation of hydrotherms implements at the several kilometers distance, because that, mineralization processes occurs relatively low temperature regime period, mainly within 100-200^{0}C.
4. As conducted works by us and available data analysis shows, Upper Svaneti is rich in Gold bearing mineralizations, characteristic of orogens. They are formed as in the crystalline basement as well as in sedimentary cover rocks.

Gold bearing mineralizations, related to sedimentary cover (Kazakh-tvibi, Lahil-chala, Guli, Jagari, Bakhi, Gogiashi, Gvashkhaa and Nacashari) do not characterized with large scales and mainly presented with gold-quartz-sulfide association of seam facies.

Unlike the sedimentary cover, in the basement along the Alibegi fault, are formed numerous gold bearing mineralizations (Hokrila, Tskhvandiri, Memuli, Tetrnashera, Kakrinachkuri, Nenskra, Mestiachala, Tviberi, Sgimazuki, Shkhara, Kirari, Lukhra, Ushba, Lakhvra and Orkari, Manchkhapi and Uturi). These mineralizations are typical hydrothermal formations, which is characteristic of collisional orogenic systems [2].

On the base of conducted works was established, that magmatic processes hold important place in the Upper Svaneti and also hydrothermally altered zones, which are generated from this way. They are presented with pyritized, greisenized, oxidized, sericitized, skarned and quartzite rocks. In most cases, these rocks are sheared, fractured and are cemented with quart and quartz-gold veins and veinlets, which have different sizes, shapes, orientation and length. Clay minerals holds important place between them [3].

Of course, hydrothermal mineralization types, discussed by us, can not completely depicts current geological processes in Upper Svaneti, but as conducted works showed us, mineralization processes is related to regional magmatic activation genetically.

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OBSERVATIONS OF MODERN MOVEMENTS IN THE FERGANA GEODYNAMIC RANGE

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The study of geodynamic movements with the use of GPS technologies for the Fergana geodynamic test site and the adjacent territories is described in the works of many researchers. The most detailed results for the last period of GPS observations on the Ferghana part of the Tien Shan were published in [1, 2]. At present, in the Fergana geodynamic range, instrumental observations are being developed to assess the displacements of the earth's surface using GPS technologies. They pursue the goal of searching geodynamic earthquake precursors. In this zone 2015-2017 we conducted test instrumental GPS measurements, initial estimates of displacements and collected quantitative data on possible movements of the earth's crust. To enable comparative analysis, an additional fixed GPS receiver is installed at the Yangibazar Observatory. It also works in a stationary mode.

At the Kitáb sub-station in Kashkadarya region, a reference GPS receiver operates. All measurements are equalized with this reference receiver. In addition, the stations Tashkent, Namangan, etc. were included at a certain stage. The above devices operate at the same time intervals and parameters [2]. The East-Uzbekistan and Fergana network is laid in 2010-2015 and includes, in addition to the peripheral 4 more points: Namangan (NAMF), Fergana (FERG), Tashkent (TASH) and Yangi-Bazar (YNGB) (Figure). The most constantly operating Fergana and Namangan stations. In 2015 and 2017, the local network compaction profiles with non-stationary points of time measurements were expanded and compiled within 2-3 days.

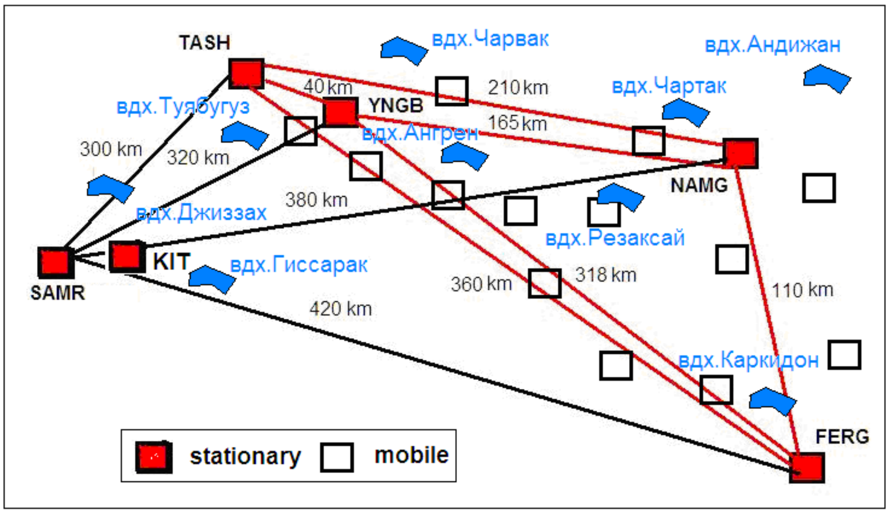

Fig. Scheme of GPS measurement points.

In the difference in the lengths of the vectors, the offsets for the selected reference are determined. Data on the implemented scheme was entered into the ARC-GIS database. Estimation of the speeds of modern movements for studying the manifestation of strong earthquakes and other geodynamic phenomena in the peripheral boundaries of tectonic blocks in the Central part of the Ferghana Valley against the backdrop of the measured displacements was based on observations at four stationary GPS stations in Eastern Uzbekistan. The speed estimation is based on the analysis of time series of coordinates of GPS stations calculated from the primary data, which are sets of phase and code measurements at two frequencies with a duration of 24 hours with a registration interval of 30 s. To the set of measurements at the NAMF, TASH, FERG stations, the data of two closely located network reference stations were added. Selected reference stations with the specified encoding are included in the implementation of the international terrestrial reference base. Test measurements were carried out with a 30 second interval. During this period, an additional fixed GPS receiver installed by the Institute of Seismology of the Academy of Sciences of Uzbekistan at the Yangi-Bazar Observatory, also worked in this mode.

At the Kitab (KITB) sub-station in the Kashkadarya region, a reference GPS receiver was currently in operation. Receivers conducted GPS measurements at the same time intervals and parameters. Primary estimates of velocity components and vectors of horizontal motions in the above GPS stations in Eastern Uzbekistan and IGS support stations located in the Tien Shan have shown that time series can be characterized by seasonal variations, most pronounced for vertical components. A characteristic aspect of the movements of the peripheral zone of the Fergana Valley blocks is a possible accelerated horizontal displacement in the northeasterly direction with practically the same velocities. Similar movements are characterized by the North Fergana fault and the sub-latitudinal part of the South Fergana fault, adjacent to the Sokh zone.

Station points in the central part of the test site also move in a northeasterly direction, but their speed is somewhat less, 18-20 mm/year. The speed of the reference station FERG significantly exceeds all others (38 mm/year). For the kinematic analysis of the given differences in the speeds of the movements of all these stations, it is correlated with the motion of the Western Chatkal peripheral zone represented by the YNGB station. To determine the parameters of the YNGB motion, a set of reference stations was used for SAMR (Samarkand), TASH and FERG. The movement of the TASH and YNGB reference stations located to the west of the Chatkal range seems to correspond to the kinematics of East Uzbekistan (within the limits of measurement errors), since these stations are among the reference stations determining its stable inner part. At the same time, the stations of the internal field of the Fergana Valley, as well as the station YNGB when combined, are characterized by excessive values of velocities of 4-8 mm / year with respect to the calculated values.

These differences, manifested in the form of residual offsets GPS points, because these speed values are defined with respect to SAMR, which we assumed to be fixed. The modern relatively faster displacement of the peripheral boundaries of the tectonic blocks of the Central part of the Fergana Valley is apparently due to the main field of tectonic movements in eastern Uzbekistan.

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FREQUENCY OF NATURAL OSCILLATIONS OF THE DAMS OF THE REZAKSAI AND KARKIDON RESERVOIRS OF THE FERGANA VALLEY

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Evaluation of the dam's own oscillations by profile seismic survey has not been thoroughly investigated for forecasts of geological risk of reservoir zones. Intensification of exploitation of technogenic objects (in particular, reservoirs with a large volume), causes the restructuring of the stress-strain state. There are cases when in the zones of large dam's there was a threat of increasing seismic activity with unpredictable consequences. In the present, various methods for assessing seismic and geological risks in the near areas of large reservoirs have been developed. Despite this, the possibility of estimating dam oscillations, using quantitative instrumental results, leaves much to be desired.

Determining the seismic properties of ground and small-fragmented massifs in the dam zone of the Rezaksaisky and Karkidon reservoirs, as an experimental material under different loads and water volumes, we performed several methods: recording weak transit earthquakes; studying the characteristics of the bodies of dams analyzing microseisms. Directly on the objects of measurement, microseisms were made using a digital seismic station CMG-6TD. The frequency response of the seismometers is uniform in the range 0.03 - 50.0Hz. The oscillations are measured along the profile, and the maximum amplitude of the vibration speed, A_{max} **(mm/s)** and the corresponding oscillation periods, the duration of the oscillations are determined in the seismograms [1, 2]. Estimates of natural oscillations by multi-profile seismometric surveys in Rezaksa and Karkidon dams have been made. The calculation of the relative change in the intensity of the oscillations is determined from $\boldsymbol{\delta_i = A_{ma\ (i)}/A_{max}}$, where $\boldsymbol{i}$ - is the number in order of the measuring points.

Calculations of the thickness of the layer from coarse clastic massifs to shallow clastic rocks were carried out using the following empirical equations: $\boldsymbol{h = 156 \cdot f_0 - 1{,}08}$ where h is the thickness of the layer of bulk rocks, $\boldsymbol{f_o}$ is the resonant frequency of each part of the clasticity of the massifs.

To determine the velocity of transverse waves $\boldsymbol{Vs}$**,** the expression is used: $\boldsymbol{T = 4h/Vs}$; where $\boldsymbol{T}$ – is the resonance period for each type of rock mass, $\boldsymbol{h}$ - is the thickness of each part of the rock, and $\boldsymbol{Vs}$ - is the velocity of the transverse waves. The coefficient of seismic instability is determined by the equation $\boldsymbol{K_g = HVSR^2/f_o}$ (Figure 1 and Table).

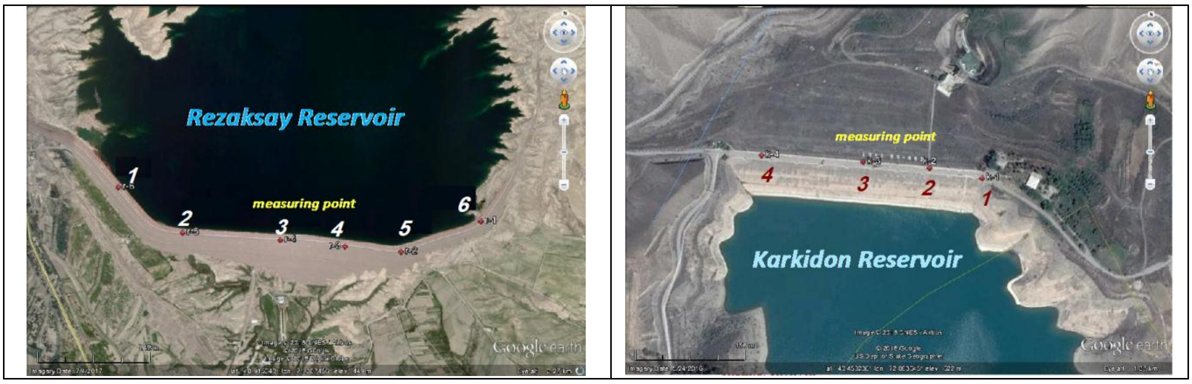

Fig. 1. Location of measuring points in the dam zone of the Rezaksaisky and Karkidon reservoirs in the Fergana Valley.

The results of the calculations show the range of $\boldsymbol{Vs}$ variations within the range of 564-655m/s. The coefficient of seismic liquefaction of soils was determined by the formula: $\boldsymbol{K_L = A_{HVSR}/f_o}$ where $\boldsymbol{A_{HVSR}}$ – is the value of the ground transfer coefficient **HVSR** (Table). Spectra are calculated and filtration is performed to eliminate random impulse noise.

Table.

Results of the assessment of the **HVSR** spectrum for measuring points in the dam zone of the Rezaksaisky and Karkidon reservoirs in the Fergana Valley.

Rezaksai				Karkidon			
№ mp	$\boldsymbol{f_o}$	***HVSR***	***Kg***	№ mp	$\boldsymbol{f_o}$	***HVSR***	***Kg***
1	5.9	2.8	1.33	1	4.1	4.0	3.90
2	6.6	2.3	0.80	2	2.05	4.8	11.24
5	1.1	4.1	15.28	3	2.05	4.8	11.24
6	4.6	2.5	1.36	4	4.0	4.8	5.76

where: $\boldsymbol{f_o}$ *- resonance frequency;* ***HVSR*** *- oscillation amplification factor;*
$\boldsymbol{K_g}$ *- is the coefficient of seismic instability. mp - are measured points.*

An example of the vibration spectrum at the middle part of the Rezaksaisky and Karkidon reservoirs in the measuring points of the mp3 (Figure 1) is shown in Figure 2 below.

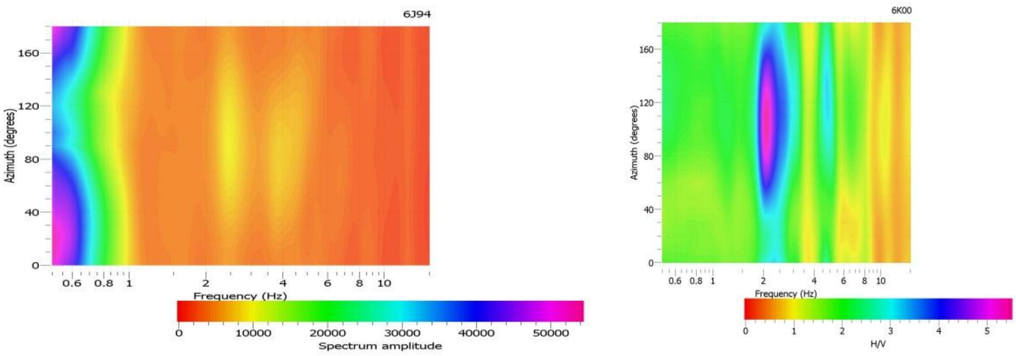

Fig. 2. H-HVSR vibration spectra in the middle part of the Rezaksaisky and Karkidon reservoirs in the measuring points of the mp3.

The ratio of the spectra of the ***H/V*** components was constructed by weighing. Data processing using the JSesame program allowed to estimate the spectral ratio of ***H/V*** [2]. As a result of the analysis, it can be noted that seismic vibrations on the crest of the dam are enriched by harmonics associated with resonance phenomena.

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JURASSIC PILLOW BASALT LAVAS (SOUTHERN SLOPE OF THE CAUCASUS, GEORGIA)AND RELATED ORNAMENTAL AND FACING STONES

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Products of Jurassic subaquaeous basaltic volcanism are widespread within the Southern Slope zone of the Great Caucasus. They are intercalated with the Leiassic slates and are introduced by basaltic pillow lavas and breccias.

Our study is focused on the origin and composition of basalt breccias from Kazbegi region (Figure (a)). The rocks are known as “Kazbegi stone”. The clasts are cemented by hydrothermal epidote, chlorite, quartz and calcite. Due to its attractive decorative pattern and good physical and mechanical properties Kazbegi breccias are the source of rather popular in Georgia facing and ornamental stone. They have been formerly identified as “diabase breccias" or "decorative diabases" due to ophitic or diabase textures of the brccia clasts. Our detailed petrographic observations revealed, that the breccias clasts are basalts in composition [3, 6]. According the historic whole-rock geochemistry data [1, 2], the rocks of so-called "spilite-diabase" formation (pillow lavas and breccias) show similarities with toleiitic mid-ocean ridge basalts. The results of our geochemical data analysis support this opinion.

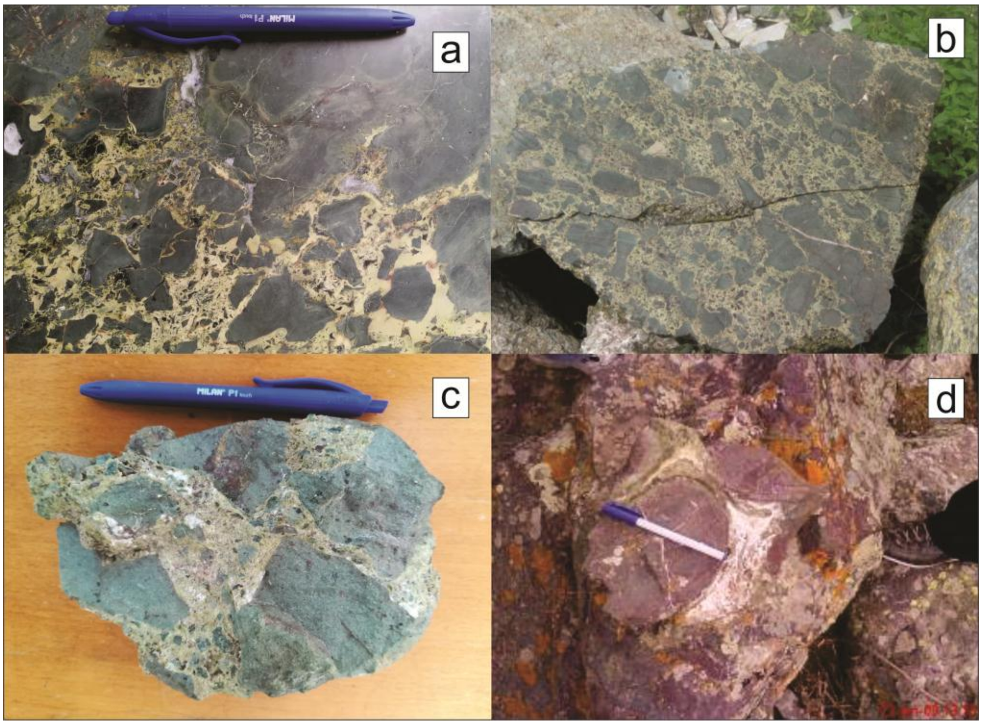

Fig. Kazbegy basaltbreccia (a); Basalt breccia (Chimgis klde) (b);
Pillow basalt (Chiukhi) (c); Breccia basalt (Roshka) (d).

