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**«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ
АКАДЕМИЯСЫ» РҚБ**

«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ

ХАБАРЛАРЫ

ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК РЕСПУБЛИКИ КАЗАХСТАН»

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PROSPECTS FOR EXPANDING GOLD RESERVES IN THE BAKYRCHIK ORE DISTRICT IN EASTERN KAZAKHSTAN

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Abstract. The Bakyrchik gold ore district, located in Eastern Kazakhstan, represents one of the most promising areas for gold reserve expansion. This paper examines the geological structure of the district, with a particular focus on the Kyzylovskiy compression zone as a key element of the ore-bearing structure. Special attention is given to gold deposits hosted within black shale formations, including the type locality—Bakyrchik. The study analyzes the lithogeochemical conditions governing the formation of gold-carbon-sulfide ores, which are associated with Carboniferous-age carbonaceous marine formations that played a crucial role in ore-forming processes.

Prospective ore localization zones have been identified, encompassing the Bakyrchik ore field, which hosts both large deposits (Bakyrchik, Bolshevik) and medium to small-scale occurrences (Sholabay, Kholodny Klyuch, Promezhutochnoye, Goluboy Log, Sarbas). The structural characteristics of ore-hosting rocks and their influence on gold concentration are described. The study also explores the role of tectonic deformations, hydrothermal processes, and metamorphism in the redistribution of gold within ore-bearing zones.

Specific recommendations for geological exploration aimed at expanding the resource base are provided. Methods of structural-geological and geochemical analysis are suggested for predicting new ore occurrences. The paper also discusses the potential for discovering additional deposits within the studied area and the applicability of these findings to other ore-bearing regions in Kazakhstan.

The results of this study hold significant theoretical and practical value for gold deposit forecasting and exploration in black shale complexes, as well as for assessing the potential of analogous structures in other regions. The findings can be utilized to optimize exploration strategies and the development of gold ore deposits.

Keywords: Bakyrchik, Bakyrchik ore district, Kyzylovskiy deformation zone, black shale formations, gold deposits.

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ШЫҒЫС ҚАЗАҚСТАНДАҒЫ БАҚЫРШЫҚ КЕН АУДАНЫНЫҢ АЛТЫН ҚОРЛАРЫН КЕҢЕЙТУДІҢ БОЛАШАҒЫ

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Аннотация. Шығыс Қазақстанда орналасқан Бақыршық алтын өндіру аймағы алтын қорын ұлғайту бойынша перспективалы аймақтардың бірі болып табылады. Мақалада облыстың геологиялық құрылымы және кенді құрылымның негізгі элементі ретінде Қызыл ығысу аймағының ерекшеліктері қарастырылады. Қара тақтатас қабаттарындағы алтын кен орындарына, соның ішінде типтік Бақыршық кен орнына ерекше көңіл бөлінеді. Кен түзілу процестерінде маңызды рөл атқарған карбон дәуірінің көміртекті теңіз түзілімдерімен байланысты алтын-көміртек-сульфидті кендердің түзілуінің литогеохимиялық жағдайлары талданады.

Кенді оқшаулаудың перспективалық аймақтары анықталды, оның ішінде ірі кен орындары да (Бақыршық, Большевик), шағын және орта объектілер де (Шолабай, Холодный ключ, Промежуточное, Голубой Лог, Сарбас) бар. Кенді жыныстардың құрылымдық ерекшеліктері және олардың алтын концентрациясына әсері сипатталған. Кенді аймақтарда алтынның қайта бөлінуіндегі тектоникалық бұзылулардың, гидротермиялық процестер мен метаморфизмнің рөлі қарастырылады. Ресурстық базаны кеңейтуге бағыт-талған геологиялық барлау жұмыстарын жүргізу бойынша нақты ұсыныстар берілген. Жаңа кен объектілерін болжауға болатын құрылымдық-геологиялық және геохимиялық талдау әдістері көрсетілген. Зерттелетін аумақ шегінде жаңа кен орындарын болжау және алынған мәліметтерді Қазақстанның басқа кенді аймақтарына қолдану мүмкіндігі мәселелері қарастырылған.

Зерттеу нәтижелері қара тақтатас кешендеріндегі алтын кен орындарын болжау және барлау үшін, сондай-ақ басқа аймақтардағы ұқсас құрылым-дардың әлеуетін бағалау үшін маңызды теориялық және практикалық мәнге ие. Алынған мәліметтер алтын кен орындарының барлау және игеру стратегияларын оңтайландыру үшін пайдаланылуы мүмкін.

