ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ
Satbayev University

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Satbayev University

N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
Satbayev University

SERIES
OF GEOLOGY AND TECHNICAL SCIENCES

4 (448)

JULY – AUGUST 2021

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

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«ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Меншіктеуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).

Қазақстан Республикасының Ақпарат және қоғамдық даму министрлігінің Ақпарат комитетінде 29.07.2020 ж. берілген **№ KZ39VPY00025420** мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Тақырыптық бағыты: *геология, мұнай және газды өңдеудің химиялық технологиялары, мұнай химиясы, металдарды алу және олардың қосындыларының технологиясы.*

Мерзімділігі: жылына 6 рет.

Тиражы: 300 дана.

Редакцияның мекен-жайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., тел.: 272-13-19

http://www.geolog-technical.kz/index.php/en/

Типографияның мекен-жайы: «Аруна» ЖК, Алматы қ., Мұратбаев көш., 75.

«Известия НАН РК. Серия геологии и технических наук».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и общественного развития Республики Казахстан **№ KZ39VPY00025420,** выданное 29.07.2020 г.

Тематическая направленность: *геология, химические технологии переработки нефти и газа, нефтехимия, технологии извлечения металлов и их соеденений.*

Периодичность: 6 раз в год.

Тираж: 300 экземпляров.

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, оф. 219, тел.: 272-13-19

http://www.geolog-technical.kz/index.php/en/

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75.

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.

ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Owner: RPA «National Academy of Sciences of the Republic of Kazakhstan» (Almaty).

The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Social Development of the Republic of Kazakhstan **No. KZ39VPY00025420,** issued 29.07.2020.

Thematic scope: *geology, chemical technologies for oil and gas processing, petrochemistry, technologies for extracting metals and their connections.*

Periodicity: 6 times a year.

Circulation: 300 copies.

Editorial address: 28, Shevchenko str., of. 219, Almaty, 050010, tel. 272-13-19

http://www.geolog-technical.kz/index.php/en/

Address of printing house: ST «Aruna», 75, Muratbayev str, Almaty.

NEWS
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278
Volume 4, Number 448 (2021), 99-107 **https://doi.org/10.32014/2021.2518-170X.87**

UDC 553.411

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THE BAKYRSHIK DEPOSIT'S GOLD MINERALISATION PROSPECTING MODEL

Abstract: Kazakhstan is one of the world's most important gold-bearing provinces. Due to depletion of easily discovered deposits and the ever-increasing needs of the economy in scarce raw materials and to replenish the gold reserve of Kazakhstan, a steady increase in the efficiency of prospecting works and the accelerated development of new gold mining sites are required.

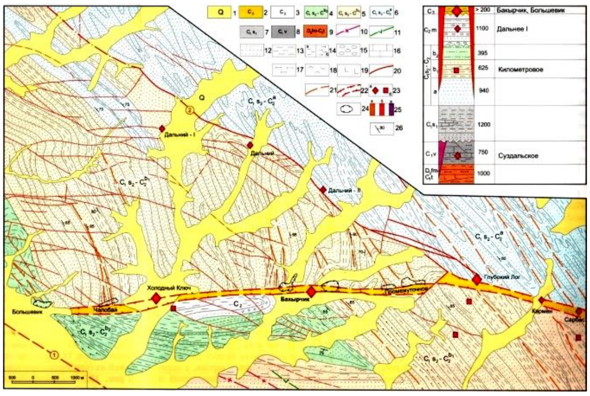
One of the main suppliers of gold in the world are sites of black shale formation, keeping enormous reserves of the metal.

The unique Bakyrshik gold deposit is a close analogue to the world-famous giant Muruntau in Uzbekistan and shares its many features in the formation of commercial gold ores. Based on the new factual data obtained, a three-stage prospecting model of the Bakyrshik deposit formation has been developed including the sedimentary sedimentary-diagenetic stage, the tectonic-metamorphogenic stage and the intrusive-thermal-metamorphogenic one.

Key words: gold, black shale strata, prospecting models, deposit.

Introduction. The Bakyrshik ore field, consisting of a number of carbonaceous-gold-sulphide deposits (Bakyrshik, Bolshevik, Gluboky Log, Promezhutochnoye, Chalobay, Kholodny Klyuch and Sarbas) is located in the complication zone of Late Hercynian collisions of simatic blocks and tectonised ophiolite blocks of the Zaisan folding system. It is composed of Carboniferous marine (C_S-C_2b), coastal-marine (Bukoni Formation C_2m) and continental (Bakirshik black shale sequence C_3) terrigenous sediments with several stratigraphic levels of gold-bearing carbonaceous-silt-pelitic horizons with syngenetic gold-pyrite mineralisation. Their gold content is an order of magnitude higher than that of the background, while the Bakyrshik black-shale stratum contains 100-150 mg/t, 0.2 to 1.5-2.0% of organic matter, which reaches 26.5-54.1% in anthraxolite lenses of the Bakyrshik stratum. Tuff horizons and covers of trachyandesitic porphyrites are isolated in siltstone-sandstone sediments. The Carboniferous terrigenous strata are broken by single stockworks and numerous dikes of plagiogranite-porphyries and dioritic porphyries, which form belts of northwestern and sublatitudinal strike [1].

