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«ХАЛЫҚ» ЖҚ

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

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

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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»!

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.

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SCIENTIFIC RATIONALE FOR ASSESSMENT OF INVESTMENT POTENTIAL OF RUDNY ALTAI POLYMETALLIC DEPOSITS

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Abstract. Rudny Altai is the oldest ore mining region of Kazakhstan, and polymetallic ores have been mined for more than 300 years. The main problem of non-ferrous metals mining and production at Rudny Altai and in Kazakhstan in general is that there are no reserve deposits with active reserves in operating mining enterprise's balance. This jeopardizes further economic development of East Kazakhstan, where majority of people work at mining and processing enterprises of the region. Investment potential of Rudny Altai region was assessed with the use of basic geological, economic, and social criteria. From geological point of view there are reliable prerequisites for identifying big industrial facilities within the known ore fields, on the flanks and in deep levels of the developed or suspended deposits of the region. Economic and social factors have been considered taking into account special infrastructure for mining operations

(autoroads, railways, energy complexes, operating mines and concentrators), labour force and universities, governmental programs supporting geological prospecting and exploration.

Keywords: Investment potential, criteria, deposits, complex ores (polymetals), reserves, assessment

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КЕНДІ АЛТАЙДЫҢ ПОЛИМЕТАЛЛ ОБЪЕКТІЛЕРІНІҢ ИНВЕСТИЦИЯЛЫҚ ТАРТЫМДЫЛЫҒЫН БАҒАЛАУДЫ ҒЫЛЫМИ НЕГІЗДЕУ

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Аннотация. Кенді Алтай **—** бұл Қазақстанның ең көне тау-кен өңірі, мұнда полиметалл кендерін өндіру 300 жылдан астам уақыттан бері жүзеге асырылып келеді. Қазіргі уақытта Қазақстанда сияқты кенді Алтайда түсті металдарды өндіру мен өндірудің басты проблемасы жұмыс істеп тұрған тау-кен кәсіпорындарының балансында белсенді қорлары бар резервтік кен орындарының болмауы болып табылады. Бұл халықтың едәуір бөлігі өңірдің тау-кен өндіру және қайта өңдеу

кәсіпорындарында еңбек ететін Шығыс Қазақстанның одан әрі экономикалық дамуына соққы береді. Негізгі геологиялық, экономикалық, әлеуметтік өлшемдерді пайдалана отырып, кенді Алтай өңірінің инвестициялық тартымдылығын бағалау жүргізілді. Геологиялық тұрғыдан алғанда, белгілі кен өрістерінің шегінде, аймақтың игеріліп жатқан немесе консервацияланған кен орындарының қапталдары мен терең горизонттарында ірі өнеркәсіптік объектілерді табудың сенімді алғышарттары бар. Экономикалық және әлеуметтік факторлар тау-кен жұмыстарын (автомобиль жолдары, темір жолдар, энергетикалық кешендер, жұмыс істеп тұрған кеніштер, байыту фабрикалары) өндіру үшін арнайы инфрақұрылымның болуы, жұмыс күшінің және оны толықтыру көзінің болуы, геологиялық барлау жұмыстарын қолдаудың мемлекеттік бағдарламаларының болуы фактісі бойынша қаралды.

Түйін сөздер: инвестициялық тартымдылық, өлшемдер, кен орындары, полиметалдар, қорлар, бағалау

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НАУЧНОЕ ОБОСНОВАНИЕ ОЦЕНКИ ИНВЕСТИЦИОННОЙ ПРИВЛЕКАТЕЛЬНОСТИ ПОЛИМЕТАЛЛИЧЕСКИХ ОБЪЕКТОВ РУДНОГО АЛТАЯ

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Аннотация. Рудный Алтай — это старейший горнорудный регион Казахстана, добыча полиметаллических руд здесь осуществляется уже более 300 лет. К настоящему времени главной проблемой добычи и производства цветных металлов на Рудном Алтае, как и в Казахстане в целом, является отсутствие резервных месторождений с активными запасами на балансе действующих горнорудных предприятий. Это ставит под удар дальнейшее экономическое развитие Востока Казахстана, значительная часть население которого трудится на горнодобывающих и перерабатывающих предприятиях региона. Проведена оценка инвестиционной привлекательности Рудно-Алтайского региона с использованием основных геологических, экономических, социальных критериев. С геологической точки зрения имеются достоверные предпосылки обнаружения крупных промышленных объектов в пределах известных рудных полей, на флангах и глубоких горизонтах разрабатываемых или законсервированных месторождений региона. Экономические и социальные факторы рассмотрены по факту наличия специальной инфраструктуры для производства горных работ (автомобильных дорог, железных дорог, энергетических комплексов, действующих рудников, обогатительных фабрик), наличие рабочей силы и источника ее восполнения, наличие государственных программ поддержки геологоразведочных работ.

