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MINING SECTOR TRANSFORMATION: THE EXPERIENCE OF EMERGING ECONOMIES

Kazakhstan adapts the accumulated world experience, demonstrating the need to take into account the socio-environmental and national factors in the assessment of mineral reserves. The purpose of the study is to reveal the possibilities of the mining industry in Kazakhstan in the context of strengthening the international positioning and decarbonization of the economy. The article analyzes the results of state regulation in the sphere of subsoil use. Scientific novelty of the work: for the first time, as a case-study of International Holding Kazakhmys, the results of the transition of the country's mining enterprises to the international reporting system CRIRSCO are given. Based on the analysis of the results of state regulation in the sphere of subsoil use, the authors identify key aspects of the transformation of the mining sector, which has the potential to increase its attractiveness to foreign investors. The role of digital solutions in the growth of objectivity and correctness of the geological and economic assessment of deposits that have mineral resources, but are characterized by a low degree of exploration and lack the necessary infrastructure, is substantiated. The practical significance of the study lies in the fact that Kazakhstan adapts the accumulated world experience, demonstrating the need to take into account the socio-environmental and national factors when assessing mineral reserves.

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Introduction

Since 2006, Kazakhstan has been included in the group of countries with an income above the average level. During the post-Soviet period, the country has overcome structural transitions from a planned economy to a market economy, and further to a raw material growth model. Kazakhstan became the first state in Central Asia to create an organizational and legal basis for the transition to "green growth" and is now ready to use the accumulated hydrocarbon potential to maintain energy security in the world and in European markets. Therefore, the key direction of the current structural transition, which involves inclusive development, is the systemic diversification of the economy, taking into account the principles of "green" growth. The economy of Kazakhstan is characterized by features of emerging markets. In the light of the above, the country is taking effective steps to build a new model of globalization in the context of achieving sustainable development, decarbonizing the national economy, and increasing investment attractiveness.

However, the ongoing policy to stimulate export diversification and the adaptation by Kazakhstan of the reporting standards of the CRIRSCO system, to which it is a member, have not yet led to a significant decrease in the share of commodities in domestic exports, mainly formed by supplying energy raw materials and metals to foreign markets.

As mentioned above, mining research is being updated to accelerate the transformation of an export-oriented model based on carbon-intensive export products and energy-intensive processes. Kazakhstan plans to build a new economic growth model by 2025.

Materials and methods

In many works, the opinion is expressed that countries endowed with natural resources have more opportunities for economic development [1] and treatment of natural resources for specific production [2]. Considering the growing shortage of natural resources, their depletion, the influence of natural resources on the economic growth of countries with developing economies is emphasized [3].

Kazakhstan is extremely interested in works devoted to assessing the impact of energy on the economic situation in the country [4], the choice of investment policy, taking into account the importance of sustainable energy sources [5], the growing role of state regulation in promoting green technologies and the growth of corporate social responsibility.

Of particular interest are the results of studying various aspects of state regulation of the mining industry, the possibilities for improving its economic performance [6], as well as the economic aspects of mining [7].

The contribution of scientists to the study of the digitalization of the mining industry and the adjustment of the policy of enterprises in the field of resource use is invaluable [8]. The work [9] reveals the possibilities of increasing the efficiency of resource use due to technological innovations. It is demonstrated how, with the help of digital maps and geoinformation models, which geographic information systems (GIS) are based on, it is possible to assess and predict the resources of a deposit, and to plan the costs of prospecting and survey work.

Special attention deserves the work on the study of specific features inherent in the assessment of mineral reserves. Scientists are interested in taking into account national standards when evaluating minerals, searching for new directions for the analysis of mineral raw materials that increase the validity of investment decisions, and assessing the environmental consequences for the economy of changes in the dynamics of minerals [10].

The development of the international reporting system CRIRSCO by Kazakhstan requires increased attention to the study of the intricacies of corporate social responsibility in the mining industry [11].

