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S-I

GEOLOGICAL PROCESSES, STRATIGRAPHY, TECTONICS AND GEODYNAMICS

PRELIMINARY RESULTS OF STUDYING A ZONE OF LIMESTONE PYRITIZATION AT THE PAN'SHINSKOE DEPOSIT, MOSCOW OBLAST

[1]Galushkin A.I., [2]Ivanov V.M.
[3]Yashunsky Yu.V., Research supervisor
[1]alexgal@mail.ru, [2]bankir00115@yandex.ru, Ordzhonikidze Russian State Geological Prospecting University, Moscow, Russia; [3]yryashunsky@gmail.com, Aerogeologiya Scientific and Production Enterprise, Moscow, Russia

A zone of pyritization of Middle Carboniferous limestones was studied in the course of educational geological practice at the Pan'shinskoe Deposit in Kolomenskii raion, Moscow oblast. The deposit is being developed to produce raw cement. A quarry strips limestones and dolomites of the peskovskaya stratum, myachkovskii horizon, moskovskii stage, Middle Carboniferous. Those deposits are overlain by clays of Callovian stage, Upper Jurassic.

Fine-grain limestone with numerous boring mollusks lies in the roof of carboniferous rocks. They are underlain by coarse- and medium-grain organogenic–detrital limestones. The fine-grain limestone disappears in some areas, where Jurassic clay is underlain by coarse- and medium-grain limestone, also bored by mollusks. A member of interstratified fine-grain greenish-grey low-clay limestones and calcareous greenish-grey clays lies underneath.

Heavily pyritized rocks at the contact between Carboniferous carbonate and Jurassic clay deposits, revealed at the Pan'shinskoe deposit, are unique for the Moskovskaya Synclise. Similar contacts of Carboniferous and Jurassic rocks can be seen at the Nikitskoe, Domodedovskoe, Afanas'evskoe, and Shchurovskoe deposits; however, no pyritized limestone was found here.

Pyritized rocks, represented by coarse- and medium-size organogenic-detrital limestones of black, dark grey, and grey color, lie as interlayers and lenses 0.2–0.5 m in thickness and up to 20–50 m in length in the roof of Carboniferous rock section, in which they have been stripped in the northern part of the quarry. In some areas, limestones in the roof of interlayers and lenses are oxide-brown in color. Macroscopically, pyrite was detected in both dark and axide-brown rocks in the form of fine (1–2 mm) inclusions. Detailed sampling followed by analytical X-ray spectroscopic determinations of Fe_2O_3 and S have shown the black and dark grey rocks to contain, on the average, 3.2%; grey rocks, 0.8%; and oxide-brown rocks, 0.3% of disulfides. No sulfur was recorded in the rock immediately underlying the lenses and interlayers.

Combined polished sections, made of rocks with different petrographic composition and color, were found to contain the following authigenic minerals: calcite, pyrite, white iron pyrite, iron hydroxides (judging by its color, it is likely pyrite), and chalcedony. The pyrite, which is far in excess of white iron pyrite, is represented by cryptocrystalline inclusions, sometimes, in the form of framboidal aggregates.

Stage analysis of the mineral-formation series at this phase of study established the following mineralogical–geochemical zones: zone of unaffected rocks, pyritization zone, oxidation zone, repyritization zone.

Studying the polished sections established that the disulfide mineralization is represented by pyrite alone, sometimes, in the form of framboidal aggregates. In black and dark gray limestones, pyrite partially replaces organogenic detritus, mostly, echinoderms fragments. Those fragments show very intense regeneration of calcite with fringes of the newly formed carbonate with automorphic faceting almost completely fill the pore space and form basal cement, making the rock extremely strong.

In oxide-brown limestone, pyrite in organogenic detritus is partially or completely replaced by iron hydroxides, while idiomorphic regeneration fringes of calcite are overgrown by a new pyrite generation showing no oxidation signs.

Stage analysis of mineral formation series shows the pyritization of limestones in the roof of Carboniferous deposits to have include two stages, separated by a stage of rock oxidation.

The development of the Pan'shinskoe deposit (which is known in the paleontological literature as the Peski location) showed the limestones of the peskovskaya stratum to contain five karst funnels, filled by sad-clay deposits of Bathonian–Bajocian time, Middle Jurassic, containing bone remains of fishes, amphibian, reptiles, and mammals, as well as seeds, leaf fragments, and the woody tissue of fern and gymnosperms [1]. These finding show that the climate during the Middle Jurassic was warm and subtropic. The presence of annual rings in wood remains and leaf fragments of foliage plants suggests the seasonal climate, though the analysis of the width of annual rings shows the seasonal character of the climate to be due to drought periods rather than cooling [3]. Such conditions were favorable for the formation of bogs with considerable accumulation of plant remains in depressions of Paleozoic paleorelief. The sedimentogenic waters of such bogs were ultra-acid and highly reducing with high concentration of dissolved Fe(II) [2] and sulfur, resulting from sulfate reduction. Penetrating into underlying limestones, those solutions caused redistribution (regeneration) of calcite, while their neutralization led to pyrite precipitation. During periods of droughts and disappearance of bogs, oxygen-containing waters could penetrate into pyritized rocks, resulting in their oxidation, while when the climate became humid, the territory will become boggy again and new pyrite generations will appear.

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COSMIC MICROSPHERES FROM PALEOZOIC ROCKS OF THE PRE-URALIAN FOREDEEP

Gluhov M. S., Sungatullin R. Kh.
gluhov.mixail2015@yandex.ru, Kazan (Volga) Federal University, Kazan, Russia

Due to the widespread adoption of electronic scanning microscopy in geology, in recent years, the interest among local researches has sharply increased in rare for sediment rocks metal microparticles up to 1 mm in various shapes: spheres, drops, plates, spiral wire. Geologists have paid attention to such particles in connection with the study of cosmic matter and the origin of the Earth, the degree of influence of terrestrial and cosmic processes to climatic and biotic events in geological history, the prospect of the correlations of global, regional and local levels for the different facies strata. However, in the geological community origin of such metal microparticles is controversial; the main hypotheses of their formation are natural, space and man-made.

The present paper deals with the morphological description and analysis of the chemical composition of metallic microspheres extracted from Carboniferous rocks of the Usolka, which is located in the southern part of the Pre-Uralian foredeep (Republic of Bashkortostan). The incision is flysch condensed type and complex series of deposits (from the Middle Carboniferous to Lower Permian) carbonate-clay-siliceous composition of volcanic tuffs interbedded with. It is characterized by the continuity of sedimentation, good exposure, lots of conodont fauna; studied in detail in the biostratigraphic and lithological aspects [6, 8, 9, 10 and etc.]. Some researchers consider section Usolka as a reference object for the boundaries of Upper Carboniferous and Lower Permian tiers and it is included in a field tour of the XVIII International Congress on Carboniferous and Permian systems (Kazan, 2015).

In the rocks section of Usolka magnetite microspheres and teardrop-shaped magnetite-composed particles are predominantly found, rarely – microspheres of silica and apatite compounds. Thickness of a studied section was 12 meters; 70 samples were studied and in 20 samples microspheres in an amount from 1-2 to 20 or more pieces were detected. In 2 samples teardrop-shaped formation was found. The microparticles were analyzed in the laboratory of Kazan Federal University on a field emission scanning electron microscope "MERLIN" Sarl Zeiss, equipped with an energy dispersive spectrometry «AZTEC» X-MAX Oxsford Instruments (analysts N. Osin, V. Vorobiev).

Analysis of the chemical composition of the microspheres showed that their main elements are iron and oxygen, which accounted for 98.5-99.5% of the weight of all the elements. Hence, the mineral composition of the microspheres is very primitive and includes polycrystalline aggregates of magnetite (predominant) and wustite; perhaps there is also a small proportion of native iron. Such mineral composition is a characteristic of stony meteorites [1, 2]. Comparison of oxygen and iron in magnetite microspheres from Usolka and Paleozoic rocks of the Caspian depression [5] showed the general direction of the trend, which indicates a common genesis of these entities.

In microspheres evenly distributed small (maximum – 0.68%) amount of manganese; in isolated samples of chromium and nickel this amount reaches, respectively, 0.14 and 0.13%. In microspheres there is no titanium, which confirms their extraterrestrial nature [3], Si, Al, Ca, K present in small quantities indicating their formation as a result of ablation of stony meteorites [7]. Internal structure of polished magnetite microspheres is very interesting. Along with solid magnetite balls with a domain structure, there are hollow microspheres with magnetite crust up to S of the radius thick. The internal structure of these microspheres resembles a miniature structure of the globe with the manifestations of mantle convection [4]. Thus, chemical and mineralogical characterization of section Usolka microspheres can be attributed, with high probability, to the objects of cosmic origin.

Among the magnetite particles of Usolka teardrop-shaped formations are found, which are comparable to the size of the microspheres. Thus teardrop-shaped formation date to the interval of the maximum content of magnetite microspheres at the bottom of Kasimovian Stage. Comparison of the chemical composition of the microspheres and teardrop-shaped formations shows their common origin. Morphological differences of microspheres and drops are probably the evidence of the different residence time of the particles in the air or the aquatic environment.

Based on the above, we can conclude that the studied magnetite microspheres were formed in the Earth's atmosphere during the flight and spraying meteorite or as a result of an impact event on the border of Moscow and Kasimovian centuries. Finding the metal microparticles in sedimentary sequences can act as a new tool for regional correlation, lead to a revision of models of biotic crises. According to the authors, it is necessary to continue the special litho-geochemical, mineralogical, paleontological, paleomagnetic and cosmological research to find impact structures in the Upper Paleozoic sediments.

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THE WAVE PLANETOLOGY IN THE NATURE WAVE STRUCTURE AND ITS REFLECTION IN CONTRASTING CHEMISTRY OF KAROO, TUNGUSKA AND DECAN TRAPS

Kochemasov G.G.
IGEM RAS, Moscow, Russia, kochem.36@mail.ru

A visible demonstration of existing in nature wavelengths is presented by NASA as a scale line started from gamma rays (10^{-12}m) at the right end and ending with km-long radio waves (10^{3}m) at the left end. For convenience, wavelengths are compared with sizes of some common objects. Thus, gamma rays correspond to atom nuclei, roentgen waves (10^{-10}) to atoms, UV (10^{-9}–10^{-7}) to virus, IR (10^{-6}–10^{-4}) to bacteria and cell nucleus, microwaves (10^{-3}–10^{-2}) to pin head and a bee, radio waves (10^{-1}–10^{3}) to human size and football field. At the right end occur high-energy waves, at the left low energetic radio waves. Visible light waves occur between 10^{-6} and 10^{-7} m. We consider as a logic prolongation of the scale to the left long planetary waves [2–6] long from a portion to several radii of cosmic bodies. Thus, in the solar photosphere they make supergranulas of πR/60 size, in Mercury πR/16, Venus πR/6, Earth πR/4, Mars πR/2, asteroids πR/1. In the outer planets the sizes are 3πR – 62πR (Jupiter – Pluto). The sizes of tectonic granules are proportional to orbital periods of planets.

Except tectonic granules sizes of which depend on orbital periods (or inversely with orbital frequencies) all cosmic bodies are warped by the fundamental wave 1 long 2πR or a planetary ring. An origin of warping planetary bodies warping waves is due to their movement in non-round (elliptical or parabolic) keplerian orbits. This means that the movement is with periodically changing accelerations that leads to an appearance of inertia forces making in bodies warping standing waves. In rotating bodies (but all bodies rotate!) these waves have four ortho- and diagonal interfering directions and harmonic overtones.

The fundamental wave inevitably divides a body into two differently elevated halves – two hemispheres [3-5]. This universal tectonic phenomenon received one more confirmation in images of the dwarf planet Ceres acquired by the cosmic probe DAWN approaching Ceres to become its satellite on the 6th March 2015. The images from the distance of 237000 km of this 950 km in diameter body clearly show its two hemispheres – the lighter northern and the darker southern one. A previous prediction of this phenomenon was based on the first theorem of the wave planetology: “cosmic bodies are dichotomous,” and known bright tectonic dichotomies of Earth, Mars, and the Moon [3-5].

Two antipodean segments-hemispheres of Earth – uplifted eastern continental and subsided western oceanic are divided by waves of the first overtone (wave 2 long πR) into tectonic sectors. They are clearly observed at the eastern hemisphere as differently colored on geographic maps sector – blocks meeting at the mountain massif Pamirs-Hindukush. Being the faces of the Earth’s structural octahedron, they present two opposite uplifted sector-blocks: The African-Mediterranean and Asian and dividing them two opposite subsided sector-blocks: Eurasian and Indoceanic.

On the tectonically uplifted and subsided sectors tectonic granules are arranged; they are presented by the Archean cratons and surrounding them fold belts. On Earth a size of these uplifted tectonic blocks (granules) and intermittent with them subsided blocks is πR/4, thus, 8 roundish blocks in the great planetary ring – equator. Laying on the uplifted and subsided areas of segments and sectors (2πR- and πR-structures) tectonic granules (πR/4-structures) acquire some distinguishing characteristics. These are in particular petrochemical and physical features of trap basalts voluminous effusions of which are characteristic for cratons. Connected with kimberlites and lamproites diamonds being the deepest formations also are peculiar.

Like basalts of oceanic basins of two hemispheres are chemically different (in the Pacific basin they are more ferruginous thus more dense than in other oceanic basins), trap basalts of differently uplifted sectors of the continental hemisphere also are differing in chemistry and thus by density. More ferruginous on the whole are Decan traps what suit their position in limits of the mostly subsided Indoceanic sector. Such subsidence with diminishing planetary radius requires increasing mantle density to preserve angular momentum of the descending block (Le Chatelier principle). Neighboring to the Indoceanic strongly uplifted African sector carries traps enriched with Mg (plus high contents of potassium as, for an example, in limburgites of the SE Africa). This makes basic rocks of traps less dense that regularly correlates with the thick decreased density African lithosphere. Tunguska and Putorana traps occupy intermediate position by Fe-Mg chemistry between Karoo and Decan according to their origin on risen Asian sector, less uplifted than strongly uplifted African sector.

Anomalously "heavy" lithosphere of Hindustan is characterized by the decreased thickness (100 km), well-developed underlying asthenosphere, increased heat flow and CO_2 degassing. Increased magnesiality of the Siberian traps is emphasized by an association with them of ore deposits of magnemagnetites.

The universal division of cosmic bodies lithospheres in risen (continental) and fallen ("oceanic") tectonic blocks of various sizes obeying the harmonic wave row is an essence of the wave planetary tectonics. Orbits make structures. Cosmic researches of the last years showed that to the terrestrial oceanic basins in the lunar lithosphere correspond Basins of Procellarum Ocean (analogy of the Pacific Ocean) and the South Polar-Aitken (analogy of the Indian Ocean)[1, 6, 7]. Such structural analogies in bodies of various sizes, masses and compositions witness leading structuring role of wave processes. A confirmation of the same type of lithosphere structurization in the Earth-Moon pair moving in one circumsolar orbit is the Mars-Phobos pair also moving in one circumsolar orbit.

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THE FIRST FINDING OF SERPENTINITE OUTCROPS IN THE MOUNTAINOUS CRIMEA AND ITS SIGNIFICANCE FOR THE REGIONAL PALEOGEODYNAMICS

Demina L. I., Promyslova M. Y., Tsarev V.V.
lidem06@rambler.ru, The geological faculty of Moscow state University, Moscow, Russia.

The serpentinites are one of the most important members in the composition of the orogenic ophiolite associations. Such associations are fragments of ancient oceanic crust is stored, usually in suture zones representing traces of closure of the large basins such as oceans and back-arc spreading basins. In the Mountain Crimea collisional suture was first identified by Yudin [8] based on the marking melange zones, which contain traces of ophiolite association – serpentinized ultramafic rocks found in the core of a hole drilled in 15 km to the north-east of Simferopol [4]. Subsequently serpentinites have been described in the pebbles of Lower-Middle Jurassic conglomerates of Bitakskaya suite [9], revealed by drill holes on the Heraclei plateau of the south-western Crimea and dredged from the Lomonosov underwater massif located at the bottom of the Black Sea in 24 miles South-West of Cape Fiolent [8]. At the same time, outcrops of serpentinite in the region were not known.

In the fieldwork-2014 we were the first who found serpentinites outcrop and fragments of parallel dikes complex to the Crimean Mountains in the Cape Fiolent, which as well as the pillow lavas, gabbros, peridotites, and jasper could be confidently attributed to ophiolite association [3]. We must note that earlier the possible presence of ophiolites in the area was indicated by Shnyukova [5] and Promyslova and others [2].

Magmatic rocks in Cape Fiolent area make up rocky cliffs on the coast of southern part of the Heraclei Peninsula for about 7 km long. Magmatism of Fiolent traditionally compared with island-arc Karadag type [1,7], and its manifestation is referred to middle Jurassic (Bajocian). It is believed that the basement of Fiolent paleo-volcano consists of sediments of the Upper Triassic to Lover Jurassic Tavriya Group. However, this sediments have not been found in the Fiolent area [6]. Igneous rocks are discordantly overlapped by Sarmatian limestones (Neogene) which are nearly horizontal.

Gabbro-dolerite, gabbro and peridotite occur mainly in the western part of the Cape Fiolent area, where the outcrops of serpentinites were found by us. They are confined to the intersection of the two sub-vertical fault zones NE and NW trending, bounding the cliffs of Utyug rock. The rock is composed of highly fractured gabbro with crushed grains of clinopyroxene, and altered calcic plagioclase. Altered and brecciated aphyric amygdaloidal pillow lavas with typical spilit structure are developed to the west of Utyug rock.

The pillow lavas outputs limited on the east by the fracture zone, along which they are in contact with serpentinized ultramafic rocks with numerous sliding mirrors and shearing planes, giving them schistosity and lenticular texture. On chips that are perpendicular to the direction of shearing, rocks have spectacled texture expressed in the presence of individual fragmented and quite large (up to 2 mm) grains of clinopyroxene, streamlined by aggregates of serpentine, chlorite, rarely actinolite. Ultramafic rocks are most likely can be attributed to wehrlites or lherzolite, as in under the microscope in addition to clinopyroxene sometimes there are relics of the individual grains of crushed rhombic pyroxene.

Further to the east directly at the Utyug rock there is a cataclasite and mylonites zone. It is to this zone that serpentinite outputs are confined, forming rounded, convex surfaces on the background of crushed rocks. In general, these formations are of serpentinite melange, visible width of the output of which is about 15 m. Serpentinites in the outcrop are characterized by coarsely flaky and lenticular separation, brownish dark-gray on weathered surfaces and spotted silky coloration of different shades of green in the fresh chips. They are composed of fine needles serpentine aggregates – chrysotile, oriented either parallel to each other, or forming sheaf-like clusters. There are chlorite, actinolite, carbonate, rare albite, quartz and ore minerals in these rocks. Relics of the crushed clinopyroxene grains are distributed in the rocks unevenly and in a substantially smaller amount than in serpentinized ultramafic rocks.

Also serpentinites has been observed by us in the outcrops of breccias metamorphized under conditions of greenschist facies and developed in the Tsar's bay. The breccias are overlain by pillow lavas and broken by a series of parallel dolerite-basalt dykes that were feeders for the mafic magma. They are composed of mafic and ultramafic rock fragments cemented by siliceous material – jasper of light bluish-green color. In the wreckage there are typical chlorite, chlorite-actinolite, rarely chlorite-epidote schists, and apo-dunite serpentinites with loopy structure. This fact indicates that ultramafic rocks were bred on the sea floor and intensely destroyed before the outpouring of basalt.

Almost all researchers refer the Mountain Crimea magmatism to the island-arc type, which representative is the Fiolent volcano. However, a single volcano in the vicinity of Cape Fiolent does not exist. In the coastal cliff outcrops there are clearly visible multidirectional flows of pillow lavas, which indicates the presence of several eruption centers. Feeders were parallel cracks formed by dolerite and dolerite-basalt. Late plagiorhyolites, which compose not more than 10 vol % of the all magmatic rocks, make up mainly dikes, stocks, extrusive domes with columnar parting, and are differentiates of basaltic magma [2].

A detailed study of the chemical composition of Cape Fiolent magmatic rocks, including the distribution of rare earths and a wide range of other trace elements, indicates their supra-subduction nature and belonging to a back-arc basin, which created spreading [2, 3].

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DEVONIAN AGE TSIPIKANSKIY THICKNESS OF THE BAIKAL-VITIM FOLD SYSTEM (WESTERN TRANSBAIKALIA).

Doronina N.A., Minina O.R.
dna48@mail.ru, Federal State Institution of Science Geological Institute,
Siberian Branch of the Russian Academy of Sciences (GIN RAS),
Ulan-Ude, Russia

The paper presents the first results of palynological studies of metamorphic rocks tsipikan strata from Bagdarin district of Western Transbaikalia.

Western Transbaikalia is a part of the Central Asian fold belt. Questions of formation of its continental crust over the years are of particular interest. In recent years, Western Transbaikalia has been allocated the Baikal-Vitim folded system (BVFS), which includes Baikal (RF), Caledonian (V- Є -S_1), Early (S_2-C_1) and the Late Hercynian (PZ_2) structural-formational complexes forming the respective structural floors. Complexes Baikal and the Caledonian structural floors compose the foundation on which formed Hercynian complexes [6]. Baikal structural floor BVFS integrates magmatic (with age from 971 to 780 Ma) and metamorphic complexes, composition, structure and geodynamic conditions of formation of which is still are debatable [1, 6, 7]. Precambrian metamorphic complexes are presented garginskaya series, whose age is currently insufficiently substantiated.

Tsipikan strata is considered a representative garginsky series and distributed in the basin Tsipikan. In stratotype (river *Tsipikan*) suite is composed mainly of biotite-quartz-plagioclase schists interbedded with calcite marbles and accommodates amphibolite sills with age 324.1 ± 5.0 million years. In the basin of the river *Ushma* it consists of metasandstones and tufosandstones, silty mudstones, aporiodatsite shists. As part of stratum thickness more than 4000 m is divided into four packs. Found that the sedimentation took place in an environment active continental margin and/or continental island arc due to the destruction of Precambrian magmatic complexes of intermediate and acid composition, as evidenced by the age of detrital zircons (the youngest 756 million years) [3].

Tsipikan stratum zonal metamorphosed. The degree of metamorphism increases in the south-east of Lake Baunt to the upper stream of the Yaksha from conditions intermediate between catagenesis and chlorite-sericite subfacies greenschist facies to epidote-amphibolite facies (staurolite-muscovite-biotite and andalusite-kyanite-staurolite-biotite-muscovite subfacies) by V.A. Glebovitsky (1977). Nevertheless biotite-quartz-plagioclase schists sometimes retain the appearance metasandstones, metaaleurolites [2]. Isotopic studies Sm-Nd and Rb-Sr methods monofractions garnet and micas from biotite-quartz-plagioclase schists and from intruding granites and metabasites, suggest Middle Triassic- Early Jurassic age of granitoid magmatism (240-192 Ma) and Upper Carboniferous-Early Jurassic age of the metamorphism of mafic rocks and aleurosandstones (302-179 Ma) [4].

At present tsipikan strata conventionally dated to the Upper Riphean. We tried to determine its age palynological method that has been used successfully in the region for dating sediments not containing visible organic residues [5]. For the study samples were preferred homogeneous addition. A total of 18 samples transversely to and along the strike of stratum.

Microfossils recovered from metasandstones and metaalevrolites the second, third and fourth packs of strata in the basins Tsipikan (streams Sivak, Yaksha) and Ushma. In all the samples are installed palynomorphs, which marked the first appearance of a Silurian or Devonian (definition L.N. Neberikutina, Voronezh State University). Miospory constitute the main part of the complex and are dispersed plant remains fully preserved in the form of sporopollenian shells and confined to certain intervals of the section. Miospory all three packs tsipikan stratum close to each other and combined into a single palynocomplex (PC).

The complex, in addition to species distributed in the Middle Devonian-Middle Carboniferous, there *Auroraspora varia* (Naum.) Ahmed *var. minor* Naum. (D), *Hymenozonotriletes emendatus* Kedo (D_3). Types *Tolisporites variabilis* (Naum.) Oshurk., *Reticulatisporites devonicus* (Naum.) Oshurk., *R. perlotus* (Naum.) Oshurk., *Tuberculispora evlanensis* (Naum.) Oshurk., *Geminospora semilucensa* (Naum.) Obukh. et M. Rask.typical for the Upper Devonian Frasnian, and *Hymenozonotriletes deliquescens* Naum., *Lophozonotriletes tylophorus* Naum., *Ambisporites eximius (Naum.) Oshurk.* typical upper Frasnian substage. Miospory *Acantotriletes buserus* Tschibr., *Densosporites sorokinii* Obukh. characterizes the lower part of the Frasnian. For Fran also characterized *Archaeozonotriletes echinatus* Naum. and miospory with distal groove *Archaeoperisaccus* (Naum.) Pot. In addition miospor in PC installed dispersed fragments of cuticle *Estonia scarber Serg.*, occurring in Frasnian deposits.

Palynocomplex tsipikan stratum determines the Late Devonian, Frasnian time accumulation deposits. Presence in the palynospectra of the second pack (Tsipikan river, stream Sivak) species *Acantotriletes buserus* Tschibr., *Densosporites sorokinii* Obukh., characteristic of the bottom of the Franc, in the third pack (Tsipikan river, stream Yaksha) *Geminospora semilucensa* Naum., which is zoned area kind of MIOSPORE *SD* medium part of the Frasnian Russian platform, and in the spectra of the fourth packet (Ushma river, stream Yaksha) *Hymenozonotriletes deliquescens* Naum., zonal species MIOSPORE zone *DE* top of the Frasnian stage [8] suggesting lower Frasnian accumulation time lower, middle Frasnian for middle and late Frasnian for the upper parts of the section stratum. Distribution of miospor the section stratum confirms the previously established vertical sequence packets. Furthermore miospory of basin sediments Ushma, previously included in the second pack, similar to the fourth pack, on the basis of which this part the section stratum to be attributed to the fourth pack. These data confirm the presence of a left shift latitudinal fault along a stream Povorotny.

Thus, for the first time tsipikan strata characterized by paleontological and dated Frasnian age of the Late Devonian, eliminating her from the Baikal structural stage BVFS. In terms of material composition and complexes of microfossils tsipikan strata comparable with the lower part the section yakshinsky suite Bagdarin subzone Vitimkan-Tsipinskoy zone BVFS [5]. Taking into account paleontological reasonable continuity of Frasnian deposits, it can be assumed and a relatively small amplitude sublatitudinal shifts as a whole do not violate the completeness the section tsipikan column. In view of the age of Frasnian deposits can be recalculated maximum model age of the protolith stratum: 1455-2038 Ma, εNd (380) -(2.8-3.8).

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ACTUAL PROBLEMS OF THE GENESIS OF DIAMONDIFEROUS DEPOSITS OF TIMAN

Grakova O.V.
ovgrakova@geo.komisc.ru, Institute of Geology of the Komi Science Center of the Ural Branch of the Russian Academy of Sciences, Syktyvkar, Russia

Problem of the diamond Tiemann is the focus of research for more than half a century. The first mention of the discovery of single diamond in the Timan belong to the XVII century, the discovery of the XIX century have completely reliable, and in the second half of the XX century diamond isolated finds are marked throughout the Timan Ridge, where the individual placers close in content to the industry.

Currently, casts doubt on the sedimentary deposits diamondiferous actively developing understanding of the nature tuffizit diamondiferous Devonian rocks of the complex, which stand out as Takatin series Vishersky Formation in the area of the Perm region within Polyudova Ridge [4]. According to the authors of this hypothesis, diamondiferous rocks are not sedimentary formations, and a kind of subvolcanic piroklastitami (tuffisites) that are specific fluidized-explosive derivatives lamproite magmatism. Outwardly, they look like heavily modified sand-clay rocks. Since Devonian diamondiferous gravel-sand deposits Vishera area and Timan are similar in properties of host rocks, structural-textural and mechanical characteristics, ideas about the nature of diamonds tufizit Timan became popular among many researchers. Moreover, special works have been put on the search for diamonds in the Timan Vishera type.

We studied two distant [2], but similar age polymineral diamond show in the Middle and South Timan (Ichetyu and Autumn, respectively). Multimineral diamondiferous placer Ichetyu located in the north-Wolski Vym Ridge Middle Timan and confined to the base of the middle Devonian sediments of the system. Productive deposits are located in the basal part Pizhma series that bedrock terrigenous deposits Maloruchey series unclear genesis, and overlap the Upper Devonian terrigenous rocks and Quaternary sediments. Within the field of placer Ichetyu total power Pizhma series reaches 30 m. In the Southern Timan diamonds set in Middle Devonian deposits Asyvvozh series ($D_{2\text{-}3}$as) in the north-western part of the hill Dzhezhim parma. Asyvvozhskaya suite includes clastic formation of the Eifel, Givetian and lower Frasnian. Formation sediments unconformably overlie Asyvvozh on deposits Dzhezhim Formation of the Upper Riphean and according to overburden Izyael suite ($D_3$is). The total capacity of this suite is more than 40 m.

Given that the diamonds in South Timan studied much less than the Middle Timan, one of the main objectives of our study was to compare two diamond show: Autumn in the South Timan and Ichetu the Middle Timan, in order to use its existing strengths on the Middle Timan, more accurately assess South Timan diamond prospects. Our studies have shown a high degree of similarity of the geological structure and conditions of formation of the two compared diamond show. Diamond show Autumn and Ichetu confined to the base of the Paleozoic section Timan. The similarity noted in the low-power producing diamond thick, unevenness of their capacity, facies variability, maturity deposits. Another similar option is the presence of diamondiferous deposits products of weathering crusts. The index of chemical weathering (CIA) for both breeds diamond show practically identical ¬- 70 [1]. Significant stratigraphic breaks and fragmentation in the spread over the area of these deposits are associated with unstable tectonic depositional environment in the late Eifel in the Timan.

Mineralogical analysis of these deposits showed that the overall species composition of accessory minerals in diamond show Autumn and Ichetu very close. In both diamond show presents chrome-spinellid, ilmenorutile and gold. The presence of minerals such as garnet, pyroxene, amphibole, epidote, staurolite, tourmaline, zircon, rutile, monazite, xenotime may indicate a similarity of rocks that form the erosion region. Grains of the same accessory minerals in both placers have varying degrees of roundness from well-rounded to slightly rounded and almost sharp-edged with well-preserved crystal faces. This location crystals and fragments, including a well-rounded, due to their multiple redeposition along the route and the arrival of new portions of detrital material.

E. Shcherbakov believes that the placer deposits formed temporary streams, in which the separation of minerals on the hydraulic size of the grains formed paragenetic associations [5]. Comparing the two diamond show we studied, we see similarities in the nature of rounding minerals in these alluvial deposits, which obviously points to close the conditions of their formation.

As a result of the research we see more arguments in favor of the traditional view of Timan diamond show as a secondary sedimentary reservoirs. Both compared diamond show Autumn and Ichetu confined to the base of the Paleozoic section Timan. Asyvvozh series in South Timan lies at the basis of the Upper Proterozoic. Pizhma series in the Middle Timan also lies at the Upper Proterozoic rocks or with a stratigraphic unconformity – on a locally developed thick terrigenous sediments Maloruchey series. Age last remains problematic: Precambrian, Late Vendian, Ordovician, Early or Middle Devonian. Rocks forming cuts both suites have a typical sedimentary look. Most of accessory minerals, like himself, diamond, are clear signs of transport in surface conditions. On the genesis of sedimentary diamond show of Ichetu results of the study indicate defects in diamond crystals made [3]. One of the weakest points in the justification of the concept of sedimentary genesis diamond show of the Timan – the almost complete absence in the productive strata minerals – paragenetic satellites diamond. However, in the first place, after all the satellites observed diamond and, secondly, given the high degree of weathering of rocks eroded, these minerals could be destroyed in the weathering crusts.

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PLATFORM SEISMIC ZONING (KOMI REPUBLIC, RUSSIA)

Lutoev V.A.
valutoev@geo.komisc.ru, Institute of Geology of Komi SC UB RAS, Syktyvkar, Russia

We have succeeded in preparing the maps of general seismic zoning (GSZ) of geosyncline belts, where earthquakes are recorded quite often, some progress has been made. The situation is different for platform areas – GSZ maps do not always meet the required forecast criteria. It is related to both small number of seismic shocks, and problems in methods of study. We proposed a method to study the seismicity of platform areas on the example of seismic zoning of Komi Republic. This method is based on I. E. Gubin's concept – study of seismic-tectonic conditions of the earthquakes formation, where the main carrier of information is the seismogenic zone [1].

<u>The first stage of the seismic zoning 1997–2003.</u>

To study local seismic-tectonic conditions we used regional geological and geophysical materials and publications of the following authors: V.A. Dedeev, N.A. Malyshev, I.V. Zaporozhtseva, A.M. Pystin, I.N. Ryzhov, V.V. Yudin and many others. Innermost isoseism sizes were assessed using macroseismic data of the Sysolsk seven-point earthquake in 1939 in the southern part of Komi Republic (survey data, Timonin N.I., 1986). The start of the seismic station «Syktyvkar» in 1997 resulted in the first seismograms of distant, proximal and local earthquakes. The combined analysis of the earthquakes with seismic geological and geophysical data allowed us obtaining the first information about the potential seismicity of the region.

As a result seismic zoning map of Komi Republic in scale 1:2500000 was made with potentially active seismogenic zones: 1 – Kirov-Kazhimskaya, 2 – Vostochno-Tsentralno-Timanskaya, 3 – Pripechorskaya, 4 – Yuzhno-Timano-Ukhtinskaya, 5 – Yuzhno-Pechorskaya, 6 – Intinskaya, 7 – Usinskaya, 8 – Vorkutinskaya. The most dangerous zone is Kirov-Kazhimskaya seismogenic zone, where Sysolskoe earthquake occurred with magnitude 5.5 units or 7 points by the international scale MSK. In the northern end of this zone Syktyvkar City is located with a population of about a quarter of million people. Due to the fact that this city is located within the seven-point isoseismic shock area in relation to the central axis of this zone we conducted seismic zoning in scale 1:25000. In addition, potential seismic shock zones were mapped in the seismic zoning map despite the lack of information about earthquakes at the time of its making [2].

<u>The second stage of the seismic zoning from 2003 till present</u>

Using the results of our subsequent studies [3-8], we concluded that the geological environment, that can initiate the foci of earthquakes, strictly subjects to the same laws of physics, as for the platform and geosynclinal areas. The difference between their physical-seismic-tectonic models of development of earthquakes focus is that in geosynclinal areas the geological blocks are more fragmented, and therefore they are more mobile in their spatial movements, the effective rates of reversing movements are higher than the platform areas. On the other hand, these areas have higher rates of dissipation of seismic energy due to their heterogeneous filling material and smaller sizes compared to the platform areas. Despite this, seismic shocks are more frequent that in the platform areas, where the dissipation of seismic energy runs at a slower rate, but their reversing rate of geological units is significantly lower that provides a more integral condition of the rocks at depth, even in the conditions of lower values of rock strengths of rocks in shear components under the conditions of the formation of earthquake focus. So, this process is mainly influenced by active factors: dissipative (mostly for platforms) and reversing rates (mostly for geosynclinal areas) of geological blocks of the earth's crust; and passive – relatively sharp differentiation of elastic parameters of rocks and the presence of waveguides in the depth of the earth's crust. Thus, for successful seismic zoning of the platform areas it is necessary to solve the following tasks:

1) to determine the dissipation rate of geological structures and on the basis of this to get the algorithm of potential seismicity in relation to the distribution of seismic events occurred;

2) to determine elastic parameters of SSE in the section of the earth's crust on the basis of the rates of longitudinal and cross waves assessed using deep seismic sounding that will allow to quantify

the depth of possible formation of earthquake focus and also to give a qualitative description of their development rates.

It is necessary to show all information on the map of seismic zoning to help existing spatial-numerical values of registered earthquakes (epicenters, magnitudes, hypocenters). Next, it is necessary to provide adjustment of general or detailed seismic zoning maps, which will be changed; namely, the platform areas will be finally divided into active, with the presence of seismogenic zones, and passive seismic areas.

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GEOLOGICAL COMPLEXES AS EVIDENCE FOR INITIAL STAGES OF THE EARTH'S CRUST FORMATION IN HADEAN AND EOARCHEAN

Mints M.V.
Michael-mints@yandex.ru, Geological Institute, RAS, Moscow, Russia

Initial stages of the Earth's crust formation are characterized by very limited data. Our knowledge on geological events of that time is to a significant extent or mostly (for Hadean) based on indirect information. The data of comparative planetology, as well as geochemical, isotopic, petrologic, and other simulations are predominant. Until recently it was suggested that soon after accretion our planet underwent intense heating, which predetermined all main parameters of geological processes of that time: origination and differentiation of magmatic ocean, prevalence of high-temperature metamorphism up to conditions of granulite facies, the Venusian environment at the terrestrial surface, etc. To obtain correct ideas, geological evidence of the early continental crust formation recorded in geological chronicle of Hadean (~4.6–4.4 Ga), Eoarchean (4.0–3.6 Ga), and Paleoarchean (3.6–3.2 Ga) is the most important.

The Nuvvuagittuq Greenstone Belt, Superior Craton, Canada is characterized by predominance of mafic rocks varying in composition from cummingtonite amphibolite to garnet–biotite schist (metabasalt to meta-andesite). The finely banded BIFs and magnetite–silicate rocks occur in stratified section. The earliest U–Pb zircon age of volcanic–sedimentary complex is dated back to ~3.8 Ga. The ^{146}Sm–^{142}Nd age of protolith (~4.28 Ga) is so far a single known evidence for a fragment of the Hadean crust [O'Neil et al., 2011].

The high-Ti amphibolites are products of metamorphism of the tholeiitic basalts, the fractionation of which proceeded under dry conditions and a low pressure. The low-Ti amphibolites correspond in composition to boninite, calc-alkaline basalt, and andesite. These rock associations are characteristic of the Archean greenstone belts and of the recent island-arc systems. A protolith of cummingtonite amphibolite restored using MINLITH program consists by more than half of Mg–Fe aluminosilicates and silicates (serpentine or chlorite occupied more than 30%). Approximately a third of rock consists of quartz fragments with insignificant contribution of feldspar. Iron hydroxides (up to 13%) and carbonates (4.5%) also occurred. The contrasting composition of fragments indicates that they have been supplied from different provenances. In comparison with the Archean greenstone belts, the Hadean section of the Nuvvuagittuq Belt contains more primitive array of metasedimentary rocks [Rosen et al., 2015, in press].

The Acasta Gneiss, Slave Craton, Canada. According to field observations, the evolution of the Acasta Gneiss comprised four tectonothermal events: (i) formation of basic to intermediate igneous rocks as a protolith of gneiss; (ii) emplacement of felsic magmas as a protolith of tonalitic gneiss; (iii) transformation of protoliths into gneisses, intrusion of granite subsequently transformed into fissile granite; (iv) metamorphism and deformation of the rock complex as a whole. The initial geochronological study yielded the following age estimates of the main events: 4.03–3.94, 3.74–3.72, and ~3.6 Ga [Bowring and Williams, 1999]. The later study depicted a complicated sequence of events: at least fourfold emplacement of tonalitic to granitic melts 3.97–3.94, 3.74–3.73, 3.66, and 3.59–3.58 ago [Iizuka et al., 2007].

Zircons from Jack Hills, Narryer Gneiss, the Yilgarn Craton, southwestern Australia. It was assumed for a long time that the continental crust started to form ~4 Ga ago. New data have been obtained as a result of studying metasedimentary rocks of the Narryer Complex deposited 3.28–3.20 Ga ago in Jack Hills area [Iizuka et al., 2010]. Metaquartzite and metaconglomerate contain a significant amount of detrital zircons, the age of which varies in a wide range. The oldest estimates correspond to 4.37–4.01 Ga [Harrison et al., 2005]. These zircons, which are the oldest known fragments of the Earth's crust, bear unique information about early geological evolution of the Earth. Quartz, K-feldspar, and monazite inclusions in zircons along with enrichment in LREE, as well as results of oxygen-isotope thermometry of zircon crystallization show that relatively low-temperature (~700°C) hydrous granitic magmas have already existed at that time. Generation of such magmas, in turn, indicates that water-bearing sediments and correspondingly water proper existed at the Earth's surface under conditions of temperate climate (lower than 200°C as early as Hadean). The initial $^{176}Hf/^{177}Hf$ isotope ratios in detrital zircons from Jack Hills zircons provide evidence for the outset of the continental crust growth already 4.5 Ga ago, i.e., immediately after completion of the Earth's accretion as a planet.

Crystals with diamond inclusions have been identified among the Jack Hills zircons dated back to 4.24–3.2 Ga [Menneken et al., 2007]. Thus, relatively cold mantle domains under conditions of diamond facies arose as early as Hadean.

In summary, we have to state that the Earth's crust started to grow immediately after accretion of protoplanetic matter 4.5–4.4 Ga ago. Later on, 4.4–4.0 ago, the Earth's surface was characterized by temperate climate, which made it possible to exist hydrosphere and probably life. It is evident that in this period meteorites fell rarely. The temperature, at least, in separate domains of the upper mantle also was relatively low. Vigorous heat generation due to radioactive decay was apparently compensated by heat release into cosmic space.

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COMPOSITION OF ERUPTIVE PRODUCTS BULGANAK MUD VOLCANO (KERCH PENINSULA) AS CRITERIA FOR ASSESSING THE STRATIGRAPHIC LEVELS SOURCES OF THEIR SUBSTANCE

Samoilov D.A., Vyrshylo A.V.
dmitry.a.samoilov@gmail.com, Taras Shevchenko National University of Kyiv, Educational and Scientific Institute "Institute of Geology", Kiev, Ukraine

Mud volcanoes (MV) are common in the Azov–Black Sea, Caspian and many other regions, the majority of which oil and gas bearing. Products of eruptions (MV breccia) are formed by the material lying below the sequences. Traced roots of the foci of mud at a depth of about 10 km (D.V.Golubyatnikov, 1923), we can assume that as "free exploration drilling". At the same time as a source of information about the deep structure breccia traditionally regarded three components : (1) the matrix (clay), (2) coarse (set of rock fragments) and (3) small fragments (aggregate of mineral grains) [2, 3, 4, 5].

The main obstacle to the implementation of these components as sources of information about the features of the composition and terms of the lying strata below is their integral nature – they are themselves breccias formed by mixing the substance of all divisions drained sections. Therefore, the evaluation of the contribution of the latter in the formation of breccia is urgent problems to be solved [1, 2, 3, 5], but mainly on a qualitative level.

Trying to quantitative solutions for the components (1) and (2) (breccia without large fragments) made by us on example of a volcano Bulganak (Kerch Peninsula). Investigated a series of samples which is representative of recent eruptions characterized by breccia hills Andrusov and Central Lake (n = 75 and n = 25, respectively). All samples were identified (XRF) concentrations of major and a wide range of trace elements, which were compared with the available geochemical data for cuts Cretaceous and Paleogene-Neogene (Maikop series). Qualitatively, the comparable data were only Zn, Zr, Nb, Ga, Sr. Therefore, the evaluation of the contribution of each of the divisions of the cut made by solving a system of five equations of the type , where: C_1 – concentration of the element in the stratum 1; V_1 – mass fraction of material stratum 1; C_n – concentration of the element *n* in the mixture (breccia).

Therefore, the evaluation of the contribution of each of the divisions of the cut made by solving a system of five equations of the type $C_1V_1 + C_2V_2 + C_3V_3 + C_4V_4 + C_5V_5 = C_n$, where: C_1 – concentration of the element in the thickness of 1; V_1 – mass fraction of material thickness 1; C_n – concentration of the element *n* in the mixture (breccia).

The resulting estimates of the contributions (hill Central Lake: Upper Cretaceous – 20, Paleogene–Neogene 80; Andrusov: Paleogene–Neogene – 100%) are realistic, but for the further application of the proposed approach is necessary to use more correct geochemical data on reference sections drained sedimentary complexes.

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STRATIGRAPHY DEPOSITS IN AREA OF PRACTICE PFUR ON THE SOUTHERN URAL

Shendrikova S.G., Shirokov D.N.
Svetlana.shendrikova.94@mail.ru, People Friendship University of Russia (PFUR)
Moscow, Russia

Southern Urals have been studied for 200 years. Existing geological concepts and paradigms have been applied to the structure of the Urals. As a result, there is no objective geological structure yet, although abundant actual data have been accumulated. Concerning the stratigraphic sequence of accumulation of sediments there are no clear and precise conceptions. Numerous researches have introduced such a variety of formations, horizons and thicknesses that their comparison is very problematic and there is no clear geological development history conception.

A place situated in Kuvandyk district in Orenberg region has become a base for practical training for several universities (Orenburg State University, Russian State University of Oil and Gas). Along with them,the ore district of Mednogorsk has become one of the bases for practical training of the Department of mineral deposits and their exploration of PFUR. Both practical training and research work are carried out by students, gradient students and young scientists there.

As a result of our research, the following unified stratigraphic sequence accumulation of deposits in the ore district of Mednogorsk can be offered.

The rock from Early Cambrian to Carboniferous system [1, 2], which is the sequence of accumulation of volcanic, volcanogenic-sedimentary and sedimentary rocks of two stages of magmatic, accompanied by a continuous accumulation of terrigenous deposition, took part in the formation of Mednogorsk ore district. The lower part of the section (from early Cambrian to late Silurian) is represented by a large stratigraphic unit – Mednogorsk complex – the formation of which was due to the volcanic activity from early Cambrian to late Silurian ($Є_1$-S_2). Sequential series of rocks of different litological composition are allocated as the part of the complex which are single volcano-terrigenious associations of rocks. We allocate them in the following suites:

- Suite of Mednogorsk – volconogenic-sedimentory with effusive subsilicic composition – ($Є_1$-O_1 md);
- Kidpyasovskaya suite – terrigenous suite – ($Є_1$-O_1 kd);
- Sarbayskaya suite – volconogenic-sedimentory with effusive acid composition – (O_2-S_1 sb);
- Sakmarskaya suite – volcanogenic-sedimentary with effusive acid composition – (S sk);

The upper part of the section (from Devonian to Carboniferous system) is represented by terrigenous and sedimantory deposition, which was formed in post volcanic era (occurrence on subjacent rocks with stratigraphic disconformity)

- Zilairskaya suite – terrigeno – sedimentary – (D zl);
- Carboniferous sedimentary deposition – (C).

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EARLY PROTEROZOIC GLACIATIONS: STABLE ISOTOPE GEOCHEMISTRY OF 2.4-2.2 GA PROTOLITHS FROM THE BELOMOTIAN BELT

[1]Zakharov, D.O., [2]Serebryakov, N.S., [1]Bindeman, N.I. and [3]Azimov P.Ya
davidz@uoregon.edu, [1]University of Oregon, Eugene OR USA 97402; [2]Institute of Ore Geology, Petrography, Mineralogy, and Geochemistry (IGEM), Moscow, Russia; [3]Institute of Precambrian Geology and Geochronology (IGGD) RAS, Saint-Petersburg, Russia

The early Proterozoic was one of the most critical periods of time in the history of Earth's evolution. Shortly after the breakup of Kenorland and a series of global glaciations (including so-called Snowball Earth), first portions of free oxygen emerged in the atmosphere, which subsequently allowed for the prosperity of metazoan life (Young, 2013). The relationships between these events remain unclear, partly because of indefinite temporal constraints: the ages of glaciogenic deposits and rocks with disappeared MIF of sulfur isotopes were estimated as 2.45-2.22 Ga and are based on the principle of superposition and cross-cutting relations (Young, 2013). No agreement has been reached on the number and extent of the glaciations, however from paleomagnetic studies it was determined that glaciogenic deposits were accumulated at equatorial latitudes (Evans et al., 1997). Ultralow-$\delta^{18}O$ values found in rocks from Karelia (down to -28‰ SMOW), suggest that 2.4-2.2 Ga mafic magmatism took place in subglacial environments. Thus, we can resolve the age of early Paleoproterozoic glaciations using intrusive rocks and associated meteoric-hydrothermal systems.

High-temperature hydrothermal interaction between hot magma and surrounding water allows for oxygen isotopic exchange between host rocks and hydrothermal fluids. When meteoric waters are involved in hydrothermal processes at temperatures higher that ~200°C, surrounding rocks become depleted in heavy isotope ^{18}O and $\delta^{18}O$ in them shifts towards lower values. Cold meteoric waters and glacial waters have low oxygen isotopic composition $\delta^{18}O$ = -22 ‰ (Craig, 1993), which is reflected in extremely low $\delta^{18}O$ subglacial hydrothermally altered rocks (e.g. modern Antarctica; Antibus et al., 2014).

The lowest known terrestrial $\delta^{18}O$ are recorded in high-Al metamorphic rocks from the Belomorian belt (Bindeman et al., 2014). Unusually low $\delta^{18}O$ values are intimately associated with occurrences of kyanite, epidote, zoisite, corundum, staurolite and other high-Al minerals in amphibolite facies rocks from the Chupa formation. All of the low- $\delta^{18}O$ anomalies and high-Al mineralization are associated with 2.4-2.2 Ga gabbroic intrusions which caused high-temperature hydrothermal alteration of the host rocks in presence of low- $\delta^{18}O$ glacial waters. Although Bindeman et al. (2014) conducted geochronology studies at several occurrences of the low-$\delta^{18}O$ rocks and gabbro intrusions, severe ~ 1.8 Ga high-grade metamorphism made it hardly possible to precisely determine the original age of emplacement. Ultralow- $\delta^{18}O$ values were originally found at the Khitostrov occurrence of corundum, but after extensive study of the Chupa formation it was discovered that $\delta^{18}O$-depletion has a regional extent and occurs within a 450-km long zone (Bindeman et al., 2014).

In the summer of 2014, we discovered a new occurrence of rocks that contain high-aluminous minerals on the northern shore of the Verkhnepolunga Lake. The occurrence spans for about 200 m and has thickness of 10 m. The high-Al mineralogy is associated with alteration of migmatizated garnet-amphibolite and kyanite-garnet-biotite gneiss of the Chupa formation. Altered kyanite-garnet-biotite gneisses experienced loss of quartz, emergence of calcic amphibole and replacement of kyanite by staurolite-plagioclase intergrowth. Altered amphibolite consists of large garnets and amphibole; some zones of amphibolite contain abundant corundum, kyanite, spinel and högbomite. Zoisite commonly occurs in altered amphibolites, associating with zoisite-garnet-amphibole-plagioclase and epidote-zoisite assemblages. This occurrence is analogous to Vysota 128 (Serebryakov and Aristov, 2004)

The new locality was mapped using $\delta^{18}O$ values in high-Al rocks. Oxygen isotope analyses were performed on garnet grains extracted from hand specimen samples. The mineral is a major component of studied rocks and is the least susceptible to weathering and retrograde metamorphism processes. In addition, garnet-whole rock fractionation factor is negligibly small ($1000\ln\Delta_{gt\text{-}wr}$ = 0-0.5‰ (Bindeman and Serebryakov, 2011)) and thus, the analyses reflect the oxygen isotopic composition of the whole rocks. The samples were analyzed at the University of Oregon using laser fluorination line with Finnigan MAT 254 duel inlet mass-spectrometer. For detailed description of the technique see (Bindeman et al., 2014). Values of $\delta^{18}O$ in garnets from least altered kyanite-garnet-biotite gneisses vary between -0.5‰ and 3‰. Garnets from altered gneisses (with staurolite-plagioclase intergrowths) return values of $\delta^{18}O$ down to -10‰. Garnets from unaltered amphibolites yield $\delta^{18}O$ = ~5‰. Samples collected closer to the alteration zone have $\delta^{18}O$ values of -7‰. Garnets from garnet-amphibole rocks with corundum, kyanite, spinel and högbomite yield $\delta^{18}O$ = -13‰. Zoisite-garnet-amphibole-plagioclase assemblages have $\delta^{18}O$ of -14‰.

High-temperature hydrothermal alteration in presence of early Proterozoic glacial waters is the only process that can be a reasonable explanation for the origin of such low $\delta^{18}O$ values in rocks of the Chupa formation. Stable isotope geochemistry in protoliths of the Belomorian belt allows us to recognize global glaciations even when severe metamorphism changed its original mineralogical (but not chemical) composition.

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FACTORS INFLUENCING THE DEVELOPMENT OF SOLID-MINERAL RESOURCE BASES

Lapteva A.M.
lapteva@mineral.ru, "Mineral" Center, Aerogeologiya Scientific and Production Enterprise, Moscow, Russia

Notwithstanding the official rhetoric of the recent years, the dependence of Russian economy on the primary sector is still very strong, thus determining the exceptional role of the mineral resources base (MRB) in the country's life. In this context, the problems of reproduction and use of MRB are of national significance [1]. To solve those problems requires an increase in the efficiency of exploration, including a better choice of its strategic directions.

No sound exploration-planning strategy can be developed without the analysis of the economic efficiency and reliability of the projects that are both having been and being implemented with the aim to develop deposits of solid-mineral resources (SMR) either in Russia or in other countries. An important point to be understood is that the integration of Russia in the world economy precludes any long-term planning and forecasting with respect to Russian MRB beyond the context of global processes and tendencies. In this connection, since 20 years ago, we have been monitoring the situation in the world mining-industry sector and carrying out multifactor analysis of this situation in the following directions:

- the state of MRB of major SMRs and trends in its development,
- the situation in individual mining sectors and forecasts of its development,
- market situation of individual types of raw materials, as well as trends and forecasts of its development.

In recent years, our studies were focused on revealing the factors that influence the development of mineral resource bases for major types of SMRs. The obtained results suggest the following conclusions:

1. The major factors that influence the state and the development of the raw-material sector of the world economy (including MRB) are prices, which are known to largely depend on the demand and supply balance. Their level not only determines the efficiency characteristics of mining operations. They are also used in determining the cutoff grades of the target components of ores in the deposit, such grades being used to assess the resources and reserves as early as the initial stages of deposit exploration. In this context, price dynamics determines both the fluctuations in the activity of companies in the sphere of exploration and production and the dynamics of resources. It should be emphasized that the reserves and resources in individual deposits in many world countries are regularly and promptly reevaluated (in the deposits that are being developed, such reevaluation is, as a rule, annual).

2. In the raw-material market, the demand–supply balance in the mid-term and long-term perspective will depend on the availability of raw material for mining or the mining capacity, as well as on the demand for those materials. The mining capacity depends on two major factors:

- the potential of the facilities now in operation, i.e., over what period their raw-material base can maintain the required level of mining;
- the potential of the deposits that are currently being prepared for development–what will be the effect of their commissioning on raw-material supply.

Let us consider a demonstrative example. The analysis of the part of tungsten base in the form of raw material that is being developed now, suggests that after 2020 the volume of mining from the deposits now under development may decrease smoothly and slowly because of their gradual exhaustion. However, as early as 2017–2018, some tungsten mines can be commissioned, in which case, their output will both compensate for the exhausted reserves and ensure a considerable increase in the production volume. On the other hand, no prerequisites have been found for an appropriate increase in tungsten consumption. This is likely to lead to excessive tungsten production, hence a drop in prices. The situation is essentially different in the case of raw material available for the tin industry. The deposits now being prepared for development cannot compensate for the decrease in the reserves ready for development, to say nothing about an increase in raw-material output to meet the increasing demand for this metal, thus creating prerequisites for an increase in prices. Thus, we have essentially different conditions for the formation of market situation for those two metals, and, accordingly, the further development of the appropriate raw-material sectors.

3. Analysis of the factors that influence the development efficiency of SMR in foreign countries shows that, when choosing deposits for commercial development, their geological characteristics (the volume and quality of their ore, the geological–commercial type, etc.) are not key factors. The main criterion in the estimation of a deposit is the comparison of the cost of the raw material it contains and the total expenses required to transform it into a commercial product.

4. Depending on the amount of the ore acceptable for efficient processing, enterprises of different size and lifetime can be created. Of particular interest are small enterprises with a short lifetime (up to 10 years), i.e., the so-called fast-money projects. Advantages of such projects are the relatively small initial capital investments, the possible rapid commissioning, and a short (up to three years) payback time. Such enterprises can be oriented at any raw material. They can be created based on both small and large, though generally low-quality deposits, containing commercial ore in small amounts.

5. Analysis of the economic–geographic conditions under which mining projects are being developed has shown that of critical importance in the assessment of their development perspective are the availability and the state of their transport infrastructure. Two key options can be identified:

- The project is being implemented in areas with developed road network of any level, which requires only a minor modernization if any. In foreign countries (including those with relatively poor economic development), such situation is most common. Only short approach roads, leading immediately to the facility, are to be constructed.
- The deposit is being developed in areas with poorly developed road network of any level. Roads with considerable lengths are to be constructed to approach the facility
- By its effect on the perspective of deposit development, the former option is neutral, while the latter is critical. The development of deposits in areas with poor transport infrastructure is promising when its base and conditions allow
- the creation of a high-output long-living enterprise, for which the construction of a transportation corridor is economically justified,
- the joint development of a number of nearby deposits, including those of different types of mineral resources,
- the construction of a facility that can be operated autonomously.

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A MINERALOGICAL AND GEOCHEMICAL STUDY OF THE ZONE OF LIMESTONE PYRITIZATION AT THE PAN'SHINSKOE DEPOSIT, MOSCOW OBLAST

[1]Galushkin A.I., [2]Ivanov V.M.
[3]Yashunsky Yu. V., Research supervisor
[1]alexgal@mail.ru, [2]bankir00115@yandex.ru, Ordzhonikidze Russian State Geological Prospecting University (MGRI-RSGPU), Moscow, Russia; [3]yryashunsky@gmail.com, Aerogeologiya Scientific and Production Enterprise, Moscow, Russia

A zone of pyritization of Middle Carboniferous limestones was studied in the course of educational geological practice at the Pan'shinskoe Deposit in Kolomenskii raion, Moscow oblast. The deposit is being developed to produce raw cement. A quarry strips limestones and dolomites of the peskovskaya stratum, myachkovskii horizon, moskovskii stage, Middle Carboniferous. Those deposits are overlain by clays of Callovian stage, Upper Jurassic.

Fine-grain limestone with numerous boring mollusks lies in the roof of carboniferous rocks. They are underlain by coarse- and medium-grain organogenic–detrital limestones. The fine-grain limestone disappears in some areas, where Jurassic clay is underlain by coarse- and medium-grain limestone, also bored by mollusks. A member of interstratified fine-grain greenish-grey low-clay limestones and calcareous greenish-grey clays lies underneath.

Heavily pyritized rocks at the contact between Carboniferous carbonate and Jurassic clay deposits, revealed at the Pan'shinskoe deposit, are unique for the Moskovskaya Synclise. Similar contacts of Carboniferous and Jurassic rocks can be seen at the Nikitskoe, Domodedovskoe, Afanas'evskoe, and Shchurovskoe deposits; however, no pyritized limestone was found here.

Pyritized rocks, represented by coarse- and medium-size organogenic-detrital limestones of black, dark grey, and grey color, lie as interlayers and lenses 0.2–0.5 m in thickness and up to 20–50 m in length in the roof of Carboniferous rock section, in which they have been stripped in the northern part of the quarry. In some areas, limestones in the roof of interlayers and lenses are oxide-brown in color. Macroscopically, pyrite was detected in both dark and axide-brown rocks in the form of fine (1–2 mm) inclusions. Detailed sampling followed by analytical X-ray spectroscopic determinations of Fe_2O_3 and S have shown the black and dark grey rocks to contain, on the average, 3.2%; grey rocks, 0.8%; and oxide-brown rocks, 0.3% of disulfides. No sulfur was recorded in the rock immediately underlying the lenses and interlayers.

Combined polished sections, made of rocks with different petrographic composition and color, were found to contain the following authigenic minerals: calcite, pyrite, white iron pyrite, iron hydroxides (judging by its color, it is likely pyrite), and chalcedony. The pyrite, which is far in excess of white iron pyrite, is represented by cryptocrystalline inclusions, sometimes, in the form of framboidal aggregates.

Stage analysis of the mineral-formation series at this phase of study established the following mineralogical–geochemical zones: zone of unaffected rocks, pyritization zone, oxidation zone, repyritization zone.

Studying the polished sections established that the disulfide mineralization is represented by pyrite alone, sometimes, in the form of framboidal aggregates. In black and dark gray limestones, pyrite partially replaces organogenic detritus, mostly, echinoderms fragments. Those fragments show very intense regeneration of calcite with fringes of the newly formed carbonate with automorphic faceting almost completely fill the pore space and form basal cement, making the rock extremely strong.

In oxide-brown limestone, pyrite in organogenic detritus is partially or completely replaced by iron hydroxides, while idiomorphic regeneration fringes of calcite are overgrown by a new pyrite generation showing no oxidation signs.

Stage analysis of mineral formation series shows the pyritization of limestones in the roof of Carboniferous deposits to have include two stages, separated by a stage of rock oxidation.

The development of the Pan'shinskoe deposit (which is known in the paleontological literature as the Peski location) showed the limestones of the peskovskaya stratum to contain five karst funnels, filled by sad-clay deposits of Bathonian–Bajocian time, Middle Jurassic, containing bone remains of fishes, amphibian, reptiles, and mammals, as well as seeds, leaf fragments, and the woody tissue of fern and gymnosperms [1]. These finding show that the climate during the Middle Jurassic was warm and subtropic. The presence of annual rings in wood remains and leaf fragments of foliage plants suggests the seasonal climate, though the analysis of the width of annual rings shows the seasonal character of the climate to be due to drought periods rather than cooling [3]. Such conditions were favorable for the formation of bogs with considerable accumulation of plant remains in depressions of Paleozoic paleorelief. The sedimentogenic waters of such bogs were ultra-acid and highly reducing with high concentration of dissolved Fe(II) [2] and sulfur, resulting from sulfate reduction. Penetrating into underlying limestones, those solutions caused redistribution (regeneration) of calcite, while their neutralization led to pyrite precipitation. During periods of droughts and disappearance of bogs, oxygen-containing waters could penetrate into pyritized rocks, resulting in their oxidation, while when the climate became humid, the territory will become boggy again and new pyrite generations will appear.

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IS THE GEOLOGICAL TIME THE NEWTON'S TIME OR EINSTEIN'S TIME?

Sadovnikov G.N.
sadovnikov.gennady@yandex.ru, Russian State Geological-Prospecting University, Moscow, Russia

> "…we were trained to determine the synchronism of deposits by presence of one and the same … guide fossils … But … in the nature … we find different fossils in the truly synchronous deposits ... It is very important at first to find out natural change facies and theyr bentos in space and in time, and only after this to correlate deposits reliable ..."
>
> R.F. Hecker

These words were addressed not to schoolboys or students, but to participants of session of the Paleontological Society. Now they are not doubtful for somebody. But only as to local stratigraphic scales. The Global stratigraphic scale is based on the Newton's conception of time. And its units – chronozones – are based on the guide fossils, that almost always belong to extremely stenofacial groups. Einstein's notion, that every system has its own time, do not spread for ecosystems. It is considered, that relativity of time is concept for physicists and philosophers.

To a marked degree it is connected with idea, that paradoxes of the theory of a relativity display only on the near-light speeds. And they are not peculiar to geological processes.

Meanwhile speed of light is only maximal speed of signal. If speed of signal is lower – paradoxes will be place by lower "near- signal" speeds. Biostratigraphy is based on processes of organisms setting that are more slowly. Therefore placing of time-boudaries etalons according to alone stenofacial group is not quite correct.

Only possibility – to build ecostratigraphical scales of various range – from ecozonal to paleobiosphaeric ones. N.I. Andrusov began this building. R.F. Hecker went on it shining. A.A. Borisiak, Ju.A. Zhemchuzhnikov, V.V. Menner have called paleozoologists to it. Last time author has published some similar articles for non-marine deposits on Carboniferous, Permian, Triassic and Jurassic of North and Central Eurasia.

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OPHIOLITIC AND ECLOGITIC COMPLEXES AND SUBCONTINENTAL LITHOSPHERIC MANTLE IN ARCHEAN

Mints M.V.
michael-mints@yandex.ru, Geological Institute, RAS, Moscow, Russia

To answer a question concerning reconstruction of geodynamic settings and processes in the Archean Earth's history, special importance belongs to geological evidence proper for such geodynamic settings typical of the plate-tectonic model as ophiolites (fragments of the oceanic lithosphere formed in mid-ocean ridges, backarc and forearc basins) and subduction-related eclogitic complexes. The mantle xenoliths from lithospheric keels of Archean continents also bear helpful information in this respect.

The Isua greenstone belt, Greenland as the Earth's oldest ophiolite complex. Two rock complexes differing in geochemistry are distinguished in the fragmented ophiolitic section: (1) undifferentiated amphibolites (UA) that retain characteristic attributes of the typical Penrose-type ophiolitic section: pillow lavas and parallel dikes corresponding to N-MORB in chemistry and (2) Garbenschiefer amphibolites (GA), which exemplify metavolcanics and volcaniclastic rocks corresponding to island-arc tholeiites and boninites in composition. Rocks of the second type are characteristic of immature island arcs. The U–Pb, Pb/Pb, and Sm–Nd ages of this ophiolitic section are 3.80–3.70 Ga (Eoarchean). According to the model proposed by Furnes et al. [2007, 2009], the UA protoliths largely are primary and fractionated mafic igneous rocks formed as a result of spreading in the forearc suprasubduction zone, whereas GA protoliths were formed at a later stage due to melting of the depleted mantle hydrated and reworked above subduction zone. In general, the features of the Isua ophiolitic complex indicate that spreading operated as early as Eoarchean.

The Meso- to Neoarchean Belomorian eclogitic province [Mints et al., 2010, 2014; Dokukina et al., 2012] is structurally related to the Central Belomorian greenstone belt (suture zone) and comprises the subduction-related Salma eclogitic association and the Gridino complex of eclogitized mafic dikes localized in tonalite–trondhjemite–granodiorite (TTG) gneisses. The protolith of the Salma eclogites is a layered complex of alternating gabbro, Fe–Ti gabbro, and troctolites formed 2.9 Ga ago in the slow-spreading ridge similar to the contemporary Southwestern Indian Ridge. Plunging of the oceanic complex into subduction zone and eclogite-facies metamorphism took place from ~2.87 to ~2.82 Ga. The injection of mafic magma into the crust of active margin resulted in formation of the Gridino dike swarm was directly related to the plunging of spreading ridge into subduction zone ~2.87 Ga ago. As a result of detachment of the active margin crust 2.87–2.82 Ga ago, its lower part was also involved in subduction. In the course of collision that followed closure of the ocean 2.82–2.78 Ga ago, the subducted crust underwent high-pressure metamorphism. This event was expressed most strikingly and distinctly in mafic dikes nonuniformely transformed into eclogites. The collisional events gave rise to amalgamation of the Kola and Karelian cratons into a common continental mass. The discovery and study of the Belomorian eclogitic province have provided convincing evidence for real subduction, at least, since Mesoarchean.

The sucontinental lithospheric mantle (SCLM) in Archean. The extensive information on composition, structure, and age of the SCLM has been obtained from the study of deep mantle nodules (xenoliths), including diamond-bearing varieties, which were entrained by kimberlitic and lamproitic pipes. The diamond-bearing harzburgites and eclogites are approximately equal in abundance as host rocks of economic diamonds mined from the Kaapvaal, Siberian, and Slave cratons. Formation of the diamondiferous lithosphere is related to the two different processes.

(1) Harzburgite composed of high-Mg olivine and orthopyroxene represents a solid residue left after partial melting of mantle as a result of thermal impact of anomalously hot mantle plume.

A relatively low density of high-Mg lithospheric matter ensures formation of stable lithospheric roots at the base of the Archean continental domains. The subsequent plume effects facilitated strengthening of the lithospheric root [Arndt et al., 2009]. High pressure and relatively low temperature at the base of root corresponded to the diamond-facies conditions. The oldest inclusions of minerals pertaining to the peridodite assemblage are dated back to 3.52–3,20 Ga [Gurney et al., 2010].

(2) The Re–Os isotopic systematics of sulfide inclusions incorporated into diamonds assumes that harzburgite has been modified as a result of percolation of C–H–O–S fluids generated in the Archean subduction zones.

The formation of Archean eclogitic diamonds began later, ~2.9 Ga ago and most likely was directly related to subduction of the Archean oceanic crust. The parameters of Re–Os isotopic system of sulfide inclusions indicate a significant temporal gap between basaltic protolith formation and its transformation into diamond-bearing eclogite. This gap is explained by a long (10–100 Ma) near-surface residence time of protolith [Gurney et al., 2010].

In summary, it should be stated that spreading and subduction, the most important processes of the global plate-tectonic model, started to operate as early as Archean. This has been testified by characteristic geological objects dated back to 3.8 Ga (spreading) and 2.9 Ga (subduction). At the same time, the initial stage of the lithospheric keel formation beneath continents was related to mantle-plume activity ~3.5 Ga ago. Evidence for Archean mantle-plume events is out of scope of this communication.

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POLYPHASE DEFORMATION HISTORY OF THE EASTERN DESERT TECTONIC TERRANE IN NORTHEASTERN AFRICA

[1]Zakaria Hamimi, [1]Basem Zoheir, [3]Mohamed Hassan Younis
[1]Geology Department, Faculty of Science, Banha University, Egypt; [2]Geology Department, Faculty of Science, Aswan University, Egypt

A general agreement is established that rifting of the Red Sea since the Oligocene and younger times led to uplifting and exhumation of the Neoproterozoic Arabian–Nubian Shield (ANS). The ANS comprises a college of tectonic terranes separated along ophiolites-decorated maga shears, and is regarded to represent the northern extension of the East African Orogen (EAO). The ANS experienced final accretion to the Saharan Metacraton in the west concurrent with Gondwana assembly through progressive oblique convergence of East- and West-Gondwanalands. The Eastern Desert Terrane (EDT), the northwestern part of the ANS, has experienced a polyphase deformation history involving three successive episodes (D_1, D_2 and D_3), where folding, thrusting and shearing are geometrically- and kinematically- related. In this study, these episodes and related geometric and kinematic relationships are envisaged for a clear understand of the evolution of this part of the ANS. In the Southern EDT, fold-thrust belts prevail and thrusts are first-order kinematic later overprinted by map-scale transpression. Fold-related faults are dominant in the central EDT, and are commonly associated with pull-apart basins linked to Najd System. In the northern EDT, faults and joint systems are dominant, and thrusts where observed are attenuated as most of the sector is masked by younger granitoid intrusions. The major structures in the south are manifested by accretion-induced sutures developed at *ca.* 750-720 Ma, while pull apart basins in the central sector of the EDT are related to the 640-580 Ma Najd System. Brittle deformation in the northern sector is evidently late. The nature and overprinting relationships between the pervasive structures at all scales in the EDT point towards structural younging towards the north, approaching the peripheries of the EDT. We assume that juvenile crust was formed in the rifted zones and surrounding the ANS and the EDT is a good example.

S-II

SEDIMENTARY BASINS AND COAL, OIL AND GAS PROBLEMS

THE ROLE AND IMPORTANCE OF THE COEFFICIENT OF LEIFMAN-VASSOEVICH IN GEOLOGY OF COAL

Ryabinkin S.V.
Ryabinkin@geo.komisc.ru, Institute of Geology of Komi SC UB RAS, Syktyvkar, Russia

One way to study the structure and process of coal formation is grafostatistichesky method which is based on statistical summaries and associated with plots of atomic hydrogen / carbon and oxygen / carbon ratio. At a certain combination of these relations, can usually be found in the course of various nuances formation reactions (and conversion!) peat, coal and anthracite. The chemical properties of peat, anthracite coal or more precisely determined by atomic ratio hydrogen / carbon and oxygen / carbon weight content instead of these elements in weight percent.

Van Krevelen diagram [1, 6] is very well suited for the study of problems and issues related to the structure and processes of carburization, oxidation and other processes. It is distinguished by the following advantages:

1. It is a combined scale, where the most characteristic (for woody debris, peat, coal, and anthracite) atomic ratio of hydrogen/carbon and oxygen/carbon.

2. The basic reaction – dehydrogenase, oxidation, hydrogenation, dehydration, decarboxylation is shown by straight lines.

Construction drawing with straight lines can be justified quite easily. So the substance CcHhOq in the process of change is deprived of n molecules of carbon dioxide, the atomic ratio of hydrogen/carbon (y) and the oxygen/carbon (x) change as follows:

$$y = \frac{h}{c-n} \text{ and } x = \frac{q-2n}{c-n}.$$

If we eliminate n, then we obtain: $y = \frac{2h}{2c-q} - \frac{h}{2c-q}x$ From this expression we can easily get that if y=0, x=2, scale decarboxylation is represented by a straight line connecting the initial substance with a point having coordinates y=0 and x=2, that is, a composition of carbon.

If you do a similar operation with methane, the destruction of methane can be represented by straight lines:

$y = \frac{h-4c}{q}x + 4$, that is, straight lines passing through the point, reflecting the composition of the original plant residues, peat, coal or anthracite and methane (y = 4, x = 0).

Water loss is also represented by straight lines according to the formula $y = 2x + (h - 2q)/c$, that is, lines with slope equal to 2.

Thus, all the main oxidation reaction represented by the horizontal straight lines, and the reaction the addition of a hydrogen – vertical straight lines.

Now we will look at how changes in the atomic coordinates of hydrogen/carbon and oxygen/carbon lines of equal values of methane, carbon dioxide and water. In accordance with the analysis of [4] we get (for carbon dioxide or hydrocarbon gas) is also a straight line, directly coinciding with the equation of water loss, but with different indicators of decline.

One of the best advantages of [7], it is seen that it uglification presented in the form of marks with the indicators of the reflectance of vitrinite. If it is to impose gravatational chart, we get a very unique chart that are not listed as requirements for the paper emphasises that the materials should be submitted no graphics or pictures.

Even more intriguing was to replace the atomic ratio of oxygen/carbon ratio of Leifman-Vassoevich (H-2O)/C, (expressed also in the nuclear relations) [3]. This circumstance is specially indicated – "... the author proposed new chart atomic ratio of hydrogen – H/C – (H – 2O)/C are used to describe processes of formation and evolution maceralov coals ..." and " ... despite a conventional parameter (H – 2O)/C and its calculation, the proposed chart H/C – (H – 2O)/C very informative for comparative analysis of processes of formation and evolution maceralov coal ..." [3, page 9 and page 16].

The more defined it is shown in [6, page 52], " ... we can conclude that graphostatistical analysis is quite intuitive method, which to trace the course of the basic chemical reactions in the study of a wide range of coals to study the processes taking place during pyrolysis, hydrogenation, and to assess the conditions of heating, the phase oxidation...".

But that not all, as shown in [2, page 118] "... metamorphization organic matter and the formation of hydrocarbon fluids should be considered as two sides of a single process...".

We come to understand that there is a single natural process peat – or turn into coal, which conventionally would stand out as two of the process, dia – and catagenesis of coal organic matter on the one hand, and inextricably linked to the process of removal of fluid from the other side.

The result is quite clear evidence that " ... the existence of the field inversion methane and carbon dioxide GGP S coal (which is undergoing profound changes in the composition of volatile products of coalification – mainly carbon dioxide composition changes significantly methane) may explain the particularly acute in marked contradiction to the stage of conglomerating coals because thermobaric conditions of coalification at the time of inversion of the indicators of a loss of methane and carbon dioxide, immediately preceding the beginning of the intense generation of methane S coals, are not yet sufficiently intense for the conversion of aromatic clusters...." [5, page 389].

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STRUCTURAL AND FORMING FEATURES OF SALT TIRE OF OIL AND GAS FIELDS. DEPOSITION IN THE HALOGENIC BASINS

Nickolay Makarov
n91mak@yandex.ru, Lomonosov Moscow State University, Moscow, Russia

For a successful search for oil and gas, first of all, the construction of reliable geological models is necessary. When using sedimentary modeling based on a retrospective analysis of the forming conditions of potential reservoirs and tires should take into account the specific of forming and transforming of geological bodies, as well as their interaction with each other during the geological evolution.

The presence of salt strata is the most favorable factor for the safety of oil and a gas deposit, as salt is the best impermeable seal. Currently, prospects of searching deposits at great depths are frequently discussed; there the tire can effectively be mainly salts because of their specific physical properties. According to [Talbot and Jakson, 1991] There are a number of fields and basins controlled by salt tires of the regional and local level. The largest of these are the Gulf of Mexico basins, the Arabian Peninsula basins, and others.

In addition the presence of salt strata cross-section allows us with more detailed researches to complement and enhance the existing geological model, knowing the specifics of the salts forming. So the salt-bearing section is an indicator of aridity or, at least, semi-aridity of climate, which provides us insight of an idea of climatic conditions for paleoclimatic reconstructions that indicates to the paleogeographic type of reservoir, its depth and its isolation degree from the World's Ocean. In addition, different composition salt-bearing stratas allow using power analysis during paleotectonic and paleogeomorphic analysis more correctly. Also, the salt is a good conductor of heat, causing an increase of thermal maturity of rocks above the salt structure and cooling of subsalt. For example, in the Gulf of Mexico, pre- and early Tertiary diapirs may have slowed the subsalt source rock maturing [Jackson and Talbot, 1991].

Laws of salt deposition from solution depend upon its composition, the concentration of solute and water temperature. The sequence of the salt strata mineral deposition as follows: 1) carbonate (carbonates of Ca and Mg); 2) sulphate (gypsum, anhydrite); 3) chloride, leading to massive deposition of halite; 4) potash-magnesia salt with kieserite, carnallite, polyhalite deposition [Schmalz, 1972].

The Earth geological history divides into several eras of grand salt accumulation: Early Cambrian, the second half of the early – late Permian, Late Triassic, Late Jurassic – Early Cretaceous, Middle – Late Devonian and Miocene (to a lesser extent) It is noted that these eras coincide with the global glaciations eras and recession of level of the World ocean. At that time the pronounced climate contrast occurred, climatic zoning appeared more apparently and arid zones clearly separated, where the salt aggregation occurred. Mesozoic salt sedimentation, dated to the era of global warming is due to the somewhat anomalous and, apparently, other reasons [Kuznetsov, 2007].

Present evaporites are generalized mainly in the subtropical zone. They are located on elevated equatorial plateaus and in arctic deserts; evaporites are also formed in the "rain shadow" zones of high ridges. Controlling Factor of salt strata forming is the balance between the rates of water flow and evaporation.

It should be noted that in a completely isolated reservoir relatively thin layer of salt accumulates. Whereas at semi-insulated reservoir intense evaporation leads to a decrease of the sea level and forming of the inclined water surface, deviating from the Geoid. This defines a constant inflow of ocean waters. The unidirectional flow, which supplies the necessary salts in a basin, occurs.

There are several environmental types of modern salt accumulation currently divided: 1) marine water in the hot arid climate zones that have difficult exchange conditions or periodically interrupted connection with the World Ocean (the Red Sea, the Dead Sea); 2) Periodically salty lagoons (Crimean peninsula Lima); 3) lake-continental stagnant basins (Great Salt Lake in the United States, Lake. Balkhash); 4) Sebkhas or shotts are flat depressions at the arid desert areas at the littoral and mainly supralittoral area occupied by salinizated marshes or shallow, drying up marshes (the Arabian Peninsula).

Two main types of basins forming the various sections of salt deposits can be mentioned in the geological history. The first type is flat semi-isolated shallow waters, where the sedimentation basin has a periodic connection with the World Ocean, at this time salt accumulation is terminated, clays and carbonates accumulate. The second type is the deep sea basins which have hindered water exchange with the World Ocean, accumulating homogeneous salt deposits. Nowadays there are no such sedimentation basins.

After the salt deposits burial salt diapirism begins. This is due to the salt incompressibility and ductility. Modern studies of this phenomenon is produced by creating a mathematical and physical models. There are several stages of development of salt diapirism released. At the initial stage there is a salt pillow, inside which there are convective motions. Then at some areas occurs breaking through overburden, laid deflections. Further there is a mushroom-shaped diapir top extension which can later reach the surface, and in the basins at deflection salt thinners, until the complete disappearance.

There is no consensus on the mechanism of forming of salt diapirs . This issue is still under discussion. Thus, according to different theories associated with the movement of salt tectonic load, both vertical and horizontal, with the gravitational buoyancy of salts, related to the difference in densities of salt and overburden. Also the salts tendency to align an energy level controlled by temperature and pressure when the salt-bearing layer flows from maximum energy level area in the direction where the level is minimum ,actually from the centre to the periphery of the basin. This is confirmed by the fact that due to the directional movement bending the top of diapir occurs in the direction opposite to the motion directed to the hypocenter of halmeic basin occurs.

Due to the complexity of the interpretation of seismic sections data complicated with salt tectonics is necessary to create a complete model of oil and gas fields salt tires, both at the regional and local level. It is also necessary to take into account the conditions of forming the evaporite sequences , knowledge of accumulation and further transformation of which may allow to supply the existing geological model and identify new promising drilling object.

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GAS BEARING CAPACITY IN ANTHRACITE QINSHUI COAL BASIN (CHINA)

Makarova E.Y., Din Cheng, Shen Zheng
lenamakarova87@yandex.ru, MSU Lomonosov, Moscow, Russia

Qinshui Basin is located in the center of northern China, in the territory of the Province of Shansi. The total area of coal-bearing strata is 150 thousand km^2. The basin is presented by several separate fields of even-aged coal-bearing strata. Now Qinshui Basin is considered from the point of view of possibility of production of coalbed methane, resources of coalbed methane are estimated in 4.0737Ч10^{12}m^3 (Ji Tao, 2007).

Coal-bearing deposits of the Carboniferous and Permian have a thickness of about 900m, divided into two formations: Taiyuan (C_3ty) and Shanxi (P_1sh), contain 16 coal beds and sheds (2-7 commercial beds), are represented by rhythmic alternation of sandstones, siltstones, shales with coal seams. The deposits of Taiyuan formation of limestones are present, confined mostly to the roof of coal seams. Qinshui Basin has a synclinorial structure NNE continuaion. The angles of incidence on the wings of the structures are about 15-30^0, in the central part of the basin dominated flat dip bedding. The faults are located in the sides of the basin.

Coal beds №3 formation Shanxi (3.8-8m) and №15 formation Taiyuan (1-7.7m) have a workable. These layers are considered the most promising for the production of methane. At the top of the layer 15 lies fissured water-saturated limestone, layer 3 hydrogeologically isolated, at the top of the layer 3 located impermeable mudstone.

Mid-ash coal, a sulfur content of up to 5% in subjacent beds. Coal is humic, main microcomponent – vitrinite (88-92%). High coal rank, from meager coal to the north and west of the basin up to anthracite in the central and southern parts. Vitrinite reflectance (Ro) has a value greater than 3.5, anisotropy of the vitrinite is present.

The coal beds Qinshui Basin are gas-bearing (methane and its homologs seldom). The highest content of gas observed in structurally deeper part of the basin. In the southeastern part of the basin methane content in the coal reaches 10-37 m^3/t (more frequently at most 24 m^3/t), here conducted research on the preparation of coalbed methane production. Gas-bearing capacity of the reservoir №.15 higher than the reservoir №.3. Gas saturation it is 56-100% usually below 80% (Zhang et al., 2000). Coal adsorbing capacity is high. Gas presence semianthracite and anthracite is (Langmuir) about 30-57 m^3/t, reservoir pressure is (Langmuir) 1,91–3,47 MPa (Zhang et al., 2000).

To study the cavitation and porosity were sampled coal seams of 3 and 15 from drilll-hole cores southern areas, as well as directly from the mines located in the extreme southeastern part of the basin at depths of up to 300m. A study conducted by various methods described in the literature for similar studies.

When macrodescription coals were built distribution model cracks. Cleavage of coal seam 3 is not expressed, coal is solid, homogeneous. In the coal bed 15 is celebrated cleavage endogenous and exogenous. Cracks are located in three mutually perpendicular directions, filled with calcite. The distance between the cracks of cleavage in the most developed system (perpendicular to bedding) is 9-12mm. Layer by layer fracture coal timed to semidull differences, due to the presence of mineral impurities.

Microdescriptions coal produced an increase in the polished sections 10, 20 and 25. Cracks were found in both the samples produced their count. We have identified three types of fractures: Type A – crack width > 10 mm; Type B – crack width 1-10mkm; Type C – crack width < 1 mm. In Qinshui County coal basin is dominated by fine cracks (Type C), but there are also larger cracks (Types A and B).

Samples of coal basin Qinshui 3 cm were investigated using X-ray microcomputed tomography (microtomograph SkyScan-1172). The sample of bed 3 in the pictures seen some short cracks filled with mineral matter (perhaps siderite). We noted the uneven distribution of cracks, they have curved shape, often represent the lens. Cracks have a width of 80 to 240 microns. In the study of the spatial distribution of cracks in the sample we were clearly visible unrelated separate rounded lenticular calf mineral matter. The void space in this study sample was not detected.

In the study sample seam 15 we have identified several systems cracks filled with mineral material having characteristics similar to calcite. Cracks have an uneven distribution, they have a width of from 30 to 150 microns, extend through the entire sample. Well seen three mutually perpendicular fracture systems. Void space in this study sample also revealed in connection with the performance of mineral interconnected cracks.

A study was conducted coal samples by standard mercury porosimetry SY / T5346-2005, it showed a significant difference in the saturation of these two samples. Sample of the bed 3 has the void of 1 to 0.016 microns, and the pores predominate 0.1 micron and more. Sample of the bed 15 contains voids communicating with sizes from 40 to 0,016 microns. Their distribution in the sample is approximately uniform. This distribution pattern of voids in the sample of the bed 15 suggests the involvement of cracks identified in other studies, and the presence of small pores, associated perhaps with coal organic matter.

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ANALYSIS OF METHANE EMISSION FROM COAL MINE VENTILATION FLOW AND PROSPECTS IN PRODUCTION

Kobylkin Sergey S., Petrova Ksenia I.
sergey@kobylkin.ru, Department of Mine Aerology, Safety and Rescue, Mining Institute, National University of Science and Technology "MISIS" (MISIS)

The problem of climate change, the danger of global and regional effects remain one of the most discussed topics in the world. The reason for this situation is a greenhouse gas. Unlike conventional pollutants CO_2 and other greenhouse gases do not have a direct negative impact on humans and ecosystems. The main greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and others. Methane – the second most important greenhouse gas, regulated by the Kyoto Protocol.

Under the Kyoto Protocol committed themselves, to reduce GHG by 5.2% compared to urovnem1990, the following industrialized countries:

- The EU should cut emissions by 8%;
- USA – 7%;
- Japan and Canada – 6%;
- The countries of Eastern Europe and the Baltic States – an average of 8%;
- Russia and Ukraine – to keep the average annual emissions in 2008-2012 at the 1990 level.

Analysis of greenhouse gas emissions shows that the advantage belongs to CO_2, the source of which is mainly the energy sector – the burning of fossil fuels. In second place is CH_4 (main sources – oil, gas and coal-related, according to the IPCC classification, the energy sector).

Global methane emissions from coal mines ventilation flows according to 2002 [2]:

	Emissions, m^3	General, %
China	$6{,}7\cdot10^9$	38,7
US	$2{,}6\cdot10^9$	15,0
Ukraine	$2{,}2\cdot10^9$	12,7
Russia	$0{,}7\cdot10^9$	4,0
Australia	$0{,}7\cdot10^9$	4,0
Worldwide	$17{,}3\cdot10^9$	25,6

Emissions of coal mine methane can be divided into three types:

- Emissions of coal mine methane through cracks and fissures in the earth's crust (in the form of leaks);
- Emissions of coal bed methane in the composition of air flow (total ventilation system);
- Emissions of coal mine methane from coal beds degasification wells.

One of the main sources of methane emissions to the atmosphere are vent streams from coal mines, as well as uncontrolled leakage due to the aerodynamic surface [1, 4]. In contrast to the second source, the first is easily controlled and has commercial value. Currently, the Russian coal mined 112 mines, according to available data from 67 total amount of air supplied to air is 471 209 m^3/min. Given that all the above in the analysis of the mine from the first category and above, as well as the fact that the rules of safety outgoing air stream should have a concentration of not more than 0.75%, it is possible to calculate that emits 360 m^3/min of methane.

The high calorific value of coal mine gas can be used for domestic heating, for producing electricity and as fuel for motor vehicles (so, for instance, for the residents of Volgograd per person per month for nearly 12 m^3, and the average mine spends more than 100 m^3/min, respectively 1 mine can provide natural gas to the population of a small town 1).

Development of technology of production of methane from coal mines ventilation flows is a priority for the near future. In different countries there are technical means [2, 3], allowing to extract methane from the ventilation air with a low (less than 0.75%) content of the gas. The second important task to improve mine safety and reduce harmful impact on the environment is to provide optimum ventilation modes and methods of management gassing through goaf. This will greatly reduce the leakage of methane jets, as well as reduce the risk of endogenous fires and explosions.

According to experts [5], utilization of coal mine methane will reduce the cost of coal in the mines, depending on the specific conditions of 3-4%. In addition, a positive impact on other indicators of economic activity of coal mining enterprises.

Firstly, to increase the mass of profit per unit of output as increases the difference between the current price and the cost of coal mining or that one and the same, reduce losses, and secondly, reduce costs, the primary fuel (coal) for domestic needs, whereby carbon respectively increase trade resources and their cost of implementation.

Successful implementation of projects for the extraction of coal bed methane will increase the safety of miners coal regions of Russia, create new jobs and provide industrial and domestic needs of the coal regions in the gas.

In the world there are installations allow the use of methane vent stream having a concentration of 0.1 to 0.7%. The principle of operation is based on the flare methane with the production of heat and electricity. The compact, the payback period is from 3 to 6 years [2]. World experience [3] also shows that cost-efficient use of coal mine methane as fuel in thermal power plants, together with coal. But to date in Russia this type of installation do not apply.

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OIL AND GAS BEARING PROSPECTS OF OBJECTS IN KARA SEA SHELF

Saricheva O.V
sov_21041992@mail.ru, Bashkortostan State University, Ufa, Russia

A global increase in demand for hydrocarbons and depletion of its reserves onshore in recent decades intensified exploration activities in seas and oceans which has led to a significant increase in offshore oil and gas extraction. The territory of the Russian shelf contains a quarter of worldwide oil reserves and a half of global gas reserves. The total area of the continental shelf of Russia is more than 6 million km^2, which is 25% of the total shelf area of the world ocean. The Arctic Seas is the leading area with 49% of deposits in Barents, 15% in Pechora, 35% in Kara and less than 1% in the Baltic and Caspian Seas [1]. According to estimates, 85% of potentially recoverable oil, gas and condensate reserves are located in shelves of seas listed above. In the Barents and Kara Seas the major share of hydrocarbon resources is represented by gas, however the bowels of the Pechora Sea are dominated by oil hydrocarbons.