Ключевые слова: инвестиционная привлекательность, критерии, месторождения, полиметаллы, запасы, оценка

Introduction

It is known that investor's readiness to invest is greatly influenced by investment potential of investment object. In this case way to represent the information about investment potential object plays the key role. The more visual and available information about opportunities and risks is, the easier it is for an investor to assess its investment potential and to make well-considered investment decision. Working on meso- and macro- levels investors often assess investment potential basing on certain set of indicators of investment object development. Similar issues were considered in the works of many authors (Litvinova, 2013; Egorova, 2007; Podshivalenko, 2010).

The goal of this article is to study factors influencing investment potential of Rudny Altai region, its investment opportunities and risks. Usually by investment potential is meant that "there are such conditions that influence investor's preferences in choosing this or that investment object" (Egorova, 2007). Thus, investment potential of the region is integral characteristics of investment media that is formed on the basis of investment potential assessment and investment risk of the region and reflecting subjective perception of the region by a potential investor (Kotikov, 2008).

We consider that the basis for the method of geological structures investment potential assessment is concept of subsurface use facilities complex study taking into account geological prerequisites, economic benefit of facilities development, as well as social and ecological situation in the region.

Geological compound is the main aspect and defines investor's attitude towards investment object. It is defined by many factors, the basic ones of them are the history

of commercial development of the region, ore density (developed or worked out ore deposits on the studied territory), geodynamic conditions for forming basic geological structures of the region, regional and local search criteria etc. Promising areas and facilities selected in the result of territory geological study are also of certain importance.

From economic point of view geological facilities potential is defined by the set of indicators such as confirmed reserves or inferred resources of minerals, existing infrastructure for mining production, available transportation routes, general economic development of the region etc. (Egorova, 2007).

Social aspects can include population welfare levels in the region of investment facilities location, the unemployment rate, available trained personnel etc.

Environmental conditions and ecological problems also play significant role in assessment of geological facilities investment potential and define possible risks and threats for further industrial development of the region (Podshivalenko, 2010).

This article represents the results of studying investment potential issues of Rudny Altai geological structures that are based on the following information sources: statistic data, scientific researches data, the results of authors' expert findings.

The results of Rudny Altai investment potential assessment. History of the region industrial development goes back more than three centuries. Rudny Altai metallogenic belt is a big geologic structure that extends to Russia in north-west direction and to China in south-east direction. Unique deposits of lead, zinc, copper, gold, silver and other commercial components are concentrated here (Chekalin, 2013; Dyachkov, 2009, 2020). Orderly economic development of Rudny Altai was pre-defined by the strategic program of USSR development that was worked out in 30-ies of the last century. Stable regular increasing of investments into metals extraction was going on during 80 years. In recent 10 years a lot of polymetallic deposits have been successfully exploited and worked out, they include Shemonaikhinskoye, Jubileyno-Snegirevskoye, Zyryanovskoye, Grehovskoye, Belousovskoye, Nikolaevskoye, Shubinskoye. Some more big deposits will be developed by 2025–2040 (Maleyevskoye ― Zyryanovsk ore mining and concentrating plant, Orlovskoye - Zheskent mine, Tishinskoye, Ridder–Sokolnoye – Leninogorsk ore mining and concentrating plant). These deposits can be evaluated as significant for the economy of Kazakhstan as only Ridder–Sokolnoye deposit produced more than 700 tons of gold for 200 years of exploitation excluding lead, zinc, copper and other associated components. As a comparison, one of the biggest gold deposits in the republic is Bakyrchik. It has reserves accounting 300 tons of gold. The following deposits are actively developed at present and enable mining till 2035–40: Artemyevskoye (polymetallic deposit), Novoleninogorskoye, Dolinnoye. There are also reserved deposits (Chekmar, remaining reserves of Nikolaevskoye deposit, Rulikhinskoye, Krasnoyarskoye and some other small deposits) that can't compensate for retired capacities of the worked out deposits and consequently mining sector will be on the wane (Ganzhenko, 2018).

According to estimation of many specialists Rudny Altai will be completely worked out in15-20 years. However, taking into account the history of Rudny Altai deposits development, it can be supposed that polymetallic deposits that haven't been opened

still have potential. The example is the experience of China where a lot of geological prospecting and exploration was completed on Rudny Altai extension (South Altai, Xinjiang Uygur Autonomous Region).

