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The Scientific Basis of the Investment Attractiveness of Geological Structures on the Example of Rudny Altai

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Abstract. *The relevance of the research arises is due to the need to develop new approaches to assessing the investment attractiveness of ore-bearing structures and mining regions of Kazakhstan.*
The purpose of the work: To develop a methodology for the scientific assessment of the investment attractiveness of the geological structures of Rudny Altai, promising for the identification of mineral deposits.
Objects of research: polymetallic deposits of Rudny Altai.
Methodology: Research methodology: information retrieval, collection and systematization of material, processing and critical understanding of the state of the mineral resource base of Kazakhstan, geological and tectonic modeling, predictive studies, field studies.
Results: A review of the reserves, production and consumption of the main types of polymetallic deposits in Rudny Altai was made, work was carried out to develop a methodology for assessing the investment attractiveness of the main geological structures and individual ore fields.

Keywords: *SWOT, VMS, copper, zinc, lead, Rudniy Altai, Kazakhstan, resources.*

Introduction

Currently there are thirty five types of solid minerals and hydrocarbons in natural resources management. Twenty-five of them are involved into operation. They are deposits of caustobioliths, ferrous, non-ferrous, and precious metals. Deposits of other minerals in particular rare metals, rare earths were suspended for dozens of years. It can be explained that the most part of the remaining raw materials are in refractory or low-grade ores.

During the last ten years under conditions of more and more growing extraction at the developed deposits and small amount and low output efficiency of exploration work, there is increasing tendency that extracted reserves won't be replenished, mining rates will be reduced and raw material quality will be decreased. Reserves of Pb, Zn, Cr, Ag, A (Figure 1) have been reduced nearly on 10%. Some increment of Fe, Mn, Pb, Zn, Au reserves was due to re-evaluation and additional study of the developed deposits at flanks and deep horizons. Ores of the deposits prospected in recent years are often characterized by low quality and can't be equal to depleted reserves.

Nowadays mining enterprises engaged in mining and processing of non-ferrous metals face serious problems. Most deposits are provided with previously prospected reserves for the period no longer than 10-15 years. Involvement of copper-porphyric deposits with low-grade ores into operation doesn't save the situation though they are processed by using up-to-date highly-productive and efficient schemes of production and processing.

There is the acute situation in using mineral raw material base of precious metals. Currently 97% of prospected gold deposits is at disposal of subsoil users, and only 53% of them are involved into operation [1]. It is due to depletion of easily beneficiated oxide ore, insufficient implementation of appropriate technologies for refractory ores concentration of proper gold ore deposits and low quality of major minerals at complex gold-bearing deposits of pyritic-polymetallic and copper-porphyric geological commercial types.

Theoretical basis for assessing investment attractiveness

It is known that the investor's willingness to invest is greatly influenced by the investment attractiveness of the subject. In this case, the way in

