

Development profitability classification of mineral deposits for mining industry

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Abstract — Mining industry is a basis for the sustainable economy development of any country. The state mineral resources sufficiency often plays a major role in geopolitics. A development of mineral deposits is inherently associated with a number of risks starting with a non-confirmation of geological research data to price shifts in the global mineral resources markets. Investors, who take these risks also has to deal with not enough justified prices on deposit development licenses, determined by the state government. The presented research is devoted to the development of universal classification of deposits according to a presumed profitability of their development, with an aim of differentiating prices for subsoil use licenses, which is proposed as a mechanism of legal and economic regulation between the state as the owner of subsurface resources and regional subsoil users.

Keywords — *mining industry; legal regulation; mineral resources; profitability; classification; deposit; estimation; financial and legal arrangements*

I. ASSESSING THE MINING PROFITABILITY

Since Russian national economy return to market way it was made a lot to harmonize national terminology of the mineral sector of the economy with the concepts of industrialized countries [1-3]. An audit of mineral resources to assess the feasibility of developing mineral deposits under market conditions was carried out both for individual regions and for the whole Russian Federation state. [4-6].

At present, the investments attraction problem in subsoil use remains one of the most relevant. With large vertically integrated mining companies gradually converted into monopolies, it is becoming harder to compete. At the same time, big-scale companies limit their interest with exclusively large deposits, leaving out its attention to small and even medium-sized mineral deposits. Small companies and individual entrepreneurs, for which development projects of small deposits are economically attractive enough, fear of the risks associated with insufficiently correct assessment of the such deposits profitability. As a result, social and environmental development is suffers.

Meanwhile, it is known that the State and society are very interested in bringing new mines into operation even the profitability of mining is close to zero [7, 8]. Beginning of the deposit development increases the State and regions taxes flow, growing demand and, consequently, the volume of production of mining and other equipment, materials, producing new number of jobs, receiving additional impulses to the building, energy and banking industries. Simply put, the beginning of the deposit development turns into a trigger reviving the economy of the region and, eventually, the nation. The leading economies of the world had already recognized this postulate, and provide effective preferences to companies investing in the development of mineral deposits [9, 10].

Pending the conclusion of a formal agreement with the Ministry of natural resources and ecology or with the Federal Agency for subsoil use, entrepreneur or investor group are participating in the contest, according to which each pretender must present a business plan or a preliminary feasibility study of the development of the proposed deposit. In design organizations, developing feasibility studies of the deposit development are usually guided by internal criteria, including a purely economic indicators (NPV, IRR, etc.), as well as social, resource, and environmental criteria influence of the project. However, a detailed study of the deposits in this case begins on the fact of acquisition of license for subsoil use [11].

Often, entrepreneurs and investors have to rely on private opinion of experts in the field of mining design, so risk of long-term investments mostly depends on personal experience and expertise of involved experts. Such objective and hard with the necessary degree of likelihood predictable risks, as the disconfirmation of geological reserves, discovery adverse mining conditions, complicating the implementation of technological processes, movement major currencies affecting the cost and maintenance of technical equipment are sometimes exclude a positive decision about investing. The successful implementation probability of profitable mine development remains underestimated.

An appropriate evaluation methodology for profitability assess would be able to serve as a basis for the unified classification establishment with the purpose to interest investors both in large and small mineral projects development. Mineral deposits classification must take into account the complex economic, social and environmental criteria for private investors, down to individual entrepreneurs who are ready to develop deposits of small scale, but still attractive for business.

The currently forecast and evaluation of the effectiveness mineral deposits development methodology, accredited by the scientific community and approved by the supervisory authorities in the field of subsoil use, does not exist. At the same time, some industrialized countries shows such examples [12, 13] (in particular, on the most common types of commodities).

II. MINING PROJECTS PROFITABILITY FACTORS EVALUATION

Geological exploration and engineering activities, including drilling, sampling and laboratory analysis of rock samples from different depths, from contact zones between different rock types and geological heterogeneity zones preceded the deposit development usually. Then creation of 3D structural block model of ore body or bodies with subsequent is designed based on received data with programmed content of useful and harmful components in the every block.

Calculation and placing mineral reserves on the State balance is made based on its conditions justification using geological prospecting and exploration data. The structure and properties of the enclosing rocks are entered into the same information deposit model. The best way of deposit development is selected using that model and taking into account the economic potential of involved reserves and the geotechnical conditions. On average cost of this stage is estimated at 10% of a total investment.

Providing a transport access, energy supply systems and, construction of living and working conditions for the enterprise personnel and other mining and construction work precede the beginning of the regular operation and take from 1 to 5 years, and total volume of investments at this period amounts to 30%.

The acquisition of technological equipment, its installation, personnel training and commissioning costs are the most expensive part of the mining production preparation, requiring up to 50% of the initial investment. The remaining 10% are spent mainly on staff salaries, insurance premiums and compensation fees on loans if it is capitally or partly borrowed.