The conducted research enabled China to create an extensive mineral raw material base of complex ores, gold, rare and rare earth elements for ten years.

To assess geological aspects of Rudny Altai geological structures investment potential, regional and local exploratory criteria of polymetallic mineralization were studied.

One of the leading exploratory criteria of regional level is geodynamic conditions for formation of basic geological structures.

According to geotectonic zoning Rudny Altai is comprised into Great Altai (GA) geostructure that refers to the system of Central-Asian mobile belt. In accordance with the common geodynamic evolution pattern of the Paleo-Asian Ocean, GA as a single integrated structure was formed in Hercynian cycle in the process of Siberian and Kazakhstan microcontinents collision and splicing on north-west flank of arched Altai-Alshan mobile zone enveloping Siberian platform from south-west. The territory of Great Altai is fault-bounded from north-west, the deep faults are Kara-Irtysh (in north-east), Chingiz-Saur (in south west). Thus, Great Altai is separated from Gorny Altai and Chingiz-Tarbagatai respectively (Safonova, 2014; Buslov, 2011).

Geological structures of Rudny Altai, Kalba-Narym, West Kalba and Zharma-Saur are joined within Kazakhstan part of Great Altai and fault bounded from north-west. They are differed by geodynamic development specifics, geologic structure, and metallogeny.

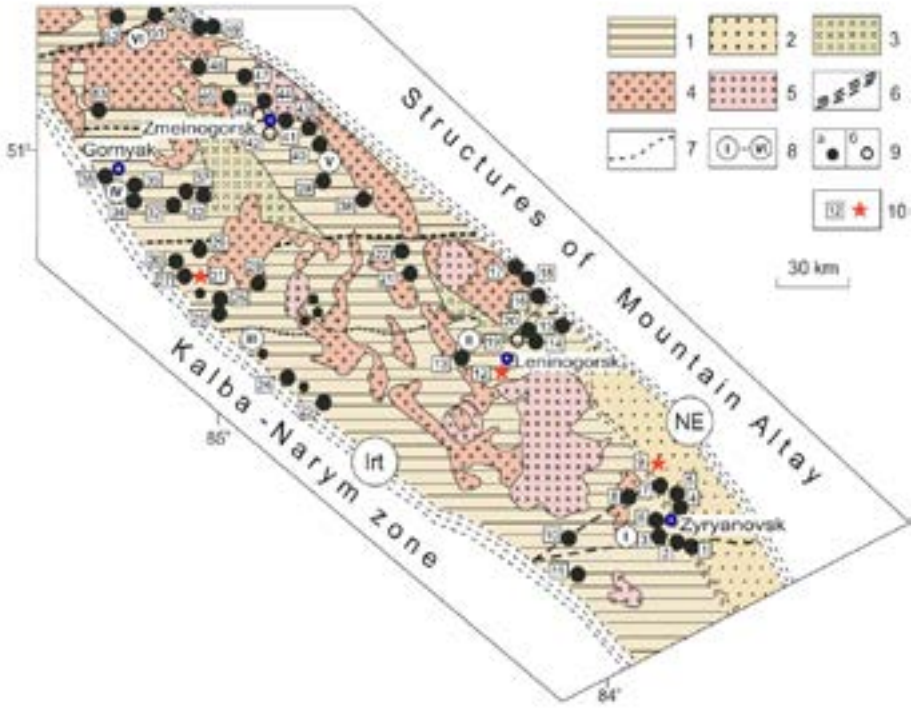
Analysis of geologic and ore formations evolution of the considered region (from Precambrian age till Cimmerian and Alpine Cycles) proves that processes of mineralization and formation of non-ferrous, precious, rare metal and other minerals commercial deposits were of different intensity in each ore belt and metallogenic zones. They were considered as favorable regional exploratory criteria under certain geodynamic conditions and regimes (Shcherba, 2000).

Raising issues of Altai geological structures investment potential assessment and geological prospecting and exploration direction finding it is required to base on local exploratory criteria and existing opinions on location of ore fields. The basis is structural metallogenic zoning represented by Rudny Altai polymetallic belt. The belt is bounded by Irtysh shear zone from south-west and North-East zone from north-east. This is the main productive structure with deposits related to marine Devonian ore-bearing basalt-rhyolite formation ($D_1 – D_3$fr).

