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INNOVATIVE APPROACH TO THE DEVELOPMENT OF MINERAL RAW MATERIALS OF THE ARCTIC ZONE OF THE RUSSIAN FEDERATION

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The comprehensive development of the mineral and raw materials potential of the Arctic regions of Russia is a complex strategic task requiring the use of modern methods for planning spatial development of territories. One of such methods is the organization of cluster formations as an effective tool for implementing innovation policy. Consolidating the efforts of many participants, diversified territorial clusters become the main points of growth, the multiplier effect within which has a positive impact both on the economy of the region and the country in general.

The high level of risk and the significant costs of Arctic raw material projects make it impossible to implement them simply by accumulating production and financial resources, which makes it necessary to model flexible territorial production systems on the principles of integration. The article analyzes the prerequisites for the formation of cluster formations based on the resource potential of the support zones of the Russian Arctic, and the main expected effects from the creation of innovative raw Arctic clusters are revealed. During the study, the expediency of using integration mechanisms in the development of hydrocarbon reserves in technically difficult conditions of the Far North was justified. The strategic analysis of the three Arctic oil and gas projects currently implemented on the principles of clustering – Novy Port, Messoyakha, Yamal LNG, made it possible to conclude that there are sufficient external effects of projects such as creating conditions for the innovative development of related industries, the formation of a high-tech infrastructure framework in the region, the accumulation of experience in the implementation of Arctic projects, the diversification of hydrocarbon exports.

Key words: Arctic, mineral and raw materials potential, clusters, oil and gas projects, LNG

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Introduction. The main instrument for achieving a comprehensive development of the Russian economy and improving the quality of life of the population in remote northern regions is the conduct of an active innovation policy in the Arctic regions aimed at modernizing and increasing the innovative activity of economic entities. A significant place in modern innovation policy is given to territorial innovative and technological industrial clusters, the formation and development of which should contribute to the establishment of a competitive environment and the fuller use of the potential of interaction between the state and business, including in the socio-economic sphere.

A key feature of the cluster approach, unlike the traditional sectoral one, is its orientation toward the rearrangement of productive forces and factors of production, which leads to an increase in the total capitalization of the territory [16]. Clusters, trying to maximize the effectiveness of their development due to factors of the internal environment, stimulate the creation of regional framework that sets the vector for the development of various sectors of the economy and ultimately serves as a unit of territorial administration.

An important aspect of clustering is the market mechanism, which manifests itself in the creation of high internal competition, which is the main driving force for the effective operation of the cluster [13]. Competition stimulates each participant to continually improve their advantages through the introduction of various innovations (technological, organizational and marketing), which leads to more active innovative development of the cluster. World experience in implementing the cluster approach indicates that it is clusters that allow to form key competencies, the progress of which serves as a basis for the competitiveness of regions in the long term [14].

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Formulation of the problem. The basis of the long-term economic development of the Arctic zone is the rich mineral and raw materials base of various types of minerals [12]. In the Arctic zone of the Russian Federation, which accounts for the greater part of the Arctic [11], there are more than 96 % of platinum metals and more than 90 % of nickel and cobalt; about 80 % of Russian gas and 60 % of oil are extracted in this region [7].

The weak level of development of the Arctic territories does not allow to achieve effective use of the region's mineral and raw materials potential by simple accumulation of financial and production resources – a considerable amount of investments in infrastructure is required [9]. The analysis of projects for the development of remote areas indicates that most of the costs fall on common infrastructure, rather than the construction of facilities for the extraction of raw materials. This cost ratio leads to unprofitability of most projects and hence to impossibility of their implementation.

When implementing large-scale raw materials projects, most of the work is performed by contractors and suppliers, which are service companies, scientific and educational institutions, transport and communications enterprises, leasing companies, etc. [6]. In view of this, it becomes necessary to model flexible local industrial systems in the form of clusters that will not only optimize project costs, but also create an infrastructure framework for the further development of the region.

Methodology. The purpose of this study is to assess the possibilities of using the clustering mechanism for developing the mineral and raw materials potential of the Arctic zone of the Russian Federation. To achieve this goal, the following tasks were accomplished: analysis of the prerequisites for the formation of clusters based on the resource base of the Arctic regions, assessment of external and internal effects of potential arctic raw material clusters, and analysis of the efficiency of Arctic projects implemented based on clustering. When solving these problems, methods of generalization, systematization, comparison along with cost analysis and investment evaluation were used.

Discussion. Successful development of technologically complex Arctic deposits implies the creation of a technologically modern, competitive industry. The prerequisites for the formation of innovative industrial clusters based on the Arctic raw material base are due to the following factors:

1) high concentration of hydrocarbon deposits and solid minerals in relatively small areas;

2) presence of the largest companies in the mineral and raw materials sector that could potentially become leaders of cluster entities and determine the long-term strategy of the regional economic system in the region;

3) interest of the state in the socio-economic development of the Arctic zone;

4) considerable need for the development of scientific and technical innovations and import substitution in geological exploration, development of deposits and production of finished products with high added value.

