

Methodological Approaches to the Assessment of Spatial Differentiation of the Basic Sectors of Subsoil Use of the Republic of Sakha (Yakutia)

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Abstract. The Republic of Sakha (Yakutia) is a major raw-material region of Russia. Large deposits of diamonds, gold and hydrocarbons are concentrated on the territory. The paper studies the territorial location of mineral resource and production potentials of the basic subsurface management sectors (oil and gas production, as well as diamond, gold and coal mining industries). The mining industry potential in the municipal districts of the region is comprehensively rated by using the method of integrated assessment on a ten-point scale. The assessment identified four local zones of development and location of subsurface management sectors: Arctic, Western, Southern and Eastern; which will allow creating territorial and sectoral clusters in the region in the future, providing the concentration of organizational and managerial efforts and the rational involvement of financial resources. The results of this study can be applied in the strategic planning of socio-economic development of local zones and municipal districts of the republic.

1. Introduction

Currently, the scientific community raises theoretical and practical questions regarding infrastructure development of territories more frequently. In resource regions, it is particularly important and reasonable to identify the development of an infrastructure, which has a greater influence on the economic efficiency of the spatial location of industrial enterprises mining and processing natural resources and which is designed to ensure the achievement of strategic goals for socio-economic development of the country, as a strategic priority. (E. E. Savchenko, 2018). According to V. A. Kryukov, A. E. Sevastyanova et alii, "under the new conditions in relation to resource regions, it is necessary to focus on the aspects of an expanded specific understanding of inclusiveness, which implies the possibility of active participation of regional authorities in management and regulation of the mineral resource complex (MRC), as well as involvement of a wide range of local communities (from organizations representing the interests of indigenous peoples to professional communities: industry associations, environmental organizations, representatives of the innovation complex) in the development of the complex. Modern approaches to the elaboration of strategic development lines for resource regions (primarily supported by the development of the mineral resource complex) should be based on the principles of sustainability, inclusiveness and the need for innovative development". (V. A. Kryukov, 2017, p. 93). At the same time, the regulatory mechanisms should be adapted according to the specific features of raw-material areas, the development of which is more effective at the regional level. Expanding powers and capabilities of regions in MRC regulation will contribute to



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increasing the socio-economic benefits from the exploitation of mineral resources. (A. N. Sevastyanova, 2018).

The most convenient scheme for creation of productive forces on the principle of location of subsurface management sectors coincides with the territory where mineral resources form. Therefore, the territorial differentiation of the mineral resource complex depends on the choice of a deposit (field), which development is economically advantageous for both the subject and the subsurface user (E. I. Efremov, 2019). This approach dictates to locate production facilities in those areas where the cost of mining mineral raw materials will be less. Thus, the economic essence of the spatial differentiation of subsurface management sectors is to identify the most significant deposit (field) from many other ones in order to economically develop not only the region, where the deposit (field) is located, but also the entire country. Therefore, it is the mineral resource and production potentials that determine the spatial system for developing subsurface management sectors as the raw-material economy base.

2. Study methods

In this article, the resource and production potentials of the mineral resource complex in the RS(Ya) municipal districts is comprehensively and integrally rated. The main indicators for the rating are the following indicators of the municipal districts:

- balance reserves of mineral resources (diamonds, gold, coal, oil and gas) of deposit (field) categories A+B+C₁+C₂;¹
- mineral outputs by enterprises (State Program..., 2017);
- volume of shipped goods of own production (Statistical Yearbook of the RS(Ya), 2018);
- average annual market price of mineral resource (The World Economy);
- average annual USD–RUB rate at the exchange rate of the Central Bank of the Russian Federation (Exchange rate database).

The algorithm of integrated assessment of the potential of the basic subsurface management sectors is as follows: (Yuzhnaya Yakutiya..., 2019, pp. 9–19)

1. The proportional factor (k_i) is calculated. It is a share of the balance reserves of the i th mineral resource in one municipal district (Z_i) of the total reserves of this mineral resource in the RS(Ya) (Z_{irs}) with the weighting factors (ω_i) assigned:

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

The weighting factors (ω_i) are calculated by the following formula:

$$\omega_i = \frac{V_{ij}}{\sum_{i=1}^m V_{irs}} \quad (2)$$

where: V_{ij} is the annual output of the i th mineral resource in thousand roubles.