Measured by volume, Russia is the leader in hydrocarbons extraction in the Arctic shelf. Shtokman (Barents Sea shelf), Rusanovskoe, Leningradskoe (Kara Sea shelf), Dolginskoe, Prirazlomnoe (Pechora Sea shelf) are all located in that area.

The development of new fields in Kara Sea shelf is considered to bear the most potential. The leading company for further study and development of these objects is 'Rosneft' NK OAO.

The oil and gas bearing capacity of the region has been studied through drilling, geological, seismic, gravity and magnetic explorations, remote sensing methods and mission oriented research.

Kara Sea is considered to be the Northern extension of the West Siberian oil and gas basin. In the exploration area the sea depth is about 40-350 m, the region has difficult ice conditions with low temperatures in winter -46˚C, and significant depth of ice – 1.2 -1.6 m. Both Jurassic (PR, Pz and T) and Jurassic-Cenozoic sediment structures form part of the Kara sea shelf.

Within the maritime part of West Siberia PNC which is located in the south of Novatek synclines, and consists of Jurassic and Cretaceous sediments of 8 to 14 km are a number of regions which contain oil and gas. Among those are the Baidarata Prinovozemelsky area in the west (oil and gas bearing prospects in Neocomian, Lower-Middle Jurassic and Triassic sediments), the South Kara area in the central part (a lot of potential is considered to lie in the Mesozoic sediments), and three areas in the South: Paykhoi-Taimyr, Yamalo-Gydansky and Yuzhno-Yamalo Messoyahinskaya. The perspectives of all three relate to the Mesozoic deposits [2].

The structure of the sedimentary section consists of two structural-formational complexes. The upper (slab) is represented by terrigenous Jurassic-Cretaceous deposits; the lower (rift) – by Triassic volcanogenic terrigenous deposits. The deposits of the South Kara basin tend to be in the central part. According to the results of geophysical studies, anticlinal traps developed over horst uplifts and are contoured by narrow and deep rift structures [3]. Common to the marine part of the West Siberian oil and gas region is the formation of Upper Jurassic Lower Cretaceous oil and gas Domanicoid column type. These are carbonate-siliceous-argillaceous strata of Bazhenov Formation of the north of Western Siberia and the south Kara sea shelf [4].

According to new data, information on oil and gas in the oil and gas province of Kara is gathered with the aid of 2D seismic surveying. In particular on Prinovozemelsky sites that are in operation at the moment and are considered to have a lot of potential. Further study of Prinovozemelsky area with the help of 2D and 3D surveying is planned to take place from 2012 to 2016.

Estimated recoverable resources of Eastern Prinovozemelsky sites of Kara Sea are as follows: section 1 – 3.33 billion tons of oil and 3.317 billion.m3 of gas; section 2 -1.82 billion tons of oil and 2.733 billion.m3 of gas; section 3 -1.118 billion tons of oil and 8.54 billion m3 of gas.

In 2014 Rosneft has completed its drilling operations of 'University-1' well. As a result of that, oil was discovered in the licensed area called Eastern Prinovozemelsky-1 in Kara sea and another oil and gas field called ‘Pobeda’ with the cumulative recoverable petroleum reserves of 130 million tons and gas reserves of 499.2 billion m^3. The gas reserves were found in the Cretaceous sediments of Cenomanian and Aptian-Albian deposits, and oil reserves in Jurassic deposits. According to research on the physico-chemical properties and composition of oil from the ’University-1" well, it is ultralight (density 808-814 kg/m3), sweet (less than 0.02 % sulfur content), is characterized by high yield of light fractions- 60-70% and low tar content -1,5% which indicates that its quality is better than well-known brands such as Brent and Urals.

Kara maritime oil and gas bearing province, according to preliminary estimates of experts, has the volume of hydrocarbon resources recoverable that should surpass provinces such as the Mexican Gulf, the Brazilian shelf, the Arctic shelf from Alaska and Canada. It is also comparable with the current resource base of Saudi Arabia. Analysis of tectonic structures and conditions of gas accumulation allows us to confidently award a high grade on the oil and gas bearing prospects of all the major uplifts of South Kara sea reservoirs. Identified tectonic shafts and large tectonic uplifts determine the possibility of discovery of significant reserves of oil and gas deposits in the South Kara Sea shelf [5].

Further development of the Kara Sea shelf is expected to take place in several stages. The objective of the first phase is to obtain missing data on the deepest structures in the region in order to complete the earth's tectonic zoning and geological analysis. In order to address this challenge the completion of the study of deep crustal structure, common-midpoint method and correlation refraction method together with geothermometric study have to be done. The second phase of regional work (the forecast of oil and gas bearing) imply drilling of support-parametric wells.

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THE BLOWERS AS ONE OF THE CRITERIA CHARACTERIZING GAS POTENTIAL OF THE DONBASS COAL ROCK MASSIFS: DONETSK-MAKEYEVKA COALMINE DISTRICT CASE STUDY

Vergelska N.V.
vnata09@ meta.ua, Institute of Geological Sciences, NAS Ukraine, Kiev, Ukraine

Long-term studies of post-sedimentary processes in the coal rock massifs and their impact onto formation of hydrocarbon sources conducted by the Coal Geology Department at the IGS NAS Ukraine testify the paragenetic relationships between various deep processes from magmatic intrusions to hydrocarbon-hydrogen gas-dynamics phenomena that are considered as prospecting criteria for hydrocarbon accumulations [3]. Gas-dynamics phenomena point out on the possibility to predict the depth of endogenous hydrocarbon sources, which are complimenting or dominating for gas accumulations formation in the coal rock massif.

The occurrence and geological settings of coal measures in the Donetsk-Makeyevka district on the flank of Kalmius-Torets depression have stipulated high gas content of coal seams and host rocks, existence of free gas accumulations and elevation of methane gases distribution upper limits towards the surface. In the western part of this district characterized by less disturbed monocline and gently dipping beds the thickness of degassing zone is about 450–500 m. In the central part of this district and its eastern part in particularly characterized by reverse faults and development of secondary closed brachy-anticlines and flexures the upper limit of the methane zone reaches the depth of 80–150 m (Yasinovskaya flexure, Zuevsky dome, Makeyevskaya brachy-syncline, and so on). The coal mines at the particular depth are pertained to the highest danger class because of high methane-bearing and hazardous to gas blowing (suffliard) manifestations [1, 2].

Among 799 gas blowers reported from coal mines in the Donbass, the majority of them (56%) are registered from the Donetsk-Makeyevka coalmine district. High concentration of natural geological blowers (250) is characteristic of that area with subordinate number of production ones (199). For adjacent coalmine districts, namely the Central one in the northwest and Torets one in the east it is fixed drastic reducing of gas blower manifestations (4% and 14.5 %, correspondingly) while in the west in the Krasnoarmeysk district the bowers did not recorded at all [3].

Upon the results of long-term and systematic studies of free gas manifestations and shows in the Donbass coal mines conducted by A.Ya. Bovsunovskiy and M.A. Frolov it is evidenced that blower seeps take place under mining of the same coal seams. For example, 70 % of the blowers are of geological origin and 80% of production one are registered while recovering coal seams from C_2^3 and C_2^5 suites (formations). Sedimentary rocks of these suites are characterized by increased content of coal seams and sandstone beds.

From all studied blowers in the basin 42% of them are attributed to plicative disturbances and 12 % to plicative deformations with faults. Host rocks contacting majority of coal beds subjected to gas blowing are represented by gas-bearing sandstones and to lesser extent by siltstones and limestones.

The gas blowing manifestations in the Donetsk-Makeyevka district with 17 coal seams under production have a regional character as a rule. Main sources of the blowers are mainly gas-bearing host rocks, which are release free gas during heading of preparatory and permanent workings (stockworks, inclines, crosscuts). This stipulates that only 7% of blowers are related to coals from production headings while the rest 93 % come from top and bottoms of coal seams under making of preparatory and permanent workings of heavy gauge that is much bigger that thickness of a produced coal seam. The highest number of blowers is detected under producing of connivent coal seams of C_2^3 suite (h_7, h_8 and h_{10}); C_2^5 suite (k_4^1 and k_8); C_2^6 suite (l_1); C_2^7 suite (m_3); C_3^1 suite (n_1).

The highest number of the blowers of geological origin is reported from Vostochnaya, Mushketovskaya-Vertikalnaya – № 1, Mushketovksaya-Zaperevalnaya, № 1-1 bis, Zasyadko and Novo-Butovka coal mines. Quantity of the blowers of geological origin per 1 km of mine deepening is sharply increasing with depth from upper margin of the methane gases occurrence down to 600–700 m. Going deeper the number of gas blowers decreases and from depth of 700–800 m the population of blowers is practically preserved unchanged.

The blowers of production origin happen under caving of the roof composed by sandstones or production of connivent coal seams overlaid or underlain by sandstones. Population density of production blowers continues to increase even below 700–800 m depth. Inasmuch as the blowers are attributed to rock micro-bends of 200–350 m size at the base their total number per 1 km of mining is tending to three occurrences that is characteristic of areas with gas-bearing sandstones.

An analysis of spatial distribution of the blowers and their population density has shown that these ones are developed in the coal fields within geologically younger transversal structures of the Donetsk-Makeyevka district, namely Vetkovskaya, Chaykinskaya, Petrovskaya, Kalininskaya, Yasinovsko-Zhdanovskya and other ones. The flexures and brachy-anticlines as well as small brachy-synclines (Makeevskaya and other ones) are complicated by reverse faults. The thrusts in the Donetsk-Makeyevka coalmine district produce porous-fractured types of reservoirs thus improving rock porosity and permeability properties especially in the central part of rock massif.

Conclusions

Spatial distribution of gas blowers defines peculiarities of the Donetsk Makeyevka coalmine district gas potential as follows:

– within the district the blower manifestations in the same coal seams are reported from several coal mines that proves exictence of regional gas saturation;

– many coal mines have opened the beds with blowers happen in different suites that speaks about multistage character of gas saturation;

– blower manifestations are concentrated at the closures or flanks of geologically younger transversal structures complicated by reversal faults;

– secondary porosity in the sandstones caused by roof caving over the working space stipulates additional releasing of gas with intensity higher comparing with the blowers from an undisturbed massif;

– gas accumulations attributed to separated structures can be determined as gas pools drained by coalmine workings.

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POSSIBILITIES OF OIL AND GAS CORE PETROPHYSICAL STUDY BY X-RAY COMPUTED TOMOGRAPHY

Khozyainov M.S., Yakushina O.A.
mkhoz@mail.ru, yak_oa@mail.ru, Dubna International university for Nature, Society and Man, Dubna, Russia

X-ray Computed Tomography, XCT is successfully used in medicine, thus there was a desire to apply this method for inorganic objects study, including rocks, ores and minerals; such researches began still in the late eighties.

XCT is a nondestructive fast physical method that permits to obtain direct visual picture of internal structure without sample preparation, at natural state of ore, breed. XCT combines not disruptiveness, simplicity and efficiency of the analysis, allows to reconstruct 3-D image of natural and technogenious raw materials for internal texture-structure analysis, porosity distribution and phase composition examination of a sample. Presence of minerals with close optical characteristics, fine or poorly crystalline, X-ray amorphous phases isn't restriction of the RT-analysis. XCT combines the X-rays merits with the advantages of computer processing data. Creation of 3D models of an internal structure without destruction of a sample is unconditional advantage of a method. However rocks, ores and minerals appeared difficult object for research by this method. The reasons of it as in the physical nature of the phenomenon (polychromatic radiation is used), designs of devices, and in the genetic nature of mineral substance.

Since 1990th the large foreign oil companies started using a tomography for core scanning as a routine method of density measure, and these researches were conducted mostly on medical CT-units [4]. In Russia early studies of oil and gas core have begun in the same years, for example [1]. Now a number of research laboratories in domestic oil and gas sector is equipped with X-ray CT-units of different brands and series, which are used, mainly, as the instrument of identification of characteristic parts of a for traditional core testing, certification and digital archiving of a core, visualization of not uniformity, porosity, cracking, caving.

Different scientific groups actively conduct XCT research in scope of oil and gas geology and a lithology for definition of petrophysical characteristics of rocks, deposits of oil and gas and modeling of development of fields. Receiving the fullest and representative primary data file about weakening of X-rays substance (rock, core material) has paramount values for studying of hollow space and calculation of petrophysical characteristics for X-ray CT data.

Today the majority of x-ray tomographs allow to carry out certification of a full-size core and sampling for petrophysical researches, such tomograph has to have a working field of 10 mm and more, for these tasks can be used as medical, to their thicket offer, or industrial tomographs, for example RKT, Filin, BT, MARS brands. Full-size core study allow to gain only general idea about heterogeneity of an internal structure and bear is insignificant a few useful information about a pore space and phase structure of a collector because of X-ray tube focal spot big size and low spatial difference, low energy of primary X-ray radiation and, therefore, low contrast (grades of gray), variations of mineral structure and general hollow space.

Today the majority of X-ray CT-units allow to carry out a full-size core study for its sampling for petrophysical researches, such CT-units have 10 and more mm working zone, for these tasks can be used as medical, to their thicket offer, or industrial tomographs, for example RKT, Filin, W, MARS. For definition of qualitative and quantitative petrophysical characteristics. It is necessary to have high spatial resolution, achievable on microtomographs (microfocal x-ray tubes) of different series on samples less than 10 mm in size (micro) and 1 mm (nano-). The working tension of a x-ray tube of 100 ÷225 kV, use the filtered x-ray radiation that reduces the volume of primary data of experiment. As a rule, μCT-units can investigate less than 50 mm diameter samples with declared resolution about 0,2 mm. To achieve micrometers, nanometers spatial diastribution one needs to test samples of centimeter-millimeters size, but data volume of the studied area, that is for their quantitative study of hollow space, like penetration phosphors mercury porometriya methods is lost.

Testing not only general, but opened, closed porosity of collectors according to XCT isn't developed. Quantitative characteristics demands the specialized software combined with the XCT unit. Phase segmentation is in shades gray (on HU scale) and by means of combination of color characteristics with data of electronic microscopy (mapping of minerals), but it may be unambiguous. The problem of scaling isn't solved: how from to XCT data from 1-10 mm (instead of 50-100 mm) to pass to the forecast of porosity jointing of breeds collectors for a well, and for a field. Creation of 3D models is resource-intensive procedure, it demands continuous shooting within 1-3 days and processing of enormous volumes of information which is estimated in hundreds of Gigabits that demands use of special super powerful computers, and can't provide mass character of researches for a set of the statistics of data demanded in geology.

Modeling of oil replacement in core at different PT (pressure, temperature) conditions have to be carried at special cameras of Pressure/Temperature. Now such researches are at the start point.

The X-ray CT method can effectively be used for certification of a core, selection of representative sites of a core for carrying out further detailed researches today. Typical spatial for full-size core is 200 micrometers that isn't enough for detailed quantitative petrophysical researches when spatial permission has to be about 5-10 micrometers.

The problem of scaling of XCT data isn't solved: as from single researches of 50 mm of a core and the more so, 1-10 mm, to pass to the forecast of porosity jointing of a collector. The XCT research technique in relation to a core of oil and gas wells for obtaining authentic quantitative petrophysical characteristics, first of all an assessment of porosity, a jointing, oil recovery (including for collectors of complex structure), in general isn't developed and demands statement of special research works.

Authors defined three main research objectives solved by the RT method:

- quality standard of full-size cores,
- studying of quantitative characteristics at the level of a microstructure and
- modeling of replacement of a fluid at various the *PT*- conditions.

The key role in successful development of X-ray Computed Tomography for oil and gas branch will be played by both improvement of hardware base (XCT-units), and the specialized software combined with the XCT device: i.e. designing of the XCT -units allowing to investigate a full-size core with a diameter of 10 cm and more at spatial permission of micrometers which can be equipped with the special camera for pressure-temperature PT-modeling of reservoir (sheeted) conditions.

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CRASTAL TYPES OF DEEP PLATFORM BASINS AND NATURE OF THEIR FORMATION AND OIL CONTENTS

Pavlenkova N.I.
ninapav@mail.ru, Institute of Physics of the Earth RAS, Moscow, Russia

In the platform regions of Russia the deep seismic studies revealed several large basins to a depth of 15-20 km. They are the Caspian, South Barents, North Barents, South Kara, Pur-Gydansky basins in the Caspian-Barents region and the Lower Angara and Vilyui basins on the Siberian platform.

Crustal structure of these basins is studied in detail by seismic methods [Egorkin, 1991; Morozova et al., 1995; Pavlenkova, 2014; Sakulina et al., 2009]. The common structural features of the all basins are their isometric form with steep slopes. At a depth of about 20 km the basin bottoms are flat and the basement surfaces surface are often represented for almost horizontal seismic boundaries. All basins are also characterized by a reduction of the earth's crust thickness due to the M uplift. But the basins are significantly different in structure of the crust, the average seismic velocities at which vary from 6.2-6.4 to 6.8-7.0 km / s. This means different composition of matter making up the consolidated crust and a different history of the basin formation.

Deep drilling and study of xenoliths in comparison with seismic data allow to distinguish three main layers in the continental crust: the upper granite-gneiss layer with wave velocities 5.8-6.4 km/s, the middle granulite-gneiss layer (6.5-6.7 km/s) and lower granulite-basic layer (6.8-7.0 km/s). That shows the layers to vary in the composition and degree of metamorphism.

The different crustal types of the basins are distinguished by the thicknesses of the main layers [Beloussov, Pavlenkova, 1989]. If in the consolidated crust, all three layers are of approximately equal thickness, this crustal type is called continental. They are the crust of the North Barents and the Lower Angara basins. If in the consolidated crust there is no upper layer, it is called "subcontinental" type (the South Kara, the Pre-Caspian and Vilyui basins). If the consolidated crust represents only the third layer, it is called "suboceanic" type (the South Barents and Pur-Gydansky basins). The last name is conventional, as for the oceanic crust is really typical of third layer seismic velocities, but its composition may be quite different.

There are several models for the formation of the described types of crust. The "sub-oceanic" basins are often associated with rifting processes: a significant stretching of the crust with formation of spreading zones, which are filled with mantle material. Such origin was proposed to the Barents Sea basins extending along the rift zone parallel to the Novaja Zemlya. But seismic studies have shown a fundamentally different structure of the crust of these basins: pure continental type for the North Barents Basin and the "sub-oceanic" type for the South Barents Basin. Both of them have a round form, not typical of rift structures.

More reasonable model for the formation of the platform deep basins is the process of crust "basification", that is the basic matter intrusion into the crust from the mantle and the crust transformation as a result of various processes of metamorphism [Frolova, Burikova, 1997]. In [Artyushkov, 2010] primary importance in the basin formation is given to the lower crust eclogitization, which significantly increases the density of the rocks and thereby causes their depression. The eclogites are characterized by high (mantle) seismic velocity and they explain well the uplift of the Moho under the basins. But these processes are difficult to explain the full destroy of the upper granite-gneiss layer that is not observed under many basins.

An additional processing may proposed for decreasing the upper layer thickness: the changes in the mechanical properties of rocks (eg, plasticity) to great depths and their mobility. The seismic data show that in the Earth's crust at a depth of 10-20 km there are the lower velocity layers, characterized by a high porosity and fluid saturation [Nikolaevsky, Sharov, 1985]. The crustal deformation can move out the week materials from these layers beneath the basins and produce the corresponding reduction in the upper layer thickness. This model can also explain a conservation of the continental crust beneath some basins by reducing the thickness of the weakened layer in the lithosphere a depth of about 100 km [Pavlenkova, 2014].

Analysis of the structural features of deep basins, their forms and structural position gives reason to believe that the processes of their formation have much in common and differ mainly only by the process intensity. In all cases, they provoke influx of the additional material and heat in the crust from great depths, provoking metamorphism of the rocks and phase transitions. Such influxes are possible along the weakened zones of the lithosphere and destruction zones. This explains the location of the deep basins along the margins of platforms and along the major faults. Since the formation of the platform basins occurred over a long geological time, it must be assumed the continued existence of the respective channels of the flows of the energy-intensive deep matter. Such income can provide the deep fluids advection, or advection of the matter saturated with deep fluids. The advection on the long-lived deep channels explains the described above structural features of the basins, for example, their rounded forms and the plane basement surface at great depths.

The fluids advection plays also an important role in the formation of oil and gas fields. It is not only a source of deep oil, the energy and fluid advection are necessary for the formation of the organic oil as well. This assumption is confirmed by the data on the hydrogen degassing of the Earth. Obviously not accidentally the richest Arabian-Barents oil and gas region is located in the zone of the maximum hydrogen degassing [Syvorotkin, 2002].

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RESIDUAL HYDROCARBONS STUDY IN ROCKS OF ULZIIT URANIUM DEPOSIT, MONGOLIA

Lebedev V.S., Ignatov P.A., Grechukhin M.N., Stukalova I.E.
vslebed@yandex.ru, Russian State Geological Exploration University MGRI-RGGRU, Moscow, Russia

Residual hydrocarbons of the new Ulziit hydrogenous uranium deposit localized within Ulziit graben that formed one of the major Late Mesozoic depression in Eastern Gobi region of Mongolia have been studied for the first time.

The deposit is localized in central part of rift-type depression near to peneplained crystalline frame formed by Jurassic granites and granite-diorites with increased radioelements content [1].

The role of tectonic is essential in the process of a coal-bearing basin forming, suitable for deposition conditions and in ore-forming epigenetic processes including deep long-life faults.

Low Cretaceous coal-bearing permeable and semi-permeable deposits are ore-hosting and infill depression. Two litho-genetic associations have been defined in sedimentary succession. The first includes speckled alluvial-proluvial-colluvial-dealluvial sediments and the second – gray-type coal-bearing lacustrine-lake sediments. Deposits of the first type are in general coarse-clasts, poor sorted, formed by boulders, bouldary conglomerates and congloro-breccias, as well as gravelites and arkosic sandstones. They distributed directly along depression margin and compose significant alluvial-fan cone along long-life north-western crosscut fault. Lake-lacustrine and less alluvial-lake limnological deposits of the second type are distributing into sedimentary basin and consist of gray colored conglomerates, sandstones, siltstones enriched by carbonaceous organics, coaly clay, minor brown coal horizons. Generally loaded intergranular space with silty-clay material has been noticed, up to 45% in average. Carbonaceous organics are fine-dispersed in rocks and mainly of sapropel type. The presence of lignite has been defined in the upper part of succession. Spots with pyrite aggregations in carbonaceous organics of gray colored sediments indicate possible presence of hydrogen sulphide in ore-deposition in permeable formation.

Uranium ore has been formed at margin of coal-bearing lake basin, on sharp facial transition boundary from coarse-clast alluvial-proluvial cone deposits. Ore-controlling factor is contrast geochemical and litho-facial variability of sedimentary formation and as a result the ore is localizing at boundary with reduced environments connected to carbonaceous organic accumulations.

Residual hydrocarbons (RH) have been extracted by thermic degassing method of 200^0C temperature in Helium atmosphere from ore-hosted sedimentary rocks, ore and coal samples. Analyses have been performed by gas chromatography method. Grade of hydrocarbons from CH_4 to C_6H_{14} was defined in extracted gases. Results are given in cm^3 on kg of rock or coal (cm^3/kg), composition – in relative % to RH sum.

RH grade in coal of deposit is 6,8 cm^3/kg in average, average grade of CH_4 – 2,7 cm^3/kg, sum (C_2-C_6) – 4,1 cm^3/kg. Unsaturated hydrocarbons have prevalence in heavy hydrocarbons, $(C_2H_6+C_3H_8)/(C_2H_4+C_3H_6)$ ratio is 0,28 on the average. Coal samples have been studied by petrographic parameters, reflectivity of vitrinite (R_0 % 0,25-0,35) as well as RH grade and composition are not different from other brown-coal deposits [2]. Thereby coal-bearing formation of studied deposit consists of brown coal.

RH grade in rocks of deposit has been analyzed in core of deep key borehole. In general RH grade of that section was about 1 cm^3/kg on the average. RH grade is sharply increasing to 1,4-1,6 cm^3/kg while intersecting with uranium mineralization areas. RH grade in intervals without uranium mineralization in general is close to coal RH of deposit – unsaturated hydrocarbons have prevalence in heavy hydrocarbons. That allows us to assume that organics of rocks at studied section's part is in brown-coal stage of transformation.

Two intervals with uranium mineralization have been defined in considerated section – upper at about 70 m depth and lower at 170 m depth. Both intervals are characterized by increased RH grade. However they differ dramatically by hydrocarbons composition.

Sharp increase of saturated hydrocarbons – butane, pentane and hexane was detected at upper level compared to adjacent intervals. At the same time, distribution of unsaturated hydrocarbons remains the same like in RH of coal and parts of section without uranium mineralization. Sharp increase of butylene in RH was detected at the lower level compared to adjacent intervals under the lower grade of saturated hydrocarbons.

Received geochemistry data supports hypothesis of uranium deposit forming in the zone of oxidation front piching-out in exodiagenesis conditions.

Oxidized uranium-containing solutions infiltrated through permeable horizons in coal-bearing deposits containing organics and reduced gases – CH_4, H_2, H_2S and others. Uranium ore has been formed and possibly keeps being transformed under the active microorganism influence. Aerobic bacteria are oxidizing reduced components and the oxygen deficit or its complete absence environments are being formed. As a result semi-anaerobic and anaerobic conditions are created. Redox reactions keep going on in those conditions, uranium is reducing and uranium deposit is being formed. Active gas-forming processes had been taken place at that geochemical barrier under the influence of microorganisms association that is reflected in a higher RH grade at the areas with uranium mineralization.

Established relation of uranium intervals with anomalous rises of RH grade and different distribution of saturated and unsaturated hydrocarbons in the ore mineralized areas have been defined for the first time for hydrogenous uranium deposits of Mongolia, definitely worth of notice and need future analysis.

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S-III

MINERALOGY, PETROGRAPHY AND GEOCHEMISTRY

NEW METAMORPHOGENIC-HYDROTHERMAL GENETIC TYPE OF BADDELEYITE

[1]Spiridonov E.M., [2]Putintseva E.V.
[1]ernstspiridon@gmail.com, MSU, Geological Department, Moscow, Russia
[2]e.putintseva@spbu.ru, SPbSU, Institute of Earth Sciences, SPb, Russia

Baddeleyite, monoclinic ZrO_2, discovered in 1892 by L. Fletcher (Dena at al, 1951), is accessory mineral of SiO_2 unsaturated magmatic and high temperature metasomatic rocks. Baddeleyite is developed in a matrix of alkaline and ultramafic alkaline rocks, carbonatotes and kimberlites (Dana at al, 1951; Bonshtedt-Kupletskaya, 1965; Kukharenko at al, 1965; Dawson, 1980); in Norilsk olivine gabbro-dolerites (Godlevsky, Nadezhdina, 1970), in anortosites, in lunar basalts. Baddeleyite disintegration lamellae in ilmenite are known in olivine gabbro and kimberlites. Grand amounts – million tons of baddeleyite are located in late derivative of carbonatite massifs of Brazil (Franco, Lowenstein, 1948), significant amounts – in kamaphorites of Baltic shield and East-Siberian platform (Borodin at al., 1973), small amounts – in extremely high temperature deep magnesian skarns of Madagascar (Gübelin, Peretti, 1997). Baddeleyite is developed in tektites and impactites (telluric and lunar) as a product of zircon shock destruction (Kleinman, 1969).

New metamorphogenic-hydrothermal genetic type of baddeleyite is established in Kimozero metakimberlites. Kimozero show of diamond-bearing kimberlites is located within Onegozerskaya structure of Karelian craton. The basement of the structure is Vodlozersky block of Early Archean stabilization (Ushkov, 2001; Putintseva at al, 2009). It is one of the most ancient shows of kimberlites, its isotopic age established by different methods varies from 1986±4 to 1742 ±26 MA (Samsonov at al, 2009). The show is flattened lode and a complex of subvertical pipe-shaped bodies, consist of kimberlites, kimberlite breccia and tuff-like rocks. Olivine or phlogopite are predominant, magnesiumchromite and ilmenite are frequent among impregnations in Kimozero kimberlites. In the cementing mass there are abundance of olivine, phlogopite, carbonates, a lot of perovskite (judging by morphology of substitution products), ilmenite, titanomagnetite, apatite; zircon is rare.

Usually Kimozero kimberlites intensively tectonized; kink bands are often developed in phlogopite crystals or phlogopite phenocrysts are crumpled and twisted. The kimberlites as well as enclosing Lyudikovian rocks underwent greenstone regional metamorphism of prehnite-pumpellyite facies and were transformed into metakimberlites. Olivine of kimberlite rocks was replaced by serpentine, predominantly by antigorite with relicts of lizardite. Brucite, rarer talc associates with antigorite. Phlogopite is replaced by clinochlore, chromspinellides – by Cr-bearing clinochlore. Primary Ti-minerals almost totally are replaced by titanite. Abundant actinolite-tremolite is characteristic mineral in Kimozero metakimberlites; it was likely formed because of transformation of olivine and primary calcite substances. It is natural to assume, that metamorphogenic-hydrothermal allanite-(Ce) arised on account of REE abundant in primary calcite of kimberlites (Dawson, 1980). Typical form of allanite-(Ce) – chains of small grains along bedding of chlorite pseudomorphs after phlogopite. Buddeleyite composes small grains of irregular form ca 10 micron in titanite aggregates (Fig.). Boundaries between baddeleyite and titanite are induction surfaces of joint growth. Baddeleyite composition, mass %: ZrO_2 93.70; HfO_2 2.04; TiO_2 0.94; FeO 0.63; SiO_2 2.60; sum 99.91. U, Nb, REE, Sc were not found in baddeleyite from Kimozero metakimberlites unlike baddeleyite from alkaline magmatites and high temperature metasomatites. Associating titanite is also poor in these elements. Possibly described intergrowth of metamorphogenic-hydrothermal baddeleyite and titanite are pseudomorphs after zirconolite, possible reaction: $CaZrTi_2O_7$ (zirconolite) + $Ca(OH)_2$ (p-p) + 2 SiO_2 (p-p) → ZrO_2 (baddeleyite) + 2 $CaTi[O/SiO_4]$ (titanite) + H_2O.

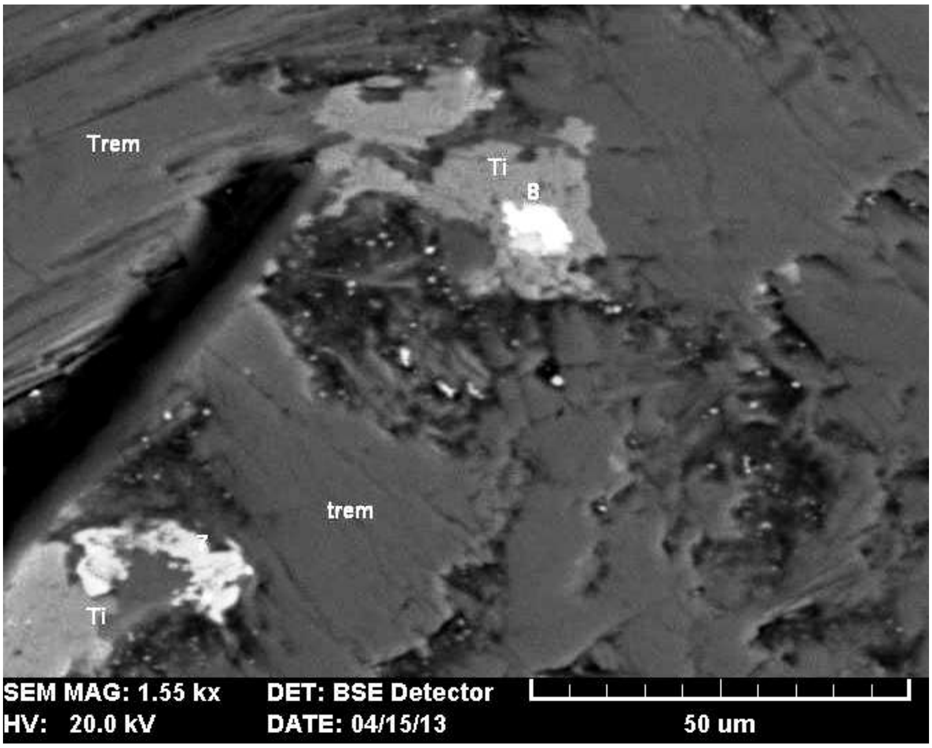

Fig. Kimozero metakimberlites, collection of E.V. Putintseva. Baddeleyite (B, white) and titanite (Ti, light-gray) intergrowth. Matrix – actinolite-tremolite aggregates (Trem). BSE image

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ON THE POSSIBILITY OF USING MICROWAVE RADIATION TO ASSESS THE QUALITY OF CHROMITE ORE

Bakhterev V.V.,
UGV@bk.ru, Yu.P. Bulaschevich Institute of Geophysics, Russian Academy of Sciences Urals Branch, Yekaterinburg, Russia

Microwave radiation is non-ionizing Electromagnetic called out so that heat radiation with frequencies from 300 MHz to 300 GHz. This radiation causes the movement of molecules through the movement of ions and rotating dipole, but does not change in the structure of the molecules [1].

Interaction of microwave radiation with matter may be accompanied by its reflection, absorption and passage through the sample volume without weakening. On the nature of Theroux interaction with microwave radiation materials can be divided into three groups. Conductors, the surface of which fully reflect microwave radiation. The metal is heated, because energy loss in its entirety there. Dielectrics, leaking microwave radiation through its volume practically without changes (these are, for example, polyethylene, fused silica, porcelain, etc.). Finally, dielectrics, when passing through the volume of which is the absorption of microwave radiation, involving, in particular, heating of the samples. Such dielectrics are the most minerals and rocks.

When applying a microwave field the motion of the dipoles (polar molecules or other marginalized groups of atoms) acquires a certain orientation associated with the nature of rum imposed field. At a frequency of 2.45 GHz, the orientation of the dipoles of the molecules and their recuperado significance may occur several billion times in 1 s, which leads to rapid heating of the sample.

Microwave processing has a number of advantages over conventional methods of heating the condensed matter (solids and liquids). It: speed, low inertia heating, lack of contact of the heated body – heater", the uniformity of heating of the sample throughout the volume, the selective heating of the components of the mixture of substances. Thanks to these features, the microwave radiation is of great opportunities for mining applications [2].

Known methods of sorting ore, for example, based on heating by microwave radiation and separating them according to the results of temperature measurement. The degree of heating is higher, the higher the level mipomersen polarization, caused by the movement of free charge carriers on the defective areas of reduced conductivity: intergranular strips, microcracks, fluctuations in the chemical composition. That is, the greater the heterogeneity of the rock, the higher its influence on heating [3].

Currently, the theory of interaction of microwave radiation with dielectrics have not yet reached a stage of development that would allow to predict in advance whether or not be visible absorption field dielectric. Therefore, required extensive research on the effects of microwave radiation on different environments.

The purpose of this work: to identify the relationship between chemical (mineral) composition of chromites ore and efficiency of its interaction (in particular, temperature) with microwave radiation to obtain the operational method of assessing the quality of ore (the content of chromium oxide %).

Research methodology and sample. Samples of chromites ore selected from Artisansage ore (Ural). Ore content of chrome-spinels disseminated and solid. The type of ore composition of chrome-spinels: high chromium, magnesium. In the table for the studied samples are shown the content of chromium oxide on the results of a chemical analysis, and for three samples the results of derivatographic and density. Samples of different mineral composition, the number and content of impurities, moisture content, porosity. Sample 1 – a massive high-chromium magnesium ore weakly metamorfizovannykh (contents serpentine 3.5 %, the density of 4.15 g/cm3). Sample 8 – disseminated ore (content serpentine 42%, the presence of hydroxides, chlorite, carbonate, opal, brucite; fractured; the density of 2.85 g/cm3).

Samples of chromites ore was cut in the shape of a cube with an edge of 0.15 m and heated in a household microwave oven, the heating power 450 W, warm-up time 5 minutes. Heating time was chosen based on experimental data [2]. After heating was off for some time temperature curve, while the sample temperature reached 25 ºC. The temperature of the sample to warm up to 20 ºC.

The results of the research. The heating temperature of the samples associated with the content of chromium oxide in them. Considering the obtained results highlight two points.

First, under the same conditions of experiment samples heated to different temperatures. The lowest temperature acquires sample 1 (49,1 ºC) with the highest content of chrome-spinels (chromium oxide 52,7 %); the highest – sample 9 (145.1 °C) with the lowest (chromium oxide 25,2 %). The heating temperature of the other samples are within this range.

Table. The results of analyses of samples tested

№№	Maximum temperature, the C	Cr_2O_3, %	Weight loss on ignition, %	σ, g/cm3
1	49,1	52,7	1,64	4,15
2	54,8	47,0		
3	60,1	42,1		
4	73,2	38,3		
5	78,5	34,7	3,65	3,12
6	100,3	31,9		
7	120,0	30,1		
8	138,3	29,5	6,03	2,85
9	145,1	25,2	6,13	2,82

Secondly, the decline of the acquired temperature is one law. Examples of the decline of temperature for some samples: T(1)=55,9-7,4 lgt, R^2=0,96; T(5)=94,3 to 15.6 lgt, R^2=0,98; T(8)=161,3-31,4 lgt, R^2=0,99. Here: T is the sample temperature in degrees Celsius; t – time, min. The time of cooling to a temperature of 20 ºC was for samples (minutes): 1–48; 5–73; 8–105.

Conclusion. The results of examination of samples of chromites ore by irradiation with microwaves. Found a link between the quality of the ore and the temperature of the samples. The results, despite the limited number of samples, allow to speak about possibility to use the received information for rapid assessment of the quality chromites ore content of chrome-spinels (chromium oxide).

The results of the fair for high-chromium ores magnesia type. For other types of ores due to their different origin and composition of ore-forming of chrome-spinels can be obtained other dependencies.

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SYNTHETIC ANALOGUES OF SHIBKOVITE AND NIAHITE – CRYSTAL CHEMISTRY PECULIARITIES IN CONTEXT OF GENESIS

[1]Kiriukhina G.V., [1,2]Yakubovich O.V., [1]Dimitrova O.V.
g-biralo@yandex.ru, [1]Lomonosov Moscow State University, Moscow, Russia;
[2]Institute of Geology of Ore Deposits, Petrography, Mineralogy, and Geochemistry, Russian Academy of Sciences, Moscow, Russia

Experiments for synthesis of mineral analogues were made in presence of mineralizers under hydrothermal conditions (T = 280°C и P = 70 atm) maximally approximated to the conditions of natural hydrothermal systems. Based on the results of the X-ray spectral and X-ray diffraction analyses the products of crystallization were identified as a synthetic analogue of shibkovite $K(K_{1.67}H_2O_{0.33})(Ca_{1.3}Na_{0.7})Zn_3[Si_{12}O_{30}]$ [1] and a new polymorphous modification of niahite $NH_4MnPO_4{\cdot}H_2O$ [2]. Crystal structures for both compounds are determined by X-ray diffraction on data obtained for the single crystals: R = 0.0402, a = 10.5327(2) Å, c = 14.2019(3) Å, sp.gr. *P6/mcc, Z* = 2, $\rho_{\text{calc.}}$ = 2.90 g/cm^3 ("shibkovite") and R = 0.0259, a = 17.582 E, b = 4.909 E, c = 5.731 E, sp.gr. D^{16}_{2h} = *Pnam, Z* = 4, $\rho_{\text{calc.}}$ = 2.497 g/cm^3 ("niahite").

Shibkovite is related to the milarite group that contains 22 mineral species and which was described in [3] by the following general formula $^{[12]}C^{[9]}B_2{}^{[6]}A_2{}^{[4]}T2_3{}^{[4]}[T1_{12}O_{30}](H_2O)_x$, where A = Al, Fe^{3+}, Sn^{4+},Ti, Mg, Zr, Fe^{2+}, Ca, Na, Sc, Y, REE; B = Na, K, H_2O, □; C = K, Na, Ba, □; $T2$ = Li, Be, B, Mg, Al, Si, Mn^{2+}, Zn, Fe; $T1$ = Si, Al. Practically each of the 22 representatives of the aforementioned group can be found in several different geological environments: in subalkaline rocks (syenites, alkaline granites, calcite veins, and granite pegmatites, for example, pegmatite boulders on a glacier moraine in the Dara-i-Pioz alkaline massif); in associations with volcanic rocks or in high-temperature contact metamorphic areas, in particular in xenoliths of volcanic rocks of the Bellerberg volcano, Eifel territory (Germany), that is known for unusual and new minerals formed as a result of the pyrometamorphic interaction of xenoliths enriched in silica and calcium with leucite tephrite lava and their subsequent metasomatic change. Some minerals of milarite group were found in meteorites: in chondrules of nonequilibrium, iron-poor ordinary Mezo-Madaras chondrite (Romania), in the Indarch enstatite chondrite (Azerbaijan), in silicate inclusions of the Colomera iron meteorite (Spain). Only two water-containing representatives of the group under consideration were found in hydrothermal crystallization products. These are calcium species: milarite (Giuf Valley, Switzerland [4]) and armenite (Armen mine, Norway [5]).

The main structural elements of the synthetic "shibkovite" are two-level six-membered $[Si_{12}O_{30}]$ rings composed of silicon–oxygen tetrahedra with shared vertices. ZnO_4 tetrahedra combine $[Si_{12}O_{30}]$ ring groups via vertex-bridge contacts into a three-dimensional anionic framework of mixed type. ZnO_4 tetrahedra share opposite edges with two octahedra, statistically occupied by Ca and Na atoms; the large voids in framework are filled with K atoms and H_2O molecules. Based on the crystal-chemical analyses of the structural peculiarities of synthetic "shibkovite" in comparison with the other members of the milarite group it is shown that the crystallization conditions for minerals and synthetic analogues of this group determine the presence or absence of crystallization water in the structures of compounds.

A new modification of the niahite is centrosymmetric. Both structures are based on chessboard type layers built from MnO_6 octahedra sharing O vertices. PO_4 tetrahedra are attached to the free cages from both sides of these layers; the "hanging" vertex of the phosphate tetrahedra, which is unshared with other polyhedra, protrudes to the adjacent layer. NH_4 groups are situated between the layers and form hydrogen bonds connecting the layers together. In the synthetic "niahite" every second Mn/P-layer is inverted with respect to the foregoing layer, thus the crystal structure as a whole loses polarity, which is inherent in natural niahite; moreover, the unit-cell parameter parallel to the axis of layers' alternation increases twice.

As we showed earlier [6, 7], a structure of the niahite $NH_4MnPO_4 \cdot H_2O$ type can be obtained by the transformation of the crystal structure of lithiophilite $LiMnPO_4$ (triphylite structural type). The layers of Mn octahedra and P tetrahedra of the same topology are repetitive polysomes of both crystal structures. Unit-cell periods along the axes that define planes of layers are close in length, which is typical of polysomatic series of minerals; the third period, along the direction of interlaying, varies. In the crystal structures of minerals of the triphylite–lithiophilite $Li(Fe,Mn)PO_4$ isomorphic series, layers are immediately connected with one another by common oxygen vertices of octahedra and tetrahedra into a 3D framework. Small octahedral voids of the structure are populated by lithium atoms. In the structures of both niahite modifications, layers of the same topology are "interlayed" by ammonium groups and the interaction between layers is performed through hydrogen bonds. In lithiophilite $LiMnPO_4$ and the centrosymmetric modification of niahite $NH_4MnPO_4 \cdot H_2O$, which crystallize in the same space group, there are two layers per unit cell, and the unit-cell period along the axis perpendicular to the planes of layers reflects structural differences naturally increasing from 10.429 E in lithiophilite [8] to 17.582 E in the new niahite modification.

A hypothesis on the possibility of the secondary origin of niahite as an alteration product of triphylite was proposed in [6, 7]. The similarity of structural fragments of niahite and triphylite is indicative of a possible genetic relation between them. The preparation of synthetic "Fe-niahite" under low-temperature hydrothermal conditions in association with a typical pegmatite mineral zwieselite Fe_2FPO_4 suggested that the natural analogue of niahite can be found among the secondary phosphates of pegmatites. It can be formed based on triphylite–lithiophilite under low-temperature reductive conditions provided that ammonium ions are available in the system [5] (as a rule, under oxidative conditions, minerals of the triphylite–lithiophilite series undergo lithium leaching and the gradual oxidation of Fe^{2+} and then Mn^{2+} ions to the Fe^{3+} and Mn^{3+} state, which result in a conversion into minerals of ferrisicklerite–sicklerite and then heterosite–purpurite series). This suggestion was indirectly confirmed in experimental works on the preparation of synthetic analogues of minerals of the triphylite–lithiophilite series based on the "niahite" precursor $NH_4\textit{M}PO_4 \cdot H_2O$ (*M* = Fe, Mn, Co, or Ni) [9-12].

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SYSTEMATIZING OF MIXTURES OF MINERALS

Bobkov A.
bobkov-a-i@yandex.ru, MGRI-RGGRU a name of Sergo Ordzhonikidze, Moscow, Russia

Many natural mixes of minerals of the various nature have received own name and have entered into help and other mineralogical literature along with mineral kinds, versions, polymorphic updatings, etc. In the thesaurus on minerals such mixes of minerals are allocated in 14th class of thematic classes of descriptors (classification of minerals) [1-5].

The proposed systematization of mixtures of minerals is, as far as it is known to the author, the first attempt to systematizing them. Total considered 315 mixtures minerals, whose composition with any degree of certainty is indicated in the literature [1-6].

Consideration of mixes of minerals has allowed to allocate, first of all, true mixes of minerals and a pseudo-mixtures which are not, strictly speaking, mixes of minerals. Among true mixes can allocate mixes with the certain and insufficiently certain structure of components. Mixes with certain structure of components are presented by mixes of equivalent minerals and mixes on the basis of a dominating mineral. More in detail systematizing of these mixes is resulted more low. In parentheses the quantity of mixes is specified. Data on mixes of minerals are resulted under the text or is close to the text of literary sources specified in the list.

1. A TRUE MIXTURES OF MINERALS (281)

1.1. Mixtures with a particular composition of components (271)

1.1.1. Mixtures without a dominant mineral (245) is polymineral aggregates usually described as:

– a mixture of two or more minerals (237): ANOKSITE – a mixture of kaolinite from amorphous silica, MORESNETITE-a mixture of sokonite and gemimorfite, CERIOANKERITE – mixture of ankerite and a parisite;

– aggregates of minerals a certain structure (3): CALCITE-AGATE – aggregate-layered quartz, calcite and chalcedony, NIFESITE – the fine-grained aggregate bravoite and pentlandite, PLESSITE- the thin-plate aggregate kamasite and tenite;

– bunches of several minerals (5): GIDRODOLOMITE – dense bunches of gidromagnezite with calcite, LEVERRERITE-bunches kaolinite and muscovite, ZINC-VREDENBURGITE – oriented mikro-bunches franklinite with geterolite.

In those mixtures do not indicate the dominant mineral.

1.1.2. Mixtures with a basis of one mineral (26)

1.1.2.1. Minerals with impurities (19). In this case, the components of the mixture are the main mineral and impurities contained therein. With the following groups:

– mineral species with impurities (7): ANTRAKONITE – calcite, contaminated coal particles, GRODNOLITE – kollofane, contaminated kaolinite, QUARTZ SAPPHIRE – quartz with inclusions of crocidolite;

– the chemical variety of the mineral with a mineral admixture (1): KODACCITE – ankerite, contains ~ 6% lanthanum and cerium and impurity a parisite;

– morphological varieties with admixture (5): BLASTONITE – crushed fluorite with quartz, SUL'FURICINE-porous opal, with inclusions of carbon, SZOGARITE – fibrous barite with admixture of quartz;

– solid solutions containing degradation products (4): ANTIPERTITE – plagioclase with naturally oriented inclusions of orthoclase – of products degradation, ILMENOMAGNETITE – magnetite with ilmenite, as some microscopic product break-up, MOGENSENITE – magnetite with discoid inclusions of ullvospinel-products of disintegration;

– coloured varieties with admixture (2): SUNSTONE – feldspar (orthoclase, microcline, albite, oligoclase) pink, white or yellowish colour with golden reflections, bright glow point highlights in orange-red, bright yellow and crimson tones, due to inclusions of hematite, HAWKEYE – bluish variety of quartz with inclusions of crocidolite.

1.1.2.2. Pseudomorph minerals (7). This group included pseudomorph minerals in mineral mixes with literary sources: AGALITE – pseudomorph talc on enstatite, IZERINE – pseudomorph rutile on ilmenite, ISTONITE – pseudomorph of vermiculite on biotite.

1.2. Mixtures with enough specific composition of components (10)

– minerals with uncertain admixtures (5): BURBULITE – contains the melanterite, PARAKOBELLITE – impurity contaminated by impurities galena, STEJNMANNITE – galena contaminated by impurities;

– mixtures with not fully defined components (5): KARMENITE – -a mixture of covelline and others. KLINOFAITE – a mixture of sulfides, voltaite and other minerals, PLUMBOMANGITE – a mixture of galenite with other ore minerals.

2. PSEUDO-MIXES OF MINERALS (34)

Pseudo-mixture of minerals-mineral objects whose information in the literature do not correspond to the notion of a mixture of physical-chemical system, consisting of two or more components. In total 34 pseudo-mixes are established. Among them:

– mixture of minerals, consisting of a single mineral (24): BEHILITE – components-ammonioborite, RUBERITE – components-cuprite, ZUBERE – components-halite;

– monomineral aggregates (5): MENILITE – dark grey-brown nodules of opal. PASSIITE – earthy-quartz, PEČENKOVAÂ ORE is a mixture consisting of earthy-cuprite;

– minerals with impurities (2): NOLASCITE – As-galenite, ZINC-CALCITE – calcite, containing zinc;

– the intermediate members of the isomorphous line (1): VOLFAHITE II – interim member of the isomorphous line gersdorfite-ulmanite;

– morphological variety of minerals (2): STAR QUARTZE is a variety of quartz from asterizmom, CORAL ORE – curved as shell idrialite.

The considered systematizing of mixes of minerals opens a way to their natural classification on the basis of a chemical compound and of structure of components. This classification should exclude pseudo-mixes and insufficiently studied mixes.

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ZNAMENSKYITE, $Pb_4In_2Bi_4S_{13}$ – A NEW MINERAL SPECIES FROM FUMAROLES OF KUDRIAVY VOLCANO, ITURUP ISL., KURILES

[1]Chaplygin I.V., [1]Mozgova N.N., [2]Bryzgalov I.A., [3]Belakovsky D.I., [4]Pervukhina N.V., [4]Borisov S.V., [4]Magarill S.A.

[1]ichap@igem.ru, IGEM RAS, Moscow, Russia; [2]Lomonosov MSU, Moscow, Russia; [3]Fersman mineralogical museum RAS, Moscow, Russia; [4]Nikolaev Institute of Inorganic Chemistry SB RAS, Novosibirsk, Russia

Znamenskyite, $Pb_4In_2Bi_4S_{13}$ – a new mineral species of indium discovered in high-temperature fumaroles at Kudriavy volcano (№ 2014-026). Elevated concentrations of In (up to 265 g/t, average of 51 samples) have been reported previously in mineralized rocks on the volcano [1]. New mineral species of indium cadmoindite ($CdIn_2S_4$), abramovite ($Pb_2SnInBiS_7$), and rich in indium (up to first wt.%) minerals of the systems ZnS–CdS and Pb-Bi-S were also established here [2–6].

Kudriavy volcano is located in caldera Medvezhia of pleistocene age in the northern part of Iturup Island. Its stratovolcanic edifice of basaltic-andesite composition is superimposed on eroded dacitic cone that was extruded at post-caldera stage. Since the last magmatic eruption (1883) Kudriavy is characterized by high-temperature fumarolic stationary degassing. The total square of fumarolic fields is ~3000 m^2 The highest temperature of gases (940°C) was measured in 1992. The temperature has droped down after small phreatic eruption in 1999 and remains as high as 870°C up to now. Volcanic gases present substantially aqueous fluid (mol.%): H_2O 92–98, S_t 1.5–2.8, CO_2 1.0–2.4, HCl 0.1–0.8, H_2 0.6–1.5, other gases <1. Total gas emission is 30000 t/d [7]. Volcanic gases form zonal fumarolic crusts first tens of cm in thickness with upper zone composed of oxide-sulfate-silicate material and lower – rich in sulfides.

Znamenskyite was found at depths from 15 to 30 cm at temperature of about 600–700°C in lower zone within fumarolic field on the flat summit of extrusive dome within north-east crater of Kudriavy volcano. Associated minerals are cosalite, lillianite, heyrovskyite, galenite, abramovite, cadmoindite, Cd-wurtzite, pyrite. The mineral occurs as elongated slender plate opaque crystals up to 0.4 mm long and 0.05 mm across that are usually striated along elongation and easily split to needles. Box-shaped skeletal crystals are also common. Znamenskyite forms druze-like aggregates. The colour is lead-grey with a metallic luster. Streak is black. Crystals of znamenskyite have hackly uneven fracture and are very brittle. Reflectance values for COM wavelength, % (R_{max} R_{min}): 470 nm (38.4 35.6), 546 nm (38.3 36.2), 589 nm (37.1 35.4), 650 nm (36.6 35.2). Bireflectance is abcent; no anisotropy. Its measured microhardness VHN_{10} is 110. The electron microprobe analysis of type znamenskyite gave Pb 30.37, Cd 2.48, Sn 0.03, Bi 34.66, In 11.15, S 18.38, Se 1.05, Cl 0.15, I 0.08, sum 98.32. The empirical formula, based on 23 atoms, is $(Pb_{3.30}Cd_{0.49})_{3.79}In_{2.18}Bi_{3.73}(S_{12.88}Se_{0.30}Cl_{0.10}I_{0.01})_{13.29}$; the idealized formula is $Pb_4In_2Bi_4S_{13}$. Ideal formula $Pb_4In_2Bi_4S_{13}$ requires Pb 35.86, Bi 36.17, In 9.94, S 18.03, total 100.00 wt.%. The strongest nine lines of the X-ray powder-diffraction pattern [d in E (I) (h k l)] are: 3.98 (7) (2 6 0); 3.56 (6) (2 7 0); 3.37 (10) (4 6 0); 3.239 (4) (3 3 1); 2,936 (4b) (0 6 1); 2.743 (10) (4 5 1); 2.008 (5) (0 0 2); 1.719 (3b) (4 6 2). The unit cell parameters of znamenskyite obtained from a single-crystal measurement are: a=21.331(1)E, b=26.435(1)E, c=4.006(1)E, V=2258.92 E^3, Z=4, space group Pbam, D_{calc}.= 6.504 g/cm^3. According to structure solution, znamenskyite is isostructural with synthetic $Pb_4In_2Bi_4S_{13}$ [8].

In the structure, four basic Pb atoms are located in trigonal prisms with centered faces (the coordination numbers 7 and 8 for Pb1, Pb2 and Pb4, and for Pb3, respectively) and Pb-S distances from 2.931 to 3.251 E. One basic In atom is located in the tetrahedron (In-S 2.469 E x2, 2.496 and 2.509 E) and two basic atoms in the octahedra (In-S from 2.595 to 2.777 E). Four basic Bi atoms are located in the octahedral (Bi-S from 2.630 to 3.062 E). The cation polyhedra form the three-dimensional framework sharing the common faces and edges in the b-axis direction and the common edges and vertices in the ac-plane. Low quality of monocrystals did not allow to provide more detailed description of the structure, and to determine possible isomorphic substitutions in positions of cations. Structurally close synthetic compounds with Se with Bi-In isomorphic substitutions

($Pb_4In_xBi_{6-x}Se_{13}$, x=2.1–2.8) were discussed in details in [9]. Crystallographic analysis of some Pb, In, Bi sulfides including synthetic $Pb_4In_2Bi_4S_{13}$ showed substantial role of cation ordering in structure formation [10].

We consider chemical transport reactions to be main mechanism of mineral growth in fumarolic environment. This mechanism allows to explain separation of chemically close elements during transport and deposition of rare metal minerals. The most expressive example is occurrence of ReS_2 and MoS_2 at different temperatures on Kudriavy Volcano [11, 12].

The mineral is named after russian geologist Vladimir Sergeevich Znamensky (1939–2002) who devoted many years to studying geology and mineral deposits of Kurile Islands. He was among first who started mineralogical research at Kurdiavy volcano.

Generalization of mineralogical and geochemical data on high-temperature fumaroles of Kudriavy volcano allows to push an idea of concentrating rare metals, including Re and In, in volcanic environments characterized by high-temperature gaseous transport of metals exposed to temperature gradient. Geological settings in young calderas and on active volcanic edifices at post-eruptive or final stages of volcanic system evolution due to long-lasting degassing of magmatic chamber are promising for discoveries of rare metal mineralization, which can appear to be economic in nearest future.

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CONDITIONS OF URZHUMIAN SEDIMENTS FORMATION ACCORDING TO GEOCHEMICAL DATA FOR SAMPLES FROM THE MONASTIRSKY RAVINE REFERENCE SECTION

Khaziev R.R., Gareev B.I., Batalin G.A., Nurgalieva N.G.
Radmir361@mail.ru, Institute of geology and petroleum technologies, Kazan, Russia

This paper examines geochemical characteristics and chemical weathering intensity of the sediments of the Urzhumian stage in the Monastirsky ravine in order to test the hypothesis that these sediments are "redeposited weathering crust" (the term proposed by B.P. Krotov [Кротов, 1931]). For this purpose, we used special lithochemical modules.

The exploration target (Monastirsky ravine) is located in the south-east of the Republic of Tatarstan, 12 km north of Tetyushi town. There are five suites in the geological section of the Monastirsky ravine (from bottom to top: first, second, third, fourth, fifth) [Форш, 1963]. The first and second suites are parts of the Urzhumian stage [1].

The first formation is exposed on the right side of the ravine where it forms a series of steep walls. The formation thickness is about 45 m. The suite is represented with a rhythmic alternation of red clay-calcareous formation and sand-silt sediments interbedded with limestone and dolomite; there are also palygorskite bands in the upper part. The distinguishing feature of the first suite is the lack of layers containing paleontological remains, which makes it difficult to perform a more detailed pack splitting and series according to paleontological data.

The second suite is also exposed on the starboard side of the ravine, as well as in different parts of the thalweg of the ravine. The thickness of the second suite is 36 m. The lower boundary of the second suite is carried on the formation tops of pinkish-gray dolomitic marl associated with the first suite. The distinctive feature is the content of three packs of clay-carbonate layers.

As noted in [4], clay sediments of the Upper Permian are often painted in red colors due to the presence of finely dispersed hematite. The origin of the hematite may be twofold: it can be formed under oxidizing conditions in an arid climate or it can be caused by postsedimentation.

As the subject of research, we took samples from the clay layers of the first and the second suite. The samples were collected at 45-50 cm.

To calculate the lithochemical modules, the authors used data of the chemical composition obtained by X-ray fluorescence. A total of 93 samples have been analyzed: 64 samples of the first suite sediments and 28 samples of the second suite sediments.

The analysis was realized on Bruker S2 Ranger X-Ray Fluorescence Spectrometer.

In the paper [8] Urzhumian sediments were studied by X-ray fluorescence analysis (XRF) and by electron paramagnetic resonance. There were highlighted geochemical zones and geochemical cycles through the example of the Cheremushka ravine reference section; they were associated with the change of salinity regime of waters and the increased dominance of continental sedimentary environments.

In order to determine exogenous transformation provenances of the studied rocks, as well as paleoclimate reconstruction, well-known lithochemical modules have been established. These include: the Chemical index of alteration (CIA) [4], the Index of compositional variability (ICV) [Скляров, 2001], the Chemical index of Weathering (CIW) [Sampa Ghosh et all, 2010], the hydrolysate module (HM), the aluminum module (AM) [4], the plagioclase module (PM) [Юдович и др., 2000].

There is a direct relationship between the AM and GM modules in samples taken from the clay deposits of the first and second suite, with high correlation coefficient (0.86 for the first suite of sediments; and 0.83 for the second).

The GM module values of the first suite vary within 0,33-0,5 (0.43 average) and sediments are classified as secondary redeposited; AM modulus values 0,26-0,35 (0.31 average) are classified as hydrolysate rocks associated with ferruginous weathering crusts. The obtained values allow us to conclude that the rocks have undergone a very strong chemical weathering and therefore can be certified as redeposited weathering crusts [4, 2].

The values of analyzed modules for the second suite have a wider range of values, hence it indicates the frequent changes of sedimentation conditions. The GM modulus values vary within 0,16-0,39 (0.27 average); AM – 0,1-0,28 (0.19 average). Periodic change in the silica content (GM) and alyumoklastic material (AM) probably indicates a frequent change of provenance [6].

As part of the second suite there is a cyclical alternation of carbonates and clay rocks, which indicates the level fluctuations sedimentation basin with frequent changes in the salinity regime.

Values of CIW and CIA modules also have high values and are compared with the data interpreted above. However, they have a wider range of values (20-95 for the first CIW suite (64 average), 11-76 for the CIA (47 average); 11-75 for the second CIW suite (42 average), 10-67 for the CIA (38 average)). Both modules have a clear direct relationship with a strong correlation dependence (R^2 = 0,994 and 0,987). The reducing of ICV module to 1 and below indicates the intensity of chemical weathering. During pedogenous transformation of clay rocks the ICV module falls below the 1,1–1,29 [7]. The PM and ICV modules have a strong direct relationship (R^2 = 0,938, and 0.952 for the first and second suite respectively).

The PM module behaves identically toward the CIA and the CIW. There can be observed a feedback with a very high value of the correlation coefficient (R^2 = 0,994 for the first suite and 0,987 for the second). This phenomenon is interpreted as follows: the arid sedimentation degree of chemical weathering increases, which can be seen on the CIA and CIW modules. When climate becomes humid, what is marked by high values of the PM, the degree of rock weathering decreases.

Analysis of lithochemical parameters showed that during the Urzhumian age there were frequent changes of hydrochemical regime of the sedimentation basin. Within the section there are weathering crusts alternating with layers of clay that have not undergone considerable weathering despite their red color.

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WATER-CHLORIDE FLUIDS IN HIGH-TEMPERATURE METASOMATISM OF THE BASIC ROCKS (EXPERIMENTAL DATA)

Khodorevskaya L.I., Varlamov D.A.
khodorevskaya@mail.ru, dima@iem.ac.ru, Institute of experimental mineralogy
Russian academy of sciences, Russia, Moscow district, Chernogolovka town

In the high-temperature metamorphic complexes which are especially dedicated to the Precambrian Shield the processes of a granitisation or charnockitization expressed in the directed transformation of host rocks from practically unaltered to metagranitoids often are observed. Similar processes take place with the participation of high-concentrated NaCl-KCl fluides which in the process of filtering through the rocks bring some components and actively dissolve and take out others. Considerable experimental data on mechanisms of dissolution of rock-forming minerals, such as quartz, albite, grossular, wollastonite are so far saved up [1 and the bibliography in article]. Information about the interaction of mafic rock-forming minerals with the salt solutions is much less. Interaction of an amphibole with salt solutions of chlorides experimentally is almost not investigated, although field observations show that changes in the composition of this mineral are associated with impact on it of salt fluids.

In this article results of studying the interaction of an amphibole (Hbl, composition is close to average composition of this mineral for metabasites) with NaCl and NaCl+KCl solutions are presented. Experiments were made by the method of quenching at 750-900^oC and pressure of 500 and 700 MPa on the high gas pressure installation with internal heating.

As initial material the tschermakite from a metasomatic vein of the Kii Island, White (Beloye) Sea served. The composition of initial amphibole (wt.%): SiO_2 – 44.05, TiO_2 – 1.09, Al_2O_3 – 15.75, FeO – 12.47, MnO – 0.05, MgO – 11.34, CaO – 11.91, Na_2O – 1.61, K_2O – 0.60, H_2O (as LOI) – 1.11.

System H_2O-NaCl-amphibole, 900^oC, P=500 MPa

As a result of interaction of *Hbl* with NaCl solutions (where X_{NaCl} = 0.0-0.5) it was established that амфибол remains stable over the entire range of fluid salinity. In significantly aqueous solutions (X_{H2O} = 0.9) along with formation of the small, well-facetted crystals of high-ferrous spinel, there is an insignificant amount of magnesian clinopyroxene. At higher concentration of chloride (and decreasing of X_{H2O}) clinopyroxene disappears, and together with spinel high-ferrous amphiboles, ferropargasite and ferrohastingsite are formed. Chlorine is almost not included into composition of both magnesian and ferrous amphibole (less than 0.2 wt. %). At X_{H2O} < 0.7 together with the amphibole there are large, to 2 mm, prisms of the chlorine-containing magnesian mica of metal color identical to phlogopite in which potassium is almost completely replaced with sodium (natural analog – aspidolite $NaMg_3(Si_3Al)O_{10}(OH)_2$).

In all experiences along with mineral reactions incongruent melting of an amphibole is observed. In the melt composition includes 50 wt.% SiO_2 and 23-25 wt.% Al_2O_3, i.e., is formed melt with quartz-corundum normative composition. Only introduction to system of a fluid phase with X_{NaCl} >0.5 leads to the formation of nepheline-normative melts. Thus, experiments showed that the essential content of NaCl in the fluid will lead to a amphibolization of rocks with formation of pargasite, ferropargasite, ferrohastingsite and to smelting of melts with plagiogranite composition.

Unlike aluminum and silicon, iron and magnesium are almost not taken out by fluids as a part of which high X_{NaCl} are noted. The similar conclusion follows also from work [2]. It should be considered when studying the processes of a granitization and charnokitization occurring with participation of fluids with high concentration of salts [3, 4]. Really, bringing in alkalis, silicon dioxide and alumina can be provided with high salinity fluids, however, the accompanying carrying out from the host rocks of iron, calcium and especially magnesium are unlikely to be associated with the highly NaCl concentrated fluids. The accompanying carrying out of the bases requires radical change of composition of a fluid phase (for example, fluids with high salt component have to be replaced by a strong-acidic fluids).

System H_2O-KCl-amphibole, 750°C, P=750 MPa

If in system amphibole-NaCl-H_2O after experiments amphibole remains as main mineral, already small additives of potassium (KCl) in composition of initial solutions lead to significant change of mineral assemblages after the experiments.

First of all, clinopyroxene remains stable in entire range of salinity of solutions. On composition it is high-magnesian augite with the content of a jadeite component reaching the 15 mol. %. Similarly, presence of KCl at system leads to emergence of biotite with a $X_{Mg} \approx 0.7$ and without chlorine. At low (0.1-0.3) ratios of K/(K+Na) in an initial fluid slight isomorphic substitution of K→Na in biotite is observed, at higher ratios of K/Na in solutions biotite practically doesn't contain sodium. Sometimes at the edges of biotite the rim of a lepidomelan is formed. The plagioclase and potassium feldspar observed in almost all experiments. With a high content of potassium in the initial solution (K/(K+Na)> 0.5) amphibole practically disappears, and clinopyroxene, biotite and garnet are stable. On the composition garnet comes nearer to an andradite, i.e. is not characteristic for metabasites.

Melting at the given parameters is observed in experiments at $X_{H2O} \approx 0.6$-0.7 that corresponds to the data [5]. The appearing melt is presented small balls (the first tens microns). On the composition of the melt – olivine-normative with prevalence of a K-feldspar component, the amount of which is determined by the ratio of K / (K+Na) in an initial fluid.

In most experiments, the initial amphibole (pargasite) doesn't change its iron content, there is almost no chlorine, but the ratio of K/(K+Na) in amphiboles is directly correlated with the corresponding ratio in the fluid. It is shown that the ratio K/(K+Na) <0.3, typical for amphiboles from mafic granulites and metasomatic hornblendites arise at the ratio K/(K+Na) less 0.3 in coexisting fluid.

It is shown that the ratios of K/(K+Na) <0.3, characteristic for amphibole from the main granulites and metasomatic amphibolites, arise at the relations of K/(K+Na)<0.3 in the coexisting fluid. The transformations of rocks which are taking place at processes of a charnokitization occur at a little higher ratios of K/(K+Na) = 0.25-0.40 in the fluid. Thus, amphibole is a sensitive indicator to a ratio of K / (K+Na) in the composition of the fluid phase.

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MINERALOGICAL AND GEOCHEMICAL FEATURES OF UKRAINIAN SHIELD NEPHELINE ROCKS

Osypenko V., Nykanorova Y., Shnyukov S., Lazareva I.
victoria.osipenko@gmail.com, National Taras Shevchenko University of Kyiv,
Institute of Geology, Kyiv, Ukraine

Ukrainian Shield (USh) is a classical distribution area of alkaline rocks. It is known near 40 massifs which are situated within Serednyoprudniprovsky, Pre-Azov and Dnistrovo-Bugsky blocks of USh [1, 3]. Traditionally typical massifs of nepheline rocks are attributed to two alkaline rocks formations [3]: alkaline-ultramafic (carbonatite) with ~2 Ga age (Proskurovsky, Antonovsky, Chernigovka massifs, and Gorodnytska intrusion) and gabbro-syenite with ~1.7 Ga age (Malotersyansky, Oktyabrsky massifs). All massifs are mainly located in the shield periphery and confined to extended deep seated fault zones, characterized by wide variety of host rocks (granitoids, gneisses and amphibolites), and are considered as a potential source of P, Zr, Nb and REE (Malotersyansky, Oktyabrsky and Chernigovka massifs), and nepheline-feldspar raw material [2].

All these massifs are generally represented by nepheline syenites (canadites, foyaites, mariupolites, pulaskites), for Proskurovsky, Antonovsky and Chernigovka massifs they are supplemented by ijolite-meltejgites and jacupirangites, and for Gorodnytska intrusion – by only the last one. Nepheline syenites composition is similar, however minerals concentrations in different massifs vary in a wide range (%): alkaline feldspars (40-80), nepheline (5-50), amphibole, pyroxene (aegerine-salite), biotite (5-60), calcite (2-7); typical accessories – apatite, zircon, ilmenite, titanite (for Chernigovka and Oktyabrsky additionally pyrochlore, orthite, and brytholite, bastnasite, rinkite, respectively) [3]. Ijolite-meltejgites and jacupirangites (%): nepheline (15-65), feldspars (5-40), pyroxene (10-70), olivine (5-20), amphibole (2-10), micas (1-10), typical accessories – apatite, ilmenite, magnetite (for Chernigovka massif and Gorodnytska intrusion – additionally titanite, monazite, graphite, sulphides [3], and garnet, Cr-spinel, ruthile [5], respectively).

Despite the similarity of mineral composition, geochemical features allow to distinguish rocks of Proskurovsky and Antonovsky massifs and Gorodnytska intrusion in separate group, which is first of all characterized by low content of such incompatible elements as Nb (3,5-35 ppm), Zr (19-95 ppm), and LREE (10-80 ppm), as well as relatively low TiO_2 concentrations [5]. Available Sr, Nd, C, and O isotopic data [2, 4] indicates mantle origin of these rocks group. That's why its observed anomalous geochemical specialization can be explained by different geochemical specialization of their material source.

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SEAFLOOR MASSIVE POLYMETALLIC SULPHIDIC ORES AS THE POTENTIAL SOURCE OF NON-FERROUS METALS

Ozhogina E.G., Yakushina O. A., Astakhova Yu.M.
vims-ozhogina@mail.ru, yak_oa@mail.ru, All-Russian Research Institute of Mineral Resources named after N.M. Fedorovsky, Moscow, Russia

Seafloor massive polymetallic sulphidic ores (PMS) are now considered as an upcoming potential sources of seen as a possible source primary of non-ferrous metals, precious and rare metals [1]. PMS are one type of oceanic ores and non-traditional polymineral raw matter. Prospects of PMS industrial development result from their complex composition, more than ten metals (copper, zinc, gold, silver, cobalt, molybdenum, germanium, cadmium, indium, sulfur) are in up to industrial content. Currently the complex of exploration on PMS in the central part of the Atlantic Ocean at the rift valley of the Mid-Atlantic Ridge (MAR) in which the application region of the Russian Federation is located is carried out. Due to the prospect of development of ores of the World Ocean it is necessary to know opportunities and restrictions of the physical methods applied at mineralogical researches of such objects [3].

Peculiarities of PMS ores are complex textural and structural picture due to a combination of several different mineral associations developed in unequal time, ore minerals various granular composition and ore minerals actual composition. That result from different combinations of mineral associations occurring at different times, presence of metastable minerals, "minerals ephemeral plants", especially in Cu-Fe-S system, temperatures, unstable at change, and pressure, broad development of isomorphic replacements in structures of many minerals, violation of their stekhiometry and extent of streamlining of crystal structure.

PMS specific features are determined by the composition of hydrotherms and the characteristics of fluid substrate seafloor. The main mineral phases of the marine ore bodies are sulfides of metals, namely iron (pyrite, marcasite, troilite, pyrrhotite) zinc (sphalerite, wurtzite), copper (digenite, chalcocite, covellite), copper and iron (bornite, chalcopyrite, cubanite, etc.), also are galena, arsenopyrite, nickeline, tennantite, silver and gold minerals, native copper, products of sulfide oxidation and non-metallic minerals, the most common are opal, anhydrite, barite.

Specific feature of is presence them the fossilized remains, i.e. pseudomorphosis on worms-Polikhetam and Vestimentifer of tubular shape that may probably impact on the technological process. The morphology of ores is very difficult and various, their thin structure, addition of ores reflect multistage and conditions of formation (primary ores) and the subsequent transformation (secondary ores). The granular structure of the ore minerals which are of industrial value varies in considerable range. Nano-phases (mineral individuals the size in some nanometers) which simply weren't identified several decades ago are of special interest, and today their presence is proved in many natural and technogenic mineral systems, including the pyrite ores of the World ocean.

It is known [2] that the shape and properties (melting point, reactivity, conductivity, magnetism and strength) nano-sized grains, in this case ore sulfides, largely differ from those of macro- and mikro- size due to the greater rate of surface atoms. Consequently, we should consider new and innovative processing technologies for seafloor massive polymetallic sulphidic marine ores, or at least, new operations in the known complex processing technologies to extract the ore minerals of non-ferrous and precious metals, also in the long term, perhaps, and rare metals.

PMS mineralogical features (presence of a significant amount of the useful minerals which are quite often closely associating among themselves, entering various paragenesis, their granular structure and morphometric characteristics) substantially complicate applied mineralogical researches and demand attraction not only traditional methods of the analysis (optical microscopy and a X-ray analysis), but precision physical methods, main from which are methods of analytical electronic microscopy today. It is necessary to consider influence of sample preparation on the received results: when crushing, dry crushing and attrition there are rather high temperatures at which there are phenomena changing structure and properties of ore minerals. When crushing sculpture ores polymorphic transformations of pyrrhotine may take place.

By Two PMS probes have been studied by a complex of mineralogical methods which were taken at hydrothermal ore field "Petersburg" on the square of the Russian Prospecting Area in the Atlantic Ocean during the 34th field trip of Russian research the vessel. The tasks mineralogical study included definition of: mineral structure, textural and structural characteristics and search of forms of finding of all useful and potentially useful elements.

Complex mineralogical and analytical study carried out by the methods of high-resolution light microscopy (LM, stereomicroscope Leica MZ12.5B, Germany), X-ray powder diffraction (X Pert diffractometer PRO, PANalytical, Holland), X-ray computed tomography (VT-50-Geotom, Russia). Tests were conducted according to known standards and methodical documents.

When studying PMS ores, the traditional mineralogical researches conducted by methods of light optics, including optiko-mineralogical, petrographic, mineragrafic, image analysis (optical-geometrical analyses), usually don't provide necessary completeness to indentify total mineral composition of the PMS ores (diagnostics of all mineral phases with a quantitative assessment of their contents though) but they are the main methods of ores textural and structural characteristics and rocks studying and are surely used at the first stage of research.

The studied PMS probes are formed by ores of various mineral types, have difficult textural and structural drawing. The first PMS probe has massive, striate, spotty, interspersed texture that is caused by alternation of ore and nonmetallic pro-layers, processes of oxidation of primary sulfides of iron in hydroxides. Structure is uneven granular thin- and cryptocrystalline. Ore is formed by copper and iron sulfides, fine-crystalline chalcopyrite and pyrites, spotty sites of hydroxides of iron are noted. Copper minerals coveline and digenit occur at small quantities. Size of ore minerals grains alliterates in a wide range, from the first to 100 microns. Emptiness, cavities, a time are widely developed. In big free space crystals of sulfides of crystallographic forms whereas on a surface of cracks are developed were formed is thin – cryptocrystalline sulfides. Quartz compose more than 50% of the ore. The second PMS probe has microcavity, striate, colloform, spotty texture. Structure is massive, crystalline, uneven granular. It is formed by iron sulfides: is thin cryptocrystalline pyrites and marcasite. Microporosity is widely developed in the inter-grain space of small pyrites crystals. In the big rock emptiness are large pyrite crystals of well-developed crystallographic forms; along a cracks surface grew thin- and cryptocrystalline sulfides/ They are cuprite, coveline, atakamite, tenorite; rock-forming minerals are halite and plagioclase (<1-3%).

So the investigated PMS probes generally are of copper, less copper-zinc specialization. The main ore minerals in PMS probes are: (1) the chalcopyrite and pyrites which are closely associating with quartz in the in the first probe; but (2) pyrites and marcasite in the form of drain fine-crystalline masses at practically lack of rock-forming phases in the second one.

Similarly to continental ores processing technologies, the prospects of PMS processing are now associated with combined technological schemes involving flotation of non-ferrous metals and minerals pyro-hydrometallurgical process of pyrite product. Finally it should be noted that the mechanism of submarine sulfide formation closely matches the formation conditions of ancient pyrite ores of the Urals, Altai, Japan, Portugal and other regions. The Ural polymetallic sulfide ores are successfully processed, and modern technologies allow to extract copper, lead, zinc and other metals. Therefore hydrothermal sulfide ocean ore having the high rate of accumulation can become a real source of non-ferrous metals in the nearest future.

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ON THE FEATURES OF MOLYBDENITE STRUCTURE AND PROPERTIES IN MOLIBDENIT-QUARTZ POOR ORES

Pirogov B.I., Yakushina O.A., Tsitsinova A.A., Bystrov I.G., Iospa A.B.
pirogov_bi@inbox.ru, All-Russian Research Institute of Mineral Resources named after N.M. Fedorovsky, Moscow, Russia

Molybdenite MoS_2 is the main ore mineral and Quartz is generally the rock-forming one in the “mineral-host medium” system. Character and the genetic nature (hydrothermal and hypergenesis stages of mineralogenesis) predetermine their interaction, technological properties and ore processing features on the whole. Thus morphostructural and constitution characteristics are the most important Technological Properties Parameters (TPP) for mineral.

Complex mineralogical study of Molybdenite-Quartz ores was carried out in the mineralogical department of All-Russian Research Institute of Mineral Resources named after N.M. Fedorovsky by light microscopy (Pirogov B.I., Tsitsinova A.A.), X-ray computed tomography (µCT, Yakushina O.A.), X-ray powder diffraction (XPD, Iospa A.V.), micro-XRF (Bystrov I.G.), some electron microscope SEM analyses were done at the Institute of Geology Komi SC UB RAS (Filippov V.N., Pirogov B.I.).

According to the content of Molybdenum (0,15% of Molybdenite) the studied ore is of poor type. Mineral composition of Molybdenite-Quartz ores technological probe (was calculated taking into account data of XPD, chemical analysis and electronic microscopy, SEM): quartz, plagioclase, potassium feldspar, kaolinite, goethite and hydrogoethite; in very small quantities are noted: pyrite, chalcopyrite, a galena, gold, yarozit, mica biotite and muscovite, apatite, magnetite, hematite, Thallium chlorides and bromides. Ore minerals of Molybdenum (Mn) are molybdenite, ferrimolibdit and powellite. Quartz is the main rock-forming mineral.

Molybdenite forms streaks along cracks and a thing impregnation in quartz. It is allocated as small and thin scales, separate grains in quartz, and also frequently form small tabular and short prism crystals, which edges are thicker than its median middle part (crystal edges have been split at the second stage of a secondary hydrothermal silicification).

Hexagonal cross section, hexagonal forms of growth, deformation shading on prism’s and dipyramid’s sides are typical for molybdenite crystals. Its scaly aggregates in the rock define natural heterogeneity of molybdenite. When studied by light microscopy, molybdenite has by strong two-reflection and bright internal reflexes of the thinnest scales in the reflected light is characterized. X-ray powder diffraction analysis (XPD, Iospa A.V.) confirmed the hexagonal polytype 2H∞ of Molybdenite, the most widespread in the nature.

Variability and variations of molybdenite composition in a hypergenesis zone result in the development of secondary envelopes of a povellit on the periphery of molybdenite units (that is confirmed with the luminescent analysis), and a ferrimolibdit (detected by light microscopy and X-ray microtomography) in association with other minerals. Molybdenite relationship with the main nonmetallic mineral, quartz is very substantial. At the initial stage of hydrothermal process it forms cracks, small and thin scaly allocations taken when quartz crystals were growing. Later hydrothermal solutions of Silicon dioxide cause the splitting of quartz crystals of a hexagonal form which is accurately shown in their reinforced part at the edges. The splitting of molybdenite plates and their gaps with twisting and crushing in lamellar shape units can be distinctly observed on electron microscopy, SEM images. Thus quartz forms films on molybdenite separate thin shredded particles, and in general such unit is cemented by quartz, so the most part of molybdenite units is preserved up to thin classes when crushing in the course of disclosure of minerals. Thus quartz plays the positive role, as its 0,2-0,5 to 2-4 mm size subindividuals crystals reflect the mosaic mineral growth when forming hydrothermal ore veins. Subindividuals of quartz are a sort of molybdenite reserve. At the same time in the hypergenesis zone iron hydroxides form thin films between grains (subindividuals) of quartz, creating the false type of accretions facilitating the disclosure when crushing.

XCT study data determined that the molybdenite units or individuals, selected in light optics as monomineral grains, on the values of Linear Attenuation Coefficient (LAC) of X-rays weakening, one may view 4 different mineral phases. That result from various degree of structure orderliness and/or isomorphic replacements because of the difficult genetic nature of a mineral including, with oxidation phenomenon on a grains surface. Local increase of LAC values inside molybdenite grains can be explained by impurities of heavy metals in its structure, for example, of Rhenium. The well-known fact that the features of the morphology and structure depend on real mineral's crystal chemistry structure, for example, broadening of diffraction reflections maxima (XPD) because of texturing of layered structure type minerals, or the variation of X-rays absorption, LAC values in mineral grain in its different crystallographic directions on X-ray computed tomography images takes place.

Thin units of scaly molybdenite those present in this ore, oxidation it in zones of contact predetermine molybdenite heterogeneity and negatively influence on the mineral disclosure. Really, the molybdenic concentrates studying set up that the grains accepted as "free" (conditionally) are actually aggregates of molybdenite scales, pyrites and chalcopyrite with insignificant quantity (up to 5%) of the non-metallic component being quartz. That is quite clear in the passing light optics testing. Molybdenite (with films of povellit and ferrimolibdit) comprise about 80-85%. The rest of ~15-20% is pyrite and chalcopyrite which are quite often covered with films of iron hydroxides. Due to ore overgrinding, the ore matter flocculate with the rock-forming one. So, as a result there is a considerable part of rock-forming minerals in ore concentrate.

Thus, minerals allocations in shredded ore and the disclosure character completely reflect the regularities in variability of ore composition and molybdenite morphostructural features, which have been determined at the outset of the ore research on the basis of the Minerals Ontogeny Thesis (Doctrine) [1-3].

On the basis of Ontogeny approach to molybdenite technological properties (TPP) assessment the fillowing data were determined. Molybdenite crystal chemical strcture is presented by polytype 2H-$MoS2\infty$, that also contains impurity of Rhenium; molybdenite forms streaks and inclusions in quartz, quite often due to splitting of the aggregates by hydrothermal quartz the surface of molybdenite particles is enveloped with thin quartz films; and in molybdenite at some separate rock blocks an oxidation zone is covered with ferrimolibdite and povellite films, both primary originated and when rock crushing was confirmed by SEM and XCT data, the latter appear as LAC changes, alterations of X-rays attenuation by the mineral when molybdenite crystal structure deficiency degree increase in separate sites of shredded particles (due to the superposition of the secondary constitutional induced properties takes place at mechanical impact on the ore when processing, according to V.I. Revnivtsev [4]).

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THE CHARACTERISTICS OF COLUMBITE FROM CRUST OF WEATHERING OF THE BELOZIMINSKOYE DEPOSIT

Sokolov S.V.
vims-sokol@mail.ru, N.M. Fedorovsky All-Russian scientific-research Institute of Mineral Resources (VIMS), Moscow, Russia

The Beloziminskoe deposit is located inside the limits of the same name massif of ultra-basic-alkaline rocks, incorporated into Eastern Sayan carbonatite province. Crust of weathering was formed mainly on amphibole-phlogopite-calcite carbonatites (which were partially intensively changed during the process of ankeritization), and the later, strictly ankerite carbonatites. The rocks that make up the crust of this deposit, are considered as ores of niobium and phosphorus and also as potential source of tantalum and rare-earth elements.

Niobium minerals in crust of weathering are pyrochlore $A_{2-m}B_2O_6(O,OH,F)_{1-n} \cdot pH_2O$ (often columbitous) and ferrocolumbite $FeNb_2O_6$. Information about niobium mineralization in crust of this deposit was given in our early publication (Sokolov, 2012), that was mainly dedicated to the pyrochlore. The more detailed characteristic of another niobium mineral – columbite is given in the present report.

Columbite occurs predominantly in the form of xenomorphic grains and only in rare cases it forms idiomorphic crystals (in the different degree), which reach size of 2.5-3 mm. Moreover, replaced pyrochlore aggregates of the fine-grained columbite are widespread in the crust. Its development on pyrochlore of calcite carbonatites can even begin in the endogenous process and it is connected with the formation of later ankerite carbonatites.

Columbite penetrates into crystals of pyrochlore on microscopic cracks, or it composes external reactivity rims. Substitution of pyrochlore occurs more intensively under physical-chemical parameters of crust formation, leading to the growth of columbite edgings. As result, only relict sections are remained from pyrochlore, and finally pseudomorphoses of columbite appear on its crystals, which preserve the octahedral appearance.

Process of columbitization is frequently accompanied by a change in the composition of pyrochlore. It is evinced by the decrease of the contents of fluorine, calcium and sodium, rise of the role of strontium and appearance of barium, and also growth of a quantity of niobium with reduction in concentration of tantalum.

The data about chemical composition of columbite were obtained by means of electron microprobe JXA-8100 Superprobe, supplied with Energy Dispersive X-ray Spectrometer INCA-400 (analyst G.N. Nechelyustov, VIMS). Standardization of separate elements was conducted by standards consisted of synthetic compounds and metals, and also natural minerals of strictly defined composition.

The obtained results that are represented in generalized form in table show predominance of iron above manganese in analyzed columbites. The table also illustrates low contents of strontium, and very low concentrations of rare-earth and radioactive elements which do not reach the limits of detection.

The studied columbites correspond to several genetic-morphological varieties, which are characterized by a close quantities of iron, but they are varied in the content of niobium, tantalum, titanium, manganese and strontium. Four groups columbites were distinguished according to these properties in crust of weathering.

Columbites of the first group present original carbonatites. Two samples from them characterize chemical composition of idiomorphic crystals and three of others relate to inclusions of this mineral in apatite, which have sizes in diameter from 40 to 70 µm. All these columbites are low-manganese, most titaniferous (in content of TiO_2 they approach to titanocolumbite) and they are enriched by tantalum (0.70-3.04 wt % Ta_2O_5).

It is remarkable that primary columbites are characterized by the lowest contents of niobium (68.81-70.10 wt % Nb_2O_5) and relatively high concentrations of tantalum, comparing to the second columbites, which appear in process of forming of crust. Therefore, the reverse correlation between niobium and tantalum occurs in columbites from crust of weathering of this deposit.

Table

Chemical composition of columbite, wt %

Groups of samples	MnO	$FeO_{общ}$	SrO	TiO_2	ZrO_2	Nb_2O_5	Ta_2O_5
1 (n = 5)*	0.77-1.45** / 1.08	19.38-19.81 / 19.61	0.04-0.46 / 0.17	4.50-4.97 / 4.78	0.41-0.57 / 0.47	68.77-70.10 / 69.22	0.70-3.04 / 1.79
2 (n = 3)	0.97-1.10 / 1.04	19.60-19.92 / 19.76	0.74-0.76 / 0.75	3.20-3.66 / 3.43	0.40-0.60 / 0.47	72.63-72.98 / 72.76	0.19-0.37 / 0.28
3 (n = 4)	1.81-1.96 / 1.89	19.55-20.03 / 19.79	0.00	2.02-2.30 / 2.12	Не опр.	74.62-75.44 / 75.06	0.00
4 (n = 9)	1.78-2.92 / 2.27	19.38-21.53 / 20.22	0.00	1.03-2.00 / 1.41	Не опр.	73.75-75.93 / 75.00	0.00-0.110 / 0.028

* In brackets numbers of analyzed samples are given.
** Above line – limit contents, under line – average value.

Non-modified carbonatite columbite contains small quantity of strontium (0.04-0.46% SrO), whereas this element is not established in many crustal varieties. However, the quantity of SrO that reaches the level 0.75 wt % was found in the columbites, which replace the strontium-bearing carbonatite pyrochlores (samples of group 2). It should be noted that both St-columbites contain high quantities of titanium and tantalum, comparing to the other samples.

The samples of group 3 were selected from zones, which arise during development of columbite on pyrochlore of standard composition. It should be noticed that similar rims preserve pyrochlore, which is unstable under hypergenesis conditions. Columbite forms complete pseudomorphoses on pyrochlore when the substitution process reaches the end. These columbites are represented by samples of group 4.

Columbites of the third and fourth groups are characterized by the highest contents of pentoxide of niobium, low level of titanium, and absence of strontium. Some divergences in the established quantities of manganese, titanium and tantalum between these columbites can be explained by the differences in the chemical composition of replaced pyrochlores.

Rare-metal concentrate was obtained in the process of enrichment of ore sample (average in the content of niobium), that was selected from the crust of weathering. According to data of X-ray diffraction analysis, this concentrate contains almost twice as much columbite as the pyrochlore.

Comparison of chemical composition of these minerals shows that a quantity of Nb_2O_5 in the columbite (68.81-75.93%; in the average on 21 analysis 73.32%) is noticeably higher than in pyrochlore (55.82-65.97%; in the average on 22 analyses 61.88%). Thus, columbite from the ores of crust of weathering of the Beloziminskoye deposit is the main niobium mineral both in quantitative and qualitative terms.