The sedimentary deposits are folds of the main mesozonal-seam type, linearly stretched in a northwest direction, compressed with extensive development of ductile faults and zones of cleavage rock flow. They are intersected by a thick (50-350 m) sublatitudinal Kyzylov thrust zone of crumpling, manifested along a single deep fault of the Upper Mesozonal-suture zone of superimposed folding. A system of close, gently sloping to north ductile faults is developed in its lying side and central part, accompanied by inclined compressed folds, layer-by-layer cleavage and goffering. Dikes of lamprophyres and sandstone interlayers are boudinised, and pressure folds are developed [2]. The tectonically weakened Kyzylov zone is intruded by a plagiogranite-granodiorites of the Kunush complex (C_3-P_1), identified by geophysical surveys at a depth of 2-5 km. It is accompanied by gold-quartz-vein occurrences (Kilometrovoye, Zolotoye, Fabrichnoye, and others), which are more recent with respect to the prevailing carbonaceous-gold-sulphide mineralization. Precise structural control of the gold mineralisation characterised the deposits. All of the carbonaceous-gold-sulphide ore objects are located within the Kyzylov crumpling zone and are confined to junctions where it intersects the ductile faults of major folding (Figure 1).



1 - Neogene-Quaternary sediments; 2 - Bakyrshik black shale sequence C3; 3 - Bukoni conglomerate-sandy formation C_2m; 4-6 - siltstone-sandy stratum sequence C_1-S_2-C_2b: 4 - upper pelit-siltstone, 5 - middle siltstone-sandstone, 6 - lower sandstone; 7 - Aganakti siltstone-sandstone formation C_1S_1; 8 - Opanov argillit-limestone formation C_1v; 9 - Karabai basalt-siliceous formation D_3fm_2-C_1t; 10-11 - dikes: 10 - subalkaline granite-porphyries and monzonite-porphyries, 11 - diabase and diorite porphyries; 12-19 - various rocks: 12 - sandstones, 13 - interbedded sandstones and siltstones, 14 - clayey siltstones (a) and clayey-carbonaceous (b), 15 - conglomerates, 16 - limestones, 17 - phthanites, 18 - tuffs, 19 - basalts and andesites; 20 - faults (1 - West-Kalba, 2 - North-West); 21 - ductile faults; 22 - Kyzylov thrust zone; 23 - carbonaceous-gold-sulphide deposits (a) and occurrences of gold-quartz vein type (b); 24 - gold-mining pits; 25 - intrusive complexes: a - gabbro-monzonite-granosienite-granite-porphyry (Semeitau T1), b - granodiorite-plagiogranite (C_3-P_1); c - ultrabasite protrusions; 26 - elements of rock occurrence.

Figure 1 - Confinement of the Bakyrshik ore field gold deposits to parts of the intersection of the Kyzylov crumpling zone with the main folding's ductile faults.

The ore bodies are various of subconcordant lens-like shapes. They dip northward at 35-40°, extending along the dip of the Kyzylov thrust, along the lines of intersection with ductile faults and zones of cleavage flow of early folding rocks. The gold deposits are controlled by an area of junction between the Kyzylov crumpling zone and a series of ductile faults developed in the axial planes of tightly compressed congruent folds. The ore bodies along the strike are no longer than 120 m, while they exceed 1200 m in the dip direction. Tracings of the ore-hosting dislocation zones by the secondary complex metal scattering halos of As, Sb, Mo, W, Au confirm the mineralisation's structural control.

Carbonaceous-sericylitic, kaolinite-hydrosludite, quartz-sericite, sericite-flogopite-carbonate, chlorite-albite and other metasomatic associations are developed in the deposit. The leading type of hydrothermal alteration is carbonaceous-sericitolitic. Total carbon ranges from 0.3 to 26.5 % in the host terrigenous rocks and 2.5-6.0 % in the ore zones. Carbon is represented by oxidized (carbonates) and reduced (cerite, anthraxolite, shungite, graphite, bitumoids) forms.

Carbonates form metasomatic, often sulphidised dolomite, dolomite-ankerite, brainerite bodies. Kerite-anthraxolite-shungite, graphite and bitumoids have a "through" development in the ore-bearing strata. The halo space is dominated by alcohol-benzene bitumoid, while the ore bodies are dominated by chloroform.

Sericite in ore-depositing areas associates with carbonaceous matter, carbonate and quartz (up to 60-80%), the intensity of this paragenesis decreases at the periphery to 10-20% [3].