Түйін сөздер: Бақыршық, Бақыршық кенді аймағы, Қызыл ығысу аймағы, қара тақтатас қабаттары, алтын кен орындары.

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ПЕРСПЕКТИВЫ РАСШИРЕНИЯ ЗАПАСОВ ЗОЛОТА В БАКЫРШЫКСКОМ РУДНОМ РАЙОНЕ В ВОСТОЧНОМ КАЗАХСТАНЕ

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Аннотация. Бакыршыкский золоторудный район, расположенный в Восточном Казахстане, является одной из наиболее перспективных территорий для расширения запасов золота. В статье рассматриваются геологическое строение района и особенности Кызыловской зоны смятия как ключевого элемента рудоносной структуры. Особое внимание уделено месторождениям золота в черносланцевых толщах, включая типовое месторождение Бакыршык. Анализируются литогеохимические условия формирования золото-углеродисто-сульфидных руд, связанные с углеродистыми морскими формациями каменноугольного возраста, которые сыграли важную роль в процессах рудообразования.

Выделены перспективные зоны рудной локализации, включая Бакыршыкское рудное поле, содержащее как крупные месторождения (Бакыршык, Большевик), так и мелкие и средние объекты (Шолабай, Холодный Ключ, Промежуточное, Голубой Лог, Сарбас). Описаны структурные особенности рудовмещающих пород и их влияние на концентрацию золота. Рассматривается роль тектонических нарушений, гидротермальных процессов и метаморфизма в перераспределении золота в пределах рудоносных зон.

Приведены конкретные рекомендации по проведению геологоразведочных работ, направленных на расширение ресурсной базы. Указаны методы структурно-геологического и геохимического анализа, которые могут быть использованы для прогнозирования новых рудных объектов. Рассмотрены вопросы прогноза новых месторождений в пределах исследуемой территории и возможность применения полученных данных к другим рудоносным районам Казахстана.

Результаты исследования имеют важное теоретическое и практическое значение для прогнозирования и разведки месторождений золота в черносланцевых комплексах, а также для оценки потенциала аналогичных структур в других регионах. Полученные данные могут быть использованы для оптимизации стратегий разведки и освоения золоторудных месторождений.

Ключевые слова: Бакыршык, Бакыршыкский рудный район, Кызыловская зона смятия, черносланцевые толщи, месторождения золота.

Introduction. Gold is one of the key mineral resources playing an important role in the global economy. The necessity of conducting prospecting and geological exploration to expand gold reserves in Kazakhstan is evident. Gold deposits in black shale formations are highly attractive in terms of resource potential. Gold deposits of the black shale type are localized in carbon-bearing sediments covering a wide stratigraphic range from the Proterozoic to the Mesozoic-Cenozoic. More than 15 giant and large deposits of this category have been recorded across Asia, with total resources exceeding 12,000 tons of gold. A significant portion of these deposits is concentrated in CIS countries, including Uzbekistan (Muruntau, Myutenbai), Kyrgyzstan (Kumtor, Taldybulak, etc.), Russia (Sukhoi Log, Natalka, Sovetskoye, etc.), and Kazakhstan (Bakyrchik, Bolshevik, etc.). All of these deposits are characterized as complex polygenetic formations.

The Bakyrchik gold ore district is located in Eastern Kazakhstan and is one of the promising areas for expanding gold reserves. Several zones have been identified here, including the Kyzylovskiy deformation zone, the Parallel zone, the Western Kalba Fault zone, and others (Figure 1).

This article examines the geological characteristics of the Kyzylovskiy deformation zone, the specific features of gold deposits in black shale formations using the Bakyrchik deposit as an example, as well as the prospects and specific recommendations for geological exploration aimed at expanding gold reserves in the Bakyrchik ore district (Zholtaev, 2024: 11; Marchenko, 2011: 9).

Materials and Methods

This study is based on a comprehensive analysis of geological, geophysical, and mineralogical data obtained from the Bakyrchik and Bolshevik deposits, as well as from the Bakyrchik ore district as a whole. Additionally, we utilized data provided by S.A. Stepanov. The recommendations regarding the exploration prospects were developed using his insights and data.

Ore-controlling Kyzylovskiy zone.

