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ҚАЙЫРЫМДЫЛЫҚ ҚОРЫ HALYK CHARITY FOUNDATION

«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ
«ХАЛЫҚ» ЖҚ

ХАБАРЛАРЫ

ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
АКАДЕМИИ НАУК РЕСПУБЛИКИ
КАЗАХСТАН»
ЧФ «Халық»

N E W S

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NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

ЧФ «ХАЛЫҚ»

В 2016 году для развития и улучшения качества жизни казахстанцев был создан частный Благотворительный фонд «Халык». За годы своей деятельности на реализацию благотворительных проектов в областях образования и науки, социальной защиты, культуры, здравоохранения и спорта, Фонд выделил более 45 миллиардов тенге.

Особое внимание Благотворительный фонд «Халык» уделяет образовательным программам, считая это направление одним из ключевых в своей деятельности. Оказывая поддержку отечественному образованию, Фонд вносит свой посильный вклад в развитие качественного образования в Казахстане. Тем самым способствуя росту числа людей, способных менять жизнь в стране к лучшему – профессионалов в различных сферах, потенциальных лидеров и «великих умов». Одной из значимых инициатив фонда «Халык» в образовательной сфере стал проект Ozgeris powered by Halyk Fund – первый в стране бизнес-инкубатор для учащихся 9-11 классов, который помогает развивать необходимые в современном мире предпринимательские навыки. Так, на содействие малому бизнесу школьников было выделено более 200 грантов. Для поддержки талантливых и мотивированных детей Фонд неоднократно выделял гранты на обучение в Международной школе «Мирас» и в Astana IT University, а также помог казахстанским школьникам принять участие в престижном конкурсе «USTEM Robotics» в США. Авторские работы в рамках проекта «Тәлімгер», которому Фонд оказал поддержку, легли в основу учебной программы, учебников и учебно-методических книг по предмету «Основы предпринимательства и бизнеса», преподаваемого в 10-11 классах казахстанских школ и колледжей.

Помимо помощи школьникам, учащимся колледжей и студентам Фонд считает важным внести свой вклад в повышение квалификации педагогов, совершенствование их знаний и навыков, поскольку именно они являются проводниками знаний будущих поколений казахстанцев. При поддержке Фонда «Халык» в южной столице был организован ежегодный городской конкурс педагогов «Almaty Digital Ustaz.

Важной инициативой стал реализуемый проект по обучению основам финансовой грамотности преподавателей из восьми областей Казахстана, что должно оказать существенное влияние на воспитание финансовой грамотности и предпринимательского мышления у нового поколения граждан страны.

Необходимую помощь Фонд «Халык» оказывает и тем, кто особенно остро в ней нуждается. В рамках социальной защиты населения активно проводится

работа по поддержке детей, оставшихся без родителей, детей и взрослых из социально уязвимых слоев населения, людей с ограниченными возможностями, а также обеспечению нуждающихся социальным жильем, строительству социально важных объектов, таких как детские сады, детские площадки и физкультурно-оздоровительные комплексы.

В копилку добрых дел Фонда «Халык» можно добавить оказание помощи детскому спорту, куда относится поддержка в развитии детского футбола и карате в нашей стране. Жизненно важную помощь Благотворительный фонд «Халык» оказал нашим соотечественникам во время недавней пандемии COVID-19. Тогда, в разгар тяжелой борьбы с коронавирусной инфекцией Фонд выделил свыше 11 миллиардов тенге на приобретение необходимого медицинского оборудования и дорогостоящих медицинских препаратов, автомобилей скорой медицинской помощи и средств защиты, адресную материальную помощь социально уязвимым слоям населения и денежные выплаты медицинским работникам.

В 2023 году наряду с другими проектами, нацеленными на повышение благосостояния казахстанских граждан Фонд решил уделить особое внимание науке, поскольку она является частью общественной культуры, а уровень ее развития определяет уровень развития государства.

Поддержка Фондом выпуска журналов Национальной Академии наук Республики Казахстан, которые входят в международные фонды Scopus и Wos и в которых публикуются статьи отечественных ученых, докторантов и магистрантов, а также научных сотрудников высших учебных заведений и научно-исследовательских институтов нашей страны является не менее значимым вкладом Фонда в развитие казахстанского общества.

С уважением,
Благотворительный Фонд «Халык»!