Methods. Samples of rocks and minerals from Bakyrshik deposits were analysed at the Natural History Museum's (London) Laboratory Research Centre using a Zeiss EVO 15LS SEM scanning electron microscope and a Cameca SX100 electron probe.

The Zeiss EVO 15LS SEM is a universal analytical scanning electron microscope, which can operate in variable pressure and high vacuum regimes. The low vacuum mode was used for imaging and qualitative XRF analysis of the samples. A pressure of 60-100 Pa was mainly used for sample analysis, although it can be increased up to 200 Pa. Mineral identification is carried out by an EDX detector with regular calibration for the analysis of major elements in silicates, the most common rock-forming minerals, and can very quickly provide the needed information for mineral identification.

In some cases, the chemical composition of 50 samples was studied in the Mineralogy sector of the IGN using a JCXA 733 electron-probe microanalyser and an INCA ENERGY energy dispersive spectrometer.

Results. The metasomatic zoning of Bakyrshik is as follows. Carbonaceous-caolinite-hydrosludite metasomatites are visible in the upper horizons, carbonaceous-sericite alterations have a "through" distribution (maximum pronounced in the central part), sericite-flogopite-carbonate association with apatite and tourmaline occupies the lower levels. Ore minerals form five paragenetic associations: the early melnikovite-pyrite-pyrrhotite-markasite (with nickel, pentlandite); the ore gold-pyrite-arsenopyrite (with cubanite, gersdorfite), the gold-quartz-polymetallic (with pale ore, chalcopyrite, galena, sphalerite) and gold-quartz-carbonate-shelite-chalcopyrite with brainerite, dolomite, aikinite, free Au; and the late quartz-carbonate-antimonite-tetrahedrite with marcasite and thin redeposited Au. The gold-pyrite-arsenopyrite association is "transitional"; the melnikovite-pyrite-pyrrhotite-marcasite and gold-quartz-carbonate-shelite-chalcopyrite are observed at greater depths; the gold-quartz-polymetallic and quartz-carbonate-antimonite-tetrahedrite gravitate to the middle and upper horizons.

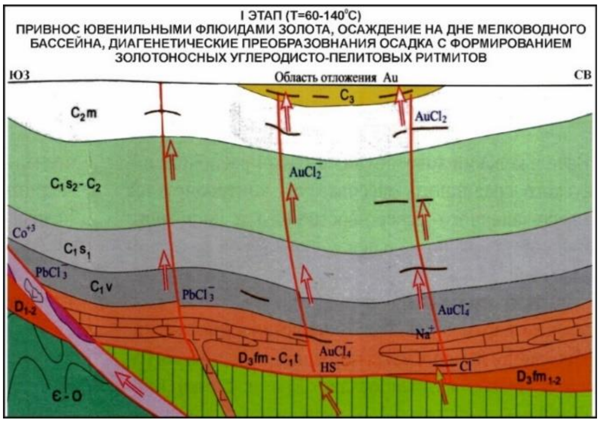
The vein-impregnated gold-pyrite-arsenopyrite association (pyrite 1.5-22.0 %, arsenopyrite 3.0-15.0 %) plays the leading role in the total gold balance (over 90 %). In the upper horizons, pyrite predominates over arsenopyrite (3.5:1); in the middle and deeper horizons, pyrite is subordinate (1:3). Fe disulphide forms aggregate clusters, globules, cubic, pentagon dodecahedral, cubo-octahedral crystals. [4].

The genesis of the deposit continues to be debated. Majority of researchers (H.A. Bespayev, V. Globa, V.I. Fomichev, and other) admit the existence of an ore-preparing exogenous stage, and a superimposed endogenous hydrothermal-metasomatic stage over the intrusive zone of the Kunush complex of small intrusions. However, these intrusions are absent in the Kyzylovsky thrust zone, the main ore-controlling structure. Occasionally, pyrite and contact alterations can be seen on the contact of dikes. Nevertheless, they are very small compared to the scale of stratiform ore bodies of the Bakyrshik deposit. All those who associate the formation of this deposit with magmatism should remember this.

Azerbayev N.A. believes that the Bakyrshik strata was formed in the thalassobatial deep-water situation at the foot of the continent, and sediments of gravity flows play a significant role in its composition. Humic acids of sapropel type played accumulating role of gold in Bakyrshik stratum, in his opinion, at the stage of late catagenesis - metagenesis [5].

According to V.N. Lubetsky and Lubetskaya, formation of this deposit is connected with mantle fluid flows, which, in its turn, is connected to the carbonaceous metasomatism. However, this point of view should necessarily be confirmed by the presence of mantle carbon. They believe, the mineralisation is formed in three main stages: 1) sedimentary sedimentary-diagenetic, 2) tectonic-metamorphic and 3) intrusive-thermal-metamorphogenic. The authors of the article accept the latter point of view, supported by our mineralogical data [6].