The large gold deposits Bakyrchik and Bolshevik are located within the Kyzylovskiy zone of the Western Kalba gold-bearing belt in Eastern Kazakhstan. Carboniferous carbonaceous-terrigenous marine formations play a significant role in their geological structure, serving as a lithogeochemical foundation for subsequent metamorphic processes that led to the formation of industrial gold-carbon-sulfide deposits (Atlas of models of mineral deposits, 2004: 140; Gavrilov, 1971: 7). The Kyzylovskaya ore-controlling thrust zone is conventionally divided into three sections from west to east: *western section* – Bolshevik deposit, including the Western Bolshevik, Chalobay, and Kholodny Klyuch sites; *central section* – Bakyrchik deposit, including the Central, Intermediate, and Glubokiy Log sites; *eastern section* – Sarbas deposit and the Carmen ore occurrences.

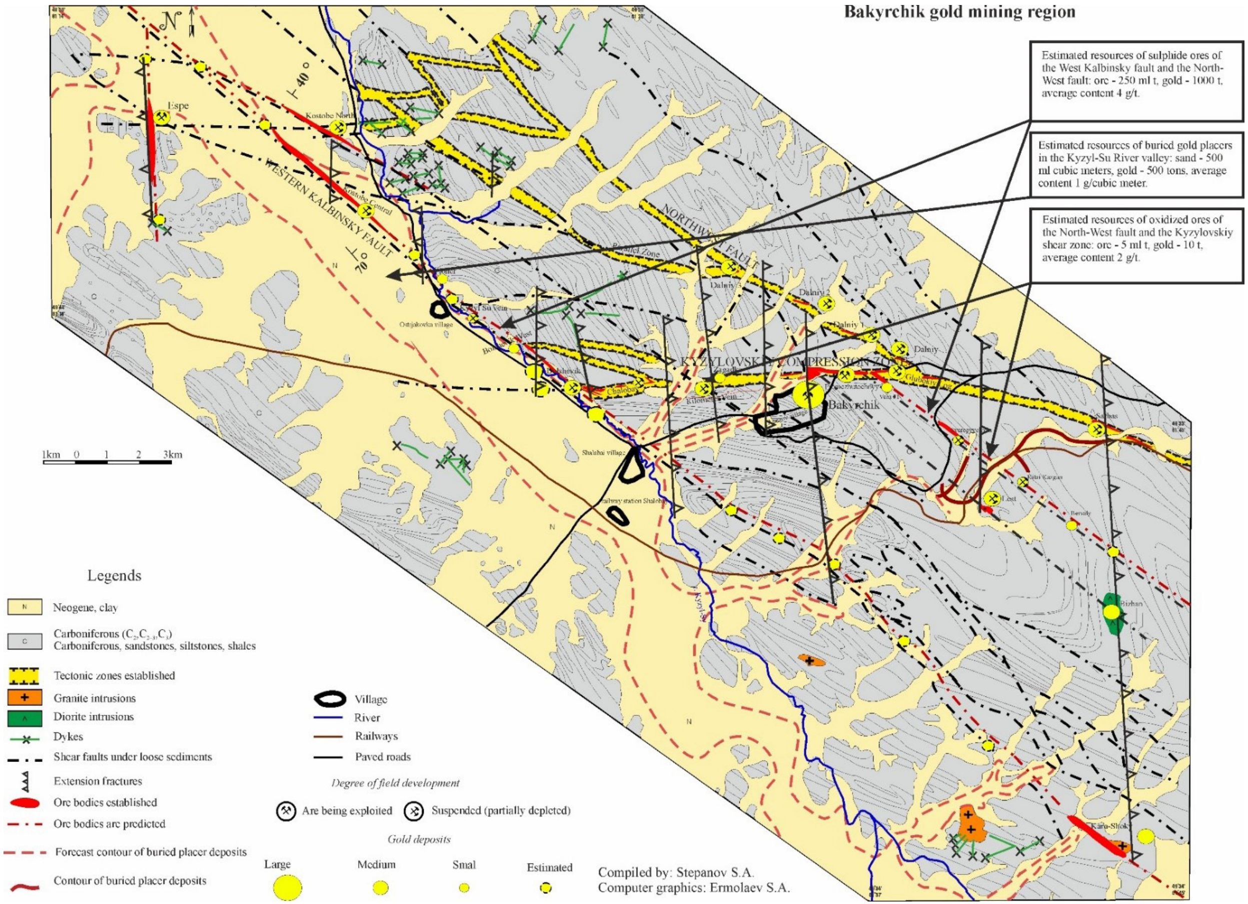

Figure 1 – Geological map of the Bakyrchik gold ore district

Along the thrust zone, a unified Bakyrchik ore field is identified over a distance of 15 km, encompassing similar-type deposits. In addition to Bakyrchik and Bolshevik, it includes small and medium-sized deposits such as Sholabay, Kholodny Klyuch, Promezhutochnoye, Goluboy Log, and Sarbas (Figure 1).