Similar basalt breccias from Pirikita Khevsureti (Figure (b)) (Chimgis Klde, norteastern part of the Caucasus range) have been studied as well. Thin section petrography and geochemical analysis revealed that basalt breccias from these two localities have similar compositions and structural-textural features. The petrographic and geochemical studies of the samples collected from the vicinities of the village Roshka (Figure (c)) are in progress in order to compare obtained results with the data from Kazbegi and Arkhoti.

Two drastically different opinions exist regarding the origin and age of pillow lavas and breccias. According to more widely excepted assumption [1, 2, 5, 6] these are typical pillow lavas (Figure (d)), pillow breccias and hyaloclastites. On the contrary, some researchers [4] suggest, that all diabases from the axial part of the central and eastern Caucasus are the members of independent hypabissal mafic intrusive rock complex formed at late-orogenic collisional stage of the Caucasus development (late Miocene-early Pliocene). Moreover, in their opinion, the pillow-like shapes in young crosscutting diabase dykes are formed as a result of spherical weathering.

We suppose, that aside from lava fragmentation processes resulted in basalt breccias and hyaloclastites formation, impact of onlapped tectonic processes should be taken into account as well. Further disintegration and fracturing of pillow lavas and hyaloclastites was accompanied by hydrothermal fluids invasion and cementation of breccias clasts.

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THE MOST ACTIVE LANDSLIDE AREA OF RECENT TIMES

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One of the most real issues of today is the landslide process and the consequences of its damage. Landslide processes are widely spread in Azerbaijan, especially in the peninsula. The most dangerous and oldest landslide field of the peninsula is Bayil slope. The first recorded landslide took place in 1870 and as well, for the first time, the research on the study of sliding processes on the Bayil slope was carried out by V. Laishvili in 1929.

Bayil landslide is located in the southern-western part of Baku, in the area called Baku amphitheater. The geological structure of the area includes clay rocks and other sediments of Absheron floor of the Quaternary. Bayil landslide has been completely covered by modern sediments with almost little thickness. They are formed from eluvial-diluvial sediments and are not observed only in the valleys and natural openings. These lithological sediments consist of sandy loam, sandstone, and limestone crumb and have developed in most parts of the field.

The last sliding in this area took place at the end of 2017 and the first half of 2018. So that, several factors played a key role in the taken place landslide. In autumn-winter months, levels of groundwater have risen due to intensive rains. This is a natural factor that caused the landslide. However, the main factor which activated this is anthropogenic effects. As we know, houses on the Bayil slope were built cutting slopes and without taking security measures. At the same time, there is no sewage system in the area. All household water is discharged into the soil, and gardens have planted to the upper part of the slope and regularly watered. They cause soil moisture and at the result, the slope loses its durability. Thus, with a small push, a large-scale sliding occurred, the depth of the cracks was 4-5 meters. Many homes remained under the sliding mass and cracks in houses which at the bottom of the slope occurred.

RESEARCH OF DANGEROUS GEODYNAMIC PROCESSES IN NADZALADEVI DISTRICTAND ELABORATIONOF PROTECTIVE MEASURES AND RECOMMENDATIONS

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The area of Nadzaladevi district of Tbilisi is basically located on the mountainous erosive-tectonic relief of the extreme eastern end of the Trialeti Range within the borders of that there also occur plain accumulative forms of relief.

The area is mainly represented by the Tertiary formations and Quaternary blankets covering them. In accordance with the engineering-geological zoning, accepted in Georgia, the researched area is located in the Manglisi-Tbilisi (VII_3^1) subzone and it is represented by the Paleogene-Neogene sandstone-sub-argillite gypsum-bearing rocks Adjara-Trialeti folded system district – VII, Paleogene-Neogene $_3{}^-{}_1{}^1$ half-cliffy and cliffy zone of sandstone-sub-argillite rocks – VII_3).

The presented report is a result of the engineering-geological studies carried out by the group of specialists in engineering-geology of LTD “GIMI”.

The task of the research was to fix and chart the events caused by current engineering-geological processes within the Nadzaladevi area generally and particularly with in the limits of the selected 11 districts.

The engineering-geological studies included: reconnaissance, mapping (surveying), geomorphological, hydrological, geological, hydrogeological and geodynamic observations together with drilling, laboratory and cameral works.

The total area of the 11 distinguished districts within the borders of the studied territory is 120 hectares.

Various scale topographic maps of the territory (1:2000; 1:5000; 1:10000; 1:25000) are presented in the WGS coordinate system of UTM projection. There have been charted the location of exploration openings and observation points and the information on the revealed geodynamic phenomena.

In order to obtain engineering-geological, geological and hydrogeological information here have been drilled 11 boreholes with a total depth of 250 linear meter and drilled 20 tip-boreholes with total depth 60 linear meter.

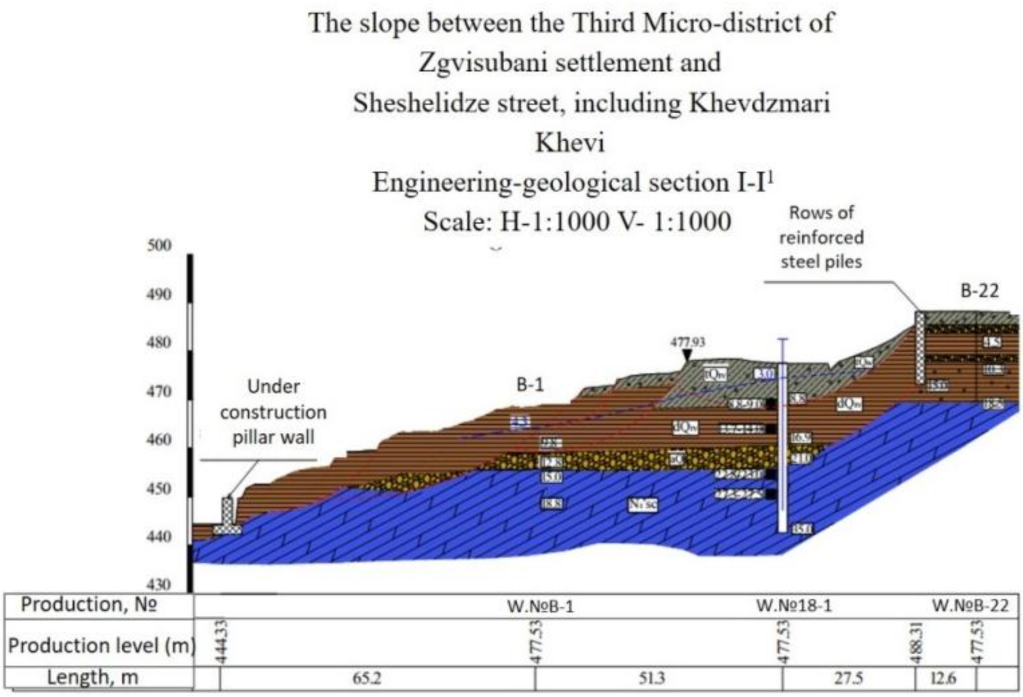

Fig. The slope between the Third Micro-district of Zgvisubani settlement and Sheshelidze street, including Khevdzmari Khevi
Engineering-geological section I-I[1]
Scale: H-1:1000 V- 1:1000.

STRUCTURAL AND STRATIGRAPHIC ARCHITECTURE IN PALEOGENE EXENSIONAL SEDIMENTARY BASIN: AN EXAMPLEFROM THE EASTERN ACHARA-TRIALETI FOLD-AND-THRUST BELT, GEORGIA

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The Achara-Trialeti fold-and-thrust belt is located in the northern part of active collisional Lesser Caucasus orogen associated with Arabia-Eurasia convergence. The collision between the Arabian and Eurasian plates caused inversion of the relief and at the place of intra-arc and back-arc basins were formed Achara-Trialeti fold-and-thrust belt and Greater Caucasus orogen with the intermontane depression (or foreland basin) in between [1, 3, 4, 6]. The Achara-Trialeti is mainly trending east west through southern Georgia and comprises thick Mesozoic-Tertiary strata deformed by fault-related folds. Our study area is eastern Achara-Trialeti fold-and-thrust belt. The rocks are involved in the deformation range from Paleozoic basement to Mesozoic-Neogene rocks. During the Cretaceous and Paleogene, Achara-Trialeti extensional basin filled with approximately 3500-4000 m of sediments [2, 5, 7].

The stratigraphic succession of the area is constrained by a borehole and the outcrop data from the study area. Seismic reflection data show that the area was affected at least by two main deformational phases, which caused firstly the formation of extensional structures (half-graben bordered by normal faults) and then compressional structures (thrusts, back-thrusts and fault-related folds). The stratigraphic relationships in the eastern Achara-Trialeti are complicated by phases of tectonism in the Cenozoic. We describe the stratigraphy and sedimentary complex of eastern Achara-Trialeti using a proposed sequence stratigraphic framework: megasequences based on the major tectonic events and related unconformities. Megasequences within study area are introduced by (1) syn-rift megasequences (Paleocene-Middle Eocene), transitional megasequences (Upper Eocene) and (3) post-rift megasequences. The associated principal lithofacies have been identified and depositional environments have been reconstructed through facies analysis.

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FRESH GROUNDWATER RESOURCES OF THE KUSAR FOOTHILL PLAIN AND PROSPECTS FOR THEIR USE

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The Kusar foothill plain is located in the north-eastern part of Azerbaijan and covers the territory between the north-eastern slopes of the Main Caucasian Range and the Caspian Sea.

Groundwater lies at depths from fractions of up to 150 m. The slopes of the hydro-relief vary from 0.2 to 0.002, decreasing in an easterly direction. In the northern part of the lowland in the Prisamur zone, the thickness of rocks containing groundwater reaches 113.8 m, in the southern part, due to the presence of pressure water in the bottoms, it decreases to

60 m. The collectors are represented by pebbles with boulders, filler. Inter layers and lenses of fine and fine-grained sands and clays occur.

From wells that opened up the groundwater of the described complex, very significant inflows were obtained during the pumping-up to 46.6 l / s, and in the Prisamur zone - up to 166.6 l / s at specific rates of 0.35-22.9, l/s·m. From the groundwater of the described complex, shallow water is obtained and the springs of the Shollar water intake are drained. The coefficients of filtration of the water-bearing strata vary from 2.7 to 80-130 m / day, occasionally more.

The pressure waters are connected with the lower part of the section of the sediments of the described complex, which is parallel to the Khazar stage. They lie in the lowlands at depths of more than 40 m, their thickness varies from 50 to 115 m. They are represented, as well as overlying deposits, by powerful bundles of pebbles with boulders filled with fine and fine-grained sand, separated by layers of sandy clay. Distributed pressure water (according to AP Popov) east of the line ss. Alexandrovka-Maksudkend-Murugoba, to the east of the railroad wells, which opened them, give self-depreciation.

Groundwater resources. The natural flow rate of groundwater gradually increases as you move away from the foothills. Counted in the alignment of the railway and was equal to the praiseworthy-Khazar complex-97, for the Baku-Kusar complex-171, for the Absheron complex-208, and only 1356thousandm^3/day.

Modules of operational reserves of fresh groundwater increase from the foothill zone to the central part of the plain and then decrease again in the coastal strip.

South of the river. Velvelechai there is a sharp decrease in the magnitude of the modules in the direction from the north-west to the south-east to the edge of the plain. The greatest value is noted in the Khudat region, where they slightly exceed 60 l / s · km^2. Slightly brackish underground waters are developed only in the south-eastern part of the plain. Modules of their operational reserves do not exceed 0.5l / ccm^2. The operational reserves of fresh underground waters of the Kusar Plain have been counted repeatedly for various parts and horizons, as well as for the entire deposit as a whole.

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KAPAZ OIL AND GAS FIELD AND ITS HISTORY

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The Republic of Azerbaijan is located in the south east of the Caucasus, and borders on Russia, Georgia, Turkey, Iran and Armenia. Throughout history, oil has been used as a leading mechanism in its political and economic life. Azerbaijan is one of the world's oldest oil producers and the city of Baku and the Absheron Peninsula have long been known as historic sites for oil. The first oil well in the world was drilled in Absheron, Bibiheybat in 1847 using a primitive percussion drilling mechanism. The first oil refinery was also built in Baku in 1878.

There are several oil and gas field in Azerbaijan and Kapaz one of them. Kapaz is an oil and gas field that lies in the centre of the Caspian Sea, in water depths of 75 to 125 metres. The block is in an area where ownership is disputed by Azerbaijan and Turkmenistan. The field was discovered in 1988, during the Soviet era, and is known as Serdar in Turkmenistan and Kapaz in Azerbaijan. The prospect, known as the Kapaz field since Azerbaijan and the other Soviet republics gained their independence in 1991, was discovered in 1959 by Azerbaijani geologists and geophysicists as a result of seismic exploration work. At that time it went by the name "Promezhu-tochnaya," which means "intermediate" in Russian. Additional geophysical operations were carried out. In 1983 the block was prepared for deep exploratory drilling by Azerbaijani oil workers (Kaspmorneft) which actually took place in 1986. In 1988 during production testing, the first well flowed at a rate of approximately 300 tpd (approximately 1887 bpd) of oil. Later two more wells also flowed with oil and natural gas. The Kapaz field is identified as being in the Azerbaijan sector of the Caspian Sea. This designation gave rise to no objection from any of the former republics during the Soviet period, nor later when the republics gained their independence in 1991. SOCAR, hereby, declares that the Kapaz field is located in the Azerbaijan sector of the Caspian Sea and that any other country's claim to this field has no international legal basis. SOCAR considers that the reports and statements which have appeared in the mass media are erroneous and confirms its intentions to develop Kapaz, hoping that the Russian oil companies, Lukoil and Rosneft, will reconsider their statements to the contrary, if such have been made. This statement was made public by SOCAR's President Natig Aliyev on July 18, 1997. In regard to the Kapaz field, SOCAR again declares that in accordance with the sectoral division implemented in 1970, this field is located in the Azerbaijani sector of the Caspian Sea. Official documents in our own possession and that of ministries, departments and other relevant bodies of the former USSR prove that any claims by Turkmenistan for this field do not have any foundation or arguments under international law.

The Caspian basin is extremely rich with oil and gas resources. The EIA estimates that there were 48 billion barrels of oil and 292 trillion cubic feet (Tcf) of natural gas in proved and probable reserves within the basins that make up the Caspian Sea and surrounding area. The offshore fields account for 41 percent of total Caspian crude oil and lease condensate and 36 percent of natural gas. In general, most of the offshore oil reserves are in the northern part of the Caspian Sea, while most of the offshore natural gas reserves are in the southern part of the Caspian Sea. Experts estimate reserves of the Kapaz field at 50-100 million tons of oil and over 30 billion cubic meters of gas.

Kapaz field is geologically similar to the giant Azeri Chirag Guneshli (ACG) field in Azerbaijan, but is a separate structure. This field play a important role in azerbaijan oil and gas sector.

Fig. Oil fields of Baku on the Caspian Sea.

GEOMECHANICAL MODELING OF THE STRESSED STATE IN THE VICINITY OF THE WELL

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The actual task related to the development and operation of hydrocarbon deposits is the calculation of the stability of the well. The solution of this problem is most important for horizontal wells and wells with an increased probability of an accident. To prevent accidents, there is a need for geomechanical modeling of the trunk and the vicinity of the wellbore.

This paper is devoted to create of a geomechanical stress state model in the vicinity of a wellbore. The method of constructing the model consists of three main stages. Creation model of elastic and strength properties (MESP), model of the stress - strain state before drilling (SSM before drilling) and after drilling (SSM after drilling). The method is based on geological and logging data obtained as a result of drilling. The values are calibrated for laboratory and drilling tests. The model was built in the software package Eiler1D.

The method was tested on the example of the Shapshinskoye field in Western Siberia. Geomechanical models of three wells were constructed, and a model of the projected well was built. The parameters obtained as a result of the simulation showed the convergence with the laboratory data.

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PETROLEUM SYSTEM EVALUATION OF THE REGIONS WITH COMPLEX TECTONIC SETTINGS

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Standard basin modeling tools are disabling to model tectonically complex basins featuring listric faults, thrusts and etc. In such geological contexts, simplifications are brought to models geometry to keep vertical pillar grids to be restored through time with a vertical shear backstripping. Sometimes being acceptable, sometimes such modifications aren't acceptable and the geological complexity of these objects needs to be explicitly modeled to accurately assess their impact on petroleum systems.

New workflows relying on existing structural restoration packages have thus emerged in the industry in the past years. Usually requiring a three step process, they consist in building the present day model within the structural restoration package, performing the restoration and then exporting the paleo-models collection to the basin modeling package in which new generation simulators are able to model fluid migration through faults and other geological features.

While they definitely bring an added value to basin modeling in complex structural settings, these workflows still have practical limitations impacting their operational use.