The sedimentary-diagenetic stage: gold, as well as associated nickel and cobalt, were extracted by juvenile fluids during tectonic activation from ultramafic rocks of oceanic basement and serpentinite protrusion zones. Mobilized gold was deposited in the silt-like environment of shallow basins and submarine deltas rich in organic matter and hydrogen sulfide; globular-framboidal inclusions and pyrite veins developed with the formation of rhythmic layered gold-bearing carbonaceous-clayey and carbonaceous-silt-pelitic sediments during diagenesis (Figure 3). Isotopic composition of rhythmites carbon δ13C= -14 ÷ -31‰ indicates its biogenic nature (N.M. Zairi, 1978) [7]. Remobilization and migration of gold during diagenesis (slightly alkaline environment, T = 100-150°C) was carried out as hydrosulfide complexes $Au(HS)_2$.

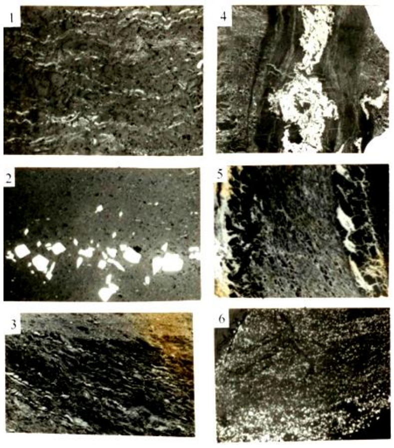


Note: See Figure 12 for the legend.
When compiling the prospecting model, materials by T.M. Zhautikov, Y.V. Gostev, V.I. Zenkov, L.G. Marchenko, E. Nusipov, V.B. Chekvaidze, A.A. Shiganov were utilised.

Figure 3 - Graphical model of the diagenesis process of rhythmic layered gold-bearing carbonaceous-clayey and carbonaceous-aleurolite-pelitic sediments

Metamorphism and dynamometamorphism of rocks, which appeared due to intensively developed collisional tectonics during the Late Carboniferous and Permian dislocation epoch, play the leading role in the transformation of ore material and formation of commercial vein-impregnated gold-sulphide ores. The coastal-marine molasse deposits (C_1s - C_2b) of 2,000-4,500 m of thickness are most widespread in the Carboniferous-terrigenous complex. In terms of carbon content ((C_{opr} = 0.3 to 2.1 %), they are low-carbonaceous rocks. Above, the marine molasse is replaced by high-carbon terrestrial molasse dominated by gray-colored argillaceous-sandstone and fluviolimnitic high-carboniferous black shale lithofacies with scattered organic matter of sapropelic and plantdetrital nature and C_{opr} contents from 0.3-0.6% to 14.5%, 0.96% on average.

Widely developed are lenses of anthraxolite and interlayers of stone coal, concretions of siderite-chamosite bog ores, phosphate-bearing nodules, horizons and lenses of various-grained sediments of suspension flows and collapsed breccias of turbidity with "pellets" of black siltstones (Figures 4-6). In ore zones, carbonaceous matter is developed as blind micro-veinlets, embeddings and small nests. Crumpled, flaky rocks and quartz-carbonaceous breccias enriched with gold-bearing pyrite appear in the crushing zones. Monomineral segregations of carbonaceous matter corresponding to shungite (according to L.G. Marchenko) were revealed in the composition of these breccias. According to A.V. Veselov, based on thermographic studies, the carbonaceous matter of the host rocks was classified as anthraxolite [8].



1 - micro-layers and dusty detritus of carbonaceous matter in silty sandstones. Polish slip, magnified x 25; 2 (3) - lenticular interlayers of anthraxolite in carbonaceous siltstones (pit scarp 3 at 330 m); 3 (4) - association of anthraxolite, carbonaceous pelite and sedimentogenic pyrite (light); 4 (6) - sub-microscopic pyrite pseudomorphosis as per organics. polished slip, magnified x 50.

Figure 4 - Nature of distribution of organic matter in ore-hosting (Cg) sediments at the Bakyrshik deposit

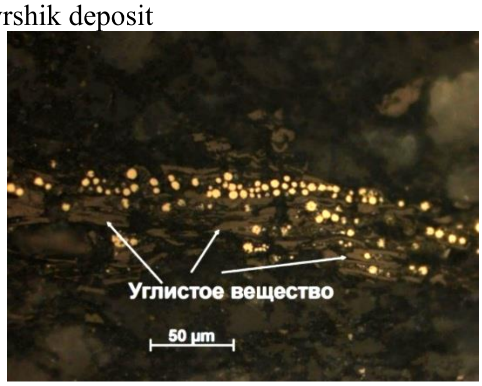
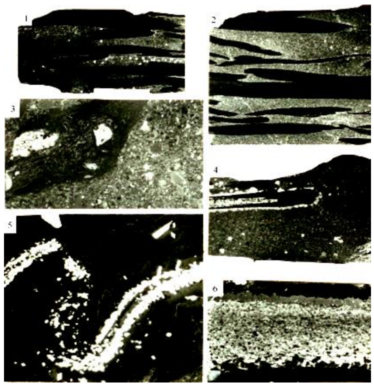