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THE BAKYRCHIK GOLD-CARBONACEOUS-SULPHIDE DEPOSIT

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Abstract. Black-shale gold ore deposits have enormous reserves of hard-to-recover gold. Thus, in Russia the predominant part of ledge gold reserves was found in deposits of carbonaceous-terrigenous complexes. These deposits are represented by sites of varying scale, from small to unique ones (Olympiada, Nezhdaninskoye, Natalkinskoye, Mayskoye, Sovetskoye in Russia; Muruntau, Kokpatas, Zarmitan, Daugyztau, Amantaitau in Uzbekistan; Bakyrchik in Kazakhstan; Chore in Tajikistan; and Kumtor in Kyrgyzstan; Maser Lode in the United States; Bendigo, Olympic Dam in Australia). The Bakyrchik deposit is located in the Kyzyl latitudinal strike contortion zone that cuts across the main structures of the Kalba region. The ore-hosting carbonaceous shale, mudstones, siltstones and sandstones are placed in a thin-rhythmic interbedded Bukon' suite of Middle Carboniferous age. The deposit was conditioned by collision zones. The rocks are intensely foliated, containing carbonaceous matter and sulphides (up to 5–10 %). Siltstones are most rich in gold-bearing sulphides (pyrite and arsenopyrite) and contain 0.2–0.4 % carbonaceous material in the presence of carbonate material. The ore bodies are represented by a system of cumulative mineralised zones of considerable thickness

(up to 20 m). Ore composition: pyrite, arsenopyrite, antimonite, gold, marcasite, chalcopyrite, pyrrhotite, faint ores (tennantite and tetrahedrite), galena, sphalerite, cinnabar, native silver, quartz, carbonates. Pyrite of pentagon dodecahedral habitus and needle-shaped arsenopyrite are gold-bearing. The mineralization of complex polygenic nature with multiple transformation of syngenetic sedimentary gold-bearing material in the near-fault zone of dislocation-thermal metamorphism belongs to the type of mineralized zones of the gold-sulphide type.

Keywords: gold, deposit, carbonaceous-terrigenous, collision zones

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БАҚЫРШЫҚ АЛТЫН - КӨМІРТЕКТІ-СУЛЬФИДТІ КЕН ОРНЫ

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Аннотация. Қара тақтатас типті алтын кен орындары өндіруі қиын алтынның орасан зор қорларына ие. Мысалы, Ресейде түпкі жыныстардағы алтын қорының басым бөлігі көміртекті-терригенді кешендердегі кен орындарында орналасқан. Бұл кен орындары кішіден бірегейге дейінгі әр түрлі масштабтағы нысандармен ұсынылған (Ресейде Олимпиада, Нежданинское, Наталкинское, Майское, Советское; Өзбекстанда Мұрынтау, Көкпатас, Зармитан, Даугызтау, Амантайтау; Қазақстанда Бақыршық; Тәжікстанда Чоре; Қырғызстанда Құмтор; АҚШ-та Масер Лод; Австралияда Олимпик Дэм, Бендиго). Бақыршық кен орны Қалба аймағының негізгі құрылымдарын бөлетін ендік созылымдағы Қызыл жаншылу аймағында орналасқан. Орташа карбон жасты буконь свитасының кенсыйыстырушы көміртекқұрамды тақтатастар, сазтастар, алевролиттер мен құмтастар жұқаритмді қабаттасуда.

Кен орны коллизия аймақтары жағдайында пайда болды. Тау жыныстары қарқынды жіктелген, құрамында көміртекті зат пен сульфидтер бар (5–10 % дейін). Құрамында алтыны бар сульфидтерге (колчедан және арсенопирит) ең қаныққандары болып карбонатты материалдың қатысуымен көміртегі мөлшері 0,2–0,4 % алевролиттер табылады. Кен денелері айтарлықтай қалыңдығы бар (20 м-ге дейін) кулисатәрізді минералданған аймақтар жүйесінен құрылған. Рудалардың құрамы: пирит, арсенопирит, антимонит, алтын, марказит, халькопирит, пирротин, күңгірт кендер (теннантит және тетраэдрит), галенит, сфалерит, киноварь, саф күміс, кварц, карбонаттар. Пентагондодекаэдрлік габитустағы пирит және инелі арсенопирит алтынды болып табылады. Кенденудің табиғаты күрделі, полигенді, дислокациялық-термалды метаморфизмнің жарылыммаңы аймағында сингенетикалық седиментогенді алтынды материалдың көп реттік өзгеруімен байланысты, алтын-сульфидті минералдану аймақтары типіне жатады.

Түйін сөздер: алтын, кен орны, көміртекті-терригенді, коллизия аймақтары

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ЗОЛОТО-УГЛЕРОДИСТО- СУЛЬФИДНОЕ МЕСТОРОЖДЕНИЕ БАКЫРЧИК

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Аннотация. Золоторудные месторождения черносланцевого типа обладают колоссальными запасами трудноизвлекаемого золота. Так в России преобладающая часть запасов коренного золота находится в месторождениях углеродисто-терригенных комплексов. Эти месторождения представлены

объектами различного масштаба – от мелких до уникальных (Олимпиада, Нежданинское, Наталкинское, Майское, Советское в России; Мурунтау, Кокпатас, Зармитан, Даугызтау, Амантайтау в Узбекистане; Бакырчик в Казахстане; Чоре в Таджикистане; Кумтор в Киргизстане; Мазер Лод в США; Бендиго, Олимпик Дэм в Австралии).

