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Article



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ON THE NEED FOR ENTREPRENEURIAL ACTIVENESS IN THE ASPECT OF DECISION PROBLEMS OF CREATING CONDITIONS FOR THE INTEGRATED USE OF RAW MATERIALS IN THE REGIONS OF THE RUSSIAN ARCTIC

Abstract: *In this article, the authors examine the systemic and emerging challenges, risks, and opportunities for economic development, including sustainable development, in the Russian Arctic. An analysis of the characteristics, trends, and prospects for industrial production in the Russian Arctic is provided, revealing the challenges and specific features of single-industry towns. The authors also establish the readiness of Russian Arctic regions to overcome current economic instability from a labor market perspective. The authors examine the challenges and substantiate the prospects for creating conditions for the integrated use of raw materials in Arctic regions. The authors also identify the conditions and prospects for shift work transformation as a reserve for changing migration trends and developing the Arctic labor market.*

Key words: *current issues, investment projects, global recessions, geopolitical processes, problems of increased costs, socio-economic processes, Arctic zones, economy of the Arctic Zone of the Russian Federation regions.*

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Introduction

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To establish such aspects and justify the tasks, the following facts are relevant, which we relied on in our research and the results of which are reflected in this article, namely:

First, the results of a review of the global and national impacts on the development prospects of the Arctic Zone of the Russian Federation regions confirmed the potential for economic and associated socioeconomic growth for the Arctic Zone of the Russian Federation regions, the development of industrial production, and the mitigation of risks to increasing the primary exports of the extractive regions. It should be noted that the current consequences of the implementation of the SVO in Ukraine have increased the risks of realizing these promising opportunities, but the "pivot to the East" and the implementation of a full-scale national economic policy by Russia support the preservation of the established potential.

secondly, the established preservation of the strategic goals for the development of the Arctic, the implementation of which is ensured by the accelerated implementation of a mechanism for increasing investment activity in the Arctic Zone of the Russian Federation;

Thirdly, an understanding of the nature of public and corporate governance policies and practices during the COVID-19 pandemic in the Russian Arctic regions revealed the primacy of environmental issues, social responsibility, and the associated climate change issues. This is fully consistent with the latest global trends in accelerating the implementation by enterprises of strategies to ensure sustainable development factors in the regions where they operate, including greening production, adhering to ethical standards, promoting regional economic growth, and corporate social responsibility.

These facts confirm the significance of our chosen broad context for studying the development of the Russian Arctic, not only from the perspective of achieving the economic performance of specific enterprises and the Arctic development targets established at the regional and national levels, but also in the context of movement within the framework of a global strategy for the development of the oil and gas, mining, and metallurgical businesses, taking into account the risks, opportunities, and new roles in social stabilization in the context of the COVID-19 pandemic and growing geopolitical tensions.

This broad context naturally indicates the scale of the new tasks that must be taken into account, namely:

- on the one hand, updating the risks and opportunities for greening production and social responsibility for enterprises in the Arctic Zone of the Russian Federation;

- On the other hand, the fact that the supporting role of the state as a regulator of conditions for the development of business initiatives by the private sector in the Arctic strengthens the development opportunities and the influence of business on socio-economic processes, but at the same time creates restrictions on business development, the need to ensure a set of security measures - epidemiological and environmental,

- Thirdly, the need to achieve the strategic development goals of the Arctic Zone of the Russian Federation, enshrined in the set of strategic indicators for the development of the Arctic Zone of the Russian Federation, including demographic indicators, the likelihood of achieving which we justified as low (the main target indicators are reflected in the Arctic Zone Development Strategy and the Russian Federation Program "Socio-Economic Development of the Arctic Zone of the Russian Federation"). Taking into account the above, we first had to decide, namely: to determine the conditions for the sustainable development of the Russian Arctic:

to substantiate the problems and prospects for creating conditions for the integrated use of raw materials in the regions of the Russian Arctic

The article presents the results of the examination of the actual readiness and conditions for the participation of large businesses in investment projects for the integrated processing of mineral resources, considered from the perspective of an environmental measure with a potential commercial effect, from the perspective of activating entrepreneurial activity and strengthening the development opportunities of single-industry towns in the Arctic.

The solution to this problem ensures the creation of realistic conditions for the integrated processing of Arctic mineral resources. This solution is a natural continuation of the work undertaken in 2024, which focused on substantiating the conditions for developing entrepreneurial activity in the Arctic in the area of integrated processing of mineral resources:

business models for organizing production are proposed;

A mechanism for their implementation has been developed, for which a roadmap has been developed. The success of this roadmap depends on a detailed understanding of the conditions under which businesses are willing to strengthen their entrepreneurial activity and combine their efforts to ensure the integrated use of mineral resources.

The novelty and increased relevance of the solution to this problem are also ensured by the identified new trends in the development of Arctic territories, including changes in prices and demand for mineral resources, and the conditions for the development of large businesses, already noted in previous chapters, in terms of greening and ensuring

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conditions for the development of the territories where they operate. This necessitates a reorientation of some company investment projects toward non-commercial ones, related to the creation of specific environmental infrastructure and the search for methods to reduce the negative impact on the environment. Under these conditions, the challenge is to maintain and increase entrepreneurial activity to achieve the socio-economic development goals of the Russian Arctic and implement the concept of integrated processing of mineral resources.

Main part

Various economic and technological factors related to the current global situation may impede the increase in the rate of reproduction and processing of solid minerals in accordance with the Strategy for the Development of the Mineral Resource Base of the Russian Federation until 2035. A distinctive feature of the current historical stage of national economic development, situated within the global context of changing technological and economic paradigms in the Russian Federation, is the implementation of a strategy for the reproduction of the mineral resource base and the processing of solid minerals in the context of import substitution. To achieve technological sovereignty and provide high-tech industries in Russia with strategic metals and other resources, as well as to address one of the key challenges—improving the efficiency of beneficiation and deep processing of strategic mineral resources of natural and man-made origin—it is necessary to update the practical implementation of the concept of integrated processing of mineral resources.

The list of key strategic mineral resources was approved by a decree of the Government of the Russian Federation.⁹⁸ Since then, it has been updated several times, but its composition has remained the same. Strategic resources in Russia include: oil, natural gas, uranium, manganese, chromium, titanium, bauxite, copper, nickel, lead, molybdenum, tungsten, tin, zirconium, rare earth metals (tantalum, niobium, cobalt, scandium, beryllium, antimony, lithium, germanium, rhenium, and rare yttrium elements), gold, silver, platinum group metals, diamonds, and high-purity quartz. Currently, the actual situation with each item varies significantly. Most of the strategic materials approved by the Government of the Russian Federation do not rely on imports. The four main mineral resources of greatest concern are uranium, titanium, zirconium, and rare earth metals. The main reasons for the shortages of these resources are:

- low quality of ores, despite significant volumes of reserves;
- structural imbalances in the economy caused by the weak development of high-tech industries and the manufacturing industry;
- the lack of cost-effective technologies for

processing complex, multi-component and low-quality ores;

- insufficiency of ongoing geological exploration work.

Solutions to the problem of import dependence determine the need to implement the following projects:

- intensification of geological exploration work to find new deposits;
- development of new known deposits;
- improvement of ore mining and processing technology;
- complex processing of ores, where these elements can be extracted as a by-product;
- development of our own production of final high-tech products and processing industries capable of separating collective compounds into individual commercial elements;
- development of technologies for processing information on the geological structure and reserves of mineral resources.

The measures proposed and currently being implemented to address the issue of self-sufficiency and sufficiency in mineral resources are both extensive and intensive. Given the principles of sustainable development, a rational approach to subsoil use, and the complexity of raw materials, intensive development methods are of greatest interest, namely the development and implementation of new technologies that facilitate the integrated processing of mineral resources. The concept of integrated processing of mineral resources was first discussed in the 1930s. Academician A.E. Fersman can rightfully be considered its founder. His principle, analogous to nature, of locating production facilities so as to extract not individual components, but the entire geochemical spectrum of chemical elements concentrated in a specific area, became the basis for the concept of integrated use of raw materials. Since the 1960s, the accumulation of industry knowledge on the rational use of mineral resources has continued. This period is associated with such scholars as S. G. Strumilin [and others]. In the 1990s, during the transition to a market economy and the formation of private ownership of natural resources, researchers focused on defining the role and place of the state in addressing environmental management issues, developing measures to stimulate the integrated development of mineral resources and the use of mining and processing waste, and on state participation in waste disposal. Scientific research during this period more clearly defined the mining-technological, mining-ecological, and economic (ecological, geological-economic) aspects of environmental management. The mining technology approach, based on the principles of the intensification concept (low-waste, comprehensive use of minerals), was developed in the works of V. N.

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Makarov et al. Ecological and economic issues of rational nature management during this period were reflected to the greatest extent in the works of O. F. Balatsky et al. Scientific research of man-made deposits as complex geological objects with significant resource potential was developed (K. N. Trubetsky et al.). In addition, the need arose for the economic assessment of man-made deposits as investment objects (V. V. Chaynikov et al.). Since the early 2000s, changes have begun in the system of state management of natural resource management. These problems were reflected in the studies of L. Z. Bykhovsky and others. The researchers note the need to systematize information on waste and man-made deposits, their resource potential, systematic environmental and economic assessment and state accounting. In view of the geographical distribution of developed and promising deposits by the identified most scarce and import-dependent types of mineral resources (uranium, titanium, Zirconium and rare earth metals) in the Arctic Zone of the Russian Federation and the Far East (Table 1), the strategic objectives for the development of these territories, and the relevance of the practical application of the integrated processing concept are further increasing today and in the near future. Most projects for the development of promising deposits in the Russian Arctic regions are included in the Strategy for the Development of the Arctic Zone of the Russian Federation and National Security through 2035, approved by Decree of the President of the Russian Federation No. 645 of October 26, 2020. This determines a high responsibility for ensuring the preservation of the fragile ecological balance in the territory of the Russian Arctic, with an emphasis on intensive methods of mineral extraction and processing, including through the use of integrated processing of mineral raw materials at existing and promising deposits. The implementation of these solutions is impossible without intensifying the entrepreneurial activity of economic entities directly involved in their implementation. The term "entrepreneurial activity" (EA) originated in foreign studies of entrepreneurship theory as a synonym for entrepreneurial activity (R. Cantillon, A. Turgot, A. Smith), then evolved into the category of personality traits (A. Marshall, T. Veblen, J. Schumpeter), which can have different types of manifestations (. Further, the concept of a qualitative characteristic of

entrepreneurial activity took the form of a quantitative indicator (Global Entrepreneurship Monitor, GEM project) in the form of an integral value - as a synthesis of the results of economic activity. In domestic studies, the path of development of this term was similar, and currently, as abroad, the most authoritative study is the GEM project, in which Russia has been participating since 2018. Turgot, A. Smith), then evolved into the category of personality traits (A. Marshall, T. Veblen, J. Schumpeter), which can manifest in various ways (. Further, the concept of a qualitative characteristic of entrepreneurial activity took the form of a quantitative indicator (Global Entrepreneurship Monitor, GEM project) in the form of an integral value - as a synthesis of the results of economic activity. In domestic studies, the path of development of this term was similar, and currently, as abroad, the most authoritative study is the GEM project, in which Russia has been participating since 2018. Turgot, A. Smith), then evolved into the category of personality traits (A. Marshall, T. Veblen, J. Schumpeter), which can manifest in various ways (. Further, the concept of a qualitative characteristic of entrepreneurial activity took the form of a quantitative indicator (Global Entrepreneurship Monitor, GEM project) in the form of an integral value - as a synthesis of the results of economic activity. In domestic studies, the path of development of this term was similar, and currently, as abroad, the most authoritative study is the GEM project, in which Russia has been participating since 2018.

At the same time, despite the fact that all researchers postulate the multifaceted nature of entrepreneurial activity, existing theories often take a one-dimensional approach to its study, primarily viewing it as the entrepreneurial activity of the population. A one-dimensional approach to studying the concept of entrepreneurial activity from the perspective of only one market participant leads to a correspondingly one-dimensional selection of indicators used as the basis for its calculation methods. This approach does not allow for a comprehensive assessment of the level of entrepreneurial activity. Existing studies examine it primarily at the national level, while regional studies are limited to individual regions or their rankings, compiled by various agencies based on their own methodologies.

Table 1. Geographical distribution of existing and prospective deposits of import-dependent mineral resources by regions of the Russian Federation

Mineral raw materials	Regions with operating deposits		Regions with promising deposits	
	Regions of the Arctic Zone of the Russian Federation	Other regions	Regions of the Arctic Zone of the Russian Federation	Other regions

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Uranus	Republic of Sakha (Yakutia)	Transbaikal Territory, Republic of Buryatia, Kurgan Region	-	Amur Oblast, Jewish Autonomous Oblast, Transbaikal Krai
Titanium	Murmansk region, Komi Republic	-	Murmansk region	Tomsk region, Transbaikal Territory, Amur region, Chelyabinsk region
Zirconium	Murmansk region	-	Komi Republic	Tomsk region, Irkutsk region
Rare earth metals	Murmansk region	-	Republic of Sakha (Yakutia), Krasnoyarsk Territory, Komi Republic	-
Fluorspar	-	Transbaikal Territory, Republic of Bashkortostan, Republic of Buryatia	Republic of Sakha (Yakutia), Krasnoyarsk Krai	Primorsky Krai

In addition to the understudied regional aspect, the multifaceted nature of entrepreneurial activity from the perspective of each economic agent operating within the regional economic system—namely, the population, businesses, and the state—has not been fully explored. This is a key prerequisite for the need to change the approach to studying entrepreneurial activity, driven by contemporary scientific trends associated with the transition from a traditional economic view of entrepreneurship, focused on markets, to a new economic perspective emphasizing people, networks, and institutions. In this regard, in our previous studies, we proposed the following definition of entrepreneurial activity: a comprehensive, integrated indicator reflecting the intensity of participation in entrepreneurial activity by all economic entities (households (population), businesses, and the state), the synergistic effect of whose interactions will determine the level of development and specific features of entrepreneurial activity in a particular territory. In accordance with this definition, we proposed using a multivariate average method for calculations for each identified type of entrepreneurial activity (population, businesses, and the state). The calculations made it possible not only to assess the current state of entrepreneurial activity, but also, based on these calculations, to draw a conclusion about the predominant strength of participation of a specific economic agent in the economy of a particular region and to create a “heat map” of entrepreneurial activity in Russia by region, classifying them by the level and

type of its manifestation (Figures 1 and 2).