V_{irs} is the annual output of the i th mineral resource in the RS(Ya) in thousand roubles.

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

$$k_{ij}^N = \frac{k_{ij} - \min(k_{ij})}{\max(k_{ij}) - \min(k_{ij})} \quad (3)$$

3. The integral index of the mineral resource potential of the basic subsurface management sectors in one municipal district (I_{irs}) is determined by the average value of the normalized factors (k_{ij}^N):

$$I_{irs} = \frac{\sum_{i=1}^m k_{ij}^N}{m} \quad (4)$$

4. The rating of municipal district potentials is calculated from the average republican index: high, medium and low levels.

¹ Extracts from the State Register of Mineral Reserves of the Republic of Sakha (Yakutia), provided by Sakhageoinform State Unitary Enterprise of the Republic of Sakha (Yakutia).

5. The production potential I_{pr} is assessed similarly.

6. The final comprehensive potential I_{pot} is assessed as the average value of the resource and production potentials:

$$I_{pot} = (I_{rs} + I_{pr})/2 \quad (5)$$

3. Mineral resource potential

Mineral resource potential is a set of mineral resources available for real involvement in human economic activity with the modern technical and socio-economic capabilities of the society, which includes proven balance reserves and forecast reserves of minerals resources. Economically estimated mineral resource potential in the administrative and territorial aspect is a part of the national wealth. (M. V. Pilschikova, 2017).

The basic subsurface management sectors in the region are the main budget-forming sectors of the mining industry: oil and gas production, as well as diamond, gold and coal mining. The status of the mineral resource base of these subsurface management sectors is given below.

3.1. Diamonds

The main reserves of natural diamonds are located in the Western zone of the RS(Ya), in Mirninsky and Nyurbinsky Districts; in addition, 1 ore and 13 placer deposits are located in the Arctic zone: in Anabarsky, Bulunsky, Zhigansky and Olenyoksky Districts.

More than 70% of ore diamonds are concentrated in Mirninsky District, 35% of alluvial diamonds – in Nyurbinsky and Anabarsky Districts (Table 1).

The deposits of natural diamonds are characterized by a high degree of their development: 96.6% of ore reserves and 98% of alluvial reserves of categories A+B+C1+C2 are involved in economic turnover, which indicates the need for additional geological prospecting and exploration.

3.2. Oil and gas

In the republic, all 35 oil and gas fields are located in Western Yakutia. At the same time, most of oil reserves are concentrated in Mirninsky District, most of gas reserves – in Lensky District (Table 1). There are unallocated gas fields in Nyurbinsky and Vilyuysky Districts. (Soromotin, 2014)

The degree of involvement of the oil and gas fields in Western Yakutia is very high: 100% of oil and 87.55% of gas. Therefore, additional oil and gas resources will be required in the future. In this regard, offshore hydrocarbon reserves in the Arctic zone of the Republic of Sakha (Yakutia) are proposed in the long term. Continental margins of the Arctic Ocean, including the Russian sector, are considered the most important reserve of hydrocarbon raw materials for the XXI century. The passive continental margin of the Laptev Sea stands out as a part of the Russian Arctic sector. At the moment, it is one of the most poorly studied water areas. In the meantime, a number of forecast and exploration criteria indicates a high enough prospect of both the shelf of the Laptev Sea and adjacent continental territories. According to different experts, the initial raw material resources on the shelf of the Laptev Sea are 3.8 billion tonnes of oil equivalent (A. F. Safronov et alii, 2013).

Currently, a major project of the Russian gas transportation system is the construction of the "Power of Siberia" gas pipeline from Chayandinskoye field (Lensky District).

3.3. Coal

The Republic of Sakha (Yakutia) has significant forecast resources of various quality coals, which will serve as the base for development of the coal, metallurgical and chemical industries in the long term. In the republic, there are Yuzhno-Yakutsky, Lensky, Zyryansky coal basins and the Eastern part of the Tunguska basin at 48 deposits, which compose 95 areas with balance coal reserves of categories A+B+C1 and C2 amounting 14,340.3 million tonnes, including 8,337 million tonnes of black coal and 6,003.3 million tonnes of brown coal (State Program of the RS(Ya)..., 2017).