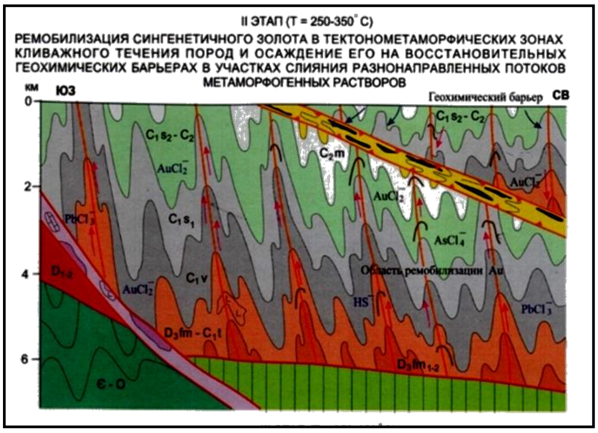
Figure 5 - Globular pyrite (bright balls) in carbonaceous matter. Bakyrshik



The underwater-slide breccias (1-4) with selective metasomatic replacement by sulfides of the cementing mass and interlayers of calcareous silty sandstones (5,6). Fragments of carbonaceous siltstones with syngenetic sulfides are often found in breccias (3,4). Figures 4, 6 show the deposition of pyrite metacrystals on the surface of carbonaceous siltstones. The samples are polished, natural size.

Figure 6-Samples characterising the underwater-slide breccias

Tectonic-metamorphogenic stage: the mesozonal-seam folding under increased temperatures of zeolite and chlorite-sericite facies of metamorphism and cleavage flow of rocks; occurring were dehydration of epizonal carbon-terrigenous sediments with gold extraction as chloride complexes $AuCl_2$, formation of hydrothermal-metamorphogenic solutions and their circulation along highly fluid-permeable viscous faults (Figure 7).



Note: see Figure 12 for the legend

Figure 7- Graphical model of the tectonic-metamorphogenic phase

The carbonaceous matter was transformed into shungite, graphite and rare carbin, and the recrystallized framboidal-globular pyrite acquired the pentagonal-dodecahedral and cubic habitus. In this stage (stress-metamorphic, according to V.B. Chekvaidze, 1999), migration of metamorphogenic solutions was accompanied by diffused near-fault sericitization, manifestation of cleavage and vein silicification, and formation of shungite-sericite metasomatites. The content of carbonaceous matter in shungite-sericite metasomatites and tectonites framing the mineralization is 13.4-15.2%. Remobilized gold was deposited on reductive geochemical barriers, most intensively at the sites of confluence of differently directed flows of hydrothermal-metamorphogenic solutions circulating along ductile faults of the main folding and Kyzylov crumpling zone. The metamorphogenic nature of new formations is confirmed by isotopes of shungite carbon (δ13C = -22 ÷ 26.8‰), oxygen and carbonate carbon (δ18O = +12 ÷ +18 ‰, δ13C = -2.5 ÷ -10‰). The temperature interval of metamorphogenic transformation is 200 - 250°C (N. M. Zairi, 1978). The predominance in the gas phase of fluids of nitrogen, hydrogen, methane, carbon dioxide (V.A. Narseev, 2001) is due to their formation during decomposition of organic, including nitrogen-containing, compounds during tectono-metamorphic transformation of rocks [7].

The tectonic-metamorphic stage is combined with late diagenetic-catagenic transformation of weakly lithified sediments. During this period, intensive dynamometamorphism of ore-hosting rocks takes place along the top-thrust faults, combined with regional metamorphism of Carboniferous deposits of the whole West Kalba metallogenic zone, with hydroplastic extrusion and flow of sulfide-bearing pelites, their boudinisation, delamination, brecciation and crushing (Figures 8-11).

Figure 8 - Zone of crumpling with maximum conversion of carbonaceous matter in sliding mirrors. Grinding-in.

Figure 9 - Distribution of pyrite and arsenopyrite mineralisation and quartz cuttings in carbonaceous-enriched boudin. Sample.

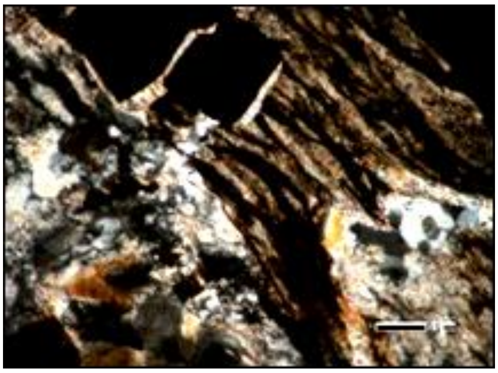


Figure 10 - A laminated brecciated argillite with pyrite embedding. Transparent section.