Taking into account these characteristics of the manifestation of entrepreneurial activity in the regions was defined as the basis for the formation of a regional policy for managing the region's economy and the selection of the most appropriate strategies and instruments for stimulation and development, including in relation to a specific industry.

Companies participate in the extraction and/or production of a new valuable component (which is a finished or intermediate product), as well as in the creation of new enterprises to implement projects necessary for the development of the mining and processing industry, and their participation can be both direct and indirect.

Direct participation includes the direct establishment of a new company through a contribution to its authorized capital, while indirect participation involves the creation of conditions that facilitate the creation or emergence of new business structures.

All market actors—business, government, and the public—can participate in these processes, both independently and jointly, determining the level and type of entrepreneurial activity in the region.

There is no clear consensus regarding who should become the driving force in the integrated processing of mineral resources and the appropriate forms of implementation. Potential business management concepts applied by domestic and international companies regarding the leading market player are discussed.

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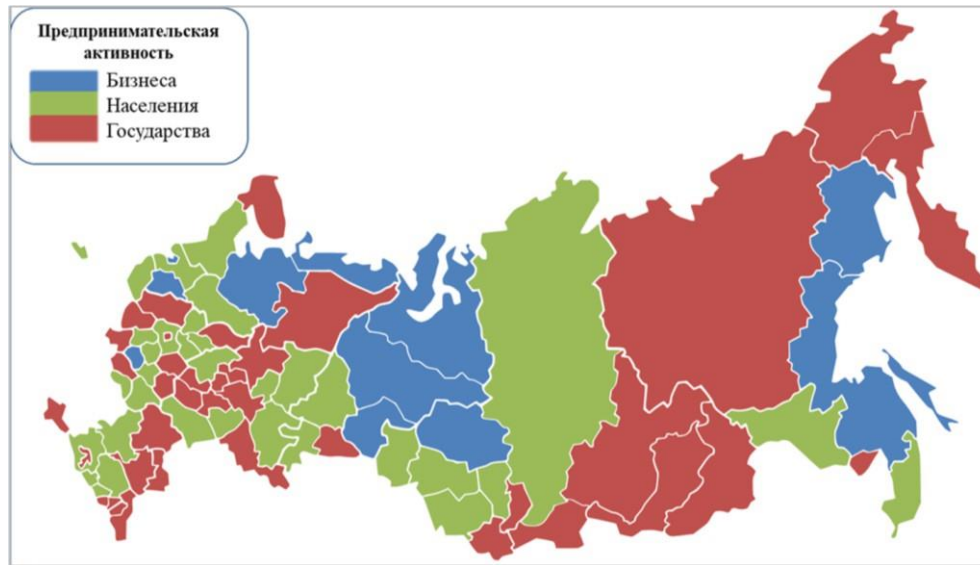


Figure 1. Distribution of entrepreneurial activity by predominant types in the regions of the Russian Federation, 2018



Figure 2. Distribution of regions of the Russian Federation by level of entrepreneurial activity, 2024

According to previous calculations of the level and type of PA, it has been established that in the regions of the Arctic Zone of the Russian Federation, whose territory is fully included within it, entrepreneurial activity is predominantly carried out by the state and business, while in the partially Arctic regions, it is carried out by the state and the population. Taking into account this regional characteristic and the corresponding concepts of economic management for the implementation of the integrated processing of mineral resources relative to the leading economic agent (population, business, state), the following conclusion can be formulated: for the intensification of entrepreneurial activity in the mineral extraction and processing industry in the fully

Arctic Russian regions, the most optimal concepts will be internal outsourcing, the creation of a technology park with state participation, and the establishment of new business structures based on public-private partnerships. In the partially Arctic Russian regions, the development of small and medium-sized mining businesses with state support will be the most optimal (Table 2). Thus, despite the Russian Federation's significant mineral resource reserves, there are areas that require particular attention given global geopolitical changes and the need to develop high-tech industries within the country to ensure the independence and self-sufficiency of the national economy and maintain its stable, sustainable development. This issue can be

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addressed through the use of both extensive methods related to the exploration and development of new deposits and intensive approaches, including the improvement of mineral extraction and processing technologies to ensure sustainable environmental management and the comprehensive extraction of all valuable components, as well as the development of systems and tools for working with this information. Given the geographical distribution of import-dependent and strategically important mineral resources across the regions of the Russian Federation, primarily located in the Arctic zone and the Far East, the practical application of integrated mineral resource management concepts is currently increasingly relevant due to the high level of environmental responsibility in these regions.

Implementing the concept of integrated use requires intensifying entrepreneurial activity among economic entities in the mining and processing industries, necessitating the development of an appropriate regional business environment

management policy that takes into account the specifics of economic activity and entrepreneurial activity within a given region. Taking these regional characteristics into account has allowed us to develop a pool of business management concepts that are most applicable to the implementation of integrated processing of mineral resources in the Arctic Zone of the Russian Federation. Thus, in fully Arctic regions, intensifying entrepreneurial activity is possible through internal outsourcing, the creation of a technology park with state participation, and the establishment of new business structures based on public-private partnerships. In partially Arctic regions, this can be achieved through the development of small and medium-sized mining businesses with state support.

Further focusing on these concepts requires identifying corresponding business models and specific tools for intensifying entrepreneurial activity that facilitate their practical implementation.

Table 2. The correlation between business management concepts for the implementation of integrated processing of mineral resources and the prevailing type of entrepreneurial activity in the regions of the Arctic Zone of the Russian Federation, 2024.

Subject of the Russian Federation	Population	Business	State	General level	The predominant type of entrepreneurial activity	Concepts of business management
Completely Arctic regions						
Murmansk region	0.22	0.32	0.35	0.89	State	PPP, clusters, technology park
Yamalo-Nenets autonomous district	0.16	0.90	0.31	1.36	Business	Large mining companies, subcontracting and outsourcing
Chukotka Autonomous Okrug	0.01	0.08	0.11	0.20	State	PPP, clusters, technology park
Partially Arctic regions						
Republic of Karelia	0.31	0.29	0.29	0.89	Population	Small and medium-sized mining businesses
Komi Republic	0.29	0.32	0.41	1.01	State	PPP, clusters, technology park
Krasnoyarsk Krai	1.42	1.06	1.37	3.84	Population	Small and medium-sized mining businesses
Republic of Sakha (Yakutia)	0.45	0.75	1.31	2.51	State	PPP, clusters, technology park
Arkhangelsk region and the Nenets Autonomous Okrug	0.44	0.55	0.43	1.42	Business	Large mining companies, subcontracting and outsourcing

The term "business model" first appeared in 1960. Its use in Russian management practice began in the 2000s. Its popularity subsequently increased. Currently, academic sources, both foreign and

domestic, offer numerous interpretations of this term. For example, a review of the literature on business models showed that the definition has evolved over time, but the fact remains that a business model is a

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way of conducting business, a way for a company to generate profit through the use of its resources or assets (Table 3). A business model itself is a logical

framework for describing the interactions between its elements.

Table 3. An overview of the main definitions of the term "business model"

Author	Definition
K. Prahalad, In Ramaswamy [The business model concept is a unified unit of analysis that helps understand the process of value creation, which is the result of engaging many types of resources and the outcome of many processes. An organization's business model is the logic behind the integration of resources and capabilities to consistently achieve its fundamental goals and conduct business activities. Furthermore, it is proposed that this configuration of resources and capabilities allows the firm to create unique value.
P. Timmers]	A business model consists of a set of products, services, and information flows, as well as a description of the various participants in the business process, their role in the value chain, potential benefits, and revenue streams. To understand the company's business mission, a marketing model is added, which integrates the business models and marketing strategies of the target business entity.
J. Linder and Cantrell S. [Business model as the main logic of creating added value in a company. They distinguish three types: component business models, operating business models and change models.
J. Gorjizhn	Term "business model" is often misunderstood and confused with the term "business process model". They try to describe the business model using modeling languages: UML, EPC, Petri nets

Continuation of Table 3

P. Ville, M. Vital]	A business model is a description of the roles and relationships of customers, partners, and suppliers that identifies the main supply channels, products, information flows, and cash flows.
O. Petrovik, K. Kittle	Business model as a logic of value creation in a business system
L. Applegate	A business model is a description of a complex business system that allows one to study its structure, the relationships between its structural elements, and how this system will interact with the real world.
P. Steichler]	A business model is a conceptual description that explains how a business operates. A model is always a simplification of a complex reality. It helps to understand the fundamentals of a business or plan what that business should be like.
A. Slivotsky	A business model is how a company selects a customer, formulates and differentiates its offerings, allocates resources, determines which tasks it can perform internally and which it will outsource, enters the market, creates value for the customer, and profits from it. Companies may offer products, services, or technologies, but this offering is based on a comprehensive system of actions and relationships that constitutes the company's business model.
M. Rappa [Rappa, 2006]	A business model is a way of operating a business that generates revenue and profit. A business model formally reflects the process of earning money, defining its disposition and role in the value chain in detail.
J. Funder	A business model can be defined as a sustainable method of running a business.
G. Hamel	A business concept and a business model are cut from the same cloth: a business model is simply a business concept brought to life. A successful business model generates its own intellectual hegemony.

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Chesborough G.	Business model- is the method a company uses to create value and make a profit
A. Osterwalder, I. Pigneur	A business model is an abstract conceptual model that illustrates the logic of creating added value (profit)

End of table .3

A. Osterwalder, I. Pigneur	A business model is a representation of how an organization makes (or intends to make) money. A business model describes the value an organization offers to various customers, reflects the organization's capabilities, the list of partners required to create, promote, and deliver this value to customers, and the capital relationships necessary to generate sustainable revenue streams.
Z. A. Avlasko	To radically improve the efficiency of operations Enterprises using a process-based approach to management do not necessarily need to use revolutionary production technologies or create fundamentally new products; it is sufficient to use new approaches to organizing the functioning of key areas of the business model
S. I. Mezhov, A. V. Boldenkov	A business model is a logical, schematic description of a business designed to help evaluate the key factors of a company's success. The goal of business modeling is to create a reliable, visual, and easy-to-understand description of a company's activities. This can be a drawing, diagram, or 3D model, all drawn according to certain rules. The most important thing is clarity and applicability.
L. N. Semerkova, N. G. Ostroukhova	In new business models, value will be created through attracted assets, and some business processes will be performed by specialized enterprises

Research into business models in relation to the concept of integrated processing of mineral resources, in the modern interpretation of the term "business model," originates from the ideas of V. I. Vernadsky and A. E. Fersman, which postulated the need for a harmonious coexistence between man and nature, including through the rational use of natural resources, expressed in the extraction of all valuable components from the extracted raw materials.

The first scheme of complex processing - a closed cycle scheme for the complete use of materials (Figure 3) was proposed by V. A. Reznichenko and A.

A. Morozov and presented at the "Materials Week" in Chicago (USA).

It was later improved by A. D. Verkhoturov from the point of view of orientation towards future technologies of processing mineral raw materials through its decomposition by concentrated energy flows without preliminary separation of the minerals contained in it and without enrichment.

The basis for its implementation was the creation of mini-factories at raw material extraction sites. This scheme was called an open (ideal) cycle of complete material utilization (Figure 4).



Figure 3. Complete material utilization cycle.

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Figure 4. Open loop of full material utilization.

In the works of F. D. Larichkin, one of the authoritative modern researchers of the problem of integrated processing of mineral resources, it is shown that "the nature of the synergistic effect of the integrated use of multicomponent raw materials can be identified and clearly presented by examining the fundamentally possible models of individual (single-product), integrated (conglomerate type), and combined (complex) production organized on the basis of a deposit of multicomponent mineral raw materials" (Figure 5). A key feature of the models under consideration is that they are implemented within the framework of a single enterprise and directly by it. It is argued that "the expansion of the range of extractable useful components during the

processing of multicomponent raw materials is accompanied by the transformation of only part of the processing capacities at the beneficiation stage or, most often, only in the final chemical-metallurgical operations of processing concentrates, semi-finished products, and intermediate products. At the same time, there is no need to increase the volume of raw material extraction, and, accordingly, no additional investments or ongoing costs associated with the preparation of the raw material base, mining operations, and the initial stages of preparing raw materials for processing (crushing, grinding, classification, etc.).

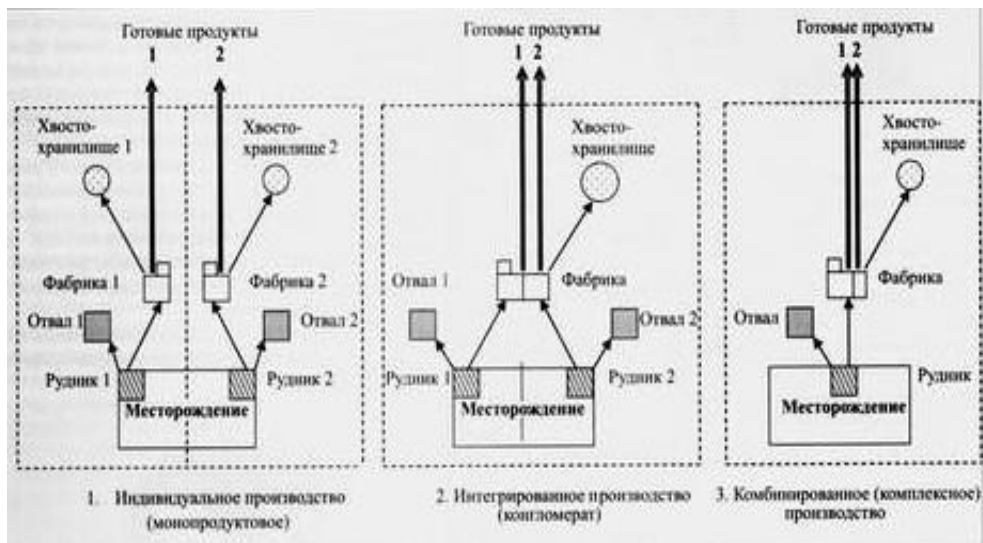


Figure 5. Types of fundamentally possible production models using a deposit of multicomponent mineral raw materials.