Месторождение Бакырчик находится в Кызыловской зоне смятия широтного простирания, секущей основные структуры Калбинского региона. Рудовмещающие углеродсодержащие сланцы, аргиллиты, алевролиты и песчаники в тонкоритмичном переслаивании буконьской свиты среднекаменноугольного возраста. Месторождение образовалось в условиях зон коллизии. Породы интенсивно рассланцованы, содержат углеродистое вещество и сульфиды (до 5–10 %). Наиболее насыщены золотоносными сульфидами (пиритом и арсенопиритом) алевролиты с содержанием углеродистого вещества 0,2–0,4 % при наличии карбонатного материала. Рудные тела представлены системой кулисообразных минерализованных зон значительной мощности (до 20 м). Состав руд: пирит, арсенопирит, антимонит, золото, марказит, халькопирит, пирротин, блеклые руды (теннантит и тетраэдрит), галенит, сфалерит, киноварь, самородное серебро, кварц, карбонаты. Золотоносными являются пирит пентагондодекаэдрического габитуса и игольчатый арсенопирит. Оруденение сложной полигенной природы с многократным преобразованием сингенетического седиментогенного золотоносного материала в приразломной зоне дислокационно-термального метаморфизма, относится к типу минерализованных зон золото-сульфидного типа.

Ключевые слова: золото, месторождение, углеродисто-терригенный, зоны коллизии

Introduction

The Bakyrchik ore district is located within the West Kalba gold ore belt, which in geodynamic plan represents an ensimatic collisional zone (fig.1). The structure of the complex is dominated by carbonaceous-terrigenous formations (marine and terrestrial molasse), which served as the lithogeochemical basis for subsequent metamorphic processes, including dynamometamorphic ones, that led to formation of commercial gold-carbonaceous-sulphide deposits of the Bakyrchik type (Zhautikov, 2003).

The predominant part of the carbonaceous-terrigenous complex are marine molasse deposits (C_1s-C_2b) 2,000-4,500 m thick. In terms of their carbon content (C_{org} = 0.3-2.1 %), they are low-carbonaceous rocks. Above, the marine molasse is replaced by high-carbonaceous terrestrial molasse dominated by gray-coloured argillaceous-sandstone and fluviolimnitic high-carbonaceous black shale lithofacies with scattered organic matter of sapropel and plant-detrital nature and C_{org} from 0.3-0.6 % to 14.5 %, averaging 0.96 %. Widely developed are lenses and interlayers of hard coal, contractions of siderite-chamosite bog ores, phosphate-bearing nodules, horizons and lenses of various-grained sediments of suspension flows and caving

breccias of swelling with "nubbles" of black siltstones. In ore zones, carbonaceous matter is developed in the form of blind microveins, impregnations and small nests. L.G. Marchenko notes that crushed zones contain crumpled, flaky rocks and quartz-carbonaceous breccias enriched with gold-bearing pyrite. In these breccias, monomineral segregations of carbonaceous matter corresponding to shungite were identified. A.V. Vesselov, in accordance with results of thermographic studies, attributes the carbonaceous matter of the host rocks to the anthraxolite group.

Materials and methods

Most researchers of the Kalba region deny the direct correlation between gold and C_{org}. Their positive correlation is observed only in the interval of C_{org} from 0.2 to 1.5 % with gold concentrations not exceeding hundreds of milligrams per tonne. At the same time, in the Kalba gold deposits noted are significant amount of migrated carbonaceous matter, its wide participation in metamorphogenic-hydrothermal processes and presence of above-ore halos in the form of quartz-carbon "cape" (Umarbekova, 2017).