1. The number of steps to restore. Structural geologists usually focus on the main deformation phases whereas petroleum system modeling requires basin geometry at the end of deposition of each simulated layer. This constraint imposes additional work with tools that are not necessarily suited to build easily full kinematic scenarios.

2. The ability of generating a mesh continuously deformed through time. This point is essential for mass balance considerations in basin simulation but it is optional in structural restoration and most packages do not honor this constraint.

3. Any modification made on the structural model or the structural scenario post simulation (such as additional layer insertion or new hypothesis on eroded thicknesses) requires starting again the kinematic work in the restoration package. All of these technical issues drastically limit the efficiency and productivity of such methods.

The paper illustrates a new workflow intending to overcome these problems with the introduction of a new kind of 2D kinematic tool, designed in the first place for basin modeling purposes. This new tool aims at producing very easily and rapidly consistent geological scenarios in order to feed new generation simulators able to take advantage of an accurate description of structural evolution through time. In addition to classic geometrical methods, a new mechanical engine taking into account compaction and rock mechanical properties (anisotropic elastic behavior) is being investigated along with several deformation models. The ability to provide geologically valid results in all structural contexts and an intuitive definition of deformation parameters to optimize productivity constitute the core of the tool, dynamic mesh deformation being guaranteed through the model topology preservation as restoration work progresses.

We want to demonstrate several cases the software usability for salt tectonics and compressional environments as well as its ability to quickly generatetens of paleo-sections continuously deformed through time for the simulation of compaction, heat transfer and hydrocarbon generation, migration and accumulation. Bridging the gap between structural geology and basin modeling, the achievement of this project will be a major step forward to easily increase basin models structural complexity without any compromise neither on execution time nor results quality.

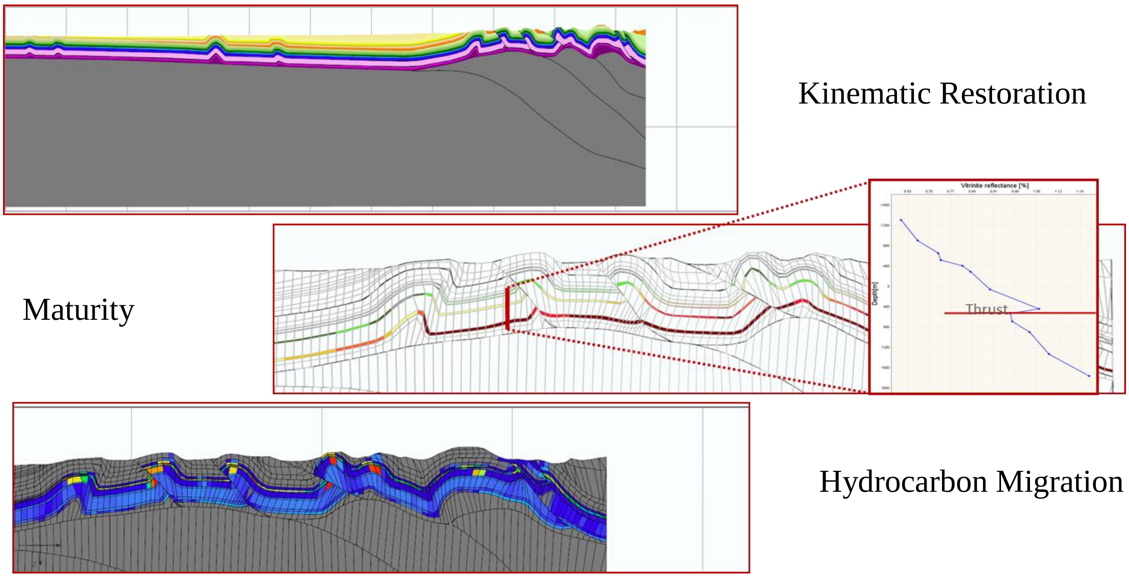

Fig. The example of results the software usability for compressional environments.

TYPOMORPHIC FEATURES OF DIAMONDS OF ULTRA-DEEP ORIGIN

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Ultra-deep origin diamonds (formed at depth below 250 km) are found in single deposits of the world. Snap Lake kimberlite dykes (Slave craton, Canada)belong to such deposits based on physical and mineralogical characteristics of diamonds. It was established that the mantle source of kimberlite magmas of this dyke complex was different from that of diamond-bearing kimberlites of Siberia and Africa [2]. However, sufficient mineralogical data had not been obtained to characterize the chemical nature of the environment associated with the processes of diamond formation in this region.

Diamonds from Snap Lake are greenish (34%), followed by colorless (30%), yellow (16%), brown (11%), grey (9%). The high proportion of green diamonds most likely indicates these diamonds were affected by radiation damage. The brown colouration of natural diamonds is linked to high levels of plastic deformation[5]. Diamonds from the Snap Lake deposit are characterized by various morphology: octachedral, dodecahedral, cubicshapes or transitional form.In some cases coated diamonds andspinel twins are presented. There are often cracks and cavities on the surface of the crystalls, some of which are the result of natural etching of diamonds in hypogene conditions, the other part is formed due to the opening of fluid inclusions [1].

The syngenetic inclusions in diamonds reflect a composition of the mantlesource [6]. The compositions of 112 homogenous crystalline inclusions from Snap Lake diamonds were determined. The inclusions of ultramafic paragenesis are predominant. Garnet inclusions in studied diamonds show a distinct excess of SiO_2, which points to high-pressure conditions of diamonds crystallization. Omphacite inclusions are characterized by high concentrations K_2O. This is additional evidence of the diamond crystallization under ultrahigh pressure [7].

A large phlogopite inclusion in the central part of Snap Lake diamond was found. The studied phlogopite inclusion is characterized by high concentrations of SiO_2 and TiO_2, and differs from all the known phlogopites in diamonds of ultramafic and eclogite paragenesises from various deposits of the world[8].

Micro- and submicro-inclusions in the Snap Lake diamonds are mainly located in the central part of the diamonds. Olivine and enstatite inclusions are predominant. Also, carbonate inclusions were identified.

Nitrogen is the main impurity that determines many physical properties of natural diamonds. The nitrogen concentration and aggregation form reflect the conditions of diamond formation and diamond evolution in primary source [4].

FTIR measurements were made on 40 diamonds from Snap Lake kimberlite dyke system. Studied crystalls are characterized by a complex internal structure, they are heterogeneous that reflect the change of formation conditions [3]. Thediamonds differ in nitrogen content, distribution and aggregation degree. The total nitrogen content in different zones of samples is up to 1100 ppm. Inhomogeneity in nitrogen distribution from the center to the edge of the crystals indicates, at least, about two, or even more growth stages of the studied diamonds.There is no correlation between the nitrogen content and the aggregation degree. High nitrogen aggregation degree according to “annealing” model is evidence of diamond staying in the high temperature region or of their residence in the mantle conditions.

Results obtained allow one to assume that the Snap Lake diamonds (Slave Craton) were crystallized as the result of interaction between enriched volatile and titanium high-potassium carbonate-silica melts and peridotitic substrate at the base of an abnormally thickened lithosphere mantle (at depth below 300 km) [6, 9].

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KARSTIFICATION OF LAR FORMATION IN CENTRAL ALBORZ

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Identification of geomorphological phenomena that were created by the dissolution can help to identify the karst systems. Processes of Karstification on the one hand cause problems in carrying out civil projects, and on the other hand it can help in the exploitation of water resources from hard formations and development of the geotourism industry. Karst develops in many types of rock, including limestone, dolostone, gypsum, salt and some others. These rocks, subjected to different climates, assume many morphologies and landforms. Limestone purity (%CaCO3) is one of the most important controls on karst development. Karst landforms develop best on pure, dense and thick limestones and marbles. In karstification processes three parameters of lithology, climate and fracture are more important than others such as pedology, vegetation cover and topography. Among sedimentary rocks, salt rock has maximum dissolution rate. After that sulphate rocks such as gypsum, shows 10 times more Chemical Denudation than limestone. Limestone also has more dissolution rate compare it to dolostone. Bedding planes and fractures (joints and faults) are of the greatest importance because they host and guide almost all parts of the underground solution conduit networks that distinguish the karst system from all others. The availability of water is the key climatic factor in karst development. It is certainly the principal variable controlling total denudation by dissolution.

Central Alborz sedimentary-structural zone located in north of Iran. Rock units in this area include formations of Paleozoic, Mesozoic and Cenozoic Era. These formations consist of various carbonate, clastic and evaporite sedimentary rocks, as well as a variety of igneous rocks. The most important carbonate formations of Central Alborz are: Mila (Cambrian), Mobarak (Carboniferous), Rute (Upper Permian), Elika (Triassic), Lar (Upper Jurassic) and Tizkuh (Cretaceous). Carbonate rocks of central Alborz are under highly dissolution because of carbonate rocks, climate condition and also high density of fractures. Average rainfall in this area is more than 500 mm. Temperature is low, e.g. in Haraz valley 8 month of year is under 0 centigrade degree. The trend of faults in west part of Central Alborz are NW-SE, but in east part are NE-SW.

Potential of Karstification evaluated after field studies and sampling of carbonate rock units and compare them from the point of view of development of karst landforms formations. After sampling Carbonate rocks and preparing thin sections and also staining using Alizarin Red S for identification dolostone with limestone, they were studied under petrographic microscope. Investigation of remote sensing was performed by satellite images Landsat using GIS software to achieve separation and calculation of area of carbonate formations, natural lineaments, drainage map, as well as digital elevation model.

Lar Formation is one of the most karstified carbonate rocks in Central Alborz structural zone. The most important of karstic landforms in the area are Karren, vug, cave, sink hole and karstic springs. Varieties of Karrens are microkarren, karren, runnel Karren, rill Karren, grike, rain pit. The caves of Central Alborz identified in Lar Formation, for example: Asaldarreh cave in south of Ira village and Polmun cave in near Polour. The most important parameters casual Karstification of carbonate rocks in this area are: purity, thickness, outcrop area and time of exposure of carbonate rocks, also rainfall, temperature and fracture intensity.

Based on combination of all field work and remote sensing data, Lar Formation, related to other carbonate formations, shows maximum intensity of karstification in the east of Central Alborz zone. but in the west of Alborz zone (Alamut) (Figure left) it has less intensity of karstification among all carbonate rock units. This difference is because of more thickness and outcrop of Lar Formation in east of Central Alborz (Figure middle and right). In general, outcrop of this Formation is less in the west (3%) and is more in east (71%). On the other hand, karst intensity increasing from west to east. It shows that there is direct relation between outcrop of formation and karstification. Based on geomorphic classification, Central Alborz can be classified as merokarst.

Fig. Lar Formation in Central Alborz: Alamut (left), Haraz (middle) and Firuzkuh (right).

USING OF PROBABILISTIC-DETERMINISTICMETHODS FOR PREDICTION GEOLOGICAL PROCESSES

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Russia has a huge area and a wide variety of natural, geological and climatic conditions, so the territory and numerous infrastructure facilities are exposed to virtually all known types of dangerous geological processes. Geocryological processes located in permafrost occupy the largest area of distribution (about 65% of the territory of Russia). The total average annual economic damage of Russia from these processes is 6-7% of GDP [5].

Methods of prediction geological processes were created mainly on the basis of deterministic views on their nature, suggesting the possibility of a rigorous mathematical description of processes using the laws of mechanics, physics, and thermodynamics. The most significant drawback of this approach is related to the need to replace multicomponent and multifactor objects with their simplified models. Insufficient accuracy of these methods is also due to the poorly developed procedure for accounting for changing external factors. However, such methods, combined with geological methods, supported by monitoring data, as well as by physical or mathematical modeling methods, allow the forecasting of processes with sufficient accuracy for practical purposes.

The essence of the idea of probabilistic-deterministic forecasting of processes is the use of established deterministic and probabilistic laws for the development of these processes, taking into account the likely nature of external influences (main factors) and their possible combinations, as well as environmental in homogeneities with subsequent probabilistic interpretation of the obtained data. Probabilistic methods were used to predict various processes: landslides [2], karst processes using reliability theory [4], earthquakes [3].

Let consider an example of thermokarst development. Thermokarst is the process of uneven settlement of soils and underlying soils due to the thawing of ice rich soils or underground ice. As a result, funnels, dips appear, resembling karst forms of relief. Predominantly process distribute in permafrost. A prerequisite for the development of thermokarst is the presence of underground ice or icy soil. A sufficient condition for the onset of thermokarst development or the cause of thermokarst is the change in heat exchange on the soil surface, in which either the depth of seasonal thawing begins to exceed the depth of the occurrence ice and frozen soil, or a change in the sign of the mean annual temperature occurs, and the long-term thawing of frozen soil begins [1]. To calculate the probability of thermokarst development, it is necessary to estimate how the temperature (climate) will change and whether this will be sufficient for the development of thermokarst. The climate, as is known, is a random process, the forecasting of which is possible only from the standpoint of the probability-statistical approach. The next task is to estimate settlement of frozen soil. Soils are also multicomponent systems, so their properties must be evaluated using a probability-statistical approach. As a result of the work, various methods for processing temperature data and calculating settlement for prediction the development of thermokarst are considered.

Thus, the varying degree of certainty and randomness of geological processes greatly complicates their forecast. Therefore, it is necessary to increase the degree of validity and accuracy of the forecast within the framework of complex probabilistic-deterministic modeling techniques.

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STUDY OF GENESIS OF SEDIMENTARY BODIES LATERAL GROWTH IN SOUTH CASPIAN BASIN

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The experience of regional seismic-stratigraphic researches in the South Caspian and Middle Caspian basins testifies the widespread development of uncompensated subsides regimes at various stages of their evolution. Based on the results of our studies, no less than

50% of the deposits of the South Caspian Basin (SCB) were in uncompensated depositional condition. Such sequences accumulated mostly during of sea level regredation period, when offshore areas were hollowed-out by erosion as a result of increased activity of paleorivers and underwater channels, and sharp decrease river base level. The river fan and underwater channels formed the sedimentary bodies in continental slopes. Such bodies are characterized by the primary slopes of the layers and the clinoform configuration at their boundaries. Seismic stratigraphic studies show that, the horizontal-layered models of sedimentation for the SCMB section are not typical. A large number of lateral sedimentary bodies with various shapes are common in the seismic section. They are characterized by the primary slopes of the layers and the sigmoid configuration at their boundaries. Due to this factor, the known methods of "thickness analysis", "recovery of unexposed thickness" and other surface extrapolation and interpolation can not be used .

Seismic stratigraphy according to regional profiles indicates a broad development of uncompensated deposition mostly at all stages of megadepression development. Sequence sedimentation was uneven in all paleogeography zones, depending on tectonics, relief morphology and hydrodynamics.

Seismic stratigraphic studies in the context of SCB shown that two-dimensional models of deltaic sedimentary systems are different. The progradate delta of Paleo-Uzboy on the northwestern periphery of the Pliocene basin have been spread to 200km northward. The delta front clinoform of the SCB in the early Pliocene section have been formed during one complete paracycle of relative sea- level fluctuation (~ 500 thousand years). According to seismic section, it covered primary shelf of the topographic slope laterally 10-15km and vertically 100-200m. As a result, have been formed new sedimentary slope, which after a long break covered by new slope clinoforms (about 300 thousand years) [1, 2].

The edge structures of Epic-hersin platform basis of also played an important role in formation of laterally increased sedimentary deposits of different ages. The trace of gravity and flows clearly visible in seismic sections.

At the north boar of Balkan zone of the SCB and high continental slopes clearly visible. Such slopes have been formed from middle-late Jurassic to Oligocene. The absence of sediments on the steep slope indicates that it is a transit surface. In some places slope washed and destroyed with canyon systems. The same age deposits are selected in shelf and bottom of slope.

In time sections, the upward terraces of slope flow and collapse of seismic facies are clearly visible. The regulatory mechanism of accumulation of deposits at the bottom of the slope was the cycle relative sea-level fluctuation.

When large and active delta systems and other sources of denudation far from the basin, the paragenesis of shelf carbonates, slope depositions and thin overlying bases occured in its terrestrial. This type of paragenesis is also the most important indicator of the deep water basins.

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KINEMATICS AND SEISMICITY OF THE EASTERN CAUCASUS

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Azerbaijan is located in the zone of active collision between two continental lithospheric plates: the African and Eurasian plates. The velocity of the northward motion of the Arabian Plate relative to the Eurasian Plate is more or less constant since the onset of the collision (20 mm per annum). This causes the lithospheric shortening along the Main Caucasian Thrust, which extends in the meridional direction, and horizontal displacement of the lithosphere. Being responsible for crustal deformations, these regional tectonic processes cause earthquakes throughout the entire Caucasus. This work is dedicated to the investigation of the rate of crustal deformations in Caucasus based on the GPS measurements and its relationship with seismicity. Velocity vectors obtained from Azerbaijan GPS network for the period of 1998-2017 years were used in order to evaluate the deformation rates. The large earthquakes and associated seismic hazards in the eastern Caucasus need to be investigated with more attention. Taking into account that the easternmost part of the Greater Caucasus is an area of dense population and sensitive industrial infrastructure.

We present updated results from a GPS network between the northern edge of the Lesser Caucasus and Greater Caucasus, providing geodetic constraints to the problem. A significant strain rate is observed in a profile over a distance of about 150 km across the Kura Basin. We attribute this to inter-seismic strain accumulation on buried fault structures and present simple elastic dislocation models for their plausible geometry and slip rate based on the known geology, seismicity and the GPS velocities. Due to the close proximity of the strain anomaly to Baku, further observations are needed to determine whether observed contraction is due to inter-seismically locked faults and, if so, implications for the seismic hazard in the region.

