Technique of Determination of Commodity Cost of a Subsoil on the Basis of Calculation of Mineral and Raw Potential of Expected Resources

V S Dadykin¹, M N Okhlopkov², T M Gerashchenkova³

¹Department of Economics, Organization of Production, Management, FSBEI HPE BSTU, 7, 50 let Oktyabrya bul., Bryansk, 241035
²Yakut Scientific Center SB RAS, Sakha (Yakutia) Republic, city of Yakutsk, Petrovskogo St., 2, 677000
³Department of Computer technologies and systems, FSBEI HPE BSTU, 7, 50 let Oktyabrya bul., Bryansk, 241035

E-mail: dadykin88@bk.ru

Abstract. Exploration and mining are logically interrelated. Currently, it is not necessary to carry out the work on reproducing the entire available mineral resource base, but only its cost-effective part. For forming investment projects it is required to assess the mineral resource potential of the territory. Calculating the mineral resource potential (MRP) typically includes data on reserves of deposits, estimated resources, the cost of subsoil and coefficients of bringing forecast resources to contingent reserves. The issues of a comprehensive study of the mineral and raw material potential from the point of view of a systematic approach, the efficiency of the mineral and raw material complex in the process of subsoil use, taking into account the specificity of solid minerals, are not well understood and require their scientific substantiation.

1. Introduction

The main result of the exploration process is the increase in proven reserves and the volume of localized forecast resources. The resultant indicator of developing the mining industry is the output of final commodity products. Exploration and mining are logically interrelated. Volumes of output of mining commodity products are calculated from the condition of satisfying the country's need (taking into account export-import volumes) in mineral raw materials, based on the subsoil ability to satisfy the intended need.

The forecast production volumes of commodity mining products under the chosen scenario of the mining industry development are calculated on the basis of industrial raw material facilities and industrial raw material sites.

The volume of investment in mining enterprises is accepted according to the feasibility studies of conditions, feasibility reports and business plans of developing deposits or is calculated according to aggregate standards using the method of analogies.

Investments in the mining industry are accepted, according to the data of the respective companies. At the same time, the mining and industrial complex refers to a production and economic system that is being formed on the territory of one or several geological and economic regions, the basic elements...
of which are processing enterprises of various industries that provide for manufacturing products of the secondary mineral processing, as well as having infrastructure facilities that provide manufacture and transportation of the received commodity products to the final consumer (including foreign one). At the same time, the centres for manufacturing secondary goods processing can be located within the limits of other subjects of federal districts.

2. Relevance
Calculating the mineral resource potential (MRP) typically includes data on deposit reserves, estimated resources, the subsoil cost and coefficients of bringing forecast resources to contingent reserves [4,5,7,8,10,11,13].

A.Ya. Kats, S.A. Kimelman, N.K. Nikitina and others [1,2,3,6,9,12,17] suggest calculating the value of the total mineral and raw material potential, which includes the valuation of balance reserves of categories A + B + C1 + C2 and forecast resources of subsoil use objects (fields and forecast areas) of various prospect degree. At the same time, the forecast resources of categories P1, P2, and P3 should first be brought to reserves (reliability of reserves) of category C2 by applying appropriate coefficients.

In our opinion, it is necessary to supplement the methodology for determining the commodity value of the subsoil based on calculating the mineral and raw material potential of the forecast resources.

3. Formulation of the problem
The issues of a comprehensive study of the mineral and raw material potential from the point of view of a systematic approach, the efficiency of the mineral and raw material complex in the process of subsoil use, taking into account the specificity of solid minerals, are not well understood and require their scientific substantiation.

4. Theoretical part
The required growth of proven reserves and the volume of localized forecast resources for the selected scenario of developing the mining industry are calculated by individual industrial raw material facilities and industrial raw material sites. Summing the increase in reserves and the volume of localized forecast resources gives the total volume of reserves and resources by a geological and economic region [14,15]. The amount of growth in reserves and localized resources in the territory of a constituent entity of the Russian Federation is determined by their summation over geological and economic regions and individual industrial and raw material sites that are not included in any geological and economic region selected within the subject of the Russian Federation.