The main core of the innovative cluster of mineral and raw materials is the mining complex, which is a system of connected objects – economic units for industrial purposes within one or several mineral deposits concentrated on a certain territory and integrated with certain production and technological links. The composition and direction of production is determined by the potential of the resource and infrastructure base of a specified area, which is the main feature of clusters in the mineral and raw material complex.

Thus, the basic unit for the formation of arctic raw material clusters is a set of prospective subsoil resources located near each other, sufficiently studied and expedient to attract investment. Such clusters will be the support points in the spatial organization of the regional economy, which determine the main directions of socio-economic development of the region and serve as a driver for related industries.

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Thus, the cluster model for the development of the mineral resource base in the Arctic region is the most optimal. The rationale for the potential effects of creating clusters based on the resource potential of the Russian Arctic is presented in Table 1.

Table 1

The projected effects of the creation of innovative raw material clusters in the Arctic zone

Type of effect	Value for cluster members	Value for the region and the state
Production efficiency	Savings in capital and operating project costs Increase in labor productivity due to internal competition Increased opportunities for diversification of sales through the development of transport infrastructure Decrease in transaction costs due to many cluster members Possibilities of obtaining state support	Growth of GRP and GDP Increase of taxes and payments to budgets of different level Strengthening of positions in the external and internal markets Decrease in dependence on imports of raw materials and products of its processing Growth of the service market Implementation of new projects based on cluster infrastructure
Innovative efficiency	Establishment of innovative environment and acceleration of innovation distribution Increase of innovation activity due to internal competition Reduction of costs for access to new technologies	Import substitution for technologies Increase of innovative potential of the region
Social efficiency	Improving working conditions through the introduction of advanced technologies Developed labor market	Inflow of population Reduction of unemployment Preservation of local qualified personnel Creation of general infrastructure facilities Electrification and gasification of remote areas Advantages from the social policy of subsoil users and other companies participating in the cluster
Globalization effects	Opportunities to attract foreign partners: participation of foreign companies in financing, exchange of technologies and experience in implementing complex and high-risk projects	Development of international cooperation
Ecological efficiency	Minimizing the negative impact on the environment through innovative technologies to organize production and conduct joint environmental activities Reduction of fines and other payments related to violation of environmental standards	Preservation of the ecological balance, active implementation of resource-saving technologies

In accordance with the state program «Socio-economic development of the Arctic zone of the Russian Federation for the period until 2020 and a further prospect» approved in 2014, the Arctic development is planned through a system of «support zones», based on the principle of administrative-territorial division. To date, the Ministry of Economic Development has allocated eight support zones, which corresponds to the number of Arctic regions of the Russian Federation [7]. Each zone is considered as a territorial multiproject and accumulates a set of diversified projects. Such a mechanism presupposes the creation of favorable conditions for the implementation of large investment projects in the Arctic, the intensification of navigation along the routes of the Northern Sea Route, the systemic modernization of the existing infrastructure, which together will have a positive effect on the development of the Arctic regions of Russia.

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Estabishment of support zones provides for a broad use of the project approach of primarily budgetary financing, which creates the conditions for solving various socio-economic problems. Given the planned interconnection of diversified projects and activities, the implementation of such a program assumes active use of integration forms to achieve complex strategic goals.

A significant amount of reserves and forecasted resources of raw materials in the support zones, along with the lack of infrastructure and high capital intensity of its construction in the areas of prospective production, opens wide opportunities for the formation of mineral and raw materials centers based on the principles of clustering and allowing to obtain positive effects (Table 2). This approach will not only increase the investment attractiveness of the region by improving the profitability of developing the mineral and raw materials potential of the target zones but will also form constructive relationships between various participants based on a balance of strategic interests in the long term.