According to seismic exploration data, the Kyzylovskiy zone extends to a depth of up to 3 km from the surface (with a total dip depth of 5.0–5.5 km) and has an average dip angle of 35–40° to the north. The thickness of this zone at the surface varies from 15 to 30 meters and reaches up to 300 meters.

Initially formed as a major splay fault of the Western Kalba deep fault (strike-slip), this structure later underwent multiple tectonic transformations, resulting in the formation of a complex fault-related deformation zone. A characteristic feature of this zone is the presence of ductile deformations at its base and brittle dislocations in its upper part (Zhautikov, 1987: 448; Zhautikov, 1985: 6).

Overall, the Kyzylovskiy zone is characterized by a highly complex structure, with more than 70 ore bodies identified within its territory. Of these, 35 ore bodies have been explored to depths of 160–200 meters and up to 1,000–2,000 meters down-dip, with an average gold grade of 8–10 g/t.

The largest ore body, No. 1 of the Bakyrchik deposit, extends 170 meters along the surface and reaches 200–500 meters at various depths without significant thickness reduction with increasing depth. This ore body has been traced down-dip to 700 meters. Its morphology is highly complex, featuring significant thickening in the central part and occasional pinching and branching at the flanks. The maximum ore body thickness reaches 32.8 meters (Umarbekova, 2021: 8).

The stratigraphic section of the Kyzylovskiy zone includes the Aganaktinskiy (C_1s), Bukonskiy (C_2), and Bakyrchikskiy (C_3) formations, which formed within a residual, degrading marine and later continental sedimentary basin (Figure 2).

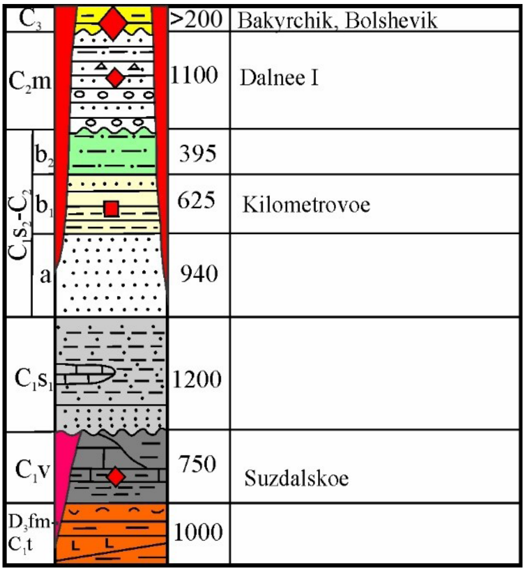

Figure 2 – Cross-section of the Kyzylovskiy zone
Bakyrchik black shale formation (C_3); Bukon conglomerate-sandstone formation (C_2m); Siltstone-sandstone formation members (C_1S_2–C_2b): Upper pelite-siltstone member (b_2), Middle siltstone-sandstone member (b_1), Lower sandstone member (a); Aganakty siltstone-sandstone formation (C_1S_1); Opanov argillite-limestone formation (C_1v); Karabay basalt-siliceous formation (D_3fm_2–C_1t)

Carbonaceous-terrigenous formations are located within a narrow trough, 60–90 km wide and extending over 750 km. The internal structure of this trough is characterized by complex folding, the extensive development of metamélange facies within the axial subzone, as well as olistostrome facies and thrust-nappe dislocations associated with the late-collisional stage (C_2-P_1) of the region's evolution.

The key features of the depositional conditions of carbonaceous-terrigenous formations that determine the gold-bearing profile of the region include:

1) The composition and structure of the Caledonian basement, represented by a melanocratic, locally sialitized complex of metamorphic oceanic crust. This contrasts with the neighboring Kalba-Narym and Zharma-Saur geoblocks of the Hercynides, which developed on continental crust.

2) The ophiolitic composition of the underlying formations (O_2-D_3fm), predominantly consisting of spilite-diabase and limestone-siliceous sequences.