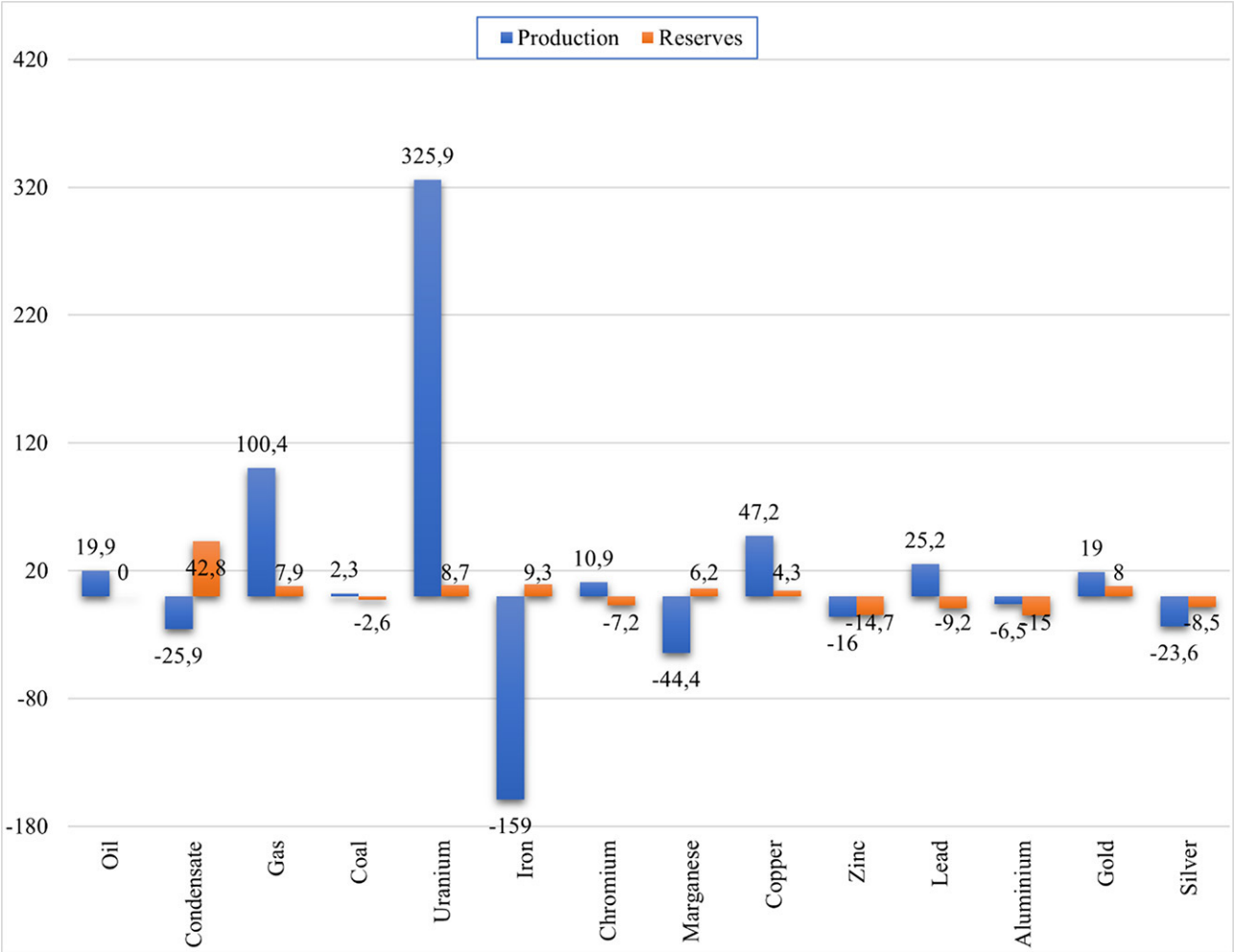


Figure 1 – The change of extraction volume and balance sheet minerals reserves of the Republic of Kazakhstan: 2016 in comparison with 2007, % (KAZGEOINFORM data 2016)

which information about a potential investment is presented plays a key role. There is a model form of the business plan of the investment project, and integrated investment plans of monocities and industrial regions are developed. The more visible and accessible the information on opportunities and risks associated with an asset, the easier it is for an investor to assess its attractiveness and make an informed investment decision. Working at the meso- and macro-level, investors often assess investment attractiveness on the basis of a set of indicators of the development of the investment target. Similar issues were addressed in the works of I.I. Roysman, I.V. Grishinoy, A.G. Shahnazarov; G.P. Filed A.K. Bakitzhanova, S.A. Filina et al. [2-3].

This chapter examines the factors influencing the region's investment attractiveness: investment potential and risk, and their components; It is a factor of image, of time, of objectives and of the main stages of assessing investment attractiveness.

Investment attractiveness is usually defined as the existence of investment conditions that affect the investor's preferences in selecting an investment. The investment attractiveness of the region is thus an integral characteristic of the investment environment resulting from the assessment of the investment potential and investment risk of the region, reflecting the subjective perception of the region by a potential investor [4-5].

In our view, the investment attractiveness of geological structures should be determined by a set of indicators, taking into account four main components: geological assumptions, economic benefits, social and environmental situation.

The geological component is the main aspect that determines the investor's attitude to the investment. It is determined by many factors, chief among which are the history of industrial development of the region, geodynamic conditions of formation of the main geological structures of the region, density of weapons (Presence of mined or depleted ore objects in the study area, regional and local search criteria, etc.

From an economic point of view, the attractiveness of facilities is determined by such a set of indicators (existing infrastructure, availability of transport routes, overall economic development of the region, etc.) [6].

Social aspects can include indicators of well-being, unemployment, availability of skilled personnel.

The state of the environment and the presence of environmental problems also play a significant role in the assessment of innovation attractiveness and identify potential risks and threats to further industrial development of the region [7].

All components of the innovation attractiveness assessment are evaluated by indicators. Each indicator forms an indicator framework, with indicators defined from different perspectives, measurable and not overlapping. Thus, the analysis of the region's investment attractiveness will begin with the identification of integrated and private indicators, the identification of their determinants, and the role and place of each component of the system.

At the same time, it should be borne in mind that the number of indicators and private indicators should not be excessive, as this complicates calculations and makes the model unmanageable. However, too few indicators and private indicators will not produce the right result.