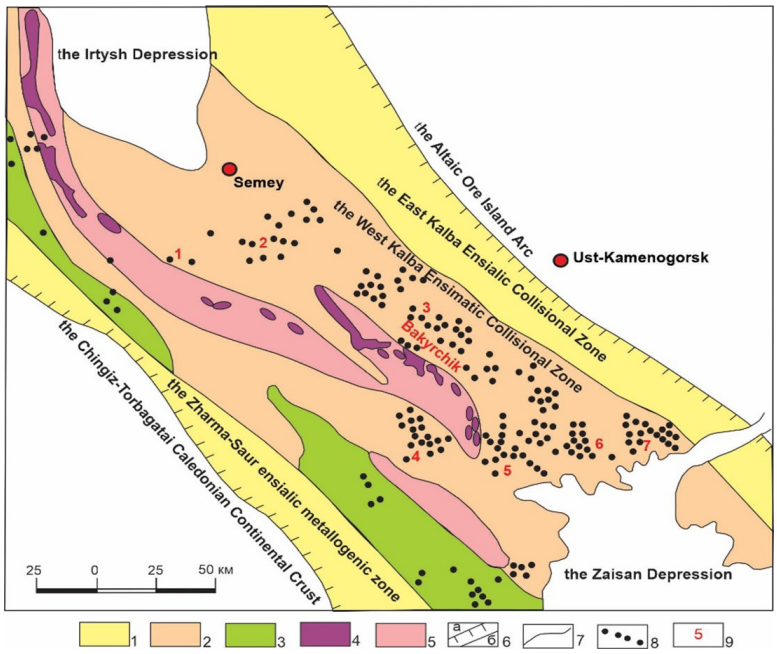

Fig. 1 - The geodynamic position of the Bakyrchik deposit

1 - ensialic collision zones; 2 - ensimatic collision zones; 3 - carbon island arc terranes; 4 - ultramafic intrusions (sutura of the collision zone); 5 - zones of tectonized ophiolites; 6 - boundaries of the collision zone (a) and blocks on different bases (b); 7 - other geological boundaries; 8 - gold deposits and occurrences; 9 - most important gold-mining centres: 1 - Suzdal, 2 - Mukur, 3 - Bakyrchik, 4 - Akzhal-Bokon, 5 - Balajal, 6 - Zhumba, 7 - Kuludjun.

In West Kalba, magmatic processes are widely manifested. Many researchers (A.M.Mysnik et al.) connect them paragenetically to many vein fields placed in over- and near-intrusive zones (Zhumba, Kulujun, Laily, Sentas) or directly within ledges of small granitoid massifs, where they are represented by gold-beresitic mineral type (Balajal) in the root part of the ore column. According to A.M. Mysnik, such deposits are dispersed throughout the section of carbonaceous-terrigenous formations, but most often occur at four stratolevels: Late Visean (Akzhal, Northern Ashaly), Early Serpukhov (Sentas, Zhumba, Terekty), Late Serpukhov (Kulujun, Laily) and Middle Carboniferous (Espe) (Narseev et al., 2001).

Despite the large number of quartz-veined and berezite deposits associated with these intrusions, they contain no more than 8-12% of the reported gold reserves, and researchers' opinions regarding their genesis are ambiguous. Most likely, they belong to the category of regenerated deposits and, unlike vein-impregnated ores, contain free gold associated with sulphides of polymetals and antimony.

Results

The main gold reserves of the West Kalba collisional zone are concentrated in non-intrusive deposits, a typical representative of which is the Bakyrchik deposit, which together with similar and structurally related objects of Bolshevik, Shalabay, Kholodny Klyuch, Promezhutochnoye, Gluboky Log, Sarbas form a single ore field. Their placement is controlled by the latitudinally oriented Kyzyl thrust-contortion zone at its junction with the West-Kalba and North-East faults. The length of the ore field along the Kyzyl thrust zone exceeds 15 km (fig. 2).