3) The presence of volcano-terrigenous deposits directly beneath the carbonaceous-terrigenous sequences, containing a large number of gold-sulfide occurrences.

4) The subsequent multiple transformations of petro- and ore-forming components of carbonaceous-terrigenous rocks due to diagenetic, dynamometamorphic, and magmatic processes, which contributed to the gradual conversion of initially mobile gold forms (ionic and colloidal) into native gold (Evgeny, 2017: 115).

The carbonaceous-terrigenous complex is dominated by coastal-marine molasse deposits (C_1s-C_2b) with a thickness ranging from 2,000 to 4,500 m. Based on carbon content (Corg = 0.3–2.1%), these rocks are classified as low-carbonaceous. Above this, the marine molasse transitions into a highly carbonaceous terrestrial formation, characterized by gray-colored argillaceous sandstones and fluviolacustrine high-carbonaceous black shale lithofacies with dispersed organic matter of sapropelic and plant-detrital origin. The carbon content (C_{org}) in these formations varies from 0.3–0.6% to 14.5%, with an average of 0.96%.

Lenses of anthraxolite, interlayers of coal, siderite-chamosite bog ore concretions, phosphatic nodules, and horizons and lenses of polymictic suspension flow deposits and collapse breccias with "pebbles" of black siltstones are widely distributed. In ore zones, carbonaceous material is present in the form of fine blind microveins, disseminations, and small nests. The fracture zones contain deformed and schistose rocks, as well as quartz-carbonaceous breccias enriched with gold-bearing pyrite.

These breccias contain monomineral segregations of carbonaceous matter identified as shungite (according to Marchenko L.G.). Specific facies of C_{1-3} deposits enriched with syngenetic ore material are also present. These ores, along with carbonaceous-clayey aleuropelites, are frequently found in fragments of postsedimentary breccias. Under the influence of localized tectonic stress along faults, combined with late diagenetic and catagenetic rock transformations, these formations progressively acquired high mobility, undergoing general hydroplastic extrusion and layer flow. This process facilitated the solid-state transport of mineral substances, leading to the separation of gas-fluid components and the formation of ore-bearing metamorphogenic-hydrothermal systems (Zhautikov, 1985: 6).

The ore-generating energy capacity of carbonaceous-terrigenous sediments is determined by the presence of highly migratory organometallic compounds of carboxylic acids with heavy metal ions, which, during metamorphism, transition into hydrothermal solutions. Additionally, the heterogeneous layered internal structure of the sedimentary sequence, which includes both productive components and reservoir rocks, contributes to this process. This could explain the frequent localization of gold mineralization within layered (often rhythmically layered) carbonaceous-terrigenous sequences.

At the Bakyrchik and Bolshevik deposits, the dominant gold phases are colloidal and ionic, while free native gold is predominantly present in a finely dispersed form. The highest concentrations of native gold are recorded at levels of 5–10 g/t in ores with dense disseminated and massive pyrite-arsenopyrite mineralization. These findings indicate that free native gold could have significant industrial value in the Bakyrchik deposit ores. However, according to rational analysis of a technological sample, the content of free amalgamable gold is only 0.14 g/t, representing 2.02% of the total gold content (with an average of 6.9 g/t) in the ores.

Native gold at the Bakyrchik deposit exhibits distinctive features, including a fine, spongy structure and crystalline (hollow crystal) formations, with gold grains measuring 30–50 microns. In addition to hundreds of small grains, there are also dozens reaching sizes of 1–2 mm.

The metasomatic zonation of the Bakyrchik deposit is as follows. In the upper horizons, carbonaceous-kaolinite-hydromuscovite metasomatites are present, while carbonaceous-sericite alterations have a widespread, “pervasive” distribution, with the most intense development in the central part of the deposit. The lower level is characterized by a sericite-phlogopite-carbonate association with anorthite and tourmaline (Rafailovich, 2009: 7). Carbonate accumulations (breunnerite, ankerite, dolomite) are associated with quartz, native gold, chalcopyrite, and scheelite in deeper horizons. Albite and albite-chlorite alterations (10–20%) occur along fracture zones, extending for hundreds of meters, and are widespread in the supra-ore and upper ore zones. Fine-veined albite-chlorite mineralization is associated with supra-ore migration halos of carbonaceous material, serving as an indicator of “hidden” mineralization.

