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Rating Assessment of the Potential of Extractive Industry Resources in the Economic Zones of the Republic of Sakha (Yakutia)

V V Nikiforova¹

¹North-Eastern Federal University, Yakutsk, Russia

E-mail: nikvalentina2010@yandex.ru

Abstract. Spatially, the territorial structure of the Republic of Sakha (Yakutia) economy is divided into five economic zones: Central, Western, Southern, Eastern and Arctic zones, on whose territories there are many mineral deposits that are unevenly explored and involved in economic turnover. The article presents a quantitative integrated assessment of the potential of extractive industry resources in the economic zones. The assessment was performed using a point rating system with weighting factors determined by the expert evaluation method based on resource importance and taking into account the importance of each resource type in the region's economy. It has been revealed that the main factors that influence on the potential of extractive industry resources, along with transport and energy infrastructures, are exploration immaturity of deposits, quality of ores, low content of mineral resources, as well as market conditions. In this regard, to improve the ranking of an economic zone, it is recommended to carry out exploration and appraisal activities in economic zones, which need for a strong government support not only in funding, but also in regulation.

1. Economic zones of the Republic of Sakha (Yakutia)

A complex structural organization and a combination of potentials of natural and climatic, territorial and sectoral, settlement and production resources are characteristic of territory of the Republic of Sakha (Yakutia). This regionalization is caused by the social and economic differentiation of rather developed and poorly developed areas, specifics of territories where indigenous minorities live, underdevelopment or absence of road and other infrastructures.

Spatially, the territorial structure of the Republic's economy consists of municipal areas united in five economic zones: Central, Western, Southern, Eastern and Arctic (Table 1). [1] All the economic zones are large territorial entities that have a different administrative and territorial identity; transport and energy infrastructures; a clear economic specialization based on using favourable natural, social and economic conditions of the territory; a geographical proximity; general economic, social and cultural relations; similarity of natural and climatic conditions. The formation of large spatial structures is caused by the implementation of long-term investment projects for inter-regional and inter-municipal cooperation.



Table 1. Economic zones of the Republic of Sakha (Yakutia).

No.	Economic zone	Municipal areas
1.	Central zone	Urban districts "city of Yakutsk" and "settlement of Zhatai", Gorny, Kobyaysky, Megino-Kangalassky, Namsky, Tatinsky, Ust-Aldansky, Khanga-lassky, Churapchinsky
2.	Western zone	Lensky, Mirninsky, Olek-minsky, Vilyuysky, Verkhnevi-lyuysky, Nyurbinsky, Suntarsky
3.	Eastern zone	Tomponsky, Ust-Maysky, Oymyakonsky
4.	Southern zone	Neryungrinsky and Aldansky
5.	Arctic zone	Abysky, Allaikhovsky, Anabarsky, Bulunsky, Verkhneko-lymsky, Verkhoyansky, Zhigansky, Momsky, Nizhneko-lymsky, Oleneksky, Sredneko-lymsky, Ust-Yansky, Eveno-Bytantaysky

Source: [1].

Works of many foreign and domestic scientists concern the economic assessment of the potential of natural resources:

- Foreign scientists explore issues concerning the presence and depletion of mineral resources in Europe and America, particularly, in the Nordic countries – Canada and Norway. They propose different approaches to assessing the potential, taking into account criticality, strategic importance, economic, social and environmental factors, availability of extracted mineral resources, etc. The combination of these factors suggests that, although the Earth's upper crust has a fixed geological resource, the share of this geological resource, which is available for use by the society, ultimately depends on the technology, economic relations and ever-changing market conditions. Therefore, there is a great uncertainty in assessments of the mineral resources potential; [2, 3, 4]

- Methodical and methodological basis for assessing the potential of primary natural resources of Siberia and the Far East are reflected in works of the domestic researchers V. V. Balashenko, M. N. Ignatyeva, D. A. Durdueva, V. A. Kryukov, I. Yu. Novoselov, A. V. Neverov, A. A. Kostylev, O. V. Ivanova, V. N. Gerasimovich, etc.; [5, 6, 7, 8, 9, 10, 11, 12]

- The specifics of subsurface management in the North and territorial aspects of the development of raw material economy are discussed in works of E. I. Yefremov, R. R. Nogovitsyn, V. V. Nikiforova, N. S. Batugina, V. R. Gryaznukhina-Stepanova, etc. [13, 14, 15]

The studies of the potential of raw material resources mainly emphasise the cost estimate of a certain deposit or an individual type of mineral resources. As you know, the territory of the Republic of Sakha (Yakutia) has deposits of quite varied mineral resources. Currently, only deposits of readily available mineral resources, such as diamonds, oil, gas, coal and gold, in the Western and Southern economic zones are being developed. Other mineral deposits of equal importance in the Eastern and Arctic zones are underexplored and mainly located in the unallotted subsoil reserve fund. Consequently, a comprehensive assessment of the potential of extractive industry resources in these economic zones is of great relevance.