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At the same time, the economic entity still bears costs associated with the "conversion of a portion of its processing capacity." Furthermore, the creation of an additional processing stage will lead to increased operating costs associated with hiring additional workers, increased repair costs, and the purchase of necessary reagents for the technological process, which will ultimately impact metrics such as productivity and production costs. In today's environment, reducing production costs and increasing productivity are key priorities for many large companies listed on international stock exchanges. In such a situation, the economic interests of investors and shareholders may conflict with the goals of rational use of mineral resources through their comprehensive processing. Therefore, a solution to this situation appears to be the need to develop the proposed models by involving other economic entities in these processes and establishing partnerships. As a result of this approach, production models using a multi-component mineral deposit will take the form shown in Figure 6.

Implementation of business model A "Involvement of economic entities in mining processes" may be adopted in the presence of unused deposits with small reserves, the exploitation of which within the framework of large businesses is unprofitable, and provided that it is possible to process the extracted ore at the existing capacities of the main business's factories.

Implementation of business model B "Involving an economic entity in processing" occurs when the mined ore contains an additional volume of a valuable component that is unprofitable for independent extraction within the current production process, but has potential market demand as a finished or intermediate product. It is worth noting that the creation of such an additional processing facility can

be based on the infrastructure of an existing production facility, which will reduce initial capital investment for its construction, transportation costs during operation, and the environmental impact through the use of existing tailings storage facilities.

Implementation of business model C "Ensuring integrated processing by engaging economic entities in both mining and processing" is possible in the presence of unused, small-scale deposits whose exploitation by large businesses is unprofitable and in the absence of existing processing facilities for the extracted ore raw materials.

When considering the practical nature of the presented business models in relation to the problem of moving away from import dependence on strategic mineral raw materials using the example of apatite-nepheline ores of the Khibiny deposits located in the Murmansk region, a conclusion was reached on the possibility of their implementation, taking into account the accumulated scientific groundwork for processing technologies, established trends in corporate management of production and business, as well as in connection with the increasing demands for environmental safety and the global geopolitical changes taking place in the world.

The Khibiny apatite-nepheline ore deposit is distinguished by the diversity of its valuable components and complex composition. It is a source of phosphates, nepheline, sphene, titanomagnetite, and several other valuable rare earth elements. Developed apatite-nepheline ore beneficiation processes allow for the production of concentrates of the main minerals (nepheline, sphene, titanomagnetite, and aegirine), as well as a variety of products for a variety of applications, including those in high demand—rare metal compounds, pigments, sorbents, coagulants and flocculants, construction and welding materials, etc.

<p>A. Involvement of an economic entity in the extraction processes</p>	<p>B. Involvement of an economic entity in processing processes</p>	<p>C. Ensuring comprehensive processing by involving economic entities to both mining and processing processes</p>
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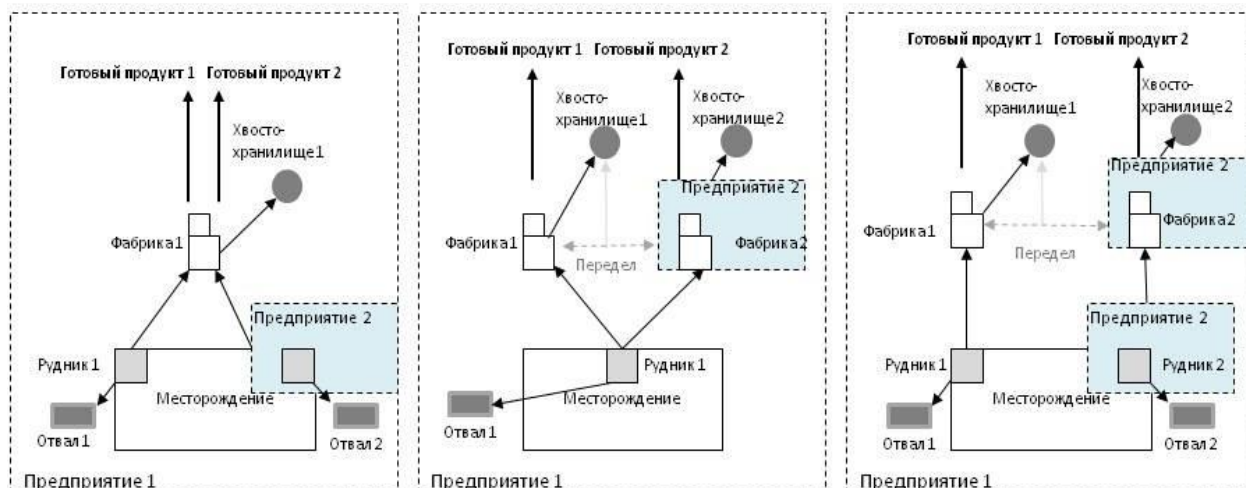


Figure 6. Business models for organizing production in the integrated processing of mineral resources with the involvement of other economic entities.

Table 4. The relationship between technological schemes for processing apatite-nepheline raw materials and business models for organizing production in the complex processing of mineral resources with the involvement of other economic entities

Raw materials	Production process	Finished product	Business model
Nepheline concentrate dust	Preliminary laser cleaning with the introduction of alloying elements by the sorption method [New welding..., 2010]	Coating of welding electrodes	B
Titanomagnetite concentrate	Pyrometallurgical processing with ilmenite and sulfuric acid [Shchelokova et al., 2018]	Pigmented titanium dioxide	B
Gremyakha-Vyrmes deposit	Mining and processing [Chemical processing..., 2003]	Ilmenite	A
Sphene concentrate	Beneficiation and hydrometallurgical method [Chemical processing..., 2003]	Titanium sorbents	B
	Purification of radionuclides by removing perovskite using enrichment methods [Purification of sphene..., 2014] and products of its chemical processing according to the sulfuric acid scheme	Titanium sealants	B
Unevaporated extraction phosphoric acid	Processing within the existing production by means of sorption using the strongly acidic macroporous cation exchanger Purolite C-150, carried out in the temperature range of 40–80 °C and corresponding to the operating parameters of the production process at the enterprise, washing the sorbent saturated with the sum of rare earth elements with water, desorption with a solution of ammonium nitrate with the production of a commercial desorbate and subsequent extraction purification of the resulting desorbate with	REE	B

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	100% tributyl phosphate [Nechaev, Polyakov, 2020]		
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Taking into account the priority objectives of developing the mineral resource base, which are related to organizing small-scale production of products in demand on the domestic market—namely, inorganic sorbents, electronic materials, titanium

dioxide-based sealants, functional rare metal compounds, and rare metal powders for capacitor and other industries—existing production processes were analyzed relative to the identified business models. The results of this analysis are presented in Table 4.

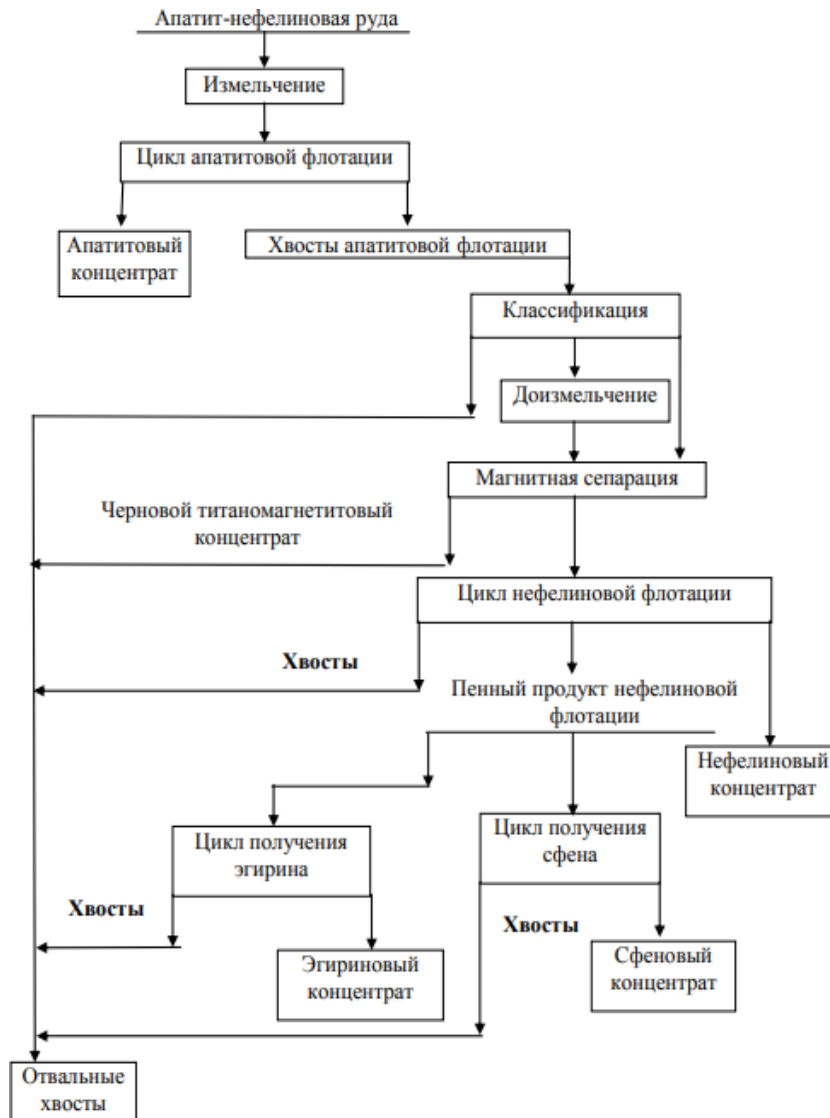


Figure 7. Scheme of production of concentrates at JSC Apatit.

Sources of these products may include current and accumulated waste from mining and processing facilities, by-products generated during primary production, and a wide range of explored deposits on the Kola Peninsula currently unused by industry. From this perspective, business models B and A, respectively, are the most promising for the Khibiny deposits.

Business Model B will determine the need to

create additional production conversions to the current technological process for the production of concentrates at JSC Apatit and gaining access to process waste, which serves as raw material for the next stage of production (Figure 7).

Business Model A will be adopted if it is necessary to obtain access to deposits for the organization of production and primary processing there.

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In both cases, these conditions in practice become key issues in the search for both the performers of this process and the definition of the mechanism of interaction between them.

Direct contractual relations of "lease", "purchase and sale", "subcontract" These projects are becoming practically unfeasible due to emerging institutional barriers (defining property rights, gaining access to industrial deposits and production waste), economic assessments (regarding pricing and cost calculations), and the risk of losing control over both the processes and the complex as a whole. For this reason, it becomes necessary to change the mechanism of interaction between economic entities within business models, allowing for the elimination of existing barriers and ensuring systemic management of the complex as a single, unified entity.

Such instruments have already been widely used globally. These include the standard Joint Operating Agreement (JOA), developed by the Association of International Petroleum Negotiators (AIPN) and used globally in hydrocarbon field development. Russian oil companies are developing fields outside the Russian Federation based on such terms in contracts previously concluded under English law, including for the implementation of Russian projects involving foreign partner companies.

The sanctions imposed against the Russian Federation prompted legislators to seek solutions regulating such contractual structures, taking into account the specifics of the Russian economy. As a result, on April 1, 2022, Federal Law No. 75-FZ "On Agreements Concluded in the Implementation of Geological Survey, Exploration, and Production of Hydrocarbon Raw Materials, and on Amendments to the Law of the Russian Federation" was adopted.

"On Subsoil Resources." This regulatory act aims to create legal conditions in the Russian Federation for the joint implementation of oil and gas projects, including offshore ones, and to stimulate investment in this sector. It provides for the possibility of concluding two types of agreements:

- service risk agreements (SRA);
- Financial Management Agreements (FMA) - for cases where there is no need for all project parties to participate in the FMA.

The practical application of the adopted Federal Law on the SSR raises many questions and comments among business entities and the public, including:

1. The problem of classifying a joint venture agreement is that a joint venture agreement is similar in nature to a joint venture agreement or a simple partnership agreement. In circumstances not regulated by the Federal Law on Joint Venture Agreements, they are governed by Russian subsoil legislation and the Civil Code. However, the lack of a clear indication that a joint venture agreement is a type of joint venture agreement may give rise to disputes regarding the application of the provisions of the Russian Civil

Code on joint venture agreements to joint venture agreements.

2. Inconsistency with internationally accepted standards—the organizational and legal model (JAA and SUA) differs significantly from the standard provisions of the Joint Activity Agreement developed by AIPN. Specifically, the parties to the JAA must always be a subsoil user and an operator, who cannot be a subsoil user, while the operator, in turn, can enter into a separate agreement with financial investors. This multi-step scheme creates difficulties in monitoring its implementation, financial, and tax accounting. It would be advisable to align the JAA agreement with the generally accepted standard AIPN Joint Activity Agreement, which requires only a single agreement in which the operator, the license holder, and financial investors not involved in mineral extraction jointly participate, and to allow the license holder to also act as the project operator.