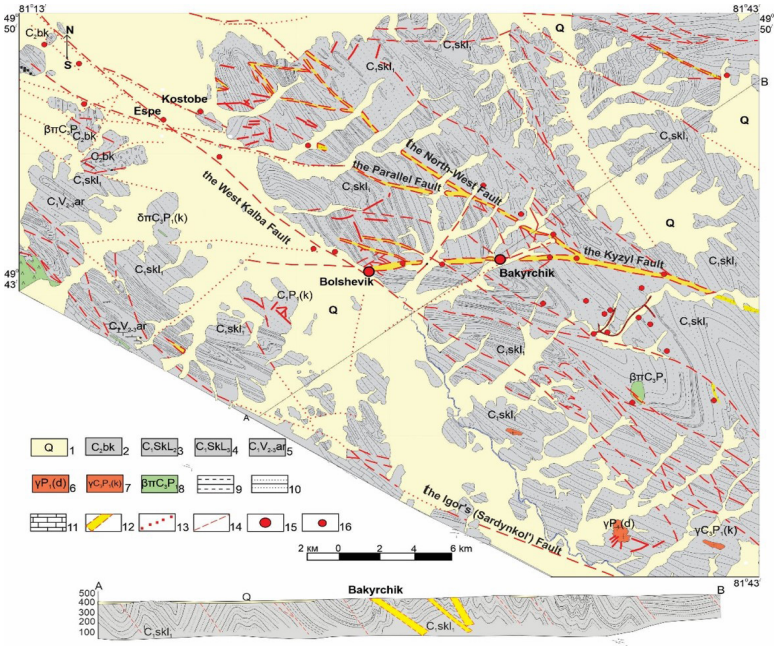

Fig. 2. Geological map of the Bakyrchik deposit

1. Quaternary formations not dissected. Loam, sandy loam with gravel, pebbles, sand, boulders-pebbles, sands. 2. Carboniferous system, middle division: 2. Bukon suite. 3. Sandstones, conglomerates, gravelites, clay shales, siltstones. Lower division, Serpukhov stage: 4. the Kalba suite, upper subsuite. Carbonaceous-clayey shales, interlayers of polymictic sandstones, rare lenses of pelitomorphs; 4. the Kalba suite, lower subsuite. 5. Polymictic and oligomictic sandstones, interlayers and lenses of carbonaceous-clay shales, siltstones, single lenses of siliceous shales and limestones; 5. Viseian stage. Arkalyk suite, siliceous, siliceous-clayey, carbonaceous-clayey schists, siltstones, reefogenic limestones, sandstones, jasper; diabase porphyrites, tuff conglomerates, tuff-sandstones; Delbeget complex: 6. small-grained porphyritic biotite granites; Konush complex: 7. small- and medium-grained biotite granites and plagiogranites: 8. small- and medium-grained hornblende diorites; 9. argillites and clay shales; 10. sandstones; 11. limestones; 12. Kyzyl contortion zone; 13. faults, overlain Quaternary deposits; 14. deep faults; 15. large gold deposits; 16. small and gold ore occurrences.

The main ore-localising structure, the Kyzyl zone, is traced to a depth down to 3 km from the surface (5.0–5.5 km in dip) with an average dip angle of 35–40° to the north, according to seismic survey data. The thickness of the zone at the surface varies from 15-30 m to 300 m. It is characterised by the occurrence of plastic dislocations in its soil and brittle dislocations in its roof.

The Bakyrchik ore field covers an area of about 3,500 km^2. It consists of several structurally connected sections. From west to east, the following sections are located sequentially: West Bolshevik, Bolshevik, Chalobay and Kholodny Klyuch united under the common name the "Bolshevik deposit": the sites of Bakyrchik, Intermediate, Gluboky Log are attributed to the "Bakyrchik deposit"; sites of Zagadka, Karmen, Sarbas are independent (Marchenko et al., 2011).

The ore field is characterised by a heterogeneous block structure and a varying vertical range of constituent gold deposits. Distribution of ore bodies and ore areas in the plane of the ore-bearing zone is bundle-like, within bundles it is fan-like (fig. 3). Deposits of central and eastern parts of the Kyzyl zone (Bakyrchik, Zagadka, Promezhutochnoye, Gluboky Log) form a single bundle of ore deposits, opening to the surface. The ore body no.1 (Bakyrchik deposit proper), located in the axial part of the bundle, has minimum level of erosional cut (thickness of eroded part is estimated at 300-600 m), and its vertical range, taking into account reconstruction of the ore bundle and mineralogical and geochemical zoning, is estimated at 2.0–2.5 km. The Zagadka deposit (ore body no.12), located on the west flank of the ore bundle, is characterised by a medium level of erosional cut, with a predicted vertical range of 1.5 km. The eastern flank deposits (Promezhutochnoye, Gluboky Log) have a deeper erosional cut with a vertical range of 1.0–1.5 km. A second similar bundle is traced in the west part of the Kyzyl zone. In the axial part of this bundle is the Bolshevik deposit. According to some researchers, the gold value of this ore object should correspond to that of the Bakyrchik deposit (Umarbekova et al., 2021).