THE PROCESS OF LANDSLIDE IN ZIKH HILLSIDE POWER SURVEY RESEARCH METHODS

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Landslide on the slope of the hill, and under the influence of gravity is moving gradually away from rocks or a glimpse of one of the exogenous geological processes. Landslides occurred in features A.P. Pavlov and delyapsiv detruziv is divided by type. According to the geological structure and anthropogenic impacts, as a result of the landslide area is developing and.

The structure of rocks that form the structure of the slope landslides, asekventkonsekvent and insekventn type is divided.

Landslide in Zigh hillside occurred at. In the south-east of Baku and in settlements located in the territory.

Zikh landslide 1943, 1948, 1952, 1953, 1973-1974 years after the break, which lasted from 2012 until today, almost every year there is activation of the landslide on the slope of a small.

Great damage to settlements, various technical engineers plants as a result of the landslide process is. Therefore, the study of the landslide process is one of the urgent issues.

Zikh landslide in order to study the events of geophysical research, according to geological issues set for the following:

- The exact separation of the geological cross sections to the depth of 40m;
- Probable termination of the lines to detect and monitor;
- The thickness of the landslide mass and sliding surface of a deep sleep definition of impairment.

Various geophysical methods used in the study of vertical Electrical Sounding (ŞEZ) methods, one of which is the landslide process. Landslide occurred in the territory of the republic successfully carried out and positive results were achieved in the world and in the study of the use of this method. The landslide in Zigh hillside ŞEZ method is applied symmetrically (AMNB) to examine this experience and given. Field measurement works were implemented in 1:500 for the exploration of the instruments of power ERA-MAX 6 core.

Geophysical exploration in the area where the construction of accommodation amounted to 6,0-65,0 m distance between points of observation, given the conditions and various relief of. The specified depth of 100 m maximum distance between electrodes to feed the EU adopted. The length of 1 meters and a diameter of 0,02 m, which is made from iron electrodes, MO, and latundan perceiving sensory data as are nutritious electrodes. Receiver electrodes are connected via a cable wire electrode among themselves, with GSP-2 QPSMPO such as nutritious.

As a result of work carried out by the geological cross-section, the rocks that form f.o.e ŞEZ wild.And x.e. According to the tracking, their f.o.e 50 m depth of resistance. Resistance 1,0 - 1200,0 Ohm, my x.e. The resistance of lithologic and thickness of 1,0-9,0 m in the range 0,1 - 1250,0 Omm my part of it was found that the.

A map of the thickness of the landslide mass was supposed, according to the geophysical data. According to the map, it should be noted that research work carried out at depth of 9,0 10,0 m on the edge of his bed while changing thickness of the landslide masses (sliding surface of a deep sleep) of the North - Western part alleged Southeast area varies between 15,0- 18,0 meters.

The following results were carried out geophysical survey:

- Zikh landslide area as a result of geophysical research conducted in 1:500 on the scale of 6 units of electric resistance and geophysical – cross-sections of lithologic made up of vertical alleged;
- Probable composition of special electrical resistance and Ohm 1- 9 m, the thickness varies between 1250.0 to 0.1 have found their lithologic;
- Research cross-section of lithologic rocks that form of tracking up to 40 m deep and cross-section x.e.m the resistance has been allocated for distribution;
- The lithological composition of the cross-section is likely to consist of technogenic sediments, cemented clay sands, sandy clays, clays, and cobbled limestone limestone;
- In order to ensure the safety of underground water is collected and gradually built retaining walls behind the geological environment feeds of different origin;
- The bulk of the amount of underground water is moving along the lines of disorder found in research;
- Closest possible landslide plane on the ground level of intensity of natural moisture

from the north-west to the south-east is reduced;

- The total depth study of the geological environment of the decade has undergone a moist within;
- Hillside homes in excess of the limit with loaded;
- That is close to the surface in addition to a depth of several alleged landslide plane was discovered and chased the alleged landslide site;
- The research work carried out on the territory of the upper part as a result of the activities of various fields, at different depths and subsidence landslide process is high likelihood of domestic water collected;
- Houses built on the slope of the hill beyond the impact on household water exceeds the norm;

Survey the area and disjunctive processes plikativ exposed.

Summing up the results of the human and natural factors, mainly as a result of complex hydrogeology and geological conditions, dangerous slope Zikh settlement where a geophysical survey should be noted that in changing often formed.

Hazardous conditions are necessary to implement measures for elimination of emergency engineer.

THE DANGER OF DEVELOPMENT OF DROPS FOR OPERATED RAILWAYS

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Railroad tracks laid along steep rocky slopes are always prone to the formation of landslides caused by a variety of geological and technogenic factors. Geological, in the first place, includes natural fracturing, which determines the stable state of the massif. The rocks of the slope are subjected to weathering processes for a time, in connection with which there is an expansion of existing cracks and the formation of new ones. All this is exacerbated by the impact on the array of dynamic loads from passing railroad trains.

To ensure the safety of the movement of passenger and freight trains along hazardous areas, a thorough examination of the jointing of the massif and an assessment of the risks of the development of landslides should be carried out. When solving the tasks set, classical methods of processing and displaying measured elements of the occurrence of cracks in the form of various planar diagrams and primitive histograms are applied, but these methods become obsolete and recede into the background. Modern software allows more visual representation of information in the form of 3D images and models, thanks to which it is possible to give a qualitative assessment of dangerous systems of cracks and slope stability. One such software is the widely used system of automated design and drawing of AutoCAD.

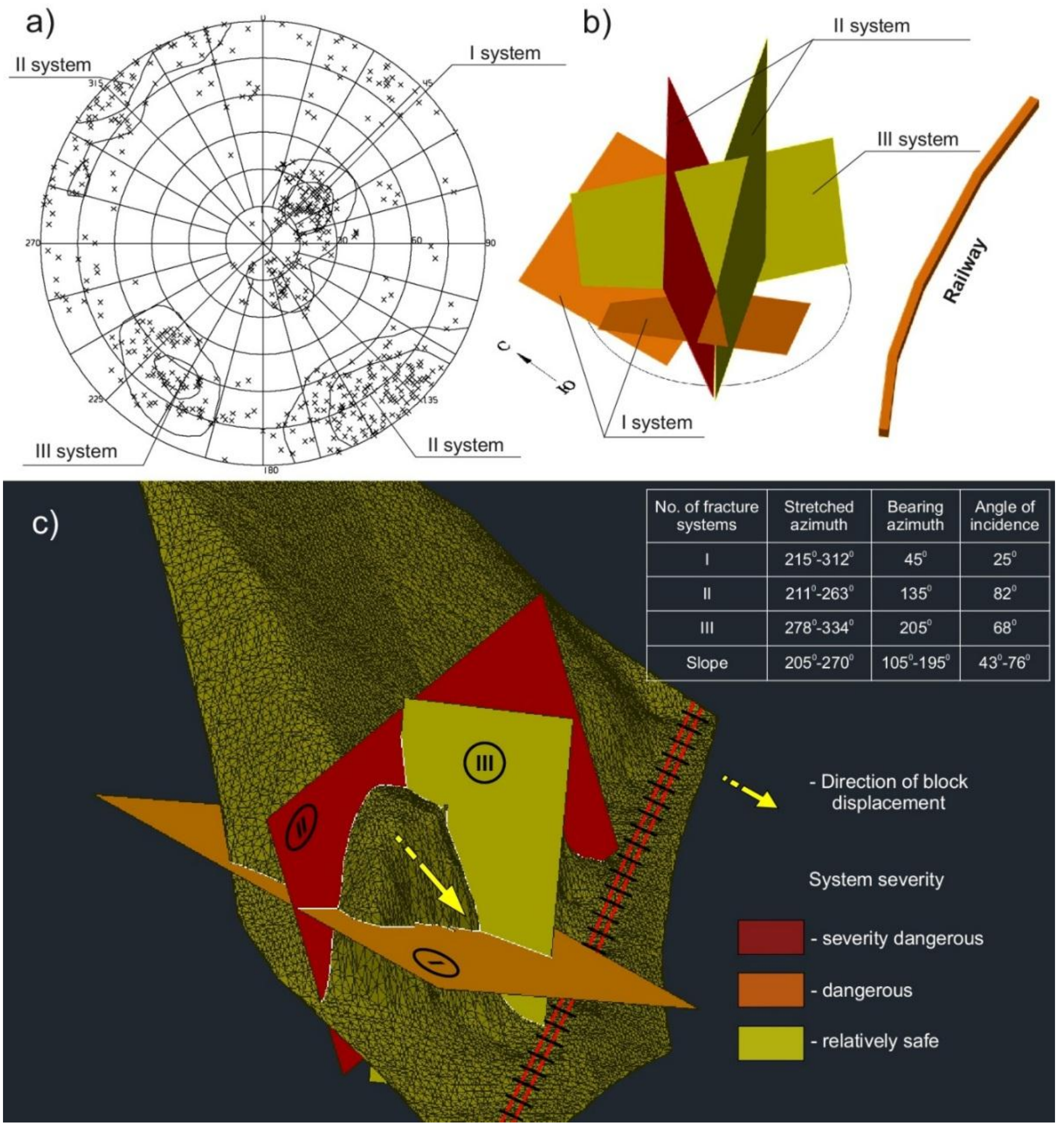
In the AutoCAD program for a short period of time, it is possible to build a perspective 3D diagram that reflects the basic cracks in the form of planes. The construction is carried out based on the results of field studies and measurements of elements of occurrence of cracks (angle and azimuth of fall, azimuth of strike) with the help of a mountain compass. The data obtained are summarized in a table on the basis of which a "classical" fracture diagram is constructed, with three predominant fracture systems identified (Figure (a)).

A perspective 3D diagram is constructed on the basis of a flat diagram (Figure (b)), which allows to visually assess the degree of danger of a particular system of cracks in relation to an engineering structure or an infrastructure facility. A flat perspective diagram using a set of tools in the 3D modeling work space is transformed into a three-dimensional model, oriented to the sides of the world. Further, the diagram is integrated into the slope model, thereby allowing to identify the most dangerous fracture systems of the rock massif and to see the geometry of the dangerous blocks (Figure (c)).

These diagrams were used in assessing the danger of fracture systems in rock massifs adjacent to the railroad track (see Figure), where in the summer of 2017 a block of rock with a volume of 50 m3 collapsed onto the passing freight train, fortunately there were no casualties.

The constructed diagrams made it possible to visualize the data obtained during field investigations, to identify cracks that promote the displacement of rock blocks, to predict the danger of development of landslides and in the future to take the correct measures to prevent emergencies.

Of the systems isolated on the site, the most dangerous is the II system with the transition of the orientation of the angle of incidence of cracks through 90˚, the systems I and III contribute to the "cutting" of steeply falling cracks, as a result of which it is possible to tilt massive blocks of rocks towards the railroad.



No. of fracture systems	Stretched azimuth	Bearing azimuth	Angle of incidence
I	215°-312°	45°	25°
II	211°-263°	135°	82°
III	278°-334°	205°	68°
Slope	205°-270°	105°-195°	43°-76°

Fig. a) Pie chart of fracture; b) perspective 3D diagram; c) perspective 3D chart, integrated into the slope.

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PORE SPACE EVOLUTION RELATED TO FLUID (BRINE)-ROCK INTERACTION PROCESSES: CASE STUDY IN KOPYLIVSKA GAS FIELD (DNIPRO-DONETS DEPRESSION, UKRAINE)

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In the south eastern part of the Dnipro-Donets Depression (DDD) a number of gas and gas-condensate fields have been discovered, in particular industrial gas discharge related to the Lower Permian sediments within Kopylivska, Slovianska, Riabukhinska, Kobzivska, Lanivska, Northvolvenkivska areas, etc.

Significant criterion in the hydrocarbon fields research and exploration is the feature determination of formation and changes of reservoir properties of oil and gas accommodative sediments. Permeability, being one of the most important reservoir properties, significantly depends on pore space structure, which affects both the disposition of hydrocarbons in the layer and their amount. An essential part of this research is investigation of sediments catagenetic evolution, whereas formation of reservoir properties is generally associated with these processes.

Kopylivsky gas field is located in the village of Kopyly, Poltava region. Perspectives of this area should be associated with the Lower Permian Slovyanska Suite sediments, from which the industrial gas inflow has been received. In tectonic respect, this area is located in central part of DDD, which is complicated with Poltava mushroom type Salt Dome (Upper Devonian). Salt Dome disturbs natural layers bedding and changes hydrogeological conditions, as a result, disbalance in the fluid (brine)-rock system near salt dome leads to the formation of highly salinity brines (up to 320 mg^3/l) and chemical precipitation of neogenic minerals (calcite, dolomite, anhydrite, barite, celestine, halite, sylvite). Thus, the processes of catagenesis changes occur under the influence of brine inflow within subsalt, intrasalt and suprasalt sediments. Complex technique has been used to evaluate the degree of catagenetic transformations and the impact of these processes on sediments reservoir properties changes. It includes interpretation of SEM studies results (morphology, chemical composition) of clayey minerals and pore space structure for terrigenous and terrigenous-evaporite rocks, results of XRD, spectral and particle size distribution analysis. As a result, in the siltstone and sandstones of the Slovianska Suite, idiomorphic calcite crystals, dolomite (with an admixture of Fe 0,5-0,8%), halite and barite, quartz, plagioclase, and also illite and framboidal pyrite have been established. In Kartamysh Suite sediments, sandstones and mudstones, pore space and microcracks are filled with halite crystals, and also new formed quartz and illite. In the Upper Carboniferous sandstones, neogenic minerals are represented by well-crystallized dolomite (with an admixture of Fe – 0,8-10%, Mn - 0,3-2%), anhydrite, barite and halite, in the specimen of argillite - idiomorphic anhydrite crystals, as well as illite, ferruginous chlorite, quartz, pyrite, accessories – rutile, zircon, monazite.

Thus, it has been found that metasomatic dolomitization can reduce porosity; as well as mineral neoformations within pore space lead to permeability decrease; anhydrite (less often celestite, barite) fills caverns, pores and tectonic cracks; halite – the latest of the minerals, fills the pore space, usually heals the cavities, which are made of crystals of dolomite and anhydrite. Thereby, the main objective of this research has been to provide an update on understanding of fluid (brine)-rock interactions and catagenetic processes in evaporites, terrigenous rocks and their integration for the prediction of reservoir qualities changes across spatial and temporal scales.

RISKS OF DEVELOPMENT OF LIMITS IN CORPS OF WEATHERING IN THE PROCESSING OF MINERAL DEPOSIT FOSSILS BY OPEN WAY

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When mining open-cast mines, there is a risk of which activates natural and technogenic processes, leading to deformation of the quarries and development of emergency situations. The unexpectedness and scale of such processes can lead to the loss of not only equipment, but also human lives.

Mining enterprises, unlike many other industrial facilities and structures, are complex natural and technical complexes. Parameters and indicators of economic efficiency of mining enterprises are determined by natural factors (structure and size of deposits, topography, geological, engineering-geological and hydro-geological conditions) and structural features of the mining structure (depth of digging, angle of inclination of ledges and sides of the quarry).

As it was said above, engineering and geological factors are the determining factors for correct, and most importantly, safe working off. The choice of the optimum angles for laying the slopes of the sides of the pit depends on the strength and fracturing of the rocks (in rock massifs), the strength of the rocks for the slopes, built by the weathering crusts. A change in the geological conditions within even one zone of the deposit is followed by a change in the angles of the sides of the quarry. Therefore, it is necessary at the initial stages of the exploration (the period of geological exploration) of deposits, the sides of which will be stacked by weathering crusts, to study the characteristic features of the rocks that are inherent to them, taking into account their possible changes in the process of field exploitation.

In dispersed rocks that are able to change their properties both over time and under changing natural conditions, the risk of landslide development is particularly high. Consider 2 models of the development of events, the formation of deformations in the sides of the quarry and the development of a landslide process.

I model – the sides of the quarry of these deposits are composed of weathering crusts of different zonality. We will calculate the stability of such boards taking into account our engineering-geological regularities, with a safety factor of 1.2. The calculations were performed according to the formula of G.L. Fisenko, showed that with increasing thickness of the weathering crust, the angle of inclination of the quarry is reduced. Considering the engineering-geological zonation of the weathering crust, it can be seen that the angle of inclination of the pit of the quarry varies: in the lower part, composed of clastic zone k.v., it is

34°, in the zones of lithomarine and clay it decreases to 22-26° (this is due to an increase in the clay content of the rock, the appearance in the array of minerals such as kaolinite, hydromica) and again in the zone of secondary carburization it increases to 28°, which is associated with the appearance of structural bauxite in the rock and the transition of structural bonds from molecular to cementation.

II model – the same conditions, but we change the safety factor of stability by 1, which corresponds to the extreme situation. Calculations showed that the risk of the landslide process is significantly increased, the risk is significant and even leads to the emergence of extreme situations that require measures to minimize and eliminate possible dangerous processes, and thus an increase in economic and at worst social losses.

To determine the boundary angles of the inclination of the sides of the pit, we reduce two models to one (Figure). Let us analyze the results obtained. At 62 % of the thickness of the weathering crust, the line of the lithomar zone with k_{ust} = 1 intersects the dispersion zone line with k_{ust} = 1,2 and the total angle of inclination of the bead at the intersection point is 32° – this is the safe angle of the bead at which the risk of landslide processes is minimal.