The necessary costs for obtaining the projected growth of proven reserves and the volume of localized forecast resources are usually calculated in an integrated way, based on the unit cost of 1 ton of reserves and 1 ton of forecast resources established for the retrospective period [16,18]. The calculation is carried out for individual sections of the subsoil and industrial raw materials sites. Essentially the estimated costs for geological exploration works (GEW) are allocated at the expense of the federal budget.

Subsoil value for the initial T year of forecasting by the region (subject of the Russian Federation) is characterized by the national wealth of the subsoil and the commodity value of the reserves and forecast resources.

There are four levels of national wealth:

The mineral resource potential of the subsoil is the value (recoverable value) of balance and off-balance reserves of categories A + B + C1 + C2, taken into account by the state balance and forecast reserves (prospective resources) of category P1 (C3) approved by the Ministry of Natural Resources of Russia, and forecast localized resources of category P2 (D1) considering the probability of transferring prospective and forecast resources to reserves of category C2, in prices as of the valuation date [19].

Potential national wealth of the subsoil represents the value of recoverable balance and off-balance proven reserves of categories A+B+C1+C2, taken into account by the State Balance of Reserves (SBR)
and the part of recorded prospective resources of category P1 (C3), the potential exploitation of which provides the level of internal rate of return (IRR) more than 15%, considering the probability of transferring projected reserves (prospective resources) of category P1 (C3) into reserves of category C2, as well as taking into account the dilution factor and end-to-end extraction in prices as of the valuation date [20].

The national wealth of the subsoil is calculated as the value of the residual recoverable balance sheet, including those that are promptly registered by the State Commission on Reserves (SCR) of categories A+B+C1+C2 adjusted by dilution factors and end-to-end extraction, in prices as of the assessment date.

Demanded national wealth of the subsoil represents the value of residual recoverable reserves of categories A+B+C1+C2 of exploited deposits or their parts, taking into account the dilution and end-to-end extraction factors, in prices as of the valuation date.

At the same time, the upper possible limit of the national wealth of the subsoil is the mineral and raw material potential, which is the maximum potential of the subsoil, provided that the necessary volumes of research and geological exploration works and transfer of promising (P1) and forecast localized (P2) resources to proven mineral reserves (MR) are completed. The “minimum national wealth of the subsoil” is the minimum bar for assessing national wealth, which essentially reflects the real national wealth of the subsoil of Russia and it is demanded by the national economy of Russia, taking into account the satisfaction of both the domestic needs of the country and its imports abroad.

5. Results of experimental studies

The commodity value of the subsoil is understood as the share of forecast resources and reserves in the value of final raw materials.

The commodity value of the subsoil (Vt) is proposed to be calculated according to the formula (1):

\[ V_t = P \times M \times C_e \times C_t \times S_v \]  

(1)

where: P is the unit price of the final product (metal, chemical compound, mineral, ore, concentrates);

M is the mass (quantity) of forecast resources or reserves of raw material of this category (t, m³, kg, g);

C_e is the coefficient of end-to-end extraction of this type of component, unit fraction;

C_t is the coefficient of transfer of forecast resources and previously estimated reserves into proven reserves, shares, units;

S_v is the share in the value (price) of the final product attributable to the value (price) of the estimated resources or reserves of this category, share, unit.

The coefficients are taken according to the “Uniform requirements for the creation, scale, order and rules for preparing specialized geological and economic maps and atlases of the national wealth of the subsoil of federal districts and the Russian Federation as a whole”.