The issues considered in this article are widely discussed in Russian scientific circles. Thus, the impact on the positions of the mining industry of digital solutions affecting various business processes is being studied [12]; examines the risks that mining enterprises take on when they implement digital technologies [13]; various aspects of work safety at the field are being analyzed [14]; new methodological approaches to the creation of an effective underground ecogeotechnology that improves the ecological situation are proposed [15].

The above confirms the relevance of the issues raised in the article for Kazakhstan, which seeks to adapt the best foreign experience. At the same time, our own scientifically based measures are being taken to increase the investment attractiveness of the mining sector, the progress of which determines the change in the resource-export model of development and the increase in the energy security of the state. In order to unlock the opportunities of the mining sector of Kazakhstan in the context of the decarbonization of the economy, the following tasks were set: to analyze the transformational processes of the mining sector of Kazakhstan; evaluate the first results of the transition of the country's mining enterprises to the international reporting system CRIRSCO; justify the role of digital solutions in the geological and economic evaluation of fields with a low degree of exploration.

Method of research

This study is based on the principles of sustainable development of the mining industry in Kazakhstan and on the concept of the digital economy of enterprises. The theoretical and methodological basis of research is the methods of systemic and structural analysis, which make it possible to study an enterprise as a set of heterogeneous and dynamic economic subsystems. Using the process approach, the integration processes and business processes required for the geological and economic evaluation of the deposit are analyzed. The empirical base of the study is represented by information from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, statistical data on long-term strategies and development programs of Kazakhmys Holding. The publications in international scientific journals and many years of authors' research work on the designated topic are used.

Difficulties in collecting primary information, characterized by incompleteness, created additional complexity for their interpretation. However, the authors hope that the results obtained will broaden the understanding of the economy of Kazakhstan, provoke discussion and continue research that deepens the assessment of the international competitiveness of mining companies in emerging economies.

Results

Current state and development prospects of the mining sector. Taking into account the trend of changing the technological ways of civilization to progressive technologies, including the transition to renewable energy sources, one of the most effective ways to strengthen Kazakhstan's position in international value chains is to implement a proactive strategy to decarbonize industrial sectors.

Against the background of the depletion of mineral reserves, not many large mineral deposits have been found in the country in recent years. The tendencies of non-replenishment of extracted reserves, a general decrease in their quantity and deterioration in quality have been identified and are growing. For many priority types of minerals, the volume of extracted reserves significantly exceeds their growth from exploration. The increase in reserves of industrial categories (iron, manganese, gold, zinc) was obtained mainly due to the revaluation and additional study of previously known objects. The reserves of copper and gold deposits explored in recent years are characterized by low quality.

Now the deepest deposits in Kazakhstan are at a depth of four to five kilometers, despite the fact that in many countries (USA, China, Brazil) deposits twice as deep are being developed. The areas offered for exploration have already been explored several times, so they are not attractive for investment. The list of promising objects is almost exhausted, there are no areas for transfer to subsoil use. This is explained by the low level of government funding and, accordingly, by the low quality of studying deep horizons in order to assess the prospects for discovering mineral deposits at great depths, and by the lack of scientific research on forecasting deep-seated objects.

As world experience shows, investors invest in exploration of deposits in those countries where the state has already carried out or is conducting early stages of work at its own expense, where a base of promising areas with predicted resources has already been formed.

In order to adapt to the best world practices in mining, Kazakhstan needs to stimulate improvement of redistribution. In particular, the transition from the outdated mineral extraction tax to royalties, the rate of which, for example, in Western Australia, depends on the depth of processing of mineral raw materials: the sale of ore — 7.5%, concentrate — 5.0%, metal — 2.5%.

However, despite the search for new investors, Kazakhstan plans to increase the tax rates on the extraction of minerals for exchange-traded metals by 50%, for other solid minerals — by 30%. Only new fields will be exempt from this tax, where production will begin after December 31, 2022, until a profitability level of 15% is reached for up to five years. Such an approach will repel foreign investors, lead to a reduction in activities by mining companies and the abandonment of new projects, and the revision by investors of business plans for new deposits. In the short term the state can receive funds from the mineral extraction tax, but in the long term the industry will face problems.