3. Unclear division of responsibility—financial responsibilities for SSR participants are insufficiently defined, creating additional risks for parties not engaged in mineral extraction activities. Under the existing operating model, these parties bear limited liability proportional to their investment in the joint venture, which operates as a legal entity within the relevant licensed blocks. This, in turn, will further complicate the search for and attraction of investors and will hinder the practical implementation of the federal law.

4. Generalization of the compensation mechanism - more detailed information is requiredA description in federal law of the procedure for compensation for damages, taking into account the specifics of the oil and gas sector and the general provisions of the Civil Code of the Russian Federation.

5. Tax regulation of activities under SSR agreements - the introduction of the federal law necessitated the introduction of conceptual changes to tax legislation for its practical implementation, in terms of excluding activities under SSR agreements from the procedure for calculating VAT and income tax, which initially (at the first initiative of the bill in 2015) were a barrier to the approval of the bill. In the context of sanctions against the Russian Federation and a decline in investment activity (due to the departure of foreign partner companies), the relevance of the bill on SSR increased. Its introduction in 2021 without amendments to the Tax Code of the Russian Federation, which the Ministry of Finance opposed, showed the impossibility of implementation, in connection with which the Federal Law "On Amendments to Part Two of the Tax Code of the Russian Federation"99 FZ-No. 22 was adopted on February 17, 2023, allowing for the provision of benefits on VAT and income tax. This, in turn, made the work of the adopted.

The law regulating the conclusion of service risk

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agreements and financing management for geological exploration, prospecting, and production of hydrocarbons is currently in effect. Such innovations raise concerns due to the highly likely shortfall in federal budget funds and the further enrichment of oil and gas companies, as well as the continued trend toward an extensive approach to subsoil use and the failure to address the issue of integrated mineral resource utilization. To address these risks, it is necessary to clarify the subject of the agreement, namely, the types of projects for which the application of SSR and SSF will be possible. Such projects in the oil refining sector should include projects involving unfinished wells, geological exploration, processing, and the extraction of associated raw materials and other non-core valuable components. This approach will allow for a clearer distinction between the core activities of extracting and processing the main component and the activities of rational use of the mineral resource base and will create the basis for the possibility of a financially secure extension of the practice of using SSR and SSF agreements to other strategically important mineral elements for which there are the greatest risks of import dependence.

6. The uncertainty of the contract's duration, i.e. the lack of specifics According to this regulation, on the one hand, it creates risks of transferring project activities to a permanent work format, which, in the context of the introduced tax incentives, causes budgetary risks; on the other hand, the standard adopted corporate policy on short-term contractual relations (up to 1 year) can lead to transaction costs for companies when renewing such contracts.

7. The unequal position of the subsoil user and the operator—the provision on the termination of contracts—creates an advantage for the subsoil user and disproportionately worsens the position of operators, which may cause difficulties in their involvement and the practical implementation of the law on SSR.

Thus, the work already begun to regulate the activities of subsoil users, in terms of defining the mechanism for their interaction, requires further

clarification and improvement. At the same time, it is necessary to strengthen the systematic nature of the adopted decisions on SSR and SSF agreements, expand their application to the entire mineral resource base, and clarify the purpose of such activities to ensure the minimization of the risks of import dependence for strategic mineral resources, the development of high-tech industries as consumers of mineral raw materials, and environmental safety in the context of rational nature management.

According to the authors, increasing the systemic nature is seen in the creation of a mechanism for network interaction between economic entities in the mining and processing complex, implemented through a corresponding agreement.

The essence of such contractual relationships lies in the transfer of part of the processes to another economic entity without losing control of the process and in obtaining the required finished product. Supply and demand relationships are formed within the complex and can be regulated by the state through the use of various targeted regulators to adjust the operating conditions of the complex as a single management entity. The operation of a mining and processing complex under a network cooperation agreement is schematically depicted in Figure 8.

A resource base holder (hereinafter referred to as a RRB) is a mining and processing enterprise licensed to develop specific deposits. During the development of a technology for extracting valuable components from extracted minerals, the RRB holder independently assesses the adequacy of its own resource, the feasibility and feasibility of its creation, or the need to engage the resources of a participating organization.

The network agreement then has three execution options:

- 1) the holder of the RSB is the base organization;
- 2) the holder of the RSB is a participating organization;
- 3) The holder of the RSB is a partner organization.

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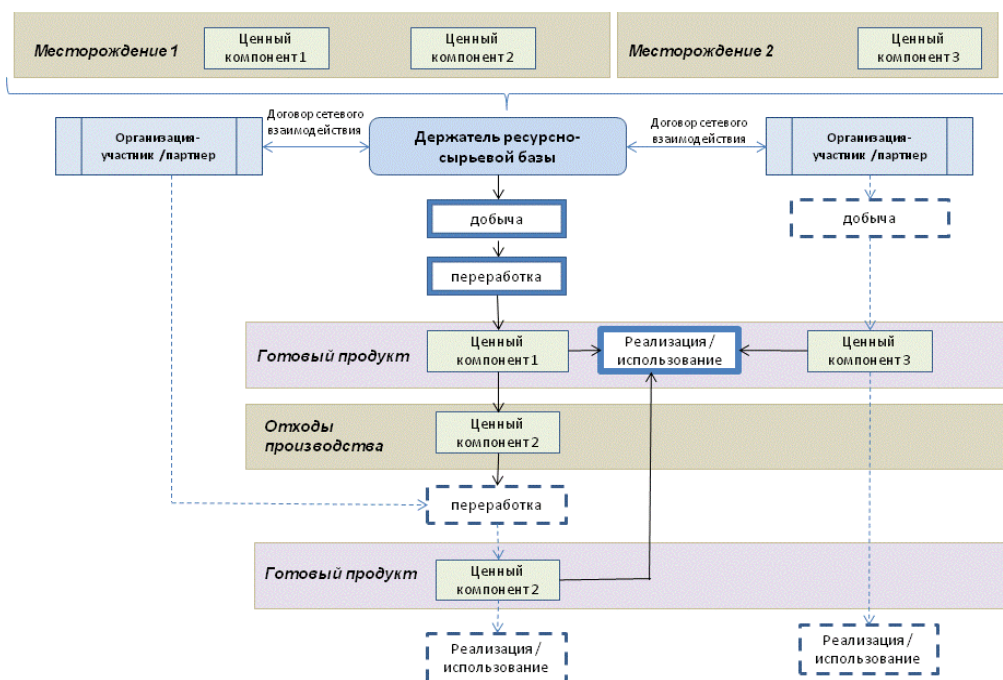


Figure 8. Scheme of organization of a mining and processing complex based on the mechanism of network interaction.

All aspects of the difference between a network interaction agreement and standard civil law agreements of subcontract, cooperation, lease and purchase and sale are presented in Tables 5–7.

The proposed methods could serve as the basis for the practical implementation of processing tailings generated during the production of apatite-nepheline concentrate, producing finished products such as

inorganic sorbents, electronic materials, titanium dioxide-based sealants, functional rare metal compounds, and rare metal powders for capacitor and other industries, for subsequent use and for in-house production or sale as finished goods. Implementation of the proposed models would also facilitate the attraction of economic entities to the region or the creation of new enterprises.

Table 5. Comparison of a network interaction agreement with a subcontract agreement

Criteria for comparison	Network Interaction Agreement (the holder of the RSB is the base organization)	Subcontract agreement
Subject of the agreement	Assignment to another party - execution of work on converting production waste into a new finished product with its subsequent transfer to the base organization	
Conditions of execution		
Rights and obligations of the parties	Establishment of production at the location of the base organization using its infrastructure	Production is located at the location of the contractor
Financial support	The contract price consists of the cost of organizing production	The contract price includes costs: <ul style="list-style-type: none"> • for the logistics of delivering raw materials to the processing site; • for production and shipping
Contract term	Long-term - for a planning horizon of 10 to 30 years	Short term - until the obligations are fulfilled

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Table 6. Comparison of a network interaction agreement with a lease and/or purchase agreement

Criteria for comparison	Network Interaction Agreement (the holder of the RSB is the participating organization)	Lease agreement / purchase agreement
Subject of the agreement	Provision of production capacity/production waste for the production of a specific finished product	
Conditions of execution		
Rights and obligations of the parties	An obligation of one party to provide and pay for the provided resources of a certain quality and quantity if the other party is obligated to organize additional production to extract a new valuable component	An obligation to provide and pay for the provided resources of a certain quality and quantity
Financial support	Preferential terms for leasing capacities and selling raw materials in the form of mutual offsets for the amount of investments in the creation of an additional production process	Market value of rent/sale of raw materials
Contract term	Long-term - for a planning horizon equal to at least the payback period for investments in the creation of a new process stage	Short term - until the obligations are fulfilled

Table 7. Comparison of a network interaction agreement with a cooperation agreement

Criteria for comparison	Network Interaction Agreement (the holder of the RSB is a partner organization)	Cooperation agreement
Subject of the agreement	Organization of joint production for the extraction of a new valuable component	
Conditions of execution		
Rights and obligations of the parties	Obligations of each party to organize and carry out production with the right to an equal share of the volume of the finished product	Provide mutual assistance for the organization and implementation of activities
Financial support	The price of the finished product if additional volume needs to be purchased at a partner organization	Situational definition in additional agreements
Contract term	Until one of the parties refuses to continue the relationship	Until the goal of cooperation is achieved

To stimulate entrepreneurial activity, the creation of appropriate, targeted government regulations is also necessary. Generally, such regulations may include special economic regimes and their extension to the mining and processing industry as a whole, including tax incentives at all levels and various social programs for staffing (housing, education, migration, etc.). The mechanism for providing these incentives may be determined by the requirement to sign an agreement on joining the mining and processing industry and a network cooperation agreement for the implementation of the business model defined above. The development of specific regulations requires an

analysis of the external environment and an assessment of the readiness of economic entities to implement such activities.

To determine the factors that hinder or, conversely, facilitate to increase entrepreneurial activity in the field of integrated processing of mineral resources in the regions of the Arctic Zone of the Russian Federation through the application of proposed business management concepts, the PEST analysis method was applied.

Among the political factors (P), it is primarily worth noting the state's recognition of the strategic importance of the Russian Arctic territories and the

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adoption of a number of fundamental documents on its development over the past six years. These include, first and foremost, the decrees of the President of the Russian Federation of May 2, 2014.

No. 296 "On the Land Territories of the Arctic Zone of the Russian Federation", dated March 5, 2020 No. 164 "On the Fundamentals of State Policy of the Russian Federation in the Arctic for the Period up to 2035", dated October 26, 2020 No. 645 "On the Strategy for the Development of the Arctic Zone of the Russian Federation and Ensuring National Security for the Period up to 2035"; Federal Law of July 13, 2020.

No. 193-FZ "On state support for entrepreneurial activity in the Arctic zone of the Russian Federation"; Resolutions of the Government of the Russian Federation of September 2, 2020 No. 1338 "On approval of the Rules for the provision of subsidies from the federal budget to reimburse expenses for the payment of insurance premiums incurred by legal entities and individual entrepreneurs who are residents of the Arctic zone of the Russian Federation", dated March 30, 2021 No. 484 "On approval of the state program of the Russian Federation "Socio-economic development of the Arctic zone of the Russian Federation", as well as other amendments to legislative acts in connection with the entry into force of these regulatory documents.

Regarding the problem of developing entrepreneurial activity in the territory of the Arctic Zone of the Russian Federation, the most indicative are: Federal Law

"On state support for entrepreneurial activity in the Arctic zone of the Russian Federation" (came into force on August 13, 2020); Decree

The President of the Russian Federation "On the Strategy for the Development of the Arctic Zone of the Russian Federation and Ensuring National Security for the Period up to 2035" and the Resolution of the Government of the Russian Federation "On Approval of the State Program of the Russian Federation "Socio-Economic Development of the Arctic Zone of the Russian Federation".

The aforementioned regulatory documents place a primary emphasis on stimulating entrepreneurial activity in the Arctic—the emergence of new economic entities willing to invest in the development of the business areas identified by the government. To this end, the entire land portion of the Arctic Zone of the Russian Federation is being designated a special economic zone, offering significant preferences to newcomers and existing economic entities diversifying their operations. The adoption of Federal Law No. 193 of July 13, 2020, is in line with one of the objectives set out in the Arctic Zone Development Strategy to 2035: "the implementation of a special economic regime in the Arctic zone that facilitates the transition to a closed-loop economy, private

investment in geological exploration, the creation of new and the modernization of existing industrial production facilities, the development of science-intensive and high-tech industries, the development of new oil and gas provinces, solid mineral deposits, and hard-to-recover hydrocarbon reserves, and the expansion of deep oil refining, liquefied natural gas, and gas chemical production."

The Arctic Zone Development Strategy to 2035 also defines the following mechanisms for achieving these objectives: providing state support to investors for capital investments in transport, energy, and engineering infrastructure; simplifying the process for allocating land plots to citizens for economic and other legally permitted activities; and creating and developing a new model for implementing economic projects on the continental shelf, which provides for increased private participation in such projects while maintaining state control over their implementation. In addition to the economic component, the solution to the problem of integrated processing of mineral resources within the framework of the Strategy is determined by the objectives of ensuring the environmental friendliness of economic activity in the Arctic and preventing negative environmental impacts during the development of natural resources.