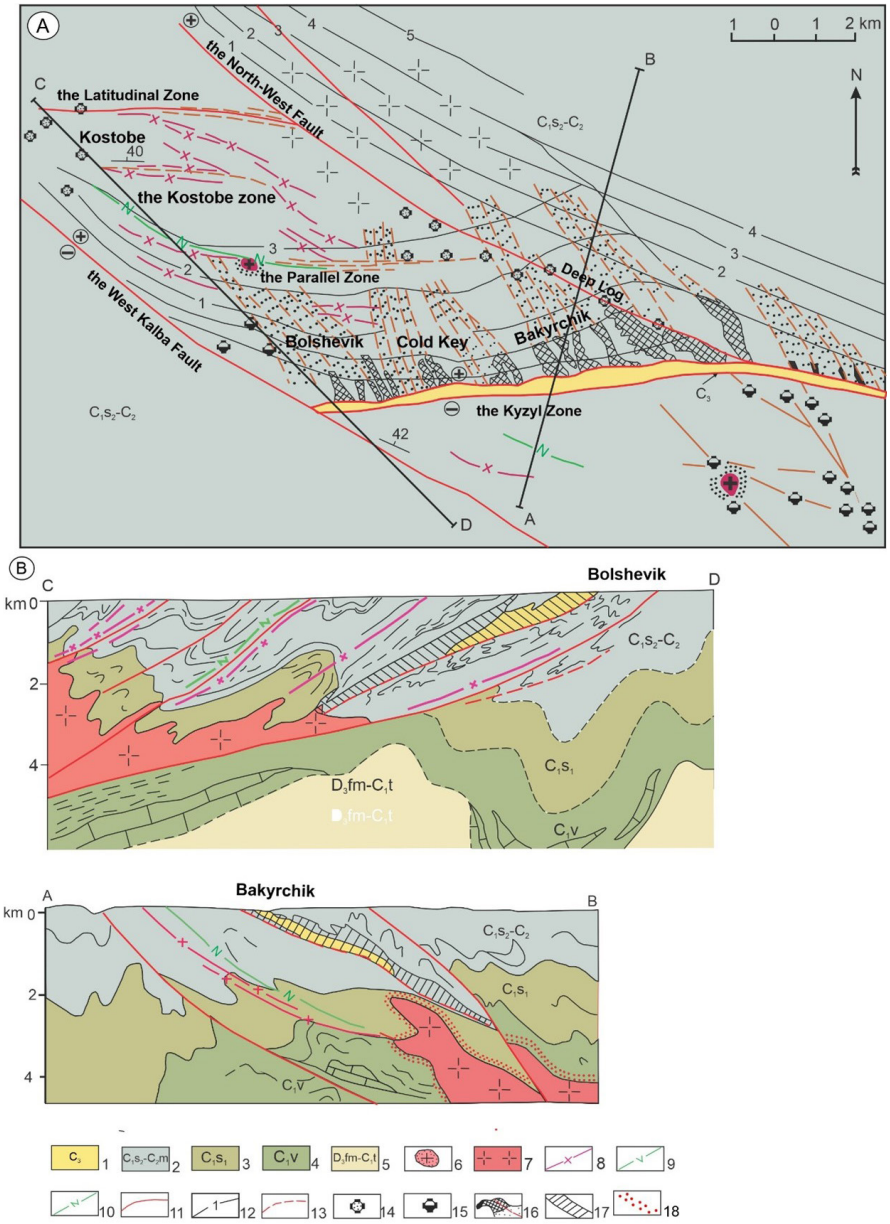

Fig. 3. The lowering of ore bodies along the dip of the ore-bearing Kyzyl thrust zone and lines intersecting with folded ductile faults: a) the geological-geophysical map, b) sections

1 - Kyzyl contortion zone C3; 2 - siltstone-conglomerate-sandstone deposits C1s2-C2m; 3 - Aganakty suite C1s1 - clayey sandstones and siltstones; 4 - Opanov suite C1v - siliceous siltstones, phthanites, sandstones, limestones; 5 - Karabai volcanogenic-siliceous suite D3fm2-C1t - basalts, tuffs, phthanites; 6-7

- granodiorite-plagiogranite intrusions C3-P1: 6 - coming to the surface, 7 - latent (according to geophysical data): 8-10 - dikes: 8 - plagiogranite-porphyries, 9 - diorite and trachyandesite porphyries, 10 - diabase porphyries; 11 - discontinuities; 12 - isolines of fault planes (km) according to RM seismic data; 13 - ductile faults; 14-15 - deposits and ore occurrences: 14 - carbonaceous-gold-sulphide, 15 - gold-quartz-vain; 16 - ore bodies and their projections on horizontal plane; 17 - gold-bearing carbonaceous-argillitic-aleurolitic deposits intensively dislocated in thrust zone; 18 - cornification.

In total, more than 70 ore bodies are known within the ore-structure (Kyzyl contortion zone) of the ore field: 35 deposits with average gold grade of 8-10 g/t were explored at depths of 160–200 m and up to 1000-2000 m (by dipping). The largest is the Bakyrchik ore body no.1, which on the surface is traced for 170 m, and on different horizons for to 200-500 m without noticeable decrease in thickness with depth. It is traced dipping down to 700 m, and no thinning to depth was identified. The shape of the ore body is very complex, with a large swell in the central part, sometimes with cramps and branching on flanks. Maximum thickness of the body is 32.8 m. Gold grade varies from 0.2 to 60 g/t, with the highest average grade in countable blocks of up to 37.6 g/t (fig. 4).