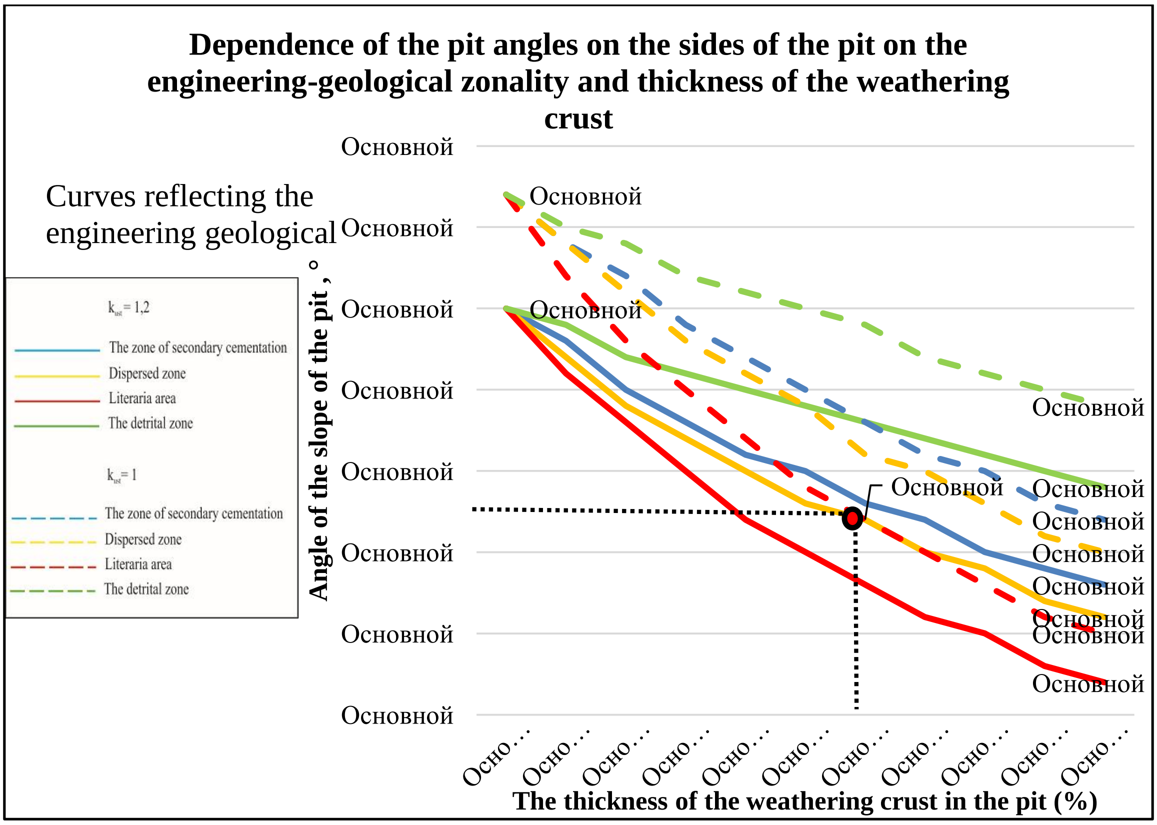

Fig. Dependence of the angle of the pit walls from the engineering-geological zoning and the capacity of the weathering crust.

If the initial angle of the side of the pit was defined incorrectly, without considering the peculiarities of the zones of the core, then rapidly begins to increase the risk of landslide processes.

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LANDSLIDES HAZARD AND THE MAIN RULES OF ITS CONTROL ON URBAN TERRITORIES

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The occurrence of gravitational processes (landslides) within slopes causes damages, destruction and demolition of man-made objects, buildings and structures on urban territories. The landslides hazard depends on morphology and geological structure of a slope, mass volume involved into movement, the distance of shift and its velocity, on energy (shift forces). The state of receiving zones and objects located there are very important also.

The engineering protection of the Dnieper slopes in Kyiv performs by periodic planning, landscaping, building of retaining walls, and drainage of different designs during the last centuries. Currently such drains and underground drainage systems have been built hundreds of kilometers.

The drainage systems as the shallow mine workings in loose sandy-clay soils, over time have caused significant reductions of the stability of soil masses, such as subsidence of the surface (the Near caves, Kyiv Pechersk Lavra, 2006), landslides and the leakage of soil particles (suffosion) from the drainage systems.

The conditions of weakened zones formation around the drainage tunnels and galleries in the arrays of loose soils adjacent to the slopes of river valleys, on the example of the right-bank slope of the Dnieper river within the territory of Kyiv are considered (Figure).

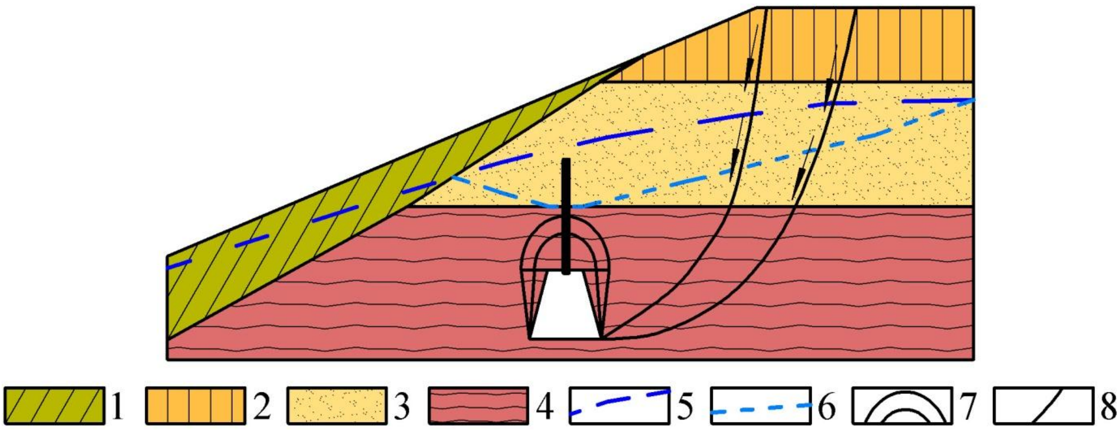

Fig. Formation of a weakened (decompressed) zone around a drainage system on a slope: 1 – landslide deposits; 2 – loess; 3 – sand; 4 – clay; 5 – depression surface before dewatering; 6 – depression surface after dewatering; 7 – contours of the collapse of arch; 8 – sliding surfaces.

Deep drainage systems made to intercept aquifers, which are unloaded on slopes and treated as one of the reasons for the development of erosion-gravitational processes [3, 4]. The redistribution of stresses in the soil mass, the development of the surface displacement, the formation of cracks and failures, violation of the slope stability and development of landslides is due to the removal of the soluble components and particles of soils, suffusion, breaking out of the quicksand. The use of this type of drainage in anti-landslide protection systems is not recommended, and the constructed drainage should be decommissioned.

The designing of measures for the protection of objects located on sites with difficult relief, special attention should be paid to proper planning of the placement of buildings, engineering networks, and transport highways. A special mode of operation should extend not only to individual objects, but also to the slope in general.

Slope stabilization measures that are planned to be conducted on or near the slope, or when using the underground space in the zones of influence of slopes, should not:

– to disturb the regime of underground and surface runoff, to cause local increase of groundwater level or redistribution of formed filtration and runoff routes;

– to give an additional water flow to the slope;

– to create additional static and dynamic loads in the zones of possible gravitational displacements of rocks;

– to deteriorate the external landscape and architectural appearance of the site;

– to promote the activation of weathering, suffusion, erosion.

The complex of works related to the decision on the use of the slope includes economic calculations, engineering surveys, coordination of decisions with the State Architectural and Construction Control, departments, organizations and enterprises.

It is necessary to take into account the staging, cyclicity, rhythm icity and seasonality of the development of processes on the slope. Experience has shown that it is most appropriate to carry out measures during the period of minimum amount of atmospheric precipitation. Slope stabilization just before the landslides requires a significant volumes of work, and in some cases may be ineffective.

Thus, the basic principles of slope stabilization measures can be combined with engineering preliminary works and engineering protection of buildings and structures [1, 2]. They should be as follows:

– maximize the ability of natural systems to self-repairing and self-regulation;

– be adequate to influence on the character and the scale of processes on the slope;

– take into account seasonality, staging and cyclicity of natural geodynamic processes;

– to ensure the complexity and selectivity of individual measures;

– to combine measures for engineering protection with engineering preliminary works of sites, special protective structures with structural elements of buildings.

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GEOMORPHIC AND SEISMIC CONTROLS OF LANDSLIDES INDUCED BY THE 2016 MW 7.8 KAIKOURA EARTHQUAKE, NEW ZEALAND

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The Mw 7.8 Kaikoura earthquake struck the northeastern South Island of New Zealand at 12:03 local time (11:03 UTC) on 14th November 2016. It was the one of the largest and complex earthquake in New Zeland's recent history. The earthquake hypocenter was at 42.69° S, 173.02° E, at a depth of 15 km in a well seismic instrumented region. The earthquake ruptured a sequence of active faults, terminating offshore and markedly affecting coastal and inland areas across the northeast of the South Island [3]. The global moment tensor solutions revealed that multi-fault rupture earthquake event is rather complex and overall propagation of the rupture process from south to north, connecting the region between the Hikurangi subduction system of the North Island and the oblique collisional regime of the South Island (Alpine Fault) [1]. The effects of the Kaikoura earthquake on the infrastructure, and the environment were severe and wide ranging, with an assessed cost of NZ$3-8 billion for rebuild efforts [3].

The 2016 earthquake not only caused severe loss of economic and bio-physical environment, but also triggered tens of thousands of landslides. This study presents the first results on analysis of the landslides triggered by the Mw 7.8 Kaikoura earthquake that occurred on November 14, 2016 in the northeastern South Island of New Zealand. Here we present the mapping results of the distribution of landslides triggered by the earthquake. An extensive landslide interpretation was carried out using sets of optical high-resolution Sentinel-2 satellite images for both the pre- and post-earthquake situation. The landslides were identified and mapped as polygons using multi-temporal visual image interpretation based on satellite imagery and morphological elements of landslide diagnostic indicators. Nearly 14,280 individual landslides with different sizes and types were mapped over a total area of about 8650 km^2, with the 85% clustered in a smaller area of about 1700 km^2 (Figure). The distribution pattern of the mapped coseismic landslides shows that the slope failures are highly concentrated along the ruptured faults and side slopes of the structurally controlled major rivers such as Hapuku and Clarence Rivers that drain the northeastern slopes of the region. Our spatial analysis of landslide occurrences with ground acceleration, lithology, slope, topographic relief and surface deformation indicated extensive control of steep slope and high topographic relief on landslides with ground acceleration as the trigger. We show that spatial distribution of slope failures shows decreasing frequency away from the earthquake faults up to 25 km towards east, and abundance of landslides spatially coincides with the coseismic fault geometries and aftershock distributions. We conclude that combined effect of complex rupture dynamics and topography primarily control the distribution pattern of the landslides triggered by the Kaikoura Earthquake sequence.

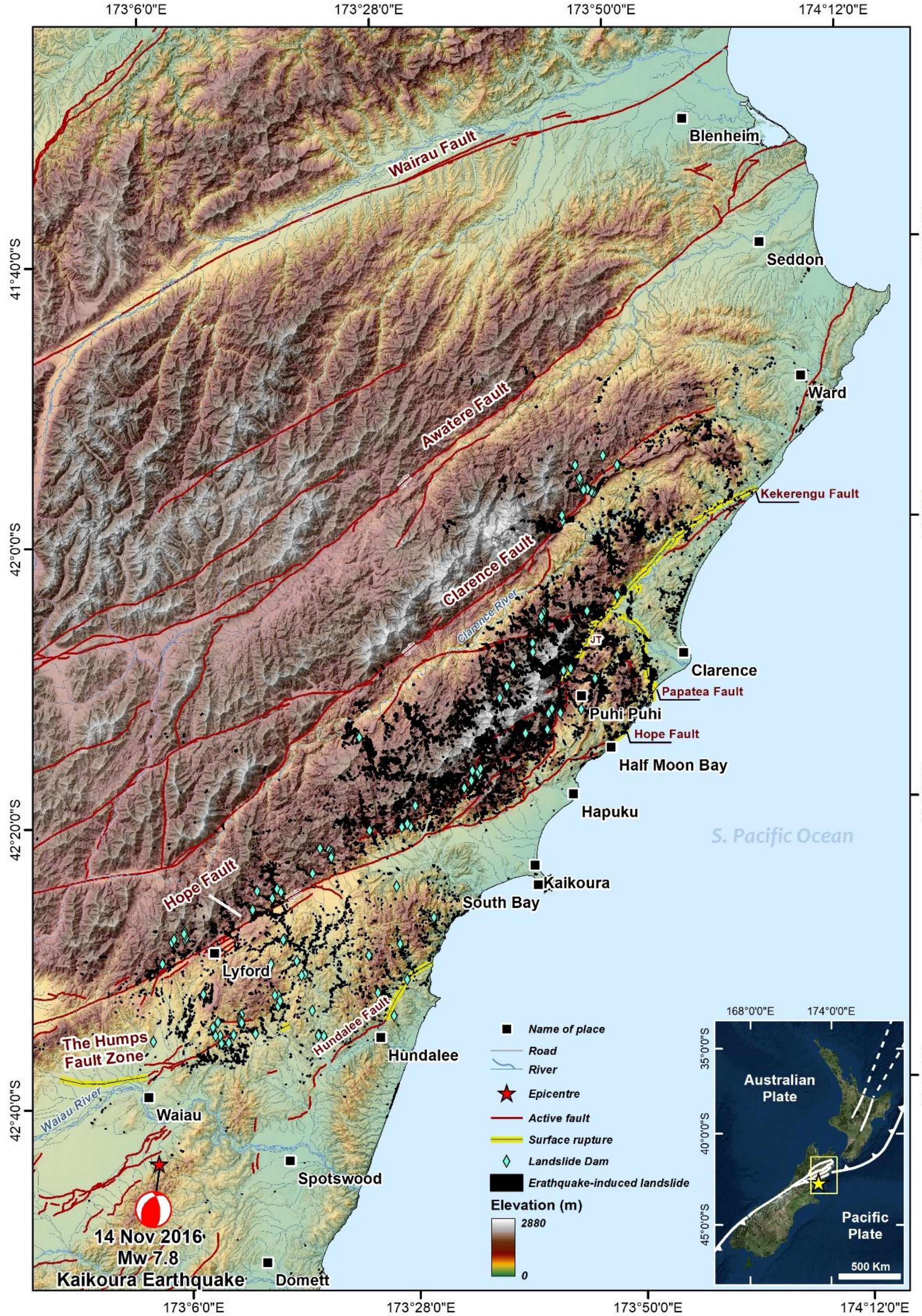

Fig. Distribution of ~14,280 landslides triggered by the 2016 Kaikoura Earthquake, New Zealand, and tectonic setting of the study area. Yellow lines are surface traces of coseismic rupture [2]; beach ball shows focal mechanism of the earthquake [3, 4]. Inset shows major tectonic boundaries between Australian and Pacific Plates.

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THE PRELIMINARY TIDAL ANALYSIS BASED ON THE CG-5 AUTOGRAV GRAVITY MEASUREMENTS AT LENKARAN (AZERBAIJAN) STATION

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Introduction. The study of the tidal variations in gravity is one of the perspective methods of geodynamic studies. Tidal variations in gravity are caused by the influence on the earth of variable in space and time the lunar-solar exposure. Experimental data is important in the development of models of tidal deformation, for the calculation of tidal corrections in high-precision measurements that reflect the variations of strain and stress in the Earth's crust, to determine the displacements of the earth's surface in the geocentric coordinate system.

Currently, the Earth's tidal observations are widely implemented in many countries, but the number of stations of earth tidal observations is far from enough. In addition, the existing network of these stations is not evenly distributed. This creates difficulties of interpretation of the geodesic results. Therefore, increase in the reliability and the quality of the experimental data, as well as the geographical expansion of the observations is highly relevant.

Lenkaran station. Lenkaran station is located on the South-East of Azerbaijan. Tidal registering station Lenkaran tectonically belongs to the Talysh folded mega zone, which is located on the northern edge of Lesser Caucasus fold system, separated from the structures of the Lesser Caucasus by cross Lower Araz deflection. Within the republic of Azerbaijan mega zone is represented by its north-eastern wing and the south-western part is a part of the Garadagh area of northern Iran, where volcanic-sedimentary formations overlap Paleogene

Miocene-Pliocene volcanic complexes of Savalan volcano. Oblique cut of northern structural zones by the Pre-Talysh fracture is also observed in the folded region contemporary structure. Along this fracture the region eastern part sinking took place in the Late Miocene-Pliocene time. This sinking promoted the separation of two morphologically defined units instead of one folded system: the Mountainous Talysh and the Lenkaran plain. Theterritory of the Azerbaijan lie within the zone of plate interaction where the African and Arabian plates are actively converging with the Eurasian Plate. The Lesser and Greater Caucasus Mountains lie within the zone of plate interaction where the African and Arabian plates are actively converging with the Eurasian Plate. The gravitational force exerted on the tested weight is balanced by a spring, and its variations in time are compensated by the electrostatic force. Since the sensor is made of a nonmagnetic fused quartz. AutoGrav system is not affected by the changes of magnetic field (if they do not exceed the magnitude of the Earth's magnetic field in ten times). It is highly accurate (1mGal) and is the easiest of the automatic gravimeters providing automatic leveling of the device and automatic diagnosis after powering. Personal observer's errors in the measurements are completely excluded, as the device is fully automated.