Integrated indicators include investment potential and investment risks. We will continue to develop indicators that form a private indicator, taking into account the goals and objectives of the evaluation. When determining the value of each indicator in the private indicator and of each private indicator in the integral indicator, it is necessary to take into account their ratio (importance) by assigning a certain weight, which is usually determined by an expert way. The calculation of the constituent indicators in assessing the investment attractiveness of the region is based on the following sources of information: statistical data; Research data Results of expert interviews [3].

The following is the data obtained as a result of studying the investment attractiveness of the geological structures of Rudny Altai.

The results of the assessment of the geological component of the investment attractiveness of Rudny Altai

The Rudny Altai metallogenic belt is a world-wide geological structure in which unique deposits of lead, zinc, copper, gold, silver and other useful components are concentrated [10-11]. For more than 100 years, the Altai Ore Ore has been an engine of industrial development of the former Soviet Union and later of the Republic of Kazakhstan. A steady and systematic increase in investment in Geological Exploration (GMT) has been taking place for 70 years. In recent decades, many polymetallic deposits have been successfully exploited and worked out: Shemonaichy, Jubilee-Snoytirikh, Zyranovsk, Sinov, Belousov, Nikolayevsky and Shubinski. By 2025-2040, several more large deposits will be worked out: Orlovskaya (Zhezkent mine), Maleevsky (Zyrian GOK), Tishinsky, Ridder-Sokolny (Leninogorsk GOK). The significance of these deposits to the economy of the country can be estimated from the fact that only the Ridder-Sokol deposit in 200 years of exploitation has produced more than 700 tons of gold, excluding zinc, lead, copper and other related components. For comparison, one of the largest gold deposits in the Republic of Bakyrchik, located in the region and launched in 2017, the Russian company «Pollimetal» is characterized by reserves of 300 tons of gold. Currently actively exploited deposits: Artemievsk gold-polymetallic, Novo-Leninogorsk, Dolinovsky will allow mining until 2035-40. Facilities available in reserve: Chekmar, residual reserves of Nikolayevsky deposit, Rulihinsk, Krasnoyarsk and other small objects cannot compensate for the output capacity of the fields being worked out and, accordingly, the mining industry will follow the downhill line [8].

It is estimated by many specialists that the Ore Altai will be fully worked out in 15-20 years. However, given the more than 300 years of mining history of Rudnoaltai deposits, it can be assumed that there is still potential for undiscovered polymetallic deposits. The experience of neighbouring China, which has invested considerable financial and human resources to carry out geological prospecting on the continuation of the structures of the Altai Ore (Altai South, Xinjiang Uighur Autonomous Region), has enabled them in less than 10 years to establish a strong mineral and raw-material base of polymetalls, gold, rare and rare earth elements [9].

Based on the results of work on the development of a methodology for assessing the investment attractiveness of the geological structures of Kazakhstan, we developed a SWOT – an analysis of their investment attractiveness on the example of the Rudny Altai polymetallic zone.

The strengths of internal, subjective factors in assessing the geological component include:

- A positive natural factor in the form of a significant potential resource of developed and depleted deposits and a resource for revealing hidden ore objects of Cu, Zn, Pb and other elements in the study area.

- A large base of accumulated information on the composition, structure and geometry of the geological environment of the territory and the availability of promising areas in search of polymetallic raw materials.

As an example, we may mention the area of the Verkhubinsky ore field, located on the left bank of Uba. in the vicinity of the village of Verkhuba. It covers the southern part of the territory of development of Devonian sediments bordering from the south-east the outlets of green Ordovician shales in the nuclear part of Aley anticlinorium [12-13]. The above-mentioned ore field comprises three objects of calcedonia-polymetallic weapons: area mineralization, Ubinsky and Verkhubinsky sections, and the Rudnikhinsk ore proofing.

Promising as well as other geologists include the so-called Sugatovsk Ore Field, located on the north-western extension of the structures of Artemyevsky and Kamyshynsk deposits, covering an area of about

8 km². The weapons installed on the ore field are located on an area of 1 km² and are represented by Sugatovsky and Surguttanovsky small deposits and adjacent to Sugatovsk deposit North-Sugatovsky, South-Sugatovsky and Novo-Sugatovsky ore phenomena. Some authors (A.E. Stepanov et al., 2006) combine these ore objects in Sugatovsk deposit. They are all housed at the Live Ore Stratum level (Figure 2).

Main socio-economic factors:

- Availability in the areas of operating mining enterprises of developed infrastructure, transport communications, skilled labor (Leninogorsk, Zyryanovsk ore districts, Irtysh area).