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METAMORPHIC TREND OF PD ARSENIDES DEARSENIZATION IN NORIL'SK ORES

[1]Spiridonov E.M., [2]Serova A.A., [3]Zhukov N.N.
[1]ernstspiridon@gmail.com, MSU, Geological faculty, Moscow, Russia;
[2]alevtina.mashkina@gmail.com, MSU, Geological faculty, Moscow, Russia;
[3]nickoliawka@gmail.com, MSU, Geological faculty, Moscow, Russia

Magmatogenic sulfide ores of Noril'sk Ore Field are derivatives of trap formations P_2-T_1 and contain products of sulfide Fe-Ni-Cu and Fe-Ni-Cu-Pb melts crystallization, pneumatholytic altaite, galena and PGM, products of solid-phase transformations, as well as various epigenetic posttrap metamorfogenic-hydrothermal mineralization (Godlevsky, 1959; Spiridonov, 2010; Spiridonov&Gritsenko, 2009).

The area of the East Siberian Platform that was covered with 4 km thick flood basalts and was saturated with the gabbro-dolerite intrusions underwent post-trap subsidence. Derivatives of the trap formation and subtrap strata were subjected to epigenetic metamorphism under conditions of zeolite facies, then prehnitepumpellyite facies at more high temperature and, again, zeolite facies. Therefore, metamorphic loop, after L.L. Perchuk, is observed. Rb/Sr ages of metamorphism based on apophyllite and metabasalts are 232 (first date) and 122 (latest date) Ma (Spiridonov&Gritsenko, 2009). The Pb isotope compositions of galena from metamorphogenic-hydrothermal carbonite veins differ significantly from galena of magmatogenic sulfide ores and corresponds to the Pb isotope composition of the Earth's crust. Model Pb-Pb age of galena from arsenide-carbonite veins is 144 Ma and galena from carbonite veins contained Ag minerals and uraninite is 110 Ma.

Each sample of Noril'sk sulfide ores contains metamorphogenic-hydrothermal micro veins with magnetite and mackinawite. The following minerals are developed as micro-veins and nests (from the earliest to the latest): millerite + chalcopyrite + pyrite ± greenalite (ZF), anhydrate + chalcopyrite + pyrrhotite + stilpnomelane (ZF-PPF), bornite + magnetite + anhydrite (PPF), chalcocite + heazlewoodite (ZF), valleriite + Ni-pyrite (ZF), U-Ag-Bi-Co-Ni formation (with Fe-Ni-Co arsenides and antimonides, native silver, arsenic and bismuth, Ag, Bi, Pb, Mn, and Cd sulfides and selenides; uraninite (ZF), marcasite + quartz + calcite + hisingerite + tochilinite (low T path of ZF) (Spiridonov&Gritsenko, 2009; Spiridonov et al., 2014). Regenerative metamorphogenic-hydrothermal mineralization of Sn, Pt, Pd, Ag occurs near and within the Noril'sk sulfide ores.

Within metamorphosed and brecciated sulfide ores in localities with abundant parkerite, micro-veins and nests of hisingerite and quartz noticeable part of pneumatolytic Sb-paolovite are replaced by Sb free paolovite. In the same type of sulfide ores micro-veins of magnetite, mackinawite and regenerative poor in Sb, but rich in Ag paolovite are present. Also in metamorphosed ores the products of endogenous replacement of paolovite – cassiterite, Sn-contained hydrogrossular, stannite – are developed. Within such localities metamorphogenic-hydrothermal malyschevite $PdCuBiS_3$, sobolevskite, froodite, Pd-containing breithauptite (up to 4 % Pd), vysotskite occur. **Palladoarsenide** Pd_2As is developed in metamorphosed sulfide ores of Talnakh deposit as a product of replacement of pneumatolytic majakite PdNiAs (Fig. 1, left) (Spiridonov et al., 2011). The chemical composition of the palladoarsenide is as follows (n=4, wt. %): Pd 68.67; Pt 1.03; Au 0.13; Cu 1.49; Ni 1.35; Fe 0.34; As 26.10; Pb 0.17; Te 0.03; Sn 0.03; Bi 0.02; total 99.36%; the formula is $(Pd_{1.84}Pt_{0.02}Cu_{0.07}Ni_{0.06}Fe_{0.02})_{2.01}As_{0,99}$. Hence, the mechanism of palladoarsenide formation is: 2 PdNiAs → Pd_2As + 2Ni s-n + As s-n. Near the localities where palladoarsenide occurs there are carbonite veins with Ni arsenides. **Arsenopalladinite** Pd_3As is present in metamorphosed sulfide ores of Noril'sk deposit in association with millerite, chlorite, prehnite (Fig.1, right). The chemical composition of the arsenopalladinite is (n=11, wt. %): Pd 77.27; Pt 1.35; Rh 0.03; Ag 0.19; Cu 0.22; Ni 0.12; Fe 0.44; As 16.89; Sb 0.28; Bi 0.13; Pb 0.22, Te 0.16; total 99.70%; the formula is: $(Pd_{2.91}Pt_{0.03}Fe_{0.03}Ag_{0,01}Ni_{0.01}Cu_{0.01})_3$ $(As_{0,90}Sn_{0.08}Sb_{0,01}Te_{0,005}Pb_{0,005})_1$. **Native palladium** Pd in the form of films rarely is found as overgrowth on native platinum that forms the replacement rim around sperrylite. The process of platinum replacement rim formation around sperrylite

T.L. Evstigneeva named as dearsenization (Evstigneeva et al., 1990). This term can be also applied for Pd arsenides.

Thus metamorphic trend of dearsenization: **palladoarsenide Pd_2As → arsenopalladinite Pd_3As → palladium Pd.**

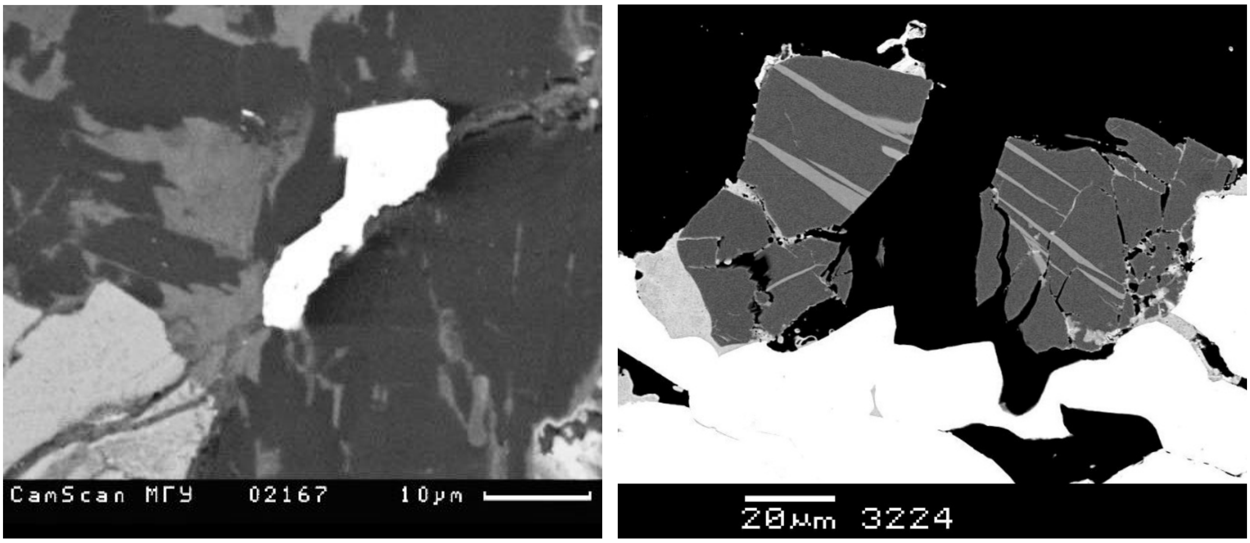

Fig. 1. Left – micro-veins of palladoarsenide (light-gray) within majakite (dark-gray) among sulfides. Tetraferroplatinum (white), Pt-Pd-tetraauricupride (light-gray). Majak mine. Right – arsenopalladinite (white) in association with millerite (light-gray), chlorite, prehnite. Bear Creek mine. BSE image

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URANIUM ISOTOPE OF THE DIAMOND AND ENCLOSING ROCKS OF KARPINSKI-1 TUBE FROM M.V. LOMONOSOV FIELD

Yakovlev E.U., Kiselev G.P.
yakov24lev99@mail.ru, Institute of Ecological Issues of the North, Ural Branch RAS, Arkhangelsk, Russia

The theoretical model of radioactive decay for ancestor and its daughter products foresees the oncoming of the secular equilibrium consisting in nuclide activity equation after a lapse of time (in comparison with duration of geological processes). For under consideration uranium series (isotopes U238 and U234) this period is about 1 million years. Accordingly, in natural compounds occurred more than 1 million years ago in uranium series the secular equilibrium should be observed. But in the environmental conditions given equilibrium is not preserved because of the different physical and chemical processes. Particularly well the separating effect of even uranium isotopes (Cherdyntsev-Chalov effect) occurs in the hydrosphere Earth objects [4]. As a rule, secular disequilibrium in nature takes place due to differences in the radionuclides mobility. The degree of disequilibrium depends on both the intensity and the exposure time of natural solutions on rocks, so the uranium series disequilibrium is widely used to study various processes in "water-rock" system. [3] Consequently, minerals and rocks exposed to natural waters are depleted of uranium-234 in a varying degree [1].

Numerous studies of the isotopic composition of uranium of various rocks and minerals demonstrate significant deviation ratio of ^{234}U / ^{238}U from equilibrium [3]. As a rule, recent beds, such as peat, bottom sediments, soils, are significantly enriched by U-234. This is due to the fact that the ^{234}U atoms remote from bed rock accumulate in the re-deposited rocks exposed to natural waters [2,4]. Uranium-234 enrichment is also characteristic for the recent volcanic deposits. For the ancient rocks the activity ratio of even Uranium isotopes for the above reasons, comes close to the equilibrium. The research of the uranium isotopic composition of solids within the Northern Tien Shan ore beds allowed to reveal the spatial trends of γ-value, consisting in excess reduction of ^{234}U from the center in a distal direction of the ore fields, to background levels closed to 1. The regular increase of the uranium isotopic ratio is also observed in groundwater draining the ore bodies [3]. Thus, non-equilibrium uranium of solid and liquid phases is a sort of prognostic criteria for mineral exploration. However, it is necessary to point out that currently the isotopic composition of kimberlite bodies uranium is still poorly explored and a judgment about the prospects of non-equilibrium uranium using for diamondiferous deposits research remains an open question.

We studied the Uranium-isotopic composition of sample series of diamond and enclosing rocks of Karpinski-1 tube from M.V. Lomonosov field relating to Zolotitsky group of Zimneberezhsky district of the Arkhangelsk diamond province. The purpose of this study was to analyze the isotopic composition of uranium in diamond and enclosing rocks and to estimate degree and potential reasons of fractionation in «ores- enclosing rocks» system. The total uranium isotopes of samples were studied for this.

For the analysis of the uranium isotopic composition in the total uranium of rocks specimens were prepared by complete rock dissolving when subjected to strong acid mixture $HClO_4$ and HF in the ratio 4:1. The sample fully unsealed in such way was transformed into the nitric acid solution from which uranium isotopes were extracted with tributyl phosphate with subsequent purification from interfering radionuclides with similar energies of alpha particles. The activity of Uranium isotopes precipitated electrolytically on stainless steel disks was measured using the alpha-spectrometer "Progress 2000" with a semiconductor detector. Uranium output was controlled by the activity of indicator – synthetic isotope ^{232}U, added in the specimen.

The analysis results of Uranium-isotopic composition of radiochemically prepared samples are shown in Table 1. The represented tabular data point at significant differences in the uranium content and γ value ($\gamma = {}^{234}U / {}^{238}U$) in the studied samples. For all samples relatively low concentrations of uranium are characterized. Mainly, the data indicate a significant deviation of the isotopic ratio of uranium as upward bias so downward bias of light isotope uranium-234, in such case γ-value changes from 0.96 to 1.60. Most of the studied samples are characterized by $^{234}U/^{238}U > 1$ values, with the exception of Kar-1 and Kar-5 samples, where there is a shortage of uranium-234.

This fact can be explained by the predominate process of pre-emptive removal of the ^{234}Th recoil nucleus by natural leach solutions – groundwater. However, the explanation of the $\gamma={}^{234}U/^{238}U$ high values in the total uranium faces difficulties, when the rock is viewed as a completely open geochemical system. In this case, we do not take into account the process of close Uranium isotope separation without the participation of the liquid phase in the individual mineral fractions of rocks with different concentrations of uranium, which subsequently determines the observable uranium-isotope composition of the original rock [2].

Table 1

The isotopic composition and uranium concentration of the diamond and enclosing rocks of Karpinski-1

Sample	Brief description of the sample	Weight, g	Radiochemistry, date	Concentration of uranium, $n*10^{-6}$, g/g	$\gamma={}^{234}U/^{238}U$ ± 0.02, Bq/Bq
Kar-1	tuffites (ore)	10.00	05.11.14	0.15	0.96
Kar-2	tuffites (ore)	10.00	07.11.14	0.78	1.22
Kar-3	red sandstone	10.00	08.11.14	0.81	1.45
Kar-4	sandstone brown in contact with tuffites	10.00	11.11.14	1.08	1.16
Kar-5	sandstone in contact with tuff	10.00	14.11.14	1.39	0.96
Kar-6	green siltstone	10.00	16.11.14	0.12	1.10
Kar-7	sandstone	10.00	24.11.14	0.98	1.60

Thus, the question of significant fractionation of Uranium isotopes exerted in the increasing of ^{234}U excess within the ore deposits compared to non-metallic areas can be uniquely solved just from the standpoint of the individual mineral fractions study, the performance of the experiments on comparative leaching, to establish the stage of involvement of natural solutions in the formation of the initial isotopic composition of rocks. At the same time, the increase of analysis statistic both in terms of area and in section of kimberlite fields is necessary for identification of the spatial trends.

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CHARACTERISTIC FEATURES OF MANGANESE ORE FORMATION CONDITIONS IN CENTRAL SELEZEN DEPOSIT (KEMEROV OBLAST)

Oksana Razva
Academic Advisor **Raisa Abramova**
Okean-ya@sibmail.com, abramova_rn@mail.ru, National Research Tomsk Polytechnic University, Institute of Natural Resources, Tomsk, Russia

Starting production development of Selezen deposit (Kemerov Oblast) could be the problem-solving in decreasing the existing manganese ore scarcity and, consequently, their import into the Russian Federation. It should be noted that, in this case, the following factors are rather important and should be taken into consideration: insufficient available exploration information (i.e. exploration maturity including both horizontally and vertically); exploration information involving different ore occurrence aspects; and the representation of available materials (i.e. maps) [1].

Geologically, Selezen deposit is located in the S-W Biysk composite anticline embracing two horizons – lower and upper. The lower horizon includes Eskongian suite slate-quartz-carbonate deposits, Vendian-Lower Cambrian (V-€1es) and Manzherogian suite quartz-carbonate volcanic deposits, Lower Cambrian (€1mn); whereas, the upper horizon includes Cretaceous-Lower Palaeogene (K2-P1) weathering crust formations, Upper Palaeogene- Lower Neogene (P2-N1) weathering crust redeposition products, as well as recent deposits [2].

Petrographic and mineralogic rock and ore characteristics were investigated, chemical and spectral analyses were conducted and a reference bank of different rock and ore samples and thin sections was designed.

The investigated samples showed such a prevailing structure as gradual transformation from low grade veined-disseminated ores via nested- disseminated, veined-disseminated breccia and simply breccia into high grade compacted ores. Cryptocrystalline, fine-grained colloform textures are predominate. Thin 0.2-1.0 m. carbonaceous ore layers with a manganese content of up to 12.42% are found in the structural eluvium of argillaceous-siliceous slate weathering crust in the upper Eskongian suite formation. Due to thin layers and low manganese content such ore deposits are non-commercial.

Quartzite breccia ores are confined to the fractured zones in quartzites and are widely spread within this area. Homogeneous breccia ore fragments are sharp isometric- elongated quartzites. Small fragments are of 0.02-0.1 mm, large-sized – from 28 mm to 10-20 mm. Quartzites are cemented either by compacted maganese (cryptomellane-hollandite) mass or quartzite maganese (maganese mass contains small quartz waste) aggregates. Compacted segregations are often contoured by cellular aggregates, In most cases rather thick maganese concentrations are confined to upswelling stockwork zones. The size of compacted maganese masses range from 0.05-0.1 mm to 0.4-0.6 mm. The quartz grain size in quartzite maganese aggregates is 0.02-0.08 mm. while maganese segregations from 0.02-0.05 to 0.15 mm.

Veined-disseminated ores exhibit isolated maganese hydroxides of up to 20 mm., showing similar structural features to those of the above-described ores, whereas, these segregations show colloform zonal texture under reflected light. Quartzite fragments are not more than 5-7 cm. in size.

Veined ores include numerous elongated quartzite fragments, size from a fraction to 10 cm. and cemented by quartz-maganese materials. The vein thickness is up to 5-10mm.

Wash ores are unconsolidated masses of powdered earthy structure consisting of not only fine ore material but also argillaceous and sand material, in which a considerable volume of sub-rounded compacted oxide maganese ore fragments sized from 0.2 to 30-50 cm. to large boulders can be found, as well as brown iron ore (hematite) and silica rocks. Ferrum oxides- limonite and hydrogoethite can also be observed.

Maganese mineralization involves psilomelane (cryptomellane- hollandite) and maganese peroxide (i.e. composite gel forming alternating gradation series), as well as an insignificant volume of goethite, limonite and hydrogoethite, and isolated magnetite and pyrite grains. According to its mineral composition these ores could be classified as goethite- psilomelane. The morphostructural features of these maganese minerals, i.e. psilomelane, pyrolusite, cryptomelane and asbolite, and, especially their interpenetrations, indicates possible production of polymineral maganese.

The basic rock-forming mineral is quartz, while accessory constituents include muscovite, hydromica and kaolinite and an insignificant volume of calcite and apatite.

The chemical analysis of sedimentary silicates, siliceous carbonates showed a hundredth and/or decile percent of maganese. Fine-floured maganese indicates the fact that ore accumulates chemically, and partially, bio-chemically.

Subsequent post-sedimentation alterations and regional metamorphism of quartzite thiscknesses furthered the formation of primary low-grade ore accumulations [3, 4]. As a result of oxidation, sedimentary maganese ores and maganese-containing rocks (containing fractioned maganese), typically, disseminate throughout the fractured host rocks forming infiltration-type deposits.

As quartzites are friable in structure they become intensively crushed as a result of active regional tectonic activities, especially in zones of direct rock-rock contacts. Intense fracturing advanced massive infiltration for maganese oxides and furthered the formation of reticulate veined ore mineralization.

Subsequently, these rocks were partially eroded to marshallit which belong to the carboneous and wash ore group. Mineral marshallit aggregates are significantly heterogeneous and exhibit high dispersion. The ore phase in marshallit is rather low- 40-45%. Loose carbonceous ores including insignificant iron-maganese concretion bodies could be found within selected areas. Apparently, these bodies formed due to secondary maganese disproportionation – secondary impregnation, i.e. dissolved (colloidal) maganese. This can be found throughout the Selezen deposit.

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IMPACT-COSMIC-METASOMATIC ORIGIN OF MICRO-DIAMONDS FROM KUMDY-KOL DEPOSIT, KOKCHETAV MASSIV, N. KAZAKHSTAN

Lioudmila Tretiakova, Alex Lyukhin
ltretia@gmail.com, St. Petersburg Branch Russian Mineralogical Society

Impact events came to pass on the Earth history and they played not only negative character, being causes of multiple catastrophes, but positive influences as well, delivered a lot of useful elements and minerals on the Earth: Diamonds, REE, Pt-, Au-, Ag-, Fe-, Ni-, Cu-ores, oil, gas and so on. Any collision extraterrestrial body and the Earth had left behind the "signature" on the Earth's surface. There in we examine the "fingerprints" of an event was caused Kumdy-Kol diamond-bearing deposit derivation, best-known "metamorphic" diamond locality among numerous UHP terrains around the world. The deposit alone host reserves in excess of 2500 million carat of diamonds, which is greater than all known diamond reserves worldwide; it has average diamond grade 19–27 carat/ton [1].

Description of Kumdy-Kol diamond-bearing deposit genesis hypothesis – mantle, crust-mantle, and fluid-metasomatic – readers can find in the literature [2 – 5]. Now, we are offering new impact-cosmic-metasomatic hypothesis of Kumdykol diamond-bearing deposit origin.

Kumdykol diamond-bearing deposit, Kokchetav massif, N. Kazakhstan located within ring structure about 4 km in diameter, in the form and size compare with small impact crater [6].There is important impact event signature.

Diamond-bearing domain had been formed on the peak of UHP metamorphism provoked by comet impact under oblique angle on the Earth surface. As a result, steep falling system of tectonic dislocations, which breakage and fracture zones filling out of host rock breccia with blastomylonitic and blastocataclastic textures, has been created [2-4]. Diamond-bearing domain has complicated lenticular-bloc structure (1300 x 40-200 m size) and lens out with deep (about 300 m). Compositions of diamond-bearing rocks are dominate garnet-biotite gneisses with graphite, sulfides, water, ferriferous-oxides, REE and discontinuous lenses of carbonate, chlorite-tremolite quart, garnet-pyroxene rocks, amphibolised eclogites [5]. The feature of diamond-bearing rocks is its strong metasomatic alteration with the strongest contrast revealed in a gneissose substrate [2, 3]. High abundances of U, Au [1] and Ti marked in the host rocks.

Spatial diamond distributions have not precise lithological lines. Microdiamond (~10–50 мк size), graphite and coesite crystals occur in intergranular interstices and within the grains of all rock-forming minerals. Diamond, graphite, and coesite distributions are not random but tends to be associated with fractures in rocks and rock-forming minerals [5].

Comet core was, possibly, consisted from chondritic matter [7] with abundances of nano diamonds, having abnormal values of noble gases (He, Ne, Ar, Xe) + IDP (diamonds, SiC, graphite with high contents of carbon, noble gases, and ^{26}Mg from the decay of extinct ^{26}Al.) + presolar grains (carbonaceous matter (including diamond and graphite), SiC, Si_3N_4, Al_2O_3, $MgAl_2O_4$, $CaAl_{12}O_{19}$, TiO_2, $Mg(Cr,Al)_2O_4$, silicates, TiC, Fe-Ni metal, noble gases and trace elements [8]). These evaporated comet substance was injected under high pressure into previously metamorphic host rocks target, appeared impact-cosmogenic source of diamond nucleuses and/or diamonds themselves. Water-vapor comet cloud (with H_2O, C, CH, CH_4, CN, HCN gases) and fine dispersed comet core, survived during comet passing through dense air layers, mixed with vapor and melting target rocks and produced complicated, saturated by carbon fluid-melt [9] that was a source of epitaxial diamond growth on carbonaceous matter seeds imported of a comet.

Signatures of UHP metamorphism are the presence of diamond, lonsdaleite, coesite, moissanite (SiC) [1], dislocations and abnormal birefringences of diamonds, syngenetic intergrowth mentioned minerals with rock-forming minerals, planar structure in quart, syngenetic inclusions UHP minerals in rock-forming minerals and also inclusions of meteoritic matter (magnetite, hematite, iocite, troilite, α-Fe, Ni-Fe) having various fanciful forms (globules, small dump-bells, drops, spherules and so on) [10].These evidences observed in metamorphic host rocks have point out to the passing through these rocks shock wave with peak pressure ≥ 50 kbars.

Conditions of retrograde metamorphism have been created after impact under sharp falling pressure and slow rocks cooling. Fluid-melt supported to metasomatic alterations target host rock that tracing of the derivation of amphibolite and granulite facieses mineral associations, inclusion compositions of high- and low-pressure minerals in zircon [11, 12] and garnet [13], syngenetic intergrowth biotite+K-feldspar of omphacite and garnet crystals rims, spinel rims of garnet crystals, graphite rims of diamond crystals, garnet chloritisation, chlorite-sericite host rocks matrix, and so on.

Syngenetic polycrystaline nano-inclusions in diamonds represented by oxides Si, Ti, Fe, Cr with trace element impurities: Mg, Ca, Al, К, Na, S, P, Pb, Nb, Cl, Zn, Ni, and Ca-Ti-containing zircon, ThxOy, $BaSO_4$ [14], Si-P-К-containing glasses with high abundance Si, low К, and also K-Si-COH fluid inclusions with high abundance К, and low Si [15].

Carbon represents by diamond, graphite, transition forms with diamond structure, lonsdaleite, chaoite, alpha- and beta-carbines, X ray amorphous skeletal forms. Diamonds have different morphologies: cubes (predominate), distorted forms, skeletal and spheroid crystals, octahedra, twins. Syngenetic diamond/graphite growth, coated diamonds with graphite rim and graphite crystal are observed [16]. Carbon matter composition compared with those presolar nanodiamonds.

Values of diamond carbon isotope composition of б^{13}C (–8.9 through –27 ‰) compare with б^{13}C (-5 through -31 ‰) in meteorites. Diamonds from various rocks are differentiated on their carbon isotopic pattern: diamonds from gneiss have lighter isotopic compositions relatively to those of pyroxene-carbonate and garnet-pyroxene rocks. Varieties of carbon modifications and its isotopic compositions suggest to discrete carbon sources. Values of graphite carbon isotope composition of б^{13}C are lighter than those in diamonds [2] that do not supported the hypothesis of transformation graphite to diamond for this deposit.

^{3}He/^{4}He isotopic ratio (7x10^{-1} до 8x10^{-9} ‰) of Kumdykol diamonds [17, 18] is significantly higher than ^{3}He/^{4}He ratio of IDP (> 10^{-4} ‰), Earth's atmosphere (1.4x10^{-6}), solar wind (4.3x10^{-4}), MORB-source mantle (1.1x10^{-5}), mantle magmas (> 10^{-5} ‰)[[19]. Ne, Ar, Xe also present in these diamonds. ^{3}He occurs in diamond lattice and inclusions (more abundance, then in the lattice) in diamonds [20], it means that ^{3}He was trapped by diamonds during its formation outside Solar System [21], presuming that ^{3}He more likely primordial galactic component.

Latter conclusion supported by high nitrogen content (up 3300 ppm) and enrichment by H, Ni [22]. Values of б^{15}N (+5.3 through +25 ‰) in diamonds compare to those of comet coma gases (CN, HCN), diamonds from chondrites and presolar diamond grains. Diamond preservations, low nitrogen aggregation state (Ib +1aA) depend from sharp falling pressure and gradual thermal cooling conditions. Very small diamond sizes suggest on short-term Kumdikol diamond growth process.

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GENETIC ASPECTS OF A NON-GRANITIC PEGMATITE FAMILY LA PANCHITA, FROM THE 1 GA OAXACAN COMPLEX, OAXACA STATE, SOUTHERN MEXICO

[1,*]Shchepetilnikova V.M., [1]Solé J., [1]Abdullin F.R., [2]Pavlinova N.V.
[*]shchepetilnikova@gmail.com, [1]Universidad Nacional Autynoma de Mexico, Mexico city, México; [2]Peoples Friendship University of Russia, Moscow, Russia

The Oaxacan Complex is the largest (~10,000 km^2) outcrop of Neoproterozoic basement rocks, exposed on the Oaxaca state territory, southern Mexico. It is composed of sedimentary and magmatic rocks that were metamorphosed up to the granulite facies during the Grenville orogeny (Ortega-Gutiйrrez et al., 1977). The Oaxacan Complex is considered the southern portion of the Grenville belt in the North American continent, which extends from the northeastern part of Canada to southern Mexico (Ruiz et al., 1999). The Oaxacan Complex, as well as other lithologies of the Grenville belt, is characterized by multiple intrusions of pegmatite dikes and lenses along its extension.

Till now most pegmatites of the Oaxacan Complex were studied with the aim to develop different radiometric dating methods using zircons, micas and other minerals because of its giant crystal size (Fries and Rincyn-Orta, 1965; Fries et al., 1962; Anderson and Silver, 1971; Ortega-Gutiйrrez et al., 1977). But mineralogy, geochemistry and genesis of these pegmatites were almost not mentioned in the literature. The pegmatites of the Oaxacan Complex, depending on their mineralogical composition, can be divided into those with simple granitic mineralogy (with quartz, feldspars, and micas) and into those with uncommon mineralogy (with scapolite, pyroxene, and calcite).

This work presents the results of a detailed mineralogical, geochemical and geochronological study of a pegmatite with uncommon mineralogy, named La Panchita, which is located in the central part of the Oaxacan Complex. The La Panchita is a group of post-tectonic miarolitic pegmatite bodies, emplaced within a pyroxenitic dike, which in turn concordant intruded the host quartz-feldspar gneisses. These pegmatites have zonal mineralogical composition: calcite core and pyroxene-scapolite-phlogopite border zone. Basically La Panchita pegmatites consist of minerals of calcic-alkaline series: meionite $Ca_4Al_6Si_6O_{24}CO_3$ (calcic type of scapolite), diopside-augite $FeCaSi_2O_6$ – $(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al)_2O_6$ (calcic type of pyroxene), calcite $CaCO_3$, apatite $Ca_{10}(PO_4)_6(OH,F,Cl)_2$, and phlogopite $KMg_3AlSi_3O_{10}(F,OH)_2$. On the territory of the Oaxacan Complex no other bodies with similar mineralogical composition has never been found, but on the Canadian territory of the Grenville belt a lot of similar pegmatite mines were exploded to extract apatites and phlogopites during the first half of the XX century. Before now, it has been considered that the pegmatite family La Panchita was a granitic type of pegmatites and formed during the last stage of the Grenville orogeny by partial melting of the host gneissic rock (Haghenbeck-Correa, 1993; Arenas-Hernбndez, 1999). The geochemical study of trace elements in zircons and apatites from the La Panchita pegmatites shows that these geological bodies do not have any genetic relationship with rocks of granitic composition, but formed during an ultramafic or alkaline, SiO_2 depleted, melt evolution, like a carbonatite or a syenite rock.

The isotopic study shows that the origin of the La Panchita pegmatites is magmatic, not metamorphic, i.e., the pegmatite material is not a product of the host rock melting, but was formed from a material genetically akin to the mantle.

The field observations and the relatively young age of phlogopite, apatite and zircon crystallization from these pegmatite bodies, compared to the age of the same minerals from the host rock, show that the pyroxenite dike intruded the cool host rock (gneisses) and partially melted it.

The absence of any feldspar in the La Panchita is a distinctive feature of the Oaxacan pegmatites from similar Canadian pegmatites. La Panchita pegmatite family formation was a result of the fluid phase fractionation during progressive crystallization of the pyroxenite dike. The fluid phase enrichment with Ca, depletion of Al_2O_3 and SiO_2, and presence of a significant amount of volatiles (CO_2, Cl, SO_4, F and OH) caused the crystallization of scapolite instead of calcic feldspar (anorthite) and also cause the crystallization of a calcite core instead of the classic quartz core. According to Shmakin et al. (2007) pegmatite bodies with the same mineralogical composition were formed at the time when the host rock have cooled down to a temperature of 400-450° C, and the pressure was 400 MPa.

Thereby the La Panchita pegmatite family formation as well as the host pyroxene dike is likely related to the evolution of ultramafic alkaline parental magmas intruding into the Oaxacan Complex rocks under an extensional tectonic framework during the last stage of the Grenville orogeny.

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SPHERULITES AND PHENOCRYSTS IN THE GLASSES FROM THE IMPACT MELTS OF KARA IMPACT CRATER (NENETS AUTONOMOUS OKRUG, RUSSIA)

Dolgushina A.O.
a.dolgushina.geo@gmail.com, Institute of Earth sciences, Saint Petersburg State University, St. Petersburg, Russia

Kara impact crater is located on the SW shore of the Baidarata Bay (the Yugorsky Peninsula, Russia). Its diameter is c. 60 km. Together with Ust-Kara impact crater, located in 5 km to NE and almost entirely covered with water of the Kara sea, it composes Kara twin impact structure. It was formed c.70 Ma ago [1] on a shallow shelf as a result of an impact of two large parts of a single projectile that broke apart near the Earth surface [2]. The target was the heavy dislocated rocks of NE flank of the Central Phai-Khoi anticline presented by PR shales, O-C shales and limestones with D diabasic dikes and sills, and P molasse [3].

The Kara impact rocks are allogenic breccias and suevites with lenses of impact melts and clastic dikes with total thickness c. 2 km. The percentage of impact melts is very low (<1%) for an impact crater of such scale, that is believed to be a result of the loss of energy due to the ejection and vaporization of the water that covered the target rocks at the moment of the impact [3]. The impact melts occur within the suevites and allogenic breccias as bodies of complex or sheet-like forms with thickness from <1 to 10-15 m and length from 1 to 200-300 m.

The studied impact melts were collected from an outcrop near the Kara river by geologists of ZAO "Polyargeo" in 2008-2009. Macroscopically they are dark-, violet-gray glassy rocks of irregular oblong shape several cm in size distributed among suevites. Microscopically in the melts can be observed areas with different degree of recrystallization: from fresh and <10% recrystallized glasses and areas with up to 60% of recrystallization. Fresh glasses can be presented by massive glass or with fluidal texture. Chemical composition of the glasses is a mixture of Fe-Mg silicates, feldspars, and quartz.

Spherulites. In the glassy areas with fluidal texture small slightly oblong rounded spherulites up to 1 mm in size occur. Some of them are shattered into blocks. In plane-polarized light they are colorless occasionally with brown areas. In cross-polarized light the spherulites present abnormal behaviour close to the conoscopic interference pattern. Often they are arranged in line with the fluidal texture. Investigation of the spherulites via electron microscope allowed determining their radiating structure. Also tiny voids in the central parts of several spherulites were observed that implies that the fibrous aggregates grew from the periphery to the center of a spherulite.

At first glance, the spherulites chemically are close to feldspar. And feldspar spherulites were observed before in impact melts of Kara crater from an outcrop near the Anaroga river [4]. Although in the studied melts the chemical composition of the spherulites, counted on 8 atoms of O, shows lack of alkali and Al: K+Na+Ca – 0,38-0,48 instead of 1, Al – 0,55-0,63 instead of 1. An interesting fact is also that the chemical composition varies within a spherulite. In the central parts (that are optically brown) there are increased contents of Al (by 3 wt.%), K (by 3,5 wt,%), decreased concentrations of Ca (by 1 wt.%), and Ba appears. Also the stoichiometry is getting closer to the feldspar composition (the amount of alkali is up to 0,84). By all appearances, Ba-containing zones are a result of later crystallization than surrounding ones as they located at the peripheral areas relatively to the center of growth in the spherulites.

The process of formation of the spherulites is unclear. Although, according to their relation with the fresh glass and appearance it can be inferred that they are more likely syngenetic with the surrounding matrix than are results of a secondary alteration of the rock. The arranged distribution concordant with the fluidal texture of the rock, in turn, implies that the spherulites were formed while the groundmass was still in the liquid state.

Phenocrysts. In some areas of the massive glass there are several sites with occurrence of tiny crystals that are phenocrysts separated from the impact melt. They are very fine filamentary or needle-like aggregates c.10 μm long and <1 μm thick and distinguishing from the matrix by tone.

Some of them look like separate straight "needles" others have additional short branches on both sides of a "needle". The appearance of the phenocrysts allows concluding that they were formed as a result of skeletal growth. There is distribution of concentrations of the petrogenic elements between the phenocrysts and the groundmass. The phenocrysts show much higher contents of Mg (6,85-13,84 wt.% for the phenocrysts; 0,55-75 wt.% for the matrix), while the groundmass represents higher contents of Al (in average by 2-3 wt.% higher), Na (in average by 3 wt.% higher) and K (in average by 1,5 wt.% higher). The bigger and the more often the phenocrysts are the more intensive the phase contrast between them and the surrounding glass is.

An accurate diagnosis of the nature of the phenocrysts is very difficult at the current stage of the study. Their chemical composition, counted on 6 atoms of O (because of a relative similarity to the composition of pyroxene) can be presented as a formula:

$$Na_{0,00\text{-}0,18}Ca_{0,07\text{-}0,18}Mg_{0,55\text{-}1,13}Al_{0,43\text{-}0,64}Fe_{0,23\text{-}0,35}Si_{1,70\text{-}1,96}O_{6}.$$

Skeletal crystals develop when cooling and solidification of a melt is very fast and the growth of crystals is extremely rapid. It means that the phenocrysts were formed by crystallization from the initial melt but not as a result of recrystallization of an already solidified rock. At the same time, presence of phenocrysts reflects slightly lower solidification rate than when an entirely amorphous phase forms. What caused the difference in cooling rates of very close parts of the melt is unclear.

The described spherulites and phenocrysts sporadically occurring in the glasses of the impact melts of Kara impact crater indicate heterogeneity and complexity of the process of cooling and solidifying of the impact melts. That reflects complexity and explosive dynamics of the impact process.

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S-IV

GEMOLOGY

IDENTIFICATION OF NATURAL, NATURAL-TREATED AND HPHT SYNTHETIC DIAMONDS BY OPTICAL SPECTROSCOPY

Vins V.G.
Evgvins@gmail.com; «VinsDiam, Ltd.», Novosibirsk, Russia

Finding reliable methods of identification of natural diamonds from treated and synthetic diamonds is extremely important for the global diamond industry. Optical spectroscopy techniques, especially IR-Vis-UV absorption, in combination with luminescence at different excitations and certain practical skills [1-2] allow performing almost 100% accurate identification.

The first step is to separate a diamond from a simulant. The peak at 1332 cm^{-1} in the Raman spectra is the "brand identity" of the diamond. Moreover, the FWHM factor can show how perfect a diamond crystal is, with the perfection of the crystal growing from natural and CVD single crystal type IIa diamond through natural type Ia diamond to HPHT synthetic type Ib diamond to polycrystalline CVD-diamond. The presence of IR intrinsic absorption in the range of 4000 to 1600 cm^{-1} is also indicative and observed in all diamond types.

The second step is to detect HPHT synthetic diamonds using a strong Fe-B-Nd–magnet. Most HPHT synthetic diamonds contain ferromagnetic inclusions and are attracted to the magnet. However, modern growth technologies allow producing crystals that cannot be detected with the help of the magnet test and must be subjected to other tests.

The third step is the identification of colorless diamonds. Natural type Ia diamonds are detected by the superimposed IR absorptions due to A, B centers and platelets in the range of 1500 to 1000 cm^{-1}, as well as hydrogen-related absorption (3107 and 1405 cm^{-1}) that may be present in a variety of concentrations. The visible and UV spectra often reveal N3 absorption typical of natural diamonds. The presences of these absorption bands along with the colorless appearance provide unambiguous indication that diamonds are natural and untreated. Colorless type IIa diamonds are detected based on their photoluminescence spectrum. When laser-excited at 532 nm, the spectrum of colorless and near-colorless untreated type IIa diamonds shows a much weaker band at 575 nm compared to the 637 nm band due to the concentrations of NV$^-$ and NV°-centers. On the contrary, the 637 nm band dominates the spectra of HPHT treated colorless type IIa diamonds because residual nitrogen defects dissociate and the concentration of electron donors (C-defects) increases. As a result the concentration of NV$^-$ centers exceeds that of NV^0 centers. This feature is the main identification criterion for natural colorless and natural color-treated type IIa diamonds. Diamonds can be identified as colorless HPHT synthetic type IIa diamonds if they a) have a weak absorption at 270 nm related to C centers; b) show no tatami graining when observed under an optical microscope between two crossed Polaroid plates; c) reveal mixed growth sectors readily seen in UV luminescence and not typical of natural diamonds; d) exhibit stronger PL when excited with shorter UV radiation (200–220 nm) rather than when excited with longer wavelengths (~360 nm).

The fourth step is the identification of colored diamonds. Natural diamonds with high concentrations of N3 centers are yellow which makes them more valuable than colorless or light yellow diamonds. The N3 center is observed not only in absorption, but also in PL spectra, with the absorption and luminescence spectra showing mirror symmetry. Upon UV excitation, diamonds containing only N3 centers exhibit bright blue uniform luminescence. Identification of these diamonds is based on the fact that N3 centers are not formed in synthetic diamonds upon HPHT treatment. HPHT color-enhanced natural type Ia diamonds reveal these centers only in combination with C and H3/H2 centers.

Natural green diamonds have a few microns green coat, which is a top layer produced by natural alpha radiation. These diamonds show vacancy-related GR1 absorption. An example of such diamond is the famous Dresden Green diamond. The intensity of the GR1 band is extremely low in this diamond, only 0.2 cm^{-1} compared to other absorption features. So the diamond only appears to be green because of its large size (40.7 carats). If the spectrum of a diamond has a stronger GR1 absorption (compared to that of the Dresden Green) it can be argued that the green or blue-green color of this diamond has an artificial radiation origin.

Irradiation is often used in combination with subsequent annealing (T≥ at 800°C) to enhance light yellow type Ia diamonds to a deeper yellow shade. The main centers produced are 595 nm, H3 (A+V) and H4 (B+V). The concentrations of H3 and H4 centers in type IaAB diamonds that contain both A and B centers are in the following proportion: [H3] / [H4] α [A] / [B]. In nature, there are diamonds the color of which is mainly due to the absorption of the H3 center. But in this case no band at 595 nm is observed, which is the main identification feature. Moreover, such natural diamonds have weak absorption associated with the H4 center, even though most of the nitrogen is present in the form of B centers. This differs from color-enhanced diamonds in which the ratio of H3 and H4 centers is consistent with the equation shown above.

Pink or red color can be obtained by irradiating and annealing natural and synthetic type Ib, Ia+Ib, and Ib+Ia diamonds. The color appearance may resemble that of a natural diamond but absorption and luminescence spectra of irradiated diamonds reveal NV^- centers with a sharp line at 637 nm as well as related H1a and H1b absorptions in the IR region. The unique red or pink color of natural diamonds is associated with an absorption band at 550 nm. In addition, such diamonds show no luminescence and absorption due to NV^- centers which allows them to be easily detected.

The blue color of type IIb diamonds is caused by substitutional boron ions. Boron concentration calculated from the intensity of the corresponding IR absorption bands in very rare natural blue diamonds does not exceed 3 ppm. On the contrary, HPHT synthetic diamonds doped with boron have a much higher concentration of boron. Accordingly, the color of such crystals can vary from light blue to dark purple. Moreover, boron concentration in synthetic diamonds strongly depends on the growth sectors, the highest being in <111> planes, the lowest in <100> planes. This inhomogeneous color distribution can even be seen on visual examination, thus making the detection easy.

Yellow-green color of natural diamonds that were HPHT treated at 1800-2300^{0}C is attributed to superimposed transmission of nitrogen centers – N3-, H3/H2-, and C centers. These centers are not observed in such combination in natural diamond spectra. When HPHT treated at temperatures over 2500°C, natural diamonds become near colorless as all nitrogen defects transform to B center and the diamond is classified as type IaB. The absence of a hydrogen-related line at 3107 cm^{-1} is indicative of HPHT treatment, because it is normally present in the spectra of natural type IaB diamonds.

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CRITERIAS OF PROGNOSIS OF PRIMARY JADE DEPOSITS IN CENTRAL KUNLUN AREA, CHINA

Ignatov P.A., Zhao Heng
petrignatov@gmail.com, Russian State Geological Exploration University MGRI-RGGRU, Moscow, Russia

Primary and placer deposits of jade are widespread in Central Kunlun. Among endogenous deposits there are also Lyushei (Lyushitag), Sanzhutag, Kanakan, Karala, etc. mentioned [Bukanov, 2008]. Most valuable white jade and other jade types are occurring here and described by Li Min, Lu Hua and other specialists in monographs published in Chinese in 2010 and 2012. Publications related to geology of that region jade deposits on Russian or English are unknown to the author, except only paper of K.I.Bogdanovich dd. late of XIX century [Bogdanovich, 1892]. The area is quite extensive and obviously has potential for new jade deposits discovery. Conceptions about possible geological-industrial types of primary jade deposits and criteria of their prognosis should be clearly defined.

There are two geological-industrial types of endogenous pneumatolitho-hydrothermal deposits distinguished by E.Y.Kievlenko – Alpine type ultrabasites and dolomitic marble [Kievlenko, 1983]. Similar classification was given in methodic recommendations of Russian State reserve commission where two geological-industrial types have been defined [Methodic…, 2007]. The first deposit type is related to ore-controlling rocks of dunite-peridotite formation, the second one – to granitic. Deposits of the first type are connected to altered serpentinitic metasomatic rocks of ophiolites. Jades of the second deposits type were localized in altered dolomitic tremolite-calcite magnesia skarns.

Four formation types of primary jade deposits have been defined by R.V. Kolbantsev and A.Z. Konnikov [1986] 1. Altered ultrabasitic – at cold contacts of serpentine ultrabasites with basic and less acid rocks and host carbonate-terrigene rocks including their xenoliths; 2. Altered mafic – in inclusions of basic rocks in sedimentary-volcanic, metamorphic and granitic rocks; 3. Altered carbonate – contact-metasomatic in zones of active metasomatic contacts of granites with dolomites; 4. Altered calciphyre – related to metasomatic by carbonate rocks of granulite schist-gneiss complexes of early Archean.

Generalizing available data of jade deposits geology the main criteria of geological-industrial types of jade deposits are worth noting for its prognosis (Zamaletdinov, 1975, Kolbantsev, Konnikov, 1986, Methodogical, 2007 and etc.)

For the first type deposits in the Alpine-type ultramafic rocks they are as follows: ultramafic massifs in zones of intense tectonic dislocations, including boudinaged bodies of serpentine melange; peripheral portions of ultramafic massifs in which xenoliths of the surrounding rocks are common and often tectonically disturbed; contacts of ultramafic rocks with discordant dikes and gabbro bunchs; contacts with later granites; contact of ultramafic rocks with host rocks represented by volcanics and tuffs of basic composition, greywackes and carbonate rocks; areas of metasomatic rocks – rodingites, diopsidites, tremolites, epidosites, albitites, antigorite serpentinites.

For contact-metasomatic aposkarn deposits related to granite-diorites it is necessary to note the following criteria: granite massifs occurring disharmonious relative to the folded structures enclosing Proterozoic or Lower Paleozoic carbonate-terrigenous formations; steeply dipping (tectonized?) granite contacts; xenoliths of dolomitic marbles in the contact zones; areas of epidotization, sericitization and carbonation; magnesian skarns expressed by quartz-diopside, amphibole-diopside-epidote, zoisite-diopside, tremolite and ophicalcite aggregates.

To assess the residual potential of jade primary deposits prospects in this area is convenient to distinguish taxon of jade-bearing zones containing jade deposits fields. Area of such zones should be tens – few hundreds of square kilometers according to the principles of the fractal nature (including mineragenic formations).

Presence in Central Kunlun of ultramafic and granite massifs localized in magnesia Proterozoic formations, widely shown dynamo-metamorphosis [Geological..., 2002, Tectonic..., 2002] suggest the spread of jade deposits here of both geological- industrial types. The basis of promising areas selection based on the following criteria*: the presence of closely spaced massifs of ultramafic rocks, gabbro and granites; distribution of Proterozoic carbonate formations in which dolomitic marble and magnesites are possible; the presence of regional thrust faults and local fault (strike-slip) structures.*

On this basis analyzing of geological and tectonic maps of 1: 2500000 scale six mineragenic jade-bearing zones have been allocated in the Central Kunlun with the provisional names of rivers, headwaters of which they are drained, from northwest to southeast: Yarkend, Tiznab, Tazgun, Karakash, Chira and Keriya.

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X-RAY COMPUTED TOMOGRAPHY APPLICATION IN GEMOLOGY

Yakushina O.A.
yak_oa@mail.ru, Dubna International university for Nature, Society and Man, Dubna, Russia

At present the area of use of a method of the computing X-ray Computed Tomography (XCT) among laboratory physical methods of research of substance extends. This method is known as a method of a nondestructive testing, defectoscopy in the industry for studying of internal volume of object without destruction (the scanning layer-by-layer raying) [1-5].

The most significant progress was received by XCT application in medicine, so for appeared a desire to use a method for research of inorganic objects, including rocks, ores and minerals; such researches began still in the late eighties abroad and in our country [1, 2]. High spatial resolution microfocal X-ray tubes of different series and on samples with the size, as a rule, provide less than 10 mm; it is emphasized with a prefix of a "micro" method in the name (μCT or High-resolution X-ray ST). In Belgium in 2013 there took place the first international conference on "non-medical" tomography [5].

X-ray Computed Tomography is a nondestructive fast physical method that permits to obtain direct visual picture of internal structure, to reconstruct 3D image of natural and technogenious raw materials for internal texture-structure analysis and phase composition examination of a sample. It is developing actively and widely used today in research as an ordinary routine analysis. XCT combines not disruptiveness, simplicity and efficiency of the analysis. Testing is conducted without sample preparation, at natural state of ore, breed. Presence of minerals with close optical characteristics, fine or poorly crystallized. X-ray amorphous phases isn't restriction of the CT-analysis. Creation of 3D models of an internal structure without destruction of a sample is unconditional advantage of a method. However rocks, ores and minerals appeared difficult object for research by this method. The reasons of it as in the physical nature of the phenomenon (polychromatic radiation is used), designs of devices, and in the genetic nature of mineral substance.

Mineral substance study has a task definition the morphostructural analysis (including quantitative), i.e. phase (mineral) structure and textural and structural characteristics. We will emphasize distinction of industrial, XCT and medical, KT X-ray tomographs (CT-units) and techniques of a tomography.

Attenuation of X-rays by a substance, essentially various on ability, are investigated: metals, alloys and biological fabrics. They are:

- different ranges of working energy, respectively, and different effects of interaction with substance from 200-500 KeV to Mev and Compton effect for XCT, from 17 to 100 keV, usually 20-25 keV and photoeffect for KT);
- different scanning geometry (tested object usually rotates in XCT, but is immobile in KT);
- different modes (XCT pulse and KT continuous);
- different doses of radiation and working areas of scanning.

At 100 keV, I=100 мA for blood, muscular and bone tissue μ~0,178, 0,180 and 0,48 cm^{-1} (μ air=0), but only some minerals have alike μ values: 0,44 quartz, 0,53 calcite is, as a rule, much higher – 0,63 fluorites, at ore minerals ~ 1,5 – sulfides (pyrites, blende) and oxides (magnetite), 6,1 barite; at metals 2,91 iron, 14,9 silver, 62,6 lead, 98,6 gold.

In KT of medical and biological appointment the “Haunsfild" (HU) scale of density (attenuation) – the X-ray density of biological fabrics in relation to the distilled water accepted for 0 HU at standard conditions is used. We elaborated an jriginal method of phase identification on XCT data. X-ray absorption depends on the substance properties by LAC μ (x, y).

Our idea of identification [3] is based on proximity comparison of the experimental and calculated Linear Attenuation Coefficient (LAC) of the X-ray radiation for an identified element and for sample of comparison. Tomogram image displays the internal irregularities (texture, structure, inclusions, cracks, defects, pores, etc.).

XCT technique to study internal structure and diagnostics of gemological objects, including organogenic minerals (pearls, a coral) by means of the x-ray tomography (XRT) – a nondestructive method of researches as developments of a X-ray analysis is offered. Tomogram image displays the internal irregularities (texture, structure, inclusions, cracks, defects, pores, etc.). The received picture of distribution of internal not uniformity in a flat thin layer (3 microns) doesn't depend on visual experience of the expert.

We present some examples of XCT for gemology. The most attractive gem is diamond. We studied natural and synthetic diamonds with inclusions by XCT. Inclusions in diamonds are grasped in a certain stage of crystal growth and indicate their genesis, also allow to identify natural and synthetic diamonds. High diamond "transparency" for X-rays is benefit for XCT study for finding of inclusions in natural and synthetic diamonds impurities – carbides brown, other – spinels, "crystal in crystal" inclusion. We also tested a collection (GIA) of diamond imitations. XCT data αэ/Al for diamond and its imitations: Diamond, natural 0,55 diamond, natural synthetic 0,57 (carbon, C), Moissanite 1,40; Zirconium 12,44: GGG, synth. 17,85; YAG, synth. 6,57; Sr-Titanate, synth. 7,58; Rutile, synth2,86; Shpinel, synth. 1,01; Leucosapphire 1,14. So, LAC of natural and synthetic diamonds and main types of imitations are definitely different.

Usually diagnostics of pearls and corals (organogenic minerals) can be reliably carried out only by data about an internal structure. For this purpose endoscopy, radiography and Laue's method are routinely applied to pearls; however, these methods aren't always effective, especially for the "nuclear-free" cultivated or painted pearls. XCT data, αэ/Al: natural pearl, nacre 1,25-1,30; cultivated pearl nacre 1,3-1,40; mother of pearl 1,35-1,50; glass imitation 0,73-0,88; plastic imitation 0,28-0,50; natural coral 1,40-1,60; plastic cora l0,35-0,60; calcite, aragonite 1,25-1,50; quarts 0,70-0,95.

The XCT successfully solves the main questions of pearl testing:

(1) is the examined sample a pearl or its imitation;

(2) natural it or the cultivated pearl;

(3) the type of pearl cultivation: nuclear or nuclear-free.

Moreover, the X-ray CT allows to measure the size of the nuclei and the cultured nacre; to determine the internal emptiness or cavities, and thus to give recommendations how to drill and to timber the pearl better in order not to make damage to nacre; to get the X-ray CT image – an individual "passport", or a binding, first of all for especially valuable or unique pearls.

The natural coral has not so accurately expressed zone structure and higher value of X-ray density, than pearls. Unlike natural, the pressed or synthetic coral and its imitations don't possess zone structure. Coral display different internal structure then the one of pearls. Though coral is also composed of calcite, but has greater values of LAC than pearls and has 'grain' structure. Various corals and peals of different types and main producing districts have been investigated. Some interesting results and exiting images of the internal structure peculiarities have been obtained; we may name them 'the pictures of the Nature'.

XCT can be used for the express analysis and certification of objects at the solution of problems of an applied gemmology.

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S-V

GEOLOGY AND EXPLORATION OF SOLID MINERALS; MINERAGENY

GEOCHEMICAL ZONES, AS A RESEARCH ATTRIBUTE AND A METHOD OF INFERRED RESOURCES ON CU-(AU)-(MO)-PORPHYRY TYPE ORE OCCURRENCES (FOR EXAMPLE BURGAKHCHAN ORE FIELD)

Alekseev Anton
Scientific supervisor: **Voskresenskiy Konstantin Ivanovich,** project geologist, Rio Tinto
aleksrybinsk@gmail.com, Moscow State University name M.V. Lomonosov,
Moscow, Russian Federation

Burgakhchan ore field (south-west part of Chukotka, Bilibino district) it's south part of Baimka trend. The geological characteristic of ore field corresponds the typical synsedimentation back-arc basin: late Jurassic – early Cretaceous sedimentary and volcano-sedimentary rocks (siltstones, sandstones, basalts, tuff sillstone, grits, and others) contains early Cretaceous diorite-granodiorite intrusions (Vesenninskiy) complex and gabbro-monzonite intrusions (Egdegkych complex).

Enrichment rock of such elements as lead, zinc, arsenic, gold, antimony, bismuth, silver, beryllium, cobalt, nickel and chromium links with hydrothermal activity of Vesenninskiy complex intrusion. Accumulation of molybdenum, tungsten, copper, barium, tin reflects geochemical specialization of Egdegkych complex intrusion (Furman, 2008).

Geochemical search on secondary dispersion halos was carried out from 2011 in the territory of the licensed area. Sampling was carried out by a meshes of 200*100 m (a part of territory a meshes of 100*100 m). Samples was analyzed in the laboratory «Stewart Geochemical and Assay» ICP-MS method and assay for gold. A comparison of geochemical zonation ore occurences Temniy (porphyry copper and epithermal mineralization) and Verniy (epithermal mineralization) demand to characterize the geochemical zonation of the ore field Burgakhchan.

Ore occurrence Temniy. Conclusion after correlation analysis (Table 1):

- significant correlations *Au* with a number of elements, especially with *Ag*;
- high positive correlation *Cu* with *Mo*;
- negative correlation *Cu* with *Pb* and *Zn*;
- high positive correlation between *Pb* and *Zn*.

Interpretation of geochemical anomalies was founded on main elements as copper, zinc and gold. The overall negative correlation of copper and zinc generally points us to the possibility of detecting copper porphyry system. Positive correlations of copper and zinc observes in two areas of ore occurrence: the south-western part and the southern part, which may indicate the genesis of epithermal metals, which corresponds to R. Sillitoe (2010) subepitermal veins with Zn-Cu-Pb-Ag-(Au) mineralization or veins of epithermal mineralization type HS (high sulfidation) with Cu-Au-(Ag) mineralization. The drillholes (DHT13-007; -006; -005), which situated on watershed of the Temniy and Sredniy brook, was uncovered quartz-sulfide veins, which enriched of gold and silver.

Table №1. Spearman correlation table of the basic elements according to geochemistry at the ore occurrence Temniy

	Au	**Ag**	**Cu**	**Mo**	**Pb**	**Zn**
Au	1.000000	0.423241	0.470025	0.315796	0.145043	0.079627
Ag	0.423241	1.000000	0.156190	0.091203	0.431935	0.351394
Cu	0.470025	0.156190	1.000000	**0.605842**	**-0.186753**	**-0.175345**
Mo	0.315796	0.091203	**0.605842**	1.000000	**-0.206641**	**-0.394466**
Pb	0.145043	0.431935	**-0.186753**	**-0.206641**	1.000000	**0.710070**
Zn	0.079627	0.351394	**-0.175345**	**-0.394466**	**0.710070**	1.000000

Ore occurrence Verniy. Conclusion after correlation analysis (Table 2):

- positive correlations *Cu, Mo, As, Ag, Pb, Au*, and *Zn*;
- thin, but positive correlation *Mo* and *Cu* with *Pb* and *Zn*;
- *Au* and *Ag* has the most similarity correlation with all the elements.

Table №2. Spearman correlation table of the basic elements according to geochemistry at the ore occurrence Verniy

	Au	**Ag**	**As**	**Cu**	**Mo**	**Pb**	**Zn**
Au	1,000000	**0,516740**	**0,621848**	**0,431984**	**0,440212**	**0,568049**	**0,321315**
Ag	**0,516740**	1,000000	**0,437375**	**0,316596**	**0,335162**	**0,541980**	**0,519713**
As	**0,621848**	**0,437375**	1,000000	0,248530	**0,320339**	**0,647800**	**0,436386**
Cu	**0,431984**	**0,316596**	0,248530	1,000000	**0,421969**	0,108540	0,111884
Mo	**0,440212**	**0,335162**	**0,320339**	**0,421969**	1,000000	0,293899	0,229323
Pb	**0,568049**	**0,541980**	**0,647800**	0,108540	0,293899	1,000000	**0,684853**
Zn	0,321315	**0,519713**	**0,436386**	0,111884	0,229323	**0,684853**	1,000000

Positive correlations and complex anomaly of main ore elements (*Cu, Pb, As, Ag, Au*) show an common genesis of these elements. It also confirms the general assumption annular arrangement of anomalies associated with the contact between nenkan subvolcanic rocks and vessenninskiy complex intrusive rocks with volcanogenic-sedimentary rocks of Elgakchanskaya suite. In the center of structure (where the development intrusion of vesenninskiy complex and the volcanogenic rocks of nenkanskiy complex) observed negative anomalies all major ore elements. This geological structure and geochemical anomalies characteristic of a typical volcano-plutonic structures and mineralization may correspond to several types by R. Sillitoe (2010): epithermal disseminated mineralization Au-Ag-Cu (such as high-sulfidation), subepitermal veins with Zn-Cu-Pb -Ag-(Au) mineralization, or epithermal mineralization Au-Ag (type intermediate-sulfidation). The trenches (K1, K2, K3), which situated on watershed of the Gek and Zheltayay brook, was uncovered quartz-sulfide veins, which enriched of lead, copper, zinc, gold and silver mineralization.

The next stage is inferred resources based on the secondary dispersion halos, expressed in tonnes of the metal on the footage depth (counting according to Instructions..., 1983). Here is an example inferred resources for the two ore occurrences Temniy and Verniy based on samples in meshes 200*100 m (Table. 3, 4).

Table №3. Inferred resources for ore occurrences Temniy

	Au, ppb	Ag, ppm	Cu, ppm	Mo, ppm	Pb, ppm
Сф (background content)	3.345	0.294	49.284	1.827	9.73
P (productivity)	1827531957	11030057	7.14E+08	9.05E+08	1.49E+09
Q, т (amount of metal on meter)	0.0456883	0.275751	17.8494	22.61887	37.32885
H, м (depth)	200	200	200	200	200
P2 (т)	**9.13765978**	**55.15028**	**3569.879**	**4523.774**	**7465.769**

Table №4. Inferred resources for ore occurrences Verniy

	Au, ppb	Ag, ppm	Cu, ppm	Mo, ppm	Pb, ppm	Zn, ppm
Сф	87,08	0,42	150,68	4,41	12,32	65,53
P	2495227887	3169022	3,31E+09	2,13E+08	1,28E+08	1,73E+08
Q (т)	0,0623807	0,079226	82,79201	5,32104	3,196161	4,314395
H (м)	200	50	200	200	50	50
P2 (т)	**12,5**	**4**	**16560**	**1060**	**160**	**215**

We can be assumed based on these data that the ore occurrence Verniy is a typical epithermal mineralization (average scale) and ore occurrence Temniy is a typical porphyry copper ore occurrence (small scale) with epithermal manifestations.

Thus geochemical prospecting, which are among the low-cost point of research work, are a good way to detect porphyry copper mineralization in the initial stages of work.

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STRUCTURAL AND MINERALOGICAL FEATURES OF THE AMESMESSA MINERAL DEPOSIT IN THE ALGERIAN SAHARA

[1]Aouli Essaid, [2]Belov S.V.
[1]ae356789@mail.ru: ORGM, Boumerdиs, Algeria; [2]belov.s-2011@yandex.ru, JSC OZGEO, Moscow, Russia

The first signs of a gold mineralization in the Algerian Sahara in southwest part of a shield Hoggar were for the first time found by the French geologists in the fifties years of the last century [1]. However only in the 70-90 years after collaborations of the Soviet and Algerian geologists really industrial Saharan gold was revealed.

Amesmessa mineral deposit located in South-West Hoggar is the typical and the biggest object of the In-Uzzal gold area. Amesmessa mineral deposit has Proterozoic age and arose during an eburney tectonic-magmatic cycle. It belongs to the gold-quartz low-sulfides formation typical for the metallogenic zones of the greenstone belts of ancient shields [2].

Amesmessa mineral deposit and other similar objects of the In-Uzzal gold area settle down mainly within faruziysky Proterozoic granitic-greenstone belts and are often located in the fields the metamorphic of diorites. A basis of structure of the gold area and a standard geological situation of finding of ore bodies are the break structural paragenesis which arose during geodynamic development of the regional East In-Uzzal meridian fault which is the shear-shift zone.

Within Amesmessa mineral deposit the most productive gold mineralization is localized within the longitudinal cracks of a shear which are controlled the axial zone of the East In-Uzzal

regional fault. These cracks are generally parallel to the main shear plate (Y-shifts by Ridel). Less ore productive is the cross shifts (R '-shifts or antithetic shifts by Ridel) which are settling down under corners of 60-75 ° to the axial plane of the East In-Uzzal fault. Thus, the general structure of this mineral deposit is a striking example of emergence in process of geodynamics of large shear zones.

The structural and tectonic situation and field of tension throughout the Eburneys tectonic-magmatic cycle during which gold bodies were formed, were defined by conflict processes between the West African craton representing area of early consolidation when Hoggar was a part of the Faruziy-Nigerian mobile belt of Africa. Thus orientation of the squeezing efforts during the intrusion of diorite magma was the latitude and subsequently, when the ore of structural paragenesis are forming, it was longitude [3].

Native hypogene gold is dominating to the Amesmessa mineral deposit and composes primary light concentrate ores and there is at quartz and ore veins also the hydro-thermal no-changed rocks (zones of a berezitization and a feldspatization). Four of its generations are allocated. Gold in the form of a non-uniform grains is present at quartz, pyrites, pyrrotine, chalcopyrite, having a form the isometric or oval grains of tens microns in size. Its main part is presented thin grains (from 0,005 to 0,5 mm). The gold in ores is distributed very unevenly. For mineral composition of ores rather small amount of sulfides is characteristic. The oxidized ores, despite often higher contents and larger gold, have the subordinated value. The other component of ores representing having the industrial importance is only silver.

Studying of ores composition, relationship of the mineral associations composing them allowed revealing the general sequence and staging of the processes of mineral genesis happening when forming a gold field of Amesmessa. In general it is possible to allocate endogenous and exogenous stages of ore genes. At an endogenous stage 7 stages of mineral genesis were allocated.

Before ore mineral associations at the Amesmessa mineral deposit are consistently presented: a carbonate – chlorite and quartz-feldspar stages. The first is shown in the form of low-power chlorite-calcite of streaks in the milonite and an ultramilonite, and the second – in formation of quartz streaks and feldspar of rocks. At the end of this stage there is an adjournment is thin scattered magnetite and hematite.

The beginning of ore process is marked by a quartz-epidotic-chlorite stage. In this stage, after process of a cloritization and an epidotization there is an adjournment of the gold I of generation connected with quartz. The stage following quartz-chalcopyrite-pyrrhotine is one of the main in gold adjournment. In the beginning it is allocated in the form of a Copperaourite (solid solution with the content of copper of 23, 39% and silver of 1,6%) steady at temperatures below 410 °C. Native gold II of generation was emitted after adjournment of bulk of sulfides when solutions contained poorly connected sulfur and were rich with copper. This gold contains the raised maintenance of elements impurity.

Quartz – gold and sulfur stage on concentration of gold is the most significant. Mineral para genesis of this stage is very plentiful, and is various. Adjournment of minerals happened in the following sequence: quartz IV → (sericite + (chlorite III) → (pyrites III + pyrrhotine II) → marcasite → (chalcopyrite II + tetradimit) → bismuthine to → native bismuth → (blende II + chalcopyrite III) to → (pyrrhotine III + galenite) → native gold III → calcite.

End of hypo gene adjournment of gold happens in quartz-zeligmannit-galenita stage when generation gold IV is emitted. It according to the microprobe analysis often corresponds to an electrum. It is remarkable that for all main generation of native gold (II, III, and IV) constant impurity is mercury. Sometimes its contents reaches 4,2%. High contents of mercury in gold can be considered as a sign of a deep origin of gold-bearing hydro terms.

Hydrothermal ore formation quartz – carbonate comes to the end with a post-ore low-temperature quartz-carbonate-chalcedonic stage which is developed in education carbonate, quartz – chalcedonic streaks and lived with rare grains of pyrrhotine and galena.

On features of mineral composite, structure, geodynamics, age and morphology of ore bodies this gold object is represented analog of gold deposits of a belt of Abitibi at the Canadian Shield (Hemlo [4], etc.). Considering all this it is possible to assume that the In-Uzzal gold area in the south of a Precambrian board Hoggar has good prospects of accumulation of the resource potential when carrying out in the future purposeful prospecting works.

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THE SOLID MINERAL RESOURCES OF THE EASTERN SEAS OF RUSSIA: STATE AND PERSPECTIVES

Astakhov A.S., Astakhova N.V., Lopatnikov E.A.
astakhov@poi.dvo.ru, V.I.Il'ichev Pacific Oceanological Institute Far East Branch of RAS, Vladivostok, Russia

The coast of the Far Eastern Federal District of Russia bordering the peripheral seas of the Pacific (Bering, Okhotsk, Japan) and Arctic (Chukchi, East Siberian, Laptev) oceans. Economic zones of the seas make up nearly two-thirds of area of marine areas currently under the jurisdiction of Russia. The deposits of solid minerals of the coastal zone of the seas have been studied extensively in the 60s-80s of the last century. Now partially used in those years sand deposits, mineral muds, mammoth ivory.

Significantly more was invested in studying the phenomena placers of the gold, tin, platinum, iron on the nearshore shelf. There are a number of small ore deposits, but of practical interest to them now is missing. The large titan-magnetite ore deposits of beaches and marine terraces coasts of Kamchatka and Kuril Islands sometimes referred to offshore deposits, although they are located on the land and an important role in their formation have aeolian processes. The practical interest in the foreseeable future among marine solid mineral deposits can submit barytes, manganese metalliferous sediments and iron-manganese crusts.

The barite deposit "Barite Hills" is located on the eastern border of the Deryugin Depression (Deryugin Basin, Okhotsk Sea) that is typical elisional basin [1, 4]. The barite chimneys built up to a height up to 10-16 m [6] were formed by elisional hydrothermal waters, which is currently. When profiling system OFOS on the western top of the Barite Hills warm and brackish sea waters were identified [7].

K. Vallmann and co-authors [8] studying pore water in the same point, set the flow of fresh water, emerging at a depth of some kilometers with dehydration clay minerals (smektit-Illit) of rocks under high temperature. These water are depleted in magnesium and chlorine and do not contain sulfates, but rich in silica. In a survey of seabed system OFOS and TVSA "COMANCHE" revealed the existence of emerging barite chimneys up to a height of 0.5-0.7 m. The absence of large new forming chimneys does not give information about the source of barium. Whether new chimneys are formed by diagenetic solutions, circulating in the body of the barite deposit, dissolve and recipitate barite, or deep elisional waters that previously formed the barite deposit. This issue is important for determining the recoverable of barite deposits in the case of its exploration.

Manganese metalliferous sediments are known in the Japan and Chukchi Seas, but are most common in Deryugin Basin of the Okhotsk Sea. They are found in the Holocene diatom layer and presented two types: carbonate and oxide. The most common oxide, covering the central part of the Basin by the surface (up to 30 cm) sediment layer in a strip of up to 40 km and a length of 180 km. Their formation is associated with multiple processes. The main of it is the precipitation of manganese from the water plumes which forms in the deep water mass above the low-temperature hydrothermal vents, together with absorption of trace elements (Zn, Ni, Co, Cu, Au) by manganese hydroxides. The significant one is diagenetic redistribution of manganese with a concentration in the surface layer of sediment.

Fe-Mn crusts are known in all the Far Eastern Seas in the economic zone of Russia. Unlike oceanic crust and concretion they are located on the much smaller sea depth, near the shore and major port cities as possible sources of marketing. Their exploration may be under subject to Russian law. This allows treat them as an independent source of manganese products. But, they generally do not contain large quantities of non-ferrous metals and do not cover such large areas of the seabed (at least on known data) as oceanic nodules and crusts [2; 3; 5]. The Central (Japanese) Basin of the Sea of Japan, referring to the economic zone of Russia is more perspective on ore of manganese. At 8 sites in the area discovered iron-manganese crusts, up to 25 cm with a manganese content of up to 64% [3], which is considerably higher than in the ore crusts of the oceans. Some of these crusts are enriched with platinum metals. Sometimes this crust has increased by nickel: 0.24 % in crust from Pervenets Rise of Japan Sea; 0.67% in the crusts of the Kashevarova Rise slope of northern Sea of Okhotsk [1, 4].

Increased content of micro-and nanominerals of noble metals, sulphides and intermetallic compounds of copper, nickel, tin, lead, zinc, silver in the ore crusts and basalts of submarine volcanoes can be considered as possible objects for polymetallic sulfide deposits discovering [3].

As recommendations for future discovering and development of the mineral resources of the Far East and Eastern Arctic Seas of Russia is a limited works for search and geological survey on the barite deposit "Barite Hill" and on some submarine volcanos and rises with Fe-Mn crusts of specific mineralization and signs of polymetallic (North Slope of the Deryugin Basin in Sea of Okhotsk, Pervenets and Beljaevsky in the Sea of Japan), as well as special studies of technological properties of hydrothermal iron-manganese ores.

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NEW PERSPECTIVE TYPE OF GOLD FIELDS OF MONGOLIA

Bayarsaykhan C, Vercheba A.A.
aa_ver@mail.ru. MGRI-RGGRU, Moscow, Russia

As a result of carrying out hard geologo-search works at the beginning of the XXI century ore fields and fields of copper porphyritic type in the Sonth Mongolia, such as by Oyuu Tolga, Tsagaansuvarga, Oyuut Ulaan have been revealed, etc. In ores of fields gold mineralization is established. Some of these fields are occurs within Paleozoic terreyn, created in late Devon on continuation of the Tiyn-Shansky metallogenichesky belt of copper mineralization of porphyritic type within which fields of the average and late Paleozoic are had: Almalyk (Uzbekistan), Wu-Zu, Er Gashan (northwest China). Recently in communication of golg in porphyritic fields interest of geologists to this area accrues.

Rather recently in the Sonth Mongolia the new type of gold deposits in bereziti metasomatic breeds has been established. It fields of the ore area Olon-Ovoot, which are in 500 km. to the South from Ulan Bator in rather mastered economic region.

Fields of the first, copper and porphyritic type in the Oyuu-Tolgoysky ore area, are studied rather fully and introduced until recently the main potential of mineral resources of gold in the territory of Mongolia.

The ore field of Oyuu Tolga in the desert of the Sonth Gobi, in 650 km to the south Ulan Bator and consists of five fields (Sonth, Southwest, Central, Youzhny and Northern Hyugo Dammett). Within ore field as a result of detailed exploration works resources more than 25 million t of copper and more than 1000 t of gold are established, and on stocks these fields enter in a row giant gold-copper fields of the world. The content in ores makes 0,5 % of copper and 0,36 g/t of gold on ore ton. The geologo-ekonomic assessment of field Oyuu-Tolga allows to carry it to largest of uninvolved gold deposits and copper in the world. At injection in exploitation of fields of ore field by Oyuu Tolga gross national output per capita Mongolia twice will increase.

Therefore fields of copper and porphyritic type with gold mineralization will be important in mineral resources of gold ores of Mongolia as are the main geologo-industrial type of gold fields.

According to researchers copper and porphyritic fields contain resources of copper, gold and other metals are created by uniform mineral system into which compound enter magmatic complex, metasomatic breeds and ore educations. For this type of fields it is established that the stage of ore deposition finishes, as a rule, difficult process of emergence, transit and sedimentation at first metasomatic, and then and gold educations. Research of minerals systems has shown that magmatic bodies in them at the small sizes cannot provide energy and fluid components for formation of large-capacity fields. These magmatic bodies for the known reasons play role of concentrators of ore substance. In many events important factor of ore deposition is activity of ground waters which can get, on the one hand, into area of movement of magmatic substance, with another, influence ore deposition and transformation of ores in oxidation zone. When studying fields of porphyritic type there is need for establishment of petrographic and geochemical features of magmatic complexes of ore field, paragenesis of ore bodies and metasomatic breeds. On field metasomatity are introduced by paragenesis: early kalishpat-biotite-magnetit (high-temperature), average-temperature quartz-seritsit and argillizitovy (low-temperature). Mineral zonal distribution metasomatitov is shown by replacement from below up early high-temperature paragenesis, average-temperaturny, and then low-temperature. Process of formation of all ore system comes to the end with hydrothermal phase with formation of the mineralized brekchiya.

The new type of gold fields of the Sonth Mongolia in the geological relation is studied insufficiently though reproduction of mineral resources of gold in modern economic conditions can be reached at the expense of operative development of the reconnoitered ore field of gold deposits of Olon Ovoot. The field of Olon-Ovoot is in 500 km. to the South from Ulan Bator in rather mastered economic region.

In the structural relation the field is had within Sonth Gobiyskoy folded structural zones to the North from the regional Olon-Ovotinsky shift structure having ore-control value.

The field lies in more thickly Devonian vulkano-sedimentry deposits and poorly metamorfizm greenshale breeds. Vulkano-sedimentary breeds are combined by formation of alternation of andesites, andezit-tuff, seritsit shales, phyllites and the sandstones, the broken-through dayka of diorites. We carry volcanic rocks to the competent geological educations favorable for localization of ore of gold.

Containing gold ores rock formations are crumpled in folds and broken by system of breaks with amplitudes of shift in the first tens meters. It is established that gold mineralization is dated for lenses of vulkanogenny breeds of andezitovy compound which differ from terrigenny breeds high fortress and tendency to treshchinovatost. The main part of gold ores lies in strongly tectonic the deformed synclinal structures. In anticlinal folds gold ores as a rule is absent.

As a result of earlier executed geologo-film-making works around field gold ore deposits of dayka of the diorites which age is established as Jurassic have been established dorudny granitoid intruzivy late and coal age and secants. Gold ores in dense containing volcanic rocks of andezitovy compound lies in being bent according to skladchatost of breeds. The extended lentiform ore bodies have extent 50–100 м and capacity of 5 References 20 m. Ore bodies are introduced by the pulled together series of quartz veins in auras of okvartsevaniye and intensive metasomatic transformation of andesites. On mineral composition metasomatic breeds correspond to formation berezitam. Zhilnye of zone and veins differ the raised content of gold reaching on meter intervals of approbation of some tens grams on ton. In lateral parts of ore veins and zhilny zones andesites are turned into average and coarse-grained metasomatic breeds – berezity, which impregnirovany by large crystals of pyrite, the size to 0,5 – 0,7 mm. The content of gold in berezitakh is essential below, than in quartz veins, makes 2-3 g/t. Berezita are combined generally by intensively seritsitizirovanny and karbonatizirovanny plagioclases and quartz. Dark-colored minerals in them are completely replaced with the unit of essentially hloritizirvanny and karbonatizirovanny sericite. The content of sulfides in ore (generally in pyrite) does not exceed several percent. Judging by high extraction of gold when using to the technological scheme of processing of ores cyanides, the share in gold ore of the persistent, tonkodispersny gold being normally in sulfides, is negligible. On field ore production by the opened way with the subsequent processing of ore by factory way is begun.

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ON THE APPROACH TO FINDING GOLD DEPOSITS IN THE MOUNTAINS OF SOUTHERN WEST SIBERIA

Butvilovsky V.V.
wladimirbutwilowski@gmail.com, Institute of Polymer Research, Dresden, Germany

The gold ore deposits of the mountains in the south of Western Siberia (Salair, Mountain Shoria, Kuznetsk Alatau, Altai and Western Sayan) are confined to an area of volcanic-sedimentary rocks of the Lower Cambrian for the most part. On the example of the Kuznetsky Alatau it is clearly seen that in the eastern and north-eastern slope of the highlands significantly more gold deposits and occurrences were found, than in the central and southwestern parts. Also the placer gold of the eastern slope of Kuznetsky Alatau is clearly a smaller scale. Why there were discovered more ore deposits, but less placers – can be argued, but we must not forget that a certain number of fields are also a consequence of such a simple thing like how they were detected or not. In the north-east, and especially the eastern slope of Kuznetsky Alatau ore bodies are easier to find due to better availability of nudity and, due to a lower altitude, drier climate (near Khakassian almost semiarid basins) and less overlap. Furthermore, there lived and worked more people nearby, who engaged in intense artisanal and searching activities. In the south-western slope of Kuznetsky Alatau the situation is quite different and much less favorable. Peculiar to most of the territory poor exposure worsens of conventional geological prospecting.The inaccessibility and remoteness of many areas from settlements contributes to this situation. Therefore, the method of searching for gold deposits in these areas should be well thought and specific to be ultimately successful and not so expensive.

Compared with the data on the ore of gold in the north-eastern part of the Kuznetsk Alatau, the Orton-Fedorov area of the south-west part looks poor, even as an alluvial unit it is much more productive (about 40 tons were produced), and the valley Fyodorovka is one of the richest regions. This ratio of ore and placer gold can be alarming. In any case, placer gold in the mountain valleys of small orders accumulated as a result of denudation of local indigenous sources. If placers were formed mainly due to the poor mineralization, the productivity of the placers would be about the same. Anomalously rich placer created abnormally rich primary sources – the conclusion is logical enough, but it is not directly related to the mineralization that is still possible in the depths of the area. We can only say that the presence of the rich indigenous sources is very likely to Orton-Fedorov area, but no more. This probability is confirmed by findings of rich gold ore occurrences (metasomatic silicified Bonanza 10-15 m and an average grade of 100 g/t), which were discovered by the miners while stripping and washing of the valley and the stretcher placers, in particular in the valley Fyodorovka. It was no coincidence that they were successful, and not the fourteen search parties that worked here.

In other words, there are small but rich gold ore bodies on Orton-Fedorov space available; possibly in large numbers, but finding them in a poor exposure is not easy, and it would be wrong to rely on coincidence. Detailed prospecting of the area is too expensive, and its effect is also questionable. Even at a density of drilling search network 20x40 m, most of these bodies will be "unnoticed" and searching for them in a more sparse network would be useless. Local excavation overburden within larger zones of mineralization also did not get much effect. The question arises whether it is worthwhile to seek some small-rich ore bodies peculiar for local mineralization in conditions of poor exposure in areas of poor (0.01-0.1 g/t) gold mineralization with conventional geochemical, geophysical methods and mine workings? If you approach the matter from the perspective of an economist of the host, it is not worth it, of course. If you do not take the costs into account, as was done previously, it is possible to look for a long time without success. For the exploratory development of such territory it would be more correct to take a different approach from the position of rational host geologist, whether it is a group, a co-operative or a state-owned enterprise.

This area is especially attractive for the opportunity to dig for gold here and there are significant alluvial reserves. Gold mining is the main liquid product and a priority, and so all the work plan and the process should be subordinated to the production of this product. Extraction and exploration shouldn't be separated in this case. Everything should be linked in a single chain, a single balance of costs and revenues. It is necessary to invest in the search and exploration and production. Where, when, how much – it's a decision of the owner, but for the opportunity to conduct business efficiently, he must obtain the license, as well as the opportunity to receive state support (subsidies) in such a complex case as the exploration and production of gold.

The first step is to start the production of "light" alluvial reserves available here – thus be able to generate income and means to conduct a search and appraisal placers of various types (technological, valleys, terraced, hillside, stretcher, eluvial placers, more clearly insufficiently studied here) first. In other words, mine known reserves, to fill them with new, closely spaced. In developing placer it is necessary to conduct the search for gold ore, as there is a virtually "free" opportunity to explore gold ore in the root raft witch expands over kilometers in length and has a width of tens or hundreds of meters, and the under placers raft is the most interesting. No excavation research could provide such something like this. Discoveries of small but very productive gold bonanza, that would be worth the effort in the parallel production of geological studies, could happen repeatedly already at this stage. That's right, performing the simple, reliable and gainful is the main business, and it is necessary to be simultaneously engaged in the search for gold ore and do it more efficiently, "to the last drop" to use the passing exploration opportunities available in mining placers, especially stretcher, slope and TSP. Placers themselves lead to indigenous sources of supply, and there is nothing special to it! The way seems long, but additionally cost-effective (most profitable) and as a result it leads more accurately and quickly to the goal of the effective prospecting of the area.

The problem of gold ore in the Orton-Fedorov area still remains unresolved, however, is the possibility of opening of commercial deposits large enough. Therefore, it is not advisable to leave this area, the complex work on gold should be continued, but with change in goals and methods. Primarily there work and research could and should be done on different types of placers, which potential is far from exhausted [1]. During the mining placer and parallel to identify and develop deposits of weathered zones of metasomatism and oxidation of gold mineralization. In the process of working out all these fields it will be possible to find reasonable price in addition and develop numerous small, but rich orebodies-Bonanza. To spend some large-scale, highly specialized search works now with the hope of discovering large rich ore deposits – is to condemn oneself to fail in most cases and to cause huge ineffective costs. This also applies to other similar regions.

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POSSIBILITY OF SEARCHING OF MINERAL RESOURCES BASED ON PALEOVOLCANIC RECONSTRUCTIONS

A.E. Kotelnikov, V.V. Diakonov, V.M. Usova
mdf.rudn@mail.ru, Peoples' Friendship University of Russia (PFUR), Moscow, Russia

Paleovolcanic reconstruction with a resource estimate of endogenous mineralization should be considered relevant to the areas that are formed by magmatic rocks.

Our model of paleovolcanic structures, based on years of scientific and practical research in areas Polar, Northern, Southern Urals, Caucasus, Chukotka, Gornaya Shoriya, Kazakhstan considered in several previously published works [1-3, 6 and others]. Briefly we can say that paleovolcanic structure consists of pyroclastic, lava and volcanic-sedimentary, sedimentary and intrusive rocks. Combination of rocks forms facies. Each of the facies takes its spatial position and accumulates on the entire time interval of the structure. Facies are classified: vent; slope; distant (far distant); post volcanic (intrusive).

Structures are formed in three stages. Basaltic or basalt-andesitic shield volcano is formed at the first stage. Acid stratovolcano is formed at the second stage. Formation of a stratovolcano associated to the same volcanic pipe (conduit). Stratovolcano forms on shield volcanoes, this is due to the change of the chemical composition of the magma at a significant time interval (more than 100 million years). The first and second stages characterize effusive period of structures development. The third stage characterize post-volcanic period of development, in which there are introductions of intrusive bodies (lopolith, laccolith, etc.).

The following zone of paleovolcanic structures are the most prospective to search for endogenous mineralization of nonferrous and precious metals [2, 5, 6]:

1. Zones, composed of vent near vent facies, with numerous subvolcanic bodies and necks in the central caldera and on its periphery. It can be expected from small to unique deposits.
2. The apical part of slightly eroded intrusive massifs. It can be expected from small to unique deposits.
3. Parasitic vents, the interface between the ring and radial faults, etc. It can be expected medium and small deposits.

We have developed an algorithm of paleovolcanic reconstructions with a resource estimate, which includes three stages:

Stage 1. Paleovolcanic reconstruction of the territory.

- Deciphering multispectral satellite imagery (getting tectonic, lithological and petrographic, historical and geographical information);
- Analysis of archival material (reports, geological and geophysical maps, etc.) in investigated territory;
- Conducting a specialized paleovolcanic mapping, which includes a series of geological tracks required to indicate facial transitions.

Stage 2. Distinguish (contouring) of promising areas

- Selection (identification) of prospective areas is based on the structural conditions we have identified the localization of mineralization in paleovolcanic construction.

Stage 3. Estimation of prospective areas.

- Assessing the prospects of selected areas by geochemical (for primary and secondary halos, and by iodimetry) and geophysical (magnetic and electromagnetics) methods;
- Preliminary assessment of resources (inferred resource – category P3);
- Presorting prospective areas and formulation of recommendations for further work (drilling, etc.);
- Carrying out drilling and assessment of resources (indicated resources – category P2, P1).

The main results can be obtained:

Stage 1 – Create a map of paleovolcanic facilities,

Stage 2 – Create a map of prospective areas (Cu, Mo, Pb, Zn, Au, Ag, and others.).

Stage 3 – Create a map of prospective allotment (less than area) with the resource estimation for category P3 based on geochemical and geophysical investigations; on the basis of the drilling is carried out resource estimation for P1, P2.

The possibilities and advantages of this method:

- Prediction of prospective areas/allotment with minimal costs.
- Opportunities for such works in areas with outcrops of <30%, and developed mining infrastructure.
- Forecasting of endogenous mineralization to a depth of 500 m (based on iodometry [4]).
- High degree of reliability assessment of the resource potential of areas (category P3 + P1, P2).
- Getting the results of in optimal time – less than 3 years (depending on the size and availability of the work area).

Approximate cost of the work:

1. paleovolcanic mapping and selection prospective areas (stages 1 and 2)

The area of one construction	~ 7 000-10 000 km2 (~ 120 km x 70 km)
Prospective areas	from 100 to 150 km2 each area
Terms of work performance:	6 – 12 months
Costs:	2.5 – 3.5 million Rubles.

2. Estimation of promising areas (Stage 3)

Square of prospective areas	from 10 to 20 km2 each section
Terms of work performance:	12 -24 months. (3 – 6 stations)
Costs (without drilling):	4.5 – 10 million Rubles.

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REGIONAL PETROPHYSICAL CHARACTERISTICS OF THE EARTH'S CRUST IN THE NORTH OF THE URALS

Ponomareva T.A.
taponomareva@inbox.ru, FGBOU VPO "SyktSU", Syktyvkar, Russia;
IG Komi SC UB RAS, Syktyvkar, Russia

Comprehensive interpretation of geophysical and geological data should be applied when studying deep structure of the Earth's crust and upper mantle on the regional scale [1]. Two components of the one research need to be proved by the petrophysical characteristics of rock associations because any change in physical properties of rocks is reflected in geophysical fields. Thus, comprehensive analysis of results obtained from petrophysical and geophysical researches in the north of the Urals allowed to reveal two large petrophysical associations. These associations, in their turn, consist of several groups of geological masses [2, 3, 5, 6, 7] combined by the common regularities: variations of density and magnetic field values, character of correlations between different physical properties of rocks reflected in geophysical fields.

The first petrophysical association I comprises Lower Precambrian rocks of the Western-Uralian structural zone characterized by high density and mainly low magnetization. Low and average intensive negative magnetic and gravity fields are typical for this association. It includes three petrophysical groups of rocks [3, 4] different in petrophysical connections between density and magnetic receptivity of rocks. Group Ia is represented by the rocks of gneiss-migmatite associations (Nyarta and Kharbei). Density values are in the interval 2.61–2.97 g/cm^3 and magnetic receptivity values are less than 100Ч10^{-6} SI units. There is a week inversely proportional dependency between the density and magnetic receptivity of rocks. The rocks of eclogite-schist associations (Nyarta and Kharbei) are referred to the second group Ib. Density values vary within the limits of 2.7–3.32 g/cm^3. Analysis of magnetic properties shows the broad range of magnetic receptivity values from tens to several hundred of SI units. Density and magnetic receptivity are directly proportionally connected. The third group Ic combines the rocks of granulitic-metabasitic associations (Khord'yu and Malyk). These rocks have the highest density values ranging from 2.94 до 3.12 g/cm^3. There is no density differentiation, neither laterally nor along the section, that allows to consider the Khord'yu and Malyk associations as monolithic blocks. Magnetic receptivity of rocks in these associations do no depend on rock's density. It may vary in a broad range that is connected with the diverse content of titanomagnetite in the rocks.

The second petrophysical association II combines the rocks of the Eastern-Uralian structural zone including different igneous (intrusive) rocks (from ultramafic to felsic), and also volcanic, volcanic-sedimentary and sedimentary rocks. This association is characterized by average- and strong intensive positive magnetic and gravity fields. It consists of three petrophysical groups of rocks differ from each other by physical properties and by the character of their inter-correlations.