Beloubinsko-Sarymsaktinskaya zone is built up by volcanogenic and carbonate-terrigenous Devonian rocks formed in coastal marine area. The zone comprises a range of occurrences and small stratiform deposits (mainly lead deposits). The known lead-zinc deposits on the border with this structure are Chekmar and Guslyakovskoye. In nearest years it is recommended to carry on thematic work for forecasting assessment of mineral-raw material base taking into account available and potential inferred resources up to 1500 m deep.

The three ore regions are identified in Rudny Altai zone, they are Priirtyshsky, Leninogorsky, and Zyryanovsky where basic deposits of complex ores are located. There are the following deposits in Priirtyshsky region: Nikolayevskoye, Belousovskoye, Irtyshskoye, Artemievskoye. They include the following ore fields: Verhubinskoye, Avrorinsko-Rulihinskoye, Vavilonskoye, and Sugatovskoye (Figure 1)

Leninogorsk ore region comprises Ridder-Sokolnoye deposit, Tishinskoye deposit, Novo-Leninogorskoye deposit, Obruchevskoye deposit, Dolinnoye deposit and others. The biggest deposits of Zyryanovsk ore region are Zyryanovskoye, Maleyevskoye, Grehovskoye, Putintsevskoye, Mayskoye, Bogatyryovskoye, Bukhtarminskoye, Dolinskoye and other deposits (Ganzhenko, 2018).



1 – Middle-Upper Devonian island-arc volcano-sedimentary formations of Rudny Altai; 2 – deposits of Belaya Uba-Maymyr back-arc trough; 3 – Pre-Eifelian complex (D2): diorites, quartz diorites, granodiorites, plagiogranites; 4 – Middle-Upper Carboniferous (C2–3) granodiorites, diorites, plagiogranites, and adamellites (Zmeinogorsk complex); 5 – Upper Permian–Lower Triassic (P2–T1) porphyraceous biotite and biotite-hornblende granites (Kalba complex); 6 – major faults separating the fold system (Irt – Irtysh, NE – North-East shear zones); 7 – transverse faults; 8 – ore districts; 9 – deposits: а – pyrite-polymetallic and copper-pyrite, б – barite-polymetallic; 10 – studied deposits. I – Zyryanovsk ore district, the deposits: 1 – Grehovskoye, 2 – Snegirevskoye, 3 – Zyryanovskoye, 4 – Bogatyrevskoye, 5 – Osochihinskoye, 6 – May-Zyryanovskoye, 7 – Putintsevskoye, 8 – Paryginskoye, 9 – Maleevskoye, 10 – Zavodinskoye, 11 – Bukhtarminskoye; II – Leninogorsk area, deposits: 12 – Ridder–Sokolnoye 13 – Tishinskoye, 14 – Shubinskoye, 15 – Starkovskoye, 16 – Strizhkovskoe, 17 – Guslyakovskoye 18 – Chekmar, 19 – Novoleninogorskoye, 20 – Uspenskoye, 21 – Anisimov Kluch, 22 – Snegerihinskoye; III

– Priirtysh ore district: 23 – Belousovskoye, 24 – Irtyshskoye, 25 – Berezovskoye, 26 – Novoberezovskoye, 27 – Nikolaevskoye, 28 – Pokrovskoye, 29 – Shemonaikhinskoye, 30 – Kamyshinskoe, 31 – Artem′evskoe; IV – Zolotushino ore district: 32 – Jubileynoye, 33 – Kryuchkovskoye, 34 – Zolotukhinskoye, 35 – Novozolotukhinskoye, 36 – Orlovskoye, 37 – Gerihovskoye, 53 – Loktevskoye; V – Zmeinogorsk ore district, deposit: 38 – Vorovskoye, 39 – Semenovskoye, 40 – Maslyanskoye, 41 – Lazurnoye, 42 – Zmeinogorskoye, 43 – Korbalihinskoe, 44 – Sredneye, 45 – Zarechenskye, 46 – Strizhkovskoye, 47 – Mayskoye, 48 – Tushkanihinskoye; VI – Rubtsovsk ore district: 49 – Stepnoye, 50 – Talovskoye, 51 – Zaharovskoye, 52 – Rubtsovskoye.

Fig. 1 – The structural-formational scheme of Rudny Altai (Ganzhenko, 2018)

It should be taken into account during prospecting and exploration that deposits of Rudny Altai have positional, time and paragenetic relation to Devonian volcanism. Ores are hosted in Devonian basalt-rhyolite terrigenous- siliceous formations and are differed by stratiform ore shoots that gravitate to volcano-tectonic structures. In many cases ores are located in certain facies of volcanogenic rocks (Shcherba, 2000).