In general, despite the difficulties, Kazakhstan has a fairly large potential for discovering new deposits, which is strategically important for strengthening its international positions.

Conceptual industry innovations suggest Kazakhstan's approach to the best world practices, reducing the duration of geological exploration, reducing administrative barriers, increasing the requirements for quality control and reliability of geological exploration, as well as transition to CRIRSCO international standards for reserves estimation.

For Kazakhstan, integration into CRIRSCO is one of the key objectives of attracting foreign investment in the mining sector by increasing the transparency and predictability of the subsoil use through the introduction of an international reporting standards for mineral reserves. In particular, this means giving an investor the opportunity to evaluate the characteristics of a mine field and the strategy for its development on the basis of proposals made by the project manager, and protecting the investor from misinterpretation by the project developer of the potential of the field.

The reporting methodology for solid minerals, when the state accounting of reserves is assessed according to the classifications of the State Reserves Commission (GKZ), was developed under conditions of centralized ownership of assets. According to the degree of reliability, reserves are divided into 4 categories: A — detailed explored mineral reserves, B — preliminary explored mineral reserves, C1 — reserves of explored deposits of complex geological structure and poorly explored mineral reserves, C2 — prospective undiscovered reserves.

However, despite the fact that the Soviet classification system, depending on the degree of geological knowledge, allowed control over subsoil use, Kazakhstan needed a model that reflected the balance of interests in the state–subsoil user–investor system.

In order to improve legislation and improve the investment climate in the field of subsoil use, the standard of the Kazakhstan Association for Public Reporting on the Results of Geological Exploration, Mineral Resources and Mineral Reserves (KAZRC Code), integrated in 2017, was introduced to the CRIRSCO family of public reporting codes. The KAZRC Code is based on the Australian model of subsoil use and on the principle of "Presumption of good faith of a subsoil user". The KAZRC Code is aimed at providing investors with reliable information about deposits. It is applicable to all solid minerals, for which the submission of a Public Report on the results of geological exploration, assessment of mineral resources and / or mineral reserves is required by the relevant regulatory authorities, including the Kazakhstan Stock Exchange (KASE), which advances the ESG agenda and has joined the United Nations' Sustainable Exchanges initiative.

Currently, Kazakhstan is moving away from the assessment of reserves of ore deposits based on information about the chemical composition of ores. The new assessment is based on a labor-intensive mineralogical approach that allows predicting the technological properties of the ore and operating costs in ore processing, based on a huge amount of data from quantitative mineralogical analysis of ordinary samples and the uniqueness of each deposit.

The introduction of the international system of reporting standards for reserves involves a phased transition to CRIRSCO international standards using the current GKZ system: from 2018 — under new licenses, from 2024 — under existing contracts; for the SPE-PRMS system: from 2021 — large; from 2022 — medium; from 2024 — small companies. Until January 1, 2024, the basis for inclusion in the state accounting of solid mineral reserves under contracts and licenses concluded before June 28, 2018 is a positive conclusion of the State Reserves Committee or a report of a competent person on the mineral resources and reserves of the deposit, prepared in accordance with the KAZRC code. From January 1, 2024, the basis for inclusion in the state accounting of solid mineral reserves will be a report of a competent person prepared in accordance with KAZRC.

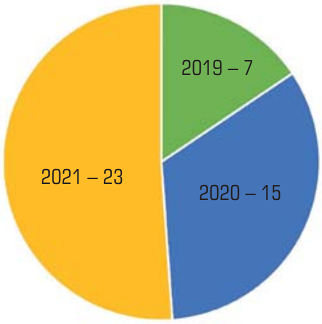

Fig. 1. Number of reports accepted by the Committee of Geology in accordance with KAZRC
Source: Compiled by the authors according to the source [16]

Until January 1, 2024: according to the GKZ ore reserves, washability, commercial reserves ((A+B), C1, C2), non-commercial reserves are reflected; for the reserves of the main minerals according to the GKZ indicate commercial reserves ((A + B), C1, C2), non-commercial reserves; for reserves of associated minerals according to the GKZ, recoverability, commercial reserves ((A + B), C1, C2) are indicated.