2. Methods for integrated assessment of the potential of extractive industry resources

This article has assessed the potential of extractive industry resources using the method to calculate an integral index based on the ranking of indicators characterizing quantitative indicators of the potential of extractive industry resources. The integrated assessment in points is calculated based on methods of scientific investigation aimed at identifying the relative importance of indicator groups to assess the importance of individual indicators within the group. The main database for assessing the modern potential of the extractive industry resources is the State Register of Mineral Reserves of the Republic of Sakha (Yakutia). [16, 17, 18, 19, 20, 21] The study subject is mineral resources located in the economic zones of the Republic of Sakha (Yakutia).

Stages of the integrated assessment of the potential of extractive industry resources are as follows:

1. The proportional factor (k_i) is calculated. It is a share of the i th mineral reserves by the category $A+B+C1+C2$ in the municipal area (Z_i) of the total reserves of this mineral in the Republic of Sakha (Yakutia) (Z_{IRS}) with the assignment of the weighting factors (ω_i):

$$k_i = \frac{Z_i}{Z_{IRS}} * \omega_i \quad (1);$$

2. To bring indicators of different mineral resources to a uniform measurement system, we normalize the factors using the formula:

$$k_{ij}^N = \frac{k_{ij} - \min(k_{ij})}{\max(k_{ij}) - \min(k_{ij})} \quad (2);$$

3. We obtain the integral index of the potential of extractive industry resources in the municipal area (I_{iMO}) using the average value of the normalized factors (k_{ij}^N):

$$I_{iMA} = \frac{\sum_{j=1}^m k_{ij}^N}{m} \quad (3);$$

4. We calculate the generalizing index of the potential of extractive industry resources in the economic zone (I_{EZ}) as a sum of the integral indexes of municipal entities entering this economic zone:

$$I_{EZ} = \sum_{i=1}^n I_{iMA} \quad (4)$$

5. For a more correct assessment of the extractive industry potential, we assign the reserves of mineral resources with the weighting factors (ω_i), which are determined by the expert evaluation method with distribution to groups based on the mineral importance for the region's economy (Table 2).

Table 2. Weighting factors for calculating the potential of extractive industry resources.

Group	ω_i	Criteria
I	0.60	Mineral resources, which have the largest share in the structure of the region's industrial production
II	0.25	Mineral resources, deposits of which are being developed or prepared for development
III	0.10	Minerals, deposits of which are planned to be developed in the future
IV	0.05	Non-metallic minerals for use within the Republic
	1.00	

3. Rating assessment of the potential of extractive industry resources in municipal entities

Applying the above method, we calculate the potential of extractive industry resources for municipal entities of the Republic according to the State Register of Mineral Reserves of the Republic of Sakha (Yakutia) as of January 01, 2017 by the category $A+B+C1+C2$. The Aldansky area is at the top of the municipal entities ranking (10 points); the Lensky area takes second place (9.91); the Mirninsky area is in third place (8.75); the Neryungrinsky area is in fourth place (7.23). The Verkhoyansky, Nyurbinsk-

sky, Oleneksky, Suntarsky, Tomponsky, Ust-Maysky, Ust-Yansky areas – where there are deposits of gold, diamonds, coal – lie above the average value throughout the Republic (1.85), some municipal areas of the Arctic economic zone and all areas of the Central economic zone have values below the average (Figure 1).