Deposits ores were formed in abrupt sub-marine conditions of Devonian volcanism development and accumulated at depth 300–400 m (Parilov, 2012; Ganzhenko, 2018). Paleoenvironments occurred in lithosphere areas boundary with Rudny Altai zone that contribute to accumulation of stratiform hydrothermal mineralization (Guslyakovskoye, Strezhanskoye).

When geological structures in Priirtyshsky region are assessed it should be kept in mind that there is clean-cut ore confinedness to certain stratolevels — Eifelian and Givetian (*stratigraphic control*). They are confined to Losishihinskaya and Talovskaya suites respectively (Shcherba, 2000; Mizernaya, 2020; Cheprasov, 1972). The most perspective in this relation areas are Verhubinskoye ore field, Rulihinsko-Avrorinskoye ore field and the area between Orlovskoye and Kamyshinskoye deposits.

Local mineralogic-geochemical criteria are the important compound for assessment of ore-bearing structures. Geologic- geochemical criteria are identified basing on the fact that mineralogic composition of most deposits in Rudny Altai is rather identical: galenite, chalcopyrite, sphalerite, pyrite, gold, etc. Only copper-lead-zinc ratio is different for different deposits of Altai. (Ganzhenko, 2018). There are also fahl ores, melnicovite-pyrite, pyrrhotine, magnetite, numerous minerals silver, tellurium and other elements. Stable material composition of ores suggests same type source of ore substance, close genetic types of deposits, similar composition of ore-forming solutions and fluid flows. Ore-bearing fluids contained wide range of ore elements (Cu, Pb, Zn, Fe, S, As, Au, Bi, Te etc.), lithogenous (Si, Mg, Ca, K и др.) and dissolved gases (CO_2, N_2, H_2S, SO_2, S, HCl, F, Cl, H, H_2O) (Cheprasov, 1972; Ganzhenko, 2018; Mizernaya, 2019).

Recent mineralogic researches (including those ones carried out by the authors of the article) resulted in finding complex mineral associations of ore and accessory minerals. Ores are different complexes of sulphides related to several generations (early syngenetic to late). They differ considerably by basic components compositions, impurities compositions, typomorphic characteristics. There are many secondary minerals in paragenesis with sulphides, they are bismuthite, aikinite, gold, silver, cadmium, etc. (Eremin, 2000: 177; Mizerny, 2017).

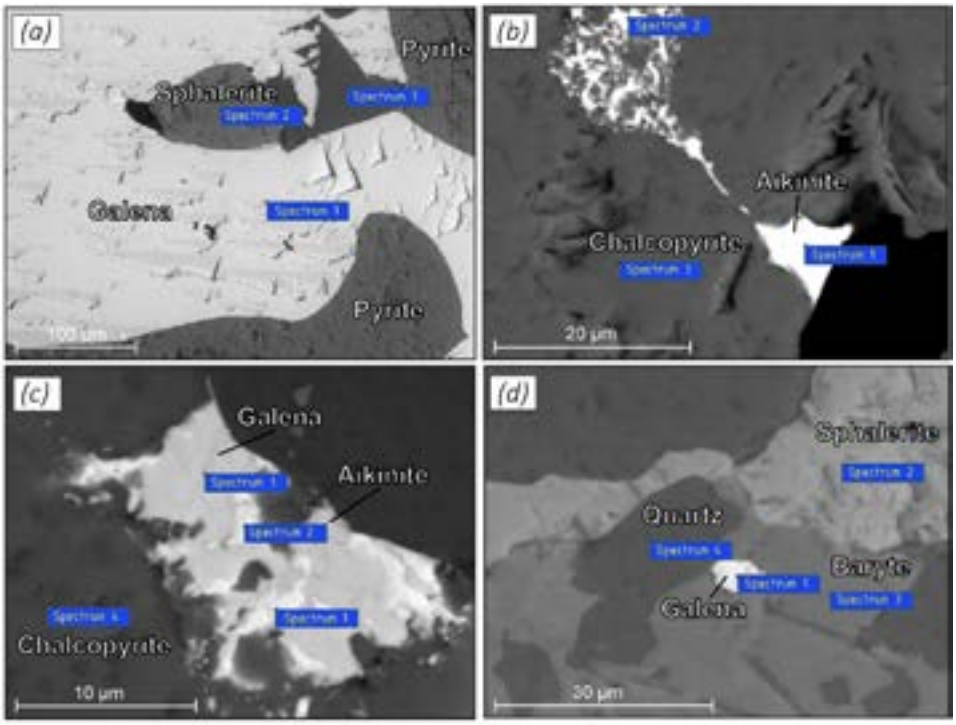


Fig. 2 – Minerals microinclusions in pyrite - polymetallic ores of Ridder-Sokolnoye deposit: late generation of galenite in polymetallic ores (a); veinlet inclusion of aikinite with Se impurity in chalcopyrite (1.23 mas. %) (b); aikinite micro-inclusion in clustered mass of galenite (c Se impurity-6.78, Ta-3.10, W-2.17 mas. %) (c); galenite micro-inclusion in associations with quartz, sphalerite and barite (d).