Ore reserves according to KAZRC also contain information on washability, reserves are divided into proven and probable, resources — into measured, identified and inferred. KAZRC reserves of key minerals are also shown as proved and probable, and resources as measured, indicated and inferred. For reserves of associated minerals, KAZRC also adds data on recoverability.

Legislative changes have intensified licensing activities, automation of the process of issuing licenses has reduced the processing time from 30 to 5 days. If in the period 1996 — June 2018, 551 contracts for the subsoil use of solid minerals were issued, then from July 2018 to 2021, more than 2.000 new licenses for solid minerals were issued, mainly to junior companies for "green field" prospecting. In addition to the existing Contracts, 800 licenses for the exploration of solid minerals were issued with exploration periods of 3–6 years. The number of reports adopted by the Geology Committee in accordance with KAZRC has increased (**Fig. 1**): in 2019 — 7, in 2020 — 15, in 2021 — 23, as a result of which the reserves were placed on the state balance sheet [16].

During the transitional period, the calculation of ore reserves of deposits is carried out in accordance with the JORC code (The Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves) and KAZRC, and is estimated according to the classification of the GKZ of Kazakhstan. The total operational reserves of ore are established for categories C1 and C2 (placed on the state balance sheet). The assessment of the mineral resources of deposits is carried out in accordance with the KAZRC Code, a block model is compiled in the MICROMINE program.

In support of the above, let us discuss two different deposits, namely, Kusmuryn (Eastern Kazakhstan) and Alaigyr (Central Kazakhstan), which have similar conditions for the formation of the ore body.

Table 1. Comparison of field reserves

Counting options	Cut-off grade	Ore	Content		Metal	
		thousand tons	Pb, %	Ag, g/t	Pb, kt	Ag, t
Block model	0.9	26 012.0	4.22	20.15	1097.7	524.0
SRC approved in 1988	1.5	18 518.0	5.40	26.07	1000.2	482.8
Growth		40.5	–21.9	–22.7	9.8	8.5
Source: Compiled by the authors according to the source [17]						

The authors carried out a feasibility study of the Alaigyr lead–silver deposit, including an assessment of ore reserves in accordance with the JORC Code (2012). The effectiveness of building a block model of ore bodies with a cut-off grade of lead of 0.9% and calculating reserves by two methods (ordinary kriging (OKRIG) and the inverse distance method (IDW)) was studied, the increment of ore and metal was estimated with a decrease in cut-off grade of lead from 1.5 up to 0.9%.

In accordance with the classification of proven reserves and probable resources of solid minerals, the Alaigyr deposit is assigned to the 3rd group of complexity. The ores of the deposit are monometallic, the main value in which is lead, associated in sulfide ores with galena, and in oxidized ores with cerussite with a small proportion of anglesite, pyromorphite and platterite. Lead within the ore bodies is distributed unevenly, its content fluctuates from tenths of a percent to a few tens of percent in the places of development of solid ores. Ores contain cadmium, mercury, antimony, sulfide sulfur. Harmful elements — impurities such as phosphorus and arsenic — are absent in the ores. The main associated element is silver, which is fully recovered into lead concentrate. The difference in the results of comparing the two counts as a whole did not exceed 1.2% (**Table 1**).

Subsequent comparison of resources with reserves of a deposit with combined ore mining and a cut-off lead grade of 1.5%, approved by the State Reserves Committee in 1989 and an assessment of resources of polymetallic ores, calculated reserves for a deposit in the context of areas, using Mining and Geological Information Systems (GGIS) Micromine, allowed us to conclude the following (**Table 2**, **Figs. 2 and 3**). The obtained volumes of ore and metal, with a cut-off lead grade of 0.9%, are 40.8% more than those obtained in 1988 for ore and 9.8% for lead. The difference is mainly due to a decrease in the cut-off grade, and as a result, an increase in ore reserves and a decrease in the average grade in the calculated reserves. The largest increments in terms of ore and metal were obtained in the Eastern and middle sections, while the Eastern section of the deposit is the most promising in absolute terms.