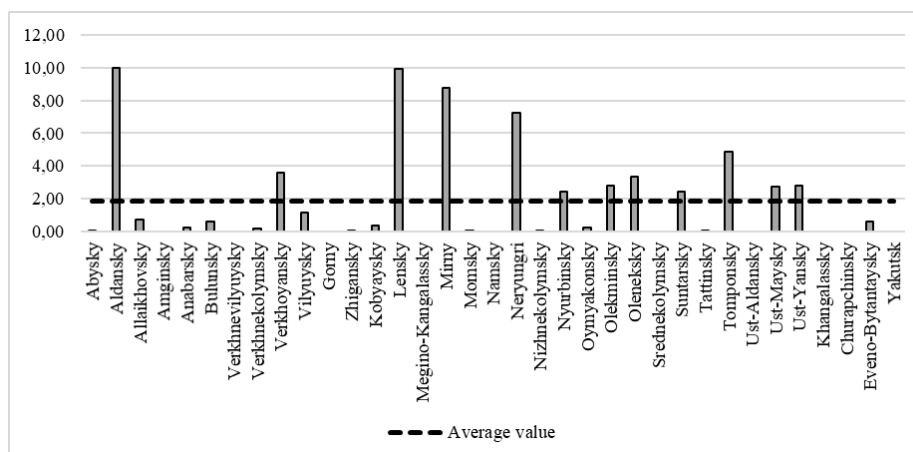


Figure 1. Rating assessment of the current potential of the extractive industry resources in municipal areas of the Republic of Sakha (Yakutia), 2016 (calculated using a scale from one to ten).

The rating assessment of the extractive industry potential in the economic zones of the Republic of Sakha (Yakutia) for 2006–2016 shows the leadership of the Western economic zone, the Southern zone takes second place, the Arctic zone is in third place, the Eastern zone goes fourth, and the Central zone is the last. With that, the Eastern zone demonstrates a clear upward trend, while the Southern and Arctic zones show downward trends. The Western and Central economic zones make a small shift upwards (Figure 2).

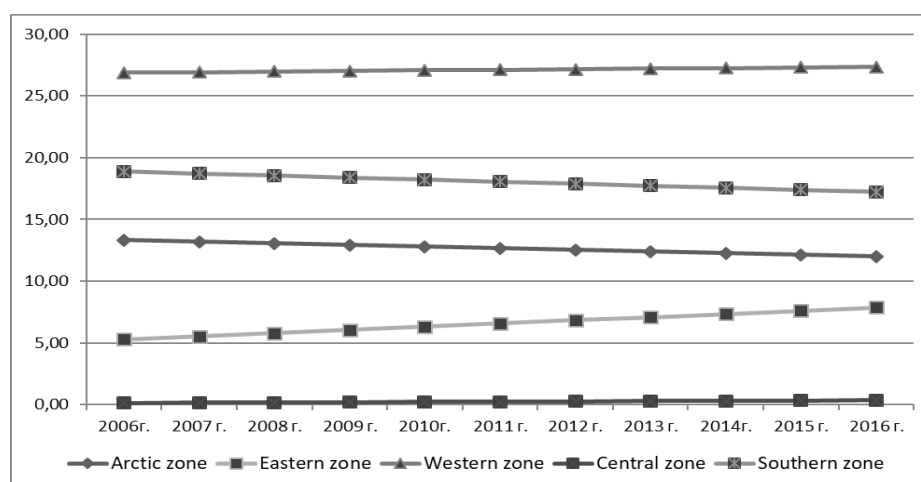


Figure 2. Comparative dynamics of the potential of extractive industry resources in economic zones of the Republic of Sakha for 2006–2016 (calculated using the sum of municipal entities' points).

Thus, the integrated assessment of the potential of extractive industry resources has showed high ratings of the Western and Southern economic zones, which have reserves of readily available resources such as oil, gas, diamonds, gold and coal. The decline in the Southern zone's potential suggests the ongoing depletion of alluvial gold reserves, while the decline in the Southern zone suggests exploration and appraisal immaturity due to the absence of transport and energy infrastructures. The

Eastern zone, where there are large Nezhdaninskoe ore gold deposit and Verkhne-Menkechenskoye silver and complex deposit, holds great promise.

In general, the Republic of Sakha (Yakutia) has a high potential of mineral and raw material as well as fuel and energy resources. Consequently, there are high prospects for social and economic development of its administrative territories that requires an innovative approach to the development of mineral resources, for example, a cluster approach, which is achieved by consolidating efforts of interested economic entities seeking to increase competitiveness and obtain the synergy effect. In addition, the public authorities should grant favourable preferences, taking into account the regional northern specifics.

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