Analysis of geologic aspects (history of exploration and industrial mining of regional metals, regional and local exploratory criteria, analysis of previous exploration and assessment etc.) (Baibatsha, 2020a, 2020b; Safonova, 2014; Buslov 2011) resulted in identification of areas and sections for finding new polymetallic deposits.

Verhuba ore field is located on the left bank of the Uba river in surroundings of Verhuba village. It comprises south part of Devonian sediments development territory that in south-east borders with Ordovician greenshist outcrop in nuclear part of the Aleisky anticlinorium. This ore field includes three deposits of sulphide-polymetallic ore: areal mineralization, Ubinskoye and Verhubinskoye sections and also Rudnihinskoye mineral occurrence. As it was found out in the end of the last century, Ubinskoye and Verhubinskoye deposits are located in the same mineralization zone and continuously tracked as half-arcs from Ostroi city in the east to Luniha city in the west for more than 6 km. Ore is located in sediments Losishinskaya suite of Lower Middle Devonian Age and it is represented by series of stratiform ore bodies separated in the section. Its size is 100 m × 75 m up to 1150 × 950 m, its thickness is from 1 to 9 m.

C_2 category reserves (Ganzhenko, 2018) were found in Verhuba area that includes the deposit with the same name in the result of prospecting and evaluation works in 1986-88. They include ores (13 645 thou.tons), copper (136.5 thou. tons), lead (24.8 thou. tons), and zinc (173.5 thou. tons). Mineralization of nearly the same scale was found in Uba area.

Evaluation of Beryozovskoye deposit in the depth of ore structure is worth noticing, upper bodies of this deposit are worked out. Most deposits of Rudny Altai have several ore shoots in its section that lean to the depth (Orlovskoye, Artemyevskoye, Maleyevskoye etc.)

Sugat ore field refers to potential areas, it is located on north-west extension of Artemyevskoye and Kamyshinskoye deposits structures and covers the area about 8 km^2. The ore that was found out in ore field is localized on the area 1 km^2 and represented Sugatovskoye and Surgutanovskoye small deposits, and ore occurrences that are contiguous to Sugatovskoye deposit: North-Sugatovskoye, South- Sugatovskoye, and Novo- Sugatovskoye. Some authors (Stepanov et al., 2006) refer the mentioned ore deposits to Sugatovskoye deposit. All of them are located on Givetian ore strata-level.

Sugatovskoye deposit is represented by a stock body embedded in endomorphic zone of porphyres breaking out volcanogenic rocks of Talovskaya suite of Givetian age. The size of the stock on the surface is 120 ×80 m. In "cabinet" period stock was developed up to 102 m deep. Ore was represented by oxide ores until 45 m deep, they are two vein-shaped sills of brown iron ore with bunches of and individual barite separated by mineralized ferrum oxide and pyrite rocks. Average metal content in ores of these sills was as follows: gold 10 g/t, silver 720 g/t, copper 0.6 %, lead 8 %, zinc 0.2 %. This ore changed considerably by pyrite mineralization below oxidation zone, and pyrite is with galenite, sphalerite, and chalcopyrite with the following average content: lead 0.9 %, zinc 1.3 %, copper 2.0 %, золота 1.5 g/t and silver 8.3 g/t. Geological prospecting work completed in 1970-ties enabled to find out that the following reserves in oxidation zone are still unmined: ore 860.7 thou.tons, containing gold 2194.8 kg, silver 24 692.2 kg, copper 1 032.8 t, lead 2 237.8 t and zinc 258.2 t (Ganzhenko, 2018).

Surgutanovskoye deposit is located in Talovskaya suite volcanites. Ore zone is followed along the strike on 280 m, it is lensed downdip at 200 m depth. Its thickness on the surface is 1–1.5 m. Ore interval 1.8 m was crosscut by the drilled hole in 1916 (according to V.K. Kotulsky). It contained copper 0.38%, zinc 22.4 %, gold – trace amount, серебра 18 g/t. Oxidation zone is 50 m thick. Content of non-ferrous metals in oxide ores is as follows: copper 0.4–1.2 %, lead 0.6%, zinc 0,5 %, gold – trace amount, silver from 0.5 up to 286 g/t.