Large coal deposits under development are located throughout the region, with more than 80% of industrial coal reserves concentrated in Southern Yakutia, in Neryungrinsky District. Reserves of the

RS(Ya) unallocated fund make more than 48.34% and are generally in the Arctic zone and Western Yakutia (Table 1).

3.4. Gold

The main gold resources are located in Southern and Eastern Yakutia, the Arctic zone of the RS(Ya) (Table 1).

The State Register of Mineral Reserves in Southern Yakutia considers 25 indigenous gold deposits containing 50.8% of industrial reserves. Almost all reserves of indigenous gold are concentrated in Aldansky District. At the same time, there is a steady depletion of the alluvial gold potential on this territory, which indicates the need for reorientation of the mining facilities for ore gold development.

In Eastern Yakutia, in Tomponsky Municipal District, there is one of large gold deposits in Russia – Nezhdaninskoye deposit (reserves of categories A+B+C1+C2 are 622 tonnes). After years of downtime, in 2019, Polymetal JSC started construction works at the deposit, gold mining is planned to start in 2021. (Na Nezhdaninskom mestorozhdenii v Yakutii nachalis stroitelnye raboty, 2019)

In the Arctic zone, there are currently 17 ore and alluvial gold deposits in the allocated subsurface fund, 14 of them are being developed, 3 are being prepared for development. Most of gold deposits are in the unallocated subsurface fund in Abyysky, Allaikhovsky, Momsky, Nizhnekolymsky and Verkhoyansky Municipal Districts. The largest amount of gold reserves is concentrated in Ust-Yansky District, thanks to one of large ore deposits in Russia – Kyuchus deposit, which is in the unallocated fund. In 2006, assets of the deposit were bought out by a leading gold mining company (Polyus PJSC), but this project appeared to be ineffective and the deposit was returned to the unallocated fund. The deposit reserves of categories C1+C2 are 175 tonnes of gold. (V Yakutii nadeyutsya na skoroye litsenzirovaniye mestorozhdeniya Kyuchus, 2016).

Table 1. Proportional factors for the balance reserves of mineral resources of the basic subsurface management sectors in the RS(Ya) municipal districts (on average over 2015–2017), categories A+B+C1+C2.

No.	Zone / Municipal district	Oil	Gas	Coal	Diamonds	Gold
	<i>Arctic zone</i>	–	–	0.0956	0.0815	0.1430
1	Abyysky	–	–	0.0024	–	0.0004
2	Allaikhovsky	–	–	–	–	0.0006
3	Anabarsky	–	–	0.0002	0.0331	–
4	Bulunsky	–	–	0.0741	0.0014	–
5	Verkhnekolymsky	–	–	0.0189	–	0.0014
6	Verkhoyansky	–	–	–	–	0.0305
7	Zhigansky	–	–	–	0.0001	–
8	Momsky	–	–	–	–	0.0034
9	Olenyoksky	–	–	–	0.0470	–
10	Ust-Yansky	–	–	–	–	0.1066
	<i>Eastern zone</i>	–	–	0.0282	–	0.4819
12	Oymyakonsky	–	–	–	–	0.0404
13	Tomponsky	–	–	0.0282	–	0.4298
14	Ust-Maysky	–	–	–	–	0.0118
	<i>Western zone</i>	1	1	0.1176	0.9185	0.0811
15	Vilyuysky	–	0.1745	–	–	–
16	Lensky	0.3428	0.5656	–	–	0.00005

17	Mirninsky	0.6180	0.1852	0.0001	0.7492	–
18	Nyurbinsky	–	0.0013	0.1171	0.1693	–
19	Olyokminsky	–	0.0049	–	–	0.0810
20	Suntarsky	0.0392	0.0685	0.0004	–	–
	<i>Central zone</i>	–	–	0.004	–	–
21	Tattinsky	–	–	0.004	–	–
	<i>Southern zone</i>	–	–	0.7581	–	0.2940
22	Aldansky	–	–	–	–	0.2896
23	Neryungrinsky	–	–	0.7581	–	0.0044
	RS(Ya)	1	1	1	1	1

Source: This table is calculated by the author using data form the State Register of Mineral Reserves of the Republic of Sakha (Yakutia) provided by Sakhageoinform SEU of the RS(Ya).

