Forming an Information System for Assessing Mineral Resource Availability for Enterprises

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Abstract. Forming an information system for assessing mineral resource availability for enterprises is currently of particular relevance due to the necessity to provide a number of industrial enterprises with proven mineral reserves for the prospect of the licensed period of the field exploitation. An exploration enterprise in the course of its operation is subject to influencing various factors, which can be conditionally divided into the controlled and the uncontrolled ones. The first group includes such factors as economic and technical-technological factors. The second group includes natural, socio-demographic and ecological ones. The author carries out the controlled factor simulation as a part of the management system model of a geological exploration enterprise to determine the principles of managing the system and factors affecting the state of the controlled object represented by this enterprise. In this paper, the authors design the management system of a geological exploration enterprise and evaluate the influence of the environmental factors on the system. When determining the prospects, the criteria of infrastructural (availability of road communication) and resource (human, technical, technological, financial resources) availability during the field exploration were also considered. As a result, an information system for assessing mineral resource availability for enterprises was formed as a set of indicators for assessing the availability. This work was supported by the grant given by the President of the Russian Federation No. MD-2409.2020.5.

1. Introduction

It should be noted that a significant part of geological exploration enterprises have now ceased to exist due to their unwillingness to work in the new economic conditions, where external economic factors prevail. Indeed, the previously existing system with the state planned distribution of geological exploration to geological prospecting parties and then to exploration enterprises, which are part of them, is currently not functioning. [3].

Exploration enterprises have found themselves in new working conditions, when, in order to fulfil their production programme, it is necessary for the minerals-consuming enterprises to independently search for orders to carry out their geological exploration.

At the same time, the strategy for the geological industry development until 2030 [5-9] has been adopted at the state level, which implies the obligation to carry out geological studies of the subsoil and mineral resource replenishment. Within the framework of the strategy, there is also a state program [1] aimed at carrying out geological exploration for replenishing and incrementing mineral reserves.
However, at the regional level, this strategy is practically not supported by the regional industry needs, and, as a rule, there are no mechanisms for its implementation by the local geological exploration industry due to the lack of demand on the part of enterprises for growing these raw material types. [2].

Geological exploration enterprises in the current economic conditions need to fill the resulting deficit, on the one hand, by forming a system for forecasting the enterprise needs in mineral resources using the developed methodology and, on the other hand, by developing a methodology for forming a portfolio of projects for geological exploration of subsoil and mineral resource replenishment [4,11,15-18].

It is possible to solve these problems associated with creating appropriate methods, relying on the management system model for a geological exploration enterprise.

2. Theoretical part

While working a decision-maker in a geological exploration enterprise should rely on the federal programmes and strategy in terms of the programme indicators for geological exploration of subsoil and mineral resource replenishment, which give a setting influence. As a part of the management system model for a geological exploration enterprise, the authors will consider it as an executive device (ED). Then, the ED as a part of the system model, based on the software product presented by the decision support system “Projects for the geological study of subsoil and mineral resource replenishment” (DSS “Projects of GSS and MRR”), forms a controlling effect on the controlled object represented by the enterprise production programme.

The production programme is formed based on calculating in the region the needs of the enterprises that consume the types of mineral resources for which it is necessary to ensure an increase in reserves.

After influencing the controlled object (geological prospecting company), it goes into a new state, because the volume of mineral reserves in the course of the enterprise work inevitably changes either upward or downward. At the same time, there are environmental factors such as other subsoil users’ work, which inevitably affect the reserves. Therefore, already at the output of the controlled object, a negative feedback is formed, which is expressed in emerging a deviation from the value specified by the federal programme or regional programme, which must be corrected within the framework of the enterprise production programme.

From the management theory viewpoint, this control principle is based on using the feedback principle, which forms a closed loop of control. Applying this principle allows maintaining the management system in a given state, exclusive of forming the resource and deposit reserve shortage.

3. Practical part

It is proposed to use the following block of indicators presented in Table 1 to assess the external environment impact on the part of other enterprises – subsoil users.

Table 1. Indicators of the assessment block (AB) of the external environment condition as a result of functioning enterprises – subsoil users.

| Code | Indicator | Unit of measurement | Designation | Formula calculation / data source |
|------|-----------|---------------------|-------------|----------------------------------|
| 1.1. | Proven reserve availability deficit year | O_{def} | O_{def} = O_{des} - O_N |
| 1.2. | Availability of active reserves (design level of depletion) year | O_{des} | O_{des} = Q_A - D |
| 1.2.1. | Average annual extraction volume foreseen by the field development project ton | A | Feasibility study of conditions for a specific field |
1.2.2. Average annual depletion volume foreseen by the field development project

\[ D = A \frac{1-r}{1-p} \]

1.3. Regulatory availability year \( O_N \)

Normative acts. Existing dynamics of extraction.

1.4. Increase in proven reserves of the category \( A + B + C_1 \), required to fill the reserve deficit

\[ Q_{\text{def}} = Z + D \times t \]

1.5. Deficit of active reserves ton \( Z \)

\[ Z = O_{\text{def}} \times D \]

1.6. Mineral resource deposit implementation time year \( t \)

Depending on the stage of the object study and the degree of its industrial development mineral resource deposit implementation time includes the terms of prospecting, evaluation, exploration, design and construction.

Based on the indicator system proposed in the management system model of a geological exploration company, the authors will assess the external environment impact, relative to the subsoil users in the Central Federal District territory, applied to the mineral resource base of refractory clays used in producing facade ceramics, sewer pipes, acid-resistant bricks, additives to the feed for ceramic bricks, etc. [4].

The results of calculating the reserve availability and deficiency indicators 1.3-1.5 in individual enterprises-subsoil users in the AB model are shown in table 2.

**Table 2. Indicators of the reserve availability and deficiency 1.3-1.5 in the AB model.**

| Type of commercial product | 2019 (factual) | 2021 (assessment) | 2025 (forecast) |
|----------------------------|----------------|--------------------|-----------------|
| The CFD need for raw materials, thousand tons | Product of raw materials, thousand tons | Deman d balance | The CFD need for raw materials, thousand tons | Production of raw materials, thousand tons | Balance, thousand tons |
| Ceramic products, total, including | 1993,3 | 1066 | -927,3 | 1600 | 1535 | -456 | 2450 | 2450 | 0 |
| Ceramic tile, total, incl. | 1495,7 | | | 1200 | | | 1838 | |
| -wall tile | 416,5 | | | 335 | | | 512 | |
| -floor tile | 1067,6 | | | 855 | | | 1312 | |
Thus, according to the analyzed enterprises in the Central Federal District territory, it is advisable to establish exploration to eliminate the existing deficit by 2025. To solve this problem, it is necessary to organize geological prospecting for the required types of raw materials to extend the field, or to carry out other geological exploration.

4. Conclusion

Thus, the work has analyzed an exploration enterprise, as a controlled object from the viewpoint of the management theory in the economic and social systems. The author has built a management system model of the geological exploration company and analyzed the external environment effect on the model under consideration. As a result, indicators are selected, which allow characterizing the external environment and influencing the decision-making subsystem through the principle of compensation. Using the example of refractory clay deposits on the Central Federal District territory, testing of resources is made, consequently indicators of the deficit in the analyzed enterprises of the Central Federal District are set. To eliminate the shortage it is necessary to carry out geological exploration work in the resulting deficit volume to liquidate it.

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