Table 2. Comparison of lead ore resources of Alaigyr deposit calculated by statistical methods

Ore type	Okrig							IDW						Discrepancies					
	Ore		Oud. weight	Metal				Ore		Metal				Ore		Metal			
	th. m^3	th. tons		Pb, %	th. tons	Ag, g/t	t	th. m^3	th. tons	Pb, %	th. tons	Ag, g/t	t	th. m^3	th. tons	Pb, %	th. tons	Ag, g/t	t
Middle Site																			
oxide	308	841	2.73	3.24	27.2	15.4	13.0	308	840	3.18	26.7	15.11	12.7	0	–0.1	–2.0	–2.1	–2.0	–2.1
primary	551	1511	2.74	3.88	58.6	18.2	27.5	551	1510	3.86	58.3	18.09	27.3	0	0.0	–0.5	–0.5	–0.5	–0.6
mixed	31	86	2.77	3.83	3.3	19.5	1.7	31	86	3.58	3.1	18.32	1.6	0	–0.3	–6.6	–6.9	–6.0	–6.5
Eastern Site																			
oxide	1316	3600	2.74	3.43	123.5	16.3	58.8	1316	3597	3.36	120.8	15.98	57.5	0	–0.1	–2.1	–2.2	–2.2	–2.3
primary	392	1079	2.75	4.24	45.8	20.1	21.6	392	1078	4.17	45.0	19.7	21.2	0	–0.1	–1.6	–1.7	–1.8	–1.8
mixed	477	1327	2.78	4.10	54.5	20.8	27.5	477	1327	4.10	54.4	20.72	27.5	0	0.0	–0.1	–0.2	–0.1	–0.1
Western Site																			
oxide	901	2498	2.77	4.68	116.9	22.4	55.9	901	2502	4.86	121.6	23.25	58.2	0	0.2	3.9	4.0	3.9	4.1
primary	4814	13245	2.75	4.25	562.9	20.1	266.2	4814	13251	4.32	572.4	20.46	271.1	0	0.0	1.6	1.7	1.8	1.8
mixed	644	1825	2.84	5.76	105.1	28.4	51.8	644	1828	5.94	108.6	29.24	53.5	0	0.2	3.2	3.4	3.0	3.2
TOTAL	9435	26012	2.76	4.22	1097.7	20.2	524.0	9435	26020	4.27	1110.8	20.39	530.5	0	0.0	1.2	1.2	1.2	1.2
Source: Compiled by the authors according to the source [17]																			

In general, the calculation results on ore and lead reserves by mining horizons indicate a fairly homogeneous, with some exceptions, distribution of lead content in depth of the Alaigyr deposit.

Since all deposits are unique, formed under the influence of a combination of different factors, they have specifics and characteristics and require an individual approach to block modeling. When modeling a deposit, first of all, indicators are calculated that reflect operating costs, which govern the calculation accuracy of the net present value of ore blocks depends. Next, the proceeds from the sale of goods are determined taking into account the extraction of a useful component and the content to be recovered.

Basically, digital mines are created, software products are mastered, and SGIS and GIS are introduced by city-forming, financially stable enterprises in Kazakhstan. Due to this, the automation of technological processes has accelerated, the time spent on exploration work has been reduced with a simultaneous increase in the accuracy of their implementation.

The ultimate goal of the digital transformation of an enterprise is the Digital Twin. In the future, to solve the problem associated with both the extraction of minerals and its enrichment, it is planned to create twins of technological enrichment schemes using the SCADA platform-system. In exploration programs by subsoil users, analytical studies are activated in accordance with the standards of quality assurance and quality control QA / QC, the context of sustainable development.

Adaptation of international standards: experience of a city-forming enterprise. The main activity of the vertically integrated Holding Kazakhmys is the extraction and processing of copper ore into cathode copper and copper rod, refining and sale of precious metals and other by-products resulting from the extraction and processing of copper.