To assess the mineral resource potential, we determine the weighting factors of mineral resources (ω_i) from the mineral output share in one municipal district of the total output in the region in value terms (Table 2).

Table 2. Weighting factors (ω_i) of mineral resources

No.	Mineral resource	Weighting factor (ω_i)
1	Diamonds	32
2	Oil	26
3	Coal	24
4	Gold	15
5	Gas	3
	Total	100

This table is based on the author's calculations.

The potential of mineral resources was assessed from the average indicators in all 35 municipal districts of the republic over 2015–2017. The district rating is identified against the average republican indicator on three levels (the RS(Ya) average indicator is 0.93): low (0 to 0.01), medium (0.01 to 0.93) and high (0.93 to 10), see Fig. 1.

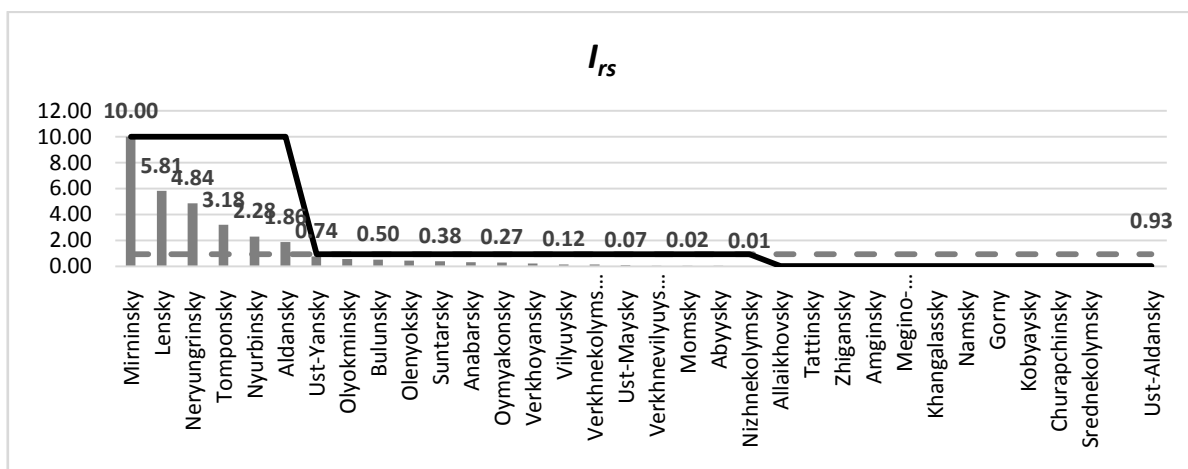


Figure 1. Ratings of the mineral resource potential (I_{rs}) of the basic subsurface management sectors in the RS(Ya) municipal districts on average over 2015–2017, points.

The results of the mineral resource potential assessment are:

- high ratings are observed in Mirninsky, Lensky, Neryungrinsky, Tomponsky, Nyurbinsky and Aldansky Municipal Districts;
- medium ratings are observed in 15 districts of the Arctic, Western and Eastern zones.
- low ratings are observed in the Central and Arctic zones, where there are small gold reserves, which are of no interest for industry yet, and coal reserves for local use.

4. Production potential

4.1. Diamond mining sector

In the region, diamonds are mined in Mirninsky, Nyurbinsky and Anabarsky Municipal Districts.

The diamond mining profile over 2015–2017 shows an increase in the output in Mirninsky and Nyurbinsky Districts. Meanwhile, a decrease in the output by 0.1 million carats was recorded in Anabarsky District. (Table 3).

Table 3. Diamond mining in the RS(Ya) municipal districts over 2015-2017, million carats.