Inferred resources of this are (Nazarov et al., 1990) are defined according to P_1 category in the following amount: ores – 4600 thou.tons, copper – 121 thou.tons. It is supposed that there is a real opportunity of non-ferrous metals, gold and silver orebodies delineation on this territory. They are small but rich in their content.

Rulikha area comprises Rulihinskoye deposit and its contiguous fields. The deposit was explored in 50-s of the last century and assessed as a small one with C_1+C_2 category reserves: 1 600.1 thou.tons, copper 8.9 thou.tons, lead 14.2 thou.tons, zinc 87.4 thou.

tons. Prospecting work completed in the end of the last century enabled to find out new ore bodies. General reserves (Ganzhenko, 2018) of C_1+C_2 category were defined in the following amounts: ore 8 983.92 thou.tons, copper 105.18 thou.tons, lead 39.73 thou. tons, zinc 337.08 thou.tons, gold 2 347.3 kg, silver 111.33 t.

In 2003 materials on the field ore bearing were summarized and that resulted in confirming the assessment of prospecting work results. Besides, rationale was provided for finding one more ore zone, its inferred reserves are evaluated according to P_1 category in the amount: ore 735 thou.tons, copper 8.8 thou.tons, lead 3.2 thou.tons, gold 220.5 kg, silver 11.0 t.

Exploration, as well as the organization of exploitation works, are hampered by finding most of the reserves of the deposit under the buildings of Rulikha village. The field is located under the bed of the Talovka river. But a significant part of the deposit is located outside of these deposits and can be involved in additional study and further development.

The intermediate site is located in the northwestern extension of the Rulikhinsky site. Studies performed in 2003 have found that it is understudied. The possibility of identifying mineralization here that is comparable in scale with the Rulikhinsky deposit is confirmed. Inferred P1 category resources are defined in the following amount: ores 4 583 thous. tons, copper 55.0 thous. tons, lead 20.0 thous. tons, zinc 175 thous. tons, gold 1 375 kg, silver 68.75 thous. tons.

The so-called Rulevsko-Baykarovskaya zone of pyrite-polymetallic mineralization belongs to the promising areas. This zone from the south directly adjoins the area of the Rulikhinsky area, separated from it by the Rulevsky fault. In the southwest, the zone is bounded by the marginal northeastern Irtysh fault. In the southeast and northwest, its boundaries remain "blurred". The area of the zone is poorly exposed except for the Rulevskoye copper-pyrite ore occurrence. The prospecting works, carried out in the last century,enabled to identify more than 30 occurrences of copper and polymetallic mineralization in the zone. Earlier the sediments forming this area were referred to late Devonian, but the last data of G.D. Ganzhenko, E.M. Sapargaliev show the possibility of these strata location within the limits of Givetian ore-bearing stratolevel, that significantly increases the prospects of industrial mineralization identification here. Forecast resources of the zone, defined by category P2, are as follows: ore 7 000 000 tons, 81.0 thousand tons of copper, 30.0 thousand tons of lead, 260.0 thousand tons of zinc, 1.8 tons of gold, 90.0 tons of silver.

The northeastern framing of the Irtysh shear zone is still promising. Large and medium-scale deposits that were previously mined (Berezovskoye, Novo-Berezovskoye, Belousovskoye) and Irtyshskoye deposit that is currently mined are located here. Beside the mentioned deposits, there is Krasnoyarsk deposit which is small in its reserves, but rich in metal content, and Mayachnoye ore occurrence which is also understudied. The assessment of Berezovsky deposit deep horizons prospects is worth notice, as the ore found at this deposit is not delineated at depth. All the mentioned deposits are located in sediments of the Eifelian strata. (Ganzhenko, 2018).

One large deposit (Chekmar) and a number of smaller deposits (Dolinnoye,

Obruchevskoye, etc.) remain undeveloped in Leninogorsk ore region. Moreover, geological exploration works in this area, unlike in other ore areas, are still carried out by "Geolen" LLP with Kazzinc JSC financing, though on a smaller scale. These works resulted in positive results, which reduced deficit of raw material base for mining industry development.

The only Maleyevskoye deposit, which is currently developed by Kazzinc JSC, has limited reserves. Grekhovskoye deposit is mothballed due to inefficiency of ore mining on deep horizons.

Prospects of Revnyushinskaya structure cannot be considered exhausted, in spite of its rather high exploration rate. The identification of promising gold-polymetallic ore occurrence in the Selektsionnaya zone proves it.