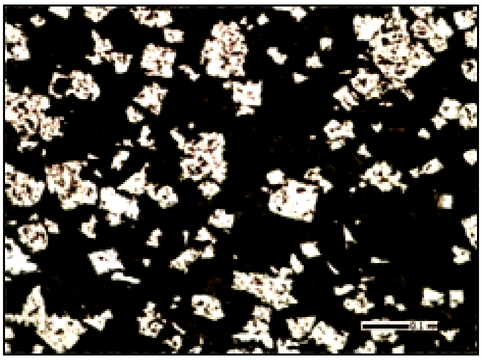
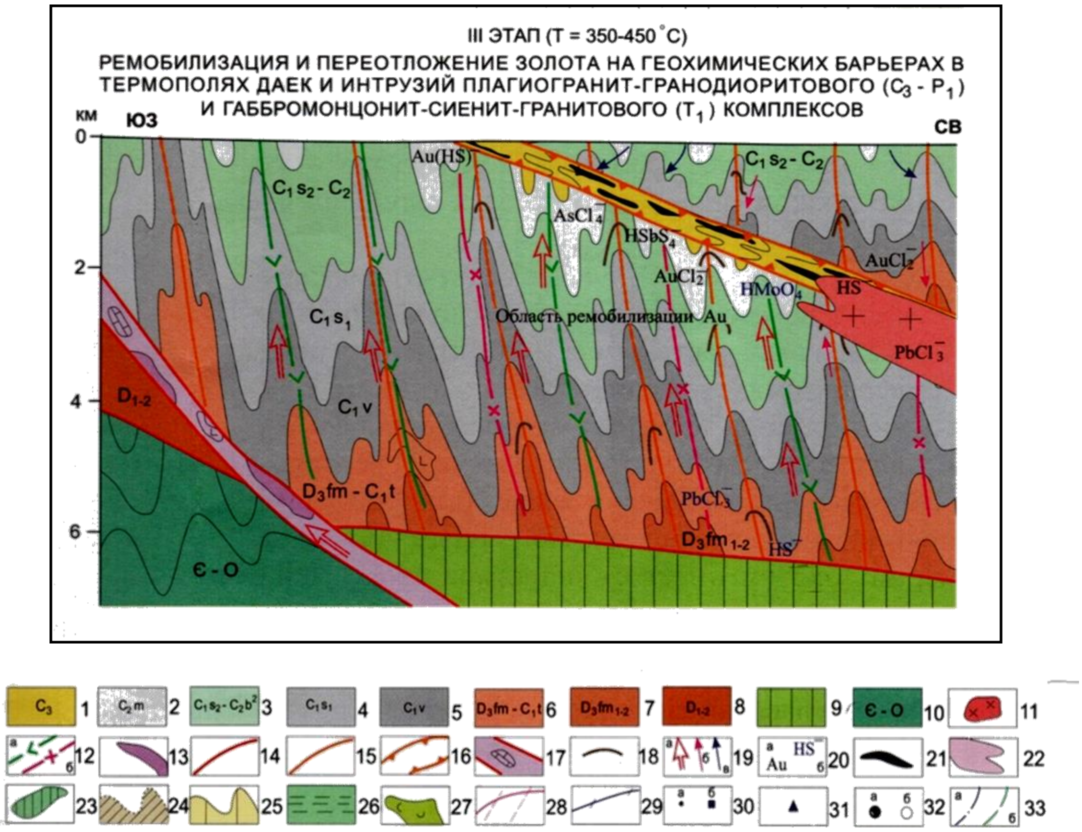


Figure 11 - Pyrite-arsenopyrite ore in carbonaceous laminated argillite. Polished section.

The intrusive-thermal-metamorphogenic stage: remobilisation of syngenetic and hydrothermal-metamorphogenic gold in areas affected by intrusion and dikes of the granodiorite-plagiogranite complex (C3-P1) and pyroxene diabases of the Semeitau intrusive complex (T1); transport of gold by hydrothermal solutions through viscous disturbances, formation of a gold-antimonite-anargite paragenetic association with enrichment of previously formed ore deposits and their accompanying metasomatites (Figure 12). In contrast to the leads of the early ores, the absolute age of leads of the intrusive-thermal-metamorphogenic stage are 300 ±15 (C3-P1) and 230 ±10 (T1-2) million years (N.G. Syromyatnikov, 1999).