In the AutoGrav system angle gravimeter sensors that allow you to enter data for the automatic adjustment of the inclination of the device are implemented. The system of automatic adjustment of data also introduces a correction for lunisolar attraction, and, in addition, has a progressive function of rejection the noisy indicators and seismic noise filter FIR. Protection from changes of external temperature and atmospheric pressure is achieved by sealing the sensor element of the AutoGrav system in the vacuum chamber with temperature stabilization. Small displacement of the zero point allows conducting the accurate long-term assessment of the displacement sensor. (Scitrex Limited CG-5 Manual 2006).

The implementation of measurements by tidal devices requires a preliminary assessment of systematic instrumental characteristics. The measurements are usually conducted by means of linear sensors or in the linearity of the measuring system. When measuring the displacement of sensor element were used different types of sensors: differential photocells, capacitive displacement sensors with the feedback system, laser movement sensor, inductive displacement sensors. In fact, most of the received information was obtained without the use of schemes to enhance the signal, i.e., sensor – galvanometer.

In the spring gravimeters are widely used various feedback systems for increasing the sensitivity. This technology was used when working with gravimeter Scintrex on the tidal station Lenkaran. Special attention is paid to the account of the instrumental delay of registration systems. The importance of an accurate determination of the phase delay in the tidal variations derives from the existing tidal models of tidal Earth's deformation, ocean tides, and the effects of tidal dissipation in the theory of evolution of the Earth.

Data analyses. The observation results were processed using a combination of programs PreAnalyse and ETERNA. Dynamic of recording: For long-term Earth tide observations and secular weare using the function "Continuous observations". This function permits the continuous measurement of gravity as required for Earth tide observations and secular gravity studies. Sample rate: The date sample rate was set to 3 minutes. Time base: Date and time were adjusted to UTC.Interpolation of gaps: During the primary treatment we introduced gaps where data were missing. The 1 min samples were cleaned with PreAnalyse and filtered to 5min- and 1- hour-samples. Time series were analyzed using program of tidal analysis ETERNA 3.4.

Conclusion. More than two years of CG-5 Autograv gravity data from Lenkaran, Azerbaijan have been analyzed. As a result of conducted studies using Scintrex CG5 gravimeter a technique of observation of the gravity tidal variations has been learnt, the values of the Earth's tidal parameters (amplitude factor and phase delay) of the gravitational field for 9 major diurnal waves and 6 main semidiurnal waves in the southern part of Azerbaijan has been obtained.

K1 tidal, which is mentioned in the literatures as "mixed lunisolar" one, is the first-size amplitude of the tidal wave. Since the period of this tidal wave is approximately 23.93 hours, obviously, the direction of this peak period in the star frame of reference is not dependent either on the phase of the Moon or Sun, and consequently is not also on their gravitation.

The main lunar semidiurnal wave M2 (the period of this tidal wave is around 13.66 hours) is the second-size amplitude – phase indicator of the elastic response of the Earth's crust on the tidal effect. Tidal O1 (the main lunar declined wave with the tidal wave period of around 28.984104 hours) is the third-size amplitude of the tidal wave.

PLACER GOLD OCCURRENCES OF UPPER SVANETI (GREATER CAUCASUS, GEORGIA)

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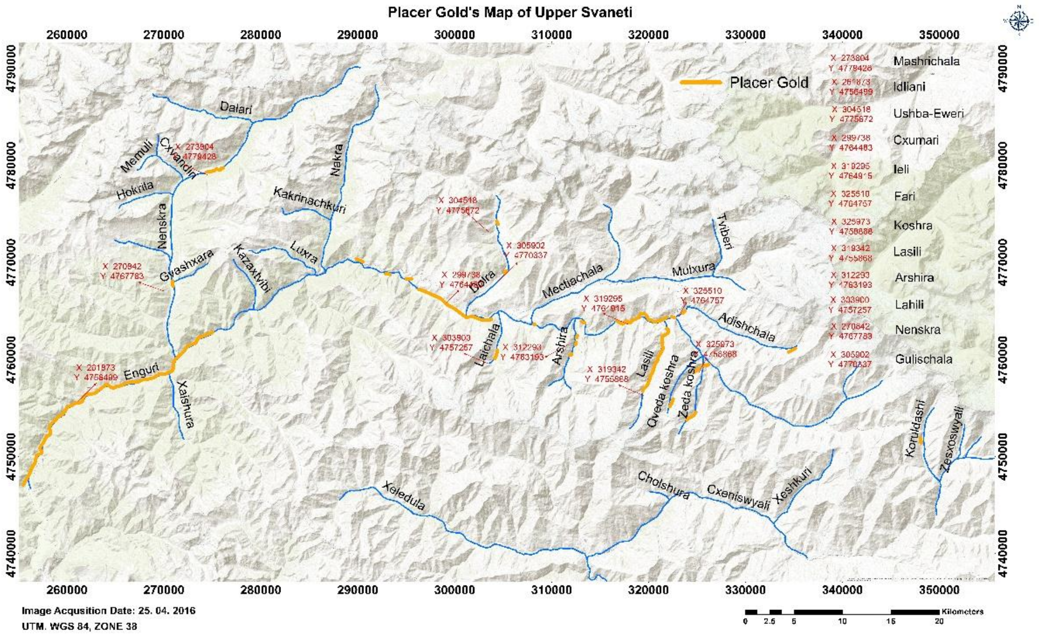
Distribution regularities of Upper Svaneti gold mineralization are conditioned by the combination of metallogenic, structural and magmatic factors. Gold occurrences are distinguished by mineral composition diversity, grade of metamorphism and deformation of mineralization hosting environment, types of mineralization hosting fold and fractures structures, the morphology of ore bodies, composition of ore bodies and adjacent metasomatites and etc.

In spite of the area occupied by Svaneti region is small, numerous ore mineralization of various genetic type occur here. They are connected with magmatic formations as well as with the sedimentary ones. During the Soviet times, since 1934 near the village of Jvari, from the Enguri River (main water collector of the region) alluvium mining of gold sands was started and lasted until 1957. After 30 years gold sampling was renewed in the mentioned area and it turned out that geologically such an insignificant time interval took place replenishment of these gold field to the industrial mark [1]. It was natural that after that uncovering discovery of gold-bearing main structures and bedrocks in Svaneti became aktual.

Data about Svaneti natural resources are considered in the works of the ancient Greek and Roman scientists. Greek historian Strabo (44 B.C.-23 A.D.) in his IX Book of Geography wrote about Svaneti and its natives: "In mountain rivers of this country there is a lot of gold mined by these barbarians using the perforated vessels and sheepskin". It is interesting that the ancient Roman historian Apian Alexandrine in his XII book "The Argonauts Travel in Colkheti Kingdom", consider the main aim of a campaign was to the method of gold mining. In his opinion, the "Golden Fleece" implies the sheepskin technique of gold mining. Recent geological studies of Svaneti also show that high contents of gold are present here in main rocks as well as in river alluvium. At the same time, the natives in Svaneti still mine gold from the rivers using special wooden vessels and sheepskin. The main purpose of the paper is to justify geologically that Svaneti is a region where the fact of probable gold mining using sheepskin and wooden vessels was realistic and the notion of "Golden Fleece" was associated with the sheepskin technique of gold mining from the rivers.

It should be mentioned, that following placers are known in Upper Svaneti: The Enguri, The Latali, The Ieli, The Arshira and The Tskhumari. Placers are also known in the right and left tributaries of the Enguririver: The Gulischala, The Idliani, The Nenskra, The Mashrichala, The Upper and Lower Koshriani, The Fari, The Ushba-Etseriand The Lahili (Figure).



This analysis of our geological research and this review has shown that the Svaneti region is rather rich in gold occurrences [2]. These occurrences are found in the Paleozoic "crystalline basement complex" as well as in alpine intrusions and sedimentary cover. From our modern geological research data we can come to the conclusion that the "gold sands" mentioned in ancient Greek mythology and in historical sources were a geological reality. Our work also shows that the gold content in the rivers sands of this region are sufficiently large to give grounds for the creation of legend, which describes Svaneti as the "country rich of this noble metal". When our geological research is coupled with the presence of modern implements and techniques that have ancient historical precedents for gold placer mining, we share the view point of the Roman historian Apian Alexandrine (90-170 A.D.) who believed that the myth about expedition of the Argonauts and their quest for the "Golden Fleece" was based on reality. We contend that their trip to the Colchis Kingdom, was a real event, the main purpose of which was to obtain gold and gold mining technology from those who were working the rivers sands of the Colchis Kingdom [3]. The phenomenon of the "Golden Fleece" is likely, according to our research, to be connected with the sheepskin (fleece) technique of gold mining from the rivers; the final result of which was a gold impregnated sheepskin. It was the fanciful characterization of this actual process which led to the romantic concept of the "Golden Fleece" that has been known in the civilized world ever since Homer's time.

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MUD VOLCANOES OF SAKHALIN ISLAND – ADVANCE FOR THE LAST TEN YEARS

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Mud volcanism represents one of the most mysterious geologic phenomena with important implications in hydrocarbon resource exploration, seismicity, natural disaster risks and geologic emission of greenhouse gases in atmosphere. Many aspects of mud volcanism, such as the genesis, mechanisms of activity and relationship to other natural processes and phenomena are still poorly explained and remain at the level of hypothesis.

Sakhalin Island is the single region in the Far East of Russia where terrestrial mud volcanoes are known. There are four areas of the manifestation of mud volcanism: in the south part of the island – Yuzhno-Sakhalinsk and Lesnovskiy mud volcanoes, in the central part of the island – the group of the Pugachevo mud volcanoes and mud volcano Vostochnyy, in the north part of the island – Daginskiye gryphons and pools. The presence on Sakhalin of thick sedimentary strata with oil and gas deposits, high modern seismotectonic activity of the region and complex systems of faults make this region a unique test site for the study of mud volcanism.

In recent years, the Institute of Marine Geology and Geophysics of the Far Eastern Branch of the Russian Academy of Sciences has carried out a series of investigations of mud volcanism in Sakhalin Island, which have a number of interesting and original results. The main object of these studies was Yuzhno-Sakhalinsk mud volcano – one of the largest and most active volcanoes in Sakhalin Island. The volcano is controlled by the Central Sakhalin submeridional fault, along which the Cretaceous rocks were moved on the Paleogene-Neogene deposits in the eastern direction. Strong eruptions of the Yuzhno-Sakhalinsk mud volcano were registered in 1959, 1979, and 2001. One relatively weak eruption occurred between 1994 and 1996; another one, at the beginning of 2011.

Gasgeochemical monitoring on the Yuzhno-Sakhalinsk mud volcano was implemented in 2007. Daily sampling of free gases from three volcanic gryphons was carried out in July-September 2007. We detected that the chemical composition of free gases in different gryphons has statistically significant differences. At the same time, however, the isotopic compositions of gases from different gryphons do not carry statistically significant differences; i.e., one can state that gas is supplied to all the gryphons from one reservoir. The degree of separation for carbon isotopes in the CO_2–CH_4 system depends on temperature conditions during generation of these gases. The range of isotopic equilibrium temperature in this system, calculated for average values of $\delta^{13}C$-CH_4 (–28.7 ‰ PDB) and $\delta^{13}C$-CO_2 (–6.3 ‰ PDB), is 330-350 °C. This corresponds to the interval of gas generation depths of 8.0-8.5 km.

Daily observations for temperature of mud breccia of from gryphons of the Yuzhno-Sakhalin mud volcano were made in 2005-2007. It is established that the temperature of mud breccia varies considerably among gryphons. The temperature of mud breccia in active gryphons will be lower than in passive gryphons in the summer. In addition, for active gryphons, the range of temperature variations will be less than for passive gryphons.

Mathematical model of the temperature regime dynamics for mud volcano gryphons was developed. The model is elaborated on the basis of a nonstationary equation of thermal conductivity with a convective term. The main parameter that determines differences in temperature regime for various gryphons is the motion velocity of the mud breccia in the supply channel of gryphons. Model calculations agree well with the observation data from nature.

The isotopic and chemical composition of waters from the Yuzhno-Sakhalinsk mud volcano was determined. Sampling have been implemented in 2009-2010 at the time of the stage of the gryphon-salse activity. It is established that mud volcanic waters belong to the hydrocarbonate-chloride-sodium type and total mineralization is 16-25 g/l. The formation temperature of mud volcanic waters was estimated by hydrochemical geothermometers. Based on this estimates it is assumed that aquifers, which feed the mud volcano, is located at the depth of 3 km and more. The isotopic characteristics of mud volcanic waters ($\delta^{18}O \sim +5$ ‰, $\delta D \sim -20$ ‰ SMOW) indicate minor contribution of meteoric waters in the water supply of the volcano.

In May-September 2015 hydrogeochemical monitoring has been implemented at Yuzhno-Sakhalinsk mud volcano. Sampling were carried out once every two weeks from five gryphons of mud volcano with various degrees of activity. Statistically significant differences in the chemical compositions of mud-volcano waters from different gryphons are established. These differences are determined by the activity of the gryphons. The more active gryphons showed higher Na^+, Mg^{2+}, and concentrations, whereas the Cl^- concentration was approximately the same in all gryphons independently of their activity. Hence, there is no dependence between the concentrations of Na^+ and Cl^- (nearly zero correlation factor). The chloride ion is a conservative anion and believed to be one of the indicators that the groundwaters are of deep origin. Therefore, the chemical composition of mud-volcano waters is controlled by the gryphon activity and not by the groundwater supply from deeper horizons to gryphons.

The representative data on the isotopic and chemical composition of waters for the group of the Pugachevo mud volcanoes and mud volcano Vostochnyy were obtained for the first time. These waters also belong to the hydrocarbonate-chloride-sodium type, but have a lesser mineralization – from 9 to 12.5 g/l. High concentrations of boron are noted - from 260 to 360 mg/l. Thermodynamic calculations show that the waters of group of the Pugachevo mud volcanoes and the volcano Vostochnyy are supersaturated to calcite. The values of the $\delta^{18}O$ and δ^2H parameters belong to the interval (+1; +6) ‰ and (–36; –23) ‰ SMOW respectively. Consequently, these waters are slightly isotopically lightweight compared to the waters of the Yuzhno-Sakhalinsk mud volcano.

Thus, our studies allowed us to obtain new data about the chemical composition of mud volcanic products, about the regularities of the formation of their chemical composition, and about the dynamics of the temperature regime. This enables a better understanding of the mechanisms of mud volcanic activity and move on to the development of adequate geochemical models of mud volcanoes.

ABOUT THE RELATION BETWEEN MUD VOLCANIC ACTIVITY AND EARTHQUAKES

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At present, many scholars believe that mud volcanic activity is largely controlled by seismotectonic settings. Mud volcanoes are used as stress indicators in active compressional tectonic settings. In recent years, in many publications are argued that the eruptions of mud volcanoes are triggered by earthquakes. However, the stress and strain caused by earthquakes and their control mechanisms on the eruption of mud volcanoes still require further study. Obviously, the stress changes caused by earthquakes may have some effect on the activity of mud volcanoes. Static stress may expand or compress the supply reservoirs or change the permeability of the mud volcanic channel. However, the static stress is rapidly decays with increasing epicentre distance and becomes insignificant over a distance of more than several lengths of the earthquake source. Researches have show that dynamic stress may play a major role in regulating the mud volcanic activity. The frequency of seismic waves, in addition to their amplitude, also could play a role in triggering eruptions. Additionally, there is a connection between the locations of mud volcanoes and faults. The triggering eruptions can be enhanced when mud volcanoes and earthquakes are located in the same fault structure.

We performed daily observations of the Yuzhno-Sakhalinsk mud volcano activity in 2005-2007. These observations were conducted in the warm season (June-September). The response of the Yuzhno-Sakhalinsk mud volcano to strong earthquakes in the southern part of the Sakhalin Island is established. Positive and negative anomalies in the temperature of mud breccia in gryphons, a significant increase in the emission of free gases in gryphons, changes in the elemental composition of mud breccia in gryphons (in particular, an increase in the concentration of Ca, Fe, Mg and Mn), changes in the chemical composition of free gases in gryphons (in particular, an increase in the concentration of CH_4 and a decrease in the concentration of CO_2) were observed on the volcano after earthquakes.