To assess the prospectivity of Revnyushinskaya structure and to determine prospecting and exploration work direction it is required to analyze the available materials on its study, with the identification of potentially promising areas for mineralization, with the further staging of prospecting and exploration work in these areas. In carrying out the recommended studies all the achievements of geological science on the peculiarities of pyrite type ore development and localization should be used.

Discussion

The results of investigations showed the availability of numerous promising deposits of pyrite-copper-zinc and copper-pyrite mineralization within the known ore districts of the Rudny Altai. Geological exploration in new promising areas could lead to the discovery of new medium and large industrial extraction facilities in the Rudny-Altai region. Geological prerequisites analysis for expanding the available mineral resources of non-ferrous metals in the region, considering economic and social aspects of Rudny Altai development, availability of well-developed historically established infrastructure for mining and processing of polymetallic raw materials, have allowed to develop a system for estimating the investment potential of the region. Internal (objective) and external (subjective) reasons describing the trends of the region's development and determining its profitability on the part of subsoil users and investors have been determined. There are a number of objective reasons that constitute the strengths and weaknesses of the future of the mining and metallurgical industry of non-ferrous metals in the Rudny-Altai region.

The strengths include:

- A significant possible resource of abandoned and mined deposits, prospects of revealing new deposits of Cu, Zn, Pb and other elements.

- Availability of a substantial database of accumulated information on the composition, structure and geometry of the geological environment of the territory.

- The availability of the experts in the fields of geology, metallogeny, mathematics, computer technology, who master the modern methods of ore deposits potential forecasting.

- The availability of a well-developed infrastructure, transportation services and qualified workforce in the areas of operating mining enterprises (Leninogorsk, Zyryanovsk, and Priirtyshskiy ore districts).

The weaknesses include:

- The influence of traditional attitudes and methods on metallogeny as well as outdated approaches to the ore deposits potential forecasting complicate the discovery of new large ore deposits in the territory of the Rudny Altai.

- The challenges of coordination, governance, and interaction with local government.

-Poor interest of subsoil users in scientific researches funding to replenish the mineral reserves of the region.

External or subjective factors determine the opportunities and the threats associated with these opportunities for the further development of the region.

The so-called opportunities include:

- The availability of regional and local signs and criteria for discovering new areas promising for nonferrous metal ores.

- Realization of high subsoil potential and scientifically sound, accurate and reliable mineral resource evaluations attractive for investment.

- Turning the results of scientific and technological research and software development into investment products.

There are certain threats and risks, for example:

-Mine development within the next 10–15 years of the reserves of most of the known deposits in the region.

- Lack of science-based methods for assessing the investment attractiveness of the territories of Kazakhstan.

- Fluctuating market conditions for raw materials, the sensitivity of metal prices to the political situation, the cost of hydrocarbons, international sanctions on partner countries, etc.

- The complicated environmental situation in the areas of mining and processing enterprises.

A strategy has been developed to compensate for weaknesses and reduce risks by:

- Raising the awareness of investors and subsoil users about the latest metallogenic concepts, methods and technologies of ore deposits potential forecasting.

- Research commitment to the application of new theory, new information in the form of physical and virtual models of geological space, innovative technologies of knowledge and information conversion into further ore deposits forecasting.

- The availability and development of own methods, algorithms and software products for digital forecasting of ore deposits.

- Development of more environmentally friendly technologies for mining and processing of nonferrous metal ores.

Conclusion

As is commonly known, the proven reserves in the subsoil of the Rudny Altai are sufficient for the production activity of mining enterprises for the period up to 2030-40, with the rational and stable mining of about 6-8 million tons of ore per year and on the condition of simultaneous mining of high grade and low grade ores. (Bespaev, 2004: 141). However, according to experts, the overall ability to provide polymetallic ores to mining and processing enterprises in the Rudny Altai is determined by the so-called "initial metallogenic potential" of the region (Ganzhenko, 2018).

Analysis of the investment potential of the Rudno-Altaysky region has revealed that the region has a high potential for further expansion of the mineral resource base with sufficient and stable funding of the exploration works. Highly sought investment sites are concentrated on the flanks and deep horizons of known ore fields, within promising but insufficiently explored areas, and in closed territories. There is a well-developed system of transport links in the Rudno-Altaysk region. There is some infrastructure in the form of energy complexes, worker's neighborhood; there is no need to build mining and processing plants. Highly qualified personnel are available. The recruitment of young specialists in mining, geology, metallurgy, enrichment and construction is provided by D. Serikbayev EKTU. This enables to classify Rudny Altai as a region with high investment potential.

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