At the same time, researchers studying the problem of integrated processing of mineral resources note institutional barriers as one of the main barriers to the implementation of this concept. These barriers are associated with the "imperfection, fragmentation (lack of systemic nature) and inconsistency of Russian natural resource legislation, the system of state regulation of subsoil use processes (including taxation) in general and the integrated use of subsoil resources in particular. Active normative work in the field of subsoil use regulation, which began with the adoption of the Strategy for the Development of the Mineral Resource Base in 2015, made it possible to remove most of the identified restrictions and create a basis for the application of new tools and mechanisms of interaction by economic entities. The primary emphasis is placed on hydrocarbon raw materials. They are also the focus of the Strategies for the Development of the Mineral Resource Base and the Development of the Arctic Zone of the Russian Federation, which coincide in terms of solving the problem of replenishing mineral resources by intensifying geological exploration while stimulating private investment. This imbalance overshadows other types of solid minerals, as well as addressing stated environmental challenges, particularly the problem of accumulated man-made deposits. The amendments to the Arctic Development Strategy to 2035 add "the reproduction and development of the mineral resource base, as well as the exploration and production of solid minerals in the Arctic zone, including in the exclusive economic zone of the Russian Federation and on the continental shelf," to

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the objectives of the first stage of its implementation for 2020–2024. This provides an opportunity to mitigate these imbalances, but, in turn, also requires corresponding adjustments to the action plan for implementing the Arctic Zone Development Strategy, which, in its current version, is clearly insufficient to address this issue. Thus, the focus of state policy on the development of Russian Arctic territories and the improvement of subsoil use legislation are creating a favorable environment for the development of entrepreneurial activity in the mineral extraction and processing industry. However, its practical implementation requires further work to specify the introduced provisions, adjust related legislative acts and expand the range of their impact on other types of

mineral resources that are of strategic importance for the development of high-tech sectors of the national economy and moving away from import dependence.

Economic factors(E) The current challenges regarding the implementation of the integrated processing approach for mineral resources include: high processing and transportation costs; uncertainty in demand for additionally extracted valuable components; and a lack of necessary production capacity. Finding customers willing to purchase small volumes of extracted raw materials is a challenging task, given the remoteness of the Arctic regions and the limited market of local economic entities, the number of which in the Arctic Zone of the Russian Federation is decreasing every year (Table 8).

Table 8. Comparison of the rates of change in the number of economic entities, %

Region	2011	2012	2013	2014	2015	2018	2020	2021	2022	2023	2024	Average for the period
Republic of Karelia	103	104	96.9	101.2	103.3	100.1	93.7	91	95.3	94.9	92.5	97.8
Arkhangelsk region, including the Nenets Autonomous Okrug	98.6	99.8	102.6	96.3	101.7	92.7	95.3	95.5	94.9	94.7	94.2	96.9
Russian Federation	100.9	100.4	99.1	100.9	103.2	94.5	95.7	92.4	90.8	91.9	95.1	96.8
Yamalo-Nenets autonomous district	94.8	100.2	102.2	98.2	103.2	101.2	91.4	91.5	92.8	93.8	94.5	96.7
Komi Republic	96.7	93.9	102.5	97.6	101.9	97.6	92.8	95	90.3	92.9	90.9	95.6
Murmansk region	93.3	99.2	101.6	101.1	103.5	84	96.2	94.2	85.9	95.8	97.4	95.7

When considering the most common business management concepts for the integrated processing of mineral resources, it should also be noted that a key role is still assigned to the existing business, as the primary user of the deposit. Decisions by existing businesses are based primarily on economic considerations: ensuring the profitability of a new activity and maintaining the current level of profitability and productivity of existing production. Implementing these considerations in Arctic conditions is impossible without government support.

In view of this, the measures and objectives set forth in the Arctic Zone Development Strategy until 2035 and Federal Law No. 193-FZ of July 13, 2020, "On State Support for Entrepreneurial Activity in the Arctic Zone of the Russian Federation," provide a foundation conducive to their implementation. At the

same time, with regard to subsoil use, the established mechanisms for interaction between economic entities of the SSR and the SCF need to be expanded to cover other production processes related to the processing of extracted mineral raw materials, due to their capital intensity being no less than geological exploration and deposit development, and the need to attract investment in this activity. Synchronizing such measures across Russian Arctic regions has the potential to both stimulate entrepreneurial activity in these regions and make integrated processing projects cost-effective, increasing the practical interest of existing subsoil users. The greatest concern for measures aimed at increasing entrepreneurial activity in general and in terms of the integrated processing of mineral resources are caused by social factors (S), caused by a shortage of labor resources in the areas

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where investment projects of Arctic zone residents will be implemented. The key negative trend for all regions of the Arctic Zone of the Russian Federation is the decline in the working-age population and its migration outflow (Table 9). Over 20 years, the permanent population of the northern territories has decreased by 1.1 million (from 10.9 million people in 2001 to 9.8 million people in 2024). Negative trends in the area of migration population growth persist. Thus, the migration population growth was -51.1, -30 and -10.7 thousand people in 2014, 2020 and 2024, respectively.

Achieving the economic feasibility of integrated mineral resource processing is largely possible through the search for and development of effective technological solutions. Therefore, technological factors (T) continue to play a key role in ensuring waste recycling and the integration of the entire range of valuable components contained in ore into processing. A combined processing scheme necessitates not only the alignment of processes and functions within the economic entity but also the development of intersectoral collaboration.

Table 9. Population dynamics by regions of the Arctic Zone of the Russian Federation in 2010–2024, thousand people.

Regions	2010	2011	2012	2013	2014	2015	2019	2020	2021	2022	2023	2024
Completely Arctic regions												
Chukotka Autonomous Okrug	51	51	51	51	51	50	50	50	50	50.3	49.5	50
Nenets Autonomous Okrug	42.1	42.1	41.8	41.7	41.6	41.4	41.3	41.2	41.1	44.1	44.4	44.5
Yamalo-Nenets autonomous district	525	537	542	540	540	534	536	538	541	544.4	547	552.1
Murmansk region	794	788	780	771	766	762	757	754	748	741.4	732.9	724.5
Partially Arctic regions												
Krasnoyarsk Krai	2830	2833	2842	2849	2855	2862	2870	2875	2875	2870	2861	2852
Republic of Karelia	642.6	639.7	636.9	634.4	632.5	629.9	627.1	622.5	618	614.1	609.1	603.1
Komi Republic	899.2	889.8	880.7	872	864.5	856.8	850.5	840.9	830.2	820.5	813.6	803.5
Republic of Sakha (Yakutia)	958	956	956	955	957	960	963	964	967	972	982	992.1
Arkhangelsk region	1224.9	1182.8	1202.3	1191.8	1183.3	1174.1	1130.2	1155	1144.1	1092.4	1082.7	1069.8
Russian Federation	142,865	143,056	143,347	143,667	146,267	146,545	146,804	146,880	146,781	146,749	146,459	175,864
Total for the Arctic Zone of the Russian Federation	5094.7	5075	5048.9	5015.2	4994.3	4966.8	4949.3	4924.4	4898.3	3786.8	3778.5	3769.8
Share in the all-Russian indicator, %	3.57	3.55	3.52	3.49	3.41	3.39	3.37	3.35	3.34	2.58	2.58	2.14

Since, when developing a "deposit assigned to a particular industry based on its main mineral, the funds released are intended for the production of that

particular mineral—the industry's product. The rest is waste. But when it comes to regions such as the Krivoy Rog Basin, the Kola Peninsula, the Urals, and

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the Kursk Magnetic Anomaly, the implementation of waste-free technology within a single mining and processing plant is hardly possible. Rational nature management requires not only the disposal of the majority of waste; it also implies the organization of an industrial circulation of substances that will not disturb the ecological balance. Consequently, it is necessary to obtain products for various industries" [Vilkul et al., 2013]. One such industry is mechanical engineering. Russia's high dependence on imports for mining machinery and equipment increases the risks of implementing both Strategies, including the development of the Arctic Zone of the Russian Federation and the mineral resource base as a whole, in the event of a deterioration in geopolitical conditions. Since the 1990s. In search of the most effective solutions, companies resorted to a combination of domestic and foreign technologies: this included laboratory, quarry, mine, conveyor, and auxiliary equipment, digital and automation systems, and software. Due to the complexity and scale of the mining industry, not all equipment can be replaced quickly and without compromising efficiency.

This primarily concerns complex equipment: for example, according to estimates by the Non-Profit Partnership "Mining Industrialists of Russia," in the mining machinery sector, it will soon be difficult to find comparable imports in the required volumes for underground drilling machines, load-haul trucks, compact dump trucks, and open-pit mining

equipment. This risk can only be mitigated by developing domestic production and providing it with the necessary mineral raw materials, as well as by encouraging research and development through public-private partnerships and developing a lending system for such projects.

A primary (theoretical) assessment of the identified factors, as perceived by economic agents, was conducted through in-depth structured interviews with business and government experts, the main market participants whose entrepreneurial activity predominates in the Arctic Zone of the Russian Federation. The business expert interviewed was the head of a major mining company in the Murmansk Region, responsible for ensuring integrated processing and developing mining operations at the company. The government expert interviewed was the head of the municipal administration where the major mining company operates. The comparison of business and government opinions on integrated processing of mineral resources is shown in Figure 9, and the assessment of barriers is shown in Figure 10.

It has been established that both business and the government recognize the importance and potential of implementing integrated processing of mineral resources, provided that this activity receives special support from the government and that efforts are made by all market participants. Business, unlike the government, sees not only the advantages of implementing this concept, but also its disadvantages.

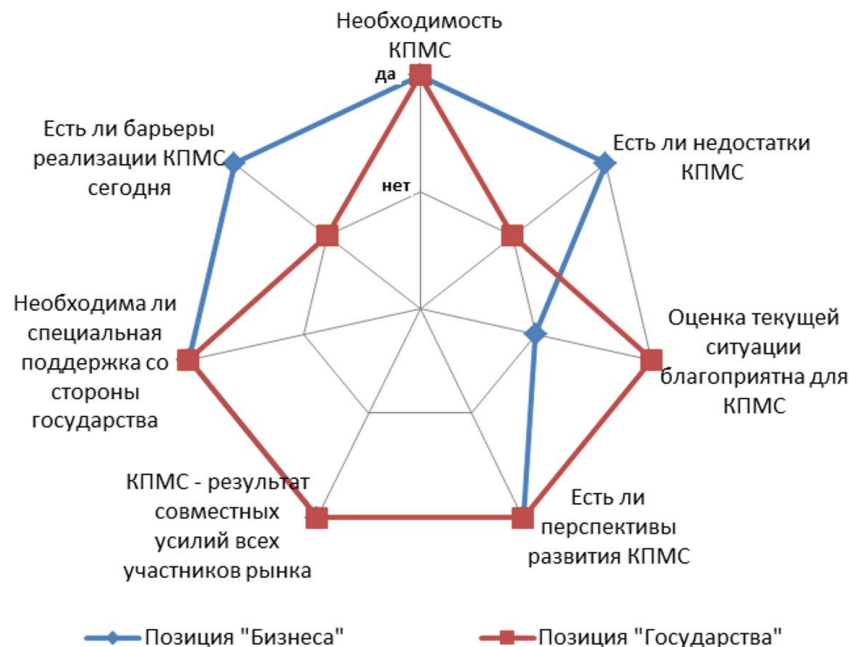


Figure 9. Comparison of opinions on the integrated processing of mineral resources among business and government representatives.

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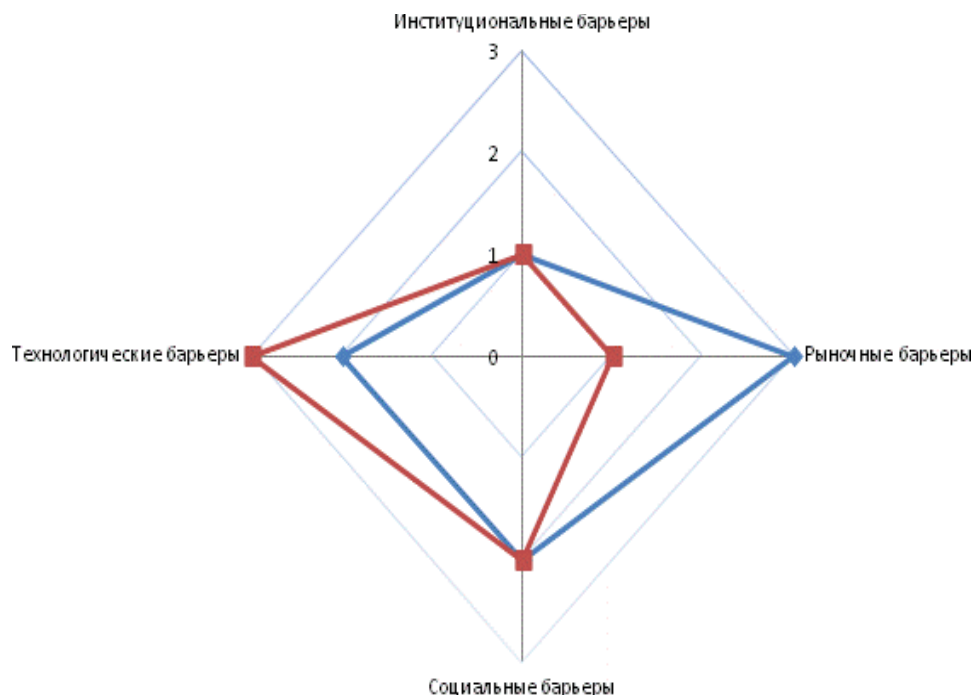


Figure 10. Comparison of opinions on barriers to the implementation of integrated processing of mineral resources.

The risks identified by businesses primarily included "demand risk," "profitability risk," and "competition risk." Technological risk is also assessed differently by businesses and the government, with the former assigning it less significance and defining it as entirely solvable.

It is noteworthy that the "institutional risk" associated with the regulatory framework for the approach to integrated processing of mineral raw materials and waste recycling, which is widely covered in existing scientific research as a key issue complicating the solution of the issue in the Russian Federation, was not identified as significant by either business or the government.

"Social barriers" were noted by businesses and the government as significant, but manageable and mitigated by diversifying production based on the integrated processing of mineral resources through the creation of additional jobs and the implementation of corporate and government programs to attract and retain personnel.

The interviews allowed for a deeper understanding of each of the PEST analysis factors and the identification of new aspects relevant to economic entities in terms of their readiness and resistance to the practical implementation of the integrated mineral resource processing concept. To account for and systematize all possible factors determining the readiness and resistance of market participants to implement the integrated mineral resource processing concept (hereinafter, IMPC), and to conduct a more in-depth and expanded assessment using content analysis as the second stage of the study,

a review of scientific publications on the topic of integrated mineral resource processing was conducted.