The first group IIa contains ultramafic rocks of ophiolite association demonstrating high density (2.90-3.10 g/cm^3) and average magnetization (100–750)·10^{-6} SI units). Specific feature of rocks of this group is the absence of any connection between density and magnetic receptivity. Physical properties of rocks varied during the serpentinization process. When the extent of serpentinization grows, dunites strongly lose their density and obtain magnetic properties. Harzburgites retain their density characteristics and almost lost magnetization under the similar conditions. The highest values of density and magnetic receptivity are found in voikarites. Average intensive magnetic anomalies and intensive Δg anomalies are detected above rocks of this group.

The second group IIb includes rocks of dunite-verlite-clinopyroxenite and gabbro associations and also volcanic mafic and rarely intermediate rocks. Intrusive and volcanic mafic rocks have higher density (from 2.80 to 3.20 g/cm^3) and magnetic receptivity (750·10^{-6} SI units) values. The stable directly proportional dependency is found between density and magnetic receptivity. Rocks od this group generate intensive magnetic and gravity fields.

The third petrophysical group IIc comprises felsic and moderately felsic intrusive and effusive rocks and also volcanic-sedimentary and sedimentary rocks characterized by average density (from 2.65 to 2.68 g/cm^3), weak and average magnetization (from 1 to 750·10^{-6} SI units). The general feature of rock in this group is the absence of dependency between density and magnetic receptivity. Physical properties of rock may vary due to the differences in mineral composition of rocks. Alternating-sign anomalies of magnetic and gravity fields are found above these rocks.

Summarizing the data on physical properties of rocks in the north of the Urals the scheme showing evolution of petrophysical characteristics of geological bodies of different age (PR–KZ) was constructed. This scheme reflects the long history of geological development of lithosphere of the Polar Urals. The obtained results are important for comprehensive interpretation of geological-geophysical data and is used for construction of the physical-geological model of the Earth's crust and upper mantle of the region.

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GOLD NANOSHAPES IN FIELDS OF SULPHIDE ORES

[1]Vorobyev A.E., [2]Vercheba A.A
[1]fogel_ae@mail.ru. RUDN, Moscow, Russia; [2]aa_ver@mail.ru. MGRI-RGGRU, Moscow, Russia

The concept "invisible" gold concerns to the fine-dispersed gold which is not taped by optical methods: colloid, cluster or to chemically connected in sulfides.

As it appeared, as a result of examinations [1,3] "invisible" gold or nanogold appeared is widespread widely in sulfides both naturally gold, and pyritic, copper and porphyritic and cooper-nickel fields.

By instrumental methods of the analysis it is established that with decrease of a content of sulfur in pyrite concentration of gold essentially increases that allowed to guess availability of gold in pyrite.

And only after discovering in the north of the State of Nevada (USA) of gold deposits in arrays of particulate metamorfic sedimentary carbonaceous and silica-alumina rocks, with its concentrating both in different sulfides, and in coal material, with the prevailing dimension of abjections of gold less than 5 microns. It became obvious that examination of nanoshapes of determination of gold in ores should be carried out on in essence new instrumental analytical basis.

So, a distinctive singularity of ores of karlinsky phylum is "invisible" gold. Thus gold nanoshapes normally are present at pyrite, arsenopyrite, pyrrhotite and various oxides of metals (chromite, magnetite) and to a lesser extent – in quartz, carbonates, silicates and organic matter [5].

On the basis of the gained outcomes of natural and pilot analytical studies of golden ores of some fields the concept of «natural nanotechnologies», i.e. the physicochemical processes occurring in a litosphere in areas of the nanometer dimensions which lead to shaping of mineral nanoframes and nanoparagenesis with the abnormal physicomechanical properties was developed.

N.V.Petrovskaya, considering singularities of allocation fine-dispersny (0,5-10 microns) gold, came to quite important deduction: «Particles of fine-dispersny gold are widespread much more widely, than seen gold. They are present at all ore fields not only gold, but also many other metals where visible gold does not meet, and also are dispersed in major masses hydrothermally altered rocks».

Formation of the basic morphospecies of nanogold normally explain, proceeding from known mechanisms of a crystallization of material from its intermediate state [5]. Therefore they can have the shape of various dendrites, rings, cones, polyhedrons, orbs, rods, flakes etc., and also flocks of combinations from these enough simple shapes and fractal units.

In fine-dispersed ores of gold fields of the Bakyrchinsky ore region (Kazakhstan) nanotubes, the orbicular and faceted nanoframes, unilaminate (one-layer) and multilayer, obturated and dense [2] were met. Thus, the spherica or orbicular nanoframes filled with metal – normally opaque, and filled with nanoparticles of arsenides, sulfides, carbides and oxides – translucent or almost completely transparent.

Similar nanotubes were met as in nanolayers of gold-bearing sulfides (arsenopyrites and pyrites), and in the environment of solid carbon matter, being in tight paragene association with sulfides [2].

It is necessary to score that the nano – gold formations on fields Vasilyevsky and Quartzitic Hills (Kazakhstan), substantially differ from available nanoframes of the Bakyrchiksky region. In particular, it was established that on a field Quartzitic Hills are more educed the fullerene-frames, differing by a little smaller dimensionality, and also essentially larger denseness.

"New" nanogold also is often provided by the individual spherical nanoparticles in the dimension of 50-100 nanometers in which generally it is not observed explicitly expressed modular constitution. For this phylum rather narrow range of the dimensions, with prevalence of individuals about 50-60 nanometers [4] is characteristic.

Earlier, at traditional chemical analysis of graphite ores in them found only 0,021-3,57 g/t of gold therefore to extract from them gold it was read unprofitable [3]. In the subsequent, by means of ionic mass spectrometry it was possible to find that concentration of gold and platinum in graphite ores much more. So, in the studied assays of connatural graphite a content of gold reached 17,8 g/t is level of ores enough rich gold fields. The similar odds reflect essential losses of noble metals at a thermooxidative breakdown of grafit assays, as a result of volatiles emission of organometallic compounds.

Except graphite ores gold is concentrated and in different connatural coals. The taped connection of a content of gold in coals, peat and their leaches testifies to preferentially organic shape of its finding. Thus for coals two phylums of the carrier of gold (organic and mineral substance) can be excreted.

It is necessary to score that the gold, measuring particles less than 20 microns, the plate-like or spicular shape, normally does not give in to extraction by all existing enrichment technologies [1].

Singularity of plate-like nanogold is its very high buoyancy (buoyant gold, owing to the fine shape, it can be retained on a water surface by a surface tension force) therefore the considerable proportion of gold of such classes is not extracted by the modern enrichment technologies from scatterings [1]. Thus from 25 to 40 % of thin buoyant gold goes to enrichment "tails".

Thus, detection of nanoparticles of gold on the majority of golden fields allows to dilate essentially mineral resources of this metal, and specification of its possible nanoshapes – will ensure development of very effective technologies of its enrichment (extraction).

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GEODYNAMIC EVOLUTION AND STRUCTURE FORMATION OF THE IROKINDA AU-QUARTZ VEIN FIELD (NORTHERN BURYATIA)

Zlobina T.M.
tatiana1946@yandex.ru, IGEM RAS, Moscow, Russia

Investigation of the structures of some mesothermal Au-quartz deposits of the Muya gold ore region led to establishing the paleoseismicity-related deformation origin of the ore-bearing structural features [1, 2]. Gold deposits are located in the marginal zones of the southeastern segment of the Baikal–Muya Belt, near the *major geostructures* of the Barguzin Superterrane and the Baikal–Patom Belt. They are connected to deep-seated fault zones, where paleoseismic foci were concentrated, and their ore forming systems are connected to the magmatic proto-sources of ore forming fluids. Such ore deposits are usually classified as orogenic or related to intrusions formed in collisional geodynamic settings. However, the variability of geodynamic regimes of various ranks accounting for the specific arrangement of structural features in fluid-conducting rock frame produced by "slow" and "quick" tectonics. Compiling the models of the pre-ore tectonomagmatic proto-structures (in terms of geodynamic evolution of the region) including the imprinted local intra-ore seismic deformations provided a possibility to set out a new approach to studying the structural-hydrodynamic organization of ore-forming systems from proto-sources to ore emplacement region. Geodynamic evolution history of the Irokinda vein field located within the tectonic block of the same name in the SW part of a horseshoe-shaped promontory of the rigid Precambrian cratonic block surrounded by the Baikalian foldbelt appears to be the most ancient. The northern and southern boundaries of the block are defined by roughly E-W-trending branches (North and South) of the Muya deep-seated fault zone buried beneath superimposed Cenozoic depressions, whereas the western and eastern boundaries are defined by mobile zones with faults that stem from the South Muya branch of the Muya Fault zone in the south. The genetically single fold-and-thrust complex of deeply metamorphosed *Archean* rocks of the block (ortho- and paragneisses, schists, marbles, amphibolites) hosts commercially significant gold-quartz veins. Vein occurrence is controlled by dynamometamorphic schists. Fold axial planes strike NNE; fold limbs dip at 40°-50°. Schist beds (dated 2.0 Ga [3]) were formed from incompetent rocks as the result of shearing in a setting of E–W compression and metamorphism. Folds are complicated by intrablock faults. During the *Proterozoic*, the promontory of the Archean block was surrounded by a Riphean foldbelt (Ripheides). The Ripheides were involved into the *Early Baikalian geodynamic cycle* (1-0.8 Ga [3]) together with the Muya Block with syntectonic magmatism and hypabyssal volcanism around its rigid promontory. During the*collision event* (0.8-0.78 Ga [3]), deep-seated faults surrounding the block developed in differential stress fields with different movement senses: E–W trending right-lateral strike-slip-tension gashes (transtension) and N–S trending left-lateral strike-slip faults (transpression). E–W trending fault system produced pull-apart basins [4] (traceable as rhomb-shaped grabens in Cenozoic superimposed depressions). Extensional regime associated with high heat flow led to the emplacement of intrusions with varying extent of magma differentiation. Pull-apart basin formation and tectonomagmatic reactivation took place simultaneously with the destruction of the Archean block and the surrounding PR_1 foldbelts. The multiple-deformation, fractured small-block structure of the Irokinda Field is genetically due to the complexly differentiated regional and local dynamic fields. The inception of NNE-trending faults accommodating the push-up of minor granitoid intrusions (ancient crustal sources, 0.78 Ga [3]) that occur as chains of small bodies traceable along them is often confined to the axial planes of Archean folds with similar strike. Paragenetic with these faults are small divergent imbricate thrust/reverse faults (dipping WNW at 40-50°) that formed along schist beds only in *northwestern* limbs of Archean folds as the result of collision-related unidirectional eastward compression. They occur as series of en-echelon thrust structures that make up extensive zones permeable for metamorphic abyssal fluids (slip zone schists are diaphthoric). Dike bodies of the postmagmatic differentiates of crustal and *plutonic intrusions* are spatially associated with these zones. This tectonic-metamorphic-magmatic organization resembles the so-called "palm-tree structure" [5] with a tectonically active "trunk", along which the metamorphic-magmatic material is pushed up from various depths in a setting of transpression and a system of divergent thrust faults, along which this material is offset in the upper part of the crust. The PR_1 "palm tree" structure in the Irokinda Block displays complex organization with intracrustal and post-plutonic magmatism in spatially isolated regions (as confirmed by isotopic studies [3]) and, at the same time, inherits some elements of the Archean structural pattern. At the boundary between the *Early and Late Baikalian cycles*of tectogenesis (0.78-0.72 Ga), as in PZ_1, local changes in tectonodynamic setting were manifested predominantly in the Baikalides surrounding the Irokinda Block. PZ_2 times are characterized by extensive plume-related granitoid magmatism (Angara-Vitim Batholith). The batholith could not induce changes in the tectono-magmatic *protostructure* of the Irokinda vein field directly, considering that surface outcrops of this batholith are unknown within the block, but its subsurface influence on ore formation is quite possible. The Paleozoic proto-sources of the Barguzin and Vitimkon complexes of this batholith were accumulated in the pull-aparts of the South Muya fault system, whereas the differentiates of the Proterozoic proto-sources could be melt out in pull-aparts of both South Muya and North Muya fault systems.

Intra-ore processes were induced by deep-focus *seismo-tectonic reactivation* events [1, 2] that probably took place not only during the syn-ore period. The syn-ore seismodynamic model is based on ore veinlets; benchmarks for the pre-ore seismodynamic model are absent. Studies of paleo-seismic mechanisms [2] provided a possibility to create a syn-ore deformation model and to establish the hydrodynamic drainage area of the hydrothermal system focused in the South Muya Fault zone as well as the main feeder and distribution channels of the structural-hydrodynamic system. The results of computer-based 3D vein morphology and spatial distribution modeling taking deformation model into account [2] suggest that the main ore-bearing structures are extensive en-echelon divergent fault zones. Paleo-seismic events complicated the interior structure of these zones giving rise to unusual combinations of structural features and the nonlinear vein morphology.

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THE QUESTION OF ENVIRONMENTAL MANAGEMENT STRATEGIES

Butvilovsky V.V.
wladimirbutwilowski@gmail.com, Institute of Polymer Research, Dresden, Germany

Human activity is somehow based on environmental and resource management, which is the use of the environment and its resources meeting the personal, socially material and spiritual needs. Common sense dictates that the irrational use of natural resources is not optimal, and wouldn't lead to any good eventually. It is believed that the amount of material and cultural benefits created with rational environmental management should exceed the losses from the deterioration of the landscape and the scope of the cost of its restoration. But this kind of accounting is insufficient, not at least because it may not be accurate and, moreover, hardly deteriorating environment can be fully offset by some revenue. The use of environment has to lead to an improvement of the environment or at least not deteriorate it; with the use of natural resources not being reduced, and the necessary needs of people met. This is the main strategic goal.

Theoretically, such a nature management is possible. But in order to its practical implementation is necessary to create special humanitarian conditions, moral values and ideals. Such conditions are not created immediately, society can not change instantly, but there are always people in a society, which are looking for it, search for knowledge and have a predisposition to creativity and goodness, and there are a lot of such people. It is them who, armed with understanding what to do and where to go, with their personal example and the daily work in all fields of human existence (especially in government, education and upbringing) may begin to turn the movement of society in a different direction, corresponding to the ideas of goodness and justice. It is only necessary to understand and believe that there are no objective prohibitions on these ideas, that they can begin to take place, if desired, by the action of even small amounts of associates. Human capital – the most important thing!

The core of social development – culture and morality, which are formed spiritually and physically with training and education both in terms of nature, and in relation to society. The principle is simple: to do so that our children will be a little better than us, and their children – even a little better. To achive this it is useful to have a personal example, and the general idea which can bring things in motion [1]. I believe that the idea of a better arrangement of life and the environment is unlikely to get anyones aversion. Such an idea could become an international (rational and aesthetic cultural landscape arrangement Small and Big Homeland) and become, so to speak, a material force that is capable of long-acting. Through it optimal association of economy, ecology and aesthetics could be possible, which is the rational nature. After all, look around: almost everywhere are so much precarious, undone or done poorly, ugly things, that lead to the detriment of the environment! How many people are still on the other side of progress, they lack even the simplest life support and knowledge and so many talents do not receive their proper development, what a great spiritual and material potential is not realized! The amount of work is enormous, and it will last for our grandchildren and great-grandchildren.

However the political system and the economy might be now, we must do everything possible for rational environmental management and improvement, because positive examples even on small plots have primarily educational value. And examples of such sites and such activities are available both in the West and in the East (the best examples – a creative and humanitarian work of Henry Ford, the local improvement of the environment in Western Europe, USA and others.) [2]. How and by what means they are now carried out – is another matter; importantly, the practice confirms: You may want to build economically, ecologically and aesthetically pleasing. The idea of aesthetic and rational arrangement is able to unite and bring together capitalists and workers, civil servants and intellectuals, bankers and farmers, because of its implementation all benefit and, thus, may decrease antagonism in the societies and lead to strengthening of genuine democracy and humanism.

To achieve the goal of rational environmental management a strategy of actions is needed. Humanitarian and labor education, humanitarian and technical education – the most important part of this strategy, as well as the change of the liberal-dictatorial democratic into social relations based on the perceived freedom and responsibility, humanity, justice, security, and on the termination of the exploitation of man by man and usury.

The second important component of the strategy of nature management is a scientific and technological creativity of the broad masses. That technological capabilities and scientific advances have opened a vast expanse for rational environmental management. Therefore, not the increase in exploration and production (use) of more and more new mineral deposits and other natural resources should be a priority, but the improvement and implementation of technologies for the products that are already produced and extracted, which can be recycled and used again. In this area should evolve the best scientific, engineering and manufacturing strength. But the dictatorial liberal market system, focused on profit, which is based, in addition to the surplus value and interest, and is bestowed upon the nature of the land and resource rent, prevents it. This given rent capitalists tend to exhaust till the end, causing great harm in passing environment. Improving technology would dramatically reduce the negative effects of intensive castings subsoil, water, biosphere, or even eliminate them, but the monopoly and the state capital, not only willingly enough improves and implements technology, but often prevent their implementation, buying and hiding under the carpet innovative technology patents – all in order to have more gratuitous profit. In addition, new technologies are rapidly becoming available to all countries, in terms of liberal capitalism is extremely disadvantageous to developers who are losing their monopoly on the implementation of the technology and, as a consequence, an additional profit. That is why it is important for environmental management and, ultimately, for the development of a human, humane and just social system.

Technological progress is for all and in the end will allow to extract and use natural resources very locally and on the toughest places to live, thus enabling us to increase, preserve and make greater use of recreational, aesthetic and other human resources. To not support the development of optimal technologies or hinder their development and implementation is a moral and social crime against humanity, and the desire to reduce the earth's population – even more so! Human life is of great value. It is correct to bring up, to enlighten every man, to give him an opportunity of self-realization. The more of us, the more super talented people, the more effective will the problem of natural resources and livelihoods be solved.

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REFERENCE PAIR: GOLD DEPOSIT – PLACER GOLD-BEARING PRIAMURSKAYA PROVINCE

Stepanov V.A.
vitstepanov@yandex.ru, Research Geotechnological center, Petropavlovsk-Kamchatsky, Russia

It is known that gold placers are formed mainly due to the destruction of one or more gold deposits and occurrences of placer formations (Shilo, 2000). Forecasting and prospecting of gold deposits of greatest interest are cases of placer formation at the expense of one particular gold deposit. In this case, the basic parameters of placer and native gold typomorphic features depend on the formation type, level of erosion characteristics of native gold and gold deposit. The presence of the reference pair gold deposit – placer – scattering allows us to solve the inverse problem – determination of the parameters of undiagnosed primary source on the main characteristics placers. The solution to this problem is of considerable interest in the ore-placer provinces such Priamurskaya with well-known exhaust placers for the prediction of new deposits of gold ore.

In the report the reference pair ore deposit – placer gold-bearing Priamurskaya Province (Stepanov, Melnikov, Vakh et al., 2000), in which the placer is formed due to the specific deposits of gold-silver, gold-sulphide-quartz, gold-quartz and gold-polymetallic formations.

The first pair of gold-silver deposit Pokrovsky – placer creek. Sergeevsky. Pokrovsky gold-silver deposit average reserves of gold ore. It is represented by the complex structure of the ore-bearing fallow among granitoids and volcanic rocks of Early Cretaceous age. The ores are represented silicified and argillised volcanics and granitoids with low sulfide gold-silver mineralization. Among the ore minerals, the amount of which does not exceed 1%, dominated by pyrite, marcasite occur, arsenopyrite, sphalerite, galena, stibnite, argentite, hydroxides of iron and native gold. Gold thin, low-grade (626-735 ‰). The deposit is attributed to volcanic gold-silver formation. Placer creek Sergeevsky originates directly from the ore bodies Pokrovsky deposit. A scattering of small, completely spent. From it produced 200 kg of gold. Gold in a scattering of small and very small, dendritic and rod-shaped. A sample of its low (690-780 ‰). Minerals of gold placers are magnetite, limonite, hematite, pyrite, barite and cinnabar.

The second pair of gold-sulphide-quartz deposit Pioneer – placer Ulunga. Pioneer deposit is sizable. It is located among the Early Cretaceous granitoids intruding clastic rocks of Medium-Late Jurassic age. The ore bodies are steeply inclined linear stockworks vein-mesh silicification and carbonation with stringer-disseminated gold-sulfide mineralization. Sulphide ores ranges from 2 to 8%. Ore minerals dominated by pyrite and arsenopyrite. More over, there pyrrhotite, magnetite, chalcopyrite, molybdenite, galena, sphalerite, bismuthine, stibnite, sulfosalts lead, copper, arsenic, antimony, native gold, sometimes silver, argentite and acanthite. Native gold forms micron separation and nanoparticles in pre-ore pyrite mineralization stage, but mostly it's fine selection hooked, and risy rounded shape. A sample of it from 650 to 880 ‰ in the ordinary ores to 870-915 ‰ in the rich. Mineralization is related to gold-sulfide-quartz formation. Widely developed oxidation zone, with capacity from 10 to 220 m. Due to erosion of the upper part of the deposit formed placer Ulunga (Pioneer mine area). Placer worked out of it produced 6600kg of gold. Gold shallow, lumpy and lumpy-crystalline form. Average sample it – 880 ‰, with fluctuations from 800 to 965 ‰. Minerals satellites gold placers are zircon, apatite, scheelite, galena, pyrite and cinnabar.

The third pair of gold-sulfide-quartz deposit Bamskoye – placer. Chulbangro. Bamskoe deposit is sizable to reserve and forecast resources. It developed among the gneisses and crystalline schists of Archaean age and Early Proterozoic granites. Orebodies are stringer zones of silicification and linear mineralized zone metamorphism, rarely carbnate-quartz veins, concentrated in the area Bamskoye reset. Ore from small to moderately sulfide. As a part of non-metallic components dominated by quartz (chalcedony sometimes), carbonates, sericite, barite and fluorite are marked. Among the mineral ore, the number of which varies from 1-5 to 10%, widespread pyrite, chalcopyrite, galena, and gold. Less common faded ore, sphalerite, scheelite, hessite, matildite, acanthite and petzite. Gold and fine particulate. Taste it varies from 730 to 952 ‰. The deposit is attributed to gold-sulfide-quartz formation. Placer Creek Chulbangro originates directly from the ore bodies Bamskoye deposit. A scattering of small, not worked out. Gold shallow plate, lumpy and hooked shape. Average sample it is 850 ‰.

The fourth pair of gold-quartz deposit Tokur – placer creek Bol. Tokur. Tokur is the average deposit reserves of gold ore, now largely spent. It is located among clastic strata of Late Paleozoic, Cretaceous dikes intruded. The ore bodies are represented by quartz veins. They have a breccia, banded or network structure composed of quartz with an admixture adularia, calcite, ankerite, sericite and chlorite. Ore minerals, the amount of which does not exceed 1-3%, there are arsenopyrite, pyrite, galena, sphalerite, and native gold. Less common scheelite, rutile, chalcopyrite, marcasite, gray ores, antimony and kustelite. Native gold in the pea size from microns to first 1-2mm. A sample of its low and varies from 673 to 803 ‰, on average 726 ‰. The deposit belongs to low-sulfide gold-quartz formation. Placer to creek Bol. Tokur developed, produced about 0.5t of gold. Gold small and medium size, plate, tabletty, rod-shaped, and wirely and lumpy forms. A sample of its low (on average 720 ‰).

The fifth pair of gold-polymetallic deposit Berezitovoe – placer creek. Haykta. Berezitovoe field is the average gold reserves. It is located among the Early Proterozoic granodiorite. Mineralization is represented by a large mineralized zone of metasomatic rocks of complex composition. In terms of area has a lenticular shape. It combines two high-angle funnel body tapers off with depth. Metasomatites contain nests, veins and disseminated gold-polymetallic composition. Among the ore minerals dominated by galena, sphalerite, pyrite and pyrrhotite, rarer magnetite, chalcopyrite, arsenopyrite, marcasite and native gold. The most common native gold xenomorphic, teardrop and lumpy forms rarer flattened elongated aggregates, scaly and lowplate allocation, complex openwork, and dendritic crystal grain. Sample individual gold particles ranging from 666 to 999 ‰, with an average of 861 ‰. The most common moderately high-grade gold (800-899 ‰). Mineralization is related to gold-polymetallic formation. Placer creek. Haykta developed, produced 2.7t of gold. Gold small and medium size, has a plate-like, flattened, and lumpy and wirely forms. The average gold content of 865 ‰. In conclusion, the analysis of sample pairs gold deposit – a scattering helps to predict the presence of new gold deposits.

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VEIN CLARIFICATION IN RED-COLORED CAMBRIAN ROCKS OF NAKIN FIELD OF YAKUTIA

[1]Ignatov P.A., [1]Zaripov N.R., [1]Novikov K.V., [1]Shmonov A.M., [2]Liskovaya L.V.
[1]petrignatov@gmail.com, nail750@mail.ru, novikovkv@gmail.com, shmonov@mail.ru
MGPI-RSGPU, Moscow, Russia; [2]NIGP ALROSA, Mirniy, Russia

Detection of new features of structures which contained kimberlites is important condition of local prediction and searching of original diamond deposits in overlapping areas. One of the detected synkimberlite mineral neogenesis in ore-contained cambrian rock mass is vein clarification of red-colored rocks [Ignatov et al., 2007]

Often in process of study red-colored upper-cambrian rock mass in Malo-Botuobinskiy and Sredne-Markhinskiy districts of diamondiferous province of Yakutia observe bright cutting and sublayers clarification. To determined origin of this neogenesis studied their textural and structural characteristics, chemical and mineral composition.

At this moment factual material include 12 samples of cutting and sublayer clarification and red-colored rocks with X-ray fluorescence analysis, x-ray phase analysis of 6 samples, petrographic studies of 3 thin sections, X-ray fluorescence analysis of approximately 40 samples, which collected from Cambrian and Ordovician rocks. All samples were collected from searching, prospecting and hidrogeological holes, which drilled in Nakin area of Sredne-Markhinskiy district of Yakutia.

Low-paleozoic sedimentary rocks, which contain diamondiferous kimberlite pipes and dykes of Nakin and greater part of Mirninskiy kymberlite areas are presented by terrigenous-carbonate Cambrian and Ordovician rocks. They are overlaid by mesozoic-cenozoic formations of Triassic, Jurassic, Cretaceous, Quaternary systems with thickness 40-100 meters and more.

In the Cambrian slit, clay, carbonate sedimentary rocks observed red-colored rock masses. limestones, dolomites have grey, whitish or greenish-grey color. Red color connected with terrigenous and terrigenous-carbonate rocks, which look like siltstone or marl. Under the microscope such rocks are determined as clay-silty calcareous dolomites or clay-dolomity slit rocks. In this rocks iron oxides and hydroxides envelop and cement clastic part and crystals of carbonates. It is observed in thin sections and confirmed by results of X-ray fluorescence analysis. For example, in red-colored rocks iron content more than in grey-colored rocks. Sublayer distribution of iron oxides and hydroxides, disseminate-cement structures, mud rolls of red-colored argillites, textures of roiling in red-colored layers indicate diagenetic origin of iron oxides.

In this red-colored rock masses widely distribute sublayered clarification. Probably, this occurrence connect with catagenetic gleying process. Catagenetic gleying is common process in any red-colored rocks [Borisenko, 1980; Perelman, 1972].

There are cutting clarification observe in nearkimberlite space with the distance to three diameters of pipes or thickness of dykes. Evidences of endogenous origin of these veins are provided by their morphology, chemical and mineral composition.

Cutting clarification meet in the form individual veins with thickness to the first centimeters, systems of crossing veins, have branched form, develop along thin filiform fractures. Thickness and quantity of veins are reduced, when distance increases. Clarification with maximum intensity is observed in red-colored xenoliths of Low-paleozoic rocks, situated into kimberlite breccia. It confirms direct connection of vein clarification with endogenous processes.

Contents of minerals, chemical elements in clarification veins and in contacting red-colored rocks are comparable. In clarification part only content of iron decreases significantly. At least in clarification part content of silicon is less than in red rocks. It confirmed by corrosions of silicon by dolomite as can be seen in thin sections.

X-ray phase materials of vein and sublayered clarification detect serpentine in 4 samples of 6. Serpentine is mineral-indicator of kimberlites mass in Malo-Botuobinskiy and Sredne-Markhinskiy districts of diamondiferous province of Yakutia. In these two samples indicate smectites instead of serpentine.

When studying the gas composition of the lower Paleozoic rocks of the borehole depth of 470 m, in one of the 80 samples within the area of veined lightening set the high water content, which is not typical for catagenetic (exogenous) clarification. Because exogenous type of clarification is characterized by an increase in dispersion, reducing porosity and permeability [Borisenko, 1980].

It should be noted presence in veined lightening and near the contact zone thalassophile dispersed element bromine, established by x-ray fluorescence analysis (analyst M. S. Gurvich, laboratory MGPI-RSGPU). This means part of the formation of salt water. Bromine, probably marks the kimberlite fluid magmatism or special volcanism on V.A. Milashev [Milashev, 1990]. In ultrabasic rocks bromine especially little, and its source is volcanism [Perelman, 1980].

Thus, the substance evidences of endogenous fluid-magmatic nature of vein clarification are received.

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PRINCIPAL ELEMENTS OF GOLD MINERALIZATION PROSPECTING MODEL OF THE PROSPECTIVE AREA SOUTHERN WITHIN SREDNE-ISHIMBINSKAYA AREA OF YENISEI GOLD PROVINCE

Mansurov R.Kh.
Rinman81@bk.ru, Federal state unitary enterprise Central Research Institute of Geological Prospecting for base and precious metals (FSUE TsNIGRI), Moscow, Russia

Within the framework of the state contract FSUE TsNIGRI conducts currently prospecting of large-dimension gold mineralization localized in the carbonate-terrigenous complexes within the Sredne-Ishimbinskaya prospective area in the central part of the Yenisei gold province. According to the results of the work completed at the moment, the author has made a preliminary gold mineralization prospecting model of prospective area Southern. Complex of geological, geochemical and geophysical prospecting methods revealed an ore-controlling zone of fold-discontinuous deformations, within which we had localized the gold-mineralized zones. The principal elements of prospecting model of the research subject are the following:

1. Localization in gentle parts of fold flanks complicated folding of higher orders;
2. Position at the intersection of tectonic faults of several directions, including the system of faults feathering to Ishimbinskaya deep ore-controlling fault zone;
3. Considerable spatial distance (more than 10 km) from large outcropping intrusive granitoid massifs; there may be hidden deep-seated intrusions;
4. Location in chlorite subfacies of regional metamorphism of greenschist facies; localization in carbonate-dominated sediments;
5. The linear stockwork-like sub-parallel to folding ore zones (width of the gold-mineralized zones is a few hundred meters) are composed of silicified, brown spar (ankerite) rocks saturated various width transversal and conformable quartz, sericite (muscovite)-ankerite-quartz veins and veinlets with intense impregnation of sulfides (5-7 vol. %) with lower average gold concentration;
6. Wide sustained secondary dispersion halos of gold (0,1 g/t); at the same time, low arsenic content in primary and secondary dispersion halos – less than 0,001% (probably due to the lower sensitivity of spectral analysis);
7. The ore-controlling zone of cleavage comprising gold-mineralized zone is represented by high anomaly of induced polarization and low apparent resistivity.

The comparative analysis of the studied object with known gold deposits of the Yenisei Ridge showed that several prospecting criteria and indicators of Eldorado, Vasilyevskoe, Sovietskoe and Bogolyubovskoe deposits are similar to prospective area Southern at this stage of the research. It should be noted, that all these deposits are located in the zone of dynamic influence of the Ishimbinskaya ore-controlling deep fault.

SPECIALIZED GEOLOGICAL MAPS UNDER EXPLORATION OF CHROMIUM-ORE OBJECTS ON EXAMPLE OF ULTRABASIC MASSIFS OF THE POLAR URALS

Zibrov I.A.
ZibrovIlya@gmail.com, VIMS, Moscow, Russia

Specialized geological maps of ultrabasic massifs, usually medium-scale, that shows different aspects of their structure, composition of rock-forming and accessory minerals, metamorphism and chromium ore-bearing making-up during a long time. In Polar Urals' massifs was mapped dunite component (percent of dunites among all ultrabasites), degree of serpentinization, metamorphic mineral association, magnetic suspectibility of surface rocks, composition of accessory chrome-spinel, Fe# of rock-forming olivine [3].

Except single works [1, 2] mapping was middle scale (close to 1:200 000). Works on topo-mineralogical mapping showed, that olivine's composition (Fe#, that correlated with Ng) possible to use for regional forecast of ore-bearing. Fe# of olivine reduced with approaching to chromium ore bodies [3].

Maps of composition of accessory chrome-spinel was suggesteв for forecast rate of industry type of chromium. During lizardite serpentinization composition of chrome-spinel was staying constant. But during high-temperature serpentinization (antigoritization) Fe# of accessory chrome-spinel was increasing, and after that is impossible to use chrome-spinel's composition for forecast the ore's industry type. Compositon of accessory chrome-spinel was measured by infra-red spectroscopy [3].

Maps of serpenitnization's degree, metamorphic minerals association and magnetic suspectibility of surface rocks by same authors, can be use for interpretation of magnetic prospection's results. On areas with high-temperature serpentinized ultrabasites magnetic prospection is spurious because of a lot of newborn magnetite [3].

During exploration works on Polar Urals' massifs [4,5] we used some new ideas for specialized mineralogical mapping.

Dunite component map with 5%-step contours due to regular grid made up for Pogurey-Labogey area, scale of the map is 1:25 000. In contrast to A.B. Makeev's maps, where dunite component is synonymos to structural-material complexes, we use only dunite component's contours. Analysis of this map showed, that ore bodies is located in maximums of dunite component. Mapping with quantitative analysis of dunite component is possible to use for chromium-ore forecast in poorly known ultrabasic massifs and for selection areas for detail exploration works.

Maps of chemical composition was made with reflection on geological base triple circle diagrams (Cr, Al, Fe^{3+}) [4]. This map permit to establish a fact of relation with comfosition of chrome-spinel and affiliation it with any structural-material complex. Merits of such mapping method is: greater precision of composition demonstration, than maps in legend of minerals species, simplicity creating in ArcGIS, good visualization and absence of information falsification during making contours due to irregular grid. With regular grids is possible to make maps in contours of ratio of Cr, Al, Fe^{3+} to their sum.

Interesting, that our data on chrome-spinel composition in North ore field (Ray-Iz massif), measured by microprobe analysis is not similar to A.B. Makeev's data, measured by infra-red spectroscopy [3].

For summarizing and systematization of heterogeneous materials on chromium-ore objects of thy Polar Urals was developed complex GIS-project, that associated maps of non-uniformly scaled objects (from province to unprofitable deposit) and database. GIS-project contains review map of the Polar Urals, geological maps of Syum-Keu, Ray-Iz and Voykar-Synynsky massifs, 10 maps of ore objects [4].

All additional information (characteristic of ore objects, data on resources, literature, chemical analysis of ore and ore chrome-spinel and others) compiled into Microsoft Access database. For this database also was made user interface. Every map except GIS-project (*.mxd) was made as publication (*.pmf), that can be open by freeware program ArcReader. Connection between GIS-projects and the database is bidirectional and realize by Hyperlinks and Go to XY features in ArcReaded and by additional scripts for correct request from/to ArcReader. The database, ArcReader's installation files and GIS-projects (as *.mxd and as *.pmf) was written on installation CD.

This decision (storage of information in database, not as attributive in ArcGIS) makes possible to use big geoinformation system without costly programms, such as ArcGIS. It makes our GIS more accessible for users. Source data makes possible for users copying information from database to ArcGIS and analyze it.

Database contains information about 225 ore objects, 3571 ore chemical analyzes, 2951 chrome-spinel chemical analyzes and also information about probable resources of 33 objects an measured resources of 29 objects.

Similar GIS-projects can be create for any areas and mineral resources. The key merit of this way is simlicity and accessibility for users.

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ABOUT PROGRESSIVE-SEQUENTIAL CLASSIFICATION OF MIXTURES (FOR EXAMPLE PRODUCTS OF HYDROTHERMAL PROCESS)

Bobkov A.
bobkov-a-i@yandex.ru, MGRI-RGGRU a name of Sergo Ordzhonikidze, Moscow, Russia

In the base of progressive-sequential classification (PSC) of lower-level discrete organization of matter is the law of the progressive-sequential relationships (LPSR). The wording of the Act [1]: kernel, chemical elements, molecules, substances and mixtures are in a progressive-sequential relationship, which defined by a critical charge Y and deficit of charge X cores, associated with charge Z.

The report examines the characteristics of PSC for example of products of hydrothermal process. The mineral aggregates of two stages of this process are borrowed from [4].

Base the PSC reviewed in [2]. Here are brief explanations necessary for the understanding of the process of classifying objects in the PSC. As follows from the wording of the LPSR any object (hence the mixture) is in a progressive-sequential relations to other objects. This means that the object belongs to a defined progression Y (charges Z is an arithmetic progression), as well as to a certain sequence of X (the values X is of a numeric sequence). In tabular form a relationship with the index R represents the table lines are a progression of objects and columns to their sequence.

Next would be the values of the X, Y, Z (in parentheses after the character element) of the nuclei of the atoms of certain elements [2]: C (6, -6, 12), O (-4, 8, 12), Mg (0, 12, 12), Si (-6, 14, 20), S (16, -4, 20), Ca (20, 0, 20), Fe (-12, 26, 38), Cu (-9, 29, 38), Zn (-8, 38, 30), Pb (-6, 82, 88).

The general scheme of classification: composition of object (qualitative side of composition (quality) → quantitative relationship of parts of composition) → structure of object → properties of object.

Similarity, likeness or analogy the structure and properties of objects are linked in the PSC with equality of values of X.

Values of X, Y, and Z are characteristics of quality object.

Quality is a nuclear composition of the object, taken without consideration of quantitative relationships of kernels of atoms of different elements. Characteristics of quality are: *multiplicity* (M) is the number of elements of quality; *heterogeneity* (H) is the number of elements of quality with different Y values. The heterogeneity of the object determines the number of relations R, in which participates this object. Value of the X, Y, Z, of quality an calculated as the sum of the values of the elements of the quality of that object, i.e. have the property of additivity.

Inversion of quality or simply inversion reflect the variety of relationships object. Formulas inversions are obtained by permutation character of elements in a formula of quality. For example, quartz is SiO_2 as silicon connection will have the formula SiO inversion, and as oxygen connection -OSi. In theses for short is only one the most essential basic inversion with the order of the elements from the nonmetals to metals.

Quality of object is a strategic factor in building a common progressive-sequential classification.

The general formulas for calculating the indices of relations R and their sequences of different orders (S, S^{II}, S^{III}, ...) on the basis of the formula of inversion:

$$R = Y_0 + Y_1 + \dots + Y_{M-1}, \tag{1}$$

$$S = Y_0 + Y_1 + \dots + Y_{M-2}, \tag{2}$$

$$S^{II} = Y_0 + Y_1 + \dots + Y_{M-3}, \tag{3}$$

$$\dots\dots\dots\dots\dots\dots, \qquad (\dots)$$

where M is the multiplicity of quality object, Y_0-constant is equal to zero. So, for singlet (M = 1), for example, chemical elements, simple substances, the ratio R = Y_0 = 0 (1), i.e. they are all zero relation (R0).

After these preliminary comments, can move on to consideration of the classification of products of the two stages of hydrothermal mineralization process. Mineral aggregate first galena-pyrite-dolomite stage being submitted to dolomite, galena, pyrite and quartz. Mineral aggregate second sphalerite-galena-calcic stage consists of calcite, dolomite, sphalerite, galena, pyrite and quartz.

Mineral aggregate each of these stages is a mixture of substances (minerals) of the first order. Then the hydrothermal mineralization process in general can be seen as a mixture of substances of the second order. The report examines the systematization of these mixtures of the first order. First of all, define the data element composition of mixtures. The first mixture consists of Mg, Ca, Fe, Pb, Si, S, O. element composition of the second mixture-Mg, Ca, Fe, Cu, Zn, Pb, Si, C, S, O. Characteristics of first quality: M = 8, Z = 184, X = -38, Y = 222. Heterogeneity of H = 4, therefore the mixture is involved in four relations. Formula basic inversion OSCSiPbFeCaMg. For the basic inverse find indexes relationship (R) and its sequences differing orders formulas (1) to (3): R = S = 190, 210, S^{II}, S^{III} = 152 = 64, S^{IV} = 44, S^{V} = 32, S^{VI} = 12, S^{VII} = 0. In accordance with a mathematical model of the progressive sequential relationships of objects [3] attitude R210 contains progression Y = 212, 214, 222, 230, 248, 266, 298, 330. A mixture similar to the first mixture is any mixture, basic inversion which has index relations R210 and X = -38. Quality second mixture is: M = 10, Z = 243, X = -55, Y = 298, H = 4. Formula basic inversion OSCSiPbFeCuZnCaMg. Characteristics of basic inversion: R = S = 266, 286, S^{II}, S^{III} = 228 = 190, S^{IV} = 152, S^{V} = 64, S^{VI} = 44, S^{VII} = 32, S^{VIII} = 12, S^{IX} = 0. Relationship R286 contains progression Y = 288, 290, 298, 306, 324, 342, 374, 406. In this case the mixture similar must belong to the same relative R286 and have X = -55.

Stoichiometry basic inversion of the first mixture – 8: 3: 2: 1: 1: 1: 1: 1. For basic inversion the second mixture of stoichiometry – 11: 6: 3: 1: 1: 2: 1: 1: 2: 1.

Furthermore, in accordance with the common scheme classification describes the texture and structure of ores. A similar mixture should have a similar structure, texture and stoichiometry.

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OPPORTUNITY OF DEVELOPMENT OF OZERNOYE ZINC DEPOSIT COMPEARED TO THE WORLD ZINC PROJECTS

Tokar O.V.
o.v.tokar@gmail.com, FGUNPP «Aerogeologia», Center «Mineral», Moscow, Russia

In the recent years the problem of the global zinc mining sector stability and supply has been much discussed as the zinc market has been already experiencing a deficit. Nowadays Russia has a good potential for participation in the challenge for the status of one of the major zinc mining countries; the statement is confirmed by the analysis of the consolidated economic and financial indicators (EFI) of sixteen current development zinc projects in the world.

The absence in the global industry of two leading zinc mines – Canadian Brunswick and Perseverance mines – in the very year of theirs closure (2013) turned zinc market to the deficit for the first time during the previous six years, which was amounted by 97kt of refined zinc metal. According to the preliminary data compiled by The International Lead and Zinc Study Group, the global market for refined zinc metal was still in deficit in 2014 – by 255kt over the eleven months from January to November 2014. In addition, the closure of a major Australian zinc Century mine is expected this summer, which could make the deficit much felt by the market.

Russia has a great potential for the support of the world production of zinc, as it has one of the largest zinc mineral bases in the world. But among the producers of the zinc concentrates and refined metal the country does not occupy any leading position and supplies only 2% of world production. In zinc mining sector Russia could be compared with the total production of the two or three large mines, while zinc in the country is mined from four dozen deposits, mainly including small producers by world standards (up to 50kt of zinc annually).

The largest zinc producers in Russia are mines developing zinc-containing volcanogenic massive sulphide (VMS) deposits: Uzelginskoye (mine produced 60.7kt of zinc in 2013), Uchalinskoye (53.8kt) and Gayskoye (30.7kt). In general, VMS deposits (including copper-zinc type) are the leading suppliers of zinc in the country and accounts about 70% of Russian mined zinc. At the same time in the world such deposits provide only 17% (likely to decrease the share in the nearest years) of zinc output. In Russia the majority of the developing zinc deposits also refers to the zinc-containing VMS type, while the future extension of the zinc mining sector in the country is associated with the polymetallic mineral objects including Kyzyl-Tashtygskoye (Tuva), Korbalikhinskoye (Altai Territory), Ozernoye (Buryatia) which locate a great amount of the Russian zinc reserves: 2%, 4% and 14% of Russian zinc reserves respectively. In 2013 Kyzyl-Tashtygskoye and Korbalikhinskoye deposits were involved into operation, these mines and processing plants are continuing to develop and to increase its production.

As for the third one the process of its development already has taken quite a long time. At Ozernoye deposit a giant mine and plant are projected, which would be able to process annually 8Mt of polymetallic ore. The construction of them requires significant capital expenditures which are much greater than those for the average zinc project in the world.

Ozernoye is characterized by the highest initial capital costs (CAPEX) among development zinc projects. Its initial CAPEX (US$1.33 bln) more than double the same costs of the most expensive development projects of zinc deposits as Australian Admiral Bay (US$690 mln) or Canadian Hackett River (US$668 mln), although the last two are smaller than Russian one.

However, the initial CAPEX per metric ton of zinc (to be mined in during mine life) at Ozernoye corresponds to the global picture, especially for zinc development projects with open pit mining (like at Ozernoye). The value of this parameter (initial CAPEX per metric ton of zinc) increases with the value of ore and zinc reserves, as well as with the mine capacity, mine life, and the initial CAPEX. So, for Ozernoye, which is expected to produce in total more than 5.3Mt of zinc, the parameter is US$249 per ton of zinc, for Lik project in USA – US$214 per ton (1.5Mt of zinc) and for Torlon Hill in Guatemala – US$150 per ton (145kt of zinc).

The development project of Ozernoye deposit has the longest mine life among the zinc projects considered in the analysis. It accounts as 25 years with a payback period of 6 years. At the same time, the average mine life of the zinc project is less than 10 years, and the payback period – is about 3.5 years. The longest mine life among zinc projects located out of Russia is expected at Hackett River – 16 years with a payback period of 5.5 years. The average payback period of zinc projects is about 40% of the proposed mine life.

Ozernoye project also differs significantly from other zinc projects (which are designed to produce zinc concentrate as the main product) by the net present value (NPV). NPV for Ozernoye is accounted to be US$1.5 bln and exceeds significantly the majority of zinc projects considered in the analysis characterized by NPV varying from US$3 mln to US$170 mln. Except Russian Ozernoye, great NPV have two projects: Iranian Mehdiabad (US$1.2 bln) and Canadian Hackett River (US$975 mln).

Along with the Russian project they have a large or even a unique resource base, great production and relatively long mine life. By guess, all three projects have a high value of the revenue that it is reliably known only about Hackett River project. Additional evidence of high revenues at these projects is a presence of precious metals: silver (at all three projects) and gold (at Hackett River and Ozernoye) – which would be recovered as by-products in a significant amounts.

Regard to the NPV of Ozernoye project, its volume could have a significant influence from the deep treatment of ores in which precious metals are extracted in Doгй bars produced at the site. It certainly has a beneficial effect on the final cost of production of the mine.

One of the most important factors affecting the economics of the project, including NPV, revenue, etc., are market prices for manufactured metals, especially for components of the main products of the mine; for this analysis it is zinc price. Change of zinc price in the market can lead to an improvement of EFI of the project as well as to their deterioration, including unprofitability of the project.

The base case zinc price for Ozernoye project is US$2000 per ton, that is within the range of the zinc market price in 2011-2012 and also less than the average price for zinc in 2014. While maintaining a positive price trend, supported by expectations of continuing deficit, Russian project could keep its investment attractiveness or even increase it.

Therefore, by the analysis of EFI of the projects, designed on the basis of zinc deposits, it was confirmed that Ozernoye development project is an attractive investment in comparison with the other present-day zinc projects in the world. Its development could make a significant contribution to Russian and world production of the metal and Russia has a good potential for participation in the challenge for the status of one of the leading zinc miners. It should be noted that if the funding of the large-scale Russian project hasn't been provided for a such a long time, so a partial solution of the problem could be a staged development of Ozernoye deposit.

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PALAEOPROTEROZOIC SHUNGITE FLUIDOLITE OF ONEGA STRUCTURE – NEW GENETIC TYPE OF SEDEMENTARY ROCKS

Filippov M.M., Deines Yu.E.
deines@krc.karelia.ru, Institute of geology of the Karelian Research Centre of RAS, Petrozavodsk, Russia

Injections of metasapropelite (fluidolite) were first discovered in 2012 on the site Tetyugino Tolvuyskaya syncline, which is a second-order structure of the Onega synclinorium. They are confined to the benches up to 1.5 m, folded chert and dolomites, including highly brecciated. Section on one of the benches was first described by V.I. Gorlov in 1967 [2]. Given the new views of the authors, this bench can be described as follows: at the bottom of the interval 0.0-2.0 m – intensely brecciated black dolomite (loose mass with preserved from erosion round outliers of dolomite); in the interval of 2.0-2.5 m – "conglomerate" of black dolomite, cemented by metasapropelite and anthraxolite; the interval 2.5-3.7 – chert; the interval 3.7-6.4 – breccia of chert: the first phase of cementation is fluidolite close in appearance to maksovite, the second – anthraxolite filling cracks in the cement; the interval 6.4-7.35 m – unstratified dolomite. Dolomite inclusions are spherical or elongated shape with smooth edges. Similar breccia of chert, limestone and dolomite were found in holes number 12 and 19. The largest injection of organic-matter recorded in several stripping, limited to one bench. The total length of the injection of 21.5 m, apparent thickness of 13 m. Surface of fluidolite is ocherized, slip joints clearly visible on it. In the middle of stripping the massive rock found with signs of flowage folds. Were found angular inclusions of chert and rounded inclusions of dolomite in the matrix of injection. Quartz veins are on the surface forming a complex grid without the expressed orientation.

It was also revealed several miniinjections (up to 15 cm) and channel of one of them within the layer of loose dolomite.

At the micro level the fluidolite contain inclusions of a material different from the matrix in microtexture and structure, content of carbon. In form they are angular, and more rounded. The metacolloidal structure and the zonal amygdales with signs of separation of a complex fluid phase on organic and primary clayey material are observed into inclusions.

Quartz is the main mineral in the composition of the fluid. Sometimes they are condensed into aggregates, which are isolated from each other by shungite mutter. The second most important mineral of matrix is iron- and magnesium-illite. It is often feldspar, apatite, pyrite, which in some cases replaced jarosite, forms the outer rim. More rare minerals are monazite and gold. Fluidolites contain different amounts of carbon even within the same stripping. Samples taken from the top and central part of a stripping also differ in the content of rare earth elements. Consequently, filling local faults was a multi-step, and the composition of the fluidized material has changed over time. Features fluidolite suggest that they are formed in the process of introducing pressurized fluidized organic-matter (colloidal mixture of organic and mineral matter, water, hydrocarbons) in long-lived tension crack.

On the site detected dome of maksovite developed by the sixth shungite horizon, and local faults that have characteristics of a diapir tectonics. It is assumed that the fluids received from the dome under the influence of the abnormally high formation pressure. $\delta^{13}C_{org}$ of injections of metasapropelite of Tetyugino are from -36.5 to -36.9 ‰, the average of 10 samples -36.7 ‰. Consequently, different portions of matter have the same source. The host rocks for injection are chert and dolomites of eighth shungite horizon, the isotopic composition of organic carbon in them respectively equal to -32.7 ‰ and – 33.6 ‰ [4]. In hole 12 at a depth of 19.6 m, breccia is represented by fragments of low-carbon chert cemented by metasapropelite, $\delta^{13}C_{org}$ is equal -36.62 ‰ [3]. At a depth of 98.5-110.0 m borehole 12 lays a layer in which metasapropelite with smooth winding path included in the matrix with lower carbon content. Obviously, this is a consequence of the introduction of the plastic material in the primary layer of sapropelite.

Carbon isotopic composition of the reservoir changes abruptly: $\delta^{13}C_{org}$ from -35.32 to 39.50 ‰ [5], hence the source of fluidolite could be domed body.

Shungite fluidolite identified in the Palaeoproterozoic sediments are new genetic type of sedimentary formations. They are characterized by a specific form and dimensions of the bodies that violate the stratification of precipitation, texture and structure, which differs from typical sedimentary shungite rocks, mineral composition of xenoliths and the matrix, signs of integration and disintegration of mineral phases and components, geochemical features [1], traces of the impact of fluid flow on the surrounding environment, the relationship with tectonic disturbances. By the undeniable signs of fluidolite-rocks include [3]: the traces of moving fluid flows, "blow up" the xenoliths. The findings about the fluidolite of Tetyugino allow to expressing an opinion on the genesis of Shunga deposit and prospects of opening of such deposits in the Onega structure more soundly than before.

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NEW METHODS OF PROSPECTING OF LODE GOLD DEPOSITS IN DIFFICULT MOUNTAIN-TAIGA LANDSCAPES

Mansurov R.Kh.
Rinman81@bk.ru, Federal state unitary enterprise Central Research Institute of Geological Prospecting for base and precious metals (FSUE TsNIGRI), Moscow, Russia

FSUE TsNIGRI conducts currently prospecting of gold ore within the Sredne-Ishimbinskaya prospective area, located in the North-Yenisei district of Krasnoyarsk region, at the junction of sheets O-46 and O-IV-V-46, scale 1: 200 000, in the central part of the Yenisei gold province.

Research methodology provides a comprehensive application of geological, geochemical, geophysical research methods.

1) the study of the area by a series of basic profiles, including geological routes, lithogeochemical sampling for secondary dispersion halos, geophysical surveys (magnetic, gravity, electrical exploration);

2) geological routes scale 1:25 000, 1:10 000;

3) geochemical prospecting of dispersion flux scale 1:50 000;

As a result we have localized an area of detailing works in the south part of the area (area Southern), within which there are an extensive (> 1 km) zone of cleavage, composed of hydrothermal-metasomatic modified rocks with contents of gold more than 0,15 g/t in the secondary dispersion halos, represented in high anomaly of induced polarization and low apparent resistivity.

The next step were a detailed research works in the area Southern, followed the methodology approved FSUE TsNIGRI for prospecting of gold deposits in difficult mountain-taiga landscapes [2, 3]:

4) geochemical prospecting of secondary dispersion halos (sampling density 200x20 m);

5) excavation of pits depth of 0,8 m of lower parts of the slopes within the area of detailing works (intervals between the pits are 20-40 m);

6) excavation of pits to bedrock (intervals of 10-20 m between the pits).

After excavation we conducted schlich, lithogeochemical and point sampling of deep-lying diluvium of the pits. The bedrock was sampled by trench.

As a result of the complex of prospecting works we detected a broad (more than 1 km) gold anomaly (more than 0,003 g/t in the secondary dispersion halos) corresponding to the zone of fold-discontinuous deformations of the area Southern. The zone is localized in the east flank of first order anticline at the intersection of faults of several directions: north-east (supposedly, the system of faults feathering to Ishimbinskaya deep ore-controlling fault zone), north-west and sub-lateral (faults are sub-parallel to folding containing quartz veins and intensively hydrothermal-metasomatic modified rocks.

Within the ore-controlling zone of cleavage we identified gold-mineralized zones in the central and eastern parts of the area Southern. Gold content within the gold-mineralized zones is more than 0,03 g/t in primary as well as secondary dispersion halos. The mineralized zones are composed of silicified, sulfidized (pyrite), brown spar (ankerite) alteration of host rocks rocks of varying degrees of saturation by quartz, (muscovite)-ankerite-quartz veins and veinlets. The zones are localized in carbonate sediments (calcareous-shale, marl, metasomatic modified limestone, metasomatic modified dolomite) of kartochki and aladyinskaya series combined of the suhopitskaya series of the Middle Riphean. The width of the gold-mineralized zones is more than 400 m, the length is more than 1000 m. The mineralized zones coincide with gold schlich halos in which, on average, we detected 3-5 gold grains in each schlich, maximum – 21 grains. The most frequent size of gold is relatively small – 0,2-0,4 mm.

Within the gold-mineralized zones there are the epicenters of the highest gold contents (more than 0,1 g/t) in primary and secondary dispersion halos – ore zones, representing areas of saturation by veinlets and veins (8-12 or more veinlets and veins per 1 meter) of quartz, ankerite-quartz composition with intense dissemination of sulfides (up to 5-7%). The width of the ore zones amounts to 200 m, the length amounts to 1000 m. The ore zones are sub-parallel to folding orientation and its characterized by linearity similar to stockwork morphology.

On the periphery of gold anomalies we detected anomalous fields of zinc (more than 0,007%). Gold anomaly is correspond to the anomalous field of manganese (≥0,2%). The expansion of manganese is associated with widespread of brown spar alteration of host rocks (iron-magnesian manganese-containing carbonate minerals) within the ore-controlling zone of cleavage, increasing in gold-mineralized zones. Brown spar alteration of host rocks processes, probably, occurred during several stages directly related to ore-mineralization of area Southern. According to A.I. Ivanov`s research works, the process of formation of auriferous brown spar alteration zones is ore-preliminary. Gold deposits were formed within these zones during reworking of auriferous rocks by following processes [1, 2].

The localization in carbonate sediments of kartochki and aladyinskaya series combined of the suhopitskaya serie of the Middle Riphean is the most important feature. The vast majority of gold deposits in the Yenisei Ridge is localized in the lower tuffaceous-carbonate-terrigenous flyshoid carbonaceous sediments of Early-Middle Riphean (udereyskaya, gorbilokskaya, kordinskaya series) [5].

Consequently, for the first time in the region we prognosticate the detection of large-dimension stockwork-type gold mineralization with lower average gold concentration related with gold-sulphide-quartz geological and industrial type of mineralization, localized in carbonate-(terrigenous) sediments of the Middle Riphean. At present, the objects of this type are of primary concern for industrial mining because of current well advanced processing technology [4].

The results of prospecting works indicate high degree of efficiency and informativeness of up-to-date methods of prospecting in difficult mountain-taiga landscapes (series of basic profiles, complex of schlich, lithogeochemical and point sampling of deep-lying diluvium of pits. Due to these up-to-date methods succeeded accurately identify areas of anomalous gold concentrations and locations of emplacement of mine workings (trenches) in order to continue geological exploration to localize prognostic resources P_2 category.

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S-VI

EXPLORATION GEOPHYSICS
AND GEOINFORMATICS

MNOGOFUCKTSIONALNYE GEOGRAPHIC INFORMATION SYSTEMS AS AN INTERGRATED SOFTWARE PARKAGE CONNECTED TO A LOCAL AREA NETWORK TECHNOLOGY COMPLEX

Gavrilova V.K.
vict65@rambler.ru, Stary Oskol Branch of Russian State Geological Prospecting University
Sergo Ordzhonikidze SOF MGRI-RGGRU, Stary Oskol, Russia

The most important feature of the mining industry is its inartificial, natural base. Mining, extraction is always required the use of a set of multiple techniques which have been evolved from centuries-old rock art to the modern technology of mining production.

The natural base of each field is characterized by a set of attributes, called geological conditions. These conditions determine the specificity of mining technology, and because they vary over a wide range, there is a large variety of types of mining and technological processes. In such a way, the field development deal with the probabilistic nature of mining and geological factors, and this determines the probabilistic character of the entire production process of mining, including mining and manufacturing processes.

Another significant feature of the mining and production processes – spatial nature of mining operations, due to the fact that within an enterprise is economically feasible to conduct mining operations on multiple layers, ore veins, horizon, the wings of a mine field.

In the last decennary in our daily lives firmly established the concept of information technology. Without the use of modern computers, communications, networking and various information channels unthinkable any learning process, no production, no control or social sphere.

Modern information systems and technology is receiving increasing attention in the preparation of database exploration, geological surveying and operational information, the creation of a digital geological model.

Information technologies are designed to solve various types of problems that arise at any stage of the mining industry, primarily for the information service of all employees associated with the adoption of administrative decisions. This information is usually presented in the form of regular or special management reports and contains information about past, present and possible future of the enterprise. Automation workplace involves the organization and support communication processes within production and with the environment based on computer networks and other modern means of communication and work with information. Widely used in the design of information technology in the form of computer graphics, simulation processes and engineering calculations.

Safety and efficiency of mining production is largely determined by the quality of its software and geological surveying information. The main criteria for the quality of the software – the timeliness, completeness, reliability and efficiency of information processing.

One of the main directions of improving the quality of information support mining operations – the automation of this process on the basis of multi-functional geographic information systems (GIS) in the form of an integrated software package and connected to a local area network technology complex automation of the workplace.

Geographic Information Systems (GIS) – an information system for the collection, storage, processing, access, display and distribute spatially coordinated data (spatial data). GIS are designed to solve scientific and applied problems of inventory, analysis, assessment, prediction and management of the environment and territorial organization of society.

GIS-based mapping systems make automated, and the main sources of information are various geoimages.

Electronic map, created in GIS, supported by a powerful arsenal of analytical tools, a rich toolkit for creating and editing objects, as well as databases, specialized scanning devices, printing and other technical solutions, by means of the Internet and even satellite images and information from satellites. Use of relief as the basis for numerous geographic information systems and a variety of virtual models makes it possible to take a fresh look at its key features and performance.

Geographic images for use in a GIS input vector or raster data directly, if data already exists in a suitable digital format, or using a digitizer or scanner. The main forms of presentation of information in geographic information systems are digital maps (metric and topological information), semantic database (semantic information) and service database, containing information about map projections of digital maps, the state's area, etc.

In terms of software, digital maps, semantic and service database are represented as files. The internal structure of the file, a method of encoding the information they depend on the particular software implementation of GIS. The totality of the information stored in the GIS in this area is called cartographic data bank. Cartographic database contains digital maps, semantic and service database. For working with the information stored in the database GIS provides a special set of functional tools called control system map data bank.

The distinctive characteristics of GIS are the following features: the use of different types of integration (data, hardware, technology); content independent of the complex, in which all treatment processes, and exchange of information; cyclical processing typed data associated with processing algorithms as well as with the process.

GIS generally perform from five basic procedures with the data: input, the manipulation, governance, query and analysis, visualization. Handling means are different ways of transformation and data capture (bringing the entire geo-information to a single scale and projection for the convenience of the co-processing). For storage, structuring and management of data in GIS are most commonly used relational databases, where to link the tables are common fields. Query and analysis in a GIS can be performed at different levels of complexity: from simple questions, for example, where the facility is located and what are its properties, to the search for complex patterns and scenarios.

Integration of databases includes using dozens of databases, often distributed across multiple interconnected computers of various departments.

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MATHEMATICAL MODELING P-EFFECT IN MAGNETOTELLURICS

Karinskiy A.D., Daev D.S., Krasnoselskikh A.A., Mazitova I.K.
akarinski@mail.ru, ddaev@mail.ru, andrey.krasnoselskikh@gmail.com,
kamilovn@yandex.ru, Russian State Geological Prospecting University, Moscow, Russia

In the monograph by Berditchevsky M. N. and Dmitriev V. I. about magnetotelluric sounding (MTS) [2] the phenomenon of ρ (Rho) – effect is characterized as distortion of the MTS results, due to the small near-surface objects, that differ on electrical resistivity (ρ) from surrounding rocks. Problems in mathematical modeling of ρ-effect related to the fact, that such modeling requires the numerical solution of three-dimensional direct problems of electrodynamics.

In the paper [4] we presented results of ρ-effect modeling for the case of small isometric object ΔV, witch is situated in the upper layer the horizontally – layered model of a conducting half-space. At that stage of research, we consider the case where (in the absence of the object ΔV) harmonically varying electromagnetic (EM) field is linearly polarized and conductive half-space consists of two layers. In this report we present the modeling results for two-layered and three-layered conducting half-space models.

Our modeling method based on the following statements. In the article [3] has proved the method of approximate calculation of EM field caused by small-sized spherical object ΔV that differ from surrounding medium on ρ, dielectric permittivity ε and magnetic permeability μ. In the case of uniform within ΔV primary EM field secondary field outside ΔV can be expressed as a sum of fields of electrical and magnetic dipoles with centers which are situated in the center of object ΔV. Magnetic dipole moment is equal to zero in nonmagnetic medium. In the case of quasi-stationary approximation of EM field (applying in MT sounding method) the moment of electrical dipole depends on the only one electromagnetic parameter of the medium – electrical resistivity ρ of the object ΔV and the surrounding rocks.

As known lines *MN* are used in MTS for measurement of the horizontal components *Ex, Ey* of electrical field **E**. Induction detectors (coils) are used for definition of horizontal components *Hx, Hy* and vertical component *Hz* of magnetic field **H**. The results of measurements obtained components of the impedance tensor and apparent resistivity ρ_T dependence of the square root of the oscillation period $T = 1/f$, where f is frequency.

We took the next assumptions during the process of mathematical modeling. In the absence of the object ΔV normal electromagnetic field is harmonically varying and linearly polarized. This field is the sum of the transmitted and reflected waves if layers of horizontally-layered model have a finite thickness. Anomalous field due to the presence of the object ΔV is the field of alternating electrical dipole witch moment depends on the radius of the object, electrical resistivities of object and surrounding rocks and the electrical component of normal electromagnetic field in the center of the object ΔV.

In the report (presentation) we represent the mathematical expression used for ρ-effect modeling in MTS method and results of modeling. Based on the results of the researches it is possible to draw the following main conclusions.

1) We obtained the results of modeling, that are consistent with the results reported by Berditchevsky M. N. and other scientists engaged in development of the theory and interpretation technique of MT sounding results, of conclusions about predominantly galvanical (coulomb) nature of the influence exerted by local near-surface objects on the measured characteristics of electrical field in the MT sounding method. The influence of the object ΔV on the electrical component of electromagnetic field and apparent resistivity ρ_T doesn't depend on the frequency f in the case of the medium models and normal electromagnetic field that we used in mathematical calculations. According to the approach proved in the Alpin L. M. paper [1] the sources of the anomalous field **E** is induced on the boundary of the object ΔV (as well – on the horizontal boundaries) surface charges in the form of a single layer.

2) As shown the inductive vertical component *Hz* of the magnetic component **H** of the EM field can experience a significant influence local object ΔV and the impact it increases

with the frequency f. This is evidenced by the frequency dependence relations of amplitudes $|Hz|/|Hy|$ components Hz and Hy of the magnetic field. Such dependencies can be not only criterion proving the influence of object ΔV on the MT sounding results, but it can be use for (independent from the measurement results of electrical field **E** characteristics) estimation of relation between electrical resistivities of layers with horizontal boundaries.

We will give our opinion on the physical interpretation of the phenomenon, which in the monograph [2] has called ρ – effect. This needs to take into account the I-St and II-nd Maxwell's equations. In the quasistationary approximation in the non-magnetic medium:

$$\text{I. } \operatorname{rot}\mathbf{H} = \mathbf{j} = \mathbf{E}/\rho, \quad \text{II. } \operatorname{rot}\mathbf{E} = -\mu_0\left(\partial\mathbf{H}/\partial t\right) = i\omega\mu_0\mathbf{H}, \tag{1}$$

where i – imaginary unit, $\omega=2\pi f$ is the circular frequency, t is time, $\mu_0=4\pi\cdot10^7$, GN/m is the magnetic constant. The last equality in the II-th equation in (1) is true for harmonically varying fields when using an integrated recording and time-factor $\exp(-i\omega t)$.

1) Surface electrical charges induced (due to the presence of the object ΔV) on the boundaries create anomalous coulomb component of the electrical field **E**.

2) In accordance to the Ohm’s law in differential form **j=E**/ρ, in the conductive medium anomalous electric current with current density vector **j** is caused by this component of the field **E**.

3) In accordance to the I-st equation in (1) this electric current generates vortex magnetic field **H**.

4) In accordance to the II-nd equation in (1) this vortex magnetic field **H** excites vortex electrical field **E**.

5) In turn in conductive medium this field **E** creates vortex electric currents which density depends on resistivities in variety domains of the medium. These currents excite magnetic field **H** with derivate and etc.

6) It follows that frequency f doesn’t influence sufficiently on the electrical component **E** of anomalous EM field caused by presence of the object ΔV, but magnetic component Hz of this field increases with the growth of frequency. In this case of the medium approximation Hz component of the magnetic field is the most “sensitive” to the presence of local near-surface heterogeneity ΔV in the MT sounding method**.**

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COMPARISON OF THE RESULTS OF LABORATORY MODELING OF ELECTROMAGNETIC LOGGING PROBES WITH TOROIDAL ANTENNAS AND DIPOLE-AXIAL RESISTIVITY PROBES

Kaurkin M.D.
Kaurkin_m@mail.ru, Joint-stock company "31st State Project Institute of Special Construction", Moscow, Russia

Various field exciters and sensors are used during the process of electric and electromagnetic studying of wells. The simplest exciters and sensors are current and measuring electrodes or electric dipoles and alternating magnetic dipoles. In recent years there has been increased interest in the possibilities of use of probes with generating and measuring toroidal antennas (closed solenoid) in electromagnetic well logging. In particular it is necessary to note a number of patents obtained by foreign scientists [Hans-Martin Maurer, David R. Beard, Rashid W. Khokar, 2010], [Robert A Moore, 2009] for inventions relating to the use of probes with toroidal antennas in logging-while-drilling (LWD) process. Theoretical studies have shown that the use of such probes may be promising for the determination of electrical parameters passed wellbore rock, in particular anisotropic formations parameters.

In methods of electric prospecting various arrays are used, including dipole ones, which consist of feeding and receiving electric dipoles. Dipole-axial and dipole-equatorial arrays are distinguished. The possibility of use of such devices in electrical sounding was grounded in the works of L.M.Alpin [1, 2]. According to the location of feeding end measuring electrodes dipole-dipole probes are similar to dipole arrays used in electric prospecting. We should recall that dipole probes have the distance between feeding electrodes A, B and measuring electrodes M, N, which is smaller than the distance between the centers of the segments AB and MN.

The idea of use of dipole probes for well logging has been put forward for a long time, but it is not widely received nowadays. In particular V.N.Dakhnov [3] pointed to a high dismembering ability of dipole-axial probes and insufficient knowledge about them.

Theoretical studies carried by A.D.Karinsky showed that if the generating and receiving toroidal antennas of small size are located in an isotropic well, then the influence, exerted by the parameters of the environment of the well, is identical to that effect, which such an environment would have provided to a borehole probe, comprising of generating and measuring electrical dipoles (with proper orientation). The probes, in which toroidal antennas are used, have one very important advantage: the size of such probes may be much smaller than the length of the generating electric dipole AB or the measuring dipole MN. On the basis of the above mentioned information, the probes with toroidal antennas can provide a high vertical resolution, as well as the ability to create probes with different orientation of receiving and generating antennas.

Recently the author of the report has performed research in the sphere of laboratory modeling of probes with toroidal antennas and electric dipoles [4, 5, 6]. For physical modeling there were created several laboratory facilities, including the environment model and models of several probes of electrical and electromagnetic logging. The laboratory environment model, in its turn, consisted of a formation model and models of host rock formation. Models of host rock formation had the form of right circular cylinders, bounded by the layer of Plexiglas or the air (in upper parts of the model). The cylinders were filled with an aqueous salt solution (water). In the middle of the laboratory environment model the model of wellbore formation was placed. The outer radius of the formation model and host rocks was equal to the insulator bounding the environment model in the radial direction, and the inner radius was equal to the radius of the well model.

For laboratory environment models there were constructed models of isotropic and anisotropic layers of alternating thin layer of materials with different specific electric resistances (cardboard, Plexiglas and aluminum). In a laboratory modeling the formation model, made of layers of Plexiglas, corresponded to the layer of high electrical resistivity. For modeling of the formation with low electrical resistance layers of aluminum have been applied. The formation model, which consisted of layers of cardboard (soaked in water), corresponded to an occasion of a weakly anisotropic formation.

In addition to the laboratory environment models there were created several models with different construction, models of probes of electrical and electromagnetic logging:

1) the “axial probe” with toroidal antennas (TAP), which has axes of generating and measuring antennas placed on the axis of the environment model;
2) the axial-dipole probe of resistivity logging (ADP) with short generating segment AB and measuring segment MN lying on the axis of the environment model.

The report presents new results of laboratory modeling of axial probes with toroidal antennas and dipole-axial probes. During the laboratory modeling there were identified some of the factors that have a significant impact on the measurement results, including:

- the presence of the high level of electromagnetic interference;
- the impact of the housing of the laboratory setting;
- changes in the structure of the layers of cardboard as a result of a long stay in an aqueous solution of salts.

To eliminate these factors the author of the report has taken the necessary measures, which helped to reduce, and in some cases virtually eliminate the negative impact.

On the basis of the comparison of laboratory modeling results, obtained by the axial probe with toroidal antennas and the dipole-axial probe in various formation models, it can be concluded that the arrangement of probes in a well borehole parameters surrounding the well environment have the same influence on the measurement results.

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MATHEMATICAL MODELING OF P – EFFECT AND C-EFFECT IN THE RESISTIVITY PROSPECTING BASED ON THE APPROXIMATE SOLUTION OF THREE-DIMENSIONAL FORWARD PROBLEM

Mazitova I.K., Karinskiy A.D., Daev D.S.
kamilovn@yandex.ru, akarinski@mail.ru,ddaev@mail.ru, Russian State Geological Prospecting University, Moscow, Russia

In the publications [3, 4, 5] we justify the use of an approximate approach to the definition of "area of space, that have a major influence on the measurement results" for some electrical and electromagnetic surveys. Under certain conditions the secondary field of every small object ΔV with isometric shape, witch differ on electromagnetic parameters from the surrounding space, can be similar to the field of variable electric and magnetic dipoles, witch centers situated in the middle of this object. In the case of a stationary electric field secondary field of such object (with resistivity ρ differed from the medium value) can be approximated by the field of permanent electric dipole. In the report we provide examples of the results due to this approach for modeling the influence of near-surface local objects on the results of resistivity survey methods. In the resistivity surveys such phenomena, influencing in the negative way on the electrical soundings and electric profiling data, called C – effect and P – effect.

Probably, the first definitions of the concepts "P-effect", "C-effect" were given in article by Bobachev A.A. et al. [2]. These effects was described in the tutorial [8] and other papers published by MSU. The following definitions of C-effect and P- effect we took from the book [8]. P (potential)-effect is caused by close relative position of the measuring electrode and near-surface inhomogenuity. In the case of vertical electrical sounding (VES) this effect appears as a vertical shift of the sounding curve in the direction of apparent resistivity ρa axis without changing shape of the curve. C(current)-effect is a distortion of curves caused by the movement of the source electrodes above the near-surface inhomogeneities. C-effect causes variations in the shape of the sounding curve and in the number of apparent layers on it.

There are induced surface charges in the form of simple layer – sources of secondary field ES – in the case of the electric field E and the object ΔV, differing on resistivity ρ from surrounding medium, presence. As known (for example, L.M. Alpin, [1, pp. 170–173]), if the primary field EP homogenous, and the sphere-shaped object ΔV locates in the infinite homogeneous medium, then the field ES situated outside the object is identical to the field of dipole, witch center locates in the middle of the sphere. The dipole moment is proportional to the field EP, volume of ΔV and depends on resistivity of the object and its surrounding medium.

The interpretation of measurement results in resistivity methods of electrical soundings usually based on the solution of direct and inverse problems for horizontally layered model of the medium. The solution of direct point-source field problem is well-know for the case, when point current electrode located on the flat horizontal boundary of the insulator and conducting medium, witch has plane-parallel horizontal boundaries. We suggest, that expressions for the field E located on the conducted half-space, are important in the case of VES data interpretation. We needed to determine the potential U and components of electric field E in the random point of conducting half-space (in the place where center of the object ΔV can be) for applying our approach, that was proved by us in the papers [4, 5, 6]. The method of mirror images was applied for approximation the influence of conductive and non-conductive half-spaces boundary on the anomalous field caused by object ΔV.

In the report we represented results of mathematical modeling of the P- and C- effects for the case of the local near-surface sphere-shaped heterogeneity (small size object ΔV is differ on resistivity from the surrounding medium). We considered the cases, when object ΔV is located in the homogeneous conductive half-space or in the upper layer of horizontally layered medium model. There are quantitative evaluation of these effects depending on the object parameters and the surrounding medium. The results of mathematical modeling were obtained for the cases corresponding to several electrical prospecting methods – symmetrical electrical profiling by Schlumberger array, vertical electrical sounding by Schlumberger array, dipole electrical sounding by equatorial dipole – dipole array.

We draw the following conclusions based on the results of our research.

1. We represented, how the earlier proved approach of determination medium areas, influencing on the electromagnetic surveys results, can be used for modeling of C-effect and P-effect in resistivity methods of electrical prospecting surveys.

2. The calculation methods, that we applied, can be used to quantify the impact of local surface heterogeneity on the results of resistivity survey in the case of priori information presence. The algorithms, that was developed for calculation of near-surface local objects influence on the values of apparent resistivity ρa, can also be used for quantity interpretation of measurements in resistivity methods, for example, in the program IPI2Win.

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RADIOACTIVE ISOTOPES IN THE LESS COMMON METAL ORES AND THEIR CONVERSIONAL PRODUCTS

Ovsiannikova T.M.
lab@u238.ru, FSUE «VIMS», Moscow, Russia

From up to 50 chemical elements classified as less common metals (LCM) some are radioactive and some are found in raw ores and conversional products along with radioactive elements.

There are different types of LCM deposits on the territory of Russia where radionuclides are either a major component or a byproduct: Alluayvskoe (Th), Karasugskoe (U, Th), Ulug-Tanzekskoe (U, Th), Zashikhinskoe (U, Th), Katuginskoe (U), Srednya Padma (U-V), Tuganskoe (Th), Stepnoe (U), Dalmatovskoe (U), Arbarastakh (U), Algaminskoe (U), Sredneziminskoe (U) et al. [1–3]. Higher radioactivity of ores and their conversion products in other fields is caused by smaller quantities of radionuclides in their composition. Rare earth minerals (TR) contain all radioactive elements. Uranium and thorium occur in the main minerals Ta, Nb and TR as «contaminants»: pyrochlore (U, Th), hatchettolite (Th), marignacite (U), microlite (U), xenotime (U), bastnasite (Th), parisite (Th), ittrosinkhisite (Th), fergusonite (U, Th), euxenite (U, Th), gagarinite (U, Th).

Processing of LCM ores, naturally occurring radioactive materials (NORM), often involves concentration of radionuclides in conversion products, tailings and wastes (known as TENORM – technologically enhanced materials). Deactivation of concentrates (perovskite, loparite, eudialyte, columbite, pyrochlore and others) in Ta, Nb and TR refining with chemical technologies produces radioactive cakes while piro-metallurgical treatment of concentrates results in formation of radioactive slags. For instance, the specific activity of the tailing slag of metallurgically processed Etykinsky ore concentrate (Ta) is about $1{,}1 \cdot 10^5$ Bq/kg [4].

In the US the specific activities of rare earth mining wastes (monazite, xenotime and bastnasite types of ores) vary from 210 to 119288 Bq/kg. For zirconium ore wastes the range is 2516 – 48100 Bq/kg, with 3219 Bq/kg on average. Titanium ores are of low radioactivity, 211 Bq/kg for ilmenite and 729 Bq/kg for rutile, though their wastes vary from 144 to 1665 Bq/kg, with the average activity of 444 Bq/kg. Uranium ores are the source of TENORM with specific activities from 11100 to 111000 Bq/kg (US EPA).

At some non-uranium mines in Australia the specific activities of certain radionuclides in ores exceed the reference level of 1000 Bq/kg (^{226}Ra, ^{234}U, ^{238}U, ^{230}Th, ^{228}Th, ^{232}Th), reaching $3{,}33 \cdot 10^3$ Bq/kg (^{228}Ra) [5]. In concentrates the activities are higher, up to $3{,}74 \cdot 10^4$ Bq/kg (^{228}Ra), other radionuclides also increase significantly – the activity of ^{210}Po rises up to $4{,}88 \cdot 10^3$ Bq/kg, the activity of ^{210}Pb – to $2{,}65 \cdot 10^3$ Bq/kg. Equilibrium in uranium and thorium radioactive decay chains is not observed – in natural ores the activity ratio of ^{226}Ra/^{238}U is 0,50 – 2,2, of ^{228}Ra/^{232}Th – 0,9 – 1,4. In technically enhanced products the activity ratios of ^{226}Ra/^{238}U vary from 1,4 to 2,2; reaching up to 42 for ^{228}Ra/^{232}. The activity ratios of ^{210}Po/^{210}Pb and ^{210}Po/^{226}Ra are also often out of radioactive equilibrium. At these and other fields the radiological situation is further worsened by high activity levels of radon (^{222}Rn) that can go beyond the reference level of occupation exposure (1000 Bq/м^3) as well as ^{234}U enrichment of mine and technological waters.

Titanium, zirconium and rare earth metals are mined on ore sand deposits on east and west coasts of Australia. The main ore minerals are ilmenite, leucoxene, rutile, zircon, monazite and xenotime. During mining operations and the primary separation the specific activities reach 3000 Bq/kg (for Th, a heavy mineral concentrate). The secondary separation increases the activity levels to $2{,}5 \cdot 10^5$ Bq/kg for uranium and to $3{,}0 \cdot 10^4$ Bq/kg for thorium (monazite concentrate). In tailings maximum concentrations of U and Th are $2{,}4 \cdot 10^4$ and $1{,}2 \cdot 10^4$ Bq/kg respectively, in dust fractions – $2{,}0 \cdot 10^4$ and $6{,}0 \cdot 10^3$ Bq/kg [6]. Estimated weight of tailings of the secondary separation is about 70 kt/a. The activity levels in waste materials depend largely on the monazite content of the original ore which can vary considerably depending on the location of the ore body.

At Mount Weld deposits of rare earth metals in Western Australia associated with alkaline carbonatites relative abundance of thorium is reported to be 626 g/t (2535 Bq/kg) [8]. Australian mining company Lynas is planning to set up a large refinery in Malaysia that will receive Mount

Weld ores as well as TR ores from Kangankunde deposit (Malawi). The specific activity of waste is estimated to be 6,1.104 Bq/kg.

In China rare earth refineries produce wastes with the specific activity of $7{,}4 \cdot 10^4$ Bq/kg [7].

High specific activities of rare earth metals entail risks of occupational exposure, thus refineries require proper licensing and providing safe working conditions. Further regulations include obligatory radioactive monitoring, thorough classification of byproducts, tailings and wastes and environmental protection considerations as well as extra funding. The same rules apply to other types of rare metal refineries.

Radioactive control and monitoring in the industry requires solving many problems, such as the developing of special radiochemical methods of measuring radioactive isotopes in LCM ores and their conversion products. Instrumental methods (e.g. gamma-ray spectrometry) are unlikely to measure activities of all key radionuclides in objects with complicated or unstable mineral and chemical composition as well as high level disequilibrium. Accurate estimation of cumulative specific activities of raw LCM and refined products that complies with the international classification system of radiation safety can be provided by using spectral radioisotopic methods and radiochemical procedures. To calculate the activity level the following equation can be used:

$$AC = 3A_{Th-234} + A_{Th-230} + A_{Ra-226} + 2A_{Pb-210} + A_{Th-228} + A_{Ra-228},$$

where A is the specific activity of certain radionuclides.

At the moment FSUE «VIMS» is working on the development of a standard range of radioisotopic methods for analysis of LCM ores and their conversion products, including metrological tools.

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GEOPHYSICAL SURVEY GENTLY SLOPING LAYERS OF ROCKS IN CONDITIONS OF RUGGED MOUNTAINOUS TERRAIN

Badelin A.V.
a.badelin@spbu.ru, SPSU, Saint Petersburg, Russia

Modern means of satellite positioning can significantly improve the accuracy, reliability and veracity of the results of field observations and talk about the possibility of high-precision geophysical survey. Precision technology of large-scale geophysical surveys are discussed below, includes four components: 1) field observations on a scale of 1:10000 using mobile geo-information software and hardware complex (below named GIS- complex [1]), 2) data processing based on the digital elevation model, 3) calculation of the mathematical model of the contact surfaces and borders, 4) verification of the calculated boundaries on the ground.

In the context of dissected relief and monoclonal gentle sloping strata the electric profiling methods or magnetic survey are used. The choice of method depends on the petro-physical preconditions. The profiles are projected on the map in mobile GIS-complex. In time of survey georeferencing is performed in real time by the receiver GPS. Georeference points on the profiles are located within 100 m. The distance between the intermediate observation points are measured with MN-line of profiling array. Profiles direction is taken over compass and controlled by on the GPS receiver map or mobile GIS-complex map. In conditions of rugged mountainous terrain the use of this technique allows to make georeferencing of measuring points with an error less than 1 mm in the map scale.

Interpretation of geophysical data and identification of contacts studied sequences are produced by conventional methods. Building of plan of profiles observations and points of contacts of strata, and data of geological observations are performed in ArcView ArcGIS ESRI Desktop, which equipped with relevant and verified topographic map at a scale of surveying. Based on the digital elevation model the heights of points of contacts of layers are calculated. Thus, the result of the second phase of work is the set of points which belong to the surface of strata. Based on these points, the mathematical model is calculated for each of the surfaces investigated.

If the layers of rock lie monoclonal, the surface strata or contacts fitted plane which described by equations of the form

$$Z = a_0 + a_1X + a_2Y \tag{1}$$

The coefficients a_0, a_1, a_2 are determined by the least squares method of solving a system of three linear equations

$$(n + 1)a_0 + [\sum x_i]\, a_1 + [\sum y_i]\, a_2 = [\sum z_i] \tag{2}$$

where n – the number of detected contact points; $i = 0, 1, \ldots, n$; x_i, y_i, z_i – the coordinates of the points at which contacts of layers are on the ground surface (in the local coordinate system).

On the basis of equation (1) is calculated stratoisohypses system for contact surface of layer for interval of heights in the area surveying. In the case of the plane it will be a direct line:

$$Y = -(a_0 + a_1X + Z)/a_2 \tag{3}$$

Building stratoisohypses are produced in program ArcMap ArcGIS ESRI on digital topographic map with contour lines layer. After constructing stratoisohypses, we can determine the direction of dip and to calculate the angle of incidence

$$a = \mathrm{arctg}\frac{\Delta H}{\Delta L} \tag{4}$$

where ΔL – segment on the dip line between the two selected stratoisohypses, ΔH – the height difference between them.

Strike azimuth and dip azimuth of layers can be measured on map with tools of software which named above. Output of contact of layers on the ground surface is traced on the map on points in which contour line and stratoisohypse cross each other.

On the basis of mathematical models can be calculated the true thickness of layer and depth of bedding at any points of polygon, geological cross section can be calculated in any direction.

Our method can detect tectonic faults. Signs of tectonic faults are systematic bias experimental contact points with respect to the settlement boundary on some of its ranges. If this feature is detected, the number of experimental points should be divided into groups, for each of which should be calculated equation of the surfaces and sections of the border. Tectonic faults are detected by the displacement of the new boundaries. Based on this model can be calculated amplitude of the vertical and horizontal displacements blocks of stratum, get value the angles of incidence and strike azimuths more accurately, can be found the relative rotation of blocks when an overthrust, for example.

The final stage of survey is to verify the mathematical model. To do this, the mobile GIS complex is equipped with the work map with the calculated geological boundaries and geophysical survey data. In the course of geological route is estimated accuracy of the model and is clarified the position of fault planes of tectonic disturbances.

In conclusion, we note that such approach excludes the subjective factor when drawing geological boundaries on a map, improves the accuracy and reliability of the results. Definition of dip strata throughout the base provides them greater precision, accuracy and reliability in comparison with field measurements using compass. Ability to calculate the prediction model can significantly reduce the amount of field work. We can confine a few reconnaissance profiles on key sections when plain monoclonal bedding of rocks. Sometimes can be calculated geological boundaries outside the polygon of survey, as well as the position of fault planes tectonic disturbances. However, using the method, it must be remembered when the orientation of the geological boundaries on a map is close to the strike of the strata, the solution of (2) is unstable and gives a great error. To fix the error, data are required on the opposite slope.

The technology considered is designed for educational geophysical practices for students SPSU at the polygon of the Crimean geological practice. Technology has been successfully used in geological and geophysical surveys of strata of limestone with flints on the southern slopes of the mountains Kizil-Chyhir, Belaya (White), Kremennaya (Flint), Mender, and glauconitic sandstone strata at the foot of the mountains Belaya and Kremennaya. The strata of limestone with flints are a reference horizon. Examples will be presented in the report.

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AUTOMATION AND ACQUISITION DATA OF GEODYNAMIC MONITORING

[1]Grokholskaya S.
[1,2]Supervisor: **PhD Novikov K.**
svetka_sos@mail.ru, [1]Russian State Geological Prospecting University named after Sergo Ordjonikidze (RSGPU), faculty of geophysics. Moscow, Russia; [2]“Gidrospecgeologiya”, Moscow, Russia

Geodynamic monitoring is conducted of the State Monitoring of Subsurface Conditions. In the implementation of geodynamic monitoring is:

1. hydrogeodeformation field (measured groundwater levels, electrical conductivity, water temperature, atmospheric pressure and air temperature);
2. natural pulsed electromagnetic field of the Earth (EIAMPZ);
3. Gaz-gidrodinamics indicators (volume activity of Ra and the concentration of He).

Additionally, the use of seismic data obtained from various sources.

To monitor most of these settings are automated systems that measure and transmit data via satellite and cellular communications. Automatic data recorders today are not uncommon and are used quite widely. The positive aspect of using such measuring systems is the possibility of increasing the number of measurements and the prompt receipt of information.

However, automation of the measurement process there is a need to develop a streaming procedures for the storage and processing of large amounts of data. This has necessitated the creation of a system of collection and accumulation (SSN) data geodynamic monitoring.

SSN is part of the automated information system of geodynamic monitoring (EIIS GDM), which in addition to SSN includes software means for processing and spatial data visualization (developer: FGUGP “Gidrospecgeologiya”, "OIT", "KB "Panorama"). The main task of the SSN is the collection and storage of data geodynamic (GD) monitoring, so the system meets the following requirements: stability and resiliency; the possibility of long-term data storage; working with multiple types of measuring equipment; speed of access to data; collection and storage of different sizes; differential access to data and controls.

Telemetry devices transmit data from the measurement results to the server, collecting the information. SSN performs pre-processing of measurement files and stores the measurement results in the database of the primary information SSN.

A system for automated collection and accumulation provides:

1. The description of the structure of the network of centres and collection points geodynamic information (GDI), the points of measurement, communications, types of measuring devices.
2. Description of types of monitoring.
3. Description technical features of the observation points, for example, technical characteristics and geological-technical sections of wells.
4. Description of the technical characteristics of instances of the devices installed in the observation points (composition parameters measured, the measurement accuracy and other).
5. Rapid change of the composition of the measurements stored in the database (DB) of the primary information.
6. Remote control of measurement devices using control files.
7. Gathering and primary processing of measurement results, including data editing.
8. Import measurements and other information in the database of the primary information.
9. Storage of measurement results in the database of the primary information.
10. Providing results of the initial measurements to users in a consistent format and volume based on the selected entity, time range, and the spatial location of the study area.
11. Graphical display of network status species monitoring at the requested time and measurable indicators.
12. Network administration and remote control of the measuring devices of the centers and collection points GDI.

13. Automatic and manual data replication between centers and collection points GDI.

In addition, SSN allows you to control the representativeness of the database.

The existing system of collection and accumulation can quickly obtain and analyze data, which makes it indispensable tool for geodynamic monitoring. The system is constantly evolving and being upgraded depending on the set and solve geological problems.