The deposit hosts at least 35 ore minerals (Gavrilov, 1971: 7; Zhautikov, 1987: 448), which form five paragenetic associations: Early: Melnikovite-pyrite-pyrrhotite-marcasite (with niccolite and pentlandite); Ore-forming: Gold-pyrite-arsenopyrite (with cubanite and gersdorffite), gold-quartz-polymetallic (with sulfosalts, chalcopyrite, galena, sphalerite), and gold-quartz-carbonate-scheelite-chalcopyrite (with breunnerite, dolomite, aikinite, and native gold); Late: Quartz-carbonate-stibnite-tetrahedrite (with marcasite and remobilized gold).

The gold-pyrite-arsenopyrite association has a “pervasive” distribution throughout the deposit. At greater depths, the melnikovite-pyrite-pyrrhotite-marcasite and gold-quartz-carbonate-scheelite-chalcopyrite associations are dominant, whereas the gold-quartz-polymetallic and quartz-carbonate-stibnite-tetrahedrite associations are more common in the middle and upper horizons.

More than 90% of the total sulfide mass and gold balance is concentrated in disseminated and vein-disseminated gold-pyrite-arsenopyrite mineralization. In the upper horizons, pyrite dominates over arsenopyrite, occurring 3.5 times more frequently. However, in the middle and deeper horizons, the reverse pattern is observed, with pyrite being subordinate (ratio 1:3). Iron disulfide (FeS_2) forms aggregate accumulations as well as crystals of various morphologies, including globular, cubic, pentagonal dodecahedral, and cuboctahedral shapes (Shao, 1982: 10).

Gold is concentrated in pyrite and arsenopyrite. The highest gold concentration in pyrite is observed in the upper part of the main ore zone, whereas in arsenopyrite, it is found in the lower part of the main zone and the root zones.

Small ore bodies located on the flanks (e.g., Promezhutochnoe, Glubokiy Log, and others) are characterized by a simple elemental composition and reduced zonality. V.A. Narseyev and his co-authors (Narseev, 2001: 174) note that studies of ore zonality at Bakyrchik indicate low gradients in ore properties and mineralization with depth. These findings strongly suggest a significant extent of mineralization, reaching 2.5–3 km. This is further supported by the gold fineness gradient (5% per 100 m), vertical geochemical zonation (VGZ), and the thermoelectromotive force (TEMF) of pyrites and arsenopyrites.

During the sedimentogenic sedimentary-diagenetic stage, gold, along with associated nickel and cobalt, was extracted by juvenile fluids from ultramafic rocks of the oceanic basement and serpentinite protrusion zones during periods of tectonic activation. The mobilized gold precipitated in a mud-rich environment of shallow-water basins and submarine deltas, characterized by high organic matter content and hydrogen sulfide. Globular-framboidal pyrite inclusions and veinlets developed, leading to the formation of rhythmically layered gold-bearing carbonaceous-clay and carbonaceous-aleurolite-pelite sediments during diagenesis. The carbon isotope composition of these rhythmites ($\delta^{13}C$ = -14 to -31 ‰) indicates a biogenic origin (Zairi, 1987: 7).

Gold remobilization and migration occurred in the form of hydrosulfide complexes $Au(HS)_2$, under diagenetic conditions in a weakly alkaline environment at temperatures ranging from 100–150°C.

The highest amount of native gold has been recorded in densely disseminated and massive pyrite-arsenopyrite ores.

Under high-temperature conditions of zeolite and chlorite-sericite metamorphic facies, along with cleavage flow of rocks, dehydration of epizonal carbonaceous-terrigenous sediments occurred. This process led to the extraction of gold in the form of chloride complexes $AuCl_2$ and the formation of hydrothermal-metamorphogenic solutions, which circulated through highly fluid-permeable ductile faults (Umarbekova, 2017: 7).

Considering its explored reserves and potential for further development, the Bakyrchik deposit represents a site of significant interest from a microbiological perspective, especially in the context of ore beneficiation via bioleaching.

Bakyrchik ores are also valuable as a potential source of platinum group metals (PGMs). Studies conducted by researchers from Tomsk Polytechnic University (Korobeinikov) have shown that sulfide-rich aleurolites and aleurosandstones contain metals such as platinum (Pt) and osmium (Os) at levels reaching the first grams per ton (g/t). In vein-disseminated pyrite-arsenopyrite ores of Bakyrchik, PGM concentrations reach up to 1.0 g/t, while platinum content in gold ores averages 0.4 g/t. Platinum accumulation occurs in gravity and flotation concentrates, necessitating further research to assess the reproducibility of PGM concentrations and to deepen the study of their occurrence forms (Antonov, 2012: 152; Kovalev, 2014: 12).