As a result, 20 factors were identified that scientists and researchers emphasize when considering the problem of integrated processing of mineral resources.

The first and most frequently cited factor is mineral reserves. It was mentioned in some way or another in all of the publications reviewed, and to a large extent (67%) it had a positive emotional connotation, driven by Russia's significant endowment with mineral resources of both natural and man-made origin. Conditions that facilitated the implementation of the CPMS included: deterioration in mining and geological conditions and the quality of deposits involved in development; and a reduction in the volume of geological exploration. Negative assessments of this factor, which hinders the implementation of the CPMS, included the deterioration over time of the qualitative and quantitative composition of previously formed, mature waste, and changes in the physical and mechanical properties of rocks.

Publications also highlight the potential for developed processing technologies, alongside mineral resource reserves. This is mentioned as a potential opportunity in 33% of publications and is characterized by the presence of significant scientific groundwork and accumulated experience in developed technologies for the comprehensive and in-depth processing of mineral resources. However, in other cases, the technological factor is viewed more

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negatively due to the lack of effective processing technologies ready for large-scale application and the need for further research. One of the key requirements in this area is the need to create a unified information space for accounting for mineral resource reserves, both natural and man-made, to obtain reliable mineralogical information that should be accessible to research institutes and manufacturing organizations across various departments.

The availability of required production capacity is crucial for the implementation of the integrated processing chain. This includes the availability of existing processing assets, the number of economic entities owning them, and their category (small, medium, or large businesses), as well as the equipment used in the processing. The publications reviewed positively noted that Russia has significant potential to create a complete production chain; however, interregional cooperation has not been sufficiently widespread, resulting in underutilization of production capacity at most facilities. It is noted that the organization of integrated processing chain production is possible within a single enterprise without the need to separate this activity into a specialized production facility. However, there are limitations regarding the adequacy of in-house material and technical resources, reflected in the lack of R&D departments and the efficiency of existing equipment in terms of productivity and environmental safety, as well as its wear and tear and the need for modernization. The latter requires economic entities to make significant investments in modernization, which is another factor in implementing the integrated processing chain identified in the analysis. Moreover, investments are required not only to improve the material and technical base, but also to resolve the issue of staffing.

The success of the implementation of the CPMS, like the progress of any sector of material production, is directly dependent on the quality of personnel. The personnel factor in the publications reviewed positively characterizes the existing Russian system of training higher and secondary education personnel for the mining industry, which has preserved the principles of traditional Russian education and specialized training as the level of higher professional education. However, the need for further improvement is also noted to align it with current business needs and maintain a proactive approach. Certain areas of personnel training, such as geology and mineralogy, require strengthening, as does the implementation of the concept of continuous education for mining engineers in collaboration with the educational, scientific, and business communities.

The fifth factor in the publications reviewed was government regulation (the state of the legal framework). This factor was largely (75%) viewed negatively in the publications reviewed, citing the imperfections and inadequacy of the current

regulatory framework in Russia. This was fully reflected in the content of the first stage of implementation of the Strategy for the Development of the Mineral Resources Complex of Russia until 2035, as one of its key objectives. A constraining effect was also characterized by departmental disunity in waste management (Rosprirodnadzor and Rosnedra), in matters of establishing property rights, and the lack of a unified accounting system. Opportunities were created by the emergence of new and updated legislative regulations, which strengthen subsoil users' responsibilities for waste management, as well as the need to develop new approaches to state management of deposit operations in general. The sixth factor, administrative barriers, was a derivative of the "government regulation (legal framework)" factor. It was clearly viewed as negative, as it complicates the activities of subsoil users in the use (recycling) and disposal of the waste they generate; access to accumulated man-made waste by organizations, including small mining businesses, is limited; there is a need to license waste management activities; and the principle of "developing large deposits" applies to the development of man-made waste. The latter aspects were also identified as separate factors—the factor of patents, licenses for operations, and the factor of permits for the implementation of the type of activity. The marketing component of the CPMS is directly linked to the demand factor. In the reviewed publications, it is encountered in terms of justifying the relevance of the CPMS in the analysis of the application areas of extracted valuable components. As an opportunity for the implementation of the CPMS, the demand factor is determined by the development of areas of activity where valuable components of mineral raw materials, the content of which in the mined ore is generally insignificant, are in demand. At the same time, their diversity also becomes a deterrent, since the demand for them is often differentiated and small in volume.

The profitability of implementing a multi-component mineral resource complex (MRC) is determined by the price of the extracted valuable components. The key scientific question addressed in the publications is the definition of a pricing methodology for MRC, including the justification of the price of each valuable element that makes up a multi-component mineral resource and the various products of its complex processing at different stages of production, including recycled mining waste. Having a scientific foundation for the pricing methodology is a positive aspect of this factor. The constraining nature of the price factor is reflected in the correlation between the dynamics of global prices for the final products of the mineral resource complex and the traditional primary processing technologies used, necessitating government regulation of this issue through cost subsidies and a corresponding export policy. In examining the MRC issue, the

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authors also consider the energy factor. The feasibility of organizing a MRC is justified by the sufficient energy supply of the Russian national economy. In a market economy, maintaining the competitiveness and profitability of companies requires a constant search for new technological solutions that improve production energy efficiency due to rising energy prices. Russia currently has effective energy-saving technologies for the comprehensive and deep processing of refractory ores with complex compositions and man-made mineral raw materials, enabling the production of high-quality finished products that are competitive in the global market. Besides energy, the main production costs in mineral processing are related to the purchase of chemical reagents used to obtain concentrates and isolate marketable products. Therefore, the component selection factor was the next key consideration. The positive impact of this factor, which determines the feasibility of implementing the CPMS, is due to scientific advances in the development of new, efficient processes. However, it is noted that the reagents used have several drawbacks, including their environmental hazards and economic inefficiency. Therefore, the search for and development of new reagents remains a pressing scientific challenge. Furthermore, this factor can be attributed to resistance due to the shortage of domestically produced products noted in publications and the insufficient technical base for their production in Russia. The authors of the publications identified the need for government support as a mechanism for mitigating all resistance factors. In terms of government incentives for the CPMS, the issue of tax regulation of this activity is most frequently raised in publications. Researchers argue that increasing the economic efficiency of the CPMS requires eliminating the causes and conditions contributing to the unlawful formation of the tax base and determination of taxable objects for organizations implementing the CPM. However, so far, this condition in the publications reviewed acts more as a deterrent due to its impracticability in Russia. The flat scale of the current mineral extraction tax does not allow for differentiation in its collection depending on the stage of development, mining and geological conditions, degree of depletion, and location of the deposit, which creates an unequal playing field for mining organizations. Extraction of minerals with significant operating costs becomes impractical for subsoil users (a negative indicator of the economic efficiency of the field development project), and the state (the owner of the subsoil) experiences an increasing number of unprofitable deposits. Other government support measures include preferences related to cost subsidies, stimulating demand for new products, and price regulation. The insufficient implementation of these mechanisms in Russia, compared to other countries, such as China.

In terms of rare earth elements, this is considered

a factor hindering the implementation of the CPMS. The development of the CPMS also depends on the level of interaction between economic entities in the industry. In the publications reviewed, this condition is reflected in the factors of competition and the availability of necessary suppliers (contractors) and partners. Competition is viewed as a factor hindering imports, which fully satisfy domestic demand for valuable components that are by-products in the production of the main product at Russian facilities and are often inferior in quality to imported ones. The lack of economic entities willing to act as suppliers and the low level of cooperation and interaction between companies as partners to create a unified production chain are also negatively assessed in the publications where they are mentioned, which classifies these factors as factors of resistance.

In order to optimize the work on further analysis and evaluation of the identified factors, and also due to the fact that their list is not exhaustive, the listed factors were systematized according to their generalizing feature into five main groups.

The first group "Resource component" will include factors such as the availability of mineral reserves, the availability of production capacity, the number of personnel and their qualifications, investment opportunities, the sufficiency of components for production (additives, reagents, materials, components, etc.) and energy security.

The second group of factors, "Technological component," includes the developed potential technology for processing mineral raw materials, as well as patents and licenses for carrying out activities.

The third group "Institutional environment" is represented by factors that determine the legality of an activity, namely, the availability of permits to carry out a type of activity, the level of administrative barriers and state regulation of this activity from the point of view of the state of the legal field.

Market factors are included in the fourth group, "Market Component," and include the level of prices, demand, and competition in the market, as well as entrepreneurial activity in the market in the form of the availability of necessary suppliers and contractors that must be attracted to organize activities for the integrated processing of mineral resources.

The fifth group of factors is designated as "Supporting Environment" and is represented by measures to support the type of activity from the state, as well as the development of partnerships and the willingness of economic entities to cooperate in implementing the CPMS.

The resulting classification of factors served as the basis for developing a questionnaire, which was used to interview representatives of the business and scientific communities operating in the Arctic Zone of the Russian Federation using expert assessments. The Murmansk Region was chosen as the study region, following on from a previous study. Expert

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assessments were obtained from two major mining companies in the Murmansk Region and from representatives of the scientific community. A key condition for the survey was. The survey was conducted anonymously, so the results of the assessments obtained are presented in a generalized form. The collected data was processed using a method for determining the probability of successful change implementation. This method was chosen because it is applicable to any project, regardless of its scale, and can be considered in relation to a specific project or enterprise, as well as changes at the

economic level as a whole, based on a wide range of indicators, allowing for a comprehensive assessment of the upcoming changes.

Based on the results of the expert survey and the processing of the obtained assessments, the following summary assessments of the level of readiness and resistance of the regional economic system of the Murmansk region to the transition to the implementation of the concept of integrated processing of mineral resources were obtained (Appendices B and G, respectively).

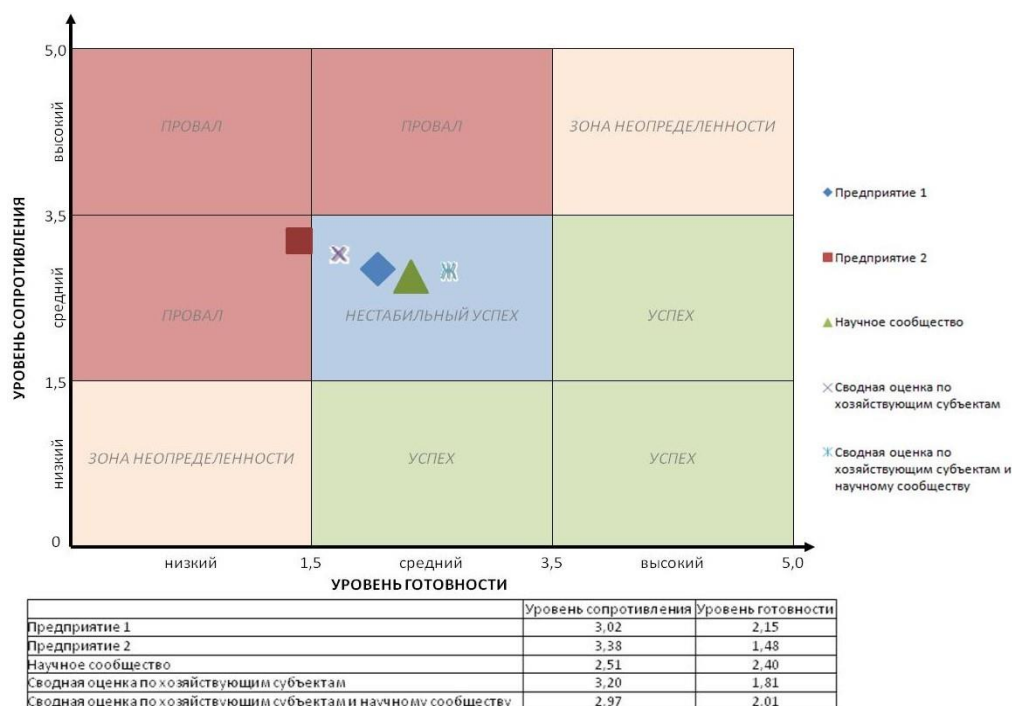


Figure 11. Positioning matrix of the regional economic system of the Murmansk region in relation to the success of the transition to the implementation of the concept of integrated processing of mineral resources.

After assessing the readiness and resistance of the Murmansk region's regional economic system to change, we positioned the region's economic entities and the regional economic system as a whole (with and without consideration of the scientific community's opinion) relative to the success of the transition to the integrated processing of mineral resources. The resulting positioning matrix relative to

the success of the changes is shown in Figure 11.

During change management, it's important to assess the level of resistance to each specific change. Therefore, the level of readiness and resistance was also assessed for each identified group of factors, as the sum of its constituent indicators. The positioning of each group of factors relative to the change implementation success matrix is shown in Figure 12.