Municipal district / Enterprise	2015	2016	2017
Mirninsky			
ALROSA Stock Company (PJSC)	23.5	23.2	24
including:			
Aikhalsky Ore Mining and Processing Plant	12.3	12.2	13
Mirninsky Ore Mining and Processing Plant	6.9	7.8	7.2
Udachninsky Ore Mining and Processing Plant	4.3	3.2	3.8
Nyurbinsky			
ALROSA Nyurba PJSC	7.5	6.8	7.7
Anabarsky			
Almazy Anabara JSC	5.3	5.1	5.2
Total for the RS(Ya)	36.3	35.1	36.9

Source: Annual report of ALROSA Stock Company (PJSC). 2017. [Electronic resource]. URL: <http://www.alrosa.ru/documents/годовые-отчеты> (reference date: 01.10.2018).

ALROSA Stock Company (PJSC) is a world leader in diamond mining and has assets in Africa at Catoca deposit; the ratio of diamond mining at the end of 2018: RS(Ya) – 46%, Catoca – 54%. (Yu. G. Danilov, 2019).

Almazy Anabara JSC mines alluvial diamonds on the rotation system in Anabarsky District: at Mayat placer (areas of Ebelyakh, Pravoberezhnye Morgogora, Kholomolokh, Khara-Mas, Bolshaya Kuonamka, Billyakh Tributaries) and Molodo placer (Molodo area). By the end of 2018, the company mined 5.4 million carats of diamonds. Currently, the company has 22 subsurface management licenses for geological survey, exploration and mining of alluvial diamonds. For diamonds, geological survey and mining operations are focused on Anabarsky, Kuonamsky (Western part) and Prilensky (Eastern part) diamondiferous areas. Administratively, subsurface areas for geological survey are located within the municipalities: Anabarsky National Dolgan-Evenki Ulus (District), Olenyoksky National Ulus (District), Bulunsky Ulus (District). (Almazy Anabara JSC, 2019).

4.2. Oil and gas production sector

In the Republic of Sakha (Yakutia), powerful production capacities have been created that can provide oil and natural gas at a level higher than one million (A. F. Soromotin, 2013, pp. 1275–1279). Oil and

gas are produced in Western Yakutia, in Lensky, Mirninsky and Vilyuysky Districts. At the same time, about 90% of oil is produced in Lensky District (Table 4).

Table 4. Oil and gas production profile in the RS(Ya) municipal districts.

Mineral resource / Municipal district	2015	2016	2017
Oil, total, thousand tonnes	9,451.2	10,101.4	10,227.0
<i>Lensky</i>	8,435.0	8,894.1	8,965.0
<i>Mirninsky</i>	825.2	1,017.9	1,363.5
Natural gas, total, million m ³	1,938.0	2,011.0	2,010.3
<i>Vilyuysky</i>	1,685.5	1,735.8	1,743.9
<i>Mirninsky</i>	210.8	224.9	216.35
<i>Lensky</i>	41.7	50.3	49.97

Source: Ministry of Industry and Geology of the RS(Ya). [Website]. URL: <https://minprom.sakha.gov.ru/dinamika-dobychi> (reference date: 12.10.2018).

Prospects for increasing the oil production in the republic are associated with fields, which are located in relative proximity to the "Eastern Siberia – Pacific Ocean" pipeline system and have access to it. These include oil fields of Surgutneftegas PJSC (Lensky District) and Taas-Yuryakh Neftegazodobycha LLC (Mirninsky District). Geologists also recommended carrying out high priority oil exploration activities in West Botuoba, South Vilyuy and Aldan-Maya areas. (V. A. Sitnikov, N. N. Alekseyev, K. A. Pavlova, 2016).

Large Chayandinskoe oil and gas condensate field located in Lensky District is the main base for gas supplies to China. The field reserves of categories C1+C2 amount to 1.24 trillion m³ of gas and 68.4 million tonnes of oil and condensate. The license for the field is held by Gazprom. The field is planned to produce 25 billion m³ of gas per year. (Chayandinskoe field)

4.3. Gold mining sector

Currently, gold is mined in 11 RS(Ya) municipal districts of the Southern, Eastern and Western zones, as well as small alluvial mining is carried out in the Arctic zone. The main output share falls on Aldansky and Oymyakonsky Districts, they were joined by Olyokminsky and Ust-Maysky Districts in recent years (Table 5). Large mining companies are Polyus Aldan JSC, Seligdar Holding Company, Zapadnaya Ore Mining Enterprise CJSC, Neryungri-Metallic LLC, Rudnik Duet LLC, etc.