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LABORATORY AND MATHEMATICAL MODELING OF DIPOLE – DIPOLE PROBES RESISTIVITY LOGGING TO JUSTIFY THE METHOD OF DETERMINING ELECTRICAL ANISOTROPY PARAMETERS OF ROCKS

[1]Karinskiy A. D., [2]Kaurkin M.D.
[1]akarinski@mai, l.ru, Russian State Geological Prospecting University, Moscow, Russia;
[2]kaurkin_m@mail.ru,State Design Institute of Special Construction, Moscow, Russia

Anisotropy on the electrical resistivity ρ is inherent in many rocks. In particular, the anisotropy is inherent in many sedimentary rocks. This is due to the formation of sedimentary rocks, usually accompanied by multiple changes in depositional regime with corresponding changes in the composition and dispersion of the material sediment. This process often leads to the formation of a layered or thin-layered structure of sedimentary strata and the anisotropy of their physical parameters. The terrigenous sedimentary rocks, which may be oil and gas reservoirs, anisotropy is usually caused by alternation of different lithology layers, for example, siltstones and mudstones.

Commonly used in geophysics for anisotropic rocks model of the medium is a model with axial anisotropy. Resistivity ρ of such a model is characterized by two values: ρ_n along the anisotropy axis *n* (oriented normal to the bedding thin-breeds) and ρ_t for any orthogonal to this axis *n*, the direction *t*. The anisotropy coefficient $\lambda = \sqrt{\rho_n/\rho_t}$. The parameters ρ_t, ρ_n in Geophysics are also called "horizontal resistivity" and "vertical resistivity".

To determine the most important for the practice characteristics of anisotropic reservoirs, for example, the character of their saturation, the permeability of the formations, the parameter ρ_n is more informative than ρ_t. However, with subhorizontal bedding layers and layers composing the terrigenous sedimentary rocks-collectors, the results used in well logging electrical and electromagnetic methods (resistivity well logging, induction well logging, high-frequency induction well logging and other) in vertical boreholes mainly depend on the parameter ρ_t. It is not possible to obtain data on the well logging information about the parameters is ρ_n and λ traversed by a borehole in an anisotropic reservoir. Therefore, the development of well logging methods, the results of which you can define values λ or ρ_n formations, is a task not only important for the development of theory, methods of logging, but also for practice – determining the parameters of layers in prospecting and exploration of hydrocarbon deposits.

Dipole-dipole equatorial and dipole-dipole axial arrays have been widely applied in ground based geoelectrics. But, at the same time, dipole probes are not used in resistivity well logging. However, a promising application of the dipole probes for studying the geological section was marked in the works of well-known scientists – geophysicists. The dipole probes, as in ground based geoelectrics, have the distance between the current electrodes *A*, *B* and the measurement electrodes *M*, *N* – much smaller than the distance between the centers of lines *AB* and *MN*. In the dipole-axial probe (DAP) electrodes *A*, *B*, *M*, *N* lie on one straight line, for example, on the axis of the borehole. In the equatorial dipole-probe (EDP) located in the well line *AB* and *MN* are mutually parallel and orthogonal to the axis of the borehole.

Solving the direct problem of the theory of stationary electric field **E** to model an infinite homogeneous anisotropic medium showed the following. When orientation the potential probe, gradient probe (and DAP) is on the anisotropy axis *n*, then (in accordance with the paradox of anisotropy) determined by the measurement results with such probes the apparent electrical resistivity $\rho_a=\rho_t$. If the anisotropy axis (in infinite homogeneous medium) and EDP axis are mutually parallel, then determined by the results of measurements with EDP apparent electrical resistivity

$$\rho_{\text{к}}^{\text{ДЭЗ}} = \rho_t / \lambda^2. \tag{1}$$

In accordance with the expression (1) value ρ_a^{EDP} is in λ^2 times less, than ρ_t and values ρ_a for oriented along the anisotropy axis of the potential probe or gradient probe. This gave reason to suppose that the integrated interpretation of the results of measurements with EDP probes and data standard probes of electrical logging may allow to determine the anisotropy coefficient λ and the vertical resistivity $\rho_n=\lambda^2\cdot\rho_t$.

For dipole-axial probe we were able to compare the results of laboratory experiments with the data of mathematical modeling. Mathematical modeling for DAP was based on the basis of numerical solutions of the corresponding 2D-direct problem finite difference methods [1]. Comparison of results of laboratory and mathematical modeling for DAP contributed to the identification and elimination of the influence of some interference influencing the results of laboratory modeling, and to take measures for their elimination [2]. In addition, comparison of the results of laboratory simulation data mathematical modeling for DAP under different values of ρ_t and λ were used to determine the parameter ρ_t formation model, obtained by laboratory measurements.

In order to obtain the estimated materials quantitatively determine the influence of parameters traversed by a borehole in an anisotropic reservoir on the results of measurements with EDP, was found analytical solution of the 3D- forward problem of the theory of stationary electric field **E** for 1D- models "borehole – anisotropic layer of unlimited power." This solution has the appearance of improper integrals in the sense of the main value. The integrand is an infinite series. Members of these series contain modified Bessel functions of the first and second kind: *Im*, *Km* integer order *m*, and trigonometric functions. The main problem, of course, was not to find the solution of the direct problem, but the development of computational algorithms and computer programs, which would allow for mathematical modeling on the basis of the obtained solutions. These problems have been overcome, while for the case when the current and measuring electrodes are located on the boundary of the well's model.

This report presents the data obtained in the laboratory and mathematical modeling for dipole – dipole probes of resistivity well logging. The results of laboratory experiments for the model covered the well layer, which had a special treatment before measurement. Based on the solution 3D – direct problem for the well traveled model traversed by the borehole anisotropic layer during its unlimited capacity installed features of the influence of parameters of the well and the surrounding environment on its anisotropic. Received nomograms for determining the values of the anisotropy coefficient λ and $\rho_n=\lambda^2\cdot\rho_t$ by the values of the data ρ_a^{EDP} and data other methods of well logging. The possibility of such an approach is shown in the example of processing of the measurement results obtained in laboratory modeling.

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THE APPLICATION SPECTROMETER ReSPECT FOR ANALYSIS OF THE ELEMENT COMPOSITION OF MINERALS, ROCKS AND ORES

Gurvich M.Y., Medvedev A.A., Poserenin A.I.
Russian State Geological Prospecting University, Moscow, Russia

Currently, there are quite a large number of commercially available automated systems for fast multi-element X-RAY fluorescence analysis. The range of application is very wide. It's the ecology, geology, metallurgy, medicine, biology, agriculture, food industry, criminology and any other areas where highly sensitive fast multi-element analysis of the material composition of the samples is required.

One of these systems is energy dispersive fluorescence X-ray spectrometer elemental composition of substances Respect, manufactured by the «TOLOKONNIKOFF» enterprise.

The specified spectrometer operated successfully in the laboratory of physical methods of analysis ores and minerais RSGPU since 2004.

In this modification, the semiconductor Si-Pin detector with a resolution of 150 eV and the X-ray tube with a silver anode are used. The upper limit of the X-ray tube emission is 120 Watts. The system water-cooled X-ray tube is closed. In any single analysis simultaneously determine 20-25 elements (from Al to U) is possible. The measurement process is completely automatic.

During the years of operation of the spectrometer has accumulated extensive experience of its use for analysis of both powder and liquid samples.

In the analysis of powder samples (geological sampling, soil) sample mass of ~1 g poured into a cuvette with a basis of thin polypropylene film, the cuvette is placed into the carousel for 16 samples. The minimum detection limit in powder samples is $\sim 10^{-4}$%. The analyzed concentration range is from 0.0001% to 100%.

When analyzing the fluid sample volume of 20-100 mkl put on thin polypropylene film and dried. Analyze dry the precipitate formed after drying drops of the original solution (the drop dry method). For quantitative calculations of the concentrations of measured elements the method of internal standard is used. The rubidium (Rb) is used as a standard. The natural concentration of the sample after drying; measurement in thin layers significantly reduces the background scattered radiation and the close coupled geometry X-ray optics lead to a significant improvement in the sensitivity analysis. The minimum detection limit in liquids is $\sim 10^{-7}$% (mg/l).

Widely used instrument for solving various gemological tasks (non-destructive multi-element analysis faceted crystals of various shapes). Due to the large aperture ratio analyze samples of very small size up to 0,1 mm is possible.

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THE APPLICATION OF ISOTOPE-SOIL METHOD WHEN SEARCHING BLIND URANIUM MINERALIZATION IN TRANSBAIKALIA

[1]Gulynin A.V., [1]Ovsyannikova T.M., [1]Starodubov A.V., [2]Medvedev A.A., [2]Poserenin A.I., [2]Kuvezin S.N., [2]Mashnin D.M., [2]Milgunov A.S.

[1]All-Russian Scientific Research Institute of Mineral Resources, Moscow, Russia,

[2]Russian State Geological Prospecting University, Moscow, Russia

One of the perspective directions in search of deep uranium deposits is isotope-soil method, developed by the All-Russian Scientific Research Institute of Mineral Resources in 1980-1986.

The method is based on testing of a representative soil horizon definition of specific activities (SA) natural radioisotopes ^{210}Pb and ^{210}Po in muriatic beds from prepared samples. Based on the results of measurements (alpha-beta-radiometry counting samples prepared using radiochemical procedures) are 2 indicators: product of specific activities 210Pb and 210Po (multiplicative indicator) and ratio of specific activities ^{210}Po/^{210}Pb (isotopic indicator). Abnormal values of isotopic indicator, combined with abnormal areas of multiplicative indicator, indicate the presence of a deep source of ^{210}Pb and ^{210}Po-uranium mineralization [1].

The ability and prospective use of ^{210}Pb and ^{210}Po as indicators of uranium mineralization is explained by the following: ^{210}Po and ^{210}Pb are children of the decay products of ^{238}U, follow each other in a series of decay of uranium; as core multiplier effect they are the least connected with the crystal lattice of minerals and have a high migration ability; they have a relatively short lifespan that "binds" them to the source of the anomaly under favorable conditions (presence of artesian groundwater, hydraulic interconnection of aquifers of high permeability and capillary-diffusion transfer etc.) ^{210}Po and ^{210}Pb are separated during migration due to differences in their chemical properties, and ^{210}Po has higher migratory ability in the exogenous processes.

Usually the isotope-soil method is used in the profile or area options on sites allocated in the complex of geological-geophysical characteristics as prospective for uranium. Interpretation of the results of the isotope-soil method in many cases allows you to grade anomaly fields emanating radon or other methods, as well as to obtain additional information.

However, the use of isotope-soil method may be complicated by a number of factors. Anomalies multiplicative indicator with isotope ratio ≈ 1 can be confined to zones of high permeability of the rocks which migrates radon, and areas with shallow rocks with a high content of uranium or radium – parent relative to ^{210}Po and ^{210}Pb radionuclides. In these cases, accordingly, the gas migration mechanism and the lack of a "buffer zone", where the separation of isotopes of ^{210}Po and ^{210}Pb, determine their equilibrium content in the tested soils.

In the arid climate with an active evaporative and sorption processes in the upper part of geological section often is enriched soil horizon radionuclides. In such areas, there are high values of multiplicative indicator, accompanied by anomalies of ^{238}U and (or) of ^{226}Ra, however, the ratio of activities of ^{210}Po/^{210}Pb remains an equilibrium. Difficulties with interpretation of the results of the isotope-soil method experience in the detection of biased halos of ^{210}Po and ^{210}Pb from intensive lateral fluid flow. In these cases it is useful for integration with other geophysical and radioisotope methods, involvement of geological information.

The isotope-soil method in option Po-Pb (with processing samples with perchloric acid) was widely experienced and methodical checking of uranium facilities in various regions of the Ukrainian shield (field Yuryev, Severinski, Forestry and others), uranium-Vitim district (Khiagdinskoe), Aldan shield (North) and others Confirmed the depths of the method ranged from 100 to 150 to 350-400 meters.

Since 2002 in technology have made changes and improvements (at the stages of sample preparation, measurement and interpretation of attracting new isotopic indicators). Developed modification of the isotope-soil method, which includes determining the ratio of specific activities ^{234}U/2^{38}U in carbonate extracts (5% solution of Na_2CO_3). The method is implemented for solving search and evaluation problems in promising areas and sites in Russia (Karkou, Bulkowski Hohlovsky, objects in Acidance, carscom and Vitim uranium districts) and Kazakhstan (Inkai and others); objects have different origins and are located in different geological-structural and landscape-climatic conditions. Recognized for effective use of integrated isotopic indicator), taking into account the values of multiplicative indicator, isotopic indicator, and $^{234}U/^{238}U$ with certain weighting factors [2].

In 2014, experts all-Russian Institute of mineral raw materials and students MSGPI-RSGPU the work was done by the method of the isotope-soil method plots Yeravinsky uranium district, Urtujskij and North-Shamanic squares (Streltsovsky ore field). The sampling points isotope-soil method was also performed blast hole gamma survey. According to the survey results identified several anomalies isotope-soil method (multiplicative indicator), which is also accompanied by elevated values of gamma activity in the holes. The nature of these anomalies may be different, for example, be due to outcrops or permeable fault structures. For a reliable interpretation of the data requires additional geological-geophisical research.

On the search site Urtujsky of the area has a number of anomalies multiplicative indicator. The anomaly of the North-Western stretch manifested along a zone of fluoridization and, in General, corresponds to the direction of Lydian fault, which has the most rich "blind" uranium mineralization within Botoguisky plot. The maximum value of multiplicative indicator is marked at the point 617, located 80 metres South-West of well 32, where at a depth of discovered uranium mineralization in association with pyrite, ferrous carbonate and chlorite. In general, the North-Western zone traced by a series of anomalies of multiplicative indicator with different intensity, which may indicate its ore content (along with geological, structural and mineralogical and geochemical data). Intense anomaly on the southern slope, Butogotoy, coinciding with the contour of the maximum concentration of uranium according to AGSM-shooting, can be associated with a change in radio background (high content of radionuclides in the granites) and uranium mineralization in the contact zone of granite and shale.

On the North-Shamanic square passed one profile isotope-soil method and blast hole gamma-shooting (sampling points). Several anomalous zones isotope-soil method, two of them dedicated to the thalweg fold Khargantoy, and two trace smaller tectonic disturbance sublatitudinal strike. Work on the area is expected to continue.

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S-VII

MINING OF SOLID MINERALS
AND SURVEYING

DIMENSIONING OF THE THIN CAVITIES WHEN USED BOREHOLE HYDROEXCAVATION

Bryukhovetskiy O., Borovkov Yu., Naidenko I.
Russian State Geological-prospecting University

The creating new ways and modernization of existing methods of the hard minerals mining using hydroexcavation technology do not lose relevance. It refers to technologies such as: borehole hydroexcavation (BHE), creating of impervious curtains (IC) for improving the environment, strengthening of soil in hydraulic and construction engineering, restoration & increasing production rate of the water & technological wells.

Intense pace of mineral resources development suggest increased demand for these technologies. One such technology is borehole hydroexcavation. This technology has been successfully implemented by the authors of this article conducting research on titanium-zirconium raw materials objects (Tuganskoe, Lukoyanovskoe, St.George, Tarskoe field), phosphorite deposit (Manevichsko-Klevanskaya area), reservoir kimberlites (diamond-bearing areas of the Arkhangelsk Region). Moreover IC was built on the object of "Orsknefteorgsintez" using our method.

Essence of BHT-method is as follows. The submersible equipment such as hydrojet unit (HJU) is lowered into the new or old well. Thin cavities (TC) traversed with the help of this unit. The washout is carry out with free undrowned hydraulic giant jets in drained face and hydro elevating rise. Under this scheme the TC remains drained. This simplifies goaf stowing with quick-settings material (construction of IC, strengthening of soil) or filtration material (filtration veils, restoration & increasing wells' production rate).

Surface complex for the work in question includes: self-propelled drilling rig, pump to supply washout, reservoir pressure water, module preparation of stowing materials.

Hydro elevating rise provides closed loop water supply and environmental safety. This is a huge advantage over alternative methods of constructing TC, for example, over thin jets of high pressure using airlift spouting through the wellhead

The basic indicators of proposed technology:

Depth of works, m	0–200
Outer diameter of HJU, mm	134, 168, 273
Operating liquid head, MPa	4–7
Slot width, min, mm	0.05
Washout radius, m:	
Sandstone	8-12
Clay	3-5

The rheology model of calculation geomechanical phenomena soak the basis due to the transience of formation TC and occurring inevitably processes of deformation and destruction their surface of outcrop.

The main geomechanical element of TC is stability of the surface outcrop. This calculation is similar to the calculation of protective pillars' stability, rocks suitable for BHE-systems with an open production areas to the rocks for creating TC. There are sand & clay deposits with inclusion of clastic material.

The proposed technology has a distinct advantage over alternative methods of construction diaphragm wall when question of temporal stability is in study.

Stability of the surface outcrops in alternative methods is solved by filling the cavities of thixotropic solution. Extrusion of the basic solution is followed. This procedure in proposed technology is absent. On one hand this is greatly increases the workability of the process, but on the other hand it is also requires careful study of the stress-strain statue.

There are some assumptions made in methods developing:

1) The main type of deformation is bulging of TC walls, wherein established that outcrops are homogeneous lithology; the point of max. strain locates in the middle of the outcrops;

2) The originally occurring tension take into account hydrodynamic pressure by jet flow; this pressure is constant at the considered period of time;

3) The min. thickness of TC is 0.05m; it is the same over the entire length;

4) The max. height of outcrop shall be equal to the vertical motion length of HJU and consists 6 m.

Width of cavity as a function of one cycle process steps (washout, dismantling, stowing):

$$b_t = \frac{3}{4} \cdot \frac{l_t}{\sigma_{сжт} - \gamma H_t}, \text{ m},$$

in which $\sigma_{сжт}$ – long-term unixial compressive strength, MPa; H_t – current vertical washout coordinate, m; l_t – current coordinate of washout critical length, m; γ – specific weight MN/м^3.

Sustainability of TC is defined as a function of strain, leading to the impossibility of the stowing.

Conclusions

1) Washout modes do not effect on the deformation and temporary sustainability, when the width of TC consists 0.1–0.3 m. 2) TC walls' stability is guaranteed within one cycle time. 3) Successive exploitation of 2 wells with conjugate cavities is possible, when their width do not exceed 0.2 m.

SUBSTANTIATION OF RATIONAL USE OF EXCAVATION AND TRANSPORT COMPLEX ON THE CAREER STOILENSKY MINING-OBOGOTITELNY COMBINE

Gavrilova V.K.
vict65@rambler.ru, Stary Oskol Branch of Russian State Geological Prospecting University Sergo Ordzhonikidze (SOF MGRI-RGGRU), Stary Oskol, Russia

Increasing the depth and extent of open pit mining is saved in the future, which will require the introduction of high-performance technologies, and it is primarily related to transportation technologies of the rock mass. Moving career cargo is the most energy-intensive and therefore expensive production process at the quarry. For the carriage of cargo career using almost all known types of transport:

- continuous action (conveyor, pipeline, cableways);
- cyclic operation (trains, automobile transport).

Depending on the properties of rocks, array, surface topography, the production capacity of the quarry, spoil, receiving points and mineral development system placeable on the career of rock mass is divided into traffic flows. They originate in the faces and end in waste rock dumps, substandard ores or minerals in warehouses. With regard to freight traffic generated mechanization of production processes.

All processes on a career in the combined transport chain. Each of them, starting from the preparation of rock to excavation, consistently performs the task of developing the mineral deposit open pit. Of all the processes of the rock mass transportation is the most time-consuming (50-60%).

Optimal technical and economic parameters of overburden and mining operations can be determined only when the joint examination and the presence of a uniform methodology for calculating the production technology of overburden or mining operations, on the one hand, parameters and technological characteristics of complex equipment – on the other hand.

To implement such a unity of technology and comprehensive mechanization opencast introduces the concept of technological complexes of overburden and mining operations as a set of complex equipment and technological solutions (primarily in systems development and opening and their parameters), together providing safe, high-performance and cost-effective implementation of mining operations in the planned volumes.

Complex equipment is characterized by performance, the total installed capacity of engines, metal content, the number of attendants and consumption of basic and auxiliary materials.

In terms of production of marketable ore Stoilensky Mining-obogotitelny combine, part of the Novolipetsk Iron and Steel Works is one of the leading producers of iron ore: it accounts for over 15% of salable ore production in Russia.

Stoilensky occurrence developed open pit, excavated trenches group. System development – with external dumping. Loose deposits by rotor complex and cyclic excavators, rock stripping, high grade ore and ferruginous quartzite are extracted by cyclic excavators with preliminary opening by drilling and blasting. Ore mass of the quarry by trucks, railway and conveyor belts.

Technological grade ore processing includes three stages of crushing and screening with separation of sintering ore and enrichment of ferruginous quartzites (magnetite) – three stages of crushing with closed final stage, three stages of milling, magnetic separation, desliming, dehydration of concentrate in vacuum filters. Hydrotransport tailings – pressure-gravity. Water recycling is used.

Excavation and loading equipment at the quarry with poluskalnyh and rocks is currently represented by excavators, different from one another bucket capacity and, consequently, dimensions and capacity. The increase in freight traffic parameter specifies the use of excavators greater productivity (until recently worked excavators whose bucket capacity 10 m^3).

Excavator company Liebherr, using at Stoilensky Mining-obogotitelny combine, the main units are electronically monitored. The monitor displays information about the current developments – the generator lifting, bearing temperature, the temperature of the incoming and outgoing air, lifting gear. Loading ore is 25 minutes and requires 3 bucket to the wagon turned out to be complete. In comparison excavator with bucket capacity 10 m^3 need 5-6 lifts.

Using excavators greater power not only affects the performance of the transport department, but also the railway department.

Increasing the volume of export of ore and reducing the number of rolling cargo of railway transport (9-10 trains instead of 11) leads to the rational use of energy and mining equipment, which will affect the reduction of the cost of mining .

The starting point for the calculation of mining equipment are: annual performance career $Q_в$ (from the timetable) and the value of the work area (from the analysis of the field).

Performance career determines the required number of excavation equipment, and the value of the work area $H_{м\ max}$ at the maximum spread pit walls under the working angles – the number of traffic engineering. Hours of effective machine performance is given by:

$$Q_{эф}=Q_T * \eta_п * K_{пот} * K_у * K_{т.р.},$$

where $Q_T = (36000E/T_ц)*(K_{Н.К} / K_{Р.К.})*K_{Т.В.}$; $T_ц$ – coefficient, minimum cycle time winning machine in specific mining conditions, sec; $K_{н.к}$ -filling ratio of the bucket; Кр.н – coefficient disintegration rocks; Кэ – coefficient excavation; $K_{т.в}$ – coefficient of influence technology recess (takes into account the time of subsidiary operations performed in addition to the basic operations of excavation and moving rocks); $\eta_п$ – coefficient taking into account the discrepancy between the actual difficulty of excavating rock in the mine complex and accepted theoretical rate $П'_{э.}$

Factors characterizing the effective performance of excavation and transport vehicles, it is easier to take into account when determining the duration of the individual operations of the operating cycle.

Stoilensky Mining-obogotitelny combine is effective careers uniquely equipped for the removal of quarry rock, which ranks fourth modernization of the plant. This ensures maximum productivity at minimum cost. But the main problem at the plant, which prevents improve efficiency and reduce costs, are unplanned downtime, which is prohibitively long.

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INCREASE OF RELIABILITY OF QUARRIES OPERATION DURING THE DEVELOPMENT OF IRON-ORE DEPOSITS OF COMPLEX STRUCTURE

Ivanov V.V., Gurskiy S.S
vladimirivanov@inbox.ru, National mineral resources university “University of mines”, Saint-Petersburg, Russian Federation

Open development of iron-ore deposits of complex structure is connected with debugging of ore bodies with unmatured capacity structure with frequent alternation with barren interlayers of country rocks. [1]

Now opencast of high-capacity deposits of natural resources is connected with minimum volumes of stock of ready to cutting rock mass on the quarry faces. Usually their volume is not bigger than the size of month performance of cutting-loading equipment.

For the increase of operating reliability of mine technical system, carrying out development of iron-ore deposit in the opencast way, it’s necessary to carry out optimum distribution of sticks ready to the cutting according to the service levels.

The category of stocks ready to cutting includes stocks, cutting of which can be performed independently on advancing of overlying quarry face. At the same time working space will have necessary width and the bench roof should be cleared from the remains of the rock. Provision of the independency of adjacent shoulders is possible through the remaining of stocks in reserve strip of working site. This category of stocks besides the provision of independency of adjacent shoulders advancing allows solving of the tasks of provision of the required quality of natural resource, creation of reserve strip of working site for the temporal equipment layout, highways and so on.

Reliability of functioning of working quarry faces depends not only the coefficient of faces but on the stock of rock mass between them. The more coefficient of readiness of working quarry face is, the lower value of the coefficient of forced outage which characterizes the possibility of unavailability of system in any chosen time moment. Thus, creation of the reserve on the service level of quarry increases reliability of quarry work until its value will exceed the time of outage of overlying horizon.

Forming of working zone of the quarry in the space and time is carried out with the change of width of the working sites, advancing of working board in the process of the miming works development. Regulation using the width of working site with the following of laws od quarry space development allows to form working zone of the quarry corresponding to the maximum possible reliability of mining works in such conditions. Width of working sites includes minimal width and certain stock reducing influence of mining works performance on the adjacent faces. On each face in the quarry there is minimal width of the working site for which the mining works on the underlying face should be stopped to avoid their stop on this face, providing normal operation of mining technical equipment location only on this face.

The reliability of the quarry face operation is determined by coefficient of readiness of technological chain on this face, reliability of the work of overlying face and the volume of ready to cutting stocks or the advance of uncovering on the overlying horizon [2].

To normalize volumes of ready to cutting stocks it’s necessary to take into account mutual influence of basic factors:

- expanses on the driving of excavators (C_{dr});
- expenses on the maintaining of stocks necessary for the removing of stripping or extraction of natural resources above the reserve strip on all levels during the year(C_{stock});
- losses from the decrease of quarry performance of natural resources due to the necessity of stocks maintenance ($C_{м}$);
- losses from the increase of the current coefficient of stripping (C_c);
- losses due to the non-compliance of demand on the production of the enterprise in the volume and quality (C_o).

Optimal volume of ready to cutting stock corresponds to minimum of total expanses

$$\sum C_{rcs} = C_{dr} + C_{рез} + C_{м} + C_{к} + C_{о} \rightarrow \min$$

Reasoning of optimal volume of ready to cutting stocks is technical and economic task during solving of which it is taken into account the dependency of the character of stock movements due to different mining and technical and geological factors and economic efficiency determined by the mechanism of inventory control.

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AIR CONDITIONING MINE AIR UNDERGROUND MINE WORKINGS IN THE TRANSITION FROM OPEN TO COMBINED METHOD OF MINING

Malskiy K.S.
k.malskiy@mail.ru, Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze (MGRI-RSGPU)

With the development of the open pit reserves that are deposited in favorable production conditions, depleted, and it is appropriate to engage in the mining of ore that lies beyond the boundaries of the pit and under his bottom.

One of the options to maintain ore extraction is the transition from an open to a combined system development, by conducting underground mining in pribortovoy array career and under his bottom. The transition to deep horizons is accompanied by a temperature increase of the mine air, when the limit is reached, which necessitates the application of special events.

Health, health of personnel engaged in underground work, largely depends on climatic conditions. Severe thermal conditions are the reason for the sharp decline in labor productivity miners and increased injuries.

On the thermal regime of underground mining influenced by factors such as: the initial temperature of the rock mass, its natural water content and the quality of drainage, the thermophysical parameters of the mine air, the area of exposed surfaces, the rate of mining, the presence and power mechanisms. The problem of normalization of the temperature of the mine air is necessary to solve at achievement values at 26 °C.

The most simple way to normalize the thermal conditions is to increase the amount of fresh air supplied to the mine workings. But the increase of the supplied air quantity is constrained by the bandwidth of mines, and to normalize the thermal environment this method only when the temperature of the massif to 37 °C [1].

Then the possibilities of the activities listed above have been exhausted, there is a need for artificial cooling of the mine air.

For normalization of thermal conditions apply mobile mine air conditioners working in a closed refrigeration cycle using refrigerant (mainly CFCs) and open cycle using the energy of compressed air [2].

One of the most simple and effective ways of conditioning mine air in the early stages of occurrence of the temperature problem is the use of air conditioners working on an open cycle. Their feature is used as a source of cold compressed air is expanded in an air expansion machines (expanders). The use of these machines allows them to be used when carrying out horizontal and vertical mine workings in mines of all categories in the gas mode, to reduce size and weight in comparison to machines operating on a closed cycle and to simplify maintenance.

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DEPENDENCES OF MATHEMATICAL MODEL OF DEFORMATION AND DESTRUCTION OF ROCKS AT VOLUMETRIC LOADING)

[1]Norel B.K., [2]Borovkov Y.A.
[1]igd@igds.ru Leading researcher of the National research mining center – Mining institute named after A.A. Skochinsky; 2msgpa@msgpa.edu.ru, Russian state prospecting university

The rock and rock massives loading I conditions have a pronounced dimensional character. The relations between three principal stresses, characterizing mechanical state of rock massif near the mine workings are changed naturally. It defines the corresponding massif deformations and failure. The investigating the complex rock massif deformation and failure processes would be more successful under the natural conditions. However, the single tests only are possible in this case because of substantial production problems. The thorough preparation work for mine tests includes the necessary laboratory and analytical study.

In present work the systematic investigations on the mechanical characteristics of rocks under the three-dimensionally stressed state conditions, close to that, acting within the massif, are described. This study allows to reveal the most characteristic features of gee-mechanical processes, proceeding within the massif and to determine the main process parameters changing trends.

As for the gentle sloping rock bed in front of the face, all three principal stresses, acting in geo-mechanical processes, which proceed in the abovementioned zone within mine workings, are compres-sive, and three-dimensionally stressed state in different massif areas varies from summerized compression to summerized tension. Three principalstresses, defining the three-dimensionally stressed state within the massif, are varied qualitatively as follows. When approaching the face, the maximum compressive stress, directed vertically relative to the working plane and defined as σ_3, increases from the vertical compressive stress value P_3 within unmined massif zone up to the peak value, which equals $P_3 \cdot K_K$ in the maximum compressive stress zone (where K_K is the concentration index) and then falls down to the strength index value at the face edge. The minimum compressive stress, directed over the length of the face and defined as σ_1, varies from λp_3 , where λ is the side outward pressure within the unmined massif zone as well as maximum compressive pressures one, and then falls down to 0 at the face edge. The intermediate compressive stress, directed over the length of the face and defined as σ_2, varies from σ_1, within unmined massif zone to the 1/2 $(\sigma_1+\sigma_3)$ value in maximum compressive stresses zone and then to σ_3 value near the face edge.

The program on mechanical tests of rocks is carried out depending upon the calculated qualitative changes of principal stresses and three-dimensionally stressed states near the mine workings. Before analyzing the test results, some statements on deformed media mechanics, being used in this work (Nodai, 1969) should be considered because there is always the algebraic inquality $\sigma_1 \geq \sigma_2 \geq \sigma_3$ for three triaxial principal stresses. In this case, the compressive stresses and deformations are negative; tensile stresses and deformations are positive. Every three-dimensionally stressed state, excluding the comprehesive uniform compression or tension, is characterized by the Nadai-Laudet parameter μ_σ, varying in -1+1 range

$$T = \frac{\sigma_1 - \sigma_3}{2}; \sigma_n = \frac{\sigma_1 + \sigma_3}{2}; \mu_\sigma = \frac{2\sigma_2 - \sigma_1 - \sigma_3}{\sigma_1 - \sigma_3}, \tag{2}$$

In the course of rook mechanical tests under the three-dimensional-ly stressed state conditions using triaxial unequicomponent compression units (Alekseev & Nedodaev 1982 and Protodyakonov & Ilnitskaja 1971) the loading was proceeded as follows. First, the rock sample was loaded triaxially ($\sigma_1 = \sigma_2 = \sigma_3$) and unifromly up to the uniform initial compressive σ_0. After the principal stresses σ_1, σ_2 and σ_3 arrived the σ_0 value, the stresses σ_2 and σ_3 continued increasing so as to remain the constant μ_σ value with the invariable $\sigma_1 = \sigma_0$. Tensor decomposition for three main types of three-dimensionally stressed states has allowed the more clear understanding of physical foundations of the summerized compression, shear and tension stressed states. Three-dimensionally stressed state of the summerized compression, under the $\sigma_1 = \sigma_2$ conditions, is expressed as a sum of uniform comprehensive compression and uniaxial compression

$$\begin{Bmatrix} \sigma_1 & 0 & 0 \\ 0 & \sigma_2 & 0 \\ 0 & 0 & \sigma_3 \end{Bmatrix}_{\sigma_2=\sigma_1} = \sigma_1 \cdot \begin{Bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{Bmatrix} + \left(\sigma_3 - \sigma_1\right) \cdot \begin{Bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{Bmatrix} ? \qquad (2)$$

Thus, it is of great importance to realize different stressed states with tension and shear deformations even for all three comp-ressive stresses. In the work, the dependance are the representative stress-deformation diagrams for rock mechanical characteristics analysis under three-dimensionally stressed state conditions.

$$\sigma_v \div \varepsilon_v \text{ and } \tau_{oct} \div \gamma_{oct}$$

$$\begin{aligned} \sigma_v &= \frac{1}{3}\left(\sigma_1 + \sigma_2 + \sigma_3\right); \varepsilon_v = \frac{1}{3}\left(\varepsilon_1 + \varepsilon_2 + \varepsilon_3\right); \\ \tau_{oct} &= \frac{1}{3}\sqrt{(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_1 - \sigma_3)^2}; \\ \gamma_{oct} &== \frac{2}{3}\sqrt{(\varepsilon_1 - \varepsilon_2)^2 + (\varepsilon_2 - \varepsilon_3)^2 + (\varepsilon_1 - \varepsilon_3)^2} \end{aligned} . \qquad (3)$$

The diagram $\tau_{oct} \div \gamma_{oct}$ satisfies the typical deformation of the elastoplastic body and the diagram $\sigma_v \div \varepsilon_v$ shows the porous-medium deformations features. A number of researches has pointed out the possibility of three-zones separations during the average stress, acts oveffthe deformation curve $\sigma_v \div \varepsilon_v$. At the starting point of deformation the materials pores close, but the curve angle $\sigma_v \div \varepsilon_v$ is small, yet. At the middle point of deformation zone the material behaves as the elastic medium does. Finally, at the third failure zone or in the zone of elastic deformation, the stress, σ_v, is increased and the average deformation is constant.

However, as it follows from the investigations results on porous rock deformation there is carried out the disintegration in the fourth additional deformation zone, taking place during the tensile stress, $\Delta\sigma_v$, realization, when compressive stress, $\Delta\varepsilon_v$, acts. Due to the non-uniformity of stressed state, the deformation being uni-axially within the failure zone may exceed the average compressive stress, expressed as ε_v.

Volumetric and rigidity moduli, all over the deformation zone are calculated from the following equations

$$G = \frac{\tau_{oct}}{2\gamma_{oct}}; K = \frac{\sigma_v}{3\varepsilon_v}, \qquad (4)$$

Within the elastic zone, the stress strain modulus (E) and Poissan's ratio (V) are calculated all over the factors by traditional method. As it follows from the analysis data, the volumetric modulus (K) and the modulus of rigidity (G) depend on the characteristics of three-dimensionally stressed state types, μ_σ and σ_0/ During the mechanical tests of the samples, being in three-dimensionally stressed state, it has been determined the natural character of rock failure under the different kinds of three-dimensionally stressed state. The rock sample has been failured by shearing under the summerized displacement and under the summerized tension by breaking.

ACCOUNTING FOR THE STOCHASTIC NATURE OF INPUT DATA WHEN DETERMINING THE BOUNDARY OF THE RATIO OF OVERBURDEN

Semenov, A. S., Veresov, I.V.
loader3@yandex.ru, National mineral resources University "University of Mines",
Saint-Petersburg, Russian Federation

When determining the quarry at the end of the testing used the boundary ratio, characterizing the final pit, in which there would be no profit (equal to zero), and all production costs are covered. The value of the recoverable value of the ore can be used to establish the boundary of the Stripping ratio. The value of the recoverable value of the ore can be used to establish the boundary of the stripping ratio.

In the cost of production of ore takes into account all costs in the technological chain of processes to obtain a concentrate, except for the cost of removing the overburden. Edge Stripping ratio should be considered taking into account changes in the content of useful components in the ore, the market prices of the final product.

High market prices for mined ore have the effect of career development, increasing its borders, while low – on the contrary, lead to reductions quarries, increased risk of design.

When designing quarries and mining projects in risk discount rate and the interest rate to take with some increase to account for inflation and risk. When determining the boundary of the stripping ratio, to reduce the risk of making design decisions, it is advisable to factor the minimum necessary for the development of enterprise profits.

Taking certain values of the interest rate, pre-estimating the rate of return of the project (IRR), is determined by the boundary ratio, providing career development with the minimum necessary for the development of enterprise profit.

Market prices of this type of mineral raw materials are the key indicators when determining the quarry at the end of testing. Long-term calculations, usually held on a stable basis without taking into account the probabilistic nature of the source data.

With high inflation and crisis phenomena in the economy to establish a discount rate (interest rate) of various projects can serve as Deposit interest on Bank deposits in a relatively stable currency (for example, 6 to 8% per annum for USD or Euro). K.N. Trubetskoy, A. Peshkov A., Matsko N. A. the 1 who offered to take the discount factor for the implementation of new projects and the expansion of activity in the amount of K = 14–18 %.

In developed mining countries, the increase in the rate of discount (interest rate) may be due to the coefficient of risk specified in the form of expert assessments.

Select when the design value of the discount rate has a significant impact on the performance evaluation of the project. When deciding on a specific project, thus not simply rejected all other projects, but is refusing profits, which could bring investments in these projects.

When the design is determined by the rate of profit, which may be selected as the discount rate. If the project has a zero net present value, it will give investors the opportunity to return the invested funds, and to make a profit.

When using net present value as a criterion of evaluation of the project it is assumed that any positive value of NPV makes the project attractive.

The choice of discount rate in the design of quarries is one of the most difficult aspects of the calculation of the net present value of the project (NPV):

Suitable discount rate that includes protected from the risk rate on government securities and some of the award, apply it as a universal tool in the design. In this approach, the value of the discount rate is in the range of 8–15% and the risk premium accepted in the amount of 3–5%.

- You can establish maximum interest rates, by analogy with the previously implemented successful projects.
- Choosing a risk premium, it is necessary to quantitatively evaluate the latest, not to arbitrarily increase the discount rate.

- When evaluating the project in the early stages of compilation, you should use a higher discount rate than in the later design stages.
- Under difficult mining conditions and technologies of mining should take a higher discount rate than in the relatively simple cases.
- The higher the recoverable value of the ore, the higher the risk associated with fluctuations in the prices of the final product.
- For marginal mines – on the verge of profitability and at the border of entry into the market of mineral raw materials, the risk associated with participation in the project is higher than in projects where the difference between production cost and its expected price in the foreseeable future will be big enough.

To determine the interest rate of the project mining enterprise risk, you can use dependency [1]

$$i_R = (\frac{K_A \Delta A}{\Delta З + \Delta A} + \frac{K_З\left(1-H\right)\Delta З}{\Delta З + \Delta A})(1-k_u)\,, \quad [1]$$

K_A – cost of equity;

$K_З$ – the cost of borrowed funds;

H – General rate of tax;

$\Delta З$ and ΔA – the proportion of debt and equity from the total amount of investment in the project, respectively;

ku – inflation, %

For the analysis of quantitative risk projects opencast mining of ore deposits most relevant is the Monte Carlo method (graph of cumulative probability), which are widespread with the development of software.

Most convenient for the analysis of the risk indicator is the NPV (NPV), since the of this indicator is normal (Gaussian).

For each version of the draft calculation of NPV, the obtained values were used for plotting the cumulative probability. The main difficulty inherent in Monte Carlo, is the large number of computing scenarios (about 5000) and the presence of special computer programs. The result is determined by the range of NPV and IRR, i.e., pessimistic, baseline (most likely) and optimistic variants, as well as the probability of the NPV and IRR.

The increase in the value of the discounting factor due to the risk premium reduces the net present value of the project (NPV).

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DETERMINATION OF ZONE OF INFLUENCE OF BORROW CUT ON STRESS AND STRAIN STATE OF NEAR EDGE ZONE ORE RESERVES AND ON SEPARATION PILLAR WIDTH

Borovkov Yu.A., Ivchenko V.V., Rasskazov S.A.
Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze
(MGRI-RSGPU)

Near edge zone ore reserves are primarily developed applying mining methods which consist in stowing with solidifying mixtures and mixtures of different strength. It allows decreasing earth movement when undermining in the result of ore reserves extraction in the near borrow area, loss of slope stability in the pit, stability of cap pillars and chamber walls, and pillars when sloping, as well as controlling stress and strain state (SSS) of a rock mass.

When combined method of development is applied, a part of industrial ore reserves is left outside the limiting margins of pits and not infrequently under a protected area. When selecting the reservoir management plan for near edge zone reserves, it is necessary to define location thereof with regard to the pit edge. Generally, two extraction groups for such ore reserves are used: development of protective separation pillar in the pit edge or outside of it. When developing protective separation pillar, edges are deformed and stability thereof is decreased.

Depending on sloping technology and extent of mutual influence on the pit edge stability, ore reserves are subdivided into two groups:

– marginal reserves (sometimes called a transition zone), which are directly adjacent to the pit area (edge or bottom);

– peripheral reserves (located behind marginal reserves), which are developed under protection of ore or artificial barrier pillar.

Marginal zone dimensions are provisionally taken as equal to mine block dimensions. In protective pillars valuable ores are extracted with stowing using open underground or underground methods. Herewith, filling masses, which are different in composition, are used depending on cement consumption.

To increase mineral resources extraction volumes, when extracting fractured ores in the near edge zone in the course of underground works, it is necessary to handle the following issues: 1) stress and strain state (SSS) of rock masses in the near edge zone of the pit; 2) SSS of rock masses in the near edge zone in laboratory and industrial conditions; 3) develop a method to determine parameters of heading-and-stall method with stowing at extraction of near edge ore reserves.

Disturbance caused by the pit in the natural stress field leads to relief of radial stresses (normal stress applied to margins of edges) and redistribution of circumferential stresses (applied along the pit edge margins). Stress state of the mass around the pit in vertical section is characterized by the following behavior. Near to the slope surface maximum primary stresses are parallel thereto, and under the pit bottom – they are horizontal. Minimum primary stresses on the slope surface are relieved. In vertical section relief of radial stresses in the near edge mass and under the pit bottom is observed. These stresses are concentrated on sides of the pit bottom. Relief of vertical stresses lead to elastic recovery of the mass expressed in ground surface rolling near to the top crest of sides and bottom of the pit.

Therefore, proceeding from preconditions offered by V.G. Zoteyev and taking into account peculiarities of the near edge mass, its stress state (presence of horizontal stresses which exceed vertical ones) and the pit outline, we have established a formula intended for definition of thickness of zone of influence of the pit on the near edge mass:

$$h_p = H_k \cdot \left[\sqrt{1 + \left[\frac{L_\partial + H_K(ctg\alpha + ctg\beta)}{2H_K(1-\lambda)\cdot C \cdot tg\varphi'} \right]^2} - 1 \right], \qquad (1)$$

where H_k – pit projected depth, m; L_∂ – pit bottom width in section, m; C – ratio of maximum to minimum value of horizontal stresses; λ – structural weakness factor of the near edge formations after the commissioning of sloping works; φ' – angle of internal friction of the low system of joints.

When analyzing formula (1), one can assure oneself that with increase of angles of gradient of the pit edges, structural weakness factor of formations and ratio of value of maximum horizontal component of natural stress field to value of minimum component of the pit influence zone on the surrounding near edge formations will decrease as a power function.

Borrow cut causes skewness in distribution of stresses around the underground workings in the near edge formations. As a result of this, separation pillar is in conditions of compression with shear, and the roof of underground chambers, with the help of which near edge ore reserves are planned to be extracted, is in conditions of tension with shear.

There is insufficient number of analytic dependences which allow defining parameters of separation pillar between open and underground works, which preserves the pit edge stability during undermining. These, generally, offer restricted application conditions for combined method of field development. Existing methods for determination of parameters of separation pillar located in the near zone part of the pit do not take into consideration thickness of the pit influence zone on the near edge rock mass and degree of changes in the mass structural features in this zone.

On the basis of structural mechanics methods and of the facts that a separation pillar is in the conditions of severe shear loads and its stability is subject to the Mohr–Coulomb failure criterion with regard to relative thickness of the pit influence zone (h_p/H_κ) and structural weakness factor (λ), width of the near edge separation pillar during development of primary chambers can be defined from the following expression:

$$a = \frac{\lambda \gamma H^2 \sin\beta [15K + 19(1-K)(h_p / H_K)] \cdot (h_p / H_K)}{2 \cdot (10 \cdot k' \sigma_p - \lambda \gamma H \sin\beta \cdot K)}, \tag{2}$$

$$k' = \left\{ (1 - \sigma_p / \sigma_c) \cdot (1 + \xi) + 2(1 + \sigma_p / \sigma_c) \cdot \sqrt{(\xi - 1)^2 + 7.1 \cdot ctg^2 \beta} \right\}^{-1}, \tag{3}$$

where H – depth of underground works in the pit edge from the ground surface, m; $\beta = \alpha(1 + h_p/H_\kappa)$, K – ratio of horizontal stress concentration near the pit edge slope; σ_c, σ_p – ultimate uniaxial compression and tensile strength, MPa; ξ – ratio of the pillar width to its height.

Analyzing the obtained formula (2), we may make a conclusion that separation pillar width, which is left in the pit edge, depends on SSS of the mass, relative thickness of the pit influence zone on the near edge mass and strength properties of masses, and changes depending on the depth of underground masses according to linear fractional function law. It should be noted that when structural weakness factor increases, width of separation pillar increases in direct ratio.

STATISTICAL APPROACH TO DEFINING STOPE ULTIMATE PARAMETERS

Makarov A.B., Manukhin D.E.
amakarov@srk.ru.com, SRK Consulting, Moscow, Russia

The method for open stope design for mining in hard rock at depths below 1,000 m was developed by K. Mathews /1/ and is based on the analysis of case history data related to the actual condition of mined stopes. Once the stope is mined, each exposed face, depending on its actual condition, is assigned to one of three categories:

- *stable:* the stope face retains its original geometry after breaking; local rock flaking from the stope face results in ore dilution of up to 5%;
- *unstable:* caving of roof or hangingwall occurs, resulting in the formation of a stable cave column, and an air gap is left between the boundary of the caving zone and the caved material;
- *caved:* caving propagates vertically until all void space is filled with broken rocks or until it reaches the ground surface on which a cave is developed.

For every case study for which the stability category was established, two factors are calculated:

- the equivalent half-span (hydraulic radius, HR), which accounts for the dimensions of the exposed surfaces (in meters), and
- the dimensionless stability number, N, which represents the ability of the exposed rock mass to stand up under a given stress condition.

Calculation of hydraulic radius, N, accounts for the number of joint sets, their orientation, roughness, weathering intensity and the presence of infill material in the joints. The rock strength, stresses acting at the stope boundaries and the dip angle of the hangingwall are also taken into account in the calculations.

Results of the analysis of the case histories have been included in one empirical database which is used for plotting the stability graph of exposed surfaces in the HR-N coordinates. Every case history for which the stability category was empirically established is plotted on the graph as a certain symbol which characterizes one of three stability classes.

The original Mathews' stability graph was based on only 50 case studies. The collection of field data by Potvin, Stewart, Forsyth and Trueman et al /2-4/ has increased the world database to 500 cases of analyzed stopes within a wide range of mining and geological conditions. Based on the collected data, S. Mawdesley has obtained a graphical criterion for transition of stable exposures into unstable ones.

SRK Consulting has used the Mathews' method to determine the criteria for stable and caved stope conditions at Ridder-Sokolny mine has mined the Ridder-Sokolnoe gold-polymetallic deposit (East Kazakhstan) in hard rock conditions over the past 200 years.

SRK has collected data on 161 mining units (panels, blocks and stopes), of which 70 units are in stable condition, 31 units – in an unstable condition and 60 units – in a caved condition and then used the object classification theory to define the criteria for stable and caved stope conditions based on the statistical analysis of the filed data.

One of the methods used in classification exercises for splitting different cases (objects) into categories (groups, classes) is based on the Mahalanobis distance, D. The method involves calculating distances D from each classified case (point, object) to the mass centre of each category. In our case, the mass centres are points which have the mean HR and N values for each of the three categories: stable, unstable and caved stope conditions. The Mahalanobis distance differs from the Euclidian distance in that it considers correlations between the HR and N variables in each class. The Mahalanobis distance is calculated using the following formula:

$$D^2 = \left(x - \overline{x}\right)^T Sp^{-1}\left(x - \overline{x}\right), \qquad (1)$$

where $\left(x-\overline{x}\right)$ is the vector which determines the distance from the point to the mass centre of the category; $\left(x-\overline{x}\right)^T$ is a transposed vector; Sp is a covariance matrix of the HR and N variables in each category and Sp^{-1} is an inverse covariance matrix.

This method makes it possible to derive a linear function (straight line) of the boundary that splits the whole set of empirical data into categories (classes) /6/. Empirical data that belong to three stability categories should be divided by two lines. One line separates stable and unstable stopes and represents the criterion for ultimate stable stope faces. The second line separates unstable and caved conditions of mined-out areas and represents the criterion for a total subsidence of the undermined rock mass, with cave propagating to the ground surface.

The statistical analysis of the case history database conducted on 161 mining units at Ridder-Sokolny mine has enabled SRK to define the following criteria for stable and caved stope conditions (the unstable conditions are within a transition interval):

$$\text{STABLE: } HR < 0.32 \cdot N + 4.3 \qquad (2)$$

$$\text{CAVED: } HR > 0.30 \cdot N + 10.1 \qquad (3)$$

These criteria are based on the general mining experience at Ridder-Sokolny mine. Comparison of these criteria with the world database shows that within the range of N values from 5 to 40 they math each other to the accuracy level of ±1 m of the equivalent half-span. Therefore, criteria (2) and (3) that define ultimate stable stope exposures can be used for any deposit, and the SRK's criterion is more conservative than the Mawdesley's criterion /5/.

Using these criteria, the orebody mining designs can be developed to ensure stable stopes by selecting stope dimensions which are less than the maximum permissible dimension or to ensure complete stope caving by selecting the undercut dimensions which are greater than the maximum permissible dimension.

These criteria were used by SRK to validate the possibility and conditions for safe extraction of orebodies within the barrier pillar under the shafts of Ridder-Sokolny's Mine No 3 and Ventilyatsionnaya Mine, as well as to validate the stope and pillar parameters for underground mining works under the active open pit at Berezitovoye gold deposit in the Amur region.

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FEATURES OF DEPOSITS' EXPLOITATION AT HIGH ALTITUDES

Muhammadiev P.A., Valiev Sh.F., Odinaev Sh.A.
Sharif.Geolog@mail.ru, Tajik National University (TNU), Dushanbe, Tajikistan

A significant part (93%) of the territory of Tajikistan is a mountainous (conventionally up to 2000-2500 m) and high altitude (2500 m) area and the bulk of deposits located in this area. One of them is unique and only in the Central Asian region the field of high-quality anthracites Nazar Aijlok located 300 kilometers east from Dushanbe, at the eastern edge of Zeravshan-Hissar mountain range at an altitude of 3500-4000 m.

As for the geological structure the deposit is a wing of geosyncline, comprising 13 working coal seams of gently inclined bedding. Coal-bearing strata of Jurassic age of 300-1100 m capacity and a total area of about 25 km^2 extend at sub latitudinal direction by more than 10 km. The total average capacity of 13 beds is approximately 32 m, 9 of which are anthracites, others are coals. Power of stratum at an average is 1.3 to 9 m (in certain areas up to 26 m). Length beds dip reaches 500 m.

Geological and mining conditions are poorly understood, only at the stage of survey and assessment works on one small area (Shikorhona), at the stage of preliminary prospecting, the galleries were passed, where technological and laboratory samples have been extracted. The exploration of anthracites were carried out in Russia (VUKHIN – Sverdlovsk (Yekaterinburg)), Finland, Germany. The investigations have shown high their physical and chemical properties in terms of their technological resources. On specific quality indicators they superior the Ukrainian and Kuznetsk anthracites and generally close to the famous Vietnamese anthracites of the field Ha-Tu. Predicted resources of anthracites estimated at about 500 million tons.

Low sol anthracites as raw technological materials, can be used in the electro technical, atomic, military, chemical industry branches; in the metallurgical industry ones could be widely used as substitutes of flake graphite and various types of cokes at special steels' and non-ferrous metals' smelting, sintering ores, etc.

The specific strata of anthracites in the hills slopes go out directly to the surface and are now practiced out openly. But these works can be carried out during the 1.5-2 summer months only under favorable weather conditions. In this short period of time at two sites 15-20 thousand tons of anthracite has been extracted, which are used as a fuel in the household sector and in very small quantities at the aluminum plant of the republic as a substitute for coke.

Continuous year-round mining operations can be organized only at the underground method of field exploitation. At this a complete production technology infrastructure with taking into the consideration the high-altitude conditions is to be created, as the height step drop between technological systems is a thousand meters or more. Nazar-Aijlok field is at an altitude 3200-3800 m and extracted coal is necessary to pull on the level of the river valley, 2000 m, so the height drop is of 1200 meters or more.

The variants to manage this challenge may be different. Traditional ones of skip and cage-rise slopes are expensive and difficult to operate. The gravitational ways to move coal under its own weight are tempting. However, the acceleration of free falling body on such extended drops leads to high rates of incidence and the accumulation of destructive energy. There the idea is arising of the braking rate of falling of the body and high destruction energy accumulation. Following this idea the authors propose the following scheme for the organization of mining works on Nazar Aijlok and similar fields.

At the foreland in the river's valley in a mountain range a full range of capital structures pit bottom (ore yard) is to be creating. Separate buildings can be built on an open surface, as in this high-altitude level (2000 m) the entire communication link (roads, power lines, transportation and others) is maintaining through the year round.

The most important technological site is a vertical shaft for lowering cargo of coal from the mark 3200-3800 m. The trunk is equipped with two (or more) metal pipes of large diameter (1.5-2 m). These pipes for delivery of coal produced are bunkers at the same time. To fill the coal bunkers, as noted above, it is necessary to damper the acceleration of gravity of coal. For this purpose, an aqueous environment is proposed to use, i.e. the bunker-tubes are to be pre-filled with water and then upload them to a continuous flow of coal mined. With the accumulation of coal in the bunkers the water will be displaced and gradually discharged from the bunkers coal will be sent to consumers. Thus in the process of mining operations, the bunkers will be constantly filled with a renewing mass of coal.

Manufacturing, construction and operation of pipes-bunkers in the conditions of modern technology and engineering achievements, is a quite real challenge. Engineering and design features of the structures are assuming that in the bottom of the bunker the firm sealed hatches, at the top of the loading device (possibly in the form of a funnel with a lattice of crashing) and on the outer diameter as a contour (in the upper part of the building) the several water filling and spillway pipe of small diameter are to be created. Exploitation of the field 500 m long in the fall of will be conducted on the horizons, i.e. the mining will be graded descending. Pipe-bunkers in accordance with the elevation mark of roll away horizons must be shortened. These design features of the pipes must be foreseen in the design of the bunker delivery.

Filling bunkers with water and the displacement of it while the filling them with coal occurs in a relatively short period, only in the initial stage of mining and rewiring when shortening of them up to the level of the lower horizons. Preliminary calculations have shown that under the underground method of exploitation of the field Nazar-Aijlok by using the technology of delivery of coal described it's possible to ensure the mine performance of approximately 500 thousand tons of anthracite per year.

At high altitudes of Tajikistan the proposed delivery method can be used in the exploitation of various types of solid deposits, non-ferrous and precious metals and non-metallic raw minerals. In this case, there is a need to equip the loading platform at the top of bunker by the mechanized crash horizon for obtaining certain size fractions of the material delivering.

The interiors of the Republic of Tajikistan are rich of various deposits. These are the gold deposits, the largest deposit of silver ores (lead, zinc, bismuth, gold, silver), as well as iron ore deposit, mercury and antimony, tungsten and tin, aluminum raw materials. In addition to these anthracites mentioned the largest and the only in the Central Asian region the coking coal deposit and numerous coals there are in the country. Also the interiors of the republic comprise the rich deposits of salts and raw materials for fertilizers used in agricultural branches.

However unfortunately the mining industry in the country is poorly developed, the processing industry is represented by a gold mine and an aluminum plant running on imported raw materials.

Tajikistan needs large investments and new technologies for the development of the mining and metallurgical industry.

MODERN SOFTWARE FOR MINE PLANNING

Soleymanian, Shahpar
ssoleymanian@srk.ru.com, SRK Consulting, Brisbane, Australia

Using the modern software provides the best practice mine planning techniques and delivers superior results. With the new generation of software mining engineers are able to simulate life of mine visually through all stages: stripping, production, stockpiling, building up the waste dumps and finishing by rehabilitation. Mine planning can be done in any scale of short to long term regardless of the size of deposit or the operation. Using simulating software gives this opportunity to engineers to run different scenarios and find the most practical one with the lower cost in a short period of time. These plans can be used from very early stages of study (prefeasibility) and get updated by time for next studies and also handover to be used for operation. Accuracy and time efficiency are the obvious advantages of implementing technology into the work. However in the big mines with several products and complicated grade control this technology give a high confidence to managers to meet the criteria for final products.

As it's easy to set up several operation scenarios, it will prevent repetitive works and save heaps of time. Also the mine plan and schedule easily can be used with other engineers as they all have universal templates so leaving stuff won't affect the study or the operation schedule. So there won't be risk of losing data. This technology can be used for open pit and underground and also for all kind of commodities coal or metal. This software uses a very high level of mathematic for calculation and is capable and flexible to support all the engineering methods for work. So the results can be trusted to be implemented in the operation and stock markets.

In the Scheduling tool which is absolutely unrestricted by timescales, long term and short term planning horizons sit seamlessly together in a single schedule. By accessing the comprehensive suite of flexible reporting options, you'll generate more accurate output data in more meaningful ways, including detailed Critical and Point to Point path analysis. There is an interactive connection between the scheduling and designing package which enable to keep a mining eye on top of scheduling process. This is an advantage for junior engineer to get a better understanding of the work.

The landform and haulage tool has the power to design haulage road with high accuracy. It covers all the variables in the material movement equation. It also includes the haul road analysis, detailed truck modeling, fixed and mobile conveying and cost modeling. It offers numerous haulage strategies from minimizing dumping height to reducing haulage distance; the easy-to-follow wizard generates multiple scenarios with ease.

Model real world factors including TKPH restrictions, haul road congestion and speed limits; calibrate your GPS tracking data to your modeled cycle times. A comprehensive reporting suite reveals the crucial data behind your material movement schedule including detailed haulage paths, cycle time analysis and stage plans. Environmental reporting includes disturbance & rehabilitation forecasting, wet weather simulation and final landform analysis. This haulage and landform tool is equally applicable in open pit and underground environments incorporating mining schedules at any planning resolution.

There is also an advanced tool which provides more functions for open pit and underground cases. Here is a list of features:

- Truck limited haulage and other alternative haulage methodologies
- Easy reconciliation tools for compliance auditing
- Geotechnical tools including stereonets
- Margin calculator incorporating Lerchs-Grossman pit shell optimization
- Underground design toolbox for gridded roadway and longwalls
- Auto Development Designer catering for non-standard design layouts
- Margin calculator including static NPV analysis
- Advanced scheduling functions including backwards pass resource leveling, objective targeting and resource path importing.

S-VIII

GEOLOGICAL PROCESSES, STRATIGRAPHY, TECTONICS AND GEODYNAMICS

HYDRAULIC BOREHOLE MINING (BHM) OF MINERALS

Nazarkin V., Novikov A., Volkov Y., Maluchin N.
soyuz-ruda@yandex.ru, SOYUZRUDA CLOSED JOINT STOCK COMPANY

Introduction

It is known that the mining industry is capital-intensive. Its peculiarity consists in the simultaneous investment in exploration and development of mineral deposits. The construction of such enterprises takes tens of years that it is not always economically feasible and currently not practiced. Today, there is a need for deep mining of ores and non-metallic minerals modern, progressive, environmentally friendly and economically profitable methods of geotechnologies and in particular, methods of hydraulic borehole mining (BHM), which has several advantages compared to open-cut and underground methods.

Progress in the development of borehole geotechnical methods attracted a lot of attention. This is because from the hydraulic borehole mining is expected to solve many important problems that are associated with a significant reduction of the deficit in the needs of many minerals in Russia, in particular, nature-rich iron ore of Kursk Magnetic Anomaly (KMA), rare earth and precious metals, phosphates and some others, with minimal capital investment and the timing of their development.

Methods BHM successfully applied to the extraction of minerals that are found in unconsolidated or weakly cemented condition when severe flooding deposits, when the traditional methods of development are impossible or difficult to perform, for example, deposits of rich iron ore by ore district Belgorod of Kursk Magnetic Anomaly, the development of deposits of titanium – zirconium ilmenite Sands at Tarskoe and Tuganskoe deposits of ilmenite and the design and operation of airlifting devices for extraction containing diamonds rocks from the seabed on the continental shelf of Namibia [1], [2].

The BHM technology

The way of the BHM based on the physical process of conversion of solid fossil in situ in a dynamic state of the suspension (slurry). Well hydrotechnology characterized by the specification of its constituent processes and, at the same time, close their interaction.

Well hydrotechnology includes the following main processes:

– opening of a productive array of production wells;

– jet, softening productive array;

– transportation destroyed (separated from the bottom) solid to the sump wells; the preparation of the pulp delivered to the sump of the rock mass for the suction process;

– the absorption of the rock mass with regard to transporting capabilities of the suction flow;

– hydraulic lift slurry to the surface taking into account the capacity of the lifting device operating in cramped conditions wells; surface hydraulic feed slurry to the separation unit (via slurry pipelines, bypassing plant crushing and disintegration).

These processes are closely interrelated and collectively represent the unique solution of the problem – the combination of different structures of processes in a single technological cycle of mining through the well, taking into account various geological process requirements of the BHM.

Among the main advantages that distinguish the SRS from the traditional ways of development include:

– reduce capital costs by eliminating a significant part of the mountain preparatory work, as well as access to useful fossil through wells drilled from the surface.

– ability to work with a weak, relatively unstable host rocks. The absence of a clearing space people and technical equipment allows you to work up to the collapse of the roof and reduce the factor of safety when calculating the pillars, and in some cases to apply a continuous extraction without pillars.

Current state of development of the method of the BHM

In the past fifteen years a number of organizations and enterprises of Russia completed a large range of research, design and engineering work on the subject of hydraulic borehole mining. The result was developed fundamentally new scheme wellhead and downhole equipment (MKDE – Mobil Kit Downhole Equipment) for the efficient operation of BHM technology, at depths from 30–50 m to 1000 m for the development of irrigated loose or weakly cemented ore and nonmetallic mineral deposits. Mobile mining complex BHM (MKDE) allows a single well to produce from 15 to 50 tons/hour or 120–250 thousand tons/ year rich iron ore with a bulk density of up to 3600–3700 kg/m^3 in the Belgorod ore region from a depth of up to 850 m.

The advantage of the proposed technology BHM is the mining equipment production wells kit wellhead and downhole equipment, based on the maximum use of modern drilling, lifting, pumping and compressor equipment used in oil production.

In the period from 2000–2012, were developed engineering methods of calculation of the whole complex of interrelated processes of BHM technology that allow for the design of optimal mining complexes BHM for various deposits and occurrence of minerals.

The development of BHM technology for production of natural-rich iron ore by ore district of Belgorod Kursk Magnetic Anomaly (KMA) allows to include in the economic turnover unique resource base of high-quality iron ore reserves of about 60 billion tons of content Fe > 62%, SiO_2 < 1.5 to 4.0 percent (the average for Russia in the mined ore Fe < 30%). In the ore BHM content Fe > 68–69% without enrichment, and SiO_2 < 1.0 to 1.5%, the content of impurities such as S and P < 0,03–0,05 % [1].

According to available data, such ores in the total balance of deposits of ore district Belgorod of Kursk magnetic anomaly of about 50–55%. The quality is the best iron ore in Russia and the world.

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SHELF SEDIMENTS DEVELOPMENT – REAL PROSPECT OF EXPANSION OF THE RAW MATERIAL BASE OF AMBER-CONTAINING ROCK MINING

[1]Drobadenko V.P., [2]Ivchenko V.V., [3]Butov I.I.

[1]Federal State Budgetary Educational Institution of Higher Professional Education "Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze" (MGRI-RSGPU), Moscow, Russia; [2]ROSTECHNADZOR Central Department, Moscow, Russia; [3]Spectron, LLC, Moscow, Russia.

Technology of amber-containing rock mining in open-pits of Kaliningrad Amber Factory is based on the use of dry excavating equipment (dragline excavator) and equipment for hydraulic mining (i.e. for jetting of mined rock piles and hydrotransportation with dredge pumps).

Development of coastal-marine reserves of Palmnicken Field beach area was performed not only within the beach itself, but at the sea bottom areas as well. It was assured due the adopted operating technology, where overburden rocks were transported through a pipeline to the sea in order to sluice a waterproof dam. For this purpose the dam and the pit were moved from the valley wall toward the sea. Eventually the pit was moved into the sea at a distance of ~ 1,000 m. However, the applied process flow scheme with the extension of the field of mining operations and maintaining of its design parameters requires a larger volume of overburden rocks for deposition and, therefore, heavier financial expenses. What is more, storms of great intensity have destroyed the wave-protection dam and flooded the pit, and in 2014 sea waves carried a considerable amount of aquagenic amber-containing rocks out onto the beach area. Taking into consideration the above, as well as topographic and hydrogeological conditions of the field (mine face and excavation lines are fully under the water), members of the Department of Terotechnology and Integrated Mineral Development were provided with the possibility to develop the main commercial reserves of amber in underwater conditions based on the floating facilities (dredges), while carrying out scientific and technical studies in 2010. According to the current mining state, we believe that this issue should be dealt with as soon as possible, since prospective areas are below the ground water level.

When selecting the type of tool for underwater mining of the Palmnicken Field's amber-containing rocks, its capacity, mining depth, length and height of transported mined rock are to be considered, as well as amber size and the possibility of its grinding in the course of mining. On the basis thereof, in order to avoid amber crushing by the impeller of the dredge, an air lift or an elephant trunk (ejector) without any moving parts, which might overgrind this valuable component, is to be used as main mining equipment.

Experience has shown that the use of ring ejectors is the most effective at mining of depths of 20-30 m, and air lifts are better to be used at greater depths. The capacity of jet dredges may be ~ 100 m/h of bed-silts with the hard piece diameter of 120-150 mm. Air-lift dredges are more efficient at hard grounds mining up to ~ 200 m^3/h. Hourly rate can be increased up to *~ 200 m^3/h and ~ 400 m/h accordingly, using dredges with two mining fittings placed along the boats (floating crafts). Lifted hard pieces can reach the size of* 400 mm with the air lift lifting pipe of 500 mm. In our opinion, no equipment other than air-lift dredges can be used where the mining depth is greater than 100 m. When using air-lift dredges, bed-silts can be transferred using hoppers. Hydrotransportation through floating pipelines can also be performed in a single process cycle with a loading machine, the head-capacity curve of which is determined through special calculation.

It is proposed that a number of preliminary measures related to the formation of inner artificial reservoir are to be taken. One of the key measures is the preparation of a pilot trench and external trenching.

The pilot barrow pit must be located within the open-pit field in close proximity to the sea, in order to run the external level trench, through which the barrow pit will be filled with water, and as an option, to insert the dredge to the pilot barrow pit. In this case a 20-50 m wide coastal pillar will be left. External trench can be run by an excavator or by the dredge itself (if applicable). In order to separate the pit from the sea, the trench is partitioned with a wall stopping, whereto a pipe with a valve for the trench water table control is laid. Trench bottom width at its excavator run must be 2-3 m greater than the width of the dredge pontoon.

With a considerable above-water height of open-pit bench in the field development zone, caving method must be applied using hydraulic giant mounted onto the dredge pontoon.

In the course of open-pit field excavation, it is necessary to identify the possibility of placing stripping production volumes in the abandoned area of primary front of operations.

In order to protect water reservoir from contamination, it is recommended to use electric dredge in the course of mining operations. In such case the risk of water contamination with diesel oil is eliminated.

Another option of amber-containing deposits mining is to perform offshore mining. For this purpose, watercrafts of M class can be used. Watercrafts of this class are usually used for marine environment at wave height up to 3 m.

Fig.1 Sakawe Miner mining ship

MGRI-RSGPU staff members have proven experience of sea test performance with designed or new construction of air-lift drag head of diamond-bearing gravel-pebble-sand rocks from depths up to 100 m on board Sakawe Miner in the shelf area of Namibia. Mining ship was furnished with two air-lift units with air-lift pumps of 500 mm in diameter placed at different boards of the ship. The results of performed tests based on various expert reviews of air lift capacity have shown at least 2.9 times increase of mined rock hourly rate and reached ~ 220 m^3/h per one machine [1].

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MECHANICS, MECHANIZATION AND ENERGY

AUTOMATION OF CORE DIAMOND DRILLING

[1]Mikchail Y. Krylkov, [2]Nikita M. Krylkov, [3]Grigory V. Latyshev
[1]m.krylkov@mail.ru, MGRI-RGGRU; [2]MSU, [3]latyshev@lonmark.su – SGA Llc,
Moscow, the Russian Federation

For the so called core diamond drilling (CDD) two types of drives are used: electric and hydraulic. Thus it is desirable to have smooth regulation of frequency of rotation of a boring column in the wide range (to 1500-2000 rpm). The diamond bit is the most sensitively reacting rock cutting tool on change of conditions of drilling. Typically, increasing its speed (at optimum axial load on the bottom and the supply quantity of washing liquid on a face) leads to almost linear (!) growth rate of penetration.

Time spent on lift up/down operations (LUDO) with increasing depth of the well in the first approximation grow in quadratic dependence. LUDO are the most labor-intensive and time-consuming works in diamod drilling [5]. By increasing the rate of penetration relative time spent on LUDO in race drilling also increasing rapidly. Automation can improve scheduled speed drilling.

Automation diamod drilling leads to the need for creating and (use) of complex distributed systems, includes a controllers; automatic actuators, sensors, PID controllers, etc. The second important for the organization of exploration work is dispatching diamod drilling (creation of SCADA). Actually SGA Llc is also engaged in these questions, in particular makes controlers of the so called fourth generation for the distributed industrial networks of automatic equipment.

How this design is carried out? First, executive engines (electric and hydraulic) have to be capable without accident with the set margin of safety for a drillstring to provide an optimum operating mode of a diamond bit on a toe, and for LUDO to gather the corresponding speeds and accelerations. In other words, the drive of drilling rigs have to possess certain dynamic properties at an initial design stage of boring equipment for set like a mineral deposit. Why? Yes because work of a diamond bit and column of boring pipes (CBP) can't be considered separately, without category of rock mass, nature of formation of a trunk of a well in these or those geological conditions.

The increase in frequency of rotation of CBP in certain conditions leads to visible change of kinematics of CBP. Raises complex elastic rotation around CBP improper axes of different types, parametric oscillation [1], vibro-impact events.Complex combination of bending and torsional vibrations CBP leads to rapid wear of the drilling tool and as a consequence, to an increase in accidents. Still work in deep wells CBP can not be unambiguously described by differential equations. Automatic monitoring of the (active identification methods [4]) CBP in complex geological conditions necessary!

The possibility of a smooth change mode allows you to bypass the drilling resonance phenomena when rotating in the well CBP. In the last three decades, asynchronous electric motor made significant progress in its development. He drove out of the many areas of the synchronous drive and DC drive. It is connected with the world achievements in the field of power electronics and microprocessor technology. Usually in the market to an asynchronous squirrel-cage motor attached control unit and frequency converter (FC). Last (FC) is designed for speed control of three-phase asynchronous motors with squirrel-cage rotor capacity from 0.4 to 75 kW.

Another type of actuator used in the drilling, is hydraulic. It has advantages over other types of actuators, where necessary to create significant power, speed, the positional accuracy of the actuators, compactness, low weight, high reliability, and a drive chain branching. To change the motor shaft speed or velocity of the piston hydraulic power cylinder used throttle or volume regulation.

For simulation (study) designed control system is convenient to use software environment Matlab / Simulink or more simple and intuitive method for constructing a Bode plot LAFPC (logarithmic amplitude-frequency and phase-frequency characteristics) in MathCad.

For example, a block diagram of a typical servo drive with throttle control [2], controls the position of the inertia of the object (CBP), consists of a signal amplifier, electro-hydraulic booster spool type and hydraulic cylinders with CBP covered negative feedback. The transfer function [3] is represented as a formulas (1), (2):

$$W_1 = \frac{W_2}{1 + W_2 * W_{OC}}\,, \tag{1}$$

$$W_2 = \frac{K_D}{s * \left(\dfrac{s^2}{\omega_{xi}^2} + \dfrac{2\varsigma_{xi} s}{\omega_{xi}} + 1\right) * \left(\dfrac{s^2}{\omega_0^2} + \dfrac{2\varsigma_0 s}{\omega_0} + 1\right)}, \tag{2}$$

where K_D – Q-factor of the drive; ζ_{xi}, ζ_0 – respectively relative damping coefficients of the amplifier and the hydraulic cylinder with CBP, and ω_{xi}, ω_0 – respectively cutoff frequency electro-hydraulic power and natural frequency of the output side with CBP.

The latter is calculated PID. The program MathCad is easily done in three steps: there is a linear frequency response (LFR) of the drive, we plot the resulting LFR, then subtract it from the graph and obtain the desired LFR of controller automatic control system.

This approach is implemented automation Core Diamod Drilling through open of industrial automation, for example on the basis of one of the protocols, PROFIBUS, Modbus or LON – Protocol technology LonWorks. Further, for the construction of SCADA-system via radio communication controller is carried out on the rigs with the control station.

The LON (technology LonWorks) became the world-wide standard for distributed automation systems, so-MGRI-RGGRU designed to teach students appropriate stands for the automation of electric and hydraulic drives exploration techniques.

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IMPROVING ENERGY EFFICIENCY DRILLING OF PROSPECTIVE WELLS BY IDENTIFICATION OF MODE OF TORSIONAL SELF-OSCILLATIONS OF DRILL STRING

Bukreev S.V.
Scientific adviser **Grigoriev MIS.V.**
Bukreev2805@gmail.com, MIG-1.02@mail.ru, MGRI-RGGRU, Moscow, Russia

In practice of exploration drilling is widely known phenomenon of torsional self-oscillations of drill string and its extremely negative impact on well drilling. Torsional oscillations cause a reduction in rate of mechanical speed of drilling , as a consequence, the penetration of tunneling tool for rock cutting, as well as reducing the power supplied to the bottom for the purpose of its recess [1, 4]; arising sharp, periodic changes in torque (so-called "torsional shocks") form a cyclic load shock favoring the increase in the probability of failure of the working elements as crowns, and the drill string due to the increased dynamic forces and intensifying processes of destruction drilling tool wearing fatigue character. In the present work was to develop a method for identifying modes of torsional of self-oscillations of the drill string in the parameters of the current consumed by the three-phase induction motor drive of rotator drilling rig and the block diagram of information-measuring system, able to implement this technique in practice [1]. As a means for solving tasks uses methods a simulation modeling, electromechanical analogies and phase plane.

Using the method of a simulation modeling in software package MATLAB (Simulink) [3] with the expansion pack SimPowerSystems, containing standard components for modeling of electrical systems, developed a comprehensive simulation model of electro-technical complex standard rig, which includes the development of a subsystem, distribution and transformation of electric energy. The model allows to control the mode of operation of each of the above subsystems as a whole or individual condition of a particular element of complex, for example, an induction motor drive of rotator drilling rig. A wide range of software system allows accumulating and storing large amounts of data, as well as using different ways of processing the received signal spectral analysis and phase plane, significantly reducing the time and resources to conduct research.

By conducting experiments on the simulation model of electro-technical complex obtained phase portraits of the generalized current vector of induction motor drive rotator machine in steady-state operation and mode of torsional self-oscillations of the drill string (Figure 1). Significant differences in the form of phase portraits confirm the effectiveness and visibility of the method of the phase plane for the identification torsional mode of self-oscillations of the drill string.

On the basis of collected data and studies in [1, 4] developed the block diagram of the digital information-measuring system of identification torsional self-oscillation of the drill string. Presents the requirements for hardware Measurement and recommendations on the use of special software for storing and processing information.

Use of this information-measuring system will:

1. Increase the power input from the drilling rig to the bottom;
2. To increase the life of the AT, elements of the drill string and drilling machine by reducing shock loads of character;
3. To reduce the load on the rig personnel due to the partial or full automation of the drilling process;
4. Increase the speed of the mechanical drilling.

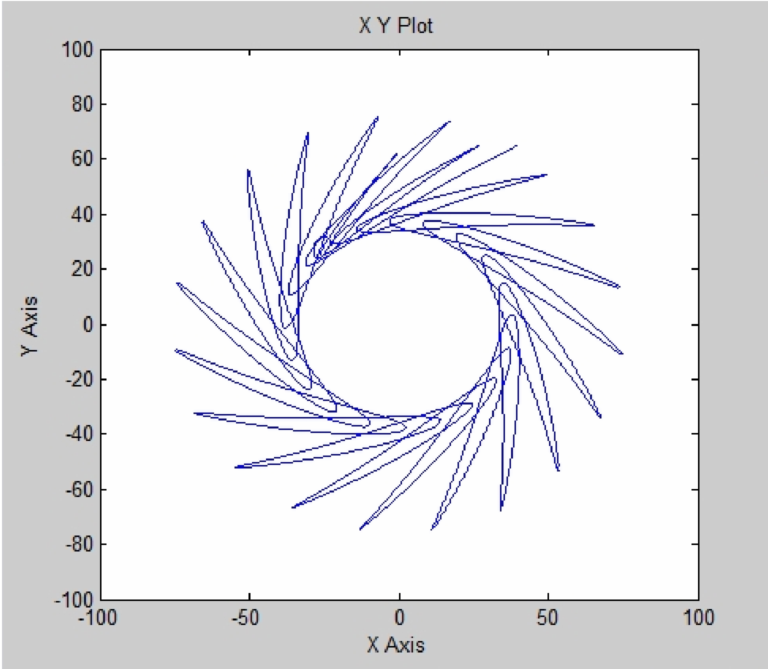

Fig.1. The phase portrait of the generalized current vector of induction motor rotator drilling rig in mode of torsional self-oscillations of the drill string.

The above positive effects to the greatest extent can influence the reduction of material, resource and energy costs, which ultimately will increase the productivity of exploration work.

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IMPROVING THE EFFICIENCY OF DRILLING EXPLORATION BOTTOMS IN THE COMPLICATED GEOLOGICAL CONDITIONS

Djuraev R.U.
Supervisor: **M.V. Merkulov**
VPO Russian State Geological Prospecting University Sergo Ordzhonikidze
(MGRI-RGGRU), Moscow, Russia

Drilling of bottoms in permafrost has specific features, which are based on the essential role of the temperature factor. As a result of thermal effects of drilling fluids on the ice, cementing mineral particles rocks (mainly sand), coherence and strength of the last drops. This leads to landslides and rockslides borehole bottoms, i.e is the reason for caving. The presence of cavities determines by a number of complications, the main of which are estuarine land subsidence, erosion of the wellhead during drilling, the low quality of cementing, casing collapse, taking the drill pipe and casing.

The most effective means for drilling in permafrost is to use compressed air instead of washing liquid to remove the degradation products from the bottom of the well. Air does not freeze at low temperatures, therefore eliminated the complications associated with the freezing of the washing fluid in the borehole while drilling However, there are other difficulties. The temperature of the air coming from the compressor into the well at the bottom is increased due to the transition of mechanical energy into heat working tool, which creates the risk of complications associated with the thawing of the borehole walls and the core. Eliminate these complications completely is possible only using the forced air-cooling to a temperature sufficient to neutralize selected at the bottom heat. In order to create a more efficient, at the same time and cost-effective equipment we propose to apply the vortex tube, in which the effect of Ranka, as freezing and heating installation.

In order to analyze the temperature regime of the vortex tube and the influence of cooling air to the temperature of the well and the crown in the research polygon MGRI-RGGRU we investigated the vortex tube and pilot drilling with air blowing, with the use of the vortex tube.

The results of experimental studies allowed to define the change in temperature of hot and cold streams, depending on the air flow and the impact of the cooled air temperature crowns.

Also, experiments carried out show that the air blowing holes of negative temperatures enables removal and thawing of the walls of the wells of the core.

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SOFTWARE FOR CALCULATION OF STATICALLY INDETERMINABLE DESIGN OF GEOLOGY-PROSPECTING EQUIPMENT

[1]Menkova N.M., [2]Menkov G.B.
[1]menkovan@gmail.com, Russian State Geological Prospecting University n.a. Sergo Ordzhonikidze" (MGRI-RSGPU), Moscow, Russia; [2]gmenkov@narod.ru, Russian State Social University RSSU, Moscow, Russia

The basis for many designs of geology-prospecting equipment are statically indeterminate beams and frames, so the development of software for calculation automation of similar objects is very topical.

Statically indeterminate designs can be calculated by the force method by setting up and solving the canonical equations of the type

$$\left.\begin{array}{l} \delta_{11}X_1+\delta_{12}X_2+...+\delta_{1n}X_n+\Delta_{1P}=0 \\ \delta_{12}X_1+\delta_{22}X_2+...+\delta_{2n}X_n+\Delta_{2P}=0 \\ :: \\ \delta_{n1}X_1+\delta_{n2}X_2+...+\delta_{nn}X_n+\Delta_{nP}=0 \end{array}\right\}. \qquad (1)$$

It should be considered that the problem of calculation of these systems can have both methodological and practical aspects.

Methodologically, it is advisable to perform assignments and term papers on strength of materials by graphical analytic method of Vereshchagin, which gives a pictorial presentation of the physical nature of the process [1-4]. To solve this problem by graphical analytic method, it is needed to create two so-called single systems for predetermined design, where each of system structural supports has single force applied, directed in accordance with the hypothetical reaction forces, then distribution diagrams of bending moments are constructed for each of these systems. Coefficients at the unknowns of the system of equations (1) are found as sum of products of areas under the distribution diagrams of single moments on ordinates of the same areas, passing through their own centers of gravity, divided by the stiffness of structure shafts.

To determine the free terms of the equations (1), it is necessary to construct distribution diagrams of bending moments from all active loads applied to the system (load distribution diagrams), determine areas under these distribution diagrams and center of gravity positions of these areas, and then find the sum of products of load distribution diagrams areas on ordinates of individual distribution diagrams lying below the centers of gravity of the loads, divided by the stiffness of structure shafts.

The coefficients of the canonical equations obtained in this way must be verified by the theorem of minimum potential energy of deformation. Mentioned method is quite generalized, and at the same time it allows a good structuring in algorithms at an arbitrary number of different structural elements and external loads different by the form and arrangement.

At this consideration, a space frame consisting of three shafts was adopted as a basis for calculation, each of shafts is parallel to one of the coordinate axes: *ox*, *oy* and *oz*. End of the first shaft has a flat or spatial hinge as a support; the last link of the design is fixed. Depending on the type of the hinged bearing, from one to three unknown reactions appear in the system: X_1, X_2, X_3 – and appropriate number of equations of the system (1).

Setting up of canonical equations by force method provides obtaining equations of bending and twisting moments, depending on all the loads applied to the frame: reaction forces, external forces: P_X, P_Y, P_Z – and moments: M_X, M_Y, M_Z; number, direction and points of application of external force factors can be set arbitrarily. Distributed loads with intensity of q_X, q_Y, q_Z can be placed along any of the shafts. The contribution of each load in the equation of bending and twisting moments is summed on the basis of principle of superposition.

For software development, in case of an arbitrary application of loads to each of the shafts, it is convenient to use global coordinates, by which geometry of the design and location of external force factors are defined. In this case, when setting up the equilibrium equations for each element of the system, the normal in any of its section may appear as directed in both the positive and negative directions, which affects the signs of bending and twisting moments. Therefore, the two options of equilibrium equations are considered separately during the calculation: with positive and negative direction of the normal to the respective coordinate axes.

The analytically obtained expressions for the internal bending and twisting moments, as well as their derivatives are substituted in formulas determining the minimum potential energy of deformation energy that allows to obtain the canonical equations and ultimately determine the support reactions, maximum loads on the elements of the system and select sizes of the components of structure shafts.

In software development, a laborious work on considering the effect of all possible external force factors on internal bending and torsional moments was reduced three times by using a cyclic permutation of the indexes. For this, first the equilibrium equations were set up for the shaft parallel to the global coordinate axis *x.* Then, similar equations for shafts parallel to the axes *y* and *z* were not fit clearly and taken into account in the program code by a cyclic permutation of the array indexes, where the internal calculated moments: x>y>z>x (or 1>2>3>1) were placed. Interface of the software created in visual development environment Delphi 7 provides a form for data input by user: there is a possibility to specify length, direction and spatial orientation for each of the shafts, as well as the magnitude, direction and points of application of reaction forces and external force factors. Next, when user clicks on the "Calculate" button, graphical construction of design by determined coordinates is being performed, and canonical equations of type (1) are displayed in the text field, coefficients of these equations are calculated on the basis of the proposed program. It is easy to determine the support reactions from these equations by any method known in mathematics.

To solve the canonical equations in this case, a simple computation program is proposed. The program uses Gaussian elimination (also known as row reduction). The method uses a sequence of elementary row operations and requires for a total of approximately $2n^3/3$ operations for a nЧn matrix. The forward elimination (first part) reduces a given system to row echelon form (until the lower left-hand corner of the matrix is filled with zeros). The back substitution (second part) puts the matrix into reduced row echelon form.

In engineering practice, the calculation of statically indeterminate designs can be made on the basis of the proposed software without using the graphical analytic methods.

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TEMPERATURE CONTROL OF POWER LINES

Nasyrov A.A.
MGPI-RSGPU, Moscow, Russia

Protection of cables and power lines for thermal performance is realized in a special thermostat majority of single-pole and multi-pole circuit breakers. When the temperature set by the thermostat, automatic tripping line protection. Typically, the thermal protection is used to monitor long-term operation. But the fact of raising the temperature of the conductor is associated with several factors for its installation and operating conditions. Heating in any case – three-factor operator. In the first case means the heating wires due to exceeding its capacity for conducting a current when the normal section of the line. The second case – when the heating occurs as a result of improper installation or operating conditions, even at rated current due to local increase in current density in the line. It may be "bridges dynamic resistance" in places docking terminal cable with circuit breakers, joints made with technological problems couplings, contacts knives in the breaker or breakers, fuse-links contacts in the sockets, contacts in the very machines. In this case, we have a local understatement of the normal section of the conductor, which causes an increase in heat release and heating in a given place. The third case – the imposition of the first and second factors; it usually leads to serious consequences – of fire and accidents. Thus, temperature of the conductor – the main indicator of its performance.

Conductors of electricity conducts heat well. Therefore, a constant temperature control and timely power lines from start to finish. Methods for measuring the temperature of the conductor or resistance may be different. But the attractiveness of the whole continuous measurement of temperature by comparing the load on the wire. Moreover, the transfer of such data can be organized at the power lines, according to a special line method or radio channel imager. When operating line can be split into separate parts, which measures the temperature and current. The regions may include not only the line wires (cables), and control and protection equipment.

As a result of measurement is allocated reference dependence $t = f(I)$ – ampere-degree characteristic of the site where the abscissa – current I; ordinate – the temperature of ^{0}C. As the operation of each section of the curve will shift up and down along the vertical axis, depending on the load and take a steeper rise of the sudden nature of its magnification. Obviously, for each of the chain can be determined safe ("green") sector changes depending on the temperature of the load within certain limits, from the data segment circuit (line length, the material, section resistivity, permissible current and the permissible operating conditions for heating, type apparatus in the chain, etc.). Then select the "yellow zone" attracts attention with its increasing steepness of development and the red zone – the zone of emergency operation. Zone boundaries can be dynamic and entered into the computer seasonally or peak loads.

As an arithmetic magnitude ampere characteristic can choose degree angle tangent to the x-axis graph or tangent, ie the ratio $k = t/I$, which can be displayed on the screen. It is obvious that the more dynamic growth of k in the yellow and red zones, the more dangerous this line in operation. In this light, it is interesting computer diagnostics working lines, as a process of continuous automatic comparison of recordable ampere-degree characteristics with reference to this section in its working condition, as well as the boundaries of the zones. Thus, the essence of the new approach to monitoring the safety of workers in the lines that competent management operation of power supply should be kept in the first place, their temperature control.

S-X

MINING, HYDRAULICS AND HYDRO-PHYSICAL PROCESSES

THIN CAVITIES STABILITY RESEARCH DURING CONSTRUCTION IMPERVIOUS CURTAINS USING BOREHOLE HYDROEXCAVATION TECHNOLOGY

[1]Bryukhovetskiy O., [2]Naidenko I.
[1]Academician of the Russian Academy of Natural Sciences (RANS), Head of the mining department, professor, Dr., Russian State Geological-prospecting University (RSGPU);
[2]Ph.D. International Science and Technology Center (ISTC), Deputy Chief Procurement Office

Construction of impervious curtains (IC) with method of borehole hydroexcavation technology (BHT) involves the use of submersible equipment such as hydrojet unit (HJU). Thin cavities (TC) are creating using this unit with the help of directed washout. Goaf stowing with quick-setting materials are followed.

Washout and subsequent filling of the cavities carried out through built-in giant.

The destruction products are brought to the surface as a pulp and underground workings are formed. This ensures the work of free undrowned hydraulic giant jets in drained face.

Created conditions for the HJU functioning are optimum for compliance with spatial geometry of the formed TC.

The rheology model of calculation geomechanical phenomena soak the basis due to the transience of formation TC and occurring inevitably processes of deformation and destruction their surface of outcrop.

Basic thesis of calculation rheology model geomechanical phenomena may be formulated as follows: uptime of the basic technological operations for washout and filling should not exceed the temporary stability of the pledged cavity.

In this approaches prototype to investigate massif stress-strain statue is the main question of deformation determination as a qualitative characteristics; then here significance will be quantitative expression which first of all refers to deformation parameter.

