Methods of Assessing the Mineral Potential in the Geographic Information Analytical System

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Abstract. This paper discusses the methods of assessing the mineral resource potential in the geo information system. The relevance of the research is justified by the need for comprehensive development of the mineral resource potential of any region, the development of not only balance deposits, but additional exploration and commissioning of those that currently belong to the category of off-balance. In order to assess the economic efficiency of objects of the mineral resource complex, appropriate methodological support is required. Taking into account the uniqueness of a number of deposits, in many cases the only proper method is to search for similar deposits or analogous industrial raw material objects. Calculations for similar objects can be used to assess the prospects of objects of the mineral resource base in conditions of insufficient information or lack of it necessary for the use of other calculation methods, which determined the purpose of this paper. The work is carried out with the financial support of the grant of the President of the Russian Federation no. MD-2409.2020.5.

1. Introduction

According to the methodology of the European Union Statistical Agency, national wealth represents the total value of all economic assets (non-financial and financial) at market prices. Mineral resources, along with water and natural biological resources, are non-financial material (non-productive) assets that are subject to assessment as a part of the national wealth of Bryansk region and Russia as a whole. Non-financial economic assets in relation to the mineral resource potential in accordance with the classification of Goskomstat (Russian State Statistics Committee) are divided into explored and pre-estimated reserves of mineral deposits located on the surface or in the earth interior, from an economic point of view, suitable for exploitation. Mineral reserves (A+B+C1+C2 categories) are mineral wealth, the value of which is determined by monetary valuation.

2. Theoretical part

The approaches to understand the definition of "mineral resource potential", methods of its assessment, the essence and economic significance in modern conditions are studied in [1-27].

The mineral resource potential (MRP) refers to the aggregate of mineral resources available for human involvement in economic activities with modern technical and socio-economic capabilities of society. MRP includes explored balance mineral reserves and reserves not accounted for by the state balance. Economically assessed mineral resource potential in the administrative and territorial aspect is a part of the national wealth.
In general, we suggest calculating MRP as gross potential value of mineral reserves using the formula (1).

\[ MSPV = C \times P \]  

(1),

where:
- \( MSPV \) - mineral resource potential, as gross potential value, million roubles.
- \( C \) – unit price of \( i \) – mineral resource products, roubles.
- \( P \) - amount of reserves or forecast mineral resources.

MRP as an extractable potential value of minerals is adjusted using the coefficient of total recovery of useful components from the earth interior to the first commercial product.

The mineral resource potential allows to give a general cost idea of the mineral resource value of the territory in question in comparison with others and allows to choose priority areas of geological research for certain types of minerals.

3. Practical part

When using data of similar mining enterprises, the amount of capital investment is adjusted to take into account the difference in productivity while developing the estimated field and the analogous enterprise using the ratio (2).

\[ \frac{K_1}{K_2} = \left( \frac{P_1}{P_2} \right)^{0.6} \]  

(2),

where:
- \( K_1 \) is capital investment according to technical and economic point of view,
- \( K_2 \) is capital investment in the calculation,
- \( P_1 \) is productivity according to technical and economic point of view,
- \( P_2 \) is productivity of the estimated deposit in the calculation.

If the productivity of the analogous enterprise \( (P_1) \) differs significantly from the productivity of the estimated deposit \( (P_2) \), the dependence (3) is used to determine the specific exploitation costs.

\[ \frac{P_1 \times C_1}{P_2 \times C_2} = \left( \frac{P_1}{P_2} \right)^{0.6} \]  

(3),

where:
- \( C_1 \) and \( C_2 \) are unit costs of an analogous enterprise and an estimated deposit.

Prices for finished products sold by mining enterprises are accepted by the actual sales market for similar types of products at the moment, excluding value-added tax.

In addition to the standard ones, indicators are also calculated that characterize the efficiency of mining:
- investment potential (the amount of capital investment in additional exploration and development of deposits);
- tax potential (the amount of taxes that should be received annually by the state from the subsoil users).

The calculation of integral indicators is performed using a geo-information analytical system (GIAS), where the necessary computational and search procedures are implemented in the embedded macro language of the system.

To assess the investment attractiveness of the mineral resource base of the region, calculations of the investment potential were made.

Investment potential is measured by the amount of necessary capital investment in the development of deposits. It is determined by the deposits, which got licenses for the development or applications for
their acquisition, and fields prepared for development, which investment attractiveness is not questioned, including developed fields that require reconstruction.

The investment potential of the region consists of the amount of capital investment of reserve deposits, which were geologically and economically assessed proving their feasibility. The sources of investment potential determination were calculations of the Russian Institute of Mineral Resources Economy based on the enlarged geological and economic assessment of 11 reserve subsoil use objects.

For the purpose of drawing up a geological and economic map, the industrial significance of the largest previously explored mineral deposits in the State reserve was re-evaluated.

The calculations of geological and economic indicators of deposits are based on the most reliable indicators in modern conditions: approved reserves listed on the balance sheet, prices for mineral raw materials of the 1st commodity conversion, averaged coefficients of end-to-end extraction of mineral raw materials into a commodity product.

The following data is provided for each deposit:
1. General information on the mineral resource base and use of mineral resources of this deposit.
2. Geological characteristics of the deposit: location, degree of study, geological structure, stratigraphy and lithology of the productive strata, site reserves, by whom and when they were approved, hydrogeological conditions.
3. Qualitative characteristics of the minerals: physical, mechanical and chemical properties, results of technological and semi-factory tests, enrichment, suitability, industry requirements for the quality of mineral raw materials.
4. Mining conditions of the deposit: mining system, priority of sites, method of drainage of the productive layer.
5. Main technical and economic indicators of deposit development: complete calculations of technical and economic indicators for this geological and economic assessment.

Valuation of the mineral potential includes the following indicators:
- potential recoverable value of balance stocks not listed on the balance sheet is defined as the product of stocks and the selling price of the mineral, adjusted for the end-to-end coefficient of extraction of useful component from the subsoil;
- real recoverable value of the balance sheet reserves is defined as the difference between the potential recoverable value of the balance sheet reserves and the amount of operating costs;
- specific value of mineral resources was calculated per 1 km of square, by dividing the potential recoverable values of the balance sheet and not listed on the balance sheet reserves in the area or administrative areas.

The ranking of MRP value indicators was performed by the following taxa:
- areal (territory of the region → administrative territorial divisions (districts). Indicators of mineral resource potential were calculated for each administrative district and the region as a whole;
- thematic (types of minerals). The calculation included all types of mineral resources explored in the territory of the region in categories A+B+C1+C2 (accounted for and not accounted for by the State balance sheet).

4. Conclusions
Thus, for the assessment of mineral resource potential there has been estimated the value of major minerals in general for the region and their distribution across administrative regions, determined the proportion of minerals in the mineral potential of the region and CFD, calculated potential recoverable, real and specific value of mineral reserves in the subsoil area.

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