Table 5. Gold mining in the RS(Ya) municipal districts over 2015–2017, kg.

No.	Municipal district	2015	2016	2017
1	Aldansky	8,681.0	9,942.4	10,833.2
2	Oymyakonsky	10,864.0	8,582.0	8,337.7
3	Olyokminsky	2,609.0	2,496.0	2,189.2
4	Ust-Maysky	1,134.0	1,221.9	1,649.4
5	Ust-Yansky	56.0	177.6	229.4
6	Neryungrinsky	1,397.0	1,118.8	941.5
7	Verkhnekolymsky	48.0	64.2	–

8	Verkhoyansky	–	44.4	16.4
9	Bulunsky	–	8.0	18.2
10	Momsky	73	42.8	60.9
11	Olenyoksky	–	–	89.0
Total for the RS(Ya)		24,862.0	23,698.1	24,364.9

Source: This table is compiled based on data from the Mining Institute of the North of the Yakut Scientific Centre of the Siberian Branch of the Russian Academy of Sciences.

4.4. Coal mining sector

Today, the coal mining industry is the third most important in the republic after the oil and gas as well as diamond sectors. It accounts for more than 8% of the industrial production, and its tax revenues to the republican budget are about 2 billion roubles.

In the republic, more than ten coal producers are actively operating, including Kangelassky (territory of Yakutsk), Kharbalakhsky (Tattinsky District), Kirovsky (Nyurbinsky District) and Kempendyaysky (Suntarsky District) coal surface mines, Neryungrinsky and Elginsky coal complexes (Neryungrinsky District), Dzhebariki-Khayinskaya mine (Tomponsky District), Zyryanskaya surface mine (Verkhnekolymsky District), etc. (Table 6).

Table 6. Coal mining in the RS(Ya) over 2015–2017, thousand tonnes.

No.	Municipal district	2015	2016	2017
1	Nyurbinsky	20	23	25.1
2	Suntarsky	21	25	26
3	Urban Okrug "city of Yakutsk"	131.1	145.0	170.3
4	Tattinsky	131.6	129	134
5	Neryungrinsky	11,248	14,303.2	16,139.3
6	Tomponsky	320.1	542	398
7	Verkhnekolymsky	160	124	151
Total for the RS(Ya)		12,032.0	15,291.0	17,043.7

Source: Coal mining profile / Ministry of Industry and Geology of the RS(Ya). [Website]. URL: <https://minprom.sakha.gov.ru/dinamika-dobychi-uglja> (reference date: 12.10.2018).

The coal output throughout the republic for the period under consideration increased due to the enterprises of the Southern zone, where new capacities were introduced within investment projects (such as Denisovsky and Inaglinsky Mining and Processing Plants), and due to reaching the first stage of the designed capacity of Elginsky coal complex.

In order to use the production potential of subsurface management sectors as one of the key criteria for spatial differentiation, we thoroughly analysed and assessed the distribution of the production potential of fuel and energy resources, as well as diamonds and gold for each municipal district of the republic (Table 7).

Table 7. Proportional factors for mining mineral resources of the basic subsurface management sectors in the RS(Ya) municipal districts (on average over 2015–2017).

No.	Zone / Municipal district	Oil	Gas	Coal	Diamonds	Gold
	<i>Arctic zone</i>	–	–	0.01	0.144	0.012
1	Anabarsky	–	–	–	0.144	–