The Bolshevik deposit is located 5 km west of the Bakyrchik deposit and is part of the Bakyrchik ore district. The northwestern section, associated with the West Kalba Fault, is referred to as Western Bolshevik. To the southeast and west of the known ore bodies, similar deposits are likely to be found, but geological exploration in these areas has been minimal. Sparse drill holes have recorded gold grades of up to 50 g/t.

Results and Discussion

It is recommended to conduct a geochemical survey across the Bakyrchik ore field. However, traditional surveys based on secondary dispersion halos are likely to be ineffective due to significant anthropogenic contamination in the area. At this stage, geochemical exploration should focus on primary dispersion halos, employing active drilling methods such as hydraulic core transport, pneumatic drilling, and auger drilling. Drilling should be conducted along known fault lines.

Special attention should be paid to the valley of the Kyzyl-Su River, where the West Kalba fault and the western continuation of the Kyzylovskiy deformation zone intersect. The valley is filled with Neogene clays up to 30–70 meters thick in the area of the Bolshevik deposit. In such conditions, hydraulic core transport is the most effective drilling method. Gold-bearing alluvial gravels are often encountered beneath the clays and should be sampled for heavy mineral (placer) gold.

In the Kyzyl-Su valley, under the Neogene clays, ore bodies typically lack oxidation zones, and oxidized ores are not expected in this area. However, oxidized gold-bearing ores may be encountered where ore bodies emerge on the elevated right bank of the river.

Ore-controlling structures consist of multiple faults and fractures with diverse orientations and planes. Therefore, exploration should aim to identify potential extensions of ore bodies in various spatial directions, accounting for all possible structural disruptions.

The Sarbas deposit is located on the eastern flank of the Kyzylovskiy deformation zone, beyond its intersection with the Northwest fault. The presence of this deposit confirms the eastward continuation of the Kyzylovskiy zone, justifying further exploration in that direction.

The Northwest fault zone is considered highly prospective for oxidized gold-bearing ores, especially south of the Kyzylovskiy zone. The fault comprises a series of quartz veins with mineralized selvages. These veins, including Vein 31, Kapitalnaya, and the Sviryepaya and Berbaly series, are hosted in subparallel northwest-trending fractures. Vein thickness ranges from 0.3 to 1.5 meters, with mineralized selvages extending 1–2 meters on each side, resulting in total ore body widths of 1 to 6 meters. Oxidized ores in this area contain average gold grades of around 2 g/t. These veins were partially mined by artisanal cooperatives during the 1940s–50s to shallow depths (5–10 m), targeting ore with grades exceeding 5 g/t. The southern portion of the Northwest fault stretches over approximately 5 km and warrants comprehensive exploration along its full length. This could potentially increase oxidized ore reserves, supporting mid-scale mining operations for 10–15 years. Heap leaching is recommended for ore processing.

Southwest of the southern segment of the Northwest fault lies a partially exploited and currently mothballed site called Lest. Its future potential should be re-evaluated.

The West Kalba fault zone is largely overlain by Neogene clays 30–70 meters thick, beneath which primary sulfide ores begin immediately. Therefore, substantial additions to oxidized ore reserves are unlikely in this zone. However, oxidized ores have been observed on the right bank of the Kyzyl-Su River and at the Kara-Shoky deposit. The potential for discovering sulfide ores remains high, as exemplified by the Central Kostobe deposit, where drilling has traced five parallel ore bodies continuously over a 4-km strike length. A similar pattern is observed at Kara-Shoky, and the intervening 30-km area between these deposits remains underexplored. The Zapadny Bolshevik deposit is only partially explored. In the West Kalba fault zone, many deposits are not fully delineated along strike and dip. The ore bodies here are comparable in thickness and grade to those at Bakyrchik. Given that the West Kalba fault is twice as long as the Kyzylovskiy zone, it is reasonable to assume it may contain twice the amount of gold reserves.

Conclusion

In conclusion, the projected resources of oxidized ores in the Northwest fault zone and Kyzylovskiy deformation zone, as well as the forecasted resources of sulfide ores in the West Kalba and Northwest fault zones, along with the potential for buried gold placers in the Kyzyl-Su valley, represent highly promising targets for resource expansion within the Bakyrchik ore district.

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