The allowable width of TC required by stability conditions of predominantly depends on deformation parameter:

$$b_{\min} = 2\varepsilon_{t\max} + b_1,$$

in which

$\varepsilon_{t_{\max}}$ – deformation of the surface outcrop at the end of cavity stowage, max, m.;

b_1 – width of the cavity by condition of effective outcrop, m.

The original equation in the adopted rheological model will be next:

$$\varepsilon_{(t)} = \left[\sigma_{(t)} + \int_0^t \lambda(t - t_0)\sigma_{(t_0)} dt \right],$$

in which

$\lambda(t - t_0) = \dfrac{\delta}{\exp \delta_1 (t - t_0)}$ – creep kernel with the empirical coefficients δ and δ_1.

The use of integrated circuits is difficult for practical application. Therefore the empirical relationship has been established, and based on the results of fixed observations.

Critical height of the cavity:

$$h_{крит} = 10^3 \cdot \frac{t_c^{2.3}}{t_0} \cdot \frac{\pi n_з \alpha R}{360} \cdot \frac{m}{H},$$

in which

t_c – uptime of the fixed jet's work, hr;

t_0 – HJU's uptime at the borehole, hr;

n_3 – number of radical stope along the cavity width;

α – stope's opening angle, deg;
R – washout length. m;
m – cavity's design height. m;
H – work's depth. m.
The basic indicators of proposed technology:

Parameter	**Value**
Depth of works, m	0-200
Outer diameter of HJU, mm	134; 168; 273
Operating liquid head, MPa	4 -7
Slot width, min, m	0.05
Washout radius, m:	
sandstone	8-12
clay	3-5

Developed technology can be applied for restoration & increasing production rate of the boreholes as good as for engineering strengthening of soil also.

SOFTENINIG OF ROCKS IN BOREHOLES FILTRATION AREA USING HYDRUEXCAVATION TECHNOLOGY

[1]Bryukhovetskiy O., [2]Naidenko I.

[1]Academician of the Russian Academy of Natural Sciences (RANS), Head of the mining department, professor, Dr., Russian State Geological-prospecting University (RSGPU);

[2]Ph.D. International Science and Technology Center (ISTC), Deputy Chief Procurement Office

The water- and technological wells operations have been complicated by the muddling processes. This entails production declaim and yield wells down.

The intensification methods of water intake and dewatering are relevant for mining solid minerals deposits.

Alternative methods to justify the proposed have been analyzed. There are: hydraulic fracturing, electro influence, electro impact, pneumatic impact, hydraulic action. These methods are effective for sand and clay deposits with filtration coefficient more then 1 m/day. Wherein the natural structure of the array is stored and their exposure limited to the first tens of centimeters; control of spatial orientation is missing.

The proposed method has a clear spatial orientation; footprint in the sand and clay deposits is 12 meter.

Essence of the method lies in horizontal slots development them collapsing the layers of the false roof. The false roof parameters are chosen so that their life amounted to $(2 \div 10)t$, in which t – borehole tools operation time in the treated gaps.

Rheology processes contribute decompaction rocks. The softening area height should not exceed the aquifer height.

There are two options for creating softening area to fulfill this condition. It's also depends on resistance layers immediate roof.

There are 4 washout sections with an opening angle of 60° and interchamber pillars with an opening angle of 30°. This is the basic configuration for both options.

For the first option: the immediate roof layers length is stable and don't require artificial fixing. In this case cutting compensatory mine workings length and immediate roof layers length are gradually decreased below the top. The softening area in elevation is natural arch collapse.

For the second option: the immediate roof layers length is not stable and do not require artificial fixing. In this case cutting compensatory mine workings length is constant. The artificial roof sections rely on the interchamber pillars and on the softening area face part.

Taking into account the time factor, a limiting span carrier roof layer defined by the formula:

$$L_{кр_{(t)}} = L_{вр}\left[1 - n_1 t^{n_2} (\sigma^{вр}_{изг})^{-1}\right],$$

in which

$L_{вр}$ – limiting span beam in a longitudinal and transverse bending

condition;

$\sigma^{вр}_{изг}$ – conditionary instant flexural strength, MPa;

n_1 and n_2 – empirical coefficients determined by the results of modeling with equivalent materials.

Below the top successive layers collapse provides the greatest intensity of softening.

The studied layer duration of the steady state defined by the formula:

$$t_i = \frac{L_{вр} - L_{i_{(t)}}}{bL_{вр}n_ф} \cdot \left(\sigma^{вр}_{изг} n_3 t^{n_4}\right)^{-1},$$

in which

b – layer's thickness, m;

$n_ф$ – workings shape factor;

t – workings duration of penetration, hours;

n_3 and n_4 – empirical coefficients : n_4 – dimensionless coefficient, n_3 has dimension, kg/m.

Thickness of each successive layer or height of cut slit could be changed for control process of consecutive collapse.

Washout is carry out with free undrowned hydraulic giant jets in drained face with hydroelevating rise.

The effective work of borehole tools experimentally proved till the depth of 180 m. Filtration properties in bottomhole zone have been exponently increased.

THE COMPLEX PROCESSING OF THE MINING CHEMICAL RAW MATERIALS USING GEOTECNOLOGY METHODS

[1]Bryukhovetskiy O., [2]Naidenko I.

[1]Academician of the Russian Academy of Natural Sciences (RANS), Head of the mining department, professor, Dr., Russian State Geological-prospecting University (RSGPU);

[2]Ph.D. International Science and Technology Center (ISTC), Deputy Chief Procurement Office

The complex technology of deep processing of coal in situ, using underground coal gasification (UCG) and borehole hydrojet technology (BHT) based on the current trend analysis in the field of mining chemical raw materials, is proposed. It could expand the range of chemical products derived from coal, and accordingly as good as their applications, improve thermochemical and technological marks.

The concept of technological approach to the bed stimulation meaning is as follows. The basic circuit element of UCG – burning channel – is formed using technical devices of BHT. It is possible to carry out both in the bed preparation to the main technological process and directly during the operational phase.

The circuit of BHT using free undrowned hydraulic giant jets in drained face with hydroelevating rise is supposed to be used. The air backpressure scheme for wellhead pressurization with the help of preventer is provided. It is also necessary both for improving the functioning of the lower cap's jetting and elevating unit and to achieve the maximum possible depth. This mode will contribute the shaped cavity drainage in the preparation of burning processes.

The knocking scheme for burning cavity or circuit of defusing wells network can be used depending on coal beds geometrical parameters and general morphology of the deposit. Burning cavity has been created with the help of hydrokerf. The spatial orientation of burning cavities envisage for any circuit operations.

The washout of thin cavities promotes for subsequent operating spatial orientation also. Bed's loosening can be realized with the help of explosion on the compensation space which have been created using technical devices of BHT. The explosion in the clamped space can be used also.

The prepared burning channels have been calculated on sustainability using geomechanical calculation scheme. Duration of sustainability should be match the time of stable operation. For this purpose rheology model of geomechanical calculation can be used.

Post-operating mount goaf can be performed using BHT-system with quick-setting material stowing or with the help of anchorage mount. This prevents surface failures, where any communications can be settled.

A complex of laboratory and pre-operational research is needed for the implementation of the proposed technology. This complex includes:

- development of borehole tools design;
- development of technological wells design, hydrokerf design, stowing wells constructions, control and observation well design;
- study of geomechanical sustainability processes in an burning channel and in a goaf;
- study of the strata movement processes in the typed coal deposits;
- modeling of thermal effect to the coal beds;
- development of the technological regimes for multipurpose mining of the deposits;
- development of installation and operating schemes;
- typing coal deposits or their parts for proposed technology.

The proposed technology refers to shaftless methods of exploration. This technology can be used both for separate parts of deposit and for new deposits, which are in difficult mining and geological conditions.

This technology rules out presence people under the ground and also allow control and prevent displacement of rocks, as good as failures the earth's surface. Thus, this technology has a positive ecological effect.

Multipurpose utilization schemes of proposed technology allows to make the getting gas condensate process manageable and of in-time.

Generating gases and liquid hydrocarbons for ammonia and methanol production will be the main products of underground gasification using borehole hydrojet technology.

MODEL OF THE ASSOCIATIVE STRUCTURE OF THE MOLECULE OF WATER

Malov V.I.
pr.maloff@mtu-net.ru, FGBOU VPO of "MGSU", Moscow, Russia

On the basis of results of the analysis of physical and chemical properties of water and manifestation of their anomalies the model of an associative structure of water is developed.

Water molecule structure model

In separately considered molecule of water of its modern model of a kernel atoms of hydrogen and oxygen, are located so that form an isosceles triangle. In its top – an oxygen kernel, in the corners adjacent to the basis, – on one kernel of hydrogen.

a – the corner between communications **O-H** is constructed by results of experimental measurements in plane display from which the electronic cloud of model doesn't follow water molecules;

b –spatial arrangement of poles of charges in water molecule model not provides an existence statics condition – it is necessary, that equally effective all forces operating in a molecule it was equal to zero;

c – appearance of an electronic cloud of model of a molecule of water it is displayed without taking into account values of diameter of atom of hydrogen $\mathbf{a_H = 0,5287\ E}$ and atom of oxygen $\mathbf{a_O = 0,6037\ E}$.

Analysis of the phase chart of water

Areas of the phase chart correspond to those external conditions (temperature and pressure) under which the water phase is steady. At the values of temperature and pressure limited to curve BT and the TC, water exists in a liquid state if points of parameters of water are located below curve AT and NC, water exists in a vaporous state. The point of T of the phase chart is called as a threefold point. In this point ice, liquid water and vapors of water are in a condition of mutual balance. To this point there correspond temperature 273,16 K and pressure 6,03 • 10-3 atm. Only at the specified values of temperature and pressure all three phases of water exist at the same time. Simultaneous existence of three phases of water leads to input of the concept – **water of each phase has own configuration of a structure of the separate taken molecule, that is water has three forms of a structure of molecules.**

Hidden warmth of melting and evaporation of water

If temperature of a solid body increased to a melting point or if liquid reached a boiling point, there comes the transitional phase, as if a pause during which two phases (firm and liquid or liquid and gaseous) exist at the same time. During this period which proceeds until the solid body completely won't evaporate in liquid or liquid in vapor, the absorbed heat doesn't cause any changes in body temperature. This heat is called as the hidden warmth, and its quantity at various substances unequally.

Model of a structure of a molecule of steam of water

Follows from records of a chemical formula of water H_2O and its structural formula H – O – H: only the linear form of a molecule of water provides performance of all stability conditions of existence it as chemical compound. The water molecule model given on drawing in a condition of steam is a dual dipole of a configuration $^{+}H - {}_{-}O^{-} - H^{+}$ with accurately expressed positive polarity. The molecule of steam of water has diameter диаметр $d_{H_2O} = 1,05$ E and length $L_{H_2O} = 2,87$ E.

Model of a structure of a molecule of liquid water

Water molecules upon its transition from a vaporous state in liquid a state that call condensation process, are shown by property to form associative structure. The property of structural formation of an associate of two molecules revealed at water can be presented by the equation of interaction of chemical molecules with formation of a physical molecule $H_2O + H_2O \leq \geq H_4O_2$, the spatial image by which it is given below. After T-shaped collision of two molecules of water of a vaporous state there is a connection of two linear molecules with formation of an associate of molecules of water of a dual tetrahedral configuration.

After that becomes clear why all experimenters within 100 years saw a water molecule with curved structure. The associate has the form which is best approached to a sphere, having diameter in horizontal section $D_{гор}$ = 2,32 E and diameter in vertically section $D_{вер}$ = 2,87 E. This fact is put in the concept *the single molecule of liquid water has a spherical form*.

The configuration of an associate provides the high durability of structure as all four atoms of hydrogen are squeezed by two atoms of oxygen taking into account existential distribution of the rotating electrons.

Model of a structure of a molecule of ice water

In an associate of liquid water at reduction of temperature of the last there is an evolution of structure. Thus the center of triangular section because of reduction of binding energy between atoms leaves the fourth atom of hydrogen. Horizontal section of an associate of liquid water is reconstructed in the square section of a single associate of ice of water, forming a dual pyramidal spatial configuration.

Repeatedly becomes clear why all experimenters within 100 years saw a water ice molecule with curved structure. The associate of ice has the form which is best approached to a sphere, having diameter in the horizontal section of D_{hor} = 2,56 E and diameter in vertically section of D_{ver} = 2,37 E.

This fact is put in the concept *the single molecule of ice of water has a spherical form.*

Having weight equal to weight to a molecule of liquid water, but bigger volume forms structure of ice of smaller density. The configuration of an associate provides the high durability of structure as all four atoms of hydrogen are squeezed by two atoms of oxygen taking into account existential distribution of the rotating electrons.

Water in the atmosphere of Earth

If the water molecule in a steam state has a formula H_2O and molecular weight 18,01528, associative formation of water from two molecules has a formula of the record H_4O_2 and molecular weight 36,03056. It is the most important feature of water revealed by the author which role in structure, properties and processes of the atmosphere of Earth it is difficult to overestimate.

The main gases and water entering into structure of the atmosphere of Earth and ranged in a row in size of molecular weight (in round figures) form sequence:

$$H_2O – 18, N_2 – 28 , O_2 – 32, H_4O_2 – 36, CO_2 – 48, CO_2 – H_2O – 66.$$

In the atmosphere of Earth from its surface they have to settle down in the return sequence even taking into account turbulent diffusion and considerable hashing of layers. From this follows if water had structure of H_2O, she would leave long ago Earth that proves the concept entered by the author – generally molecules of water are in an associative state and in the form of clouds higher than 6 km don't rise.

Conclusion: water in a liquid and firm look consists of spherical physical molecules – associates H_4O_2.

MODEL OF THE STRUCTURE OF LIQUID WATER

Malov V.I.
pr.maloff@mtu-net.ru, FGBOU VPO of "MGSU", Moscow, Russia

Water fluidity

The main property of liquids and waters is fluidity. If to a site of the liquid which is in balance to apply external force, there is a stream of particles in the direction of action of forces: liquid will begin to flow. Under the influence of external forces liquid doesn't keep a form and an arrangement of parts and therefore takes the form of a vessel in which is. And here the science came back to the oldest question which excited still medieval Florentine academicians: why water flows? The answer is simple: *water has a physical molecule in the form of set of spheres between which there are no the fixed forces of adhesion, but attraction forces therefore water will always form a horizontal surface work – will flow!*

Water durability

It is known that if on each square centimeter of a water surface to create excessive pressure in 100 kPas, the initial volume of water will decrease on 1/21000. Size almost insignificant and showing that with small pressure water perfectly "works" for compression deformation. With a pressure of tens and one hundred thousands atmospheres water – very pliable liquid and by 100 times is less elastic, than steel. If in the first case deformation happens due to consolidation of laying of molecules, in the second – there is a deformation of electron shells.

Theoretical researches and experiments with a water surface tension led physicists to unexpected result: to ideal clear water on tension shoulder in $4.7745*10^9$ Pas that 100 times are surpassed by durability of the best of steel grades known today.

The mechanism of forces of interaction between associates of water is other than interaction with impurity. It promotes decrease in durability of water and structuring at the level of a near order.

Structure of water

Realization of structure with the given properties of water in a liquid state requires performance of a condition of a minimum of its potential energy that the fullest packing of associates at their maximum rapprochement provides. Structures in which at the set minimum distance between centers of associates the maximum concentration of associates in unit of volume is reached are called densely packed.

Near and far order of structure

The near order in water or existence of regularity in an arrangement of the next associates – their orderliness in water which takes place to be only at distances, commensurable with distances between associates. The near order is revealed by researches of structure of water by plotting of function of radial distribution of molecular density. The signs of a distant order repeating at long distances from this atom are characteristic only to water in a firm state. The x-ray analysis of structure of water showed that liquid water is closer on the structure to solid bodies, but not to gases as in placement of molecules of water some regularity – a near order was obviously traced, characteristic for solid bodies.

TECHNICAL ADDRESSING OF CONSTRUCTION ECOLOGY

Kudryavtsev I.
7468140@mail.ru, «EcoProm limited», Moscow, Russia

The term "ecology" literally refers to "the science of habitat." Man must be strictly defined environmental conditions. If you deviate from the required rate, possible violations of life. The specialists are tasks: create a high quality of life while ensuring sustainability of cities, reduce the flow of pollutants in the environment and achieve ecological balance between the city and nature. Anthropogenic impacts of construction varied in nature. Construction – one of the most powerful man-made impacts on the environment, which is why the sanitary norms established that at construction sites must be provided no or minimal selection in wastewater and contaminated hazardous substances. Therefore, removal of waste water and its cleaning sanitary standards are regulated as follows: prohibited descent economic, sewage and industrial waters absorb well. Descent of wastewater from circulating water systems shall be permitted only in the production kanalizatsiyu.Vo avoid pollution of city streets and the air environment of construction machines and mechanisms during their movement outside of the construction site, there were regulations, according to which at the exit from the construction site must be equipped with cleaning item wheels. A large amount of water consumed during construction work as manual hose washing the car – from 500 l to 1200 l and mechanized – up to 2000 liters. In order to reduce water consumption provides recycling its use.

Wrong to think that in our country the protection of nature are not given attention. There is a share capital investment spent on protecting the environment during the construction of industrial enterprises in various industries. From 1 January 2005 by the decision of the State Construction Committee of the Russian Federation. Number 70 of 2004 enacted SNIP 12.01.2004 "Construction Management", which provides for compulsory equipment of construction sites paragraphs washing the wheels of vehicles.

A key element in solving environmental problems is to find a competent and efficient scientific and technical solutions. Along with other institutions, laboratories and industries for more than 10 years of "EcoProm" operates in the protection of the environment. The company develops, implements, produces a range of new high-tech products, such for example as cleaning the wheels for motor vehicles traveling from construction sites.

The simplest way to avoid contamination of the environment is already proven in practice installation option on the construction site of paragraph wheel wash with a closed cycle of cleaning and the use of treated water. From existing, they differ full autonomy – the presence of an internal combustion engine provides autonomous operation of high-pressure pump at the installation site.

Installation of water recycling washing the wheels of trucks designed to purify water from large suspended particles of sand, clay, soil and other contaminants of this nature, and the purified water is returned for reuse. Thus, the system circulates a constant volume of water equal to approximately 3.5–5 m^3.

The basis of the principle of efficient operation of wastewater treatment system in the operation of washing laid two stage cleaning – water clarification in the field of centrifugal forces (this principle is implemented in the method of water treatment in a hydrocyclone); second step – sedimentation of suspended particles under gravity. The main technological element using this principle is horizontal decanter.

Contaminated water after washing the wheels going into the pit, which will be organized right next to the installation of water recycling. From the pit water is pumped to the hydrocyclone. Hydrocyclone – a device whose action is based on the use of centrifugal forces, where the selection of mechanical impurities from water occurs under the action of these forces, which are hundreds and thousands of times the force of gravity, thereby increasing the rate of deposition of particles.

When you rotate the hydrocyclone flow of fluid is divided into two parts: the first (central) part of the stream, free of slurry discharged through the upper branch hole; second stream – tangential – enriched weighted with sand, is discharged through the bottom branch hole. First clarified stream enters the first receptacle, and enriched suspension, returns to the sump. Water from the first receptacle, flows into the second compartment, through a special window, arranged at a certain height, to avoid falling further settling of suspended matter in water.

After the first purification stage and the overflow water enters through the window in a horizontal settler. Horizontal decanter – a rectangular elongated in the direction of movement of a steel water tank, wherein the water moves in a direction close to the horizontal along the settler. The bottom of the sump has longitudinal gradient in the direction opposite to the movement of water. Movement of water in the sump has horizontal laminar in nature, with particles of suspended matter by gravity precipitate. Sediment accumulated at the bottom of the sump, gradually slips on a sloping bottom part of the national team, where manually removed through a specially equipped hatch. In the upper part of the settler is equipped with collecting tray, which accumulate floating pollutants having a density lower than the density of water.

The water then flows from the sump into a system of communicating vessels and into the clean water container. Treated water from the reservoir of clean water is pumped directly to the wheel wash. Then the cycle is repeated. To enable the functioning of the system during winter to t ≥ −5°C, the heating elements are installed to prevent water from freezing in the pumping unit.

Table 1

Types of sinks with plastic containers

INDEX	U rev	Cascade Mini-P	Economy Cascade-P	Standard Cascade-P	Cascade Suite-P	Premium Cascade-P	Cascade Profi Compart	Cascade Profi
installed capacity	**кW**	**1,1**	**1,1**	**1,5**	**2,2**	**2,5**	**2,5**	**7,5**
Maximum pressure pump	**atm**	**9**	**< 9**	**< 12**	**< 20**	**10 /170**	150	**200**
Dimensions: L W H	**mm**	**1250 1200 1150**	**1650 1200 1150**	**1650 1200 1150**	**1650 1200 1150**	**1650 1200 1150**	**1650 1200 1150**	**1650 1200 1150**
weight	**кg**	**160**	**220**	**220**	**220**	**220**	**500**	**220**
The volume of water in the tank	**м^3**	**1**	**1.5**	**1.5**	**1.5**	**1.5**	**5**	**1.5**
Number of pistols	**pcs**	**1**	**1**	**2**	**2**	**2**	2	**2**
Throughput of machines	**pcs**	**6**	**6**	**10-12**	**15**	**до 20**	до 25	**30**
Cost	**rubles**	**80 000**	**100 000**	**110 000**	**120 000**	**135 000**	135 000	**155 000**

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THE POSSIBILITY OF USING ROTATIONAL MOLDING MACHINERY DURING MINING PROSPECTING OPERATIONS

Grzhibovsky D.
bukvitsa@mail.ru, «EkoProm» Ltd., Moscow, Russia

The efficiency role of technological support of prospecting operations, drilling, and mining exploration increases in the conditions of intensive work by geological exploration crews and expeditions, with time and weather conditions limits. If computerization allows increasing mainly of computing and controlling components, the timely technical maintenance, replacement of equipment, and spare parts supplies are the second major components of the technological success. At the same time, it makes more rational sense to manufacture the rapidly wearing and spare parts on the premises of the technical base of the expedition or sufficiently large base. This gives the efficiency and independence from the transport's connectivity with the factories and suppliers; and also allows to make the necessary adjustments and changes to the manufactured items configuration and to develop the new design schemes. It is important to have prompt and year-round technological support of exploration operations that is ready to respond to the rapidly changing geological conditions.

There is a great need for different containers to store drinking and technical water, electrolytes, waste oil, POL, fuel, etc., for the processes of exploration, extraction, and enrichment. Due to the harsh climate conditions and intensive use, these containers quickly wear out. Rotational molding allows to produce plastic products with the volume of up to 25 m^3 and the wall thickness of up to 20 mm, which provides the necessary products' durability. During the plastic containers manufacture, the special importance is to maintain the sufficient wall thickness, the absence of internal stresses within the product, and the absence of polymerized polyethylene orientation. Rotational molding products can have the embedded insets and elements made out of other materials. The final plastic products are seamless, do not change its characteristics under the UV light, and can be used at wide range of ambient temperatures without losing its properties over time. To provide the desired properties to the plastic items, the various heat and light stabilizers, pigments, antistatic additives, flame extinguishers, and foaming agents are added to the raw material. Usage of thermo insulated fillings and food polyethylene is possible for the production of the multilayer products.

The production process consists of four phases:

1. Polymer loading into the mold. The required amount of powdered polyethylene is poured into the rotational mold (roto mold) – metal hollow structure consisting of two, less of 3 or more parts, and the mold is hermetically sealed.

2. Rotational molding of the product. The rotational mold is placed in a heating chamber, where the heating is performed while the roto mold revolves in two planes with up to 20 rpm. Heating is carried out using the electric heaters or gas combustion. The maximum mold heating temperature is up to 400°C. The polyethylene is melted and evenly distributed over the mold's walls. Because rotational molding occurs at normal atmospheric pressure, the roto mold has thin walls made out of steel or aluminum. Aluminum is used to manufacture the complex products. The roto mold could be made within a few days. The maximum size of the manufactured product is determined by the size of the heating chamber.

3. Rotational mold cooling. The mold is cooled using air or water mist. At the same time, the revolution of the roto mold is not stopped to ensure the uniform polyethylene hardening, thus continuing the rotation till the complete solidification of the polymer.

4. Extracting of the product. The mold is opened and the finished product is removed from the mold.

With all the advantages of containers, tanks, and products made by the rotational molding (lightness, resistance to aggressive environments, durability, etc.,), there is one drawback – quite high cost of transportation from the factory to the consumer. In these circumstances, the effect of "air transportation" is triggered: the dimensions of some products are very large; and for the transportation of several dozen products, the railway car is needed.

It is proposed to manufacture the necessary products by the rotational molding method "on the spot" – installing the rotational molding machine directly at the technical base of exploration or mining company (expedition, mine, coal pit, quarry, etc.,). Also it is possible to produce the mobile rotational molding units for manufacturing of the items with the volume of up to 3000 L.

Characteristics of the mobile unit: weight 1500 kg; assembled dimensions: length 3 m, width 3 m, height 4 m; electricity consumption – 5 kW/h. This unit is mounted in 5-6 hours and operated by two workers.

Mobile Roto

Molding Unit Houseboat

Filling Station

Thus promptly on the spot, it will be possible to produce the necessary number of containers, tanks, and other special products of diverse shapes, substantially reducing the cost of their transportation.

These are the possible examples of the rotational molding products usage in mining exploration:

1. Containers for drinking and technical water
2. Containers for drilling fluids and electrolytes
3. Containers for fuels and lubricants
4. Mobile refueling stations
5. Storage boxes for core and rock samples
6. Easily mounted reusable temporary pavements
7. Plastic panels and decks for prefabricated houses
8. Shower and toilet cabins
9. Sealed trunks for laboratory equipment
10. Pontoon systems including floating homes
11. Flushing trays
12. Equipment and containers for ore enrichment
13. Storage containers for pressurized water
14. Parts for wastewater treatment systems and sanitation
15. Sediment containers of different shapes

In conclusion, we mention one more very interesting and important ecological and technological feature of the rotational molding that is important for the conservation of the environment at mining and exploration operations. Rotational molding belongs to virtually waste-free technology and can process unnecessary items into the feedstock, and then to use it again for the production of other types of products.

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S-XI

DRILLING TECHNOLOGY AND ENGINEERING

IMPROVING THE DRILL BIT DESIGN CONSIDERING THE TEMPERATURE FACTOR WHEN DRILLING PERMAFROST

Yakovlev Boris V., Skryabin Reva M., Timofeev Nikolai G.
yakutsk_09@mail.ru, Federal State Autonomous Educational Institution of Higher Professional Education "M.K. Ammosov North-Eastern Federal University", Yakutsk, Russian Federation

Successful worn auger drilling becomes possible only when the compatibility between the intensity of rock destruction on the bottom of borehole and transportation of disintegrated rock to the surface is achieved.

The destruction efficiency of frozen rocks on the bottom of borehole and the cleaning mode of the bottomhole zone from the drilling stuff directly depends on the type and design of the rock drilling tool [1].

Experimental studies on selection of drill bit (three-and two-bladed) indicate significant effects on the drilling process temperature factor of frozen rocks, namely, the defrost and frost processes of disintegrated rock in the drilling tool, derived from the work of the rock cutting tool at the bottom of borehole.

During the rock cutting using a tool with an angular velocity, its cutting surface is heated. When some part of frictional work goes to heat the surface of drill bit Q, the other part of frictional work goes to cut the rock A_a. If the work of frictional forces completely transformed only into heat, then there would be a linear dependence of the temperature distribution on the surface of the drill bit. It means that the temperature of the working surface, beginning with a certain value in the central space of the drill bit would monotonically increase with the distance when moving to peripheral space. Consideration of the rock cutting part work of the frictional force leads to a nonmonotonic dependence of the temperature distribution along the radius of the working surface, namely, the temperature distribution has a maximum between the center and the periphery of the drill bit. This is due to the work for cutting rock increases in proportion to the square on the peripheral part of the drill bit.

The work when cutting is directly proportional to the amount of disintegrated rock.

The coefficient of friction is defined as the ratio of the amount of the disintegrated rock on the work expended $a = \Delta V / \Delta A$ [2].

Thus, for the elementary work of frictional force are expressions:

$$dA = F_{tr} dl = dQ + A_a = dQ + \frac{1}{a} dV \,, \tag{1}$$

where dl – is the displacement of the cutter during the time dt, dQ – is the heat released when friction, $\frac{dV}{a}$ – is the work spent on crushing (abrasion) rock is proportional to the amount of disintegrated rock, a – is the proportionality coefficient.

For solving that problem we have the following approximation: since the main work surface is the surface of the cutter, we will consider only the heat that stands out in the scope of the cutter, and neglect the amount of the heat leaving with destructed rock. Equation (2.1) is divided by dt and we have the following

$$mc \frac{dT}{dt} = \mu N \frac{dl}{dt} - \frac{h_e r^2}{a} \frac{d\varphi}{dt} \,, \tag{2}$$

where μ – is the friction coefficient, N – is the force of normal pressure, it is approximately F_0, h_e – effective cutting depth, r – is the distance from the center of the working surface of the drill bit to the cutter, m – is the mass of the cutter, c – its specific heat.

$\upsilon = \frac{dl}{dt}$ – is the linear speed of the cutter, which is $\upsilon = \omega r$,, где $\omega = \frac{d\varphi}{dt}$ – is the angular velocity of the drill bit.

Supplying the value of the linear velocity and angular velocity in (2) we get:

$$mc\frac{dT}{dr}\omega r=\mu N\omega r-\frac{h_e}{a}r^2\omega. \tag{3}$$

That is an ordinary linear differential equation of the first order with respect to $T(r)$. Integrating equation (3),

$$\int dT=\int\frac{\mu N}{mC}dr-\int\frac{h_e}{mCa}rdr.$$

The resulting temperature distribution on the working surface

$$T(r)=\frac{\mu N}{mC}r-\frac{h_e}{2mCa}r^2+const. \tag{4}$$

The constant of integration is determined from the boundary conditions. For example, in the middle part of a drill bit the temperature has a certain negative value, etc.

Figure 1 shows a temperature distribution according to (4) along the work surface depending on the radius of the cutters location $T = f(r)$ (solid line) for the given parameter values. The dashed line shows a linear distribution, which does not take into account the work required to the rock disintegration.

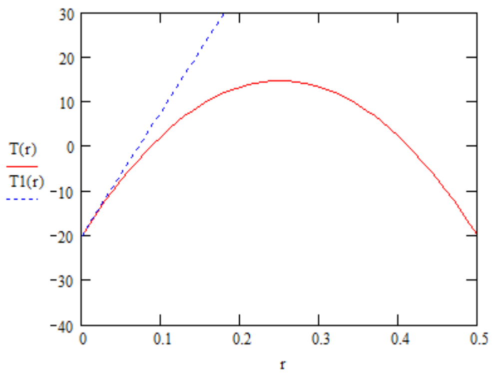

Fig. 1. Dependence of produced heat on the radius of cutters location $T=f(r)$

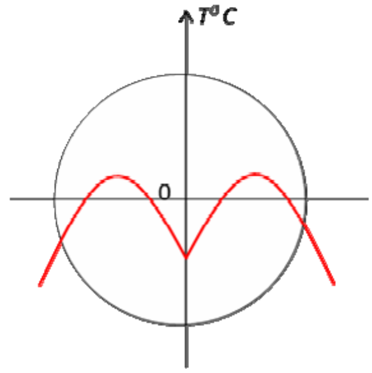

Fig. 2. Formation of maximum temperature in the bit

As can be seen from Fig. 1 the maximum temperature falls in the space between the center and the periphery of the rock cutting tool (Fig. 2).

In this space, a positive formed temperature intensifies the permafrost thawing during the cutting, which with subsequent freezing and freezing to the surface of the bit and borehole walls result in lower performance of the rock cutting tool and a worn auger conveyor.

In the space of the working surface of the rock cutting tool with maximum positive temperature, the reduction of temperature can be achieved by switching to less energy-intensive methods of rock crushing by constructing a special two-bladed rock cutting tool, in which the cutters on the blades are located at the same row with different heights, with the cutters of one series of concentric circles with rotation pass between the cutters of the second number, in this case the bulk destruction of frozen rocks on the bottom with minimal allocated temperature is provided.

Step location and different working angles of the cutters that have improved design of a two-bladed drill bit during drilling will ensure the effective bulk destruction of frozen rocks with the lowest process of heat generation. The rapid elimination of the central cutter allows to increase the mechanical speed V_{Mech} by eliminating the effect of the central reference point along the axis of the bit with zero circumferential speed $v = 0$.

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METHODOLOGY FOR CALCULATING OF SPATIAL CURVED DRILL PIPES STRING DEFORMATION UNDER ACTION OF BASIC LOAD

Yuri A. Arsent'ev, Alexander P. Nazarov
arsentev1956@yandex.ru, alexpnazarov@yandex.ru, Federal State Budgetary Educational Institution of Higher Professional Education 'Russian State Geological Prospecting University named after Sergo Ordjonikidze'

Research of drill pipe string deformation during the drilling is of great importance when calculating the durability/strength of drill pipes and their threaded coupling, estimating the power outlays during the drilling process, designing the assembly of drilling string bottom to perform drilling by computed track.

Many authors studied the problem of drill pipe string deformation [1, 4-8]. Drill pipe string was considered as elastic ponderable pivot of circular cross-section which length is much more than its diameter, and deformation is limited by borehole walls. Research objective was, first of all, the study of drill pipe string deformation from borehole bottom to the first point of the assembly of drilling string bottom contact with borehole walls, which determines a probably characteristics of borehole deviation. Deformation of this borehole part was considered as in-plane bending of elastic pivot which lost its stability.

The exact deformation figure of the lower part of drill pipe string is impossible without regard to deformation of upper part. Whether the value of axial load upon the borehole bottom is less than a weight of drill pipe string, drill pipe string includes both stretched and compressed parts. There are different models of elastic equilibrium of axes of the stretched and compressed parts of drill pipe string during their operations in the borehole:

– stretched part doesn't lose its stability and compressed part has a shape of plane sinusoid [4];
– stretched part don't lose its stability and compressed part obtains a shape of helix line [1];
– stretched part has a sinusoidal shape and compressed part obtains a shape of helix line [7].

Following basic loads have an effect on drill pipe string during the drilling:

– linear stretching and compressing forces;
– weight of drill pipe string;
– bottom reaction;
– rotative moment;
– frictional force between drill pipe string and borehole walls;
– centrifugal forces;
– borehole walls reaction.

Let's have a look at the correlation of these forces during the rotary drilling of vertical wells. The influence of centrifugal forces and walls reaction, first of all, determines the friction force value while the rotation of drill pipe string in space-limited environment. In stretched part, rotative moment and, less, stretching force are basic loads. Pivot of circular cross-section which length is much more than its diameter, loses its straight stability position and curls into some kind of spatial curve.

As a result of power loss due to the friction between drill pipe string and borehole walls in compressed part, compressing force and, less, rotative moment are basic loads. As a result of stability loss under the action of these loads, drill pipe string axis assumes a shape of screw line with variable pitch [1, 6, 7].

<u>Conclusion</u>. Drill pipe string axis during vertical drilling always assumes a shape of screw line with variable pitch.

This conclusion proves out both by basic researches and factual wear of smooth-bore drill pipe string throughout the length.

Initially, let's consider screw line with variable pitch as a model of drill pipe string axis. Parametric equations of screw line relating to the drill pipe string take the form of:

$$x = r\cos t,\ y = \mathrm{r}\sin t,\ z = bt, \tag{1}$$

where r = $(D - d)/2$, D is borehole diameter; d is drill pipes diameter, t is torsion angle of screw line in relation to borehole axis, $b = l/\pi$, l, is half step of screw line where $t = \pi$.

In this case screw line curvature determines from the formula [3]:

$$K = \frac{r}{r^2 + b^2}. \tag{2}$$

Taking into consideration that $r^2 << b^2$, equation [2] with the prevention of low accuracy can be written as: $K = \dfrac{r}{b^2}$

In accordance with the differential equation of curved axis of pivot, its curvature is [8]:

$$K = \frac{M}{EI}, \tag{3}$$

where M is bending moment caused by load, E is modulus of elasticity, I is moment of inertia of a cross section.

Let's examine drill pipe string deformation under the action of following basic loads: linear compressing force P, rotative moment $M_{кр}$, frictional force F.

Bending moment M_p in drill pipes section at their deviation from borehole axis under the action of force P by value r equals:

$$M_p = Pr. \tag{4}$$

Bending moment M_M, arising under the action of rotative moment $M_{кр}$ equals:

$$M_M = M_{кр}\frac{r}{b}. \tag{5}$$

Bending moment M_F, arising under the action of frictional force F equals:

$$M_F = F\frac{r}{b}. \tag{6}$$

Let us solve the equation system (1) – (6) in relation to the value of half step of a screw line, taking into account a principle of force action independence:

$$l = \pi\frac{-\left(M_{кр} + F\right) + \sqrt{\left(M_{кр} + F\right)^2 + 4EIP}}{2P}. \tag{7}$$

Given formula allows to determine a deformation of spatial curved drill pipe string which is under the combined action of basic loads.

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RHEOLOGICAL MODEL OF A POLYMER DRILLING FLUIDS

Solov'ev N.V., Kurbanov Kh.N.
khkurbanov@gmail.com, Russian State Geological Prospecting University Sergo Ordzhonikidze (MGRI-RGGRU) Moscow, The Russian Federation

The most widely used currently drilling fluids are fluids containing dispersed phase. As with conventional fluids, they have a mobility, i.e. ability to flow. In this case, the original location of the particles of the fluid changes, the deformation. The science of deformation and flow of bodies called rheology and properties of bodies associated with the flow and deformation, called rheology. They are characterized by certain values that do not depend on the conditions of measurement and instrumentation design. These values are called rheological constants.

The rheological properties of the drilling fluid are important in drilling. Unsatisfactory rheological properties can lead to the formation of traffic jams in the wellbore, clogging mud bottom zone of the trunk, lower penetration rates, the erosion of the walls of the barrel, stuck pipe, fluid loss, and even release.

Power law model provides a more accurate approximation to the real mud, even in the calculations based on the speed of 300 and 600 r/min. Since this model also applies to the area in the annulus (where the relative shear rate is usually less than 170 s-1, which corresponds to rotation speed of the rotor of the viscometer 100 rev / min.), it provides a much more accurate in predicting the behavior of the fluid.

This is especially true for small pseudoplastic liquids having a solids content which is currently used as working fluids for drilling wells.

Rheogram pseudoplastic fluid passes through the origin and is convex to the axis of the tangential shear stress. The viscosity of such a liquid with increasing shear rate decreases. This demonstrates the effect of "shear thinning", which is characterized by a decrease in strength of interaction of the solid phase particles, macromolecular polymers with molecules of a dispersion medium with increasing shear rate. This is beneficial for reducing the viscosity of polymer plastic with mud after rinsing of the channels and hole at the bottom hole of the rock cutting operation of the tool., Which may decrease until the viscosity of the dispersion medium. For such a solution in the annulus between the well walls and drill pipes accompanied by a significant decrease in shear rate which leads to increased viscosity of the solution and a significant improvement in the ability of efferent providing efficient particle transport cuttings along the wellbore.

Today the market is filled with polymer drilling chemicals, both domestic and foreign production. Many of these reagents have not been studied extensively, which hinders their use, particularly because of the lack of information on their influence on the rheological characteristics of polymer muds. The rheological properties of drilling fluids substantially affect the efficiency of particle removal of cuttings from the bottom as well as from the annulus while drilling, as well as the magnitude of hydrodynamic pressure in the wellbore. Cuttings removal efficiency in the wellbore is determined by the plastic viscosity and dynamic shear stress of the polymer circulating mud. In addition, significant complications arise due to the hydrodynamic flow impact burovgo solution to the borehole wall and the magnitude of this effect depends on the hydrodynamic pressure determined rheological parameters.

In foreign practice widely used rotary viscometers OFITE-800 (USA) and others.

Domestic enterprises LLC "ZIP-Magnitonika" produces a rotational viscometer ZM-1001, with which you can conduct a direct report of the effective viscosity of the polymer mud.

For processing the results of measurements, as a rule, the model of Ostwald-de Waal describes the degree of dependence on the shear magnitude of the tangential shear stress.

$$\tau = K\,(dv/dr)^n, \qquad (1)$$

where: τ – shear stress;

K – indicator of consistency;

dv/dr – shear rate; n – index nonlinearity.

Constant (n) determines the degree of deviation of the rheological properties of the fluid under consideration Newtonian fluids in a certain range of shear rates.

Consistency index (K) characterizes the viscosity of the system at low shear rates relative. Image "K" leads to an increase in effective viscosity annulus increasing the efficiency of the removal of rock borehole.

Comparisons of the models Ostwald-de Waal and Newton number of researchers to obtain the relation:

$$\mu_{\text{ef}} = K\,(\mathrm{d}v/\mathrm{d}r)^{n-1} \qquad (2)$$

where: μ_{ef} – effective viscosity;

The values of shear rate on the test instrument conforms to the corresponding device OFITE-800, which simplifies the procedure of processing the results.

As a result of the settlement of the rheological parameters based on measurements using the device ZM-1001, found that the measurement values by reference to the value of the effective viscosity of the calculated values for the above given formula.

However, studies of more complex drilling fluid formulations and in particular to the presence of the solid phase, must be accompanied by the adjustment of the model or any other rheological models need to account for the interaction of solid particles with polymer macromolecules dispersion medium such systems.

Because of their non-Newtonian viscosity muds nature varies with shear rate. Therefore viscosity mud measurements are valid only at shear rates at which they are removed.

Method for measuring the rheological properties of drilling fluids is to measure the shear stress in the controlling media situated between the outer cylinder and the rotating measuring element associated with the torsion coil spring.

We used the following reagents for the study: Flo-Trol – used for any fluid loss drilling fluids based on water. Unlike PAC, CMC and starch groups other reactants does not affect the shear buro¬voy. Biorazlozhim. "Osnopak" is a high viscosity polyanionic cellulose (PAC) with high molecular weight. "Osnopak" is intended to stabilize and control of structural and mechanical and filtration properties of any systems of drilling fluids, water-based with any degree of mineralization and polymer-biopolymer. "Osnopak" is used as polymer additives to regulate the rheological and filtration properties of drilling fluids. "Osnopak" is effective in freshwater drilling fluids and solutions of a high degree of mineralization. "Osnopak" clay-free drilling fluid imparts optimal structural and rheological properties, viscosity, and efficiently adjusts a filtration in solutions with low solids content. "Osnopak 'has a high degree of resistance to monovalent and polyvalent salts. Effective as a clay, and a clay-free fluids. "Osnopak" inhibits the hydrophilic clay. Encapsulating properties "Osnopak" provide stabilization wellbore during drilling in shales and help to reduce the solids content of the drilling fluid. "Xanthan gum" – highly pure xanthan biopolymer of high molecular weight. Used as a structurant for aqueous drilling muds based both fresh and highly mineralized. Drilling fluids based on biopolymer "Xanthan gum" effectively other types of drilling fluids provide removal of sludge to the surface of the horizontal and directional wells sites. "Xanthan gum" imparts thixotropic solutions – the ability to flow with minimal resistance at high shear to form an elastic gel at low flow velocities. Perfect as a main component of builder in inhibiting drilling fluids, water-based completion fluids. especially when drilling deviated and horizontal sections of wells. Adjusts the rheology (plastic viscosity, CSN, SNA) drilling fluids, gives them a high retention and enduring ability. Does not lose effectiveness in silnomineralizovannyh muds with significant wild "rigidity". The same applies maloglinistyh muds. "Xanthan gum" has an inhibitory effect on reactive clay deposits due to encapsulation.

ASSESSMENT OF THE PROSPECTS OF SHALE GAS

Naumova J.M.
iuliia.naumova@gmail.com, Russian State Geological Prospecting University n.a. Sergo Ordzhonikidze (MGRI-RGGRU), Moscow, Russian Federation

Currently, there is a depletion of the resource-base of many traditional oil and gas basins, which gave a significant part of the production of hydrocarbons in the world. With the existing resource-based security of gas consumption level of production capacities is about 58 years [1]. In these conditions it is very topical issue of exploring innovative deposits of natural gas, which, in particular, shale gas.

Shale gas is found on all continents, so almost any volatile country can itself provide the necessary energy source. US Energy Information Administration (EIA) in 2013 issued a fresh assessment of technically recoverable shale gas reserves, covering most of the oil-producing countries. According to new data, the total world reserves of shale gas are estimated at 206 trillion cubic meters. China leads with 32 trillion cu m, after which housed Argentina (23 trillion cu m) and Algeria with 20 trillion cu m. The United States is in fourth place with 19 trillion cu m, Russia – ninth 8 trillion cu m. Ukraine is the third largest in Europe (excluding Russia as its main reserves are in Asia) and the thirteenth in the world in deposits of shale gas. They are estimated at 3.6 trillion cu m. Among the European countries have large reserves of only France (3.8 trillion cu m) and Poland (4.2 trillion) [2]. At the same time, the EIA warns that the estimates are "about" character.

The main method of shale gas development is the use of technology drilling with a horizontal combined with hydraulic fracturing. The specificity of gas production from low-permeability shale differs significantly from traditional gas production. Production wells drilled initially give high flow of gas that falls in a year to 55-85%. After three years of operation shale wells provide an average of about 14% of the initial flow rate [3]. Rapid loss of productivity of wells requires constant drilling of new wells, which allow maintaining production at a high level. Recently, however, the mass use of the fan and multiple drilling, as well as re-fracturing, which improves the productivity of wells, providing high gas recovery.

Recent years have enriched the practice of shale gas production with new technological advances:

– drilling multiple horizontal holes and multiple drilling, this significantly reduces the load on the surface while maintaining high production volumes;

– reducing the cost of automation;

– optimization of compression;

– experimental use of 4D seismic on the background of widespread use of 2D and 3D-seismic and micro seismic;

– geosteering technology of horizontal drilling, when in real time operator "sees" the optimum drilling direction in a thin layer and a shale fracturing;

– carrying out re-fracturing resuscitation wells that could be the basis for the second wave of production at the already developed areas;

– a pilot application of a mixture of gases fracturing.

The advantages of shale gas production in contrast to the largest traditional fields – proximity to the centers of consumption. But the same factor imposes additional restrictions on ecology. Shale gas production is facing severe environmental constraints due to the large coverage areas and a large and intense compromising the integrity of the bowels. Among the main environmental problems are the following: groundwater contamination, seismic risks, surface water and soil pollution.

Since the direct pollution of underground sources of drinking water through the cracks formed as a result of fracturing require dissemination of fracturing fluid through hundreds of meters up the boundaries of the target formation through the many layers of other breeds, such contamination is highly unlikely. Virtually the only way to contamination of underground sources of drinking water can be a bad cementing casing annulus. With proper insulation wells risk of groundwater contamination as a result of the development of shale gas can be minimized.

Since the composition of fracturing fluids in each case is individual composition of chemicals and these substances can be dangerous at a sufficient concentration, regulators and health professionals need to perform testing of water and soil. To reduce the environmental risks must be carried out research on more friendly fracturing fluids. For storage and cleaning liquids must use closed tanks at a constant check all connections for tightness and integrity of the tanks themselves to avoid spills of hazardous substances on the surface of the earth.

One important issue is to study the impact of hydraulic fracturing on the occurrence of seismic activity and various types of landslides. To conduct frequent operations fracturing and shale ability to easily split into separate plates, man-made disasters can occur at the surface. However, due to seismic modeling, which takes place before drilling each hole, you can predict seismic activity after the fracture and to minimize the risk of an earthquake.

Gas emissions in Pennsylvania and West Virginia during drilling operations on the Marcellus shale gas shows the environmental problems associated with drilling in the area of high pressure and injection pressure fracturing fluids. Thus, Pennsylvania gas ejection occurred because there was no blowout preventer is designed for such high pressures. In West Virginia, according to experts, they are faced with a pocket of methane in an abandoned coal mine at a depth of about 300 m, and the blowout preventer had not yet been established. Such disasters emphasize the need for a high level of professionalism of workers, even in cases of force majeure.

Because of the large number of different chemicals at drilling sites and a large quantity of solid and liquid waste produced in the drilling process, considerable attention must be paid to the fact that these substances do not pollute the surface water and ground during transport, storage and disposal.

Since September 2010, the disclosure requirements of chemicals for hydraulic fracturing adopted in 17 states in the USA. Nine states require analysis of groundwater. At some production equipment must be installed emission control devices. On ongoing basis regulators require companies to provide an installation report casing and cementing of the geotechnical conditions of the sources and utilization of fracturing fluid, as well as the burst pressure; monthly reports on the extracted gas, water and gas flaring.

Summarizing the above, it should be noted that most of the environmental problems that arise in the course of prospecting, exploration and development of shale gas, can be solved by improving the technology of shale gas, and also due to tighter control of drilling and gas production that will affect both on the cost of production.

A short story from the beginning of shale gas production, fragmentary statistics accumulated only in the USA make it difficult to assess the long-term prospects for this new energy source worldwide. But it is clear that this is a very contradictory phenomenon, so the development of shale gas is suitable only if the obvious advantages outweigh the impressive number of environmental threats and risks, as well as commensurate with the high cost of production.

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S-XII

GEOETHICS, GEO-ECOLOGY AND ENVIRONMENTAL PROTECTION

NATURAL FILTERS OF WATER RESERVOIRS OF LANDSCAPE RESERVE "TEPLIY STAN"

[1]Guseinov, A.N., [1]Mazaev A.V., [2]Duran Kala
amirnurgus@mail.ru, antonmazaev@yandex.ru, duran.kala@ishik.edu.iq, [1]Russian state geological prospecting University named after Sergo Ordzhonikidze, Moscow, Russia;
[2]University Ishik, Erbil, Iraq

The aim of this work is to study the role of soils in the catchment area surrounding the reservoirs of the landscape reserve "Tepliy Stan" and bottom sediments of ponds reserve in determining their ecological status.

As objects of research were examined the ponds which located (the largest among all pond "Centralniy") in the recreational area (vacation area "Troparevo") of landscape reserve "Tepliy Stan".

The catchment area of the studied reservoirs cover the entire territory of the reserve. In regard with the intended purpose in territory of reserves with application of physical-geographical, geomorphological, soil related, cartographic methods a number of interrelated and complementary studies were made:

- soil slices were laid, morphological description of soil profiles were produced with their subsequent diagnosis and selection of soil samples, soil map of the landscape reserve "Tepliy Stan" was prepared;
- recreated and disturbed soils which is under campfire and accumulations of waste in catchment areas were studied, where there is a potential danger not only to mechanical disturbance of the natural structure of the soil profile, but also chemical contamination of soil thickness products which were decomposed in domestic waste;
- visual erosion survey was conducted, as a result a schematic map of soil erosion of the reserve was created;
- samples of soil, water and sediment reservoirs for laboratory analyses were taken.

In Laboratory work included:

- collection of literature and Internet materials on the geological constructions, the history of geological development, physico-geographic and ecological characteristics in the field of catchment of reserve`s reservoirs.
- preparation of soil samples, water and sediment for laboratory studies and laboratory analysis;
- systematization of data, geochemical interpretation of laboratory tests and reporting acquired results, which show the importance of soil and sediment in determination of the ecological status reservoirs of landscape reserve "Tepliy Stan".

At the present time part of the landscape reserve "Tepliy Stan" is a major recreation area (vacation area "Troparevo"). Vacation area geographically covers the valley of the river Ochakovo in its middle course, built on this river and on its tributaries artificial reservoirs – ponds. The largest pond (area of about 2.5 ha) – "Centralniy" – more than 250 years [1, 2, 3].

The natural beauty of landscapes, livability of vacation areas, entertainment places for children, boat station and the beach on the shore of the pond, also the vicinity to residential buildings, has led to a high level of attendance at vacation areas.

Mass attendance leads to the activation of geological and engineering-geological processes, which are particularly bad impact on the ecological status of reservoirs as transporters and end points of mechanical and chemical migration of contaminants.

The first law of Barry Commoner "everything is connected to everything", which reflects the existence of a complex network of interactions in the ecosphere, should be adopted as the slogan of our research. We believe that the ecological status of landscape reserve "Tepliy Stan" reservoirs cannot be studied in isolation from the ecological status of the catchment area of these reservoirs.

The catchment area is the area from which the waters of the landscape reserve "collect" their water. The ecological status of reservoirs the most heavily influenced by soils and subsoil of the catchment area, because surface water and groundwater, before getting into the supply reservoirs pass through a long way and filtered through the subsoil and soils.

Part of the substances blocked on the filtration through the soil and subsoil, and some, on the contrary, dissolving in water into small parts of soils and subsoil, get into reservoirs and sediments of these reservoirs. Sediments in certain conditions can be secondary or additional sources of water pollution and therefore they are often called "time bomb" [4, 5].

Assessing the environmental status of the waters of the river Ochakovo and pond "Centralniy" showed that the river Ochakovo flowing through the territory of the landscape reserve, experiencing pollution because of discharges from the territory of vacation area by surface flush during rains and snow melt.

The composition of the water in the pond "Centralniy" is well correlated with the results of analyses of surface water river Ochakovsky and its tributaries within the examined territory. Observations, which were made at the station, located at river Ochakovka at the "entrance" to its manifold in Akademik Bakulev street on the northern border of the reserve, allow to assess the level of impact on surface water of reserve. For example, HPK is equal to 43.2 PDK equal 30.0, the content of soluble iron salts is 0.5 mg/l at PDK 0.3 mg/L.

The most significant and constant water supply of the river Ochakovsky, pond "Centralniy" is the spruit beginning with a rill «Kholodniy». The comparison of the analysis results of the rill water with the composition of the groundwater reserve shows that water in the spring is much dirty in comparison to the background of the groundwater.

The main pollution noted chloride (10 times), sulfate (4 times), and nitrogen oxides. Thus, water features of landscape reserve "Tepliy Stan" and soil of their catchment areas are closely related surface and subsurface mechanical and chemical migration flows and consist of interrelated subsystems of the unified natural system.

As subsystems of a single system, the ecological condition of reservoirs and watercourses of landscape reserve "Tepliy Stan" is determined by the environmental health of soils. Soils of the reserve, at some point and sediments, play the role of natural mechanical and chemical filters in the paths of migration of pollutants into reservoirs.

The pollutants, for which the named natural filters are transparent, water flows of the river Ochakovsky and its tributaries, as well as subsurface migrates into water and thereby bind into a single ecological system subsystems: water – soil watersheds.

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ON THE QUESTION OF GEOECOLOGICAL STUDY OF SUBSOIL FOR DISPOSAL OF INDUSTRIAL WASTES AND ASSOCIATED WATERS IN UZBEKISTAN

Adilova M.A. Tulyaganov B.I.
muharrama@mail.ru, SE "Institute GIDROINGEO", Tashkent, Uzbekistan

Exploration and development of oil and gas fields, both worldwide and in Uzbekistan, operation processing plants, chemical and other industries associated with the formation of industrial waste and sewage produced in the gas, oil, hydrocarbon condensate, and industrial waste waters generated as a result of various chemical and biological processes.

In order not recyclable effluent disposal in many countries is widely practiced in the underground disposal of their deep absorbing horizons. Underground disposal refers to special occasions subsoil and requires compliance with a number of special conditions. The main condition is to comply with all the requirements for deep horizons and collectors, receivers wastewater, an effective system of hydrogeological monitoring and maintenance hydrogeoecological monitoring stations selected for landfills to ensure environmental safety areas and protection of mineral resources and the environment, as well as the safety ofengineering structures.

To address the elimination of industrial wastes is the main condition for selection of sites not related to mining and the proximity of landfills to the places of their formation.

To do this, you first need to plan regional hydrogeological and geotechnical works, which revealed the use of subsoil for purposes not related to mining. As a rule, the burial of highly dangerous liquid waste, including radioactive waste, free and wastewater is held in reservoir horizons at depths of from one to several thousand meters, containing saline water with high salt concentration, amount to tens or hundreds of grams per liter, not suitable for use in anycommercial purposes.

When choosing geological structures for underground disposal of industrial effluents in absorbing aquifers is taken into account a number of known criteria (1): – Aquifer must have a high absorption capacity (pick-up) and be completely isolated from other aquifers, to avoid contamination or direct access to the surfacerunoff; – Absorbing aquifer should not contain fresh water potable purposes, balneology and industrial water. Thus, dumping is only possible in aquifers unsuitable forpractical use of saline water;

– Absorbing aquifer should be completely isolated and the area landfill, and within the entire range of hydrodynamic conditions caused by the injection of industrial effluents. Therefore, to ensure environmental safety between absorbing horizon and exploited for any purpose aquifer must be a buffer layer ofimpermeable rock.

In the second case, the storage areas for subterranean oil and gas are selected on the basis that the last divided into two types. The first type is storage in porous formations in aquifers submitted sedimentary permeable rocks, which includes storage in aquifers and storage in depleted gas, gas condensate and oil fields. The second type – the type of storage tank created by the dissolution of salt deposits or the use of underground mine workings. This includes storage in rock salt by in situ leach mine type and storage.

Today in Uzbekistan released five major hydrocarbon region (LHR): Ustyurt, Bukhara-Khiva, Southwest Hissar, Surkhandarya and Fergana. In many fieldsproduced exploration and production of hydrocarbons, which is accompanied by the formation of contaminated sewage and chemicals associated waters. In connection with this problem of waste mining and processing industry in our country is very serious. Selection of areas for waste disposal in the bowels of the earth in an arid climate, where there is a shortage of fresh drinking water and water for domestic water supply is a very important issue. Reservoir performance of collectors given us by a geological study of the Mesozoic-Cenozoic sediments to the desert region of western Uzbekistan at a group of oil and gas fields located in the area of sand Kimirakkum (2).

Earlier work established industrial gas content Callovian and Oxfordian deposits. Taking into account the recommendations of the environmental impact assessment and the results of geological and hydrogeological conditions of the sediments forming deep horizons group of fields, underground disposal of industrial water for free is possible in the lower part of the Callovian-Oxfordian deposits, which corresponds to the depths of 2400-2500 m. These sequencespresented a thick sequence of carbonate deposits, which are physical and lithological characteristics are divided into two parts. The lower part is dense clayey limestones, with permeable differences. Dark gray limestone, detrital-lumpy, recrystallized, organogenic-afonit, clay-rich organic matter, capacity from 44 to 64 m. At the top of the section consists of limestone interbedded with anhydrite and clays. Limestone gray, dolomitic, weakly silicified, with the remains oforganic matter. Dark gray clay, silt, permeable difference present in the form of narrow bands. Power pack upper ranges from 99 to128 m.

Thus, provided the disposal of industrial waste oil fields group representing carbonaceous deposits produced water, the formation of inorganic salts, it is theoretically impossible in the case of sulfuric acid treatment of the water may gypsum precipitation.

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ECOLOGICAL STATE OF SOILS IN VARIOUS GEOMORPHOLOGICAL CONDITIONS UNDER THE INFLUENCE OF CEMENT INDUSTRY

Alekseenko Alexey V., Pashkevich Mariya A.
al.vl.alekseenko@gmail.com, National Mineral Resources University (University of Mines), Russia

One of the world's largest deposits of marl is developed in Novorossiysk for the production of Portland cement. The oldest Russian cement plant operating here since 1882 is a major source of environmental pollution, producing about 4 million tons annually. Novorossiysk is a city with population over 300 thousand inhabitants. The accumulation of pollutants in the soil cover, subjected to maximum technogenic impact, was studied. Processes of elements migration and accumulation were analysed on the basis of catenary sequences with the account of urban vegetation features. Soil samples were taken from the uppermost soil horizons: layer of 0–30 cm. The soil samples were analysed for gross concentrations of 22 elements, using emission spectral analysis in certified and accredited laboratory. The monitoring study was carried out in 1992 and 2014 with detailed soil sampling in Novorossiysk city (over 1.000 samples). Control sampling was performed in the amount 3–5 % of total samples number. The inner analyses control (in a volume of 6% of the total number of samples) was conducted. Calculation of random and systematic errors showed high analyses repeatability and correctness. All ordinary analyses were carried out in the single certified and accredited Central Testing Laboratory at “Kavkazgeolsyomka”. The external control was conducted in laboratories of Southern Federal University and Institute of Ore Geology, Petrography, Mineralogy, and Geochemistry of the Russian Academy of Sciences. The results of analyses were subjected to standard statistical processing.

Dust emission is the main polluting factor of environmental impact of cement industry [1, 3, 5]. Urban soils have experienced the greatest technogenic stress in comparison with soils of the other geochemical landscapes [2]. Contamination of urban soils by discharges of mining and processing industry is determined not only by technogenic features of migration and concentration of chemical elements, but also by local natural factors: geomorphological features and vegetation associations [4]. The impact of cement plant emissions on soil geochemistry is reflected in changes of chemical elements concentrations. Novorossiysk city is located in the foothills of the North-West Caucasus on the Black Sea coast. The landscapes of Novorossiysk occupied by industrial enterprises (cement factory, seaports, railway station) and wastelands as well as residential areas were set aside. Furthermore, the landscapes were divided in three main groups according to their position in geochemical catena. They are transeluvial (steep slopes), transaccumulative (low-angle gentle slopes), and trans-superaquatic (overwater slopes). The landscapes of each position in residential areas were in one's turn divided by the specifics of districts’ buildings: single-storeyed, 2–5 storeyed and 5–10 storeyed houses. The account of urban vegetation features allowed allocating landscapes with fruit and berry plants, mixed plants, and ornamental plants (parks and public gardens).

Thus, under the combined influence of geomorphological and anthropogenic factors, the number of unevenly distributed average elements contents was found in soils of residential areas. The maximum for the entire city average elements contents was also established in these landscapes. These contents are above the average concentrations in soils of cities with a half-million population.

In soils of residential areas, subjected to the greatest impact, contents of Ag, Sn, and Mn in transeluvial landscapes are maximal for the whole considered area. At the same time, the minimum average contents in the uppermost parts of the slopes are set for 10 elements: Ag, Cu, Zn, Mo, Ti, Cr, Ga, Y, Yb, and Sc. In soils of located below landscape of residential areas (transaccumulative and trans-superaquatic) the number of elements that form the maximum mean contents has increased 6 times and reached 18: Cu, Zn, Pb, Mo, Ba, Co, Ni, Ti, V, Cr,Ga, Li, Sr, Y, Yb, Sc, Zr, and Nb.

We can explain this picture as follows: the relief features led to the fact that in soils of upper slopes parts the average contents have formed mainly due to the impact of pollutants released directly from cement plant. In soils of landscapes situated below the slope pollutants appear directly from the contamination source, as well as they migrate from the soil of slopes located above. The considered influence of urban relief forms on the formation of mean contents of elements in soils is valid for residential and industrial areas, as well as for wastelands. It was found that the nature of considered geochemical changes in soil catena depends not only on the position on a slope, but also on the type of anthropogenic impact. The changes have occurred in soils of wastelands (accumulation of Zn, Co, Ni, Mn, and V in the lower part of catena with the reducing content of Cu, Ga, and Sr), and industrial areas (accumulation of Mo and Cr, and decrease of Ag, Sn, Co, Ni, Mn, V, Cr, Y, Yb, Sc, and Zn contents). The fact that depending on the combination of these two factors, the same elements during the migration process may behave quite differently, indicates firstly their migration in various forms, and secondly shows the presence of several different geochemical barriers.

Urban vegetation is the second natural factor affecting contamination of soil in Novorossiysk city. Maximum average contents of Ag, Ba, Zn, Sn, Mo, Ni, and Cr were found in the soils of landscapes with fruit and berry vegetation compared to other landscapes. The behaviour of several chemical elements could be controlled namely by the cultivation of agricultural crops and their role in urban biological cycle. Soils under fruit and berry plants are characterised by highly increased mean concentrations of Cu, Zn, Ba, Sr, Ni, and Sc. The same process can also explain the more uniform distribution of all the elements being considered (except for Ba) in soils of landscape with fruit and berry vegetation, compared with soils of one-storeyed landscapes with any types of plants. This is evidenced by the ratio between the maximum and minimum contents in single samples. It should be added in order to explain the latter phenomenon that the areas with fruit and berry crops are mastered long ago. So that, the delivery of construction materials (and therefore the appearance of intensive spot contaminants) in them is now practically non-existent.

Conclusions

The combined effect of anthropogenic load and geomorphology leads to a significant spread (up to 4.5 times) of elements average content in soils. Even greater variation of the metal content (up to hundreds times) was found in single soil samples. The number of chemical elements with maximum average contents has significantly increased in soils of the lower parts of slopes: 6 times in wastelands and residential districts, 2 times in industrial area. This fact indicates that pollutants appear directly from the contamination source, as well as they migrate from the soil of slopes located above. It was also found the undoubted influence of biological cycle features and ways of growing plants on almost all the considered elements in soils. Soils geochemical changes occurring under the dominant influence of local natural factors are so great that they must be taken into account in establishing the reasons of particularly contaminated soil sites occurrence in the city. Taking all the mentioned factors into account, enable to correctly describe the ecological-geochemical status of settlements, and result in improvement of environmental situation.

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MODEL OF NATURAL AND TECHNICAL SYSTEMS "LLC "ALCOHOL ETHANOL" – GEOLOGICAL ENVIRONMENT (VORONEZH REGION)

Zinyukov Y.M.
zinykov209@mail.ru, Voronezh University, Voronezh, Russia

In the production process of the food industry are manufactured permitted wastewater discharges into the geological strata and water bodies for different purposes. For cleaning of contaminated water in the alcohol industry to date applied hydraulic treatment facilities – filtration fields, which leads to significant pollution of groundwater.

Questions to optimize the monitoring of this kind of natural-technical interactions are considered by the example of enterprise "Ethanol Alcohol" (Novokhopersk Voronezh region).

LLC "Ethanol Alcohol" is a food business, the end-product of which is an alcohol produced by the pharmaceutical industry and the resulting processing beet molasses. Waste processing beet molasses – bard comes with wastewater filtration fields enterprise.

Ecological status of surface water and groundwater the study area due to the long-term operation of filtration fields of "Ethanol Alcohol" which is discharged wastewater and household sewage enterprise with village Red.

Filtration fields located on the left bank of the river Savala, within the first and second floodplain terraces, 1.6 km south of the site of the enterprise, and adjacent to the north-eastern outskirts village Nekrylova. Total area of filtration fields 84,03 ga.

Geological structure of the study area is characterized by the development of the Upper alluvial (mostly sand interbedded with loam and clay) deposits and Neogene – 16-18 m (from sand to gravel at the bottom, with layers of clay in the upper part of the section) deposits with capacity of 12 m.

Groundwater is the study area are confined to the two aquifers: the first lies on the surface – Upper Aquifer and lies directly beneath it – Neogene aquifer.

The depth of the groundwater level within the influence of filtration fields 5,3-8,5 m. The movement of groundwater flow within the study area is the north-western and western direction and predetermined draining influence river Savala.

Analyzing the ecological and hydrogeological situation should be noted that in the study area groundwater observed high values of dry residue 3375,0-5712,0 mg/dm^3, are also found high concentrations of ammonium 272,0-510,0 mg/dm^3, high values of COD 944 , 8-1520,0 mg/dm^3, BOD_5 415-778 mgO_2/ dm^3, chlorides 368,7-1389,6 mg/dm^3, and some other components.

In this regard, it is necessary to identify water bodies which, being in close proximity to the object of anthropogenic influence, are potentially vulnerable to contamination – groundwater Neogene and Quaternary horizons, the Savala River water, which may occur in the natural drainage of contaminated water Neogene-Quaternary aquifer system, as well as the underlying water aquifer contamination that may occur due to the process of gravitational differentiation of matter and processes of diffusion.

Natural-technical system is represented by two subsystems. In man-made simulated NTS subsystem "filtration fields of" Ethanol Alcohol "- geological environment" includes structures (man-made objects) to be controlled because of their significance responsible for the enterprise, hydraulic treatment facilities – field filtering and network communications: pipeline bards, sewage effluents .

In the natural subsystem NTS criteria for exposure to natural objects anthropogenic impact involved in: Quaternary sediments and groundwater of the Quaternary aquifer within the loop filtration fields; Neogene sediments and groundwater Neogene aquifer within the loop filtration fields, contaminated by virtue of their close connection with hydraulic quaternary contaminated waters.

These objects are experiencing primary anthropogenic influence by virtue of their close occurrence of the earth's surface. Thus, the data objects themselves become a source of pollution for the neighboring environment.

To optimize the control of natural and technical interactions within the study area are encouraged to consider these interactions as a single natural and industrial systems [1].

At the heart of monitoring NTS "field filtering of "Ethanol Alcohol"- the natural environment" is its structural and hierarchical model [2]. Previously, monitoring work was carried out only on sites dedicated itself to the fields of filtration. Observation points are represented by eight observation wells. The recommended structure of the monitoring network is based on the method of organizing the monitoring of NTS.

Man-made objects are filtration fields enterprise "Ethanol Alcohol". Protected objects, which can be susceptible to anthropogenic influence enterprises are: the river Savala, water intakes companies "Asphalt Plant", underground water village Nekrylova and underground water village Red used to supply the local population with the help of wells and boreholes. Dedicated protected objects define the spatial boundaries of this NTS.

Following the algorithm organizing and conducting monitoring of NTS [2], we carry out an operation to determine the set of vectors and monitoring their characteristic. For the study recommended the following vectors NTS monitoring:

Vector monitoring A: "field of filtration → Nekrylova village →Savala River";

Vector monitoring B: "field of filtration → Red village→ Savala River";

Vector monitoring C: «filtration fields → water abstraction asphalt plant";

Vector monitoring D: «filtration fields → Red village."

Thus, in four major general line monitoring, which should be monitored. It should be noted that in addition to the main lines of control may occur and further, with its orientation depending on the fulfillment of specific objectives of the study. However, the stability of the system will be judged by the general monitoring of the vectors.

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ENVIRONMENTAL MONITORING OF GROUNDWATER IN THE AREA OF FILTRATION FIELDS LLC "ETHANOL ALCOHOL" (VORONEZH REGION)

Zinyukov Y.M, Korabel'nikov N.A.
zinykov209@mail.ru, Voronezh University, Voronezh, Russia

Long-term operation of water treatment plants of the food industry leads to significant man-made changes in the chemical composition of groundwater. The objects of this type include the field of filtration venture for the production of alcohol LLC "Ethanol Alcohol."

The study area is located in the district of Voronezh region Novokhopersk and timed to coincide with the left bank river Savala in villages and Red Nekrylova. Filtration fields located on the left bank of the river Savala, within the first and second of terraces, 1600 m south of the site of the enterprise and adjacent to the north-eastern outskirts of Nekrylovo. Distance to the river – 1.5 km.

The main anthropogenic impact on groundwater is related to the nature of the wastewater at the plant. Wastewater and household sewage village of Red reset filtration fields. Total area of filtration fields is 84.03 hectares.

Groundwater survey area are confined to the two aquifers: the first lies on the surface – Upper Aquifer and lies directly beneath it – Neogene aquifer.

Alluvial aquifer of Upper horizon (aIII) is confined to the deposits of terraces p. Savala. Lithological composition of deposits are interbedded with sand lenses and clay deposits. The thickness of the aquifer ranges 15-25 m. The depth of the groundwater level 5,30-13,80 m.

Upper Pliocene clastic aquifer horizon (N_2^3) is confined to the Neogene sediments. Water-bearing sands deposits are from fine to coarse and gravel in the lower range of the layer. Sands interbedded with thin layers of clay. Water pressure-free-flow horizon. The depth of the roof of the horizon of 18-22 m. The depth of the groundwater level – 5,55-13,85 m. The lower confining layer of clay are Semiluki age.

The movement of groundwater flow within the study area is north-western, western predetermined direction and draining effect of Savala. Within the area of filtration fields holds the radial spreading due to the rise in groundwater levels (due to infiltration of wastewater for the long period of operation of sewage treatment plants) and the formation of a small man-made water level rising in the horizon.

Monitor the status of groundwater is carried out by a network of observation wells (6 wells located within the fields of filtration, 2 wells – upstream groundwater fitted in pairs – on the Quaternary (odd number for the second digit) and Neogene (even-numbered) horizons.

Analyzing the hydrogeochemical situation in the area of fields filtering of "Ethanol Alcohol", it should be noted that in 2014 in the study area groundwater have high values of dry residue 4300 (well.1.1) – 6882 (well.2.4) mg/l (in 2012 year – 3375-6167 mg/l), high concentrations of ammonium 394-499 mg/l. High values oxidability marked in the summer – to 1029 mgO_2/l (well. 1.1 – August) 1251 mgO_2/l (well. 2.4 – August). In the autumn (November) decreased performance oxidizability and maximum values were 821 mgO_2/l (well. 2.3) and 833 mgO_2/l (well. 2.4). The maximum value of the index of oxidizability in wells located upstream groundwater amounted to 4.91 mgO_2/l (well. 4.8 – August).

The concentration of chlorides in the summer – up to 1310 mg / l (well 3.5) and up to 1419 mg/l (well. 1.2), the concentration of hydrocarbons in the summer – up to 7930 mg/l (well 2.3, 2.4). In general, the chloride content varies within 570-1419 mg / l, the concentration of hydrocarbons in the range – 4099-7930 mg/l. The chloride content in the background wells – 24-95 mg/l, sulphate – 46-84 mg/l (well 4.7, 4.8).

Sodium content varies within 22-780 mg/l. In the background wells sodium concentrations vary in the range of 3,7-7,5 mg/l. The concentration of sodium in 2014 decreased compared to the previous year observations. Total iron concentration up – from 1.12 mg/l (well 2.4) up to 18.35 mg/l (well 1.1).

In the background wells (upstream) also have a higher iron content – up to 5.18 mg/l (well. 4.7 – in the summer) and up to 3.07 mg/l (well. 4.7 – in the autumn). This situation may be associated with increased iron content in the background of the Neogene-Quaternary complex, and can also come from the well casings.

Indicators of total hardness varies within – 7,28-37,59 mmol/l (respectively wells. 1.1. And 1.2), with an average of – 14-16 mmol/l. In the background wells total hardness varies within 2,0-4,7 mmol/l.

Concentrations of nitrate and nitrite are insignificant and do not exceed the established limits. Mineralization technologically-modified water is formed mainly due to higher hydrocarbons and organic parameters.

In addition to the observation wells were tested enterprise wells nearby villages and water Savala River. Ground water in the village Nekrylova adjacent to the fields of filtration from the south-west side, and in the village of Red, located 600 meters north of filtration fields contaminated by nitrates. Nitrate concentrations in with. Red – 47.3 mg/dm3 – 92.5 mg/dm3, p. Nekrylova – 70.4 mg / dm3 – 73.5 mg / dm3. Also noted the excess iron general – 0.67 mg/dm3 – 137.4 mg/dm3 and slightly higher values of COD, characterizing the content of water-soluble organic compounds.

All other components meet the requirements of chemical standards, including the ammonium, the primary component of the pollutant in the area of groundwater filtration fields. Water samples from the Savala River meet the requirements of regulations.

The presence of nitrate contamination in wells settlements is a phenomenon typical of most rural communities, using shallow groundwater. Contamination of ground water flows from the territory of farmsteads (from cesspools, latrines, manure storage areas and others.), Garden. Identify contaminated wells can be characterized as a typical local phenomenon unrelated to the fields of filtration, where nitrate concentrations less than in wells. The main indicator of the lack of effect on groundwater filtration fields is a very low content of ammonium in the groundwater (wells), which in the areas of filtration fields found in very high concentrations. The only exception is a well 8K, closest to the site of filtration fields (the eastern outskirts Nekrylova). There was a slight excess of standard ratio – 2.60 mg/dm3. In the waters of the well also noted the increased value of COD to the background 122.0 mg/dm3. COD can be an indicator of the effect of filtration fields where groundwater plot their locations COD values constitute 1400-1500 mg/dm^3.

Thus, the current situation with the presence of hydrogeochemical anomalies in a number of indicators in the waters of the two horizons indicates a high anthropogenic impact on the geological environment of the territory placing filtration fields, which has developed over many years of operation and there is at the present time.

COASTAL PROCESSES AS INDICATOR OF ECOLOGICAL STATE OF THE TSIMLYANSK RESERVOIR

Golubova N.V., Nidchenko N.S.
fedulova@sfedu.ru, Southern federal university, Rostov-on-Don, Russia

The Tsimlyansk reservoir, the largest artificial reservoir in the South of Russia, is used for water supply, irrigation, navigation and fisheries. In recent years this region has experienced difficulties with water supply to population and economic objects, reduction of fish stocks, pollution of the reservoir water, the consequence of which is the intensive development of blue-green algae [5, 6].

An important issue is also the catastrophic destruction of coastal escarpments of the reservoir. The length of its coastline is 660 km, from which the Priplotinnyy ples has 30.5%; Central – 37,1%; Cherskoy – 15.3%; Kalachskiy -17,1%. Coastal terraces of the first three are composed of extremely moderately and weakly resistant rocks.

The right bank of the reservoir in its upper part is the Dono-Donetskaya lofty plain, where there are abrasion-landslide and abrasion-landslide shore [2]. In the structure of the relief of the coastal zone of the left bank, the main role is played by the first and the second terrace above the floodplain of Don associated with coast flooding. And only in the area from the village Zhukovskaya to the farm Veselyy appear abrasion-landslide, landslide-debris shore and re-slided shores.

The geological structure of the banks is constituted by rocks of Cretaceous, Paleogene and Neogene-Quaternary age [1]. This age variety results from the location of the reservoir at the junction of two major tectonic elements of the East – European Epikarelian and Scythian Epihercynian platforms, which are separated by the Dono-Astrakhan fault extending in the direction of Kotelnikovo-Novozemlianski.

The most ancient consolidated and more resistant to abrasion rocks are observed at the northern edge of the reservoir. Here, from the ledges Kalachskiy ples and to Kalach-on-Don there is continuous strip of Turonian-Coniacian limestone outcrops. To the south they are replaced by Santonian and Campanian deposits, namely limestone, pelitic limestones, sandstones and clays. Their natural outputs are traced to Cherskyy ples. Paleogene deposits of clay, sand, limestone and siliceous rocks are observed on the right Bank Kalach, Cherskoy and Priplotinnyy pleses, near the towns of the Lower Chir and Tsimlyansk. Neogene formations (clay, limestone, sands of the Lower Miocene; sands and clays of the Upper Miocene; Scythian clays) are characterized by low level of resistance to wave action and are exposed on the banks of the Priplotinnyy ples (village Zhukovskaya and town Tsimlyansk). Rocks of the Quaternary age are widespread. They are represented by clays, sands and loams.

The rocks constituting the coastal terraces are characterized by low degree of lithification that leads to the input of the abrasion material to the reservoir. The most widespread minerals composing natural sedimentary rocks are quartz, feldspars, calcite, hydromica, montmorillonite, which form the basis of the material composition of coastal formations, and rare are glauconite, ilmenite, rutile, leucoxene, zircon, monazite, chalcedony, opal, gypsum, iron hydroxides, iron sulfides pyrite and marcasite

The weighted average content of heavy metals in coastal ledges is as follows: iron – 3,73%; manganese – about 40 x 10^{-3}%; Nickel – 2x10^{-3}%; cobalt – 1x10^{-3}%; copper – 5x10^{-3}%; lead – 2x10^{-3}%; zinc – 4x10^{-3}%; titanium – 35x10^{-2}%; zirconium – 14x10^{-3}%. Coastal formations are dominated by clayey component. A comparison of the values obtained with subclarcks of clay rocks suggests a deficiency of most elements in the bedrock [7]. Exceptions are copper and lead, the concentration of which is slightly greater than the subclarck values. In relation to subclarcks, sandstone composition of coastal sediments is characterized by excessive concentrations of cobalt, copper and zinc. Carbonate rocks – limestones – have not received wide distribution. Therefore, the outputs of indigenous coastal sediments, on the one hand, are not a source contamination of the water column and bottom sediments of the reservoir with heavy metals, but, on the other hand, the rate of receipt of abrasion of material (more than 66% of the total balance of incoming sedimentary material) can't affect the ecological status of the water body as a whole.

Balance calculations indicate that the items that arrive in the solid phase are almost completely trapped in the reservoir bowl. The main portions of heavy metals come into the reservoir in mineral form, as well as absorbed complexes on the substance of river sediment and products coastal abrasion. The addition of elements in the water column in the liquid phase is not significant.

The most intense erosion is exposed on the left bank. Here in the shores of recession, folded easily-eroded Neogene-Quaternary rocks, marked by the length of the sections siltstone-clayey and clayey sediments. This leads to further silting of waterways and large bays used for sheltering vessels. Such processes are observed in the bays Kurmoyarsk, Krasnoyarsk, in the mouth of the Karpovka, Donskaya Tsaritsa, as well as in the central parts of the pleses.

The intensity of the advancing edge of the natural left bank of the reservoir during 2008 ranged from 1.55 m to 8.22 m, of the right bank – 1,14 m [3]. The maximum value of the advance edge was observed in the farm Veselyy. A difficult situation was observed in the farm Ovchinnikov, where abrasion shores are close to private households. Here the speed of processing of the bank amounted to more than 1.0 m/year [4]. Nowadays, the processes of destruction of the coast ongo [5,6]

Thus, the morphological characteristics of the area and the lithological composition of the coastal formations are responsible for input of significant amount of abrasion material to the Tsimlyansk reservoir. This can lead to silting of bays and waterways and have a negative impact on the overall operation of the reservoir and its ecological state. To improve ecological situation in the catchment area and within the waters of the reservoir, effective activities are primarily localization of different drains, protection and strengthening of banks.

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STUDY OF MINOR RIVERS IN MOSCOW ON THE EXAMPLE KONKOVSKIY STREAM

Zharkova K.N.
Supervisor: senior lecturer **Savushkina E.Y.**
zharkova29@ya.ru, Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze
MGRI-RSGPU, Moscow, Russia

Urban growth leads to hyper concentration of people, goods and services, development of infrastructure leads to environmental degradation, health, degradation and extinction of many species of animals, the emergence and activation dangerous geological processes. An important component of the urban area suffering from urban influence are green areas, small rivers and inhabiting them insects, birds and animals. Vegetation and water objects provide comfortable living conditions of people in the city to regulate the gas air composition and the extent to pollution, climatic characteristics of urban areas, reduce the noise factor and are the object of aesthetic perception. Minor rivers affect the quantity and quality of the total surface flow, affecting the environment of larger rivers.

Study of the influence of a growing city on the state of small rivers were conducted, the types of anthropogenic impact on minor rivers of Moscow and consequences of this impact are described, and the features of the hydrographic network on the territory of Moscow considered. For analysis of anthropogenic factors history of small rivers of Moscow examined data on water construction of Moscow examined, the quantitative changes of the rivers from the period of the mid-twentieth century to the present is traced.

Anthropogenic impact on urban rivers began more than two hundred years ago, since then a large number of watercourses dry, was filled or hidden. Boundaries of Moscow has recently been others, so studying the number of rivers in different centuries or decades, it is necessary to take into account the size of the city. In 1950 in Moscow there were 120 watercourses with a total length of about 200 km. Provided that the area of Moscow in the middle of XX century was about 350 km^2, it is possible to determine the density of the river network. It was equal to 0.57 km / km^2. Density of a river network of open channels, respectively, was less. Now most of the small rivers of Moscow are underground. Some of them are hidden in the tube, some – for different reasons completely backfilled. At the same time, there are rivers and streams that exist in the open stream – as part flowing through the ponds and in full – in a natural way. Many minor rivers are the "mixed" type – are enclosed in the collector flow, in ponds and flow in a natural way. There are combinations of two or three types of transmission channel. This is reflected on the screen as small rivers, and the quality of the water in them, so as to reach sewage collectors to the ground surface, thus contaminating "underground" river.

The main water artery of the city, the Moscow River, currently has 33 first-order inflows occurring in the city. The largest of them are over 25 km of the river are Jauza, Setun and similar, which belong to the category of small rivers and a fully open channel. The category of most small rivers (length 10-25 km) are tributaries of the Moscow first, second and third order – River Horodnia, Bitza, Chertanovka, Nishanka, Ponomarka, Ramenka, Ochakovka, Chermyanka, Likhoborka, Hapilovka, Serebryanka that have open and closed riverbed areas. Other rivers and streams in the city belong to the category of the smallest length of less than 10 km (or streams), these rivers are mostly hidden under the ground. In total, the city is located 142 watercourse with catchment area of 1.5 km^2. Only 45 rivers and streams are completely open channel, 40 watercourses collected in collectors others have partially open channels and partially enclosed in collectors. According State Environmental Budget Agency "Mosekomonitoring" total length of rivers and streams in the city is about 660 km, including the length of open channels – 395 km, that is 60% of the length of all rivers. River network density of the total number watercourses is 0.75 km / km^2, in open channels – 0.45 km / km^2 (the area within the Moscow Ring Road). Most of the small rivers of Moscow is not used for commercial purposes, basically they have recreational value and perform of landscape function in an open flow.

In order to characterize water quality changes of the minor rivers of Moscow the Konkovsky stream flowing on the territory of SWAD was studied. The study of the river was carried out in the period from 27 September 2014 to 25 October 2014 as part of of practical work, in which was described the river valley, conducted visual, morphometric and hydrometric monitoring, water quality was studied by the following parameters: pH, T°, the quantitative content of chlorides and hydrocarbons, odor, turbidity, color. In accordance with the results of studies hydrochemical was determined that the concentration of analytes in aqueous samples does not exceed the MPC. Konkovsky stream refers to the "mixed" type of small rivers – flows through the ponds, to the collector and the open flow, but it is quite clean, open-source pollution is not observed, although it should not be used for drinking. Also during routes measurements were made background radiation, which has been established that the level of DER not exceed the allowable values and ranges 0,1-0,22 Sv/h.

Causes of quantitative and qualitative changes of minor rivers directly related to the growth of the city and the population. Initially, the number of rivers on the territory of the city had to increase as the city was captured all the new space, however, a growing number of engineering structures, which were forced to clean up the rivers under the earth. So, for example, in 1950 feature of the city along the southern border reached Cheremushki, North to the Ostankino district. Consequently, most of the rivers of modern Moscow in the list of rivers in 1950 were not included. For 65 years, the area of Moscow has grown almost 2.5 times, and with the seizure of territories and increased the number of rivers in the city, but most of it is hidden and does not exist on the surface. Converting river breaks the continuity and integrity of the water system of the city, leads to a deterioration of the natural self-purification of rivers, resulting in the elimination and fragmentation of river valleys, flooding of adjacent areas, loss of territory recreational facilities and ultimately to the degradation of the natural complex of Moscow.

According to the results of this work the following pattern revealed: the growth of the city is increasing the density of river network, but at the same time reduces the number of rivers in the open channel. Part of the rivers, hidden in the collectors in fact, "withdrawn" from nature, working only on the person, so it is necessary to monitor the state of the "underground" rivers and follow the principle of ecological validity in making decisions about hiding rivers still flowing to the surface.

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APPLICATION OF EFFECTIVE GROUNDWATER TREATMENT TECHNOLOGIES IN THE CONDITIONS OF UZBEKISTAN

Kudratov A.M., Juraev M.T., Kadirhodjaev A.A.
marufali67@mail.ru, State Enterprise «Institute HYDROENGEO», Tashkent, Uzbekistan

In most cases, the contamination of ground and surface fresh water remains invisible, because of pollutants are dissolved in water. In annual water resource influenced by thousands of chemicals with unpredictable effects, many of which are new organic chemical compounds.

At present, the crucial concerns come for the contamination of groundwater from oil facilities, mining and chemical industries, infiltration fields, sludge tanks and waste dumps of metallurgical plants, storages of chemical wastes and fertilizers, landfills, livestock farms, off-canalized settlements and others.

Recognizing the importance of the problem of contamination of fresh groundwater for human health, there comes up an urgent need for the study of a range of technologies and activities to treat and clean contaminated groundwater resources and improve their quality, that are effectively used in foreign countries, with a view to the possible application of best practices in Uzbekistan, which shall solve the problem of environmental suitability of groundwater from various pollutants and their safe use and consumption.

Analysis of modern technologies of groundwater treatment in developed countries, has indicated and focused the following technologies and equipment:

– Biogenic sulfide technology BioSulphide® or ChemSulphide®, based on the deposition process and is used to remove dissolved metals from water and produce clean water [1];

– Technology of High Density Sludge (HDS) – neutralization by oxidizing metal molding or biological oxidation. HDS process effectively removes non-ferrous metals, precipitated in the form of stable form of calcium precipitate. Iron is by-precipitated on the surface of the return activated sludge [2];

– Ion exchange to remove sulfates that used to remove calcium and magnesium by cations input for cation exchange resin, and then anion exchange resin, in order to remove the sulfate. Thus there got highly demanded byproduct as gypsum and clean water [3, 4];

– Technology – In Situ Redox Manipulation (ISRM), provides the creation of permeable subsoil area clean to reduce rolling chromate in groundwater to an insoluble form. Unlimited aquifer are to be oxygen-oxidizing environment, and most mobile contaminants are in oxidizing conditions. Contaminants that are sensitive to redox moving through the purification zone will be destroyed (organic solvents) or neutralized (metals) [5];

– Technology – Macro Porous Polymer Extraction (MPPE), efficient and fully automated, remote-controlled method, which removes from wastewater hydrocarbon compounds in the dispersed and dissolved forms at 99.9999% to below ppb by extracting a macroporous polymer beads [6] .

– Installation system for cleaning groundwater (productivity 40t/hour) used for removing free carbonic acid or organic chlorine compounds from groundwater [7]. There exist also, water treatment plant of the company EcoNova, represented as a compact mobile unit that can be used for other waste flows, such as wash water from plants and vehicles or waste water collected during mining operations [8] and the desalination process technology by SAVMIN, through demineralization of water for treating contaminated mine water or acid mine drainage, based on selective precipitation of insoluble complexes at various stages of the process [9], which is running continuously, and waste from the process may be removed as a solid waste, or, in certain cases, to form a suitable for use byproducts.

As a whole, a very sensible approach assumes a comprehensive study of technological influence classes, leading to the contamination of geological environment and an acceptable treatment technologies, taking into account the possibility of using them in depth, by selectivity with respect to certain pollutants, environmental viability and purity of the technology used with relatively high degree of purification and sustainability.

For each type of anthropogenic influence the authors examined the nature of hazardous components impact and their qualitative and quantitative characteristics: emissions of waste by t/year; sources of waste water; treatment facilities; water circulation systems; waste generated at industrial plants within definite territories of Uzbekistan. There were classified pollutants impacting the geological environment by: quantitative indicators; risk degree (highly hazardous, moderately or low); scale of impact (regional, local) and others. Observed hazardous substances that strictly threat the groundwater quality.