The legend refers to: 1 - Bakyrshik black shale formation C_3; 2 - Bukoni conglomerate-sandstone formation C_2m; 3 - siltstone-sandstone stratum C_1s_2-C_2b; 4 - Aganacti siltstone-sandstone formation C_1s_2; 5 - Opanov argillite-limestone suite C_1v; 6 - Karabai basalt-siliceous-limestone suite D_3fm_2-C_1t; 7 - siltstone-pelitic sediments D_3fm_1-2; 8 - andesite-basalt-terrigenous deposits; 9 - base of oceanic type; 10 - andesite-basalt-siliceous-terrigenous formations $Є_1$-O_2; 11 - plagiogranite-granodioritic intrusions C_3-P_1; 12 - dikes of subalkaline granite-porphyries and monzonite-porphyries (a), diabase and dioritic porphyries (b) of Semeitau (T1) and Kushun (C_3-P_1) intrusive complexes; 13- ultrabasites; 14- fractures; 15- folded ductile fractures; 16- Kyzylov collapse zone; 17- serpentinite lithomelange; 18 - gold-bearing carbonaceous-pelitic-siltstone horizons with syngenetic gold-pyrite-arsenopyrite mineralization; 19 - directions of movement of juvenile fluid streams (a), metamorphogenic solutions (b) and meteoric waters (c); 20 - orogenic components remobilized at tectonic-metamorphic transformation of rocks (a) and introduced by juvenile fluids (b); 21 - gold-ore deposits; 22-27 - near-ore metasomatic halos; 22 - intensive silicification and sericitization, 23 - albitization, chloritization and carbonatization, 24 - ankerite-quartz veins, 25 - albitization and weakly manifested seritization, 26 - schungite-sericite metasomatites, 27 - sideritization sandstones; 28-29 - graphs of lead isotope relations models: 28 - single-stage development, 29 - plumbotectonic; 30-31 - lead isotopes: 30 - data [70, p.59] of O.G.Koshevoy for ores (a) and syngenetic mineralization (b), 31 - generalized data of N.G. Syromyatnikov; 32 - horizon average values of sulphur isotope composition of pyrite (a) and arsenopyrite (b); 33 - distribution trends of δ34S values of pyrite (a) and arsenopyrite (b) along the dip of ore deposits.

Figure 12 - Graphical model of the intrusive-thermal-metamorphogenic stage characterising the remobilisation of syngenetic and hydrothermal-metamorphic gold.

The gold associated with this stage plays a leading role and is concentrated in two sulphides, pyrite and arsenopyrite, in an invisible form, giving the ores their persistence and thereby requiring technologists to develop special schemes to extract such gold. Figure 13 shows the main concentrators of invisible gold. Ultra-dispersed gold, invisible under the light microscope, has been detected using a raster electron microscope (Figure 14-15) [9].

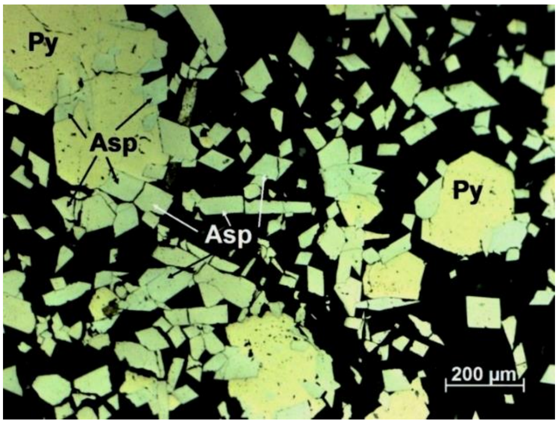


Figure 13 – Pentagonal dodecahedral and cubic pyrite (Py) in fusion with arsenopyrite (Asp)

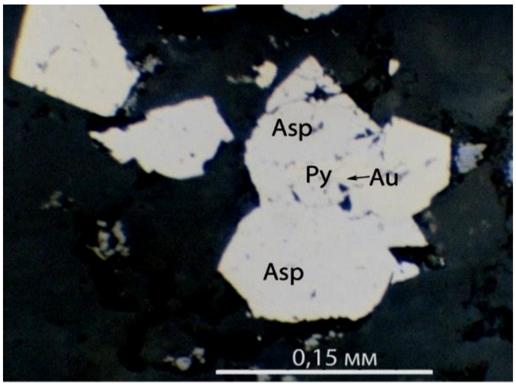


Figure 14 - Gold in pyrite-arsenopyrite concretion. Light microscope. Bakyrshik.

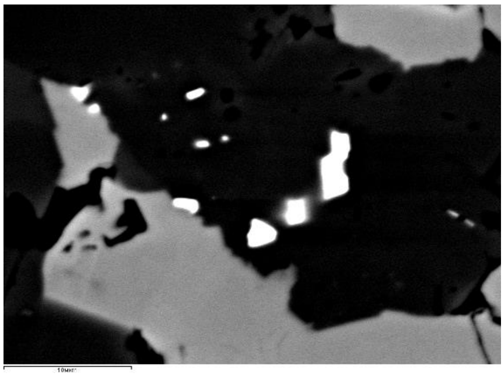


Figure 15 - Enlarged fragment. Gold grain accumulation (white) in pyrite (black) at the boundary with arsenopyrite (grey). Photographed on the microprobe in compo mode. Bakyrshik.