The enterprise seeks to ensure low-cost copper production through large-scale development of deposits, the introduction of advanced technologies for mining and processing, automation and digitalization of processes, and increasing the involvement of personnel. Application of international practices and high standards of corporate governance, principles of information openness and transparency allows attracting the attention of international investors.

According to the results of work in 1996–2016, the calculated ore reserves of the Holding's deposits were approved by the State Committee for Reserves of the country. In 2016–2021 mineral resources, already estimated according to the JORC Code and adapted in accordance with the KAZRC Code, were accepted for the State Register of the Subsoil of Kazakhstan. Based on the confirmation of commercial discovery, a decision is made to continue exploration of the deposit in order to reliably and fully assess the reserves, increase the categorization of resources, and prepare these objects for commercial development.

In the future, according to the geological assignment, exploration of the deposit is carried out in volumes sufficient to justify the calculation of mineral resources of the "identified" categories and in accordance with the requirements of the KAZRC Code, then they are approved by the State Reserves Committee. In prospective areas, mineral resources of the "Identified" and "Measured" categories are evaluated in accordance with the KAZRC Code. As a result of exploration of deep horizons of deposits, mineral resources of the categories "revealed" and "measured" are estimated in accordance with the KAZRC code.

After solving geological problems (obtaining an idea of the geological structures of the deposit and clarifying the geological and industrial type of the deposit, its belonging to a certain