Thus, one of the suitable treatment technologies in Uzbekistan is indicated the adsorption ion exchange technology for groundwater treatment, based on the composition and concentration of metal ions in them. Measures, taken to contain and eliminate pollution of mining and metallurgical plants, are being developed based on the analysis according to environmental standards, as well as economic and logistical capabilities. The extraction of metal ions, dissolved in groundwater, is done by water pumping, and taking into account the concentration of metal ions, there used specific technology for efficient treatment as of local character in order to prevent the spread. At the same time, taking into account that the adsorption-ion exchange water treatment technology of metal ions is relatively capital-intensive method, in this aspect of the approach is appropriate dilution flow for ion scattering to comply with the maximum permissible concentrations. Acceptable and available as well a local adsorption and ion exchange technology with the use of adsorbents and ion-exchange materials based on local raw materials, such as cellulose, coal and mineral clay [10].

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ACCOUNTING ELEMENTARY LANDSCAPES WITH EXPERT ASSESSMENT OF POLLUTION ENVIRONMENT IN BELARUS

Onoshko M.P., Mamchik S.O.
onoshko@geology.org.by, mamchik@geology.org.by, RUE "SPC for Geology", Minsk, Belarus

Based on the requirements of a comprehensive assessment of the impact on the environment, which, according to [1], suggests "... to determine the nature and extent of all potential types of impact on environmental systems (landscape) of planned economic activity …", when assessing the impact of any production process, including the oil complex, requires the use of the landscape approach.

Landscape approach to environmental assessment is complex research area. Units of analysis in this area can be natural complexes of various ranks – from the local to the regional level. The main advantage of this approach over other approaches (administrative-territorial, economic and regional) in that it combines the territory closest to the stability and response to technological impact.

At the regional level within Belarus, the classes, types, genera, species landscapes, forming a hierarchical hierarchical system of typological complexes [2]. At the local level within the landscape can be fleshed out tracts and facies. Facies is the primary unit of marginal differentiation environmental systems, with the same lithology of surface deposits, the nature of the relief and moisture, climate, soil, and the difference between the ecological community. Facies occupies microform relief element or meso. As the main natural units in the analysis of the interaction of natural and anthropogenic factors used elemental landscape [3], which is an analogue of the geographic – facies. But unlike facies elementary landscape is regarded as the functional integrity geosystem, systematizing the beginning of which are flows of matter and energy.

Selection of an elementary landscape as the basic unit due to inherent to different types of elementary landscapes certainty physiographic and geochemical features, as well as their relationship to the human impact. Under the terms of the migration of chemical elements, depending on the position of the groundwater table, three types of elementary landscapes: eluvial, superaqual and subaqueous. Depending on whether, to what parts of the earth's surface is timed elementary landscape (watershed slope, depression, floodplain), what rocks, vegetation presented, what are the characteristics of its water regime, it is characterized by its behavior and migration of chemical elements.

Elementary landscapes geographically part of the physiographic and geomorphological areas, geochemical provinces, districts and other soil units zoning, as bearers of their specific features. In view of this same type of elementary landscapes belonging to different regions (provinces, districts, etc.), while maintaining the original features of the typical accessories, differ in terms of underlying specific zoning.

Each type of elemental landscape has certain properties, in response to the impact of different types, certain self-cleaning mechanism – the ability to process landscape (sort, besiege, degrading, etc.) or output beyond itself falling into the landscape contaminants. Self-cleaning of the landscape – one of the elements of self-organization. Greatest ability to cleanse itself have landscapes with high intensity cycle of matter and the predominance of scattering flows. Self-cleaning mechanism controls the scattering processes (removal) of chemicals surface, soil and groundwater and groundwater flow, which allows you to select areas with varying degrees of probability of accumulation of pollutants to determine their resistance to chemical corrosion.

The group of sustainable landscapes include almost all subtypes of eluvial landscapes. Group in varying degrees of unstable landscapes presented itself superaqual landscapes, transsuperakvalnymi and autonomous superaqual (table).

Table – Ranking elementary landscapes on sustainability at [3] with our updates

degree of resistance types	types and subtypes of elementary landscapes
1	2
most stable	- eluvial krutosklonovye on the sands
stable	- eluvial krutosklonovye in loamy
	- eluvial krutosklonovye on loam
	- eluvial pologosklonovye on the sands
	- eluvial pologosklonovye on the sands
	- eluvial subhorizontal on the sands
relatively stable	-eluvial pologosklonovye on loam
	- eluvial subhorizontal on the sands
	- eluvial subhorizontal on loam
	- eluvial-accumulative in the sand
	- eluvial-accumulative in loamy
	- transsuperakvalnye on the sands
unstable	- eluvial-accumulative on loam
	- transsuperakvalnye in loamy
	- transsuperakvalnye on loam
	- actually superaqual on the sands
	- actually superaqual in loamy
most unstable	- transsuperakvalnye peat
	- actually superaqual on loam
	- actually superaqual peat
	- autonomous superaqual (bogs)

Consequently, the types and subtypes of elementary landscapes because of its geomorphological conditioning (position in relief) characterize the differences in lateral migration of chemical elements and give an idea about the possibility of the landscape to cleanse itself. Terms of vertical (radial) removal of pollutants in elementary landscapes are determined mainly by lithological composition of the parent rocks. Joint analysis of geomorphological factors (relative excess relief and slope steepness), causes lateral removal, and lithology (particle size distribution of soil-forming rocks), which determines the radial (vertical) removal, lets talk about the stability of elementary landscapes to chemical stress.

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MECHANISMS TO MANAGE ENVIRONMENTAL PROGRAMS IN BELGOROD REGION

Kryukov Yury
yury@pochta.ru, Stary Oskol branch of federal state budgetary educational institution of higher professional education "Russian State Geological Prospecting University Sergo Ordzhonikidze" (SOF MGRI-RGGRU), Stary Oskol, Russia

A necessary condition for economic and social development of any territory is managing and protecting the environment. Environmental issues in the Belgorod region pays great attention. Here one can not but recall the words of the governor of the region Evgeniy Savchenko of his appeal to the people of the Belgorod region, "Let's prove to ourselves and others that we love our homeland, our common home – the Holy Belogorie. Just here, in this our common work on respect for nature will manifest the very catholicity, which is inherent in our people, which is not just helped us out of the most difficult situations. Shaping our fellow cult of cleanliness and order, we just have to fix in the mind of every Belgorod only reasonable formula: Nature – a genuine temple, rather than the workshop, and we in the church should be a good church. This work – a good long time, you should not consider it as a short-term campaign or share. It will continue as long as the high culture of life will not be the norm. While the cult of purity and beauty will not penetrate into the consciousness of each of Belgorod, until we feel that we have achieved this goal and therefore can rightfully and proud to say that no corner on Earth better and more beautiful than our native Belgorodchine! "

Natural conditions and a variety of natural resources are the basis of production and life of the population. State of the environment, quality and comprehensive utilization of natural resources, protection and reproduction of resources determine the rate of economic growth and efficiency. Therefore, improving the environment contributes to the growth of the economy.

It should be noted that the economic growth associated with obtaining a maximum ultimate benefits from the production of the use of natural resources and the environment, today is practically impossible. The intensive use of natural resources taking into account the depletion of mineral resources, limited material resources and capacities of the natural self-healing environment in recent decades has become one of the main obstacles to social and economic development. Environmental protection and rational use of natural resources is currently one of the priorities of the state policy, which is due to the current situation, namely environmental degradation on a global scale.

To solve this problem today can be through the adoption and implementation of environmental programs that the allocation of funding at both the state and the regional level and should be a priority. The implementation of eco-programs for environmental protection and environmental management should be a systematic approach and include both targeted funding from various Russian sources of foreign investment, and the simultaneous introduction of a new eco-technology and eco-technologies.

Most of the subjects of the Federation are already taking their own environmental programs, but they are not coordinated, and finally do not have the study of all the priorities. Thus, in the Belgorod region was approved by the program "Environmental protection and rational use of natural resources" for 2010-2014., Whose purpose – to create conditions for the stabilization and improvement of environmental quality area, environmental safety; reducing exposure to harmful environmental factors of technogenic and anthropogenic environmental impact; increased environmental culture and the formation of ecological outlook of the regional population and others. But the total funding of the regional program was only 20,439.0 thousand. rubles, which is clearly insufficient for the region experiencing long-term human-induced pressures and large environmental problems.

Analysis of environmental programs has shown that in the task does not specify the specific objectives. For such purposes, for example, may include: technology for the integrated management of natural resources, waste (recycled), the installation of electrostatic precipitators, recreational work, etc. In addition, in most cases, there is a blurring of the administrative responsibility for the implementation of a program among several federal executive bodies. To this end, environmental programs should be departmental having clear goals, measurable outcomes, assessment, indicators of achievement, etc .; financing of regional environmental programs should not be long-term, since Planning for specific tasks involves the purchase of conservation equipment and the introduction of new eco-technologies determines the terms of implementation, acquisition and obtaining environmental benefits.

In Belgorod, by the way, have already appeared tendencies of the new approach to environmental management and environmental protection. Thus, research and production center of the regional branch of KMA "Ecoresource" in 2010 was invited to "establish an independent environmental center and landfill environmental monitoring of republican significance in the territory of geo-environmental violations Stary Oskol, Belgorod region Gubkinskoye." The proposed thematic focus of the center meant a synthesis of research, identification of patterns and causes of degradation processes operating in time and space and the development of the concept of nature. Such activity would be timely basis for the environmental center for the adoption and implementation of management decisions.

Obviously, for the coordination of specialists to develop and implement environmental technology must have creative teams of scientists, the work of these professionals could be based on the center of high technology. In 2008 a similar center was established on the basis of Belgorod State University; also established the Center for collective use of scientific equipment. In these centers towards environmental management project "Geoinformatics and remote sensing of land in Ecology and Environmental Management", the results of which can also serve as information for management decision making.

Policy implementation will be maximized when it is timely implementation at the regional level and monitoring at the national level, since only in this case we can assume full implementation of all the benefits of a systematic approach.

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SELF-REGULATION FACTORS OF NATURAL AND TECHNOGENIC SYSTEM OF BELORECHENSKOE DEPOSIT (GREATER CAUCASUS, ADYGEA)

Popov Yu.V., Tsitsuashvili R.A.
popov@sfedu.ru, Southern Federal University, Rostov-on-Don, Russia

Natural and technogenic systems of unexploited deposits appear as natural laboratories that reveals the autoregulation process of landscapes. In this respect interesting purpose is Belorechenskoe barite (with substandard sulphide mineralization) field, forming the upper level of polychronous mining on the flank of the Dakhovskaya crystalline uplift. Uranium deposit Dakhovskoe that has been operated since the 1960s is associated with the lower level of the mining, and the adjacent rocks containing scattered mineralization of different elements.

Infiltration slightly acid sulphate-hydrocarbonate waters (pH 5.5-6) come to underground mining. Reacting with sulphide veins (mainly pyrite and margusity), they form zones of intense oxidation being the source of acid sulphate solution saturated with metals. Water sulfates of margusity type develop on the surface of iron disulfides. Traces of anglesite, water sulphates of lead, glëta-massicot, water copper oxides are observed around galena grains. Partial neutralization of waters by hypergene solutions leads to the formation of gypsum and water, ferrous sulfate. Microphase silver sulphide (composition close to acanthite) are observed on the surface of oxidized pyrite, microphase rare native silver are observes among melanterite.

Deposition of these elements occurs in the several solutions physical-chemical barriers having different nature [1]. In the zones of acidic waters outcrop (pH ~ 2) from the fractures in the silicate rocks the oxidation barrier is traced by formation of gels which form the iron oxide hydroxide adsorbed Cu, Zn, Mn, Pb and silver sulfide microphases. Instability of oxyhydrates association in the conditions of environment with pH <3 makes it possible to consider these zones as an intermediate barrier on the path to migration of heavy metals. Sulfate physical-chemical barrier is formed within zones of the oxidation of barite ore and showed as small diffuse halation in sulfate associations. The most common mineral is gypsum. It is usually associated with copper sulfate – brochantite, serperit and devillin and often linked with jarosite-plyumboyarozit, hemimorphite and melanterite. Paragenesis denotes formation of sulfate minerals with an alkali metal hydrogencarbonate. Alkaline physical-chemical barrier is linked with areas of modern carbonate formation. Carbonate incrused aggregates are composed by calcite. Thermal analysis reveals effects linked with the dissociation of fine and microcrystalline calcite and exothermal effect associated with the crystallization of amorphous carbonate. Judging by the composition of micromineral phases formation of calcite (determinative changing of pH) primarily causes coprecipitation of compounds of Fe, Zn and Pb (less Cu and other metals) at the surface of the carbonate units. The predominant form of trace minerals on the surface of calcite are aqueous sulfates and carbonates. The instability of these compounds leads to the mobility of the metal cations, passed into solution and partially sorbed by calcium carbonate ($>CO_3H^0 + Me^{2+}(aq) = >CO_3Me^+ + H^+(aq)$) in accordance with a well-studied mechanism [2]. Divalent metal cations with an ionic radius smaller than that of calcium is known to be sorbed by calcite forming solid solutions. It explains selective binding of zinc in the form of isomorphous impurity. Large cations (Sr, Ba, Pb) can be integrate into the grid of rhombic aragonite (but not calcite) [2]. It explains separation of carbonate aggregates of independent microphase cerussite, barium calcite bariokaltsita in the internal zones. Therefore the processes of carbonate formation define an isomorphic occurrence during crystallization (Mg, Sr) and coprecipitation in micromineral phases (Zn, Pb, Cu, Ag) with the subsequent destruction of mikrominal phases crystallizing on the surface of calcite and redistribution of metals that have been controlled by sorption mechanisms. In general, there are several mechanisms of binding metals in stable mineral phases in the physical-chemical barriers: precipitation from aqueous solutions, isomorphic occurrence during coprecipitation, coprecipitation in different mineral phases, sorption with subsequent destruction of sorbate complexes and the redistribution of metals.

Analysis of elemental composition and specific activity of radionuclides in the silt sediments within the wellhead parts of the adits, drainages and streams indicates that in spite of the combination of several physical-chemical barriers, a wide range of elements in dissolved form and in the form of solid runoff is taken out minings. Cr, Ni, Cu, Zn, As, Pb are concentrated in the silt sediments near wellhead part of the adit. Ti, P, V, Co, Sr, Pb comes more intensively from dumps (in the sides of streams). It is explained by their entrance from intensive mechanically destroying disintegrated aggregates of rock-forming and diffused minerals. The specific activity of ^{226}Ra in the sediments near the wellhead part of the adit varies in the range from 83,2 ± 7,6 – 98,4 ± 8,3 Bq / kg to 398,7 ± 21,6 – 407 9 ± 27,3 Bq / kg; ^{232}Th – from 24,5 ± 1,8 – 40,5 ± 3,4 Bq / kg to 58,3 ± 5,1 – 61,8 ± 4,2 Bq / kg depending on the season (2014). In silts of river Syuk that absorbs drainage waters background values are approximately 38 Bq / kg for ^{226}Ra and approximately 27 Bq / kg for ^{232}Th.

Leakage flux is controlled by water flows within valley of river Syuk crossing the territory of the field. Concentration of elements in alluvium (its silt part was studied) was defined by geomorphological structure specificity of valley. Higher concentrations are found in areas of bed gradation (up to 5-7° downstream from wellhead part of the adit number 9) and areas of the accumulation of instrativ alluvium (a significant role belongs to rock of dumps supplied from the abrupt sides of the valley). Periodic removal of material by thin mud streams gives rise to consider graded areas as areas of short-term concentration (mainly composed of psammite and aleurite fractions of silt).

Potential barrier within the leakage flux of r.Syuk valley can be alluvial sod soils formed on proluvial-alluvial floodplain deposits of flood plain within the lower part of the valley. However the total content of metals except lead in these soils doesn't exceed the maximum allowable concentrations. Lack of effective alkali and sorption barriers impedes concentration of metals and radionuclides: soil waters have slightly reaction and clay fraction doesn't contain labile clay minerals with high cation exchange capacity [3].

Evaluation of complex geochemical and physiographic factors reveals the reasons of sustainability of natural landscapes within territory of Belorechensky field to anthropogenic pollution.

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SOLOTION OF THE MINERAL RESOURCE DILEMMA

Nikitina N.
NikitinaNK@mmcintergeo.ru, Intergeo Managing Company LLC, Moscow, Russia

It is noted that over the last few years the implementation of several mineral exploration, development and mining projects has been suspended and even completely stopped due to resistance from local communities. The key concerns of local residents typically include perceived or real impact of mining enterprises on the environment, unfair distribution of profits from mining and exploration activities, insufficient contributions to local government budgets and lack of transparency regarding ultimate ownership of companies conducting exploration and mining. The article looks at social conflicts of this kind and suggests some alternative solutions that could prevent such conflicts at the stage of granting exploration and mining rights.

Examples in other countries with the participation of different peoples and local communities indicate some real trends of increasing negative attitude of the local population toward any exploration and mining work, regardless of exploration methods, mining systems and environmental protection measures. In particular, mining activities are viewed more critically in areas However; it cannot be denied that the population growth, social progress and the unlimited desire of the population to increase its living standards and comfort require permanent economic advancement accompanied by increasing production and consumption non-renewable mineral resources production. This is also illustrated by the world production statistics.

Typically the mineral resource dilemma looks as follows:

Sooner or later companies that hold exploration or mining rights need to obtain consent (formal or informal) of the local population for exploration and mining activities in the area. Both parties have to make a decision:

a. The local community does not argue against the government decision to grant the right to explore/mine/extract mineral resources in a certain area and in 8–10 years the local budget will receive additional income, the size of which will depend on revenues and costs of the mining business, especially environmental remediation expenditures, community-related expenditures. In this case the environment and subsoil will suffer a certain degree of degradation;

b. The local community lobbies against exploration and production of mineral resources and a result the mining license is revoked by the government or forfeited be the mining company. In this case the local budget will obtain no additional revenue and no environmental damages will be suffered. Alternatively instead of forfeiting the license, the mining company can decide to substantially increase its environmental remediation expenditure (to the satisfaction of the local community) in which case the environmental and community related damages are minimized as well as the additional revenues of the local budget (Table 1).

A solution to the dilemma is determined to a certain extent by the goals and interaction strategies of parties involved. If each party is only considered its own goals (profits maximization of a company or nature preservation at any cost), alternative N 1 will be the best for the local community and alternative N 2 for the mining company. But from a joint point of view, if the mining company and the local community are aware of limited uneven geographical distribution of mineral resources, growing consumption of mineral resources by society and need for economic development, while preserving (to the extent possible) the environment from the negative effects of mining, it would be the best to act together using alternative N 3 and N 4. In this case, the solution to the dilemma will be found depending on, firstly, demands of the local community, secondly, on the amount of environmental and social oriented expenditures that the mining business is prepared to bear.

Table N 1 shows the final solution to the mineral resource dilemma. However, the origin of the mineral resources dilemmas and its consequences (protests of the local communities, economic losses of business, damage to the environment, and others) are determined, primarily, by the decision of the state to conduct a geological survey, and organize exploration and production of the subsoil plots.

Table 1

Matrix of possible solutions to the mineral resource dilemma and their consequences

<table>
<tr><th rowspan="2">Feasible Solutions</th><th colspan="4">Consequences</th></tr>
<tr><th colspan="2">The Local Community against the Proposed Mining Activity</th><th colspan="2">The Local Community is Indifferent to the Proposed Mining Activity</th></tr>
<tr><td rowspan="3">Mining business does not take into account protests or social needs of the local community</td><td rowspan="3">Alternative N 1</td><td>Mining company has to cancel the project completely and suffers a direct loss</td><td rowspan="3">Alternative N 2</td><td>Mining company obtains a maximum mining profit</td></tr>
<tr><td>Environment and abiotic nature completely preserved</td><td>Environmental and subsoil degradation</td></tr>
<tr><td>Local budget does not receive any mining revenues</td><td>Maximum mining revenues to the local budget</td></tr>
<tr><td rowspan="3">Mining business incurs substantial additional environmental remediation costs and community oriented expenses</td><td rowspan="3">Alternative N 3</td><td>Minimal profit for mining business due to maximized environmental expenditures</td><td rowspan="3">Alternative N 4</td><td>Moderate profit for mining business due to obligatory environmental remediation and community related expenses</td></tr>
<tr><td>Minimal damage to the environment and abiotic nature</td><td>Limited damage to the environment and abiotic nature</td></tr>
<tr><td>Moderate local budget revenues</td><td>Moderate local budget revenues</td></tr>
</table>

It is essential recognize that the need for a healthy environment is a basic need what if using Maslow's hierarchy comes after safety needs (protection from elements, security, order, law, limits, stability, freedom from fear) and is followed by social needs (belongingness, affection and love) of a human being:

1. In order to avoid conflicts with the public and local populations during mining activities, the government should only allocate the mining rights after thorough analysis of forecasted levels of production and consumption of the mineral resource, detailed review of possible economic and social development of a particular region, understanding specific goals and objectives of the government and the local population that will be achieved a result of a mining project and analysis of possible social and environmental risks.

2. Distribution of mineral resources revenues between budgets should be transparent and equitable, so that local population is appropriately compensated for environmental degradation, decline of bio- and geodiversity, and deterioration of population health.

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GYDROGEOLOGY, ENGINEERING GEOLOGY AND GEO-CRYOLOGY

HYDROGEOCHEMICAL ZONALITY OF THE COAL DEPOSIT MAOKHE, VIETNAM

Nguyen Tat Thang, Sudarikov S.M.
sergei_sudarikov@mail.ru, National mineral resources University, St. Petersburg, Russia

Hydrogeochemical zonality in the area of the coal deposit Maokhe reflects the influence of several factors of groundwater chemical composition formation and processes during filtration of water in coal seams [1]. In hydrogeological respect the field represents the aquifer system of the coal-bearing carbonate-terrigenous sediments of the upper Triassic. Areal distribution of total mineralization and pH values are shown on maps constructed for surface and groundwater of the area of the coal field Maokhe. Horizontal hydrogeochemical zonation is caused by changing conditions of water and atmospheric supply in different landscape-climatic zones [2]. The topography of the area is represented mostly of mountains and hills. Absolute altitude gradually decreases from North to South. Monsoon climate is distinctly seasonal. Precipitation and evaporativity affects the amount and chemical composition of infiltration water of the aeration zone, as well as depth, salinity and composition of the groundwater, depending on the time of a year. A characteristic feature of the monsoon climate is the presence of dry and wet seasons with a predominance of prevailing winds of opposite directions. Towards the direction of movement groundwater changes its mineralization and chemical composition. A gradual decrease in the total mineralization of groundwater from the centre of the study area at the North to the South from 0.6 to 0.3 g/L is observed. The highest values are observed in zones of tectonic disturbances, which, apparently, is more mineralized water (well K3 with a salinity of 0.6 g/L). The pH values in groundwater uniformly decreases from the center of the study area in the North to the South-West and South from 7.5 to 6. The southern part of the area is characterized by low relief formed by Quaternary aquifer sediments. The total mineralization of the groundwater of the Quaternary sediments mainly ranges from 0.1 to 0.3 g/L. However, in this aquifer we discovered the phenomenon of local increase in the total mineralization under the influence of hydraulic connection of the river Dabak water (maximum mineralization is of 4.4 g/L in the winter due to the inflow of sea water) with groundwater of the alluvial deposits. In the South-Western and Southern parts of the study area groundwater is slightly acidic with pH values from 5.5 to 6.5.In accordance with the hydrodynamic conditions of the groundwater of the study area investigated hydrogeological section can be divided according to the nature of the water exchange into two zones of varying thickness: 1) active water exchange, 2) slow water exchange. The *zone of active water exchange* extends to a depth of approximately 300 m, although this boundary is conditional, as in some areas it goes down to greater depths (SLE. 54A). At the same time, the upper limit of the underlying zone of the slow water exchange in some areas up to 50 m from the Earth's surface (VCS. 341). In General, the active water exchange is always correlated with hydrochemical *zone of temperate fresh waters* with total mineralization of 0.2-0.6 g/L and pH from 7 to 8, which corresponds to the average composition of groundwater in the zone of hypergenesis by S.L. Shvartsev [3]. On the dominating components in the chemical composition the underground water is bicarbonate calcium, calcium-magnesium, magnesium-calcium (1st type according to the classification of O.A. Alekhin [4]). The content of the bicarbonate-ion is from 0.1 to 0.36 g/l, Ca^{2+} up to 0,076 g/l, Na^{+} up to 0.011, $SO4^{2-}$ – 0.05-0.1 g/L, Cl^{-} – 0,013 g/L. Typically, such water formed during leaching of carbonate rocks in humid areas with sufficiently intense evaporation.

Zone of *slow water exchange* extends to depths of over 300 meters. It is hydrochemical *zone of fresh water*. It distinguishes not only by a higher salinity (up to 0,975 g/L), but by the composition of the waters. In this zone, almost universally soda water is spread with a pH from 7.4 to 8.9. According to main dissolved components waters of the zone of slow water exchange are sulphate-bicarbonate sodium, less sulphate sodium (2-nd type according to the classification of O.A. Alekin [4]). The last type occurs in the upper part of the zone at depths of about 400 m. In the zone of slow water exchange increases the content of Na^{+} (up to 0.2 g/L) and slightly the concentration of Cl^{-} up to 0,053 g/L. The content of sulfate ion is growing significantly in 2-4 times (0.43 g/L). The concentration of Ca^{2+} decreases sharply up to 0.02 g/L.

The analysis of geochemical data has allowed establish the following regularities of changes in mineralization and type of groundwater in the zone of slow water exchange. The chemical composition of the groundwater aquifer varies in the direction from North to South. These changes are manifested in the decrease in the concentration of all ions and, consequently, the decrease in the total mineralization. In the Northern zone of slow water exchange is dominated by bicarbonate-sulphate sodium water, and in the southern and southeastern parts – sulfate sodium water.

Conclusions

1. Thus, within the study area are developed waters from moderately fresh to fresh with a total mineralization from 0,221 to 0,975 g/L (with the depth salinity increases) and pH of 6.26-8.89. The content of ions in groundwater within the study area Maokhe: bicarbonate ion from 0.03 to 0,304 g/L, Na^+ – from 0 to 0,216 g/L, Ca^{2+} from 0.004 to 0.07 g/L, Mg^{2+} from 0,00012 to 0.035 mg/L, Cl^- from 0,00038 mg/L to 0,053 g/L, SO_4^{2-} from 0,015 to 0,431 g/L.

2. With the depth increase the ratio of dissolved components is changed. There is an increase in the concentration of Na^+, SO_4^{2-}, Cl^-, and the reduction of Ca^{2+}, Mg^{2+}, HCO_3^-. With the depth increase among anions the sulfate and chloride ions begin to dominate, as among cations – sodium.

3. According to the dominating components in the area of the coal deposit Maokhe the most widespread groundwater are of the following types: bicarbonate calcium-magnesium and magnesium-calcium, bicarbonate-sulphate sodium and sulfate sodium. With the increase in depth bicarbonate waters are replaced by sulfate. Deviations from normal hydrogeochemical zonality is observed in the discharge sites of deep saline waters and seasonal variations in the composition of groundwater associated with evaporative concentration, monsoon rains, entering marine waters in alluvial deposits.

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MECHANICAL-MATHEMATICAL MODELING AND RISK REDUCTION FOR LANDSLIDE PROCESSES

Svalova V.B.
inter@geoenv.ru, Sergeev Institute of Environmental Geoscience, Russian Academy of Sciences, Moscow, Russia

Landslide processes are the most common and dangerous processes in urban areas. In Moscow landslides occupy about 3% of the territory. Landslide processes developed in the valley of Moscow river and its tributaries. There are more than 15 deep block landslides (with a depth of slip surface to 100 m) and a large number of small surface landslides in Moscow territory.

In the area of Kolomenskoye on the right bank of the Moscow River in the upper part of the landslide slope periodically recorded landslide displacement. Average annual rate movements wall waterfront here reach 10-15 cm / year. In June 2007, has accelerated the deformation portion of the slope near the ski slope in the upper part of the old landslide circus on the Vorobjovy Hills. In August 2006, there was a catastrophic intensification of deep block slide in the western part of Moscow near Karamyshevskaya waterfront. In September 2009, has accelerated deep landslide near Moscow River.

Landslide processes represent a danger in the city of Moscow, especially in connection with the activation of construction and economic activities carried out often without proper geological study. Activation of landslide processes on the territory of Moscow in recent years requires an intensification of proven methods and development of new approaches to the study of landslide processes and reduce their risks.

One of the methods for the study of landslide processes is the mechanical-mathematical modeling of gravitational mass movement by sliding slopes. At different stages of development the landslide processes can be described by different mechanical and rheological models. At the stage of cracking, buckling, separation the models of elastic and fracture media can be used, in the slow movement of rocks along the slope can be used high-incompressible fluid model. The boundary conditions of the problem at the same time also depends on the situation. For example, in the case of slow motion at the lower boundary layer slip condition is used. If the process of mudflow, underwater landslide or avalanche is considered, then at the lower boundary the condition of slip or a more complex boundary conditions can be used. The choice of an adequate model of the process and formulation of initial and boundary conditions is independent mechanical problem.

Let us consider the motion of sliding down the slope of the masses as the movement of high-incompressible fluid, described by the Navier-Stokes equations. Let the characteristic horizontal scale of the landslide body L is much greater than its thickness h. We also assume a landslide quite extended in the plan, which allows a three-dimensional model is considered as a two-dimensional cross-sections for the landslide body. Following [1-3] and applying the method of expansion in the small parameter, we can obtain the continuity equation and asymptotic approximation of the Navier-Stokes equations in dimensionless form for slow motion in a thin layer:

$$\begin{cases} \dfrac{\partial P}{\partial X} = \alpha\mu \dfrac{\partial^2 U}{\partial Z^2} \\ \dfrac{\partial P}{\partial Z} = -\rho \end{cases}$$

$$\frac{\partial U}{\partial X} + \frac{\partial W}{\partial Z} = 0$$

$$\alpha = \frac{F}{R\left(\dfrac{h}{L}\right)^3}, \quad F = \frac{u_0^{\,2}}{gL}, \quad R = \frac{u_0 L \rho_0}{\mu_0}$$

Here, P – pressure, U, W – speed, F – Froude number, R – Reynolds number, , ρ – density, μ – viscosity, ρ_0, μ_0, u_0 – the characteristic density, viscosity and speed.

Then you can easily obtain the distribution of velocity and pressure fields in the layer [1-3].

Important question is determining the place of maximum speeds on the slopes. When deciding on the location of the post monitoring for landslide slopes the optimum location for speed sensor mass is the point of maximum speeds in the rock mass.

Let us consider the massif of sedimentary rocks with the upper boundary ς^* representing the landslide slopes. Lower bound is compatible with the axis X. The maximum horizontal velocity U is achieved at the upper boundary ς^* of the massif due to the conditions:

$$\frac{\partial U}{\partial Z} = -\frac{\rho}{\alpha\mu}\frac{\partial \varsigma^*}{\partial X}(\varsigma^* - Z) = 0 \Rightarrow Z = \varsigma^*.$$

The point of maximum horizontal velocity at the surface ς^* is found from the condition that the first derivative is equal to 0:

$$\frac{\partial U^*}{\partial X} = 0, \textit{where } U^* = -\frac{\rho}{2\alpha\mu}\frac{\partial \varsigma^*}{\partial X}(\varsigma^*)^2.$$

Hence it is easy to obtain the condition:

$$\frac{\partial^2 \varsigma^*}{\partial X^2}\varsigma^* + 2\left(\frac{\partial \varsigma^*}{\partial X}\right)^2 = 0 \tag{1}$$

It should be borne in mind that the ς^* (X) is a known observed function – the surface of the landslide slope. And the resulting condition allows us to find the point on the slope, where the velocity is maximum.

The model also provides an opportunity to examine fundamental aspects of the movement of material for sliding slopes and explore the problem of reducing the risk of landslide processes.

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DEPTH TEMPERATURE CALCULATION OF THE MID-ATLANTIC RIDGE HYDROTHERMAL VENT SYSTEM

Zmievskii M.V.
Zmievskiimv@gmail.com, National Mineral Resources University, St. Petersburg, Russia

The interaction of seawater and mafic-ultramafic rocks is important in the modelling of hydrothermal solutions of the Mid-Atlantic Ridge vent systems formation. To assess the role of serpentinization processes in the formation of new minerals necessary to have an idea of what the maximum temperature (base) is achieved in the lower parts of the hydrothermal systems.

One of the methods for calculating the hydrothermal systems depth temperature is hydrochemical method, namely the use of hydrochemical geothermometers. This method is used mainly to highlight the thermal anomaly, both regional and local scale that is of practical value for prospecting and exploration of geothermal resources.

The use of hydrochemical method for the calculation of deep temperatures requires some assumptions. Firstly, it is assumed that the temperature is a major factor influencing the equilibrium of the system. Secondly, it is believed that the reaction reaches equilibrium at the base temperature. Thirdly, during the migration of fluid to the sampling site it should not lose a significant amount of heat and dissolved components or acquired new ones [1].

The calculations accuracy depends on the correct choice of a geothermometer in connection with specific hydrogeological conditions, mineralogical composition of the host rocks and the degree of gas saturation of water. Of the many existing hydrochemical indicators of deep temperatures Si-geothermometer and Na / K ratio of atomic and ion and Na / K / Ca molar ratio have proven mostly. These hydrochemical geothermometers allow us to calculate or graphically estimate the depth temperature with an accuracy of ± 20°C [1]

For each of them there are several variations of the formula. The use of one or other depends on the temperature and flow rate of gas saturation of investigated vents. Scheme to choose the most appropriate formula was proposed by V.A. Ilyin and V.I. Kononov.

According to it, the calculation formulas are:

1) Si- geothermometer (R. Fournier):

$$T^0C = \frac{1309}{5{,}19 - \lg C} - 273{,}15.$$

2) Na/K- geothermometer (D. White and R. Fournier):

$$T^0C = \frac{855{,}6}{\lg(Na/K) + 0{,}8573} - 273{,}15;$$

$$T^0C = \frac{777}{\lg(Na/K) + 0{,}70} - 273{,}15.$$

3) Na/K/Ca- geothermometer (R. Fournier):

$$T^0C = \frac{1647}{\lg(Na/K) + \beta(\sqrt{Ca}/Na) + 2{,}24} - 273{,}15;$$

$$\beta = 4/3; \sqrt{Ca}/Na > 1; T < 100^0C;$$
$$\beta = 1/3; \sqrt{Ca}/Na < 1; T > 100^0C.$$

The calculations were performed on analytical data obtained by sampling of unloading solution, and the composition of the hydrothermal solution (end member). The composition of the last was calculated using the statistical treatment of analytical data and is expected to reach the maximum solution transformation in the lower parts of the hydrothermal system. Thus, it is intended to avoid the errors caused by the receipt or the loss of heat and solute during unloading. The results are shown in table 1.

Table 1

The results of deep temperatures calculations

Hydrochemical geothermometer	Temperature calculated for the analytical data, °C	Temperature calculated for the end member composition, °C
Si, R. Fournier	128	188
Na/K, R. Fournier	200	251
Na/K, D. White	198	254
Na/K/Ca, R. Fournier	232	253

Geothermometer reliability can be judged by comparing the results with temperatures measured in already studied hydrothermal vents. According representations of finite temperature hydrothermal solutions usually reaches 400°C (or more). Also, during sampling was noted that the temperature of discharged by hydrothermal solution at hydrothermal field Logatchev was 348°C [2, 4].

Analysis of the results leads to the following conclusions.

1) temperature calculated by the end member composition significantly higher than the temperature calculated from the initial analytical data that are diluted with seawater in the unloading area. This indicates that the method of geochemical thermometer in principle is workable in the calculation of the temperature in the depths of the ocean deep-sea hydrothermal system.

2) Design temperature is below the temperature measured at the vent, although in the deepest parts of the system, it should be much higher, which can be explained by incorrectness adopted assuming no losses and the acquisition of new components in the ascending migration of hydrothermal solution.

3) Further improvement of the geochemical thermometry method applied to modern ore-forming system in the ocean must be considered as part of the conversion solution on geochemical barriers with mineral formation and phase changes ("boiling" solution) on migration routes and discharge zones.

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PROCESSING OF PUMPINGS FROM IMPERFECT WELLS

Dots. Fisun N.V.
Nat.fisun@yandex.ru, MGRI-RSGPU, Москва, Россия

The additional resistance arising at operation of imperfect water wells is caused, as we know, by degree and nature of opening of the water-bearing horizon. Despite the existing methods of calculation of indicators of imperfection of such wells at the forecast of decrease [1, 2], the assessment of its value represents a problem and authentically can be received only by practical consideration.

Tasks which thus need to be solved during skilled works, can be formulated as follows:

– a choice of a settlement site of the temporary tracing reflecting linear dependence of *S* (*lnt*) and allowing to calculate coefficient of water conductivity of layer by method of a linear anamorfoza;
– definition by practical consideration an indicator of imperfection of a well which should be considered in expected calculations of a water intake;
– justification of necessary and sufficient duration of skilled and filtrational works.

The course and results of the solution of objectives are considered on the example of single pumping with the output corresponding to design water selection. The well removed underground waters of the aleksinsko-protvinsky water-bearing horizon of the lower carbon fabrics from the top interval adjoining a roof. Length of the filter made l_0 = 44 m, the power of the water-bearing horizon of m = 113 m, r_0 filter radius = 0,18 m. Calculation of an indicator of imperfection ε wells according to N. N. Verigin's nomogram [2] showed that its value can make 8 m.

Pumping was carried out within 2 days, the stage of restoration lasted 212 min (0,15 days). The provision of conditionally static and dynamic level was defined by a remote method by means of the tensometric sensor fixing water column height over a point of its installation. Indications were registered the indicator, located on a surface. At such way the operator's mistake was practically excluded.

The type of indicator schedules at stages of indignation and restoration is characteristic for a well, imperfect on extent of opening and is described by dependence, the close logarithmic. As shown Hantushy M.C. [3], it is characteristic for an imperfect well formation of water inflow in which has difficult character.

Processing of initial and final pieces of schedules of indignation, temporary at stages, and restoration is executed by method of a linear anamorfoza. On these sites dependence of S (lnt) with high degree of reliability is approximated by a linear trend, but slopes of lines of a trend, so, and water conductivity coefficients, differ in 4,4 (at an indignation stage) – 5,8 (at a restoration stage) time. Therefore, the water conductivity coefficients received on initial sites of skilled points in corresponding to number of times will be underestimated.Results of skilled works are used for calculation imperfection indicator ε wells after transformation of a formula of Teys:

$$S = \frac{Q}{4\pi km}(\ln\frac{2{,}25at}{r_0^2} + \varepsilon); \quad (1)$$

$$S = C(\ln\frac{2{,}25at}{r_0^2} + \varepsilon); \quad (2)$$

$$\Delta S = C \times \varepsilon; \quad (3)$$

$$\varepsilon = \frac{\Delta S}{C}. \quad (4)$$

In formulas (1) and (2) S – the actual lowering of the level, in a formula (3) ΔS – a difference of decreases between the actual value (an imperfect well) and a calculated value (a perfect well) which is determined by the equation describing a linear trend of the corresponding site of a skilled curve; With – the slope of linear trends.

The analysis of results of calculations of an indicator of imperfection allows to conclude:

– value of an indicator of imperfection of a water well isn't a constant and decreases during a stage of skilled works (operation);

– imperfection of a well is approximately equally shown in formation of decrease at stages of indignation and restoration (for this pumping I made 10 m);

– influence of imperfection of a well most significantly in an initial stage (20-25 minutes for the studied well) from the beginning of a stage of skilled works that it is necessary to consider when performing express pumpings – their duration in each case is defined by degree of imperfection of a well and has to be sufficient to track decrease in an interval of time when imperfection can be neglected.

At the forecast of decrease at operation of a water intake the coefficient of water conductivity pays off as average value for final linear sites of schedules of tracing at stages of indignation and restoration. The imperfection indicator in a formula (1) can be accepted according to skilled data at observance of a condition of equality of an output of pumping to the maximum load of a water intake at operation. This condition is especially important if the water intake functions in the faltering mode at uneven distribution of water selection within a day.

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GEOTECHNICAL INVESTIGATION FOR RESTORATION AND FURTHER ADAPTION OF THE ARCHITECTURAL MONUMENT ESTATE OF GOLITSYNS THE PUSHKIN STATE MUSEUM OF FINE ARTS

Sayko O.V.
Scientific adviser – Kuvshinnikov V.M.
saykoolya@gmail.com, Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze (MGRI-RSGPU); Russia Moscow

The Gallery of Art from the Countries of Western Europe and America of the 19th and 20th centuries is a new Department within the Pushkin State Museum of Fine Arts. The building was previously the left wing of the residence of the princes Golitsyn in 17-19th century. In 1928-1929 the main building was overbuilt by two new floors what resulted in the lost of pediment. In 2007 according to preparation for centennial celebrations of The Pushkin State Museum of Fine Arts (which took place in 2012) The Ministry for Culture of Russia in common with The Government of Moscow planned the creation of the a Museum town – united complex that will be situated on the territory belonging to The Museum. It is assumed to design and create the modern museum complex that meets all the innovations of the 21st century and to turn it to one of the most popular museums in the world. It should become the first modern museum complex in Russia.

Due to that fact, the restoration of Estate is carried out. The original view of the building will be returned and the underground space will be used beneficially. It is planned to build one floor with cellar eight meters deep under the Gallery.

In terms of geomorphology, the site is situated on the second fluvial terrace of the Moscow river [2]. The surface of the site was aligned with an altitude varying from 134 to 136 m. Natural relief is buried with a technogenic superficial formation (up to 5 m thickness), that predominately consists of sand with a huge amount of debris.

Geological structure of the site to 44,5 m top down composed of the technogenic superficial formation (tQ_{IV}), the Late Pleistocene lake-marsh deposits of mologo-sheksninskiy horizon ($h,l\text{-}Q_{III}^{mol}$), the Late Pleistocene alluvial deposits of the second fluvial terrace of the Moscow River (aQ^{2}_{III}), the Middle Pleistocene fluvio-glacial deposits (fQ_{II}) and Late Carboniferous deposits (C_3).

Underground waters within the studied cross-section are presented by two aquifer. According to the map of geotechnical division of Moscow by levels of danger of karst-suffosion processes the site is situated on potentially danger territory under existing geological and hydrogeological conditions.

The category of resistance of the site to karstification is defined as "V-Г" [4, 5]. During the geotechnical investigation there were no other hazardous geological process. Under the worst conditions the risk of economic loss by consequences of sinkholes and cenotes is significant and determines appropriateness of the antikarst protection on the site.

Significant changes of either geotechnical or hydrogeological conditions are not expected in the of work, excluding sectors with soils, that are potentially danger in suffosion and mechanical properties terms.

In that situation, a complex of activities, aimed at optimization of conditions for the functioning of the building, has to be performed. Here are the list of priority activities:

To work out a project and complete a replacement of technogenic soils by sandy priming in sectors, where basement will be constructed. This has to be done before the start of underground space development;

Design work of restoration of the building and development of underground space [3];

To create an observation network for geodetic monitoring of deformations of buildings before the restoration and development, during works and at least after completion of works [1].

The analysis of archive materials, laboratory data and visual description allowed to distinguish 23 geotechnical units (GU) on the site.

Wherein almost all of the sand sediments are resistant to suffosion except GU 10б (gravel sand, dense), where the possibility of suffosion washing was revealed. The weakest soils by bearing resistance on the site are loose sand of GU-2a and GU-2в. While seal failure of soil is taking place in GU-2в. Therefore, GU-2a and GU-2в have low rates of strength and strain properties, what in its turn is potentially dangerous for ordinary maintenance and restoration of the building, that requires special attention due to the possible building's settling. The mixed aquifer complex also could be included in the affected area, however, it does not have direct influence on the building and, moreover, is sufficiently protected by thick aquiclude composed by glacial deposits.

In the light of foregoing, significant changes of geotechnical or hydrogeological conditions are not expected almost on almost the entire territory of the site, excluding potentially dangerous areas with soils that are unreliable in suffosion and mechanical aspects.

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S-XIV

ECONOMICS, MANAGEMENT AND LEGAL FRAMEWORK OF ENVIRONMENTAL MANAGEMENT

FEASIBILITY STUDY OF TECHNOGENIC WASTE REUSE

Norkulov D.N.
Scientific supervisor –**A.A. Mautina**
Russian State Geological Prospecting University named after Sergo Ordzhonikidze (MGRI-RSGPU), Russia, Moscow

A technogenic deposit is an accumulation of mineral substances on the Earth surface or in mine openings formed after they were detached from the ground and stored as wastes of mining, mill, metallurgic and other industries and suitable for industrial use in their quality and quantity.

Technogenic deposits include:

- mine dumps
- tailing dumps of mills
- ash and slag disposal areas of combined heat and power plants
- stored waste of metallurgic and other industries

Recently, technogenic deposits have been of the utmost interest, since their reuse will enlarge mineral raw material base, especially for those mineral resources, which it becomes harder to extract.

Technogenic deposits become even more important source of mineral raw materials. The developed and developing countries produce on average up to 80% of aggregates from the overburden rocks, up to 20% (over 30% in the US) of copper from oxidized copper ores and mill tailings using bacterial and acid leaching technologies. The total content of useful components accumulated in the technogenic deposits for 20-30 years is equal or even more than it is annually extracted in the ores.

Today the interest to reuse of technogenic resources is escalating and becomes vital.

The economic feasibility of waste processing and manufacturing of market products from the waste allows to:

1) reduce power costs (the expenses on the implementation of power saving technologies are 5 times less than the expenses on the extraction and production of primary energy sources)

2) contribute to the construction complex development (e. g., metallurgic waste is a source of cheap and high-quality raw supplies for construction material manufacturing)

3) enlarge mineral raw material base of ferrous and nonferrous metals (e. g., ash and slag dumps of coal mining and coal washing contain many rare elements with the concentration of tens or hundreds grams per ton)

The ecological feasibility of technogenic waste processing is to improve the environmental conditions (to free several thousand hectares of land occupied by the dumps and industrial wastes).

The social feasibility of technogenic waste processing is to create new workplaces, increase the level of self-employment and extend the taxation base.

The peculiarities of technogenic deposits are:

1) complex mineral formations

2) resource value of wastes in extraction and processing of mineral raw materials

3) run of mine mainly disintegrated on the Earth surface

4) the amount of extracted resources can be more than in a common deposit

Tungsten production is considered to be the most engaging alternative in the future development of technogenic deposits.

The technogenic deposit «Ingichki» has large amounts of wastes reaching 12 million tons. OOO INTEGRA RU has developed the process flow diagrams that had allowed to extract WO3 from these technogenic resources.

The tungsten production has allowed OOO INTEGRA RU not only to provide resources to the Uzbek industrial complex of refractory and heat-resistant metals, which products are of great demand throughout the world, but also to create new workplaces and solve a number of other problems.

OOO INTEGRA RU has developed not only the technology of WO3 extraction from Ingichki technogenic wastes, but also the technology of high-quality cement production. These developments allowed Russia and Uzbekistan to establish the joint venture «Ingichki Metals».

The modern technologies developed by OOO INTEGRA RU allow to use the technogenic resources very effectively.

The enrichment technologies of OOO INTEGRA RU allow to solve important tasks on involving the technogenic resources in production of rare metals, thus improving the environment conditions and social situation in the region due to new workplaces.

Everything mentioned above proves the relevance and the national economy importance of processing and mining, metallurgic, fuel, power and chemical waste disposal.

As my research has shown, the production of these technogenic deposits using the technology developed by OOO INTEGRA RU together with Navoi mining and metallurgical integrated works gives positive results and solves a number of social and economic problems. This can improve the use of the stored waste in other deposits.

To solve this problem, the following steps have to be taken:

- inventory check and classification of the technogenic wastes
- general evaluation of mineral and raw materials potential of technogenic wastes
- regional classification of the technogenic deposits and allocation of the priority objects for potential use
- geological, economic and cost evaluation of priority technogenic deposits to be developed
- suggestions on geological, economic and legal platform to prepare the technogenic deposits for commercial development

All these issues have to be reflected in a target program of involving technogenic deposits into commerce.

The interest to the technogenic deposits is going to increase as far as the large natural deposits are petering out and the growth of industry demands. The implementation of innovative technologies in the technogenic waste processing will allow to make the deposit development economically effective and have positive impact on the social and ecological situation.

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GOLD AS A FACTOR IN MAINTAINING THE RUSSIAN FEDERATION'S NATIONAL SOVEREIGNTY

Gaganov S.Yu.
S.Y.Gaganov@gmail.com, VTB Leasing (OSJC), Moscow, Russia

The national gold reserve accumulated by the state and the population is a “currency without a country”, acting as an “insurance” fund in the time of economic and political instability. The national gold reserve is a critical resource component of many industries and a budget-forming source for the state, which helps to decrease the country’s dollarization level and strengthen the state’s financial sovereignty, and economic and national security.

Thanks to its non-debt features and its lack of financial liabilities, gold is traditionally recognized by the population as a measure of wealth. It's unique properties make gold a factor of stability for the national economy and a limited resource for strategic industries, such as defense, chemical, machine building, electronics, telecommunications, healthcare, and innovative gold application, including the technology sector.

Under the current sanctions and the Russian Federation's restricted access to foreign capital markets, de-dollarization is one means used to protect the national economy.

An increase in the amount of transactions with gold in the domestic market through the introduction of new financial instruments and payment systems will contribute to a decrease in the state’s dollarization level, as well as to the development of payment relations, which, in turn, will stimulate growth in production, exchange and consumption.

In 2013, Russia was the 3rd top gold-producing country in the world by production volumes, beating the USA and Peru. In 2014, Russia was second only to China, having outperformed Australia. In gold balance reserves, Russia is second only to SAR. Thus, the gold market plays a very important role in the development of the national economy [3].

The Russian gold market has the following special characteristics: low extraction costs; high profitability compared to other industries; significant volumes of placer gold extraction; large gold deposits with internationally confirmed quality; a large number of understudied prospective deposits; a high level of industry consolidation; the need to attract investments due to changes in mining technology; high competitiveness of the national jewelry sector. In addition, the Russian market has enough capacity to absorb physical gold in various forms (from ingots, coins, and jewelry to banking instruments). Therefore, it is possible and economically viable to increase gold mining in Russia, in order to, among other things, support the stability of the country’s social and economic development.

It is possible to strengthen Russia’s position in underdeveloped areas of the Far East and Siberia by strengthening gold mining infrastructure. The volume of state gold reserves is an additional reliability indicator for investments and affects the state’s position in the global economy and politics, as well as the level of investors’ trust. The importance of the gold reserve is primarily due to the fact that the gold value does not depend on a country’s economic development and is not a liability, but is recognized as an alternative to mainstream global currencies.

A period of low gold prices is favorable for increasing the state's and individuals' gold reserves.

As of January 2015, Russia was no. 5 in state gold reserves, after USA, Germany, Italy, and France [5]. However, China (no. 6) last reported its gold reserves in 2009. According to Bloomberg, the actual gold reserve in the People’s Bank of China is twice as large as official numbers [2]. Thus, China aims to curb the growth of gold prices in order to further accumulation the metal. The growth of the gold reserve will contribute to the strengthening of the yuan as a global currency. The opening of access to Shanghai Gold Exchange in September 2014 [4] is the next step towards establishing a global gold trade center in China, which, in the future, will help control gold prices.

The New Development Bank established in 2014 by BRICS countries [1] may become an alternative to financial organizations such as the International Monetary Fund and the World

Bank, by changing the state of the current financial and currency system through an increased role of gold.

It is the author's opinion that, given the aforementioned, it is necessary to stimulate the demand for gold in the domestic market, in order to accumulate this precious metal within the nation. This, in turn, will help strengthen the gold mining sector in Russia.

Developing a trade infrastructure for gold coins and ingots, as well popularizing investments in gold may be one means of motivating players in the precious metal market.

Measures to stimulate and develop the precious metal market will contribute to private acquisitions and hoarding of gold. Using the accumulated gold, people will be able to provide for the financial future of themselves and the nation in the event of inflation, stressful situations, crises with the global reserve currencies, economic or political crises, and wars.

The current pace of gold extraction, limited reserves of this precious metal, global population growth, and emergence of new applications for gold application are helping to maintain a minimum gold price. Thus, during cyclical shifts in the economy, gold, in the long-term, preserves its purchasing power relative to other commodities and maintains a growth tendency.

To forecast the demand for gold and to achieve target demand indicators that are beneficial for the state, it is necessary to develop and apply an organizational and economic instrument to control the demand for gold. This instrument will be a combination of regulatory, organizational, and economic control elements.

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WAYS TO ENSURE QUALITY OF THE WORKFORCE COAL THROUGH THE FORMATION OF PROFESSIONAL COMPETENCE

Kalacheva L.V., Savon D.Y.
piv1961@inbox.ru, JSC «Central Research Institute of Economy and Scientific and Technical Information of the coal industry», Moscow, Russia
di199@yandex.ru, National Research Technological University «MISiS», Moscow, Russia

For successful implementation of measures for vocational training coal industry must perform a complex of measures to implement the concept of improving the system of training, retraining and advanced training of personnel for the organizations of the coal industry. Mining production is not only dangerous, but also sophisticated in every way – this technology and equipment that are changing very quickly, and adapt to the rapid changes can, of course, only the young, educated professionals, regardless of their specialization [1].

Now the coal industry is growing shortage of skilled workers, especially young engineers and technical workers. The key factors are the decline in the prestige of working professions, high levels of occupational exposure in the coal mining industry, unfavorable demographic situation, caused a shortage of manpower, lack of effective programs to fill the human resource capacity in enterprises sector, the proportion of broken in the training of higher and secondary vocational education. The fact that young people lost interest in trades, influenced by many factors. Only 10% of the graduates of the Mining University are working on a specialty [2].

The main reasons for non-compliance and the existing structure of the functions required of staff of the coal industry are professional incompetence, structural imbalance and lack of information system.

In accordance with the concept of action in the labor market to provide upgraded and newly created jobs necessary human resources provided to balance the structure of vocational education and vocational qualification structure of labor demand through the following measures:

- review of trends and levels of training, taking into account the forecast demand and supply of labor with an appropriate structure for vocational education to labor market needs;
- development of professional standards for levels of vocational education to meet the needs of employers, are the basis of certification of personnel, creating conditions conducive to equal access to industry and professional labor markets;
- development of target programs of vocational guidance of young people, contributing to the formation of personnel of the coal industry;
- organizing awareness-raising campaigns to enhance the prestige of mining professions using the media and modern information technology.

One reason for the separation of higher education on the requirements of modern industry is the specificity of the current situation in Russia, where "business is not focused on the strategic objectives, is more primitive technological structures." Fascination with the formal side of things afield our education away from the world development, and our engineering training creates a negative value. Educational institutions throughout the world behind for the learning styles and needs in the general skills required workforce for the 21st century. The Russian education system late reacts to changes taking place in the domestic economy. Schools do not keep in touch with corporate recruiters and even more do not know about the needs of the business. In today's world of rapidly growing competition for qualified technical profile not only between companies but also between states. The main reason for low productivity and the introduction of modern technical solutions and technologies in the coal industry is the lack of absorption and use of global experience in the field of research, design and education, as well as fragmentation and disunity of coal companies research, design and educational institutions (organizations) mountain profile [3].

In accordance with the already created the preconditions for association of universities that train specialists within related UMO involved in a single issue of subsoil (exploration, mining, oil and gas complex) would undoubtedly provide a synergistic effect on the set of relevant science and technology in general. More effective in this case, there would be no cooperation with relevant universities and sector research centers. At the moment, the creation of mineral universities expedient at universities that have the greatest potential in the field of training of qualified personnel for the fuel and energy complex. In this case, the processes of globalization, the rapid pace of technology development placing ever-increasing demands on the quality of labor resources, their continuing professional growth. The level of training of graduates and content of the programs should be evaluated through technological processes. Addressing global challenges of development sectors of the economy, improve product quality can not occur in the absence of a modern and innovative system of training of highly qualified personnel.

To remedy this situation requires joint efforts of public authorities, employers, educational institutions, trade unions and social organizations. It also requires update of vocational education programs, the introduction of professional educational standards and their approval for the mining industry of the country. Precautions should be taken to implement the initiatives in higher education in relation to issues of quality staffing mineral complex country. Now it is necessary to intensify cooperation of the business community and educational institutions in order to ensure a continuous process of quality of excellence. To ensure the needs of enterprises and organizations of the coal industry needs to structure the training of specialists with higher and secondary vocational education and the amount of the issue-oriented work in the industry specialists meet the needs of the industry.

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DEVELOPMENT OF SOLID-MINERAL DEPOSITS: FOREIGN EXPERIENCE AND ITS TRANSLATION INTO RUSSIA

Lapteva A.M.
lapteva@mineral.ru, "Mineral" Center, Aerogeologiya Scientific and Production Enterprise, Moscow, Russia

The low investment attractiveness of the objects of Russian mineral resources base for the majority of solid minerals has long been a commonplace. However, it is far from always clear as to what factors govern the attractiveness of a facility and whether those factors can be adjusted. To apprehend all aspects of this problem, experts of the "Mineral" Center, Aerogeologiya Scientific and Production Enterprise, have carried out comparative analysis of the major characteristics of about 260 designs of mining enterprises intended to develop over 20 solid minerals in 59 countries, including Russia. The analysis embraced the geological characteristics of raw-material deposits, for which projects had been developed, the economic and geographic conditions in the relevant areas, as well as the engineering and technological parameters of the anticipated facilities.

The studies suggest the following conclusions.

1. Among the factors that influence the efficiency of mining projects, the main is the market of the raw material underlying the project. The situation in this case is reflected in the market prices for the enterprise output. A prerequisite for the successful commissioning and further implementation of a project is a correct and reliable forecast of market price dynamics (in the ideal case, for the entire period of enterprise activity), taking into account all factors that can influence such dynamics.

2. The choice of promising deposits will not be determined by characteristics such as the volume and quality of ores and their geological–technological type. The deposits accepted for mining in the world are not only large or gigantic, but also small ones. Such deposits can serve as a basis for fast-money projects – enterprises with operation period of 5–10 years, relatively low capital investments, and short commissioning and payback (most often, 2–3 years) periods. Such projects can be related with different types of raw materials, including iron ores, assumed to require large volumes of mining.

3. When the reserves of a deposit are large, the project may involve only a part of the total resources identified at the deposit (i.e., the total of measured, indicated, and inferred resources), this part being quite small in some cases. The decision as to what part of the ore is to be involved in mining will be made basing on the ore quality and mode of occurrence, as well as on the amount of information available on the deposit. The future fate of the resources laid aside at the first step will largely depend on the market situation.

4. The quality of ore depends mostly on the technological potential of its efficient extraction, rather than its metal content. The extraction process can be efficient for not only rich or medium-grade ore, but poor ore as well, provided that extraction processes are available ensuring the low cost of the commercial output.

5. The quality of ore to be processed can be regulated by selective mining or selective use of the mined ore. The possible scenarios include

– Primary processing the best part of ore, followed by the involvement of its poorer part.
– Mass mining of the entire ore, followed by its separation by quality and storing of poor ores for processing at the later stages of development. In such case, all mining expenses fall in the period of the highest efficiency of production maintained by the processing of high-grade ores. Once all ore is mined and its richest part is processed, lower grade ore can be processed if the market situation is favorable. In this case, mining expenses are excluded from the structure of production expenses, thus reducing the cost of production output.
– The selective processing of a small but the best ore in a deposit, which is altogether economically unpromising at the given technological level of the sector and/or under the

current market situation. This reserves the perspective of the further development of the deposit in case market conditions change and/or a new technology appears. A common practice in the implementation of such scenarios is to design small short-living enterprises based on large deposits.

6. Analysis of the economic–geographic conditions under which mining projects are being developed has shown that of real significance is the development level of transport infrastructure, rather than the territory as a whole. Two situations can be identified:

– The project is being implemented in areas with developed road network, which can be used for the transport support of the project with an insignificant modernization (the most typical case) if any. Only short approach roads to the facility are to be constructed. An exception is projects involving the deposits of solid minerals requiring large ore volumes to be transported, implying considerable modernization of the available roads or the construction of new ones. In such cases, the transport problem can be solved (a) at the expense of the company implementing the project; (b) by joint efforts of several companies, which implement nearby projects; fully or partially, at the expense of a third party.
– The project is being implemented in areas with poorly developed road network of any level – such projects are few and generally aimed at the construction of large-scale long-living enterprises, including those requiring the mining of large volumes of ores. An often solution involves the participation of governmental structures of different levels or the cooperation of several subsoil user companies.

In what regards Russia, the development problems of its mineral resources base lie in other spheres than this base itself. Our analysis has shown that there exist several deposits, whose qualitative and quantitative characteristics not only meet the current requirements of the mining industry, but are far in excess of analogous deposits being developed in other countries. However, there is no call for such deposits. These include, for example, the Deputatskoe tin and Tyrnuauzskoe molibden–wolfram deposits. The causes, in addition to the specific business conditions in Russia, include

– An extremely complicated transport situation in the major raw-material regions of the country, which excludes the deposits they contain from the sphere of economic interests, whatever the quality of those deposits (this is true even for the highest quality deposits). This situation can be hardly changed without governmental participation.
– The tendency, typical of Russia, toward large and gigantic projects with long operation periods, which can be implemented only by large companies. Smaller projects are of no interest for such subsoil users. The result is many neglected deposits which could serve as a basis for small but efficient enterprises.
– The identification of the notions of *selective mining* and *stripping the cream of a deposit*, resulting in that deposits that can yield some profit yield nothing.

EFFICIENCY – INDICATOR OF GEOLOGICAL PROSPECTING ORGANIZATIONS

Leonidova Y.A.
Research supervisor: Professor, Dr.Sc. (Econ) **Nazarova Z.M**.
yuliya-leonidova@ya.ru, Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze (MGRI-RSGPU), Moscow, Russia

Efficiency – one of the most pressing problems of economic science. Economic activity at both the micro- and macro-level involves the comparison of results and constant costs, to determine the most effective course of action.

This problem is most relevant in the mineral resources complex. Mineral resources complex plays an important role in all spheres of the country: the development of the raw materials industry contributes to a strong industrial base; production of mineral complex continues to be a source of foreign exchange earnings; almost all large companies that are part of the mineral complex or related are major employers. The situation in the mineral sector of the economy is very complex, due to a number of problems to be solved in the near future. Despite the importance, today the problem of efficiency in the mineral complex is not sufficiently studied. The study of this issue in our country over the years engaged many scientists and economists: Agoshkov M.I., Azroyants E.A. Astaf'eva M.P., Borisovich V.T., Byhover N.A., Karasevich A.M., Kobakhidze L.P., Komarov M.A., Kosyanov V.A., Melekhin E.S., Nazarova Z.M., et al.

Currently, the study of scientific papers showed that there is no single formulation of the concept of efficiency, there is no consensus on the methods of evaluating the efficiency of a mineral resources complex. Moreover, in the scientific literature often confused the concept of "effect" and "efficiency".

"The effect – a result achieved in its material, monetary, social expression." [6] The effect is not enough characterizes the organization. Economic efficiency indicators used for more complete characterization, determining what cost to obtain this effect.

In modern economic literature there are many interpretations of the essence of the concept of "efficiency." For Example: in general terms, effectiveness ratio of the result (effect) to total current costs and is calculated as follows:

Efficiency = work output/work input.

This ratio shows what the price of costs achieved economic effect. The larger and less cost effect, the higher production efficiency, and vice versa.

"Efficiency – is the relative effect of processes, operations, project, defined as the ratio of the effect, the result to the costs, expenses, contributing, to ensure its receipt." [6]

"Efficiency – is to achieve any specific results at the lowest possible cost, or the maximum possible volume of production from a given amount of resources." [2]

Efficiency exploration work is the impact of the cost of exploration and reconnaissance units of mineral reserves.

Type values is the main difference between the two most important economic category, "effect" and "efficiency". If the "effect" – the absolute value, then the "efficiency" – relative.

Efficiency is classified according to various criteria:

1. According to the results: economic, social and socio-economic.
2. The types of economic activity: the effectiveness of trade, industrial, insurance, banking and other activities.
3. In terms of facility management: efficiency of the economy as a whole, the efficiency of the industry, the efficiency of business combinations, the efficiency of structural units, the efficiency of production of certain products.
4. The level of evaluation: efficiency levels of society and the effectiveness of the level of the subject company (management).
5. Terms evaluation: conventional, real and calculated efficiency.
6. The magnification effect: primary and animated efficiency.

7. Objectives definition: absolute and comparative efficiency.
8. Types process: management effectiveness, efficiency of production processes, the effectiveness of innovation, investment, financial, marketing and other activities.

Efficiency – an indicator of development, as well as its most important stimulus. Identify specific measures occurs when an effort to increase the efficiency of a particular activity or a combination. These measures contribute to the development process and cut off those that lead to regression. The efficiency, in this sense, always linked to the practice. Efficiency becomes a target benchmark of administrative activity, directs this activity into the mainstream of reasonableness, necessity, justification and adequacy. Value increases the efficiency of enterprises in the market economy. High efficiency is the foundation of high competitiveness, sustainability and improve the condition of "market forces" of the enterprise.

In mineral complex, there are many industry characteristics that do not allow the use of traditional methods of assessing effectiveness. Difficulties in assessing the effectiveness of geological exploration arise primarily because geology makes the product suitable for immediate use. You must also remove the minerals. This makes it difficult to estimate the costs associated with the manufacture of the product. Thus, the evaluation of the effectiveness of exploration work requires a reliable forecast value of the total cost of obtaining the final product, while the exact calculation lends itself to only some of them.

This problem requires further research.

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THE STATE SYSTEM OF TECHNICAL REGULATION AND STANDARDIZATION IN THE GEOTHERMAL ENERGY INDUSTRY OF RUSSIA

Rustamov N.A.
narimrust@gmal.com, Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze (MGRI-RSGPU), Moscow, Russia

The state system of technical regulation of the Russian Federation is based on norms and rules practiced in the European Union (EU), and aims at the harmonization of work in this area with the European counterparts, which is one of the main conditions of integration of the Russian Federation in the EU and work in the World Trade Organization. The starting point in the creation of a modern national system of technical regulation was the adoption of the Federal law of 27.12.2002, № 184-ФЗ "On technical regulation" and its subsequent amendments, aimed at improving its efficiency and effectiveness.

The conceptual position of the law is ([1]) use a two-tier system of normative documents: technical regulations, which contain mandatory requirements and national standards, executable on a voluntary basis.

The system of technical regulation is intended to ensure the interests and requirements of the state in the promotion of goods and services, promote economic development, protect the life and health of citizens, environment, material assets.

Technical regulation includes legal regulation in three areas: technical legislation, standardization, conformity assessment.

The main legal document of the system of technical legislation is technical regulations – the law of mandatory application in scientific and technical sphere.

A more flexible tool of state regulation and management of economic development is the system of national standards. A standard is a document voluntary application, and it works when the contractor understands the benefits of the application of national standards. Basically, the standard is a mechanism of self-regulation. National standards are developed and adopted in support of the technical regulations. In the absence of technical regulations, national standards are the main normative-methodical base of state regulation, organize, and promote development of the industry.

The first in the history of Russia hydrogeothermal power plant (the Plant) was built in 1966 on Pauzhetskaya geothermal field in the South of the Kamchatka Peninsula. The installed electric power station was 5 MW, and later was increased to 14.5 MW [2]. Plans for the development of geothermal energy in Kamchatka – the most promising region of Russia with large hydrothermal resources (total removal of heat from the hot springs of Kamchatka in natural conditions estimates given in [3] reaches 2300 MW (thermal), including high-temperature hydrothermal systems – 1780 MW (thermal)), implemented starting in 1999, the top-Mutnovskaya geothermal power Plant (12 MW) and Mutnovskaya geothermal power Plant (50 MW). Also on the island of Kunashir in 2001, had been put “Mendeleevskaya” Plant (3,4 MW), and on the island of Iturup in 2006 enacted the “Ocean” Plant (3,4 MW).

Operation of the Plant under difficult environmental conditions of Kamchatka gives a great practical experience, combined with the experience of carrying out of repair works and modernization and improvement of systems and technologies.

In addition to the Kamchatka region in Russia there are other promising from the point of view of the use of hydrothermal resources, areas, often discussed by the experts on various forums. These are, for example, areas of the North Caucasus, Krasnodar and Stavropol territories, the Baikal region, Kaliningrad, Yaroslavl and others [2].

In recent years, actively develop technologies for the use of "hot dry rock" (see, for example, [4]) – petrogeothermal energy. With regard to these technologies, geothermal energy is one of the most promising directions of development of alternative energy in Russia.

But, unfortunately, at the state level of technical regulation is not sufficient normative-methodical documents, providing government influence and regulation of geothermal energy, and the situation in this part can only be assessed as catastrophic.

In 1994 the Institute of standardization has developed recommendations P 50-605-86-94 "Geothermal Energy. The method of determining the resources." But, apparently, the document is lost and the continuation of these works was not followed [6]. In addition to these recommendations, there are standards of organization JSC RusHydro CTO 70238424.27.100.060-2009 "Geothermal power plant. Conditions of creation. Standards and requirements" and a CTO 03.01.94-2013 "Geothermal power plant. Determination of energy efficiency of geothermal fields. General provisions". It should be noted that standards of organizations are internal normative documents of the organization and are not accepted as national standards.

From 1st January 2014 on the territory of the Russian Federation entered into force two new national standards, developed in 2012 by NIIES RusHydro: ГОСТ Р 55004-2012 "Renewable energy. Geothermal power plants. Facilities. The security requirements. General provisions" and ГОСТ Р 55005-2012 "Renewable energy. Geothermal power plants. Safety requirements during operation" and they are the first national standards in this industry, despite almost fifty years of experience in the creation and operation of the Plant in Russia.

Thus, it can be argued that geothermal energy is not provided regulatory and methodological documents regulating its development in the country. Facts development of geothermal energy in countries such as USA, Italy, Iceland, Indonesia, New Zealand, Mexico ([5]) show that geothermal energy is an important energy resource and sooner or later Russia will begin the active period of the development of geothermal energy, which is necessary to provide normative-methodical documents, on which work should begin today, using existing in-country experience.

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SEPARATE INSTRUMENTS ON MAINTAINING ECONOMIC SECURITY OF RUSSIAN ENTERPRISES IN MINERAL RESOURCES SECTOR OF ECONOMY UNDER THE CONDITIONS OF "WESTERN SANCTIONS"

Israilov M.
Scientific Advisor: Ph.D. in Economics, **V. Abramov**
Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze (MGRI-RSGPU),
Moscow, Russia

Crimea reunion and the beginning of large-scale armed conflicts on the territories of adjoining states as well as on the territories of Russian Federation's key partners on the world political arena marked the last year for Russia.

Thus, the armed conflict on the territory of Republic of Ukraine became a motive for EU, the Commonwealth of Australia and the USA to impose a range of "restricting measures" towards our Motherland, such as delivery and reexport of goods, services and technologies for oil prospect projects and oil extraction in deep-water districts, arctic shelf and shale stratum to Russian companies.

The list of equipment prohibited for delivery include drilling rig, horizontal drilling details, subsea equipment, sea equipment for Arctic conditions, software and hydraulic fracturing method equipment for oil and gas extraction, remote operated underwater vehicles, booster pumps, compression facilities, seismic exploration equipment, and chemical agents.

Besides, armed conflict on the territory of Syrian Arab Republic made a serious attack on Russian producer companies' external assets. In 2003 *Tatneft*, in particular, was the first company to win a tender for oil and gas prospect and extraction in Syria on production sharing agreement conditions, and in 2010 brought into production the first wellsite in *Yuzhnaya Kishma* field. In the country oil is extracted by *Soyuzneftegas*, *Stroytransgas*, that has already built a gas plant and gas pipe in Syria, is executing a constructing project of the second gas plant with capacity of 1,3 billion cu m not far from ar-Raqqa. In 2008 it was announced that Northwest oil group won a tender for oil refinery construction near Deir ez-Zor. *Gazprom*'s affiliated undertaking – *Georesurs* was planning to take part in tender for oil well geological and engineering survey.

In the Republic of Iraq *Zarubezhneft* and *Tatneft* had drilling and extraction contracts. In December 2009 *LUKOIL* and Norwegian *Statoil* group of companies won a tender for West Qurna-2 exploration. Field reserves being extracted are estimated at about 12,9 billion barrels of oil. *LUKOIL*'s part in the group of companies is 85%, and *Statoil*'s – 15%. According to the tender conditions, group of companies' 25% should be delivered to Iraq state company. Therefore, LUKOIL's part will total 63,75%, Statoil's – 11,25%.

The second Russian oil company to win a contract in Iraq was *Gazpromneft*. In the beginning of 2010 the company as a group of companies' operator (30%) won a tender for field development Badra having 2 billion barrels' reserves. The rest members of the group are Korean *Kogas* (22,5%), Malaysian *Petronas* (15%) and Turkish *TRAO* (7,5%). Iraq government has 25% of the project. Project execution is estimated for more than 20 years. It is suggested that oil production volume will total about 170 thousand b/d (8,5 million tons per year).

Given the situation actual practice establishes the following model of external threats for Russian mineral resources sector companies:

- access limitation to innovative technologies, which leads the rise in prospect and extraction prices on one hand, and less competitive effectiveness of mineral resources' usage on the other hand;
- low effectiveness of external assets due to social and political strains in abovementioned regions, and therefore, the absence of executed investment policy viability, which in conjunction with access limitation of Russian banks to foreign financing and increase in rates of Central Bank refinancing lead to financial deficit.

Taking into account combined vector of negative influence for Russian economy, to search single instruments for economic security maintenance we can address positive experience of companies in other sectors of economy.

The main airline company or the country – *Aeroflot*, in particular, demonstrated high effectiveness of defense mechanism of its low-cost airline project. July, 30 2014 EU announced imposing additional sanctions against Russian Federation resulting from Ukraine situation, where airline company *Dobrolet* got involved due to its only Moscow – Simferopol flight, the flight helped low-cost airline lighten Crimea integration into Russia. Sanctions are supposed to prohibit European companies against providing *Dobrolet* the access to financial resources and freezing active assets of the company in EU. They deprived *Dobrolet* of opportunity to insure its risks. Soon problems with ticket booking appeared, as airline company was dealing through American system *Navitaire*. August, 3, 2014 at 8 pm the company announced that as a result of EU sanctions "under the conditions of unprecedented pressure from European counterparties" the air carrier "is forced to put on hold its flights and ticket sales", and on the 4th of August the company ceases to exist. However, *Aeroflot* is not denying its obligations to customers, the completion of obligations is passed to another affiliated company *Orenburg airlines*, September, 16, 2014 establishes a new low-cost airline company *Pobeda,* in other words, *Aeroflot*'s management having reregistered the legal body bypasses "restricting measures" imposed by some foreign countries.

In respect to mineral resources sector of Russian economy, it seems possible to use combined instruments to maintain economic safety under the conditions of "Western sanctions", such as reregistration of legal bodies, establishment of affiliated legal bodies abroad, use of pseudo-debt obligations to off-shore companies etc.

As a possible way to establish a company belonging to mineral resources sector of economy, having external assets, under the recent conditions we suggest the model for registration of affiliated legal bodies in the countries taking part in anti-Russian "sanctions", and pass them external assets using bogus transactions and burden newly established affiliated company with pseudo-debt obligation to affiliated off-shore legal body, and therefore, transfer the external assets' profit to off-shore companies, and therefrom taking into account "financial amnesty' functioning now, transfer the money to parent company's accounts.

Negotiation of limitations in equipment and technologies purchase is possible with registering companies in the Customs Union, and purchase on behalf of these companies, indicating a final purchaser outside the Russian Federation.

Withdrawal of Russian companies' funds frozen in foreign accounts is easily accomplished by providing commercial court with notices of call in counterparty-country from the 3d country legal body, and the following money transfer with the help of the before mentioned scheme of pseudo-debt obligations to off-shore companies.

THE USE OF THE EARTH'S INTERIOR IN RUSSIA FROM THE STANDPOINT OF POLITICAL SCIENCE: THE NEED FOR "SPECIAL" INNOVATION

Bobylev Y.A.
Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze (MGRI-RSGPU), Moscow, Russia

Russia in the period of crisis its subsoil and the economy as a whole. In 2014 took place almost two-fold decrease in world market prices for oil, which sharply reduced export revenues of the state budget and oil and gas companies. For the future much for Russia deteriorated and international geopolitical situation in the force caused severe Ukrainian-Russian conflict. Suddenly Russia has become a "dangerous opponent" in the military and geopolitical relevant to the United States and such large and influential countries of Western Europe like the UK, Germany and USA. Against the oil and gas business in Russia not only introduced tough sanctions, but began trading system-industrial war.

In this connection it is necessary to «МГРИ-РГГРУ» increased attention to the study of the characteristics of global trade wars. Required courses and new topics for bachelor and master students of the Faculty of international relations and economic and legal foundations of subsoil and of the University as a whole.

According to world Bank estimates, the share of natural capital in the structure of national wealth of Russia is about 70%, while in human capital accounts for 20% of material (i.e., artificially created) – 10% of the wealth. In the developed countries of the Organization for economic cooperation and development (OECD) on natural capital accounts for only about 5%, human and material, respectively 85% and 10%. Question: Russia lives, violating the laws of the world economy? On the contrary, Russia has a large and poorly-developed territory (especially East of the Urals) and the vast resources of mineral resources, many of which have not yet been explored. According to estimates, the share of Russia in global reserves is as follows: oil – 10-12% gas 32 %, iron 25 %, Nickel – 33 %; potassium salts – 31 %. It should also be noted huge reserves in the Russian Federation fresh water, forests and other

Russia is doomed to large-scale, high-tech and cost-effective use of subsoil in the coming century, if only remain in the acute global struggle, including a variety of types of wars.

1. To survive, Russia is among the world leaders according to the latest ratings of military expenditures in the structure of its GDP. By the end of 2013, the Russian Federation occupies the 5th place, far ahead as a percentage of U.S. 31. See: http://www.vesti.ru/doc.html?id=2189632. On the contrary, in the Ministry of Finance of money on adequate development of Geology traditionally lacking. This financial feature can be felt in «МГРИ-РГГРУ». If, for example, in military-oriented studies, MIFI and Misa budget and extrabudgetary funds a visible excess, in civilian universities – an acute shortage and continued growth in the number of contract students.

2. According to the latest Report «Natural resources and the exploitation of mineral resources of the Russian Federation in 2012" (M.: 2013, 346 S.), in 2011-2012, the rising cost of exploration for solid minerals occurred in all regions of the world, but the fastest it has been in Latin America and Africa. And not Russia, and Latin America is currently the most attractive region for investment. In Mexico, Chile, Peru, Brazil, Colombia and Argentina, invested up to a quarter of the funds allocated in world exploration. Russia spends on exploration of solid minerals in the world the cost is only 3% (ibid, s 14). This report can be found on the website of the Ministry of environment.

3. Far-sighted politicians and economists of the European Union, especially Germany and France, would like one or other peaceful industrial and economic integration with Russia. For its part, Russia is extremely interested in attracting foreign investment to develop such large fields. However, all new shocks in the European Union and Russia do highly aggressive USA. Embargo on the transfer of Western knowledge-intensive oil and gas technologies in Russia will require

accelerated development and methods of applied Geology and Geophysics, as well as more effective organizations mining business.

4. As follows from the scientific literature, trade war trade rivalry between two or more countries in the world markets of goods and services. May be offensive trade war, conducted with the aim of capturing foreign markets, and mastery of the most important enterprises and organizations (especially banks, investment companies and others) and defensive trade war to counter the threat of foreign economic expansion and loss of economic and political independence. The study of causes, characteristics, occurrence and methods of waging trade wars is the subject not only of modern economic theory, but also national security.

5. Studied and described the basic methods of conducting offensive war: 1) reduction of customs tariffs; 2) increase of export quotas; 3) using dumping prices; 4) the credit growth of export deliveries of high-tech products (marine and aircraft power equipment for nuclear power plants, and others); 5) the advertisement of goods and services to foreign production 6) trade blockade on certain types of goods and services and other Methods a defensive war are: 1) the increase of import customs duties, including the use of egalitarian duties, providing for the increase in the price of the imported goods to the domestic price level to prevent dumping; 2) reduction of import quotas; 3) introduction of non-tariff barriers related to the complexity of licensing procedures and the growth of customs formalities; 4) introduction of technical barriers involving difficulties with compliance of imported goods with national standards and technical conditions and other

6. Unlike trade wars "industrial war" involve the creation and mass production of high-tech products (goods and services) and high priority funding areas of public and corporate R & D activities. In addition, qualified personnel for research, production and foreign trade. In relation to subsoil use in Russia needs the adaptation of such technology industrial trade wars and the introduction of «МГРИ-РГГРУ» and other resource universities of new thematic disciplines.

7. In the author's opinion, Russia's transition to “innovative economy", "competitive subsoil use", "building export capacity" in conditions of severe global competition requires the development of new "military-trading" organizational structures of management in leading ministries and departments of the country, especially in the Ministry of environment, Ministry of industry and trade and the Ministry of economic development. These new management structure should be integrated into the framework of the implementation of the strategic industrial projects services foreign intelligence and counterintelligence («ФСБ», «СВР»). It is proposed to call such new units in government and big business "Third division". As you know, the "First division" ensure the secrecy of the works and documents, the "Second division" work on mobilization plan (in the event of war or natural disasters).

8. In this regard, the geological community, including the leadership of the Ministry of natural resources and the Federal Agency for earth use, should strengthen their "offensive" against the Ministry of Finance and the State Duma in securing growth funding exploration and related activities (industry science, training, applied Informatics, publishing, international cooperation and others). Also need to improve the structure and function of the administrative staff in the relevant Federal ministries and departments.

9. Under the proposed strategy for the management of industrial and trade wars «МГРИ-РГГРУ» useful introduction training course "Business competitive intelligence and economic security".

METHODICAL BASES OF ESTIMATION OF EFFICIENCY OF CREATION OF MINING AND METALLURGICAL CLUSTER

Kosyanov V.A., Koryakina N.A.
kif9340000@yandex.ru, Russian State Geological Prospecting University
n. a. Sergo Ordzhonikidze (MGRI-RSGPU), Moscow, Russia

The development of iron ore deposits in South Yakutia (Taygnoe, Desovskoye, Gorkitskoe and Tarynnakhskoye) based on the cluster approach is an important industry and national tasks. Production of cheaper metal-based iron ore and coal deposits in South Yakutia will give an additional stimulus for the development of all industry in Eastern Siberia and the Far East region.

Evaluate the effectiveness of implementation of the investment project to create a mining and smelting cluster in South Yakutia, we propose to carry out the following fields.

1. **The economic effect**, which can be represented in the form of five elements:

– *Federal level:* GDP growth; revenues to the federal budget; production of products with high added value; multiplicative effects.

Given the nature of the subsoil use to the economic effect on the federal level should include further: ensuring national economy mineralnym raw materials, mining enterprises in the cluster, both the short and long-term perspective; implementation vozmozhnostey exports of mineral products and products of its processing enterprises cluster tselyu replenish foreign exchange reserves of the country; integrated development of mineral deposits within the cluster; rational use of mineral syrevoy base of the country (deposits, the development of which will carry out the enterprise, in a cluster, the introduction of advanced equipment and technology); expanded reproduction quality of the mineral resource base of the country (for exploration and expansion of the resource base of the cluster); development of new areas of the country in the implementation of the project on creation of mining and metallurgical cluster.

– *Regional level:* admission to the regional budget; infrastructure construction.

– *Local level:* local revenues, infrastructure construction.

– *Sectoral level:* the impact of the cluster on the activities of other organizations; the share of Russian companies-contractors to ensure production activities of the cluster.

– *The level of the cluster:* economic benefit of enterprises in the cluster (effect on the efficiency of investments, income, reduction of production costs of mining and metallurgical cluster, improving the economic and commercial enterprises cluster mechanisms, improving industrial safety and others.).

2. **Social benefits**, which can be represented in the form of two elements:

– *The level of social protection:* improving quality of life; reduction in immigration flows.

– *The level of the labor market:* increasing demand for specialized profession; the number of jobs for maintenance of the project; more stringent requirements for qualification of personnel.

3. **The political effect:**

– *External level:* the growth of global market share of Russian metal; increase the level of diversification of supply of the countries; cooperation with the world's largest companies for the production and consumption of steel products; ensure an uninterrupted supply of international contracts;

– *At the domestic level:* ukreplenie national independence of the Russian Federation in terms of the national economy obespechennosti mineralnym raw materials and products; increased attractiveness of the region for the action of the cluster of major international investment, thereby increasing the confidence of foreign investors in the country.

4. **Innovative effect** that can be represented in the form of two elements:

– *Technical and technological level:* technology and equipment, first used in the Russian practice or in international practice in the activities of mining and metallurgical cluster; adaptation of existing and promising new techniques and technology of extraction, enrichment and further processing of mineral raw materials to the conditions of the cluster structure of deposits; improving the efficiency of existing geotechnologies georesources conversion into products and resources; increasing the extraction of basic and associated components, completeness georesources potential use; improvement of operational and poprotsessnoe georesources conversion into products and new resources.

– *Scientific and educational level:* the creation of new skills, the development of training programs for personnel; development of fundamental and applied research and development work for the effective functioning of the mining and metallurgical cluster; the creation of new educational institutions, research organizations.

5. **Environmental effects:**

– Compliance with environmental requirements, the maximum safety of the surrounding sredy, increased environmental safety as a result of the introduction of advanced equipment and technology enterprises cluster.

NATURAL RESOURCES OF TAJIKISTAN, AS THE MAIN POTENTIAL INDUSTRIAL DEVELOPMENT STRATEGY

[1]Kholboboev F.S., [2]Kurbanov N.Kh.
[1]Plenipotentiary representative of the Republic of Tajikistan to the Committee on Economic Affairs at the CIS Economic Council, PhD; [2]Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze (MGRI-RSGPU), Moscow, Russia

In the context of globalization and integration of the countries and their involvement in global economic processes, the role of natural factors, as a basis for the development of the economy is steadily growing. This factor becomes the driving force of structural changes, the formation of new specialized industries and growth of the economy. In this regard, the assessment of natural resources of the country is defined as an important contributing factor to solve the problems of developing strategies.

Tajikistan's natural resources are very diverse. In the territory of the Republic there are many polyimides fields', rare and precious metals are revealed: zinc, lead, bismuth, molybdenum, tungsten, copper, gold, silver, antimony, mercury, Fluor spar, tin, uranium, bismuth, iron, manganese, sodium chloride, magnesium and others metals that have export potential. Known deposits of Tajikistan are gold mines of Panjakent and Shugnan, the silver deposit Big Koni Mansur mine, antimony mine of Anzob, marble deposits in Vanj, Panjakent, Darvaz, Shahristan and others. There are deposits of coal, gas, oil, marble and building materials.

Natural resources of the country can be defined as the initial basis for the development of the national economy. They consist of bioclimatic, land and water, energy and mineral resources.

Nearly a half of the territory of Tajikistan is located at the height of more than 3000 meters. Existence of mountains complicates the organization of internal transportation and communication, but at the same time, this factor is providing the Republic with rich hydropower resources

In the country the reserves of oil, gas and coal are explored. The main oil and gas region of Tajikistan is located in the Northern and Southern parts. In the Northern part of Tajikistan, there are 25 territories prospects for oil and gas. Currently 5 gas fields are open: Rawat, KaniBadam, North KaniBadam, Ayriton and Niyazbek. Explored and probable reserves of oil and gas in these structures confined to deposits of Paleocene age with depth 3000-5000 meters. In the southern part of the Republic, around 125 territories have prospects for oil and gas. Such gas-oil fields, as Komsomol, Andygensky, Kyzyl-Tumshuk, Kichik-Bel, Akbazh-Adyr, Sul-duza, Shaambara, Beshtentyak are open.Only in the territory of Tajikistan, balance reserves accounted for 30 oil and gas fields. According to the latest data, the potential reserves of oil and gas condensate in the Republic are 158 million tons, and gas – 875 billion m^3, including Northern Tajikistan: crude oil and gas condensate 56 million tons, gas – 61 billion m^3. However, oil resources exploited by 9% and gas – by 3.5%. According to experts, the total geological reserves of oil in Tajikistan estimated for 467 million tons and free gas – 1036 billion m^3.

On coal reserves, Tajikistan takes the leading place in Central Asia. The total geological reserves are about 4.0 billion tons. 80% of this coal belongs to the coked. In Tajikistan, there are more than 35deposits of coal, some of which counted for general industrial supplies. The largest of these deposits are: Shurab, Fon-Yagnob, Nazar Aylok, Kishtut-Zauran, Magion, Ziddi and Miynadu-Hayron. In 2011, coal mining was carried out only on Shurab field- about 200thousand tons (in 1990the volume of production was477thousand tons), Fon-Yagnob-20 tons and Nazar Aylok- about 15 thousand tons. All this covers only14% of the needs of the country.

A sharp decline in domestic production of coal in Tajikistan is due to difficult mining and geological conditions, drilling mines, wear mechanisms, reduced supply of lubricants, lack of spare parts for equipment, etc.

Today one of the main tasks to decrease fuel deficiency in the Tajikistan, is the organization of own coal industry through developing coal fields, such as Fon-Yagnob, Nazar-Aylok, Miyenadu-Hayron and Ziddi.

Thus, the coal industry inthe development strategy of the country's economy has quite a large part, because of it development of this industry in the future, not only to reduce the dependence on energy in Tajikistan, but also creates the necessary conditions for the transition to it sexport.

On mineral raw material resources, Tajikistan is rich with the most various types of minerals. In the Republic, explored and prepared for development about 400 deposits of more than 50 types of minerals. From the black and alloying metals in the territory of the Republic iron, tungsten and molybdenum fields are open. From non-ferrous and rare metals in a subsoil of Tajikistan lead, zinc, gold, silver, copper, antimony, mercury, tin, bismuth, strontium and aluminum raw materials fields are known. Recent years a large amount of exploration and scientific research, made it possible to identify deposits of fluorspar, boron, sand, glass, rock crystal. Mineral fields are open for chemical industry – dolomite and rock salt. The country has large reserves of raw materials for the industry of construction materials – limestones, plaster, mineral paints, marble, granite, lazurite, spinel, turquoise, amethyst, pomegranate, tourist's raspberries, sapphire, etc.