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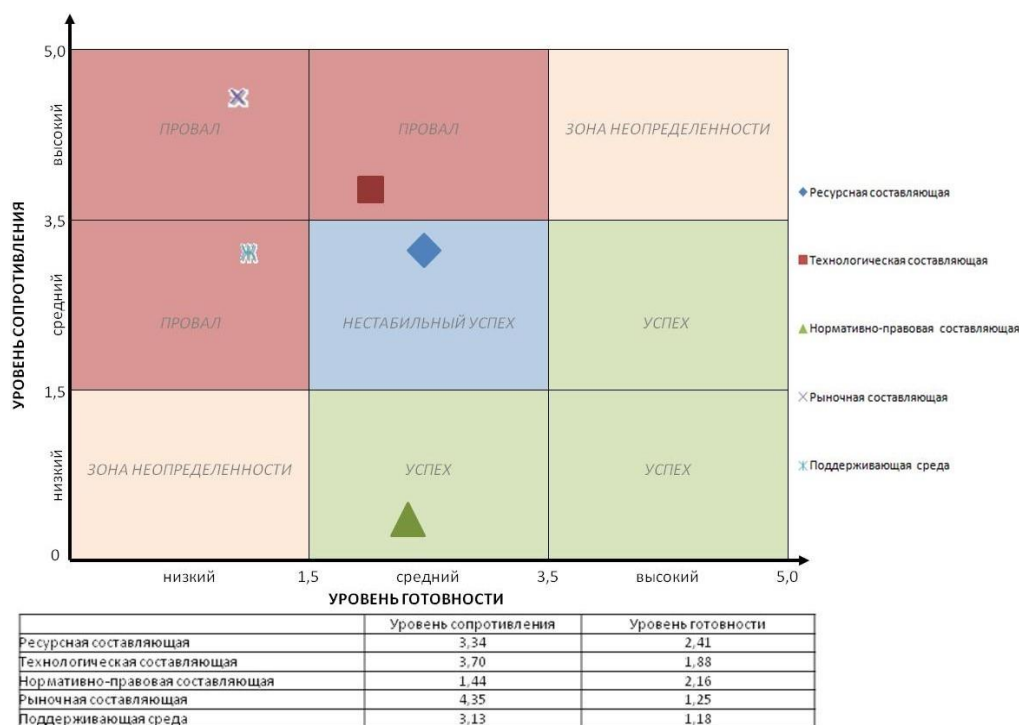


Figure 12. Matrix of positioning groups of transition factors for the implementation of the concept of integrated processing of mineral resources according to estimates of economic entities.

Thus, as a result of collecting and processing the received expert opinions, the readiness assessment of the regional economic system of the Murmansk region amounted to 1.81 points (out of a possible 5) with a resistance level of 3.20 points (out of 5, where 5 is the highest level of resistance), which can be characterized as a level of "unstable success" in the positioning of the regional economic system. This means that the regional economic system of the Murmansk region has a fairly high level of resistance and an average value of readiness for changes associated with the transition to the implementation of the concept of integrated processing of mineral resources. A separate collection of expert opinions from the scientific community on the transition to the implementation of the concept of integrated processing of mineral resources was conducted. The obtained assessments are also positioned in the "unstable success" zone, with a readiness level of 2.40 points (out of a possible 5) and a resistance assessment of 2.51 (out of 5, where 5 is the highest level of resistance).

It is necessary to reduce resistance to change and, where possible, increase the willingness of regional economic entities to embrace such changes. It was noted that the range of economic entities' assessments of their readiness varied widely, ranging from 1.48 (out of a possible 5) to 2.15 (out of a possible 5), while the level of resistance was assessed almost uniformly—from 3.02 to 3.38 (out of 5, with 5 representing the highest level of resistance). Consequently, some enterprises find themselves in a

"failure zone" when deciding to implement the integrated mineral resource processing concept, meaning the economic entity is unprepared to implement the changes and faces significant risks. Other enterprises are in a "fluctuating success zone," meaning it is difficult to definitively assess the feasibility and success of the changes. The differences in assessments between economic entities are due to the varying experience of the surveyed economic entities in this area and the availability of proven processing technologies.

An in-depth analysis of the situation to determine the conditions under which a decision could be made to transition to the implementation of the concept of integrated processing of mineral resources by economic entities was conducted using a selected set of five groups of indicators, which were used in the expert survey. These indicator groups were also analyzed using the positioning matrix method relative to the success of the undertaken changes (Table 10). As a result, the "Regulatory component" factor group fell into the "success" zone, with a readiness score of 2.16 (out of 5 possible) and a resistance level score of 1.44 (out of 5, where 5 is the highest level of resistance). Expert comments indicated the relative transparency and clarity of the legal framework, and the absence of administrative barriers to the implementation of this activity. The "Resource component" factor group is in the "unstable success" zone, with a readiness level score of 2.95 and a resistance level score of 3.34. According to the experts, the lowest risk factor scores from this set of

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indicators were characterized by insufficient (absent) existing production capacities and insufficient personnel (both in number and qualifications). The three remaining factor groups were classified as "failure" zones: "Supporting Environment" (readiness level - 1.18 points, resistance level - 3.13 points); "Market Component" (readiness level - 1.25 points, resistance level - 4.35 points); "Technological Component" (readiness level - 1.88 points, resistance level - 3.70 points). The following were identified as key risk indicators:

- lack of regular customers with significant order volumes;
- the lack of interested partner companies

willing to integrate into the existing technological process to implement processes prior to extraction and more in-depth complex processing of mineral resources;

- low competitive advantages in terms of extracted valuable components compared to analogues on the market;
- lack of subsidies for costs from the state, especially in terms of conducting a feasibility study for the integrated processing of mineral resources;
- economic the inappropriateness of the existing technology for industrial development due to the above-mentioned risks.

Table 10. Assessment of groups of factors influencing the implementation of changes in the transition to the concept of integrated processing of mineral resources, according to the level of their readiness and resistance

Group of factors	Summary assessment			
	by economic entities of the region		for economic entities and the scientific community	
	resistance level	level of readiness	resistance level	level of readiness
Resource component	3.34	2.95	3.06	2.41
Technological component	3.70	1.88	3.56	1.60
Regulatory component	1.44	2.16	1.47	2.87
Market component	4.35	1.25	4.07	1.83
Supportive environment	3.13	1.18	3.06	1.39

The identified risk indicators and readiness of economic entities and the regional economic system as a whole for the transition to the KPMS concept form the basis for developing proposals and recommendations for subsequent stages of implementing the Strategy for the Development of the Mineral Resource Base of the Russian Federation to 2035, which will enable the formulation of a new plan of activities planned for implementation from 2025 to 2035. The transition to a new paradigm of state environmental regulation since 2014, based on the principles of best available technologies and focusing on the environmental and technological aspects of mining and processing waste management, has overshadowed its economic and property aspects. At the same time, the resource potential of accumulated waste from past activities and its negative impact on the environment, in the absence of institutional conditions stimulating the effective use of waste in recycling, represented a problematic area of environmental management, which was reflected in the Strategy for the Development of the Mineral Resource Base of the Russian Federation to 2035. The objective of the Strategy is to create conditions for a sustainable supply of mineral resources for socioeconomic development and to maintain an

adequate level of economic and energy security for the Russian Federation. Its implementation was intended to consolidate the efforts of legislative and executive bodies of state power, authorities of the constituent entities of the Russian Federation, and the scientific, scientific-educational, and business communities (including small and medium-sized businesses) to create a favorable legal, investment, and business climate and ensure the necessary technological and human resources. The first stage of the strategy (2018–2024) envisaged improving the key legal and economic mechanisms that would facilitate the growth of the investment attractiveness of Russian subsoil resources, as well as optimizing work areas funded by the federal budget in accordance with the provisions of the Strategy. The results of this first stage were to include the necessary program and project documents ensuring the concentration of financial resources, technological, and human resources potential to achieve the development indicators of the Russian Federation's mineral resource base. The second stage (2025–2035) envisaged the implementation of a full range of works to achieve the goals and objectives of the Strategy, taking into account its updating.

As part of the implementation of the first stage of

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the Strategy, significant work was carried out to improve the legal framework. For example, in 2024, Federal Law No. 123-FZ was adopted, introducing the most extensive amendments to the Law "On Subsoil" in the last 30 years. Nine Russian Government resolutions, two orders of the Ministry of Natural Resources and Environment, and 22 joint orders of the Ministry of Natural Resources and Environment and the Federal Agency for Subsoil Use were approved to implement the law.

The changes implemented since 2015 have provided a significant boost to the development of

geological exploration (Figure 13). However, the strategy's approved path to achieving the goal of sustainable mineral resource supply by increasing the investment attractiveness of geological exploration at all stages, improving the quality of forecasting and prospecting for new deposits, and enhancing the efficiency of developing known deposits, including undeveloped ones, through the implementation of modern technologies for processing, enrichment, and integrated mineral extraction is not being fully implemented or balanced.

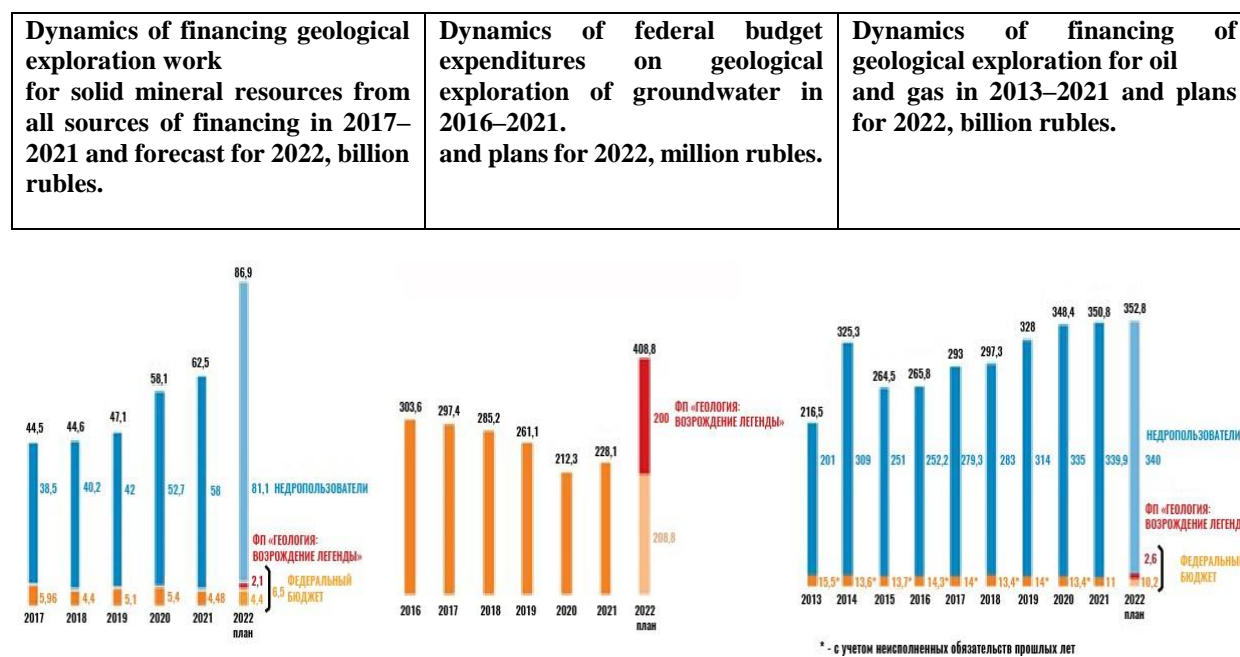


Figure 13. Dynamics of financing for geological exploration of solid minerals, groundwater, and oil from all sources of financing in 2018–2024 and forecast for 2026, billion rubles.

Currently, the Strategy's implementation emphasizes extensive methods, that is, improving the quality of forecasting and prospecting for new deposits. This is evidenced by its key performance indicators, namely, the increase in reserves of key minerals and the volume of extra-budgetary investments in geological exploration, which are being achieved quite successfully (Table 11). However, the least addressed aspect is the area related

to improving the efficiency of developing known deposits, including undeveloped ones, through the implementation of modern technologies for processing, enrichment, and integrated extraction of minerals. The consequences of this imbalance include: the continued accumulation of mining waste; the increase in the volume of man-made deposits; and the involvement of large areas of land in production processes (Table 12).

Table 11. Implementation of the Strategy for the Development of the Mineral Resource Base of the Russian Federation until 2035

Indicator	2018	2019	2020	2021	2022	2023	2024
Number of licenses issued on an application basis, units.	256	427	404	797	1244	1636	1685
Investment value of geological exploration projects carried out on a “declarative” basis, billion rubles.	9.1	17.8	25.5	23.3	38.8	65	83.4

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Furthermore, the need for a near-term revision of subsoil use policy from extensive to intensive development methods, including through the integration of accumulated man-made deposits, is supported by data on the number of discovered deposits (Table 13), as well as the results of a critical analysis of the strategy by researchers. From a methodological perspective, the approved Strategy has two shortcomings:

1) there is no mechanism (methodology) for implementing generally correctly formulated ideas,

goals and objectives for choosing a strategy for the development of mineral resources;

2) The main focus is on the geological study of the subsoil and the assessment of the current state of the provision of explored reserves of various types of mineral raw materials, but without taking into account the geological, technological, economic, natural and socio-economic conditions for the integrated development of deposits in the raw material regions of Russia.

Table 12. Dynamics of formation, use and accumulation of production and consumption waste

Indicator	2022	2023	2024
Mining			
Generation of production and consumption waste by type of activity: mining, thousand tons	6,850,485.4	7,257,022.1	6,367,335.6
Recycling and disposal of production and consumption waste by type of activity: mining, thousand tons	3,585,213.5	3,561,595.4	2,970,827.4
The ratio of waste generation and disposal by type of activity: mining, %	52.3	49.1	46.7
Processing of minerals			
Generation of production and consumption waste by type of activity: processing of minerals, thousand tons	204,190.6	214,818.7	201,332.6
Recycling and disposal of production and consumption waste by type of activity: mineral processing, thousand tons	103,395.7	113,678.3	99,668.5
The ratio of waste generation and disposal by type of activity: mineral processing, %	50.6	52.9	49.5

Dynamics of the number of deposits registered with the state

Indicator	2022	2023	2024
Number of deposits, units	59	49	37

An analysis of the Strategy's implementation conducted by the Accounts Chamber of the Russian Federation in 2020 also confirmed that the results obtained do not allow for a full assessment of its effectiveness. One of the recommended actions in the report is the recycling of mining and processing waste and the implementation of cost-effective technologies for the enrichment of low-quality mineral raw materials through the development of a targeted project for geological exploration and rational subsoil use.