No.	Zone / Municipal district	Oil	Gas	Coal	Diamonds	Gold
2	Bulunsky	–	–	–	–	–
3	Verkhnekolymsky	–	–	0.01	–	0.002
4	Verkhoyansky	–	–	–	–	0.001
5	Momsky	–	–	–	–	0.002
6	Olenyoksky	–	–	–	–	0.001
7	Ust-Yansky	–	–	–	–	0.006
	<i>Eastern zone</i>	–	–	<i>0.029</i>	–	<i>0.436</i>
8	Oymyakonsky	–	–	–	–	0.381
9	Tomponsky	–	–	0.029	–	–
10	Ust-Maysky	–	–	–	–	0.055
	<i>Western zone</i>	<i>1</i>	<i>1</i>	<i>0.003</i>	<i>0.856</i>	<i>0.1</i>
11	Vilyuysky	–	0.867	–	–	–
12	Lensky	0.891	0.024	–	–	–
13	Mirninsky	0.109	0.109	–	0.653	–
14	Nyurbinsky	–	–	0.002	0.203	–
15	Olyokminsky	–	–	–	–	0.1
16	Suntarsky	–	–	0.002	–	–
	<i>Central zone</i>	–	–	<i>0.009</i>	–	–
17	Tattinsky	–	–	0.009	–	–
	<i>Southern zone</i>	–	–	<i>0.949</i>	–	<i>0.451</i>
18	Aldansky	–	–	–	–	0.404
19	Neryungrinsky	–	–	0.949	–	0.047
	RS(Ya)	1	1	1	1	1

Source: This table is based on the author's calculations.

From the calculations using the assumed principle, the following differentiation in terms of production potential was identified (the average republican score is 1.2):

- high level (1.2 to 10 points) – Mirninsky, Lensky, Neryungrinsky, Aldansky, Oymyakonsky, Nyurbinsky and Anabarsky Districts, where diamonds, gold, oil, gas and coal are extracted;
- medium level (0.01 to 1.2 points) – 11 municipal districts of the Western, Eastern and Arctic zones and Tattinsky Ulus in the Central zone, where power plant coal is mined;
- low level (0 to 0.01 points) – municipal districts of the Central, Eastern and Arctic zones, see Fig. 2.

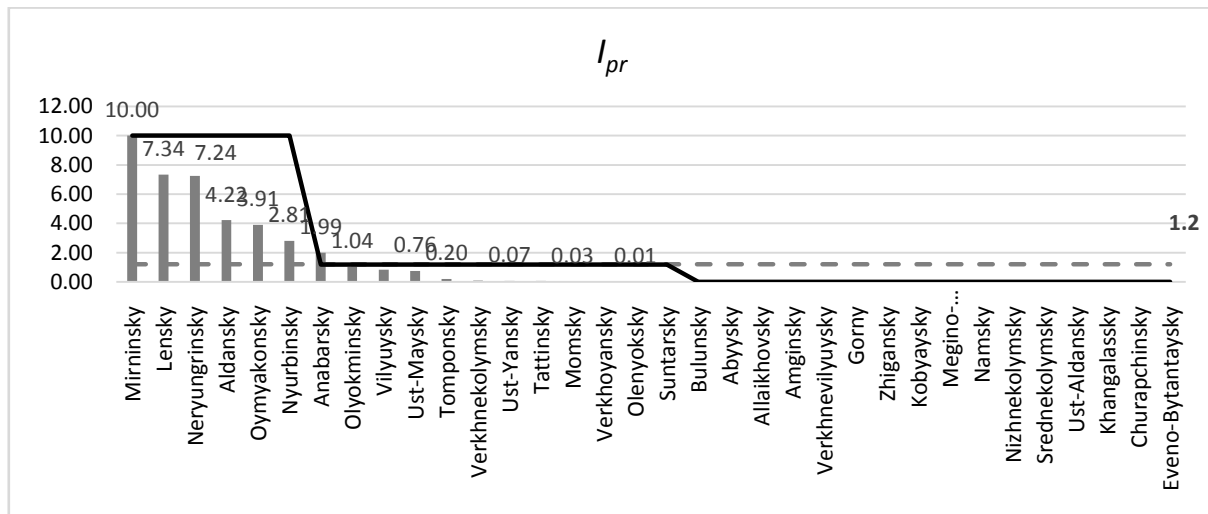


Figure 2. Ratings of the production potential (I_{pr}) of the basic subsurface management sectors in the RS(Ya) municipal districts on average over 2015–2017, points.

The final potential (I_{pot}) of territorial differentiation of the basic subsurface management sectors in the RS(Ya) municipal districts shows the following rating (the average score for the RS(Ya) is 1.6), see Fig. 3:

- high level (1.6 to 10 points) – Mirninsky, Lensky, Neryungrinsky, Aldansky, Oymyakonsky, Nyurbinsky and Tomponsky Districts;
- medium level (0.01 to 1.6 points) – 14 municipal districts of the Western, Eastern and Arctic zones;
- low level (0 to 0.01 points) – 13 municipal districts of the Central zone and a part of the Arctic zone.