- Availability of a team of specialists with competencies in various fields of geology, metallogeny, mathematics, computer technology, methods of forecasting minerals.

- Availability in the areas of operating mining enterprises of developed infrastructure, transport communications, skilled labor (Leninogorsk, Zyryanovsk ore districts, Irtysh area).

Weaknesses include:

- The pressure of established views, methods on metallogeny and approaches to predicting ore minerals.

- Difficulties in coordination and management and interaction with local authorities.

- Weak interest of subsoil users in financing scientific research to replenish the region's resource base.

There are also external factors, consisting of existing opportunities and current threats and risks.

The possibilities include:

- The presence of regional and local signs and criteria for the discovery of new areas promising for non-ferrous metal ores.

- Realization of the high potential of the subsoil and scientifically sound, accurate and reliable estimates of mineral resources those are attractive for investment.

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

There are also significant threats and risks:

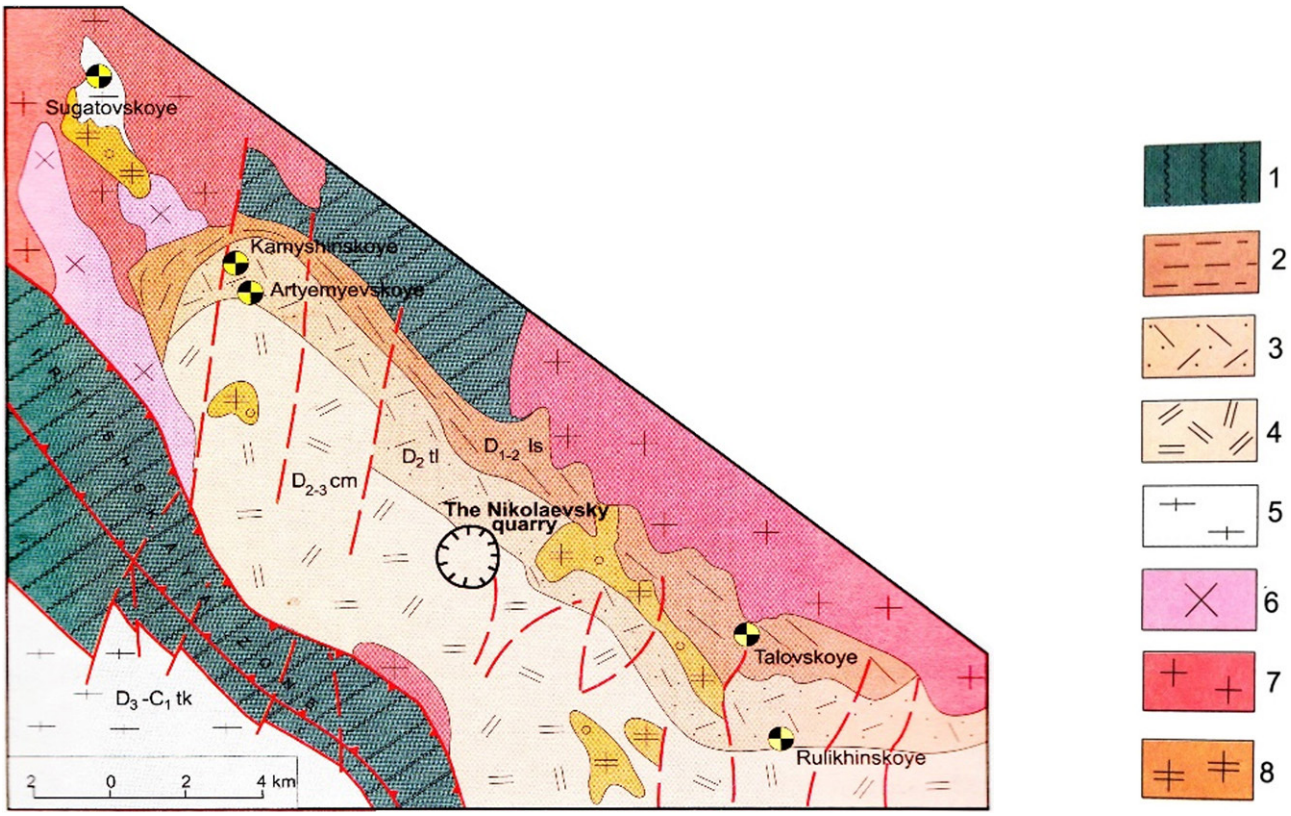
- Development over the next 10-15 years of reserves of most known deposits in the region.