We propose mechanism of mud volcano response for earthquakes, which explains the totality of the described post-seismic effects. The main driving force of mud volcanism is natural gas (mainly a mixture of CH_4 and CO_2), large accumulations of which are in the lower part of the mud volcanic canal. It is logical to assume that during the existence of the volcano, the water-mud mixture in the canal is saturated with dissolved gas. The volume of gas dissolved in the liquid is proportional to the gas pressure according to Henry's law. The dependence of the solubility of CH_4 and CO_2 on the depth in the mud volcanic canal was calculated with using the known temperature dependences for the Henry's law constant. The concentrations of dissolved gases in the mud volcanic canal for different points in time were calculated with using the diffusion equation with the convective term. The results of the calculations show that the saturation of the mud volcanic water with the gas may occur over a period of time between two eruptions (at least in the upper part of the canal). When lifting the water-mud mixture on the surface, i.e. when moving to an area with a lower pressure, the dissolved gas is gradually released from the liquid. This process largely determines the emission and chemical composition of free gases in mud volcano gryphons during the time between earthquakes. Seismic waves from the source of the earthquake pass through the mud volcanic canal and lead to decompression. In the channel of the volcano there is a process that is analogous to acoustic cavitation. A certain proportion of the dissolved gas is rapidly released from the liquid. The consequence is an increase in the emission of free gases in gryphons. CH_4 and CO_2 have a different nature of the dependence of solubility on depth. This leads to a change in the ratio of CH_4 and CO_2, i.e. to a change in the chemical composition of free gases in gryphons. The increase in the emission of free gases contributes to an increase in the current velocity of mud breccia in gryphons. In turn, this leads to a decrease in the temperature of mud breccia in gryphons. Mud breccia becomes more viscous in some gryphons and therefore the current velocity of mud breccia decreases. In these gryphons there is an increase in the temperature of mud breccia, since the air temperature is much higher than the temperature of mud breccia. A more viscous mud breccia carries larger rock particles. Our research has shown that larger particles of mud breccia contain more Ca, Fe, Mg and Mn. Consequently, the elemental composition of mud breccia can also change after earthquakes.

Thus, we propose a mechanism of relation between mud volcanic activity and seismicity. This model is approximate and requires further elaboration and refinement. The presence of such a model is important for the correct interpretation of empirical data.

ASSIMILATION POTENTIAL OF GEOLOGICAL MEDIAAS BASIC INDEX OF ENVIROMENT TECNOGENIC CHANGES

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Ukraine as Azerbaijan have the complex structural-geological building and due to this factor active development of big quantity of exogenous geological processes (EGP-landslides, abrasion, flooding etc.-more 20 species) in the natural and technogenic conditions. Upper zone of lithosphere in the technogenic conditions is the main “depot” for accumulation of environmental parameters changes. Technogenic changed part of the lithosphere is called as geological media (GM) and has the stable trend to increasing and reduction of GM protective ability or its assimilative potential (APGM) [1-3].

In other words, the APGM can be as indicator of GM protective ability in the neutralization of main ecological systems technogenic changes –soil (landscapes, surface hydrosphere and biosphere).

In the conditions of technogenic influences on the natural complex of territory, the level of APGS changes will be equal to:

$$APGM_t = APGM_0\ (1-r)^t \qquad (1)$$

Where $APGM_t$ - assimilation potential of the geological media at the estimated time;

$APGM_0$- initial value of the APGM;

r - admissible value of APGM reduction in time (of a unit / year).

From the above dependence, it can be determined the estimated time t_{min}, when the range of APGM changes from $APGM_0$ to $APGM_{min}$ will be the part that can be used in the economic activity of one or another production (object).

After logarithm, the dependency (1) has the following form:

$$\boldsymbol{lg} APGMt = \boldsymbol{lg} APGM_0 + \boldsymbol{lg} t(1-r) \qquad (2)$$

If, taking constant values, the equation (2) can be generalized as an equation of direct form (Figure 1):

$$y = a_0 - kt \qquad (3)$$

the sign "-" before the coefficient "k" is related to the fact that the member of the equation (1-r) <1.

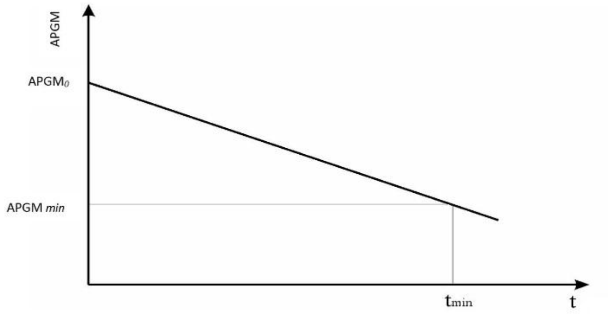

Fig. 1. Scheme of the dynamics of changes APGM.

The authors calculated the total value for the regions of Ukraine and created relevant the matic maps using ArcGIS (Figure 2).

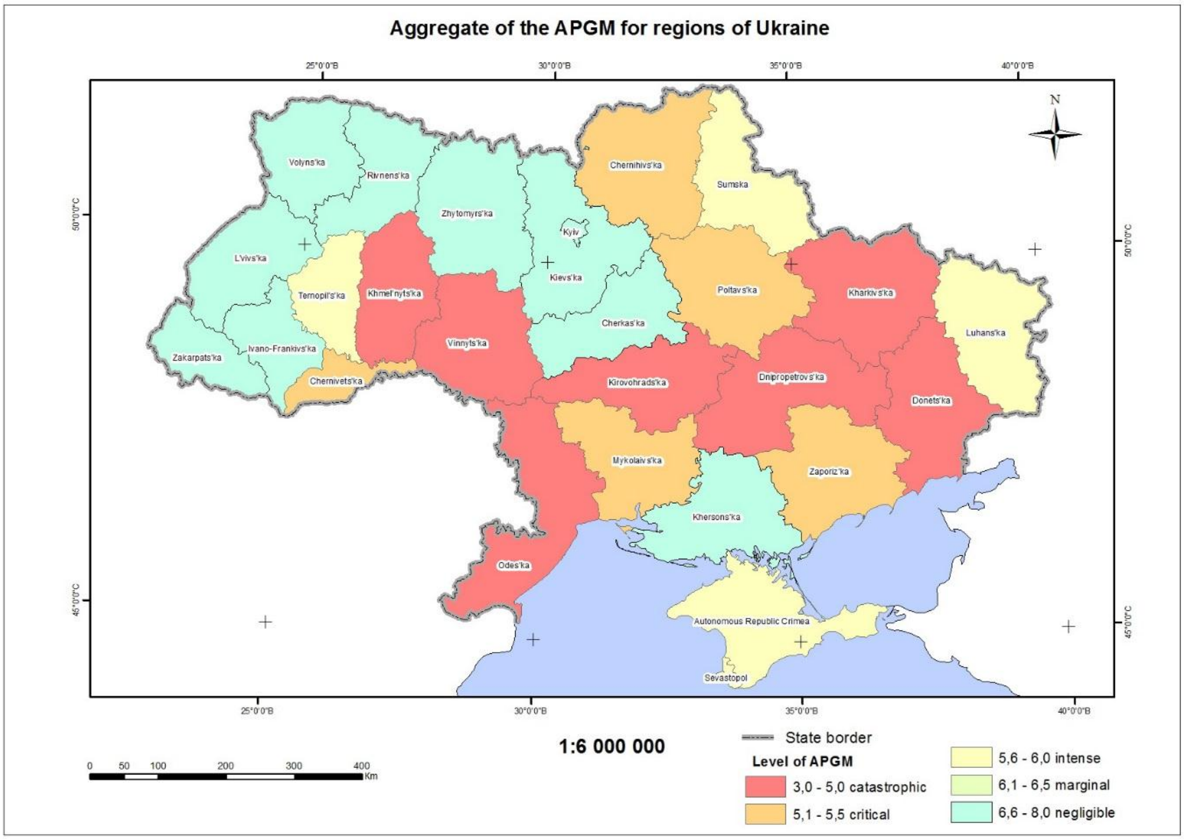

Fig. 2. Aggregate of the APGM for regions of Ukraine.

We suppose that investigations of regional values assimilative capacity of geological media is the first step in this direction for establishing of the most dangerous territories suffered from EGP. Evaluation of the APGM is effective method for dynamics determination of the growing impact of natural (geological movement of Earth, seismo- geophysical processes and mud volcanoes etc.) and man-made (flooding of mines and quarries, hydraulic engineering, increasing the squares of cities, post-mining landscapes etc.) loads on the geological media.

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GEOLOGICAL AND GEOCHEMICAL FEATURES OF THE UPPER SECTIONS: A CASE STUDY FROM THE GARABAKH FIELD, THE NORTH ABSHERON UPLIFT ZONE OF THE SOUTH CASPIAN BASIN

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The main hydrocarbon reserves of Azerbaijan are connected with the South Caspian Basin (SCB). The geological, lithostratigraphic and tectonic characteristics of the SCB are very complex, since all the oil and gas containing structures are complicated by mud volcanoes [8-17]. The risk of mud volcanoes in the marine environment in Azerbaijan attracts attention from several aspects. The seepage of natural gases is observed in those areas where mud volcanoes occur, and these zones are known for their promising structures (containing hydrocarbon reserves), and deposits produce oil and gas. Depends on paroxysm or the daily actions of mud volcanoes the areas are very dangerous to carry out any industrial activity. In order to study the engineering- geological properties of the mentioned seabed areas, which are characterized by a wide spread of gas seepages, there was an urgent need to conduct geological, geochemical and geophysical surveys in these areas [1-7]. Thus, the main tasks of these studies were to perform the following complex activities: the studying of physical and mechanical properties of the rocks that form the upper part of the sections, determining deep faults, assessing the engineering and geological conditions, and selecting sustainable areas for construction and installation of engineering hydraulic structures.

The North Absheron Uplift Zone (NAUZ) is located between the middle and south parts of Caspian Sea, and contacts North Absheron Basin from the north. This area was subjected to active tectonic processes. In ancient geological periods, sea level has been changed by regression and transgression, and in this regard, the sea beds and deltas have also changed. These factors had a significant impact on the geological structure of the region. The oil-gas reserves of the north-western part of the Absheron archipelago are associated with the sediments of the Productive Series of Lower Pliocene. Unlike the Absheron peninsula, the oil potential in the north-eastern part of the archipelago are mainly related to the sandy horizons of the Gala, Kirmeki, Post-Kirmeki suites of the Productive Series. The Garabakh structure (Figure) is located in the north-western part of the Absheron archipelago and covers an area 40 km from the Neft Dashlari field. Here the relief of the seabed is smooth and deepens in a northeasterly direction. The depth varies from northwest to southeast (from 135 to 185 m). Based on the data of the point of total depth, this fold is a brachyanticlinal structure that extends from northwest to southeast. The south-western wing of the asymmetric structure is located under the straight (18°), and northeast under a flat (3-5°) angle [1-7].

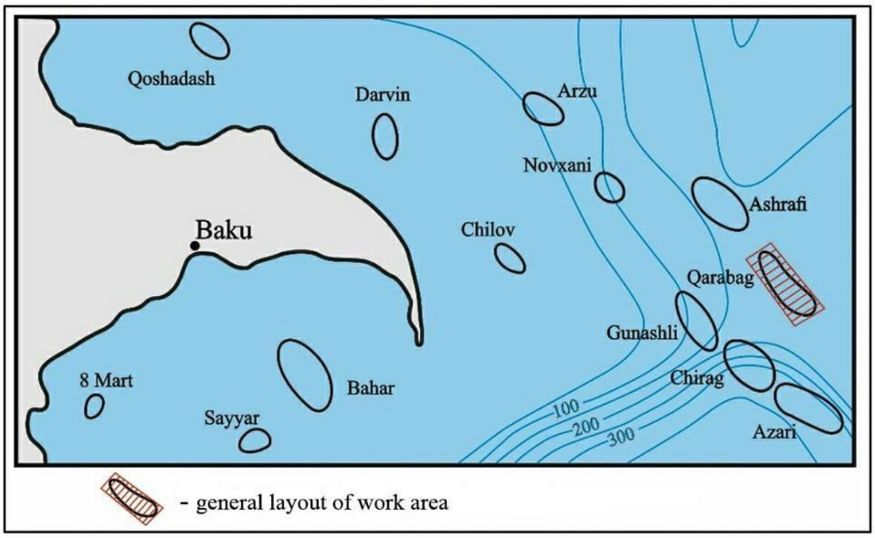

Fig. 1. Schematic map of the study area.

The construction of engineering hydraulic installations (deep water foundations, stationary platforms, floating drilling rigs, etc.) in the study territory makes necessary to conduct the integrated surveys and also laboratory analyzes of the gases, waters and rocks. The main task of the performed engineering and geophysical works on the survey site by of high-resolution seismic exploration method is to identify the possible presence of potential hazards during the engineering construction of drilling rig and subsequent exploratory drilling in the design point. Related to the main task of the study, drilling of wells, Cone penetration test, as well as continuous seismo-acoustic profiling bathymetry, Sonar surveys and geochemical laboratory analyzes were performed. The microfaunistic studies and physico-mechanical properties of collected samples from the well drilled on the upper part of sections (up to 210 m) were carried out too. The absorbed gas of the bottom sediments and near-bottom waters, as well as the samples taken from the different intervals was studied using thermovacuum degasser in laboratory. The analysis of obtained gases was investigated in gas-liquid chromatography.

The geological age of the studied samples is Quaternary (Baku stage). The relief of the seabed is stable and due to the strong underwater currents, several small (0.7 x 1.6 m) depressions were formed here. The use of continuous seismic acoustic profiling shows that there were no serious dislocation zones in the Garabakh field. The average amount of degassed gases is 0.17 %, and their composition varies between $CH_4 \div C_6H_{14}$. It was found that the waters of the studied samples are chloride-magnesium ($MgCl_2$) type.

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PERSPECTIVES OF HYDROCARBON FLUIDS OF THE MIOCENE-OLIGOCENE SEDIMENTS IN THE SOUTH-EASTERN CAUCASUS

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The Miocene-Oligocene deposits can be considered as an important factor in the increase of some oil reserves in the Republic of Azerbaijan. According to the results of the study, the total sediment volume in the Southeast Caucasus is 25,000 km^3. Studies conducted in the last 30-40 years show that the role of Mesozoic sediments in the growth of oil reserves is minimal, and small oil fileds (Siyazan monocline, Muradkhanli, Shurabad, Beqimdagh-Tekchay) with a reserve of 10-15 million tons in category $B + C_1$ were found, although more than 1 million meters drilling works were spent in more than 300 wells.

As it is known, the first industrial oil in the Miocene sediments in Azerbaijan was extracted from the 280-390 m depth (Meotis, horizont D-4) from the well no. 91003 in the Binaqadi area of the Absheron peninsula in 1913, but so far specialists have extracted oil from these sediments through shallow ditches [3]. The oil contour of the Miocene sediments has been extended both in this area and in the neighboring fields after the oil has been extracted from the Binagadi area (Masazir, Sulutepe, Chakhnag, Chalayeri, etc.). More than 30 wells were drilled in the priods 1913-1953, which confirmed oil perspectivity in the separate horizons of the Miocene deposits [4].

After the war, exploration continued on the Shurabad, Gulbakht-Sarinja, Gozdagh muldas in the fileds Fatmai, Kerkez-Giziltepe, Qaraheybet and Garadagh, and oil and gas were extracted from various wells excavated in these deposits. Among them, the Garadagh area attracts more attention. Oil from the Karaqan (Diatom layers) were extracted with the wells no. 106, 205, 129, 98, and from the Maykopian wells no. 323, 324 in the north wing of the Garadagh uplift of the Western Absheron.

In addition to the Absheron Peninsula, industrial oils were discovered from the Miocene section of South-Western Gobustan during the 1940 and 1950. Industrial oils were found in structures Umbaki, East Hadjivali, Arzani-Gilinj, Duvanni (on land) and Hajivali of Southeastern Gobustan in the 1940-1950s, and in Sangachal-Deniz of the Baku archipelago in the 1970s. Adding to this list the small oil fields of the Siyazan monoclinal, as well as the effective oil and gas manifestations of the Kur-Gabirri rivers, we can conclude that Miocene-Oligocene sediments throughout Azerbaijan are regional petroliferous [1, 2].

The number of oil and gas fields in the Miocene-Oligocene sediments of the Absheron Peninsula, Southeastern and Southwestern Gobustan (Ceyrankeçmez depression) is more than 20 (Figure).

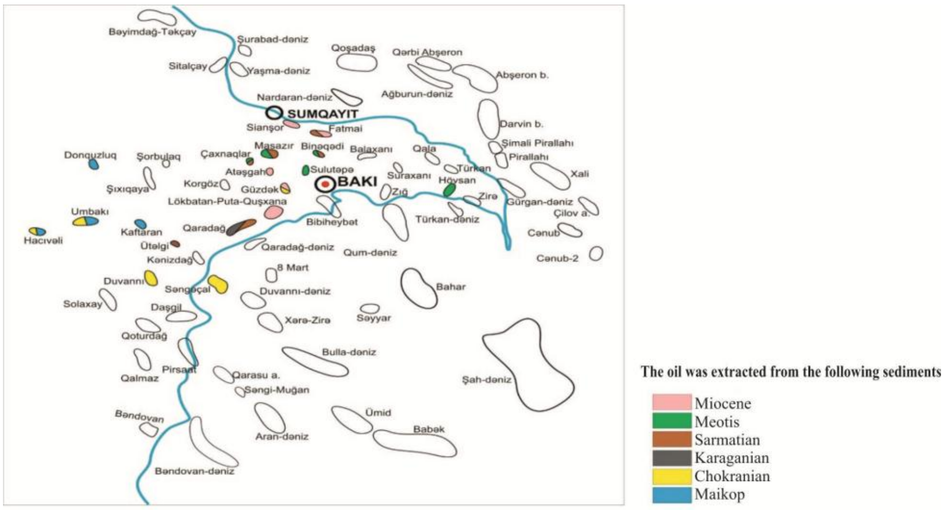

Fig. Oil-gas map of Oligocene-Miocene sediments of the Absheron Peninsula and Southeastern Gobustan.

Oil contours are not specified in these areas (Binagadi, Garadagh, Umbaki, Masazir), hydrocarbon reserves of these deposits have not been calculated and have not yet been put into operation. Although this was explained differently by the researchers, they did not come to a common view. For this reason, the wells drilled in Miocene-Oligocene sediments were drilled without proper geological factors, and often no positive results were obtained. Therefore, we should try to increase the effectiveness of the Miocene oil exploration and prepare them for extraction.