To calculate the investment potential, depending on the ratio of the total number of reserves and forecast resources, given to the explored reserves, it is proposed to use the formula (2).

\[ Inv = Q_{zap_{pr}}^{sum} \times K_z \times P_{ed} \times K_0^{levl} + Z_{grr} \]  

(2)

where: Q_{zap_{pr}}^{sum} is the total amount of reserves and forecast resources, given to the explored reserves, units. of meas.; Z_{grr} is the cost of GEW (prospecting, evaluation, exploration), mln. rub.; K_z is the factor of accounting for current and capital expenditures in the price of the first commercial product, %; P_{ed} is the unit price of the first commercial product, rub.; K_0^{levl} is the coefficient of end-to-end extraction of MR for the initial year of forecasting, %.

As a result of applying the author's methodology, it was possible to calculate the mineral and raw material potential of the reserves of deposits and forecast resources in the territory of the Republic of Sakha (Yakutia), having conducted geological and economic zoning of the territory.

The geological and economic zones (GEZ) of the Republic are divided into the following groups:
The first includes the most developed Aldan and Verkhnelenskaya GEZ, the exploitation of high-value and highly liquid mineral deposits (diamonds and gold) on the territory of which allowed to begin to identify and successfully develop in the Republic the necessary fuel and energy resources and such important types of the mineral raw materials as iron ores. The mining of fuel and energy resources and mineral raw materials allows the Republic’s economy to be brought to a new qualitative level and creates conditions for carrying out GEZ aimed at identifying and developing exploration of numerous types of minerals necessary for the needs of the construction industry and agriculture, as well as for exports to other regions. This group is adjoined by an economically equipped Srednelenskaya geological and economic zone, the identified fuel and energy resources of which will make it possible to successfully develop the energy sectors of the economy, industry, agriculture, transport construction and to create social infrastructure;

the second group includes the Yanskaya and Verkhneindigirskaya GEZ, which are rich in deposits and highly promising objects of precious and valuable non-ferrous metals; the considerable remoteness from the developed regions of the Republic and the very weak transport infrastructure make it possible to develop mainly the extraction of precious metals; the expansion of tin and antimony mining, as well as the commencement of developing copper, tungsten and polymetallic deposits largely depends on the market conditions of these metals and on coordinating efforts of the subjects of the Far Eastern Federal District (Magadan Region and Khabarovsky Territory) in geological exploration and industrial development of adjacent territories rich in mineral resources;

the third group includes the Indigirskaya, Kolyma and Anabar GEZ, which are characterized by their very weak economic development due to their location in the subarctic zone, which makes it possible to exploit mainly the few rich placer deposits of diamonds and gold, as well as coal deposits for their own needs; the economic potential created on this basis is not yet conducive to maintaining more active GEW to expand the mineral resource base.

6. Conclusions
The potential gross value of the balance reserves of the main types of minerals as of 01.01.2018 is 89863.5 billion rubles, the cost of potentially recoverable balance reserves is 64029.9 billion rubles. "Active" mineral reserves amount to 67,103.4 billion rubles, and "active" recoverable reserves amount to 47,574.7 billion rubles. By implementing the forecast resources, the gross value of the subsoil may increase to 576,184.3 billion rubles.

Taking into account the economic efficiency of developing the mineral and raw material potential, the minerals of the Republic of Sakha (Yakutia) are divided into the following groups according to the degree of demand:

1) demanded minerals that are currently being developed (oil, natural gas, condensate, diamonds, gold, silver, coal, tin, antimony, tungsten, gypsum and anhydrite, building materials);
2) potentially demanded minerals that are the minerals the mining of which can begin in the next 10-15 years (lead, zinc, uranium, iron ore, apatite, graphite);
3) non-demanded minerals that are minerals the mining of which is unlikely to begin in the next 10-15 years for various reasons (mercury, common rock salt).

The investment potential of developing the raw-materials base of the main mineral resources of the republic for the next 8-10 years is estimated at 673 billion rubles. The mineral and raw material potential of the Republic of Sakha (Yakutia), considering all the negative trends of recent years, remains extremely high and with harmonious development it can meet the needs of the economy of the region and Russia as a whole in many types of minerals.

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