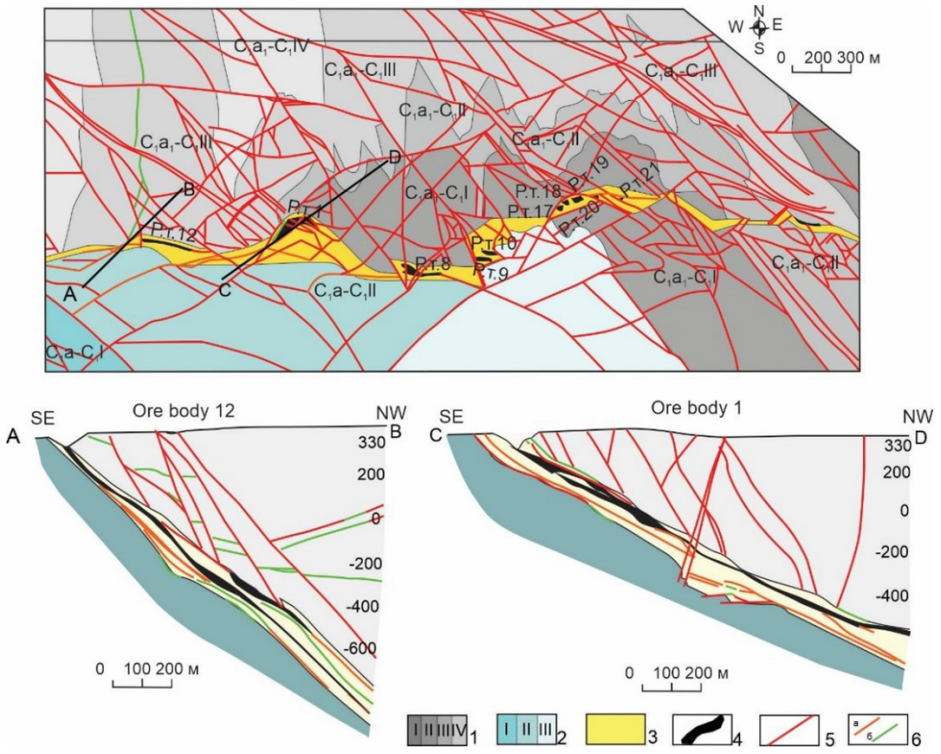

Fig. 4. The Bakyrchik deposit: diagramme of geological map and sections of ore bodies 12, 1.

1. I-IV sub-assise of the lower sandy-siltstone substratum; 2. I-III sub-assise of the upper sandy-siltstone substratum; 3 – the Kyzyl contortion zone; 4 - ore bodies; 5 - faults; 6 – dikes of acid (a) and intermediate (b) compositions.

Unlike other deposits of other formation types, all Bakyrchik golds are high-grade (900–990) with Ag content ranging from 0.3 to 6.62 %. They are characterized by constant presence of Ni of up to 3.3 %, as well as associations of native gold with nickel mineralization (bunsenite, intermetallide $AuNi_2$, also observed are inclusions of nickel arsenides in syngenetic pyrite).

However, the bulk (up to 70–90 %) of Au is contained in pyrite (46 to 350 g/t) and arsenopyrite (70 to 540 g/t) as rounded and irregular grains, dendrites, dendrite-like and drop-shaped inclusions sized from 0.1 to 5 microns. This gold is characterized by lower (827–907) resistivity, relatively high Ag content (up to 14.6 %) and constant Fe presence (up to 5.9 %). Free gold, associated with sulphides of polymetals and antimony, is characterised by the presence of Ag and Cu.

In addition to pyrite and arsenopyrite of different generations, the ores contain marcasite, galena, sphalerite, chalcopyrite, tennantite, less often pyrrhotite, magnetite, and in late associations polysulphides and sulphosols (bournonite, jemsonite, famatinite), cinnabar and native Ag, Sb. The presence of W, Mo, Bi (Rafailovich, 2009) and elements of the platinum group (Pt, Os, Pd) has been established. Sulphides and sulphosols of non-ferrous metals account for up to 2–2.5 % of ore concentrate (Matvienko, 1994).

Discussion

The industrial vein-impregnated gold-sulphide mineralization is formed in two stages: ***sedimentogenic-early-diagenetic and tectonic-metamorphogenic*** (Zhautikov, 2003). The first is formation of a geochemically specialized carbonaceous-terrigenous stratum enriched in carbonaceous matter, globular and metacolloid pyrite, lenses of siderite and coals, and interlayers of layered sedimentogenic ores. The formation is characterized by elevated clark concentrations of As, Mo, P and C. Among the rocks, siderites and pyrite containing carbonaceous siltstones with KKAu=15–100 are the most gold-bearing. According to V.N. Sorokin, diagenetic pyrite with average metal content of 0.52 g/t (maximum 1.24 g/t) are gold-bearing. Gold in rocks is mainly in the form of its metastable forms (gold organic compounds, gold adsorbed by carbonaceous and clayey matter, Fe and Mn hydroxides, colloidal gold, as low-stable chloride, sulphide and hydrosulphide complexes, etc), capable of migrating when subsequent processes are applied (fig.5).