Table 2

Raw material potential of support zones

Supoport zone	The main production centers (existing and prospective)	Main fields
Kolskaya	Offshore hydrocarbon deposits of the Barents Sea	Shtokmanovskoe, Murmanskoe, Ludlovskoe, Ledovoe, Severo-Kildinskoe
	Khibiny group of apatite-nepheline deposits	Kukisvumchorrskoe, Yuksporskoe, Apatitovy Tsirk, Rasvumchorr plato, Koashva, Norpakhk, Kuelpor, Partomchorr, Oleniy Ruchei
	Group of sulfide copper-nickel ores deposits	Zhdanovskoe, Zapolyarnoe, Korselvaara, Semiletka, Bystrinskoe, Tundrovoe, Sputnik, Verkhnee
	Olenegorskiy ore region	Olenegorskoe, Krivogorskoe, n.a. Bauman, XV let Oktyabrya, Komsomolskoe
	Kola Province	Deposits of iron ores, chromium, REM, phosphor
Arkhangelskaya	Extraction center in the Novaya Zemlya Archipelago	Pavlovsky deposit of lead-zinc ores, Prinovozemelskaya group of hydrocarbon deposits
Nenetskaya	Deposits of hydrocarbons of the Timan-Pechora oil and gas province	Prirazlomnoye, Kumzhinskoye, Kharyaginsky, Yaregskoye, Val Gamburtsev deposits
Vorkutinskaya	Pechora coal basin	Vorkutinskoe, Intinskoe, Usinskoye, Yunyaginskoe and Vargashorskoe
Yamalo-Nenetskaya	Shelf and continental hydrocarbon deposits	Kharasaveyskoe, Bovanenkovskoe, Tambeyskaya group, Kruzenshternskoe, Novoportovskoe, Messoyakhskaya group
Taimyro-Turukhanskaya	Vankor group of hydrocarbon deposits	Vankorskoe, Lodochnoe, Tagulskoe, Suzunskoe
	Ust-Yenisei Oil Production Center	Paiyakhskoe, Baikalovskoe
	Khatanga Oil Production Center	East Taimyrsky license area
	Taimyr coal basin	Chernoyarskoe, Pyasinskoe, Krestyanskoe, Syrdasaiskoe
	Deposits of sulfide copper-nickel ores	Oktyabrskoe, Talnakhskoe, Norilsk – 1
Severo-Yakutskaya	Cluster «Ust-Yana»	Rare-earth metals deposit Tomtor, tin ore deposit Deputatskoe, deposits of placer tin Tirekhtyakh, Chuppunya, Odinokoe
	Anabar diamond mining center	Ebelyakh, Morgor
	Gold production centers	Kyuchus, Khaptagai-Khaya (+antimony), Tamara-Tass
	The Taimylyr cluster	Taimylyrskoe coal deposit
Chukotskaya	Bering coal basin	Amaamskoe, Verkhne-Alkatvaamskoe, Bukhta Ugolnaya
	The centers of extraction of a wide complex of non-ferrous and precious metals	Deposits of copper, nickel, bismuth, mercury, tin, lead, uranium, gold, platinum, silver

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The Russian economy is now highly dependent on the oil and gas sector. Depletion of resources in traditional oil and gas extraction centers is actualized by the development of the Arctic hydrocarbon potential, which, in view of the huge reserves, is rightly considered the 21st century resource base [15]. So, according to calculations by the US Geological Survey, more than 13 % of the world's recoverable oil reserves and over 30 % of gas reserves are represented in the Arctic [10].

Yamal projects are of great importance in the development of oil and gas fields in the Arctic zone. The share of the Yamalo-Nenets Autonomous Okrug in the total volume of investment in the fixed capital of the Arctic macroregion exceeds 66 %, while in Russia Yamal is in the top three by the criterion of allocations to the federal budget [4]. Among the most priority projects currently being implemented are the «New Port», «Messoyakha» and «Yamal LNG», which should be considered as independent mineral and raw materials centers, accumulating efforts of Russian and foreign oil and gas companies, design institutes, research centers , service companies, machine-building, shipbuilding plants and a number of other entities.

The Novoportovskiy Center's main production asset is one of the largest Novoportovskoye oil and gas condensate field in Yamal, which until 2012 was impossible to develop because of a lack of transport infrastructure and necessary technologies. In the future, the Rostovtevskoye field, which is currently in the unallocated subsoil fund, can be connected to this center [5].

The uniqueness of this project is due to the sea way of transportation of raw materials, since traditionally Yamal oil was sold through pipeline systems. In view of this, the key strategic object of the project is the first Arctic terminal on the Yamal Peninsula – the Arctic Gate, built in the water area of Obskaya Guba. The designed capacity of the terminal is 8.5 million tons per year. The construction of this terminal will be the main driver for the development of the offshore hydrocarbon deposits of the Ob-Taz Bay. On the shore of the Ob Bay, subsea and land oil pipelines, a tank farm, pumping stations were also built; each of these facilities is designed to work in extreme conditions of the North and meets all environmental requirements.

Messoyakhsky Center includes two deposits – East Messoyakhskoye and West Messoyakhskoye, discovered in the 80s. Until 2016, the development of the unique reserves of deposits was impeded by the transport and industrial autonomy of the region. In the immediate vicinity of the deposits there are promising license areas of the non-distributed mineral reserve fund, which can later be developed as part of the improvement of the Messoyakhsky Mineral Resources Center. Synergy of potential resources with existing reserves for the field, together with the infrastructural capacities introduced within the project, will significantly increase the economic value of the asset.