Conclusion. The gold-sulphide type developed in carbonaceous strata (Bakyrshik deposit) is a unique and promising type in the West Kalba gold ore belt.

The study of carbonaceous components of ores and ore-hosting rocks established the presence there of sapropel organic matter and bitumen, the degree of post-sedimentary transformations at the stages of early metagenesis and dynamometamorphism has been determined by the character of exothermic effects. The organic matter from the beginning of sedimentogenesis concentrated gold in the form of clusters and nanoclusters and is a source of gold for formation of gold-bearing sulfides at subsequent stages of lithogenesis and dynamometamorphism. The gold content in the organic matter ranges from 3.7- 5.9 g/t (according to atomic absorption analysis) to 10 g/t (according to the author). Significant reserves of gold in the form of clusters and nanoclusters, not recoverable in the process of refining are not accounted for in the calculation of reserves. It is necessary to develop new methods of gold extraction from carbonaceous rocks, which would significantly increase the reserves of the deposit [9].

The main indicators of Bakyrshik-type deposits include the following: a) gold-bearing rhythmically layered carbonaceous-clayey and carbonaceous-siltstone-pelitic microfacies of the black shale strata with increased syngenetic gold content (10-150 mg/t), organic matter (1-10%) and globular-framboidal pyrite; b) intense manifestation of mesozonal seam folding accompanied by ductile faults and zones of cleavage flow of rocks, multistage deformation processes and formation of hybrid structures of intersecting plicate dislocations; c) extensive development of chlorite-albite, shungite-sericite and sericite-flogopite-carbonate metasomatites in the zones of cleavage flow and ductile faults.

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БАҚЫРШЫҚ КЕН ОРНЫНДА АЛТЫН КЕНДЕНУДІҢ ПАЙДА БОЛУЫН ІЗДЕУ МОДЕЛІ

Аннотация: Қазақстан әлемдегі ең маңызды алтын провинцияларының бірі болып табылады. Оңай ашылатын кен орындар қорының таусылуына және халық шаруашылығының тапшы шикізатқа деген қажеттілігінің артуына және Қазақстанның алтын резервін толықтыруға байланысты іздестіру-

барлау жұмыстарының тиімділігін арттыру және жаңа алтын кен объектілерін жедел игеру қажеттігі туындайды.

Әлемдегі алтынның негізгі жеткізушілерінің бірі – металдың үлкен қоры бар қара тақтай формациясындағы нысандар.

Алтын қоры бойынша бірегей Бақыршық кен орны Өзбекстандағы әлемге әйгілі Мурунтау алыбының жақын аналогы болып табылады және өнеркәсіптік алтын кендерін қалыптастыруда онымен ортақ көптеген ерекшеліктерге ие. Алынған жаңа нақты деректерге сүйене отырып, Бақыршық кен орнын қалыптастырудың үш кезеңдік іздестіру моделі әзірленді: седиментті шөгінді-диагенетикалық кезең; тектоника-метаморфогендік кезең және интрузивті-термалды-метаморфогендік кезең.

Түйін сөздер: алтын, қара қатпарлы қалындықтар, іздеу модельдері, кенорын.

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ПОИСКОВАЯ МОДЕЛЬ ОБРАЗОВАНИЯ ЗОЛОТОГО ОРУДЕНЕНИЯ НА МЕСТОРОЖДЕНИИ БАКЫРШИК

Аннотация: Казахстан относится к одной из важнейших золотоносных провинций мира. В связи с исчерпанием фонда легко открываемых месторождений и всевозрастающих потребностей народного хозяйства в дефицитном сырье и пополнении золотого резерва Казахстана требуется неуклонное повышение эффективности поисково-разведочных работ и ускоренное освоение новых золоторудных объектов

Одним из основных поставщиков золота в мире являются объекты в черносланцевой формации, которые обладают колоссальными запасами металла.

Уникальное по запасам золота месторождение Бакыршик является близким аналогом всемирно известного гиганта Мурунтау в Узбекистане и имеет много общих с ним черт в формировании промышленных золотых руд. Опираясь на новые полученные фактические данные, разработана трехэтапная поисковая модель формирования месторождения Бакыршик: седиментный осадочно-диагенетический этап; тектоно-метаморфогенный этап и интрузивно-термально-метаморфогенный этап.

Ключевые слова: золото, черносланцевые толщи, поисковые модели, месторождение.

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ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Редакторы: *М.С. Ахметова, А. Ботанқызы, Д.С. Аленов, Р.Ж. Мрзабаева*
Верстка на компьютере *В.С. Зикирбаева*

Подписано в печать 15.08.2021.
Формат 60х881/8. Бумага офсетная. Печать – ризограф.
4,6 п.л. Тираж 300. Заказ 4.

Национальная академия наук РК
050010, Алматы, ул. Шевченко, 28, т. 272-13-19