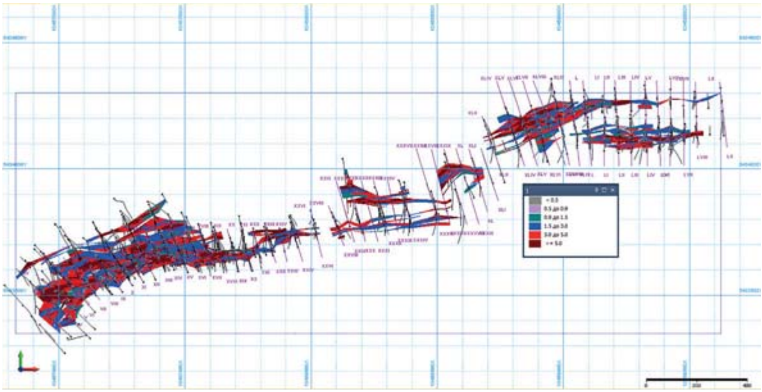

Fig. 2. Block model of the Alaigyr field. Plan

a

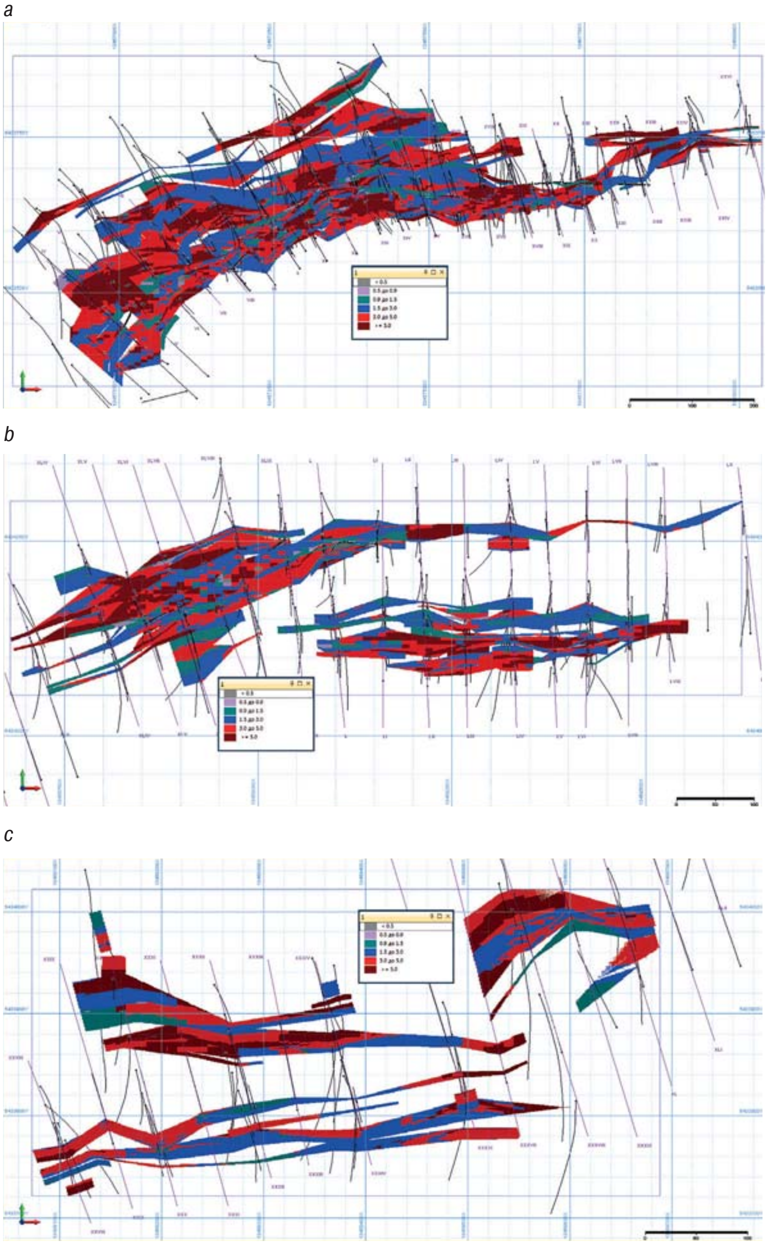

Fig. 3. Block model of the Western section (*a*), Eastern section (*b*), Middle section (*c*). Distribution by lead content [17]

Table 3. Field development program taking into account growth of reserves categorization

Field	Reserves of polymetallic ores as of 01.01.2021, thousand tons				Forecast state of reserves by 2029, excluding production, thousand tons		
	total	including by category					
		B	C1	C2	B	C1	C2
Kusmuryn	17,622.6	0.0	16,083.9	1,538.7	16,083.9	1,538.7	0.0
Akbastau	2,210.0	0.0	1,429.7	780.0	1,429.7	780.3	0.0
Source: Compiled by the authors according to the source [18]							

group, according to the GKZ classification), a report is drawn up on the mineral resources of the deposit and prospective areas in accordance with the requirements of the KAZRC code (categories "measured", "identified", "inferred"), then Mineral Resources approved by the GKZ. The report indicates the reserves/resources of a mineral as of a certain date, and in accordance with the KAZRC report, a conclusion is made (for example, ore zones of a deposit may be highlighted as the most interesting for further exploration). In accordance with the exploration plan and the geological task, the geological and industrial type of the deposit and its belonging to a certain group according to the classification of the GKZ of Kazakhstan are specified.

The Holding planned to carry out the transfer of ore reserves and mineral resources in stages. At the first stage (2021–2023), hydrogeological and geotechnical conditions were studied during 2022. For 2022–2023 it was planned to transfer 27% of the reserves to the measured (B) category and 7% to the verified (C1) category. Over the next three years, another 24% of the reserves will be transferred to the Measured (B) category and 10% to the Verified (C1) category. In 2027–2029 years 18% of reserves are planned to be transferred to the Measured (B) category and 6% to the Verified (C1) category. Overall, over 80% of resources and reserves will be categorized as Measured (B) with confidence.

As a result of the activation of exploration and research work of the Holding in order to transfer the resources of the deposits that form the basis of its mineral resource base to higher categories, by 2029 more than 80% of the resources and reserves of the Kusmuryn and Akbastau deposits will be classified as measured by the degree of reliability (C) (**Table 3**).

In the long term (over 40 years), the explored and registered proven reserves will allow the Holding to increase production and load production capacities. When predicting the life of a deposit and its ore reserves, the probability of economically viable extraction of minerals is taken into account. The expected increase in reserves as a result of additional exploration and operational exploration will increase the profitability of production by 1–25%.