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GEOCHEMISTRY AND MINERALOGY OF THE PALEOGEN-MIOCENE SEDIMENTS (A CASE STUDY FROM THE MUD VOLCANOES IN SHAMAKHI-GOBUSTAN REGION, AZERBAIJAN)

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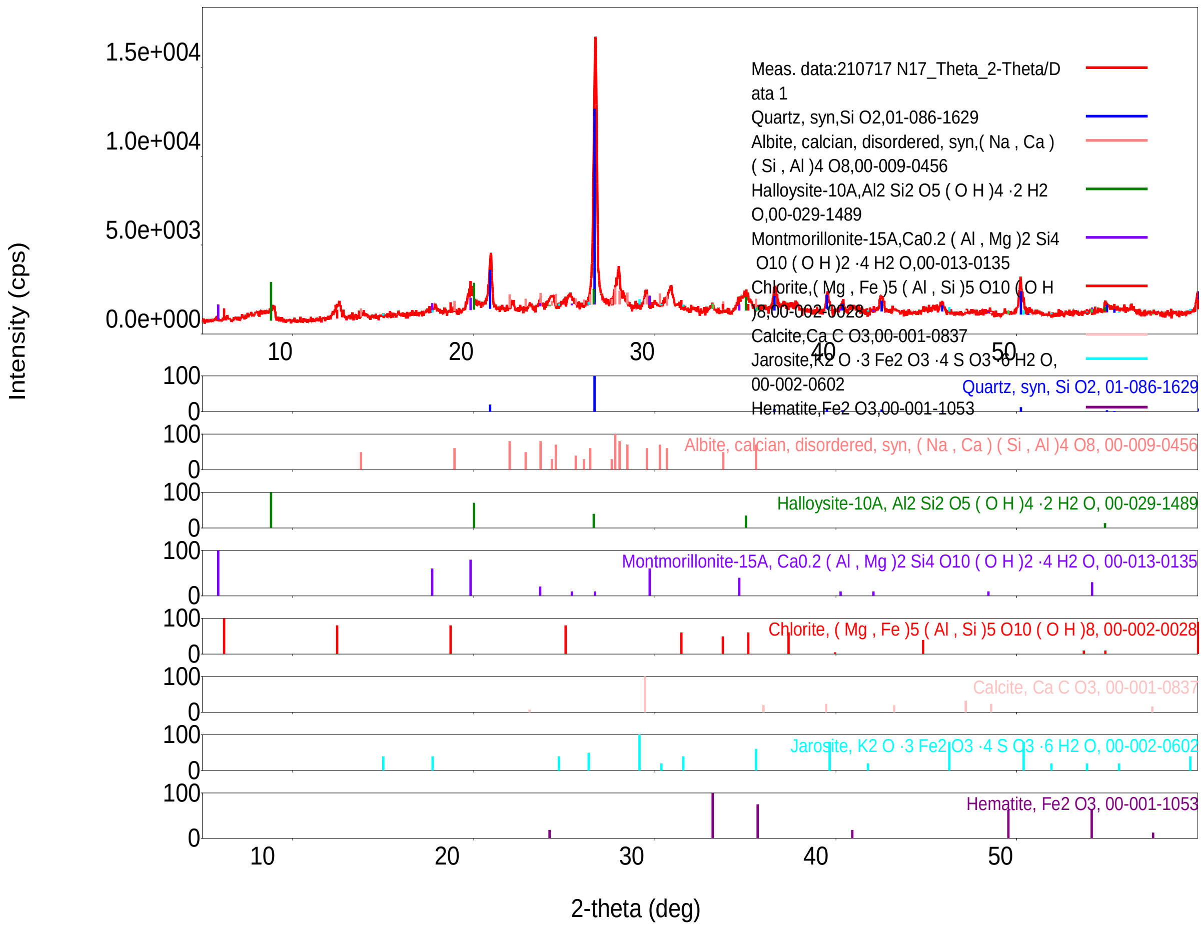
The study of the mud volcanic breccia is of both scientific and theoretical and practical significance. Volcanic ejecta are investigated in the study of some scientific and problematic issues in the Earth sciences and others as well. A number of local and foreign scholars were involved in studying the geology, geochemistry of the Paleogene-Miocene sediments, as well as relationship between seismic and volcanic activity, investigating and evaluating eco-geological risks associated with volcanism in the territory of Azerbaijan [1-18]. In the present study, attention is paid to the problem of non-organic geochemistry and mineralogical characteristics of the mud volcanoes, which has not yet been studied in Azerbaijan.

The geochemical and mineralogical compositions of the mud volcanoes of the Central Gobustan (Shikhzarli) and Northern Gobustan (Demirchi) characterized by distinctive neotectonic features were studied. These studies allow to establish some patterns based on the quantitative parameters. It was determined that silicate minerals are distributed more in the northern allochthonous zone of the Shamakhy-Gobustan region (Figure 1a and 1b).

a)



b)

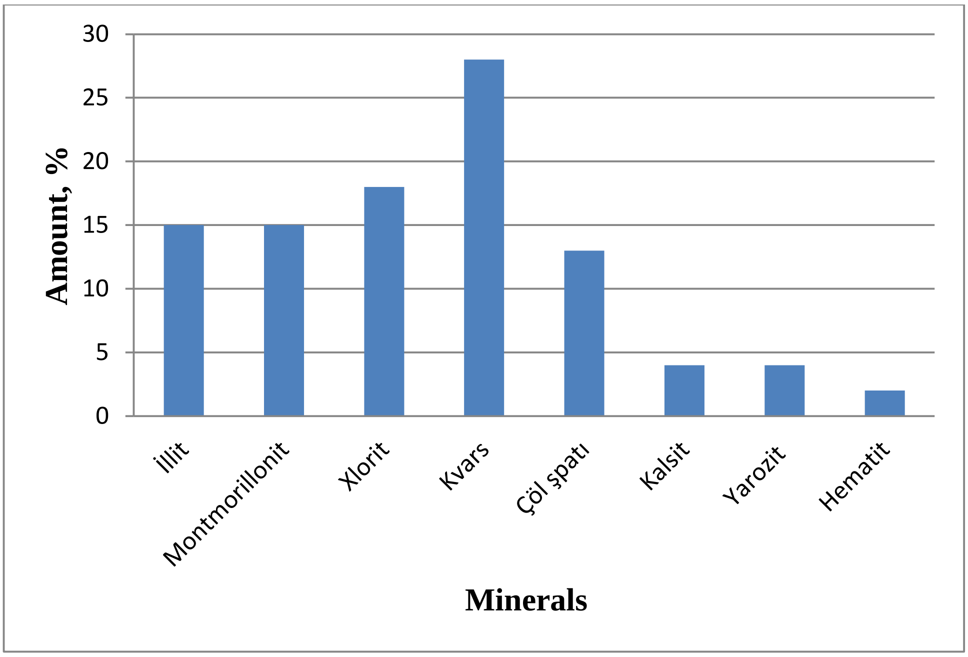
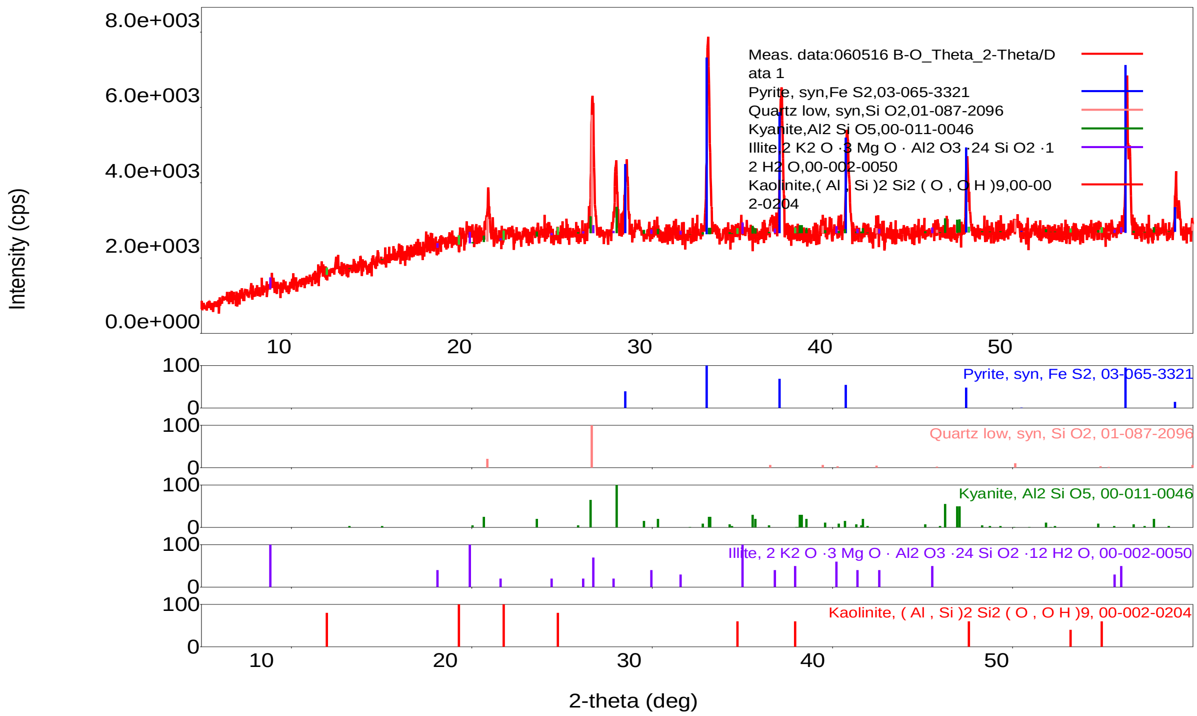


Fig. 1. X-ray analysis results (a) and distribution characteristics of minerals (b) in the samples taken from the Demirci mud volcano.

The predominant mineral of sulphides is pyrite (62.5%) on the mud volcano Shikhzarli located in a microblock of parahochthonous genesis (Figure 2a and 2b). Here the concentration of quartz is of a secondary nature. Identified a certain mineral kyanite (Figure 2a) for mud volcanoes of Azerbaijan that is not considered a characteristic mineral. The revealed radical differences in the element and mineralogical composition are associated with various paleotectonic, paleogeographic, paleoclimatic conditions, as well as paleoweathering and parent rocks.

a)



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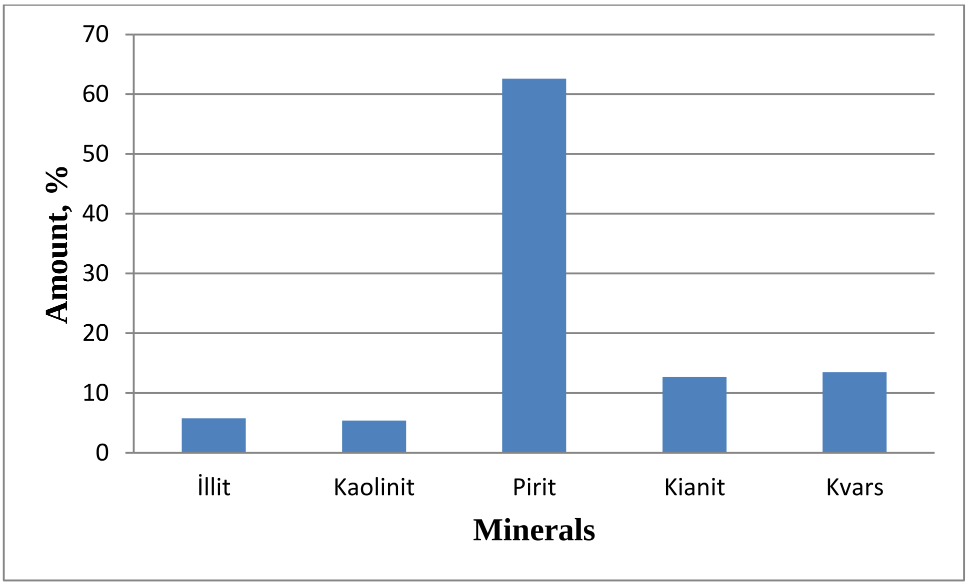

Fig. 2. X-ray analysis results (a) and distribution characteristics of minerals (b) in the samples taken from the Shikhzarli mud volcano.

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ANALYSIS OF THE DATA OF GPS SATELLITE SYSTEM IN THE STUDY ON THE SEISMICITY OF THE TERRITORY OF AZERBAIJAN

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The geodynamic and seismic activity of the territory of Azerbaijan is the result of the collision of the Arabian and African plates with the Eurasian plate. Detailed monitoring carried out over 20 years based on space geodetic techniques (GPS) allowed for the quantitative understanding of the nature of this collision zone. Till now, several different models have been proposed to clarify the mechanism of this collision process. The first studies have shown that there is an active shrink of the Earth's crust at the rate of 10-12 mm/year in the Greater Caucasus subduction zone. This process historically caused to strong and destructive earthquakes, volcanic eruptions. Taking into account the increasing population, the implementation of new modern infrastructure projects, and the geographical location of the region and the assessment of the likely seismic hazards, it is a very topical issue, given the fact that economically and strategically important facilities are located here. The Caucasus is a part of the Alpine-Mediterranean breach zone extending from Gibraltar to Afghanistan. In this region, there are two large mountain-range systems, such as the Greater Caucasus and the Lesser Caucasus. Located in the clash zone of the Arabian and Eurasian plate, this bumping system is a very complex geodynamic and seismic area. The plate tectonic reconstruction indicates that the collision of the Arabian plate with Eurasian plate continued for about 10-30 million years and the relative speed of the Arabian plate to the north of Eurasia continent, from the moment the collision started to a certain degree up to about 20 mm/year. In recent years, Global Positioning System (GPS) of cosmic geodesy has been applied intensively to study horizontal movements of the Earth's crust. From the 80s of last century, GPS re-measurements have begun to be used for the study of plate movements and deformations, coseismic and post seismic deformations, as well as other applied geophysical issues. Over the last 20 years, GPS researches with space geodetic techniques have ensured a high degree of precision monitoring of the interaction of plates, the activity of faults and the deformation processes of seismic hazard areas. For this purpose in 1998 the Azerbaijan GPS network was established by the Institute of Geology and Geophysics of ANAS with the participation of the US Massachusetts Institute of Technology. At present, Azerbaijan GPS network system includes 26 measurement points and Baku, Pirshagi, Sheki, Ganja, Neftchala, Sabirabad GPS continuously operating stations. During the period from 1998 to 2018, 10-15 measurements were made at the observation points of Azerbaijan GPS network system. Monitoring conducted in the GPS network system in Azerbaijan showed that the maximum of horizontal motion is 17 mm/year. The horizontal velocities of the Earth's crust, obtained from the investigations from GPS technology are shown in Figure.

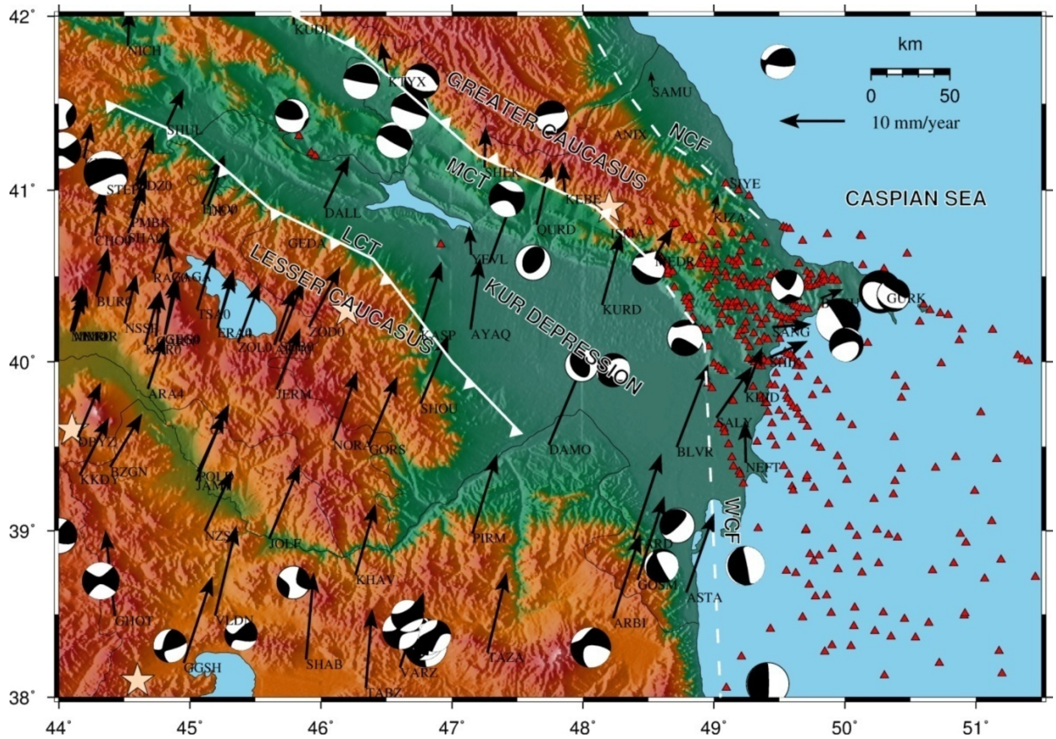

Fig. Horizontal velocity of the Earth's crust obtained from of GPS technology research.