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

- Unstable market of raw materials, dependence of prices for metals on the political situation, the cost of hydrocarbons, etc.

Compensation for weaknesses and mitigation of risks:

- Informing investors and subsoil users about the



1 – greenschists (S-D1); 2 – silictous-clayey sediments (D1-2 ls); 3 – tuffs of acid compositions (D2 tl); 4 – volcanogenic – sedimentary rocks (D2-3); 5 – terrigenous sediments (D3-C1 tk); 6 – granodiorites; 7 – granits; 8 – subvolcanocand exstrusive rhyolites

Figure 2 – Map of Sugatovsko-Rulikhinskoe ore field

latest metallogenic concepts, methods and technologies for forecasting ore minerals.

- Orientation of research to the application of new theoretical positions, new information in the form of physical and virtual models of the geological space, innovative technologies for converting knowledge and information into a forecast of ore minerals.

- Availability and development of own methods, algorithms and software products for digital forecasting of ore minerals.

Conclusions and recommendations

An analytical review and analysis of the development and state of the gold mineral resource base of East Kazakhstan allows us to give it the following perspective assessment for the next fifteen years. Explored reserves in the depths of Rudny Altai are sufficient for the production activities of mining enterprises for the period up to 2030-40, with rational and stable mining of about 6-8 million tons of ore per year, subject to the simultaneous extraction of rich and poor ores [14-15].

There are still potential opportunities for expanding the mineral resource base in the Rudny Altai, but this requires sufficient funding for geological exploration to conduct searches on the flanks and deep horizons of known ore fields in closed areas. The general possibilities of providing the Republic with precious metals are determined by the «initial metallogenic potential», which is calculated as the sum of historically accumulated production, recorded reserves and forecast resources, estimated with varying degrees of reliability according to general geological criteria, not always confirmed by analytical data. When carrying out the recommended studies, it is necessary to use all the achievements of geological science, according to the features of the development and localization of pyrite-type mineralization.

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Рудный Алтай үлгісінде геологиялық құрылыстардың инвестициялық тартымдылығының ғылыми негіздерін әзірлеу

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Аңдатпа. *Жұмыстың өзектілігі Қазақстанның кенді құрылымдары мен тау-кен аймақтарының инвестициялық тартымдылығын бағалаудың жаңа тәсілдерін әзірлеу қажеттілігімен түсіндіріледі.*
Жұмыстың мақсаты: пайдалы қазбалар кен орындарын анықтау үшін перспективалы Рудный Алтайдың геологиялық құрылымдарының инвестициялық тартымдылығын ғылыми бағалау әдістемесін әзірлеу.
Зерттеу объектілері: Рудный Алтайдың полиметалл кен орындары.
Әдістеме: Зерттеу әдістемесі: ақпаратты іздеу, материалды жинау және жүйелеу, Қазақстанның минералдық-шикізат базасының жай-күйін өңдеу және сыни тұрғыдан түсіну, геологиялық-тектоникалық модельдеу, болжамдық зерттеулер, далалық зерттеулер.
Нәтижелер: Рудный Алтайдағы полиметалл кен орындарының негізгі түрлерінің қорларына, өндіруіне және тұтынуына шолу жасалды, негізгі геологиялық құрылымдар мен жекелеген кен орындарының инвестициялық тартымдылығын бағалау әдістемесін әзірлеу бойынша жұмыс жүргізілді.

Кілт сөздер: *SWOT, полиметалл кен орындары, мыс, мырыш, қорғасын, Рудный Алтай, Қазақстан, ресурстар.*

Разработка научной основы инвестиционной привлекательности геологических структур на примере Рудного Алтая

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Аннотация. *Актуальность работы обусловлена необходимостью разработки новых подходов к оценке инвестиционной привлекательности рудоносных структур и горнорудных районов Казахстана.*
Цель работы: разработать методику научной оценки инвестиционной привлекательности геологических структур Рудного Алтая, перспективных на выявление месторождений полезных ископаемых.
Объекты исследований: полиметаллические месторождения Рудного Алтая.
Методика исследований: информационный поиск, сбор и систематизация материала, обработка и критическое осмысление состояния минерально-сырьевой базы Казахстана, геолого-тектоническое моделирование, прогнозные исследования, полевые исследования.
Результаты: Сделан обзор запасов, добычи и потребления основных типов полиметаллических месторождений Рудного Алтая, проведены работы по разработке методики оценки инвестиционной привлекательности основных геологических структур и отдельных рудных полей.

Ключевые слова: *SWOT, полиметаллические месторождения, медь, цинк, свинец, Рудный Алтай, Казахстан, ресурсы.*

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