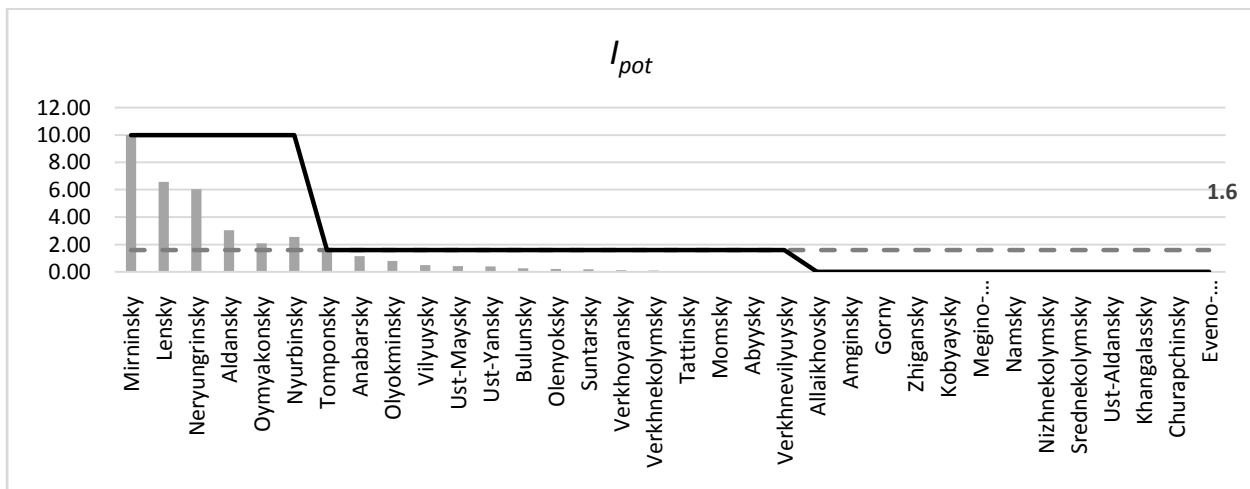


Figure 3. Ratings of the final potential (I_{pot}) of the basic subsurface management sectors in the RS(Ya) municipal districts on average over 2015–2017, points.

Thus, it can be concluded from the foregoing assessment that in view of potential levels of the basic subsurface management sectors, the municipal districts are differentiated in the Republic of Sakha (Yakutia) as follows, see Fig. 4:

- districts with a high potential in the Western, Southern and Eastern zones;

- districts with a medium potential mostly in the Arctic zone and partly in the Western and Eastern zones;
- districts with a low potential in the Central zone.



Figure 4. Map of potentials of the basic subsurface management sectors in the Republic of Sakha (Yakutia).

5. Conclusions

1. The critical basis for the spatial differentiation of the basic subsurface management sectors is a comprehensive assessment of their mineral resource and production potentials, based on which it is possible to distinguish 4 local zones, where subsurface management sectors are located: Western, Southern, Eastern and Arctic. At the same time, the Western local zone is characterized by the highest mineral resource potential.

2. The development of local zones, where the basic subsurface management sectors are located, with the concentration of organizational and managerial efforts as well as with the rational involvement of state financial resources of the state, corporate structures will enable creating four territorial and sectoral clusters. At the same time, the spatial distribution of their structural components will determine the boundaries of the territorial zones of the basic subsurface management sectors. According to S. V. Rayevsky and Yu. V. Vinokurova, "the concept of cluster development is the most effective model of public-private partnership in the Russian Federation." (S. V. Rayevsky and Yu. V. Vinokurova, 2007).

3. Currently, the basis for territorial and production zoning in a market economy is a cluster form of organization of subsurface management sectors, where a synergetic useful effect is achieved through competing segments of the cluster. Thus, the objective grouping of administrative districts

based on the features of the nature management structure with the cluster organization of production becomes the criterion basis of forming territorial and production zones. (Petrishchev, Chibileva, 2012; Atamanova, 2015).

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