The activation of digital solutions for managing internal business processes was facilitated by the transition to the new SAP ERP system using model companies, the development of BIM design, which allows creating a 3D model of the future object [19]. The introduction of the ERP system accelerated the receipt of management reporting by 22%, order processing — by 11%, reduced production costs by 7%, and increased labor productivity by 9% [20].

Conclusions

1. One of the main problems of the mineral resource sector of Kazakhstan is the exhaustion of a significant part of the prospecting reserve created in the 70–80s of the 20th century, which is manifested in the imbalance between the localization of forecast resources and the increase in reserves of industrial categories. Despite the huge potential of the reserves, many deposits require additional exploration, as they remain unexplored due to a lack of investment, which is due to the limited internal capital and the imperfection of legislation in the field of geological exploration [21].

2. Systemic problems hindering industry progress, making it difficult to optimize and concentrate resources on strategically important areas of development are: low level of advanced state geological exploration of the subsoil and weak involvement of scientific organizations in this process; low funding and digitalization of business processes; difficulties with the creation of geological infrastructure; a critical decrease in the availability of reserves for the city-forming enterprises and, as a result, a decrease in the level of production for many groups of deposits; insufficient level of interaction in the management system; personnel difficulties. As a result, the previously explored economically attractive deposits are either in development or exhausted, new deposits have not been discovered for decades. Since the early 2000s, these reserves have been estimated as subcritical.

3. Since investors are interested in an independent public reporting system that allows initial determination of risks and efficiency of subsoil use, and avoidance of the "syndrome of deceived investors", the state should finance the early stages of geological exploration of subsoil in poorly explored areas, and deepen the analysis of existing geological and geophysical data on solid minerals to determine the prospects and priority of research.

4. For a mining enterprise, the assessment of resources and reserves in accordance with international standards makes it possible to analyze its activities using the income method, display all aspects related to subsoil use, indicate not only the recoverable volumes of minerals by category, but also form a real model of cash flows as a result of mining a deposit.

In general, in order to accelerate progress towards the best world practices in the mining industry, Kazakhstan needs an understanding of the economic efficiency of the development and mining of deposits through modern, more flexible tax levers. This will lead to an increase in the number of new fields and an increase in the liquidity of the tax base of existing fields through increased transparency in the calculation of taxes and an increase in the tax base due to a differentiated approach to fields.

Further transformation of the mineral resource sector of Kazakhstan concerns the search for new cost-effective deposits. This is dictated by the growing demand for industrial raw materials and the transition to a low-carbon economy, which requires the provision of strategic reserves in the optimal amount for the main types of minerals, the creation of favorable conditions for attracting investment in mineral exploration.

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FORMATION OF MINE PROJECT MANAGEMENT OBJECT USING CHARACTERISTICS OF MINERALIZATION FOR THE BENEFIT OF MANAGERIAL DECISION-MAKING AND BUSINESS PROCESS CONTROL*

As part of the holding, two gold deposits are currently under exploration and development. The analysis of the main concerns revealed the need to modify the algorithms and procedure of the approach to an object of management on the basis of outsourcing research of geological and mining patterns of mineralization. The proposed methods were applied at two explored deposits of the holding – poor vein ore and poor skarn gold–copper ores, both non-commercial reserves. The results of the studies of three deposits as objects of management with the potential of productivity and profitability increase require reformation of both the object and subject of business process management based on expert evaluation of mining and geological characteristics of the deposits.

Keywords: *gold deposits, management object analysis, subject, object, development and implementation*
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Introduction

Insufficient attention to geological and economic prospect evaluation at an early stage may result in uncertainty about feasibility or further exploration and development at the final stages of exploration. This is conditioned by geotechnical properties of rock and ore masses, or clusters of mineralization suitable or not for cost-effective industrial development. The complex deposits with poor and scattered metal content and / or the high geomechanical risks during mining in heavily deformed ore bodies and rock masses with negative economic indicators are very problematic to be approached with any business processes.

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