Summing up all the above factors affecting the profitability of mining, one can conclude that a potential license holder must get as full as possible information at the stage of declaring the contest to acquire the license for geological exploration a particular deposit. Investor can compare risks regarding his financial possibilities and decide

about the independent participation in the auction or need in invited co-investors.

The State, as the owner of the subsoil, at present, provides the following information about the deposits or even ore discoveries: name and geographic location, the size of the outlined mineral field, land status, resources quantity (if they are, usually it is a category C_2) and prognostic resources of category P_1 and below (P_2 and P_3). It is supposed that this information is sufficient to explore the deposit area development, to make an initial assessment of the cost of infrastructure, to clarify the status of nearby lands with a view to assessing the possibility of their potential occupation. It is possible to calculate the approximate production volumes and an annual throughput of future enterprise, the number and costs of technological equipment and technical personnel, on the basis of these projections.

In fact, it is the lack of accuracy of calculation proposed mineral reserves and resources makes beginners in subsoil use to make a choice in favor of lease of already explored and exploited deposits, as in the case of disconfirmation of predictive resources volume, license cost and capital investments made now, are non-refundable.

In such a situation, the emphasis in the classification of the deposits on the profitability of mining to be done on the exploration degree, quantity and grade of mineral components, based on statistics from fields analogues of this geological region or on such developments as a whole. For example, if the deposit has an equivalent (i.e. related or similar deposits) in the region, and they were developed successfully and can serve as a source of information needed for the evaluation, the deposit will get index "A". If in this area there are no such deposits, but there is a reason to believe that such deposits are exploited or had previously been in development in other regions, but still can serve as a base for additional information deposit will get index "B". In case the deposit can be considered as a unique one in its kind, it will receive the lowest index "C".

Secondarily, it is necessary to provide an assessment of the deposit remoteness from the main transportation routes and settlements. If deposit is close to transport ways and communications, energy, water and human resources — the deposit will get index "A". If at least one of these factors is unavailable now, the category of deposits is reduced to "B", the field, located in the least utilized areas will receive the index "C".

Thirdly, based on the State interest in socio-economic development of the region, it would be useful to provide a series of guarantees, supports and subsidies in the form of State interest ranking in areas with the highest unemployment rate. Category "A" — the State guarantee refunding of the purchased license if predicted resources are not confirmed. In case the index assigned to the principle of similar deposits, will be equal to or lower than "B", an entrepreneur, taking risks having gaps in information resources, gets a chance to return the funds paid for the license, or purchase benefits for another one. Category "B" in this case will ensure State support and subsidization of wages in the event of a critical fall in world prices of the

commodity or the fall of the ruble in the domestic market. Category "C" will meet the least risky investment with good geological knowledge base or traditionally stable market without requiring additional subsidies.

According to the proposed classification, deposit gets a comprehensive index that will determine the price of the license for its development and the modalities for the participation in the competition for its acquisition, which will systematize deposits profitability and facilitate the adoption of a decision on the participation in the auction to potential users. For example, deposits profitability "AAC" will mean that mine is a typical, mining and geological conditions are studied sufficiently and have counterparts in the region, district is mastered the necessary infrastructure. Additional subsidize is excluded in such a situation.

III. LEGAL AND ECONOMIC MECHANISMS REGULATING THE PRICE ON SUBSOIL USE LICENSES

In order to achieve the ultimate goal of enhancing the investment attractiveness of subsoil use objects and the competitiveness of small regional mining companies the presented classification of the mining profitability is proposed to be taken into account in addition to the declaring the contest to acquire licenses for mining. A part of the licenses cost for small companies and individual entrepreneurs, who won in the auction is proposed to be returned in the form of a tax deduction in the amount corresponding to the *refund ratio* (R) according to profitability of deposits development classification. The refund sum (l_r) of the license total cost (l_{tc}) will be determined by the correspondence (1):

$$l_r = (1-R) l_{tc} \quad (1)$$

Classification of deposits development with a calculated refund ratio are given in the table below.

TABLE I. CLASSIFICATION OF DEPOSITS DEVELOPMENT PROFITABILITY

Classification index	Expanded description	Refund ratio (R)
AAB	There are similar mines in the deposit area; region is well developed; the State has an interest in the development of mining industry	0,0
AAC	There are similar mines in the deposit area; region is well developed; additional subsidization is not provided	0,05
ABB	There are similar mines in the deposit area; region is insufficient developed; the State has an interest in the development of the mining industry and guarantees subsidies in prescribed situations	0,13
ABC	There are similar mines in the deposit area; region is insufficient developed; additional subsidization is not provided	0,15
ACB	There are similar mines in the deposit	0,2