Tajikistan occupies one of the leading places among the CIS countries on reserves of strontium, antimony and table salt, on reserves of zinc, lead, fluorspar takes a leading place among the republics of the Central Asian region. In total in the Republic identified 500 deposits of rock salt, the reserves of which are huge and are in categories A+B+C1 – 3.6 billion tons, on the category C2 -71 billion tons

On reserves of non-ferrous metals Tajikistan is high on the list among the republics of Central Asia and can offer the world market goods which may contain silver, lead, zinc, bismuth, antimony, mercury, tin and many other metals. Reserves of silver are estimated 50 thousand tons, gold – about 400 tons. However, all of these resources in the country due to the capital intensity, especially mountainous terrain and inaccessibility used in miniscule quantities, and some have not even used.

In this regard, during the development of the national development strategy of the country for the period up to 2025, in industry section, the central place should be focused to priority sectors for efficient use of natural resources.

Thus, the hydropower, coal industry development, mining, non-ferrous metallurgy, chemical, light and food industries can become priority sectors in development strategy of the industry and increase an export potential of the republic in the short term.

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FEASIBILITY STUDY OF TECHNOGENIC WASTE REUSE

Norkulov D.N.
Scientific supervisor: Candidate of Economic Sciences **A.A. Mautina**
Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze (MGRI-RSGPU),
Moscow, Russia

A technogenic deposit is an accumulation of mineral substances on the Earth surface or in mine openings formed after they were detached from the ground and stored as wastes of mining, mill, metallurgic and other industries and suitable for industrial use in their quality and quantity.

Technogenic deposits include:

– mine dumps
– tailing dumps of mills
– ash and slag disposal areas of combined heat and power plants
– stored waste of metallurgic and other industries

Recently, technogenic deposits have been of the utmost interest, since their reuse will enlarge mineral raw material base, especially for those mineral resources, which it becomes harder to extract.

Technogenic deposits become even more important source of mineral raw materials. The developed and developing countries produce on average up to 80% of aggregates from the overburden rocks, up to 20% (over 30% in the US) of copper from oxidized copper ores and mill tailings using bacterial and acid leaching technologies. The total content of useful components accumulated in the technogenic deposits for 20-30 years is equal or even more than it is annually extracted in the ores.

Today the interest to reuse of technogenic resources is escalating and becomes vital.

The economic feasibility of waste processing and manufacturing of market products from the waste allows to:

1) reduce power costs (the expenses on the implementation of power saving technologies are 5 times less than the expenses on the extraction and production of primary energy sources)

2) contribute to the construction complex development (e. g., metallurgic waste is a source of cheap and high-quality raw supplies for construction material manufacturing)

3) enlarge mineral raw material base of ferrous and nonferrous metals (e. g., ash and slag dumps of coal mining and coal washing contain many rare elements with the concentration of tens or hundreds grams per ton)

The ecological feasibility of technogenic waste processing is to improve the environmental conditions (to free several thousand hectares of land occupied by the dumps and industrial wastes).

The social feasibility of technogenic waste processing is to create new workplaces, increase the level of self-employment and extend the taxation base.

The peculiarities of technogenic deposits are:

1) complex mineral formations
2) resource value of wastes in extraction and processing of mineral raw materials
3) run of mine mainly disintegrated on the Earth surface
4) the amount of extracted resources can be more than in a common deposit

Tungsten production is considered to be the most engaging alternative in the future development of technogenic deposits.

The technogenic deposit «Ingichki» has large amounts of wastes reaching 12 million tons. OOO INTEGRA RU has developed the process flow diagrams that had allowed to extract WO3 from these technogenic resources.

The tungsten production has allowed OOO INTEGRA RU not only to provide resources to the Uzbek industrial complex of refractory and heat-resistant metals, which products are of great demand throughout the world, but also to create new workplaces and solve a number of other problems.

OOO INTEGRA RU has developed not only the technology of WO3 extraction from Ingichki technogenic wastes, but also the technology of high-quality cement production. These developments allowed Russia and Uzbekistan to establish the joint venture «Ingichki Metals».

The modern technologies developed by OOO INTEGRA RU allow to use the technogenic resources very effectively.

The enrichment technologies of OOO INTEGRA RU allow to solve important tasks on involving the technogenic resources in production of rare metals, thus improving the environment conditions and social situation in the region due to new workplaces.

Everything mentioned above proves the relevance and the national economy importance of processing and mining, metallurgic, fuel, power and chemical waste disposal.

As my research has shown, the production of these technogenic deposits using the technology developed by OOO INTEGRA RU together with Navoi mining and metallurgical integrated works gives positive results and solves a number of social and economic problems. This can improve the use of the stored waste in other deposits.

To solve this problem, the following steps have to be taken:

- inventory check and classification of the technogenic wastes
- general evaluation of mineral and raw materials potential of technogenic wastes
- regional classification of the technogenic deposits and allocation of the priority objects for potential use
- geological, economic and cost evaluation of priority technogenic deposits to be developed
- suggestions on geological, economic and legal platform to prepare the technogenic deposits for commercial development

All these issues have to be reflected in a target program of involving technogenic deposits into commerce.

The interest to the technogenic deposits is going to increase as far as the large natural deposits are petering out and the growth of industry demands. The implementation of innovative technologies in the technogenic waste processing will allow to make the deposit development economically effective and have positive impact on the social and ecological situation.

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WAYS TO ENSURE QUALITY OF THE WORKFORCE COAL THROUGH THE FORMATION OF PROFESSIONAL COMPETENCE

Kalacheva L.V., Savon D.Y.
piv1961@inbox.ru, JSC «Central Research Institute of Economy and Scientific and Technical Information of the coal industry», Moscow, Russia; di199@yandex.ru, National Research Technological University «MISiS», Moscow, Russia

For successful implementation of measures for vocational training coal industry must perform a complex of measures to implement the concept of improving the system of training, retraining and advanced training of personnel for the organizations of the coal industry. Mining production is not only dangerous, but also sophisticated in every way – this technology and equipment that are changing very quickly, and adapt to the rapid changes can, of course, only the young, educated professionals, regardless of their specialization [1].

Now the coal industry is growing shortage of skilled workers, especially young engineers and technical workers. The key factors are the decline in the prestige of working professions, high levels of occupational exposure in the coal mining industry, unfavorable demographic situation, caused a shortage of manpower, lack of effective programs to fill the human resource capacity in enterprises sector, the proportion of broken in the training of higher and secondary vocational education. The fact that young people lost interest in trades, influenced by many factors. Only 10% of the graduates of the Mining University are working on a specialty [2].

The main reasons for non-compliance and the existing structure of the functions required of staff of the coal industry are professional incompetence, structural imbalance and lack of information system.

In accordance with the concept of action in the labor market to provide upgraded and newly created jobs necessary human resources provided to balance the structure of vocational education and vocational qualification structure of labor demand through the following measures:

- review of trends and levels of training, taking into account the forecast demand and supply of labor with an appropriate structure for vocational education to labor market needs;
- development of professional standards for levels of vocational education to meet the needs of employers, are the basis of certification of personnel, creating conditions conducive to equal access to industry and professional labor markets;
- development of target programs of vocational guidance of young people, contributing to the formation of personnel of the coal industry;
- organizing awareness-raising campaigns to enhance the prestige of mining professions using the media and modern information technology.

One reason for the separation of higher education on the requirements of modern industry is the specificity of the current situation in Russia, where "business is not focused on the strategic objectives, is more primitive technological structures." Fascination with the formal side of things afield our education away from the world development, and our engineering training creates a negative value. Educational institutions throughout the world behind for the learning styles and needs in the general skills required workforce for the 21st century. The Russian education system late reacts to changes taking place in the domestic economy. Schools do not keep in touch with corporate recruiters and even more do not know about the needs of the business. In today's world of rapidly growing competition for qualified technical profile not only between companies but also between states. The main reason for low productivity and the introduction of modern technical solutions and technologies in the coal industry is the lack of absorption and use of global experience in the field of research, design and education, as well as fragmentation and disunity of coal companies research, design and educational institutions (organizations) mountain profile [3].

In accordance with the already created the preconditions for association of universities that train specialists within related UMO involved in a single issue of subsoil (exploration, mining, oil and gas complex) would undoubtedly provide a synergistic effect on the set of relevant science and technology in general. More effective in this case, there would be no cooperation with relevant universities and sector research centers. At the moment, the creation of mineral universities expedient at universities that have the greatest potential in the field of training of qualified personnel for the fuel and energy complex. In this case, the processes of globalization, the rapid pace of technology development placing ever-increasing demands on the quality of labor resources, their continuing professional growth. The level of training of graduates and content of the programs should be evaluated through technological processes. Addressing global challenges of development sectors of the economy, improve product quality can not occur in the absence of a modern and innovative system of training of highly qualified personnel.

To remedy this situation requires joint efforts of public authorities, employers, educational institutions, trade unions and social organizations. It also requires update of vocational education programs, the introduction of professional educational standards and their approval for the mining industry of the country. Precautions should be taken to implement the initiatives in higher education in relation to issues of quality staffing mineral complex country. Now it is necessary to intensify cooperation of the business community and educational institutions in order to ensure a continuous process of quality of excellence. To ensure the needs of enterprises and organizations of the coal industry needs to structure the training of specialists with higher and secondary vocational education and the amount of the issue-oriented work in the industry specialists meet the needs of the industry.

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ACTUAL REQUIRENMENTS TO THE MATHEMATICAL MODELS FOR ASSESING ECONOMIC VIABILITY AND INVESTMENTS

Agalarov Z.S., Polyakov V.M.
zurab-lezgi_gada@mail.ru, Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze (MGRI-RSGPU), Moscow, Russia

There is often arising issues for optimal solutions studies for developing group of enterprises that form one managing system, such as a holding in today's Russian business [2]. Solution of these problems based on the results of assessing estimated investment activity options, as in individual enterprises, so of their complexes [6,8]. Those kinds of assessments could be received on the basis of mathematical modeling of investment activity that isgenerally recognized opinion of specialists [3, 5, 6, 7, 9].These issues from the economic side are nearly the same with the problems of the optimal sector planning, experience of solutions that was gained in 60th -80th in USSR [5, 7].At the same time major changes have been taken place in our country for last decade, don't allow applying this experience in modern conditions.

Under the planning economy of USSR the complaining assessment of economic viability of investment projects was conducted in magnitude of discount expenditures [8]. To take on an account the time factor by discounting expenses over time was recommended. Meanwhile in technique, that exactly shows indicators and effectiveness criteria by which occurred evaluation and a select of investment options, accounting of the random and uncertain factors was not expected. Therefore, calculations for assessing the effectiveness of managing objects carried in relatively simple mathematical models. Mainly, linear programming applied in economic models. Usually stringent restrictions considered on involved resources and fixed standards of their spending were used to produce per unit of output. Moreover, during calculations the comparing variants of economic activity should have been one at the same final result on all indicators before a cast of calculations, in addition to which the calculation was carried out.

The operating feature of the enterprises groups, that form unified economic systems is no rigid once established producing structure. The individual work items can be rolled or minimized Due to decision a holdings owner or on the contrary reinforce existing enterprises or even organize new areas. Opportunity to assessing the effectiveness of such decisions should be incorporated in the mathematical models of investment activity. For modern conditions along with the probability and the natural uncertainty [1, 4] of the original data are also characteristic next things:

- Relatively high and variable inflation in time
- Nonuniformity inflation, differences in types of products, resources and prices growth rate for them
- Particular role of government, which consists:
  - In price regulation for some important investment projects
  - In providing support to some investment projects with a total limited budget

- relatively high, variable over time the price of money that is differ for the various Russian and foreign participants of the project, what tends to widely varying and dynamics of individual discount rate, credit and deposit interest rates;
- lack of efficient markets, especially stock market and property market, and as a consequence – significant difference between "fair" and market value of securities, and between the estimated and the market value of the property;
- significant uncertainty of initial information to assess investment projects and the high risk related with their realization
- complexity and instability of tax system
- different time aspects, including the dynamics (changes in time) in the settings of the project and his economic ambience; disrupts in time (lags) between production goods an his economic ambience or resource enlistment and their payment; inequality of multi-time expenses and/or results (the preference earlier results and later expenses)

– presence of the different project participants, their diverging interests and different evaluations of the cost of capital, expressed in the individual value of the discount rate
– inflation influence (accounting the prices changes for different types of goods and resources at the project making period) and possibilities of use some currency during realization of project
– influence (quantified) of uncertainties and risks that accompany project implementation

This needs more detailed and comprehensive analysis of the investment activity and its consequences.

Thus, mathematical models of sectoral planning constructed in the fullness of time, can't be used unchanged for solving problems in justification of investments, and they need substantial revision and supplement. That's why the development of modern methods and mathematical models of optimal planning in collaboration among enterprises is very important and topic issue for today.

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LEGAL BASIS OF MONUMENTS OF NATURE IN UKRAINE

Kapelistaya I.M., Kovalchuk M.S., Bagauri M.G.
kapelistaja.irina@ukr.net, National Aviation University, Kiev, Ukraine

The question of environmental conservation for a long time is relevant, together with it pressing question of preserving an integral part of it – natural monuments, which are a unique testimony to the past and at the same time require preservation for the future.

Natural monuments – this is the territory in which are placed some unique natural objects that are protected due to their scientific, education and training, historical and cultural memorial or aesthetic value.

Currently, the status of natural monuments is determined by the law "On natural reserve fund of Ukraine". Natural monuments are recorded in the State Registry in accordance with the "Regulations on the content and documentation of the State Cadastre of territories and objects of nature reserve fund of Ukraine".

The legislative acts implementing natural reserve regulation, include the laws of Ukraine "On Approval of the National Programme for the ecological network in Ukraine for 2000-2015", "On Flora", "On Ecological Network in Ukraine", "On the animal world" "On the Red Data Book of Ukraine", "On the General scheduling scheme in Ukraine", "On Hunting Economy and Shooting", "On Land Protection", "On state control over land use and protection", "On land management" and others.

According to the Law "nature monuments declared some unique natural formations of special environmental, scientific, aesthetic, cognitive and cultural value, in order to preserve them in their natural state." Monuments of nature may occur in natural and biosphere reserves, national natural and regional landscape parks, nature reserves and other components of the natural reserve fund (NRF). However, only in the status of protected areas and natural monuments they can be independent elements of the NRF [5].

Article 38 of the same law are the basic requirements for the regime of natural monuments: "On the territory of monuments of nature any activity that threatens the maintenance or which leads to degradation or alteration of the original of their condition. Owners or users of land, water and other natural objects declared natural monuments, assume obligations to ensure the regime of their protection and preservation "[5].

Natural monuments, as well as reserves, may be of national or local importance. The value or status of the monument of nature means, above all, differences in the responsibility of the authorities for the preservation of protected areas. It is important that both local and national natural monuments are of great importance to the very nature and society, and should be protected with the same integrity, regardless of their status. This approach was approved in the Law of Ukraine "On the nature reserve fund of Ukraine", which states that all objects of nature reserve fund, regardless of their status, on an equal footing is a national heritage and property of the Ukrainian people.

Natural monuments is a national treasure of Ukraine [3], and require a serious approach to the study and proper storage. On most of the territory of Ukraine natural properties are under unfavorable conditions, which negatively affects their condition.

Natural monuments, as well as natural reserves, wildlife sanctuaries and national importance, created by Presidential Decree, no administration and no zoning, the separation of the territory into functional areas which have different goals and different security mode. Question zoning is a known cause for fraud in the NRF Kiev and near the sea, where land is more expensive [1]. The fact that the so-called "zone of stationary recreation" and "economic" zone NP(National park) and RLP(Regional landscape park) allow recreational development. Unfortunately, the class recreational buildings are the most profitable types of construction: hotels and cottages (latest official numbers, mainly as a summer residence). When you create a RLP or NP in natural areas, officials often try to "tear off" the maximum area under the zone of stationary recreation and economic, which makes it possible to build up to 50% of the territory, which is impossible not zoning monument reserve and possible zoning RLP.

With the increasing number of private areas on which there are monuments of nature, there are problems of access and even their destruction. Currently, about 90% of natural monuments and other objects of nature reserve fund local not staked out what is causing the unlawful taking of the nature monument. This issue should be resolved through state and society holding immediate monitoring of the state monuments of nature, determine their legal status or the preparation of a submission to grant or alter this status, the definition of individuals and legal entities responsible for their safety.

Due to the fact that there are currently no generally accepted criteria for identifying promising natural object as a natural monument, schemes and methods of the study, was not approved by the classification of natural monuments, their certification is not worked out the mechanism of their design, often to the natural monuments include objects and territories not having no value. In particular, the classification of natural monuments should be based on the following principles: focus on science (geological, geomorphological, hydrological, etc.) on the scientific significance (typical, rare, unique), status (local, regional, national, global significance).

District and regional councils should compile a register of objects that should be attributed to natural monuments. The relevant authorities (mainly scientific organizations or appropriate relevant agencies) must decide whether to make the object in the category of natural monuments. After a positive decision is necessary to give a natural monument in the competence of land surveyors who have practical skills drain and legal registration of land change their purpose, organization of the territory and land management.

Currently in Ukraine almost new natural monuments are not created while the existing gradually degraded and destroyed. Protection regime most monuments of nature are not performed by land users and tenants.

In our opinion, it is the State Agency for Land Resources should oversee the legal protection and rational use of natural monuments and areas of their placement.

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MODERN TRANSFORMATION OF OILFILED SERVICES INDUSTRY AND AREAS FOR EFFICIENCY IMPROVEMENT BASING ON DEVELOPMENT OF THE RANGE OF IMPORT SUSTITUTION SERVICES

Dmitry Lyutyagin
l-d-v@list.ru, Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze (MGRI-RSGPU), Moscow, Russia

Global oilfield services market has experienced a real scientific and technological revolution over the last ten years, which resulted in hasty growth of the industry and companies operating in it. Thus, for the last 15 years the size of oilfield services market has increased 4.5 times (up to $337 bln.) or 10.6% CAGR. Such meteoric rise of the market was possible only due to appearance ofnew methods to increase capacity or oil recovery in the 90-s, which then were efficiently implemented in the industry by oilfield companies. New important methods included directional (horizontal) drilling, hydraulic fracturing of formation as well as application of ESP in exploration and development of oil&gas deposits, which increased marginality of oilfield services 1.5-2 times. New services have been developed during long period of time as it took 15 to 20 year to master new methods till their application demonstrated economical attractiveness and they became widely used at the oilfields. Degradation of petroleum deposits quality, deeper and more complicated geological horizons as well as necessity to develop absolutely new type of oil&gas deposits worth noting as economic incentives, which stimulated oil producers to use more and more expensive (comparing to standard services) new services.

Russia and Russian oilfield services industry stepped in the global process. Thus, the amount of drilling in Russia has increased for more than 2.5 times and reached 25 mln. meters per year during 14 years. This amount is tremendous for modern Russia. At the same time, 5.1 million of drilled wells out of these 25 million meters accounts for horizontal (directional) drilling, which means 6 time growth since 2001. In addition to drilling other oilfield services have also demonstrated correspondent growth. For example, since 2008 formation fracturing services have been growing annually two times, 13-14% per year, field geologic exploration (seismic investigation 2D-3D, well logging measurements, etc.) increased by 5.6 and reached the amount of $2.8 bln. since 2003.

By virtue of appearance and active usage of new high efficient oil&gas services, the pattern of oil market has completely changed. Over a short period of time (5-8 years) the countries that had been formerly dependent on external supplies of hydrocarbons by 50-60% turned into net exporters of these raw material or covered domestic demand themselves. USA is a spectacular example of such countries, which growth of oil production equaled to 10% annually since 2008 till nowadays. This growth is attributed to the development of so-called complicated off-shore deposits and shale oil.

Russia being active and one of the key participants of oilfield market with 12.8% market share managed to keep and even increase its production (production of oil and gas condensate amounted to 526.8 mln. t in 2014) by means of new drilling technologies and stimulation of oil-producing formations. It even overcame stagnating production in Western Siberia, which lasted up to 2009.

Scientific and technical discoveries and innovations in the oilfield services industry for the last 15 years can hardly be overestimated. At present, further development and improvement of new oilfield services in order to cut costs and enable wider implementation is an important issue. It is a clear challenge for the market participants, who faced the market decline and necessity to react and survive, as this new pattern of oil market resulted in falling of quotations for “black gold” since mid-2014 (the priced have reduced more than two times and today level is about $50 per bbl as of the beginning of 2015). The consequence is the reduction of capital investment programs of oil&gas companies from 15% to 50% all over the world, which are the main (anchor) customers of oilfield services and geological survey companies.

This conjunctural impact will first of all hit new types of oilfield services as they are more expensive and used in capital intense and complicated deposits of oil and gas. In this area the decline can be 45-60% comparing to the level of 2014. In the light of oil turbulence Russian oilfield services industry turned out to be in even more difficult position, as it experiences not only reduction of investment programs of oil companies by sectoral sanctions as well. Let us recall that sectoral sanctions of USA and EU are mainly refer to prohibition to the foreigners to invest and transfer oil development technologies (arctic and off-shore projects, production of shale oil), i.e. prohibition to foreign oilfield services to provide formation fracturing and directional drilling services. According to estimation of Commodity Economy Centre of RANEPA, foreign participation in oilfield services has a considerable proportion – 23%. About 56% of Russian projects involving directional drilling are based on the support of foreign oilfield services companies, formation fracturing technologies are nearly totally dependent on foreign companies – 93%. At present, under the sanction regime, these companies folded their operations in Russia and left the market, including such companies as Schlumberger, Weatherfort, etc. The period of sanctions regime and possible return of foreign companies to Russian market are uncertain, but it is already clear that Russian oilfield service companies should independently develop and gain competences of directional drilling, formation hydraulic fracturing and other modern services. The state represented by the government also faced current geopolitical environment and risks threatening decline of hydrocarbons production in mid and long term perspectives due to the block of access to separate oilfield services. The government is actually reconsidering its policy and intents to support import substitution of technologies and products.

We can single out the following premium efforts to be taken in order to preserve existing (acquired) competences and maintain dynamic of industry revamping and development of new areas to support Russian oilfield services:

1. Segmentation of services among the largest Russian service companies and differentiation on the basis of amount of rendered services.

2. Restoration and development of services in vertically integrated oil companies. This trend has discerned since 2014 and should be continued. The main emphasis in this initiative should be placed upon new directions of services, which earlier were supplied by foreign companies. It is vertically integrated oil companies with their demand in such services and investment opportunities who can develop and raise new direction on the basis of their own service departments, involving foreign companies not participating in sanction regime (Corean, Chinese companies, etc.). Import substitution policy.

3. Maintenance of the highest possible amount of traditional services supplied by independent operators by tax incentives for oil companies and oilfield services themselves.

4. Development of state participation in oilfield services and geologic exploration – establishment of a large state united service operator on the bases of Rosgeologia or Rosneftegaz. The idea is to acquire competences and participate in complicated and expensive arctic projects.

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IMBALANCE IN THE TAX MANEUVER IN THE OIL INDUSTRY AND THE WAYS OF ITS OPTIMIZATION

Dmitry Lyutyagin
l-d-v@list.ru, Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze (MGRI-RSGPU), Moscow, Russia

Last years were a critical and important time for Russian oil&gas industry, as during this period formed patterns of taxation for the nearest 3-6 years. Thus, following the reform of Russian oil industry taxation scheme that started in 2011 the Ministry of Finance and the Ministry of Energy of Russia put forward the initiative to introduce next changes into the fiscal system in force intended to provide additional stimulation to extractive industries and improvement of refinery efficiency. These initiatives were named "taxation end-run" in daily use of industrial people. The parameters of the "taxation end-run" also considered integration of oil and oil products market with Kazakhstan and Belarus within the framework the Eurasion Economic Union (EEU), which entered into force on January 1, 2015. As a result of long discussion, the representatives of business and the state prepared agreed changes of the current legislation adopted by the State Duma (Act # 366-ФЗ) signed by the President of Russia, which came into effect this year.

In accordance with the "taxation end-run" mineral extraction tax rate will be significantly indexed during the nearest three years, and otherwise, export duties will be decrease to compensate the growth of tax burden on the production.

This new Act sets forth the following mineral extraction tax rates per ton of extracted oil:

766 rubles from January 1, 2015 to December 31, 2015 (previous rate is 530 rubles)

857 rubles from January 1, 2016 to December 31, 2015 (previous rate is 559 rubles)

919 rubles from January 1, 2017 (previous rate is 559 rubles).

In addition, the adopted changes will reduce marginal rate of export custom duties on crude oil (reduction of coefficient in the calculation formula at actual price per barrel over $25) from the current level of 59% to:

42% from January 1, 2015 to December 31, 2015 (previous rate is 57%)

36% c from January 1, 2016 to December 31, 2015 (previous rate is 55%)

30% from January 1, 2017 (previous rate is 55%).

Also the provisions of the Act stipulates reduction of export custom duties on light oil products (including petrol) and increase of duties on dark oil products, keeping the peg to export oil custom duty.

"Taxation end-run" also covers the change of excise duties on oil products, change of the method of mineral extraction tax settlement for gas condensate as well as adjustment of tax incentives, which major portion will be preserved in in absolute terms. The main concern for the management of dedicated departments was to balance taxation system in such a way as to ease taxation treatment in extraction (reduction of export duty), motivate oil producers to continue modernization of oil refineries (growth of mineral extraction tax and high barrier duties on export of dark oil products) in order to prevent the growth of prices for oil products at Russian filling stations (reduction of excise duties).

Everything was made in accordance with the law. However, the balancing parameters themselves were elaborated during the period of high prices for oil and law-makers didn't test draft law at violent price fluctuations period and dramatically low prices for oil. At the beginning og 2015 the prices for oil demonstrated minimal level for the last 6 years ($45 per bbl), the depth and sharpness of the drop is reflected in 59% quotations reduction during 6 month.

So, what was the flaw of this "taxation end-run", what are the consequences and how it should be modified following the existing environment?

The influence of the "taxation end-run" on economy of the industry is different depending on the price parameters. According to estimation of EY, extra revenue of extraction industry in 2017 could be $3.4 per bbl at the price $110 per bbl, while at the price of $80 per bbl – just $1.5 per bbl. Zero values (no gain for oil producers) can be reached at the price of %55 per bbl. (in January

2015 the price was less than $50 per bbl.). At that it should be noted that a general level of tax burden on oil industry in Russia cremains quite high comparing to other countries. The main reason is that Western taxation systems mainly based on standard corporate income tax (or extra revenue – raw material rent income).

Reduced rate of export duties on oil will make raw materials more expensive at the domestic market and decrease of oil refinery profitability. According to calculations the margin of oil refinery for complicated production facility taking into account modernization programs undergo within the quadripartite agreement between Federal Anti-Monopoly Service of Russia, Federal Service of Environmental, Technological and Nuclear Supervision, Federal Agency on Technical Regulating and Metrology and vertically integrated oil companies can decrease by $3-4 per bbl. before 2017 from the present level of $8 per bbl. For ordinary oil refineries in case the current configuration is preserved the margin can drop by $10-12 per bbl. that will make part of this refineries wasteful. In case of lower oil prices ordinary refineries can have even more difficulties because of possible reduction of a differential between the cost of export basket and crude oil prices. So, the average margin can decrease even more considerably.

Taking into account steep downfall of oil prices (the downfall continued during 7 month non-stop) "tax end-run" began to work at hard times and actually created additional tax burden on oil producing industry of Russia at the background of dramatic drop in income. It actually forces oil producers to reduce investments in E&P even more undermining the basis of future development, but the initial idea was absolutely different. The weakness of the "end-run" is overlook of the peculiarities of mineral extraction tax calculation. Therefore, at high level of oil prices and strong ruble extraction industry will pay less money to the budget then before the "end-run", but at lower prices and weak ruble (what we have right now) – it will pay more. Notably, the difference is $0.7 per barrel, plus or minus.

We believe that in order to eliminate this effect the formula of mineral extraction tax (R*(P-15)*□/261=mineral extraction tax) should be modified to be calculated as follows: basic rate of mineral extraction tax (R) should be increased from current 766 rubles to 790-810 rubles, but at the same time the coefficient of dynamic of world prices for oil is to be adjusted, for that end stop-out price should be increased from the current $15 per bbl. to $18-20 per bbl. (this part of income is not considered in the calculation of coefficient). As a result, at the price level of $80-120 per bbl. the companies will pay a little more of mineral extraction tax in comparison to the current and the past level (which is correct in terms of natural resource rent and necessity to recover it at high oil prices), but the price level lower $60-70 per bbl. 9as it is right now) the burden of this tax will be considerably decreased. So, at $50 per bbl. as it is now, mineral extraction tax will be reduced from 6677 rubles per ton to 6176 rubles per ton – 501 rubles saving per ton, which is 263 bln. rubles per year.

Surely, suggested adjustment should be considered in terms of general tax burden (for new deposits) and budget income, but the common logic should be preserved – gain more – pay more taxes, gain less – pay less.

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ACCOUNTING FOR THE STOCHASTIC NATURE OF INPUT DATA WHEN DETERMINING THE BOUNDARY OF THE RATIO OF OVERBURDEN

Semenov A.S., Veresov I.V.
loader3@yandex.ru, National mineral resources University "University of Mines",
Saint-Petersburg, Russian Federation

When determining the quarry at the end of the testing used the boundary ratio, characterizing the final pit, in which there would be no profit (equal to zero), and all production costs are covered. The value of the recoverable value of the ore can be used to establish the boundary of the Stripping ratio. The value of the recoverable value of the ore can be used to establish the boundary of the stripping ratio.

In the cost of production of ore takes into account all costs in the technological chain of processes to obtain a concentrate, except for the cost of removing the overburden. Edge Stripping ratio should be considered taking into account changes in the content of useful components in the ore, the market prices of the final product.

High market prices for mined ore have the effect of career development, increasing its borders, while low – on the contrary, lead to reductions quarries, increased risk of design.

When designing quarries and mining projects in risk discount rate and the interest rate to take with some increase to account for inflation and risk. When determining the boundary of the stripping ratio, to reduce the risk of making design decisions, it is advisable to factor the minimum necessary for the development of enterprise profits.

Taking certain values of the interest rate, pre-estimating the rate of return of the project (IRR), is determined by the boundary ratio, providing career development with the minimum necessary for the development of enterprise profit.

Market prices of this type of mineral raw materials are the key indicators when determining the quarry at the end of testing. Long-term calculations, usually held on a stable basis without taking into account the probabilistic nature of the source data.

With high inflation and crisis phenomena in the economy to establish a discount rate (interest rate) of various projects can serve as Deposit interest on Bank deposits in a relatively stable currency (for example, 6 to 8% per annum for USD or Euro). K. N. Trubetskoy, A. Peshkov A., Matsko N. A. the 1 who offered to take the discount factor for the implementation of new projects and the expansion of activity in the amount of K = 14 – 18 %.

In developed mining countries, the increase in the rate of discount (interest rate) may be due to the coefficient of risk specified in the form of expert assessments.

Select when the design value of the discount rate has a significant impact on the performance evaluation of the project. When deciding on a specific project, thus not simply rejected all other projects, but is refusing profits, which could bring investments in these projects.

When the design is determined by the rate of profit, which may be selected as the discount rate. If the project has a zero net present value, it will give investors the opportunity to return the invested funds, and to make a profit.

When using net present value as a criterion of evaluation of the project it is assumed that any positive value of NPV makes the project attractive.

The choice of discount rate in the design of quarries is one of the most difficult aspects of the calculation of the net present value of the project (NPV):

Suitable discount rate that includes protected from the risk rate on government securities and some of the award, apply it as a universal tool in the design. In this approach, the value of the discount rate is in the range of 8 – 15% and the risk premium accepted in the amount of 3 – 5%.

- You can establish maximum interest rates, by analogy with the previously implemented successful projects.
- Choosing a risk premium, it is necessary to quantitatively evaluate the latest, not to arbitrarily increase the discount rate.

- When evaluating the project in the early stages of compilation, you should use a higher discount rate than in the later design stages.
- Under difficult mining conditions and technologies of mining should take a higher discount rate than in the relatively simple cases.
- The higher the recoverable value of the ore, the higher the risk associated with fluctuations in the prices of the final product.
- For marginal mines – on the verge of profitability and at the border of entry into the market of mineral raw materials, the risk associated with participation in the project is higher than in projects where the difference between production cost and its expected price in the foreseeable future will be big enough.

To determine the interest rate of the project mining enterprise risk, you can use dependency [1]

$$i_R = (\frac{K_A \Delta A}{\Delta 3 + \Delta A} + \frac{K_3 (1 - H) \Delta 3}{\Delta 3 + \Delta A})(1 - k_u), \tag{1}$$

K_A – cost of equity;

K_3 – the cost of borrowed funds;

H – General rate of tax;

$\Delta 3$ and ΔA – the proportion of debt and equity from the total amount of investment in the project, respectively;

k_u – inflation, %.

For the analysis of quantitative risk projects opencast mining of ore deposits most relevant is the Monte Carlo method (graph of cumulative probability), which are widespread with the development of software.

Most convenient for the analysis of the risk indicator is the NPV (NPV), since the of this indicator is normal (Gaussian).

For each version of the draft calculation of NPV, the obtained values were used for plotting the cumulative probability. The main difficulty inherent in Monte Carlo, is the large number of computing scenarios (about 5000) and the presence of special computer programs. The result is determined by the range of NPV and IRR, i.e., pessimistic, baseline (most likely) and optimistic variants, as well as the probability of the NPV and IRR.

The increase in the value of the discounting factor due to the risk premium reduces the net present value of the project (NPV).

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S-XVI

NUMERICAL METHODS AND MATHEMATICAL MODELING

ACCOUNTING FOR RISKS AND UNCERTAINTIES WHEN SUBSTAINATING INVESTMENT PROJECTS

Agalarov Z.S., Polyakov V.M.
zurab-lezgi_gada@mail.ru, Russian State Geological Prospecting University
n. a. Sergo Ordzhonikidze (MGRI-RSGPU), Moscow, Russia

Assessing the effectiveness of decisions in the investment projects is made on mathematical models.The level of commercial success is measured by the dimension of efficiency index. A specific feature of the socialist economy was stable and low growth rates in the last years of the Soviet Union.In these conditions,accounting of "economic environment" factors [3] of the project was limited to a set of fixed parameters: the prices of used crude, materials, the amount of wages, interest rates on the bank attracting capital and so on.In operations research such factors are called "fixed uncontrollable factors."Ifconsidering only them, the index of effectivenessrepresents a function, whose argument is a variable *x*, whichcharacterizes solutions in investment planning. Fixed uncontrollable factors represent constants included in efficiency index function.Lets denote the efficiency index through *w(x)*. In this situation, the best solution will be a maximum of efficiency function by*x*. The set of possible solutions determined by restrictions to number of resources, including attracted capital for implementation of an investment project [4]. Determination of an optimal solution for the investment projectreduced to solve it by mathematical programming [2]:

$$\max_{x \in X} w(x) \tag{1}$$

In modern conditions in assessing the effectiveness of investment projects proposed to take into account not only fixed uncontrollable factors, but also the influence of uncertainties and risks accompanying the implementation of the project "[3].In recommendations [3] listed some of the sources of risks and uncertainties arising from the implementation of the investment project: inflation, the level of bank interest rates, changes in tax rates during the period of the investment project and others.Therefore, the function of efficiency index (in the assessment of investment projects is the "net income" [3]), should include variables, describing the risks and uncertainties, in a market economy. Then the efficiency index can be represented as a function of two groups of variables –which are describing solutions for the investment project and describing risk and uncertainty conditions of economic environment of the project.Efficiency index then will look like *w(x,y)*. Clear that in this situation the optimal solution for the project cannot be found by maximization (minimization) the efficiency index on the set of possible solutions *X*.

Lets dwell on the index efficiency and options of efficiency criteria of Investment projects in conditions of risk and uncertainty.Let Y be the numeric vector, and perhaps other characteristics of uncontrolled parts that adopt decisions, factors describing the situation.In operation research theory approaches are developed to accounting of their impact on the effectiveness of solutions. Particularly, Y vector components recommended to divided into three groups.

1.Fixed uncontrollable factors. Features of these factors are known to operating one up to the figures or functions.For example, the distance while planning transportation, the standard value of the minimum equity of the bank declared by monopolists, costs of services for transportation, electricity, fuel. Let's denote vector whose components are the characteristics of fixed uncontrollable factors*Y*, formalized in some way. If the economic environment is characterized by only these factors, the optimal investment option can be obtained, as discussed earlier, by solving problem (1).These factors characterized by random quantities with known laws of distribution.

2. Random uncontrollable factors.These factors characterized by random quantities with known laws of distribution.These factors may include, for example, predicted ambient temperature, the onset of insurance claims due to natural disasters or accidents, and others. Let's denote the vector whose components representsrandom variables with known laws of distribution throughY_2.Then, if the operation repeated iteratively, for example, agricultural work is investing

next year, so w(x, y) can be averaged over in Y axis. In this case, as efficiency index of the investment should be used:

$$\int\limits_{y \in Y_2} w(x, y)\, \mathrm{f}(y) dy \tag{2}$$

Where f(y) is the density distribution of y.

The efficiency criterion in this case is

$$\max_{x \in X} \int\limits_{y \in Y_2} w(x, y)\, \mathrm{f}(y) dy, \tag{3}$$

Uncertain, uncontrollable factors.These factors, which are known limitedly, within which they can assume the values.At a substantiation of investment projects as such factors may be considered the future price of raw materials and supplies, the amount of bank interest, inflation rates, actions of competitors.Assess the effectiveness of investor decisions in this case will be the function the minimum values of y:

$$\min_{y \in Y_2} w(x, y), \tag{4}$$

Accordingly, the best solution for INVESTMENTS in a situation when the economic context is marked by uncertain factors can be obtained from the solution of the problem (5):

$$\max_{x \in X} \min_{y \in Y_2} w(x, y), \tag{5}$$

Taking into account the above stated mathematical models used to assess the effectiveness decisions in investing activities should be essentially modified [1].

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QUALITY EVALUATION OF TEXTS ON GEOSCIENCES BASED ON LINGUISTIC CRITERIA

Makagonov P.P.
e-mail: mpp2003@inbox.ru, The Russian Presidential Academy of National Economy and Public Administration, Moscow, Russia

A great number of educationally- and scientifically-oriented texts are emerging on the Internet, which requires rapid quality evaluation of these texts, which actually undergo no examination but are easily available for the students. For a variety of reasons, this, in its turn, may have negative consequences. In this paper, the quality evaluation criteria for the texts, which can be made public as a complete, self-contained product, from the authors' viewpoint, are proposed and analyzed. For a linguistic analysis of such a holistic text, it is important that the vocabulary of the whole text rather than a passage of text is considered.

If a holistic text is regarded as a system, then the significative words can be considered to be the objects while the syntactic words link the objects in terms of system analysis. It is the practice to estimate text perfection by the degree of coordination of a frequency list of the significative words with the Zipf distribution $F = F_1/(i + B)$^K or $Y = A - K$ x $\log(i + B)$, where $Y = \log(F)$; $X = \log(i)$, i is a word frequency rank, while F_1, B, K and A are some constants for the texts which contain over 1800 words, and with the Zipf distribution ($B = 0$) for the shorter texts.

It has been shown [1, 2, 3] by the example of social systems of another type and then by the example of holistic texts that a sign of perfection or the "harmony" of systems is determined not only by the concordance of "rank-size" distribution of the system objects, but also by the degree of concordance (the value of the coefficient of determination or the coefficient of correlation R^2) of links between the objects (these links are syntactic and link words) with the law of distribution similar to the Zipf law.

The degree of perfection of the content and semantic value of the holistic text is related not only to the frequency list of the significative words from the text subject area, but also to the indicators of perfection of the frequency list of the syntactic words from the same text.

Verification and specification of this statement was based on the analysis of the texts of fairy tales, poems and one legal act recognized as the most significant for the culture of the English-, Russian-, German- and Spanish-speaking countries.

As a result, the following conclusions have been made for the texts containing at least 1800 uses of the words:

The relation φ1 between the uses of the syntactic (b) and significative (a) words, or φ2 between "a" and the total number of the uses of the words (a+b) in the holistic text is close to the "golden proportion" (φ= 0,618) for more perfect (harmonious) texts.

The distribution e^$G = A - KX$, where the G exponent varying between 1 and 4 is a new parameter, is suggested to be used as an equivalent to the Zipf law for the syntactic words.

A degree of concordance with the proposed distribution (R^2 > 0,97) for the "perfect texts" is established with the value of the G exponent not exceeding 2 and with the values φ1 and φ2 deviating from the "golden proportion" within 0,73 and 0,535. The indicators submitted must be worse for the texts which are not universally recognized as the most perfect in a given filed of knowledge or a given literary genre, at least at a national level.

Moreover, the paper [3] has shown that the composition of two "perfect" texts belonging to different writers loses the quality of the above mentioned indicators and does not meet the requirements of the "perfect" text. It can serve as a criterion of plagiarism.

The indicator of commensurability with the "golden proportion" is inappropriate for the texts containing fewer than 1800 words because of a small size (insufficient saturation) of a list of syntactic words. In this connection, in paper [3] a more complex text perfection criterion is proposed, for which the distribution of bonding strength between significative words is calculated by the formula similar to the law of gravitation rather than a frequency distribution of syntactic words – link-words.

Let us demonstrate here the potential for practical application of the proposed criteria for the analysis of texts belonging to a specific subject area of educational and scientific texts on geo-sciences. The texts chosen for the analysis are universally recognized as the high-quality ones, which correlates with the subjective author's opinion. Another group of texts to be analyzed includes those which are freely available on the Internet and are disseminated there as samples of teaching materials for the higher educational institutions and model course papers. They are supposed to have lower but acceptable quality. Among the texts of the first type there are the popular scientific works by Alexander E. Fersman ("The memoirs of the stone" and "Mineralogy for fun"), while the texts of the second type can be figuratively described as "A course paper" and "A course of lectures".

To carry out the analysis, each text has been separately processed by the DBD software package, which algorithms and prospective results of usage were described in paper [1]. As a result of using this software package, the following parameters for each text were obtained:

- the number of significative words and the number of their uses,
- the number of syntactic words and link words, as well as the number of their uses,
- the average number of words in a word-combination, the average number of letters in a word (for evaluation of text complexity).

According to these parameters, the text quality criteria proposed above were obtained: the "golden proportion" parameter φ, the coefficient of determination R^2, and the approximating line G exponent (on a bi-logarithmic scale).

The indicators for "The memoirs of the stone" are: φ1=0,626; φ2= 0,589; R^2=0,994; G=2.

For "Mineralogy for fun" the results are a bit worse: φ1=0,647; φ2= 0,547; R^2=0,991; G=2.

For "A course of lectures on mineralogy" φ1=0,697; φ2= 0,436; R^2=0,982; G=1,5

For "A course paper on volcanism" φ1=0,753; φ2= 0,328; R^2=0,983; G=1,25

The obtained results, written out in the order of decreasing quality by the criteria φ and R^2 with a neutral behavior of the G exponent, match with the results expected from the perspective of common sense. The criteria discussed above and procedures for their application can be helpful in the rapid analysis of the quality of texts on geology.

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DETECTION OF JUMP COMPONENT IN GPS SIGNAL BY CONSTRUCTING A STEPWISE APPROXIMATION USING PSEUDO-DERIVATIVE METHOD

[1]Yakovlev Pavel, [2]Lyubushin Alexey
[1]paulyakovlev@gmail.com, Russian State Geological Prospecting University, Moscow, Russia;
[2]lyubushin@yandex.ru, Institute of Physics of the Earth, Russian Academy of Sciences, Moscow, Russia

We offer a new method for jump detection in time series using pseudo-derivative concept. A positive side of the method is its simplicity of implementation in comparison with traditional methods for singularity detection in time series containing a noise background. The necessity of automatic jumps detection occurs, for example, during GPS signal processing. Abrupt changes of average in GPS time series generate interest because of the fact that they can result in both ordinary and so-called "silent" earthquakes. The proposed criteria are based on calculation of entropy of averaged stepwise approximations. They are constructed using pseudo-derivatives in order to detect whether a signal contains a significant jump component. Examples of real GPS time series analysis are provided.

During the time series processing, we often feel the necessity of detection such singularities as outliers, trend changes ("break of trend") and jumps of average value ("step"). Detection of these singularities may serve for different purposes. In the most often cases they are considered to be as a result of some defects of registration systems or an influence of external factors that are not related to the nature of observed data. In other words, these singularities are identified to be removed for further studying of "cleaned" data. Another task is an antipode of the first one: these singularities can be taken up as an outcome of some important changes in the data nature that are kind of "events" influencing time series behavior. After this we will focus on detection of jumps of average ("steps"). It is due to the fact that the proposed method is aimed at GPS time series analysis. In this case a part of these jumps is caused by post-seismic effects after earthquakes and hypothetically hidden events such as "silent" earthquakes [5, 7, 10 and 11].

At present there are a lot of different algorithms aimed at solving the problem of detection of characteristic elements of time series behavior. The method of fuzzy logic is applied for morphostructural analysis in articles [1, 2]. Methods for detection of statistically significant step changes of average are presented in articles [3, 8, 9, 12 and 13]. The problem of detection of abrupt average changes is also relevant in analysis of climatic time series [14, 15 and 16].

The proposed method is extremely simple to represent and is almost non-parametric method because it uses the only parameter which is called the basis of pseudo-derivative. From our point of view, this fact makes the method quite competitive in comparison with methods that have been developed so far for similar purposes.

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SEISMIC DANGER TREND ESTIMATE BY PROPERTIES OF SEISMIC NOISE

Lyubushin A.A.
lyubushin@yandex.ru, Institute of Physics of the Earth, Russian Academy of Sciences, head of laboratory, Dr. Sci. (physics & mathematics)

In the papers [1-4] an approach was elaborated for the analysis of microseismic oscillations, which gave a possibility to predict in advance the seismic catastrophe on March 11, 2011 in Japan using data from 78 broadband seismic stations network F-net on the Japanese islands. The proposed method is based mainly on the study of multifractal properties of seismic noise and it is based on the prognostic effect of the "loss of multifractality" of background oscillations of the systems before the disaster, which is common to a wide class of processes (medicine, finance, radio physics, etc.). Details of this prediction are presented in publications [5, 6].

Further on the proposed approach has been developed with the use of other statistics of noise, such as the minimum normalized entropy of the distribution of the squared wavelet coefficients, the index of linear predictability and kurtosis. The method of dynamic seismic danger estimate was created, which is based on the construction of maps of properties of the seismic noise in moving time windows [7-9]. This method allows us to estimate the so-called "spot of seismic danger" that represent areas of high or low values of a particular predictive statistics seismic noise and give a possibility to inspect the origin of such spots and their evolution. The method allows one to estimate the trend of danger (increase or decrease) and the power of an approaching seismic event on the size of the critical region.

The report presents the results of the estimate of the seismic danger trend for approaching the next mega-earthquake in Japan in the area of Nankai Trough using data from continuous monitoring of seismic noise on the network F-net over the observation period of 2011-2015. This expected event is a large danger for Tokyo and is regarded as one of the most serious threats not only for Japan but also for the global economy.

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S-XVII

VOCATIONAL EDUCATION ENHANCEMENT ISSUES

THE USE OF MULTICHANNEL ATOMIC-EMISSION SPECTRA (MAES) ANALYSER AT THE EDUCATIONAL AND SCIENTIFIC WORK IN THE GEOLOGICAL FACULTY OF LOMONOSOV MOSCOW STATE UNIVERSITY

[1]Grishantseva E.S., [1]Safronova N.S., [2]Popov V.I.

[1]Lomonosov Moscow State University, Dept. of Geology, Geochemistry Div., e-mail: shes99@mail.ru

[2] «VMK-Optoelektronika», Novosibirsk, Russia, e-mail: popov@vmk.ru

One of the most widely used methods of direct multi-element analysis of solid samples (rocks, soils, sediments) in geochemical prospectings, for analytical control of the composition of the environmental objects is atomic-emission spectral analysis with the arc discharge (AD-AES). The method used in industrial and scientific laboratories of Russia, therefore there is a need for training of specialists, geochemists and ecologists, familiar with the modern methods of analytical researches. In 2013 the scientific-production association «VMK-Optoelectronika» modernized spectroanalitycal equipment in the Geochemistry Division of Geological Department Lomonosov Moscow State University. The Ltd «VMK-Optoelectronika» is the leader in the development and production of multi-channel optical spectra analyzers, and equiped to more than 500 laboratories in Russia and other countries. Special issues of journals «Analytics and Control. Scientific and applied journal on analytics, ecology, metrology and certification» v.9, №2, 2005 and «Industrial laboratory. Materials diagnostics» v.73, 2007 were comprehensively discussed the MAES analyzers and their usage for geochemical samples analysis.

Modernized spectro-analytical equipment include the following:

- «DFS-13-2» diffraction spectrograph with grating 1200grooves mm^{-1}.
- Multi-purpose generator «Fireball» for current arc power supply, for a spectrum excitation and the atomic-emission analysis. «Potok» – the system of semi-automatic feeding of powder samples into the arc discharge.
- Multichannel atomic-emission spectra (MAES) analyzer based on 5 photodiode arrays assemblage with size 12,5x1000 mkm.
- Modern computer software «Atom» for MAES analyzer.

Training on spectro-analytical complex MAES included in the program of required courses of third year bachelor's education in geology 511000 specialization «Geochemistry» and «Environmental Geology». Teaching students to work on MAES allows learning the basics of atomic-emission analysis at the modern level, to improve the visibility and effectiveness of student learning. The transition to the photoelectric analytic signal registration can significantly reduce the duration of the measurement, processing, and obtain the final result. Multifunctional software «Atom 3.2» allows to construct calibration graphs, calculate the metrological characteristics of the results, store the data, to handle and adjust data, received by students, multiple times without re-spending of samples and standards. Students learn to perform qualitative and quantitative determination of elements in a different geochemical samples, choose standards and the analytical line. Visualization of the spectra gives the possibility of comparing the spectra of standard samples and test samples, which is important at the initial stage of teaching students.

In addition, the analyzer MAES was used to obtain analytical data for scientific research and implementation of graduate qualification works of students. In scientific research complex MAES were used to assess the composition of such natural objects as bottom sediments, and aquatic vegetation (macrophytes) in the ecological-geochemical studies of ecosystem Ivankovskoye reservoir.

The laboratory facilities and equipment modernization in the Department of Geology, Geochemistry Division using complex MAES allows us to expand the number of defined elements due to the possibility of determination of rare earth elements, to improve the productivity of the analyses, to reduce the detection limits of the elements, to improve the reproducibility of measurements. The opportunity to work on modern equipment enhances the professional competence and skill level of graduates.

S-XVIII

PHYSICAL CHEMISTRY OF NATURAL ORE-FORMING FLUIDS

THE ORE-MAGMATIC SYSTEMS AND FLUID REGIME OF THE TIN DEPOSITS OF VARIOUS TYPES FROM KHINGANO-OKHOTSK AND SIKHOTE-ALIN VOLCANIC BELTS

[1]Bortnikov N.S., [1]Gorelikova N.V.[1], [2]Kryazhev S.G., [1]Krylova T.L[1], [3]Gonevchuk V.G., [3]Semenyak B.I., [3]Korostelev P.G.
[1]IGEM RAS, Moscow, Russia; [2]TsNIGRI; [3]FEGI RAS

A comparative analysis of fluid regime and mineral-forming fluids from cassiterite-quartz, cassiterite-siliscate-sulphide and tin-rare metal deposits from Khingano-Okhotsk and Sikhote-Alin tin provinces (Solnechnoe, Komsomol'sk ore region, Khabarovsk district, Vysokohorskoe, Kavalerovo region, Prymorie, Tigrinoe, Arminsky region, Prymorie, Pravo-Urmi and Blizhnee, Badzhal, Khabarovsk district) is conducted.

The Komsomol'sk ore-magmatic system (OMS) of cassiterite-silicate-sulphide Solnechnoe deposit has been most thoroughly studied. The petrogeochemical peculiarities of magmatic and ore assembles characterize Komsomol'sk OMS as the heterogenic mainly crust with the contribution of the mantle matter. The ore mineralization of the Solnecnoe deposit is connected with various stage evolution of the Silinka monzonitoid complex. Quartz-feldspar-mica associations of an earlier molibdenum stage formed from Ca-Na-Mg-Cl brines at T=540-450^{o}C with a high salinity and density. The pay ores from the tin stage of the Solnechnoe deposit formed at T=380-280^{o}C from the homogenious hydrothermal Na-Cl fluids with a low salinity (5wt. % equiv. NaCl). Fluids participating in the formation of cut-off grade ores at deep horizons are characterized with other parameters, that is, T_{hom} – up to 450ºC, the salinity up to 50 wt.% equiv. NaCl and the more complicated cation composition. Gaseous and heterogenic fluids, brines and typical hydrothermal solutions of various salinity participated when forming deep-seated tin ores at root parts of ore zones.

The mineralized breccias and veins of cassiterite-silicate-sulphide porphyry Vysokogorskoe deposit closely associate with the two granitoid phases. It is established that at an early stage resulting from granodiorite-porphyry 1st crystallization due to the boiling of water saturated melt there was metal-bearing hypersalt magmagene fluid with the salinity 53.3-66.5 wt. %, equiv. NaCl at Na/K 2.7-1.3 and capture T=550°C and higher which took part in the formation of the early molybdenum stage. The residual ultraacid melt formed injection dykes of granite-porphyry 2nd phase with which economic ores of tin stage are joined.

The early inclusions homogenize into a liquid phase at T=380–430°C, sometimes near by the critical point. Rare inclusions of vapour associate with them. That permits to consider that at T=400°C saltwater solution with the salinity about 10% NaCl-equiv. occurred near the two-phase equilibrium line. Consequently, measured T_{hom} conform to capture temperature of inclusions and the pressure was about 200-*300 bar.* At the late stage of the evolution dilute hydrothermal solutions are implicated into ore-forming system. The most probable cause of the reduction of fluid salinity is mixing of high-grade magmagene and low-grade meteoric solutions.

Rare metal ores are represented by Sn-W greisens from Pravo-Urmi deposit (Badzhal region of Khabarovsk district) and Tigrinoe deposit (Arminsky region of Prymorie).

By means of geochemical and isotope signs, Badzhal ore-magmatic system is characterized as essentially crust with limited mantle contribution. Rare metal mineralization of the largest from this OMS deposit (Pravo-Urmi) is connected with the Badzhal complex that combines blanket and extrusive rhyolite-dazite bodies (105 – 95 млн. лет) with comagmatic rocks, that is, granites Urmi cryptobatholite (96-90 млн. лет). Minerals of cassiterite-topaz-quartz assemble form Pravo-Urmi deposit crystallized at T=370–420°C from multicomponent fluid (0.86Na, 0.1K, 0.03Ca, 0.01Mg / 0.5Cl, 0.2F, 0.3HCO_3) with the salinity 11.8±0.3 wt.% NaCl-equiv. B, Li, Mn, Br, Rb, Cs, Sr, W, Mo, As, Tl are discovered in solutions by the method of the water extract. The studied at the Badzhal region quartz-feldspar ores (cassiterite-quartz type) from Blizhnee deposit are formed when the temperature drops from 420 up to 150°C at the conditions of the fluid phase separation and the formation of specific association of vapour and chloride brines (30–37 wt.% NaCl-equiv.) inclusions. The total composition of ore-forming fluid shows the following proportion of main components: (0.92Na, 0.04K, 0.04Ca) / (0.5Cl, 0.5HCO_3), besides, trace elements B, Li, Mn, Br, Rb, Cs, Sr, W, Mo, Sn, As, Ge are detected.

The Tigrinoe deposit genetically connected with Li-F granites, at the space and temporally association with which subalcalic basites – monzonites occur. At the deposit successive some mineral assembles are discovered. The quartz-feldspar association formed from the water-salt Na-chloride and gaseous fluid at T=416-318°C with the salinity 5.8-0.9 wt.%, equiv. NaCl. The quartz-mica-topaz assemble formed from Na-chloride solutions at T=422-250°C with the salinity 7.0-5.0 wt.%, equiv. NaCl. It is found that quartz-wolframite-cassiterite veins at the Tigrinoe deposit are developed at T=420-240°C from Na-chloride fluids with the salinity 3-7 wt. %, equiv. NaCl. The specific feature of fluids is their constant composition and salinity. The pressure during mineral-forming did not exceed 300 bar. Fluid inclusions in topaz from Tigrinoe deposit contain dilute hydrocarbonate solutions (0.56Na, 0.28K, 0.12Ca, 0.04Mg / HCO_3) with B, Li, Mn, Rb, Sr, Ge. All studied mineral-forming systems of greisen deposits are defined by a higher reduction potential of the fluid (the $CO_2/\Sigma HC$ ratio = 1–3).

The conducted fluid inclusion a study of various assembles from tin deposits of the Far East show both similarities and differences of parameters of fluid regime for various deposits. The broad variations of temperatures, salinity of fluids and the concentrations of cations, rare, alkaline, volatile and ore components in mineral-forming fluids are observed. The major similarity makes oneself evident in the fact that mineral-forming systems are marked by considerably chloride composition, a high temperature, salinity and heterogenization at the early stages of fluid separating from the parent melt at the conditions of subvolcanic depth level (P 200–300 bar). For all tin deposits the diluting of high concentrated magmagene fluids by meteoric waters is installed for the late stages of the ore formation.

The revealed essential differences of mineral-forming fluids in the composition of main salt (Na-K-Mg-Ca) and volatile (B, F, CH_4, CO_2, CO, H_2) components, rare (Ge, Br, Tl, As, Mn, Sr) and ore (Sn, W, Mo, Cu, Pb, Zn) elements and also in the proportion of alkalies (K-Rb-Cs-Li) could reflect the setting peculiarities of the generation and the evolution of diverse tin-bearing ore-magmatic systems.

SPHALERITE AS A HUB OF NON-FERROUS, PRECIOUS METALS AND TRACE ELEMENTS: AN EXPERIMENTAL STUDY

[1]Tonkacheev D., [2]Chareev D., [3]Kovalchuk E., [3]Minervina E., [3]Vikent'ev I., [3]Golovanova T., [3]Tagirov B.

dtonkach@geol.msu.ru, [1]Lomonosov Moscow State University. Geological Department, Moscow, Russia; [2]Institute of experimental mineralogy (IEM) Russia Academy of Sciences (RAS), Chernogolovka, Russia; [3]Institute of geology of ore deposits, petrology, mineralogy and geochemistry (IGEM) Russia Academy of Sciences (RAS), Moscow, Russia

Sphalerite (Zn, Fe)S is one of the main components of ore deposits of hydrothermal and magmatic origin. Due to the features of the crystal structure this mineral can accumulate metals and semi-metals as admixtures. The purpose of this work is to study "capacity" of sphalerite in relation to metals, semimetals, and chalcogens (S, Se, etc.). In order to do this, we added admixtures of these elements in the synthetic phase. Then we have studied these samples using local microanalysis techniques (SEM, LA ICP MS, etc.).

ZnS crystals were grown using the gas transport method with NH_4Cl as a gas transmission chemical. In process of synthesis of ZnS we used batch composition: ZnS – 10615 mg; FeS – 347,5 mg., S (in excess) for CD 1440, 1441, 1450 samples , and pure ZnS for specimens with number from 1536 to 1545. A mixture of the starting materials and the appropriate impurities brewed under vacuum quartz glass ampoule and heated for 30 or 60 days in a horizontal position at 850 ° C (hot end) with a temperature gradient in 50 ° C.

Electron probe microanalysis was carried out in the laboratory of the Division of Mineralogy, Geological Department of Moscow State University, used microprobe Camebax SX50. Some analysis of the samples was carried out in IGEM RAS on the device JEOL JXA-8200. The concentration of trace elements there were also measured by Inductively coupled plasma mass spectrometry (LA-ICP-MS) using a quadrupole mass spectrometer XSeries. The study of color cathodoluminescence (CL) was carried out using electron probe microanalyzer of Camera company "MS-46" with high-resolution digital camera "Videoscan 285".

The first series of samples is a Fe-free sphalerites with various admixtures. Average Mn content in the sample №1545 is 0.799 ± 0.144 wt. %; Cd in the sample №1544 is 550 ± 0.067 wt. %; Ag 0.089 ± 0.091 wt. %. Silver in №1544 distributed heterogeneously. These sphalerites have strongly pronounced cathodoluminescence properties.

The second series of samples (CD 1440, 1441, 1450) is a sphalerite with abundance of Fe to 0.03 formula units. (1.73 wt.%). The average gold content in the sample CD 1440 (ZnS with Au), as measured by LA-ICP-MS, was 234 ± 34 ppm. The distribution of gold is homogeneous. CD 1441 is sphalerite with an admixture of Ag. Average concentration of Ag in the sample is equal to 343 ± 86 ppm, the distribution of Ag is heterogeneous.

The most interesting sphalerite is CD1450. In this sample simultaneously distinct admixtures were added. The average abundance is: Mn 0.240 ± 0.020, In 0.290 ± 0.011, Se 0.126 ± 0.040, Cd 0.484 ± 0.060, and finally, Au 0.300 ± 0.023 wt.% (EPMA data).

Thus, sphalerite is an effective concentrator of admixtures of trace elements, including noble metals (Ag, Au). The concentration of gold and silver in sphalerite can reach 0.3 wt. %

DETERMINATION OF THE ASSOCIATION CONSTANT OF NAF(AQ) IN HF-NACL-H_2O SYSTEM AT 25 °C BY POTENTIOMETRY

Lukyanova E.V., Zotov A.V.
lyk.kate@gmail.com; azotov@igem.ru; IGEM RAS, Moscow, Russia

In the last years it was shown that fluorine-rich fluids may play a significant role in hydrothermal transport of high field strength elements (HFSE) such as Nb, Ta, Zr, Hf (Wood, 2005; Zaraisky et al., 2010; Tagirov, Shikina, 2014). However, to quantify this phenomena one needs dataon fluoride aqueous complexes of alkaline metals (Na, K, Li) at high temperatures that are lacking. The only one corresponding experimental study of Richardson and Holland (1979) is available, where is stated that association constants of NaF at 200-250 °C are close to those of NaCl (SUPCRT98). At 25°C, the difference between existing experimental data on the association constant attains one order of magnitude (Usha, 1992; Manohar and Atkinson, 1993; Chan et al., 1984; Robinson et al., 1966; Butler and Huston,1970). It should be noted that all of them are significantly higher than that of NaCl. The goal of this study is to develop a methodology and perform control measurements of the association constant of NaF_{aq} at 25 °C in order to its subsequent study at higher temperatures.

Experimental technique. The solutions were prepared using distilled water and NaF and NaCl reagents (commercially available pure chemicals), pre dried at 200 °C. All concentrations were controlled using weight method. Potentiometric measurements were conducted in the thermostatic glass cell with magnetic stirring at 25±0.2 °C and ambient pressure .The isothermal cell with liquid junction potential. This cell includes two glass Na-sensitive solid contact electrodes (NPO "Izmeritelnaya technika"), two fluoride LaF_3 electrodes (OOO " Nico Analit") and external reference AgCl electrode. 2 M KCl solution was used in the salt bridge. The Henderson equation (Beits 1972) was employed to correct the diffusion potential. The EMF was measured by multichannel device which was connected with computer (OOO "EMF expert") with input impedance more than 10^{12} Om, resolution of 0.1 mV and accuracy of 0.5 mV.

Measurements. Several series of measurements and calibration were carried out. The main series added up firstly to a step-by-step increasing of NaF concentration from $3{\cdot}10^{-4}$ to $9.5{\cdot}10^{-3}$ M (calibration of fluoride ion activity) and then to addition of a specified quantity of concentrated NaCl solution containing $9.5{\cdot}10^{-3}$ M of NaF.

Estimation of the association constant. The activity coefficients and ions' speciation were calculated using the HCh program (Shvarov, 2008) and the modified Debye-Hьckel equation with e=4.5 E for all ions and b = 0.064 for NaCl electrolyte. The calibration lines for Na^+ and F^- are: $E(Na^+)=58.944{\cdot}\lg a(Na^+) - 2342.8$ in the range from 0.001 to 0.29 m(NaCl)) and $E(F^-)=-59.194{\cdot}\lg a(F^-)+25.76$ in the range from 0.0003 to 0.0095 m(NaF). The slope of these lines is closed to theoretical one at R^2=0.999. The dissociation constant for NaCl at 25°C was accepted according to (Ho et al., 1994): $\lg K_{as}=-1.18$. Computation of NaF association constant was carried out with the use of OptimA utility (Shvarov, 2014).

According to preliminary calculation $\lg K_{as}$ (NaF_{aq}) = 0.15±0.2 at confidence level of 0.95. This value is in a good agreement with results of (Chan et al., 1984) and (Manohar and Atkinson, 1993).

The results may be verified by considering the cell without a transfer i.e. without uncertainty related to the diffusion potential. For this we examined the dependence of calculated values of $\lg a(Na^+) + \lg a(F^-)$ as a function of measured values of $E(Na^+)-E(F^-)$. The result is a linear dependence in the range of concentration from 0.001m NaF to (0.0088m NaF + 2.09m NaCl) and the slope is theoretical (59.10) at R^2=0.9985.

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NIOBIUM IN THE HYDROTERMAL SYSTEMS: THERMODINAMIC DESCRIPTION OF NIOBIUM HYDROXO- AND FLUORIDE COMPLEXES IN A WIDE RANGE OF TEMPERATURES AND PRESSURES

[1]Lukyanova E.V., [1]Akinfiev N.N., [1]Zotov A.V., [2]Kotova N.P.
[1] lyk.kate@gmail.com IGEM RAS, Moskow, Russia
[2]IEM RAS, Chernogolovka, Russia

Niobium is the 5B element of the periodic table of chemical elements with atomic number of 41. Due to niobium's particular thermophysical properties and high corrosion stability it is considered as a strategically important metal as well as different compounds of tantalum, and, in particular, is widely employed in space and defensive industry. Production of niobium is usually performed by gravitational method from columbite-tantalite concentrate. Method of flotation is often used for extraction of pirochlor from carbonatites, which include it as sprinking or accessory component. The main minerals which contain niobium in high concentrations are "coltan", pirochlor, loparite. However, the high content of Ta is often attends to the high content of Nb in these minerals.

Russia is not the main supplier of these mineral raw materials in the world, but it has all the industrial types of Nb ore deposits such as pirochlorical carbonatites, loparite nepheline syenites, columbite- pirochlorical alkaline granits and granosyenites. "Coltan" ore is explored in alkaline granits of Katyginskoe and Zashihinskoe deposits and in the pegmatites of the Vishnakovskoye deposit. But the only loparites of the Lovozerskoye deposit are exploited at the moment.

Currently the high-temperature metasomatism model is the most popular for the processes which lead to Nb mineralization. In accordance with this model accumulation of Li, Nb, and F takes place via crystallization of the granite magma residual melt. While further temperature decrease these elements form small accessory insets of Nb-contained minerals [1, 2]. However processes of the Nb hydrothermal transport may also play a significant role equally with magmatic processes. Experimental data of solubility of niobium oxide (V) in fluoride solutions at high temperatures (300 – 550 °C) [3, 4] show, that hydrothermal transport of Nb in concentrated NaF and KF solutions may be sufficient to achieve industrial concentrations of this metal.

In order to quantitatively describe migration and accumulation processes of Nb by hydrothermal fluids it is necessary to get information about forms of this element in the fluids and their thermodynamic properties. At this moment such an information is fragmentary or totally absent. The goal of this study is to proceed the available experimental data on Nb solubility in aqueous fluids to identify stoichiometry of Nb species and to estimate stability of Nb complexes' formation for a wide range of temperatures (0 – 600 °C) and pressures (0.1 – 300 MPa).

Initially the structures and thermochemical properties of all possible OH and F neutral complexes of Nb ($Nb(OH)_5$, $NbO(OH)_3$, NbO_2OH, $Nb(OH)_5(H_2O)$, $Nb(OH)_4F$, $NbO(OH)_2F$, NbO_2F, $NbO_2F(H_2O)$, $Nb(OH)_3F_2$, $NbOOHF_2$, $Nb(OH)_2F_3$, $NbOHF_4$, NbF_5, $Nb_2O_2(OH)_6$, $Nb_2O_2(OH)_4F_2$, $Nb_2O_2(OH)_2F_4$, $Nb_2O_2F_6$) were calculated by methods of quantum chemistry (DFT B3LYP with basis set of 6-311+G(d,p) for light elements and LANL2DZ for Nb). Subsequently a relative stability of these molecules in an ideal gas state was analysed as a function of temperature (0 – 600 єC), H_2O pressure (0.1 – 300 MPa) and HF mole fraction (x_{HF} = 0 – 0.02). For instance, calculated distribution of Nb species at H_2O pressure of 50 MPa and $x_{HF} = 10^{-2}$ as a function of temperature shows that hydroxocomplex $NbO(OH)_3$ and fluorine complexes of the type $NbO(OH)_2F_n$ are prevalent in the experimental temperature range (T > 300 єC). It was also shown that contribution of F-complexes is reduced with increasing temperature. The performed computations permit to minimise number of Nb species considered in the subsequent analysis.

Experimental data on solubility of Nb_2O_5 in hydrothermal HF-NaF-KF-NaOH fluids [3, 4] were processed by the OptimA program [5] which is developed for estimation of Gibbs free energies *g(T,P)* of aqueous species. At the first stage only the experimental data of congruent niobium oxide dissolution were involved in the optimization process. It was assumed that solubility of Nb_2O_5 in the near neutral fluids is characterized by hydroxocomplex $NbO(OH)_3(aq)$

$$SNb_2O_5(s.) + SH_2O = NbO(OH)_3(aq).$$

Under acid conditions of HF bearing fluids the dissolution reaction is defined by

$$SNb_2O_5(s.) + HF(aq) + SH_2O = NbO(OH)_2F(aq).$$

The fluoride negatively charged complex is significant in alkaline fluoride-bearing solutions

$$SNb_2O_5(s.) + F^- + SH_2O = NbO(OH)_3F^-.$$

At the next step the experimental Nb_2O_5 solubility data were considered subject to formation of secondary phases of niobates, while thermodynamic properties of thee last were refined in every *PT*-point.

The estimated *g(T,P)* values for hydroxide and fluoride complexes of Nb were then employed to obtain the HKF model [6] parameters of these species by use of the OptimB program that is included in the HCh package [5].

As a result thermodynamic description of Nb aqueous species is available to perform various thermodynamic models of hydrothermal Nb transport and accumulation in a wide range of temperatures (0 – 600 єC), pressures (0.1 – 300 MPa) and fluid compositions. In particular, the model computation of Nb_2O_5 solubility at 550 °C and 1 kbar showed that concentration of Nb in fluid reaches 300 and 100 ppm in solutions of 0.1 mol·kg^{-1} HF and KF, respectively.

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ETHNOLINGUISTIC CONTEMPORARY ISSUES

IMPACT EVENTS

Volkova G.D.
Scientific adviser Docent **N.N. Lobanova**
earlinndrow@gmail.com, Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze (MGRI-RSGPU), Moscow, Russia

An impact event is a collision between celestial objects causing measurable effects. When large space objects impact planets like the Earth, there can be significant physical and biospheric consequences, though atmospheres mitigate many surface impacts. Impact events have played a significant role in the evolution of the Solar System since its formation. Major impact events have been implicated in the formation of the Earth–Moon system, the evolutionary history of life, the origin of water on the Earth and several mass extinctions such as extinction of dinosaurs.

The result of an impact event is the appearance of an impact crater or an impact structure. Another name of an impact crater is an astrobleme. The term impact structure is used in cases in which erosion or burial have destroyed or masked the original impact crater.

An impact crater is an approximately circular depression in the surface of a planet, moon or other solid body in the Solar System, formed by the impact of a smaller body with the surface.

Impact craters are the dominant geographic features on many solid Solar System objects including the Moon, Mercury, Callisto and other small moons and asteroids. On the planets and moons that experience more active surface geological processes, such as Earth, Venus and Mars visible impact craters are less common because they become eroded, buried or transformed by tectonics over time.

Impact crater formation involves high speed collisions between solid objects, typically much greater than the speed of sound. Such supersonic impacts produce physical effects such as melting and vaporization. On the Earth the lowest impact speed with an object from space is equal to the gravitational escape speed of about 11 km/s. The fastest impacts occur at more than 80 km/s speed. But the median impact speed on the Earth is about 20 to 25 km/s.

It is convenient to divide the impact process into three stages: (1) initial contact and compression, (2) excavation, (3) modification and collapse. In practice, these three processes may occur synchronously.

The first stage, which is called contact and compression, begins when the impactor first touches the target surface. This contact accelerates the target and decelerates the impactor. As a result, the impactor is compressed, its density rises, and the pressure within it increases dramatically.

The second stage is excavation. During excavation the accelerated target material moves away from the impact point and the crater appears. When this crater has reached its maximum size, it is called the transient crater.

The third stage is modification and collapse. The transient crater is not stable: it collapses under gravity. The result structure is called a simple crater. In simple craters, the original excavation crater is overlain by collapse breccia, ejecta and melt rock, and a part of the central crater floor may sometimes be flat. Simple craters typically have raised rims and floors that are lower in elevation than the surrounding terrain.

Sometimes above a certain threshold size, which varies with planetary gravity, the collapse and modification of the transient crater is much more extensive, and the resulting structure is called a complex crater. Complex craters have uplifted centers, flat crater floors, and terraced walls. It also may have a central peak, a ring of peaks and exterior or interior rings.

People can identify impact craters on the Earth using shock-metamorphic effects such as breccia layers under the floor of the crater, shatter cones, high-temperature rock types which is called impactites, presence of shocked minerals, especially shocked quartz and anomalous geological character or geophysical expression.

Although the Earth's active surface processes quickly destroy the impact record, about 170 impact craters have been identified. These range in diameter from a few tens of meters up to about

300 km, and they range in age from recent times (e.g. the Sikhote-Alin craters in Russia whose creation were witnessed in 1947) to more than two billion years, though most are less than 500 million years old because of geological processes. They are also selectively found in the stable interior regions of continents. Few undersea craters have been discovered because of the difficulty of surveying the sea floor, the rapid rate of change of the ocean bottom, and the subduction of the ocean floor into the Earth's interior.

There is an inverse relationship between the size of the object and the frequency that such objects hit the Earth. Stony asteroids with a diameter of 4 meters impact the Earth approximately once per year. Asteroids with a diameter of 7 meters enter the Earth's atmosphere about every 5 years. Objects with a diameter of 50 meters strike the Earth approximately once every thousand years, producing explosions comparable to Tunguska meteorite explosion. Asteroids with a 1 km diameter strike the Earth every 500,000 years on average. Collisions with 5 km diameter objects happen approximately once every twenty million years. The last known impact of an object of 10 km or more in diameter was at the Cretaceous–Paleogene extinction event 66 million years ago.

One of the best-known recorded impacts in modern times was the Tunguska event, which occurred in Siberia, Russia, in 1908. Although no human is known to have been killed directly by an impact, over one thousand people were injured by the Chelyabinsk meteor airburst event over Russia in 2013. Chelyabinsk meteor is the largest recorded object to have encountered the Earth since the Tunguska event. It was estimated that the chance of a single person born today dying due to an impact is around 1 in 200 000.

Impact events have generated large crustal disturbances, produced huge volumes of igneous rocks, formed major ore deposits and valuable mineral resources. The public regards them as the established destroyer of dinosaurs and as the possible destroyer of civilization. That is why we can appreciate the importance of impact events and the extent of their influence on the geological and biological history of Earth.

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THE GEOPHYSICAL EXPLORATION OF THE EARTH'S INNER CORE

Gaidukov A.A.
Scientific Advisor: Senior Lecturer **V.V. Smirnov**a
vzepy@rambler.ru, Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze (MGRI-RSGPU), Moscow, Russia

We are familiar with such methods of geophysical exploration as thermal exploration, magnetic, electromagnetic, and seismic exploration. Seismic exploration is a geophysical method of studying the geological objects by means of elastic vibrations – seismic waves. This method is based on the fact that the velocity of propagation and other characteristics of seismic waves depend on the properties of the geological environment in which they apply: the composition of rocks, their porosity, fracturing, fluid saturation, and the state of stress and pace-temperature conditions of occurrence. The geological environment is characterized by an uneven distribution of these properties, heterogeneity, which is manifested in the reflection, refraction, diffraction and absorption of seismic waves.

The study of the reflected, refracted, refraction and other types of waves in order to identify the spatial distribution and quantification of elastic and other properties of the geological environment – is the content of seismic methods and determines their diversity. The technique is based on the study of seismic waves' kinematics or the travel time of the waves from different points of their excitation to the geophones catching displacement velocity of the soil, and their dynamics and intensity of the waves. In the rather complex of special installations (seismic stations) electrical oscillations, cos geophone data in a very weak soil is amplified, and is automatically recorded on the seismograms. As a result of interpreting there can be determined the depth of the seismic and geological boundaries, their fall, stretch, wave velocity, and using geological data, the geological nature of the identified boundaries is established.

In seismic exploration we use two main methods: the method of reflected waves and the method of refraction. The methods that apply the other waves are rarely used. Solving complex problems associated with high-precision determination of the geometry of the geological section (error less than 1%), had become possible through the use of labor-intensive excitation and outlook systems and surveillance, which enabled the simultaneous, sometimes multiple removal of information from a large area and its second digital processing. This provides a selection of useful, often single reflection or refraction of waves among the many-interference.

Xiaodong Song, a professor of seismology, published his research work in the journal "Nature Geoscience" on Feb. 9 (2015). With the new application technology of reading earthquakes, the research team from the University of Illinois and their colleagues from the University of Nanjing in China found that the Earth's inner core has another inner core, which has amazing properties that can disclose information about our planet. "Despite the fact that the inner core is small – less than the Moon – it has some interesting features actually, "said Song. "It may tell us about how our planet was formed, its history, and other dynamic processes of the Earth. It shapes our understanding of what's going on deep inside the Earth."

Researchers use seismic waves from earthquakes to scan below the planet's surface, much like doctors use ultrasound to see inside patients. The team used a technology that gathers data not from the initial shock of an earthquake, but from the waves that resonate in the earthquake's aftermath. The earthquake is like a hammer striking a bell; much like a listener hears the clear tone that resonates after the bell strike, seismic sensors collect a coherent signal in the earthquake's coda.

"It turns out the coherent signal enhanced by the technology is clearer than the ring itself," said Song. "The basic idea of the method has been around for a while, and people have used it for other kinds of studies near the surface. But we are looking all the way through the center of the Earth." Previously it was thought that the inner core consists essentially of iron and nickel alloys, and stored at temperatures of about 4-5 thousand K .

In contrast to the liquid outer core, inner core is in a solid state. Its existence is known for refraction and reflection of longitudinal seismic waves .

The inner core was opened in 1936 by the Danish geophysicist Inge Lehmann. She discovered that observations of earthquakes generate seismic waves that are partially reflected from the boundaries and can be detected by sensitive seismographs on the surface Se PLR. This boundary is called "Bullen gap," and sometimes "Lehmann discontinuity".

Seismic studies show that seismic velocities were fixed in the inner core anisotropy: the velocity of propagation of longitudinal waves is in the 3-4% more along the polar axis than in the equatorial plane.

The inner core, once thought to be a solid ball of iron, has some complex structural properties. The team found a distinct inner-inner core, about half the diameter of the whole inner core. The iron crystals in the outer layer of the inner core are aligned directionally, north-south. However, in the inner-inner core, the iron crystals point roughly east-west.

Not only the iron crystals are in the inner-inner core aligned differently, they behave differently from their counterparts in the outer-inner core. This means that the inner-inner core could be made up of a different type of crystal, or a different phase.

“The fact that we have two regions that are distinctly different may tell us something about how the inner core has been evolving,” Song said. “For example, over the history of the earth, the inner core might have had a very dramatic change in its deformation regime. It might hold the key to how the planet has evolved. We are right in the center – literally, the center of the Earth.”

I believe that Russia should take part in such kinds of research.

In the near future I hope to hear about the expedition to the center of the Earth.

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THE ROLE OF THE UNIVERSITIES IN THE DEVELOPMENT OF MINING AND GEOLOGY IN RUSSIA

Kolganov D.N.
Scientific Adviser Senior Lecturer **V.V. Smirnova**
kolganov2016@yandex.ru, Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze (MGRI-RSGPU), Moscow, Russia

Throughout the history of our country people needed different kinds of minerals and rocks. Although people had started developing fields several hundred years ago, the most important period of improving geology and mining was the period of industrialization in our country. From the second half of the 19th century a great number of mineral deposits were discovered. In addition, lots of new technologies and diagnostic ways were made up.

In fact, Russia has the largest area all around the world. That is why we have countless resources of oil, gas, copper, silver and other useful minerals. However, a great part of them has not been discovered yet. In order to improve the geological and mining areas of Russia, special universities and colleges were set up, for example: The National Mineral Resources University (The University of Mines), Lomonosov Moscow State University, The Russian State University of Oil and Gas, The Russian State Geological Prospecting University and many others. The graduates of these universities work in different parts of our country. Moreover, every university has its own specialization, for example, the students of The Russian State University of Oil and Gas work in international corporations like Gazprom and Rosneft. These people are experienced and highly-qualified workers, and they know practically everything about oil and gas. The Russian State Geological Prospecting University is the only university in the world, which is specialized in geological prospecting. In fact, its graduates work in geology prospecting and mining practically in all parts of Russia and a lot of them go abroad. Nowadays our university is preparing specialists in geophysics, economics, ecology, international relations, cryology and hydrogeology.

Today Lomonosov Moscow State University is one of the most popular universities in Russia. After finishing the education a great part of students takes part in the incredible innovation projects. A lot of them are scientists, and they make research in different spheres, including geology.

The National Mineral Resources University is popular with the project “East” located in Antarctica. That is the place where the unique technology of drilling was invented. Unfortunately, since the January, 2015 that project was stopped. Thanks to the National Mineral Resources University, scientists have finally taken the samples of the relict lake, located under snow and ice at the depth of 3.5 thousand kilometers.

Nowadays, the popularity of geology is going up. Due to this, more than 30 universities of Russia are giving possibility to learn this science. Moreover, the universities are becoming the centers of scientific research and development.

The contribution of Russian State Geological Prospecting University in science is really significant. For about recent 100 years our university has prepared specialists and some of them have discovered uranium, molybdenum, diamond, water, iron, oil, gas deposits. The lecturers are also taking part in the working-out. For example, Evgeniy Zavyalov with the help of the students discovered 11 new minerals. One of them is even called “MGRIIT” after the name of the university. In general, the discovery of about 250 minerals is connected with the name of our university. By the way, a lot of people became successful politicians, and public figures, for example, Ilya Segalovich is one of the founders of Yandex.

Every year we develop northern areas as the greatest part of deposits is situated in Antarctica. The shelf of northern seas is rich with oil and gas. The drilling station in the Barents Sea is already working right now. In March 2014 the United Nation decided to make the Sea of Okhotsk enclave completely Russian.

The area of Crimea is very poor with surface water, but artesian pressure waters are used by people not only for drinking, but also for watering. In addition, scientists predict that in a half of the century Saint Petersburg may be under water. Then, 30 years later the permafrost of Siberia may start to melt and all communications and infrastructure will deform and break down. All these will happen because of the global warming, that is why our country will always need good specialists in geology, hydrogeology, geophysics and cryology, as there are so many serious problems in Russia.

Finally, professions connected with geology and mining are the basement of Russian economics. The bright future of Russia depends on us! So, let's continue to discover, improve and develop our motherland!!!

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FRENCH BORROWINGS IN THE ENGLISH LANGUAGE

Smirnova V.V.
valentine-sm@yandex.ru, Russian State Geological Prospecting University
n. a. Sergo Ordzhonikidze (MGRI-RSGPU), Moscow, Russia

Nowadays English is undoubtedly the most important language of international communication, trade, cooperation and business. However, it should be noted that the English language has undergone immense changes over the years of its development from Anglo-Saxon (Old English) to Modern English as it is known today.

English vocabulary includes about 70 % of loan words. Such a great number of borrowings in the English language can be explained by the historical conditions of the language development. In the Middle Ages, English more than any other language had the opportunity to borrow foreign words in close contact with the foreign invaders who were alternated with each other in the British Isles. Later the language was enriched with the borrowings at the time of British colonization and trade expansion.

In 1066 the Norman conquest of England gave rise to the flood of borrowings from Norman French. The power was completely in the hands of the Normans. In England they came as bearers of the French language (Norman dialect), the French culture and the French feudal system. French became the official language of legal proceeding and public administration. Teaching at schools was in French. During this period, there appeared many new concepts that have arisen in connection with new forms of governance, new customs, new organization of the army, the church, education, urban life, etc. Such updated vital concepts demanded new words to designate them. For this purpose French words were used. Until the end of the 14th century English assimilated a huge amount of French words:

- **court, servant, guard, prince, vassal, government, serf, village;**
- **army, battle, banner, victory;**
- **religion, chapel, prayer, to confess;**
- **city, merchant.**

Craftsmen who lived in the villages, kept the English names, while those who lived in towns, were named by the French words: **butcher, mason, tailor**, etc. The interesting French borrowings were marked by Walter Scott in his novel "Ivanhoe": the names of the living animals remained German: **ox, cow, calf, sheep, pig**, but their meats required the French names: **beef, veal, mutton, pork,** etc.

However, the influence of the French language on English vocabulary is not limited only to the borrowings that express new concepts, or shades of already existing concepts, for the English people. Many words of French origin displaced the English words that expressed the most basic concepts, for example: **air, place, large, river, change, front, receive, appear, blanket, blue, butcher, painter, dance, garden, message, table, chair.**

Thus, in the Middle English period (1066-1485), three types of borrowings are distinguished:

1. The struggle between the English word and the French one ends in favor of the latter, the English word disappears from the language. For example, the French word **riviиre** displaced the Old English word **ēa**; the French word **montagne** displaced the Old English word **beorz**.

2. The French word disappears from the English language. For example, the word **amity** has been replaced by the English word **friendship**.

3. The both words are stored in the language, but the differentiation of their meanings takes place. For example, the Old English word **harfest**, meaning "autumn", was replaced in this meaning by the noun **autumn** from the French **autumne**, but remained in the English language in the form of **harvest**, meaning “the process of gathering mature crops from the fields”.

After the Norman Conquest the French borrowings are often characterized by the pronunciation and spelling rules peculiar to the French language. For example, the words **machine, coquette, rouge, police,** etc. do not differ in their pronunciation and spelling from the French words.

In the Renaissance, the number of words borrowed from French, is not significant. In most cases, these are the words that express the concepts associated with trade, arts and politics.

In the 17-18th centuries, French borrowings reflect the historical and cultural relations between the French and the English people. Many borrowings of this period relate to the field of culture of the French aristocracy, to its tastes and customs, for example: **fiancй, coquette, unique, machine, police, chamois,** etc. During this period many words borrowed from French were included in the international vocabulary, for example: **toilet, hotel, illumination, elegant extravagant, delicate, miniature, grotesque, naпve, etc.**

At the end of 19th century and in the early 20th century there was the growing influence of England in the socio-political and cultural life of Europe in general and France in particular due to some historical reasons. During this period, there is a sharp decline in the penetration of French borrowings in comparison with previous periods of the development of the English language, as the flowering of the English nation was accompanied by the formation of a national English language. As a consequence, in the 19-20th centuries, French borrowings penetrate mainly into English literature.

Conclusion: The English language contains about 22 500 words of French origin. But, despite the fact that Modern English consists of about one-third of Romance words, it has not lost its identity as a Germanic language. A large number of French and other foreign borrowings, not only enriched the English language, but to some extent improved the underdeveloped language system of word-building means to express new concepts or shades of meaning.

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MINING GEOLOGY

Faradzhov T.M.
Scientific Advisor: Senior Lecturer **V.V. Smirnova**
teemoorfm@gmail.com, Russian State Geological Prospecting University n. a. Sergo Ordzhonikidze (MGRI-RSGPU), Moscow, Russia

Mining geology is a branch of geology that studies the conditions of mineral deposits occurrence in the earth, their composition and structure. Mining geology explores the origins and patterns of distribution of deposits of solid, liquid and gaseous minerals that have been forming all along the geological history, spanning a period of 3.5 billion years.

Mining geology is based on two branches of geological knowledge: **real**, that studies the composition of minerals and includes geochemistry, mineralogy and petrography; and **space**, which clarifies the patterns of distribution of mineral deposits and combines structural geology, tectonic geology, historical and regional geology.

The doctrine of the minerals was formed due to the increasing needs of human society in mineralogical raw material and the development of mining. The first picture of the conditions of mineral formation was found in the views of the ancient Greek philosophers. Neptunists founder Thales (about 625 – about 547 BC) considered the basis of the material world to be the element of water, and his opponent Plutonists Heraclitus (about 520 – about 460 BC) – the element of fire. So there were two areas of geological concepts: 1) rocks and mineral deposits among them are associated with the accumulation on the bottom water basins, and 2) they have been formed by underground heat of the Earth. The most significant works of medieval scientists about the nature of minerals belong to the German scientist G. Agricola (1494-1555), who was standing on Neptunists positions, and the French scientist R. Descartes (1596-1650), who defended Plutonists conception. In the 18th century presentation of Neptunists was developed by the German geologist and mineralogist A.G. Werner (1750-1817), that of Plutonists – by the Scottish naturalist John Hutton (1726-1797).

In the 19-20th centuries, there is a gradual shift away from monistic views of the nature of minerals. Scientists of all countries start to allocate among them as endogenous formation by the internal energy of the Earth, and exogenous, erased under the influence of surface agents. In the early 20th century, there appear various world science schools in the field of teaching about minerals.

Mining geology is sharply differentiated in types of mineralogical raw materials. It is divided into the geology of ore deposits and non-metallic minerals. Mining geology that studies the patterns of distribution of ore deposits and their relations with the processes of sedimentation, tectonics, magmatism and metamorphism has developed into an independent branch of knowledge, known as metallogeny.

Geology of industrial minerals is divided into geology of fossil fuels or geology caustobiolites, which includes geology of solid fuels (mainly fossil coal, oil shale) and the geology of oil and gas, minerals and geology nonflammable, including salts geology, geology of construction materials, etc.

Section of geology of incombustible minerals dedicated to groundwater is at the same time a part of hydrogeology. Economic Geology is a discipline, which was born at the interfaces between mining geology and economics. It is engaged in the valuation of deposits and subsoil. Since the term "useful minerals" is more economic in nature than geological, often (especially in Western literature) the concepts of economic geology and mining geology are identified.

Serious problem in Russia is building on the areas with mineral deposits, which entails additional losses in their bowels, and subsequently – the high cost of production. The mining complex has become now one of the largest sources of violations and environmental pollution. Pollutants are emitted by the mining industry. They are so diverse in composition and their number is so great that in some areas cause unpredictable consequences, detrimental impacting on the ecosystem.

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