Legislation is needed to establish incentives for organizing mining production that eliminate waste generation and utilize intermediate products in a closed-loop process for both primary and secondary production. At the same time, legislative measures alone will not be enough: it is necessary to increase the interest of existing economic entities—subsoil users—in this type of activity. The historical practice of single- and dual-component mining in Russia,

despite the significant wealth of mineral deposits, has been the traditional operating method for mining companies. The transition to the concept of integrated mineral processing is a change for which regional economic systems, and in particular the economic entities within them, must be prepared. The larger the organization and the greater the resistance of its subsystems to the innovations being introduced, the more difficult it is to implement change. An organization's size is partly related to its stability, and partly to its longevity. Both factors are, to some extent, linked to the reluctance of subsystems to improve due to their greater or lesser satisfaction with the status quo. In reviewing these provisions regarding the adopted approach to conducting activities in the mineral extraction and processing industry in the Russian Federation, we can state the need to carry out significant preliminary work before implementing such a change for its successful implementation.

The identified assumptions were confirmed

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during the study of the assessment of the regional economic system's readiness to implement changes associated with the transition to the implementation of the concept of integrated processing of mineral resources.

The regional economic system of the Murmansk region exhibits a relatively high level of resistance and a moderate level of readiness for changes associated with the transition to the implementation of the concept of integrated processing of mineral resources. Therefore, it is necessary to reduce resistance to change and, where possible, increase the readiness of the region's economic entities to accept such changes. For the Murmansk region, the resistance factors are the "market component," "supporting environment," and "technological component" factors, while the "resource component" and "regulatory component" factors ensure readiness for the transition.

Taking into account the obtained results of the study, namely: a) for the Murmansk region, as a region fully included in the Arctic Zone of the Russian Federation, the intensification of entrepreneurial activity is possible through internal outsourcing, the creation of a technology park with the participation of the state, as well as the establishment of new business structures on the basis of PPP; b) the most promising for the Khibiny deposits will be business models A "Involvement of economic entities in the production processes" (gaining access to deposits for organizing production and primary processing there) and B "Involvement of an economic entity in the processing processes" (creation of additional production stages to the current technological process of producing concentrates of JSC Apatit and gaining access to process waste, which serves as raw materials for the next stage of production), then the solution to the issue of transition to the implementation of the concept of integrated processing of mineral resources at the preparatory stage should be the fulfillment of a number of general conditions that can have practical value for all resource regions of Russia with a similar profile in terms of the level and type of entrepreneurial activity, as well as specific ones, that is, characteristic only of the Murmansk region.

The general conditions will include the following.

First, this is a condition for ensuring the necessary level of demand. It is assumed that, initially, this demand should take the form of government procurement, which would stimulate entrepreneurial activity among economic entities toward advanced processing, either independently or through partnerships or outsourcing, primarily for strategic mineral raw materials that are at risk of import dependence and necessary for the development of high-tech industries in the national economy.

Second The development of marketing in the mining industry is becoming a requirement, not only for the potential use of raw materials as components

for the production of certain products, but also from a geological perspective. This allows, at the time of developing a feasibility study for new deposits, to assess the current potential for extracting the same useful component through the deployment of a comprehensive processing concept at existing facilities and to compare the resulting economic, environmental, and social impacts for the final decision. This requirement requires the existence of a corresponding unified information system for accounting for reserves at developed and potential deposits, supplemented by interconnected databases of mineral resource consumers, their demand volumes, and data on other producers, both existing and potential. Such analysis should be a mandatory requirement for any new mining project, and its reliability should be monitored by government agencies. The third condition (from a logistical perspective) is the creation of a logistical distribution system through the establishment of a state-owned management company that issues government contracts, collects consumer orders on the market, and redistributes completed government contracts for the integrated processing of mineral resources in both small and large batches. This company also searches for potential partners who could integrate into existing technological processes on an outsourcing basis. To this end, appropriate legal conditions must be created based on the extension of the practice of working under SSR and SUF contracts from hydrocarbons to other types of mineral resources that are primarily import-dependent or strategically important for the development of high-tech consumer industries. The scope of such agreements must be adjusted to the goal of ensuring the integrated processing of mineral resources and expanded from geological exploration and development to other technological stages of mineral extraction and processing.

Furthermore, an important condition of the first stage will be government support for subsidizing costs associated with conducting feasibility studies, a high-risk and costly activity for economic entities. This can be implemented through a grant system for the scientific community, based on the analysis of corporate orders from economic entities in the industry. In other words, a grant is issued for a specific order on a research and development or experimental design topic in which economic entities in the industry express interest.

In addition to those listed above, special conditions for the development of small and medium-sized businesses will be introduced for the Murmansk Region. At the regional economic level, this will allow for the creation of an optimal number of economic entities in service, auxiliary, and related processes related to mining and processing production through the development of intra-corporate entrepreneurship. This proposal is based on the established predominant entrepreneurial activity of businesses and will also

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address the labor shortage associated with the region's rapid population decline in recent years. This latter issue requires particularly careful study to identify solutions for changing migration policy and developing proposals for managing shift work in the Arctic.

Thus, the proposed recommendations may form the basis for developing an action plan for the period 2024–2030 for the implementation of the Strategy for the Development of the Mineral Resource Base of the Russian Federation until 2035, and the proposed approach, based on an assessment of the PA and determining the readiness of regional economic systems to transition to a new operating concept, may become the methodological basis for adjusting the Strategy, allowing for consideration of the specific features of the regional economies, their individual sectors, and development plans for systemically important enterprises.

Conclusion

The article explores the challenges and prospects for developing conditions for the integrated use of raw materials in the Russian Arctic regions. It confirms that implementing the integrated use concept requires intensifying the entrepreneurial activity of economic entities in the mining and processing industries, necessitating the development of a corresponding regional business environment management policy that takes into account the specifics of economic activity and entrepreneurial activity within a given region. Taking these regional characteristics into account allowed us to develop a pool of business management concepts that are most applicable to the integrated processing of mineral resources in the Arctic Zone of the Russian Federation. Thus, in fully Arctic regions, intensifying entrepreneurial activity is possible through internal outsourcing, the creation of technology parks with state participation, and the establishment of new business structures based on public-private partnerships. In partially Arctic regions, this can be achieved through the development of small and medium-sized mining businesses with state support. Business models corresponding to the identified concepts and specific tools for intensifying entrepreneurial activity, facilitating their practical implementation, are identified. In examining the practical application of the presented business models in relation to the problem of eliminating import dependence on strategic mineral raw materials, using the apatite-nepheline ores of the Khibiny deposits as an example, we concluded that their implementation is feasible, supported by the accumulated scientific knowledge in processing technologies, established trends in corporate management of production and business, as well as increasing demands for environmental safety and global geopolitical changes. Taking into account the priority objectives of developing the mineral resource base, related to

organizing small-scale production of products in demand on the domestic market—inorganic sorbents, materials for electronics, titanium dioxide-based sealants, functional rare metal compounds, and rare metal powders for capacitor and other industries—we analyzed existing production processes for these products relative to the identified business models. Specific aspects of regulating the activities of subsoil users, including defining the mechanisms for their interaction, were identified, which urgently require further clarification and improvement. At the same time, it is necessary to strengthen the systematic nature of the decision taken on the SSR and SSF agreements and expand their application to the entire mineral resource base, clarify the purpose of such activities to ensure the solution of problems of minimizing the risks of import dependence on strategic types of mineral resources, the development of high-tech industries as consumers of mineral raw materials and environmental safety in the context of rational nature management. It is argued that improving systemic efficiency requires creating a mechanism for network interaction between economic entities in the mining and processing complex, implemented through a corresponding agreement. A diagram of how a mining and processing complex operates under a network interaction agreement is presented. The differences between a network interaction agreement and standard civil law contracts such as subcontracts, cooperation, leases, and sales contracts are discussed.

It was stated that in order to stimulate entrepreneurial activity. The creation of appropriate targeted government regulations is essential for businesses. To develop such regulations, an analysis of the external environment and an assessment of the readiness of economic entities in the mining and processing sector to implement the concept of integrated mineral resource processing were conducted.

Regulators are proposed, and risk indicators for a positive decision on the transition to the integrated processing of mineral resources by economic entities are identified. Key risk indicators include: a lack of regular customers with significant order volumes; a lack of interested partner companies willing to integrate into the existing technological process for the implementation of additional extraction and more in-depth integrated processing of mineral resources; low competitive advantages of the recovered valuable component compared to similar market competitors; a lack of government subsidies for costs, particularly in terms of conducting a feasibility study for the integrated processing of mineral resources; and the economic infeasibility of the existing technology for industrial development due to the aforementioned risks.

The identified risk indicators and the readiness of economic entities and the regional economic system

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as a whole to transition to the CPMS concept form the basis for developing proposals and recommendations for subsequent stages of implementing the Strategy for the Development of the Mineral Resource Base of the Russian Federation until 2035, which makes it possible to formulate a new action plan planned for implementation from 2025 to 2030. Therefore, special attention was paid to clarifying the conditions for improving the management mechanisms for the development of Russia's mineral resource base, taking into account the specifics of regional economic activity in the Arctic. To this end, the nature, conditions, and results of the first stages of the Strategy's implementation were examined in detail. It was established that significant work was carried out during the implementation of the first stage of the Strategy to improve the legal framework, which provided a significant impetus for the development of geological exploration. At the same time, the plan approved within the Strategy for achieving the goal of sustainable mineral resource supply by increasing the investment attractiveness of geological exploration at all stages, improving the quality of forecasting and exploration for new deposits, and increasing the efficiency of developing known deposits, including undeveloped ones, through the implementation of modern technologies for processing, beneficiation, and integrated extraction of minerals, is not being fully implemented and is unbalanced. Thus, at the current stage of the Strategy's implementation, the greatest emphasis is placed on extensive methods, that is, improving the quality of forecasting and exploration for new deposits. This is evidenced by the Strategy's key indicators by which its effectiveness is assessed, namely, the increase in reserves of the most important minerals and the volume of extra-budgetary investments in geological exploration, which are being achieved quite successfully. However, the part related to increasing the efficiency of developing known deposits, including undeveloped ones, through the implementation of modern technologies for processing, beneficiation, and integrated extraction of minerals remains the least addressed. The result is the continued accumulation of mining waste, an increase in the volume of man-made deposits, and the involvement of large areas of land in production processes. The Strategy's methodological shortcomings have also been identified, namely:

1) there is no mechanism (methodology) for implementing, in principle, correctly formulated ideas, goals and objectives for choosing a strategy for the development of mineral resources;

2) The main focus is on the geological study of the subsoil and the assessment of the current state of the provision of explored reserves of various types of mineral raw materials, without taking into account the geological, technological, economic, natural and socio-economic conditions for the integrated development of deposits in the raw material regions of

Russia.

It has been substantiated that, to fully implement the integrated processing of raw materials, it is necessary to legislate measures to stimulate the organization of mining production, eliminating waste generation and utilizing intermediate products in a closed-loop process for both primary and secondary production. However, our study of the current reality of the Russian subsoil use industry confirmed the inadequacy of legislative measures alone. It is necessary to increase the interest of existing economic entities—subsoil users—in such activities. This is due to the fact that, as we have found, in practice, subsoil users are more or less satisfied with the current state of affairs and are not prepared for the changes associated with the transition to the integrated processing of mineral resources. For example, it was found that the regional economic system of the Murmansk Region exhibits a relatively high level of resistance and a moderate level of readiness for changes associated with the transition to the integrated processing of mineral resources. Therefore, it is necessary to reduce the level of resistance to change and, where possible, increase the willingness of economic entities in the region to accept such changes.

An analysis of the resistance factors revealed that for the Murmansk region, as a region entirely within the Russian Federation's Arctic zone, intensification of entrepreneurial activity is possible through internal outsourcing, the creation of a technology park with state participation, and the establishment of new business structures based on public-private partnerships.

For the Khibiny deposits, the most promising ones will be Business models A "Involvement of economic entities in mining processes" (gaining access to deposits for organizing mining and primary processing) and B "Involvement of economic entities in processing processes" (creation of additional production stages to the existing technological process of producing concentrates at JSC Apatit and gaining access to process waste, which serves as raw materials for the next stage of production). The solution to the issue of transitioning to the implementation of the concept of integrated processing of mineral resources at the preparatory stage should be the fulfillment of a number of general conditions that can contain practical value both for all resource regions of Russia with a similar profile in terms of the level and type of entrepreneurial activity, and for specific ones, that is, characteristic only of the Murmansk Region. The following general conditions have been formulated, namely:

- ensuring the required level of demand;
- the need to develop marketing in the mining industry not only from the point of view of the use of potential raw materials as a component for the production of any product, but also in the geological aspect, allowing, when developing a feasibility study

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for new deposits, to evaluate the current possibilities of extracting the same useful component by deploying the concept of integrated processing at existing production facilities and comparing the resulting economic, environmental and social effects for making a final decision;

- the creation of a logistics and distribution system through the establishment of a state management company that issues government contracts, collects consumer orders on the market, and redistributes completed government contracts for the integrated processing of mineral resources, in both small and large batches, as well as performing the function of searching for potential partners who could integrate into existing technological processes on an outsourcing basis;

- During the first stage, government support will subsidize costs associated with conducting feasibility studies, a high-risk and costly activity for economic entities. In addition to the above, special conditions will be created for the Murmansk Region

to foster the development of small and medium-sized businesses within the regional economy, creating an optimal number of economic entities in service, auxiliary, and related processes related to mining and processing through the development of intra-corporate entrepreneurship (due to the predominant entrepreneurial activity of businesses), as well as addressing the labor shortage caused by the rapid population decline in the region in recent years. The proposed recommendations may form the basis for a new action plan for the period 2024 to 2035. for the implementation of the Strategy for the Development of the Mineral Resource Base of the Russian Federation until 2035, and the proposed approach, based on an assessment of entrepreneurial activity and determining the readiness of regional economic systems to transition to a new operating concept, may become the methodological basis for adjusting the Strategy, allowing for taking into account the specific features of the regional economies, their individual sectors, as well as the development plans of systemically important enterprises.

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