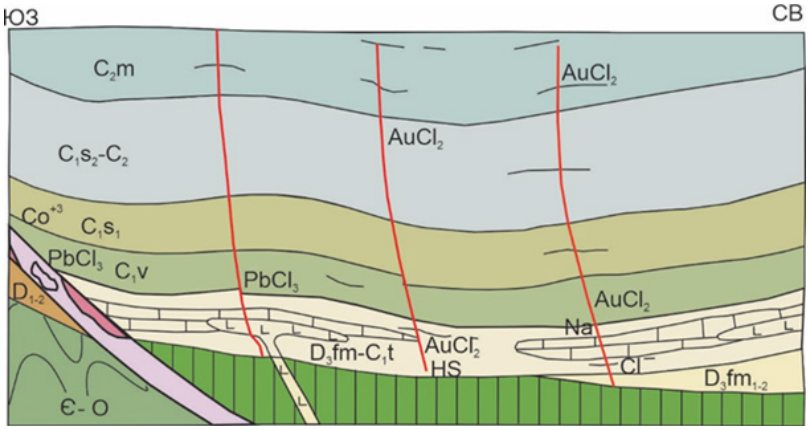

Fig. 5. The graphical model of the diagenesis of rhythmically-layered gold-bearing carbonaceous-clay and carbonaceous-silt-pelitic sediments

The next tectonic-metamorphogenic phase is combined with the late-diagenetic-catagenic transformation of poorly-lithified sediments. During this period, along the cover-thrust faults occurs intense dynamometamorphism of ore-hosting rocks, combined with regional metamorphism of carboniferous deposits of the whole West Kalba metallogenic zone, with hydroplastic extrusion and flow of sulphide-bearing pelites, their boudinage, brecciation and contortion (fig. 6).

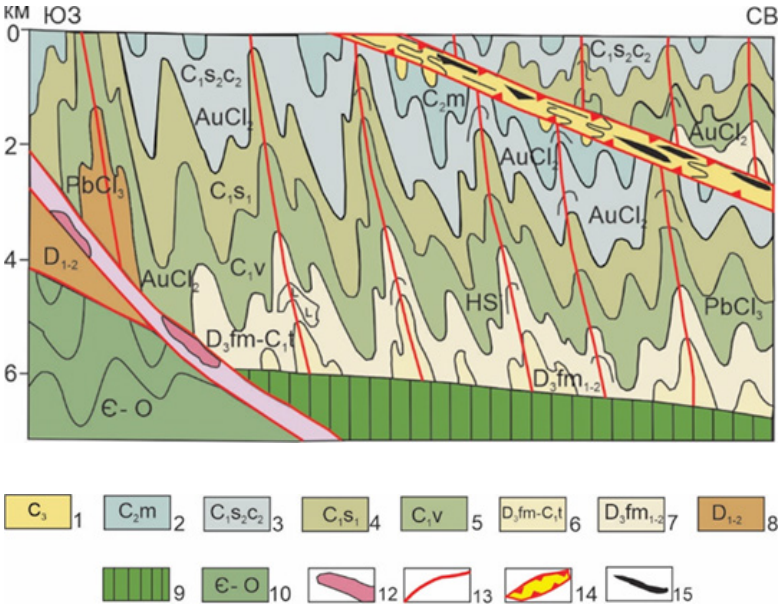

Fig. 6. Graphical model of the tectonic-metamorphogenic phase

1 - Kyzyl contortion zone C3; 2 – Bukon' conglomerate-sandy suite C2m; 3 - siltstone-sandy stratum C1s2-C2b; 4 - aganacty siltstone-sandy suite C1s1; 5 - opano argillit-limestone suite C1v; 6 - karabai basalt-siliceous-limestone suite D3fm2-C1t; 7 - siltstones-pelitic sediments D3fm1-2; 8 - andesite-basalt-terrigene sediments (D1-2); 9 - basement of oceanic type; 10 - andesite-basalt-siliceous-terrigene formations Є1-O2; 12- ultrabasites; 13- faults; 14 - Kizilov contortion zone; 15 - gold ore deposits.

Conclusions

In general, the Kyzyl zone is characterized by a very complex structure with the following structural zones (from the lying flank to the hanging flank), observed in areas of greatest dislocations: 1) a subzone of cleavage flowing, flattening, grinding, crimping and maximum rock dislocations (20–40 m); 2) a subzone of boudinage and tectonic pellets (45–50 m); 3) a subzone of clastic crushing and coarse boudinage (80–150 m); 4) a subzone of block movements along brittle fractures (50–100 m). In general, most ore bodies of the deposit are represented by a system of cumulative mineralized zones of complex ribbon- and flattened-pillar shape, predominantly located in the hanging flank of the Kyzyl contortion zone, i.e. in the brittle deformation zone.

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