Classification index	Expanded description	Refund ratio (R)
	area, which is not developed enough; the State has an interest in the development of the mining industry and guarantees subsidies in prescribed situations	
ACC	There are similar mines successfully carrying out its operation in the deposit area; region is not developed and it is far away from the administrative centres; additional subsidization is not provided	0,3
BAB	There are no similar mines in the deposit area, but mine is not unique in its kind, the mining technologies are well known; region is developed; the State has an interest in the development of the mining industry and guarantees subsidies in prescribed situations	0,15
BAC	There are no similar mines in the deposit area, but the mining technologies are well known; region is developed; additional subsidization is not provided	0,2
BBA	There are no similar mines in the deposit area, but the mining technologies are successfully tested on other enterprises; region is not developed enough; the State has an interest in the development of the mining industry and assumes the risk of gaps in resources in the amount equal to the license cost	0,15
BBB	There are no similar enterprises in the deposit area, but the mining technologies are successfully tested on other enterprises; region is not developed enough; the State has an interest in the development of the mining industry and and guarantees subsidies in prescribed situations	0,22
BBC	There are no similar mines in the deposit area, but the mining technologies are successfully tested on other enterprises; region is not developed enough; additional subsidization is not provided	0,3
BCA	There are no similar mines in the deposit area, but the mining technologies are successfully tested on other enterprises; region is not developed and it is far away from the administrative centres; the State has an interest in the development of the mining industry and assumes the risk of gaps in resources in the amount equal to the license cost	0,35
BCB	There are no similar mines in the deposit area, but the mining technologies are successfully tested on other enterprises; region is not developed and it is far away from the administrative centres; the State has an interest in the development of the mining industry and guarantees subsidies in prescribed situations	0,4
BCC	There are no similar mines in the deposit area, but the mining	0,5

Classification index	Expanded description	Refund ratio (R)
	technologies are successfully tested on other enterprises; region is not developed and it is far away from the administrative centres; additional subsidization is not provided	
CAB	The deposit has unique mining and geological conditions; region is developed; the State has an interest in the development of the mining industry and guarantees subsidies in prescribed situations	0,35
CAC	The deposit has unique mining and geological conditions; region is developed; additional subsidization is not provided	0,4
CBA	The deposit has unique mining and geological conditions; region is not developed enough; the State has an interest in the development of the mining industry and assumes the risk of gaps in resources in the amount equal to the license cost	0,4
CBB	The deposit has unique mining and geological conditions; region is not developed enough; the State has an interest in the development of the mining industry and guarantees subsidies in prescribed situations	0,42
CBC	The deposit has unique mining and geological conditions; region is not developed enough; additional subsidization is not provided	0,45
CCA	The deposit has unique mining and geological conditions; region is not developed and it is far away from the administrative centres; the State has an interest in the development of the mining industry and assumes the risk of gaps in resources in the amount equal to the license cost	0,5
CCB	The deposit has unique mining and geological conditions; region is not developed and it is far away from the administrative centres; the State has an interest in the development of the mining industry and guarantees subsidies in prescribed situations	0,55
CCC	The deposit has unique mining and geological conditions; region is not developed and it is far away from the administrative centres; additional subsidization is not provided	0,6

IV. CONCLUSION

The following research statements can express the main results of the study:

1) With the beginning of the deposit development the region receives the strongest economic momentum in the construction, energy and banking industries, followed with the increase in the flow of taxes into the region budget and the number of jobs growing. However, not

enough correct estimation of possible exploitation profitability does not allow small companies and private entrepreneurs to assume the risk.

2) In order to attract potential subsoil users in both large and small projects of the mine development it is necessary to provide them with the most complete information about a deposit. Investors need to extent information regarding deposits exploration degree on the basis of statistical data on deposits-analogues in this geological region, the degree of the deposit territory development, the interest and readiness of regional authorities to support entrepreneurs.

3) The suggesting method of assessing the profitability of deposits development allows taking into account complex economic, social and environmental factors to simplify adoption of the decision on the participation in the competition for the license acquisition of subsoil use.

It is no secret that entering the market of natural resources by one's own without the patronage of the officials and support of large amounts of capital is a challenge feasible exclusively for the most tenacious entrepreneurs. It is common in competitions for mining licenses involving front organizations specializing in decoration often-documentary part of the application, doing work with the formal side of the issue for the developing organization. Those companies work for a long time and successfully contributed to the mining business, have no interest in further investments in improving working conditions, development of social sphere and maintaining favorable environmental situation in the region. Thus, the creation and introduction of the deposit development profitability classification, on the one hand, helps to attract a larger number of entrepreneurs in mining, enhancing competition in the naturally mineral resources market and, on the other hand, targeted support and flexible changes in the taxation system to stimulate the potential subsoil users develop an local economy.

The problem discussed in the article tried to be solved by the number of scientists [14]. However, the results are still only attempts to communicate the relevance of the problem until the final decision so far remains to be "on the agenda."

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