The creation of the Messoyakhsky Center began with the development of the East Messoyakhskoye field, the first oil was shipped in 2016. The impetus for the implementation of the project was the approval by the Government of the Russian Federation of the Program for the Integrated Development of the Yamalo-Nenetsky and Northern Krasnoyarskoe Fields until 2020, which involved construction of the oil pipeline Zapolyare- Purpe, taht is part of the Eastern Siberia-Pacific Ocean oil pipeline system.

The uniqueness of the project lies in the fact that to avoid the permafrost thaw and minimize the risks of their subsidence, collapses, and therefore – accidents, all infrastructure facilities are located on the surface and built on piles. Among the most capital-intensive facilities are a central gathering point and a gas-turbine power station operating on natural and oil gas.

Mineral and raw materials center Yamal LNG on the basis of the South Tambey gas condensate field is aimed at developing the Russian liquefied natural gas (LNG) industry. The technology of transportation and storage of natural gas in the liquefied state is becoming an actual trend in the world energy sector [2]. Despite the huge reserves of natural gas in Russia, the LNG industry is only beginning to develop, and currently there is only one LNG plant in the country – Sakhalin-2. The Yamal LNG project will increase Russia's share in the global LNG market, which corresponds to the provisions of the Energy Strategy until 2035 [3].

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The main feature of this project and its significant limitation is the initial lack of transport and social infrastructure in the region, therefore, for the purposes of this project, a seaport, an airport and a camp complex were built in the village Sabetta, which in the long run can act as drivers for the implementation of other Arctic projects. Thus, the port of Sabetta will be used not only for the export of liquefied natural gas, but also will allow transporting oil, oil products, coal and other raw materials, which will increase the flow of the Northern Sea Route.

The projects under consideration are export-oriented, which determines their importance in the development of foreign trade, diversification of sales routes and strengthening of Russia's positions on world hydrocarbon raw materials markets. Among the main advantages of their implementation is the creation of an additional impulse for the Russian economy in terms of loading the existing production capacities of engineering, metallurgy, shipbuilding, and the development of science-intensive technologies for conducting work in the difficult conditions of the Far North. Among the external positive effects is the accumulation of experience in the implementation of complex Arctic projects. Advanced technologies of hydrocarbon production, preparation, transportation, developed for the purposes of projects, form an innovative potential for further development of the Arctic zone of the Russian Federation. These aspects largely determine the state's interest in the implementation of the analyzed projects, because of which each of them received a significant amount of state support in the form of granting tax incentives, and in the case of Yamal LNG also direct government investments in several infrastructure facilities.

Based on the data from open sources, an investment analysis of projects was conducted, which led to the conclusion that, despite the high capital intensity and unstable situation in the energy markets, the projects for creating Arctic hydrocarbon production centers are effective (Table 3). The calculation of budget revenues from their implementation confirms the significance of these projects in the generation of tax flows. Infrastructure potential created on previously undeveloped territories opens wide opportunities for involving in the development of previously unprofitable hydrocarbon fields and development of resource base of mineral and raw materials centers.

Table 3

Evaluation of the effectiveness of projects for the establishment of production

Efficiency category	Index	Projects		
		East Messoyakhskoye and the West-Messoyakhskoye fields	Novoportovskoe field	Yamal LNG (including the development of the South Tambeyskoye field)
Commercial efficiency	BHD, million rubles	15 837	6 338	119 827
	II	1.07	1.03	1.07
	Payback time, year	17	20	23
	GNI	17.43 % (at a discount rate 15 %)	16.87 % (at a discount rate 15 %)	12.5 % (at a discount rate 12 %)
Budget efficiency	Regional level, million rubles	37 915	40 743	101 172
	Federal level, million rubles	1 831 589	1 459 777	255 223

Conclusions

Based on the results of the study, the following conclusions were made:

1. The Arctic zone of Russia is a promising region; its resource potential will not only provide a significant part of internal and external needs in various types of raw materials and primary energy carriers but will also bring great economic benefits to subsoil users and the state.

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2. A key feature of the Arctic mineral and raw materials projects is their orientation to achieving not only commercial goals, but also to accelerate the socio-economic development of the region. This aspect necessitates the application of a specific approach to the organization of interaction between industry, the state and financial institutions, allowing to consider the interests of each subject in the long run.

3. The creation of cluster formations based on the raw material potential of the Russian Arctic increases the efficiency of implementation of capital-intensive and technically complex projects, accelerates the development of high technology and promotes the growth of the region's investment attractiveness.

4. The implementation of the Arctic projects «New Port», «Messoyakha» and «Yamal LNG» on the principles of clustering proved the expediency of cooperation between the state and business entities: in the process of project works, conditions for innovative development of related industries were created, a high-tech infrastructure framework was created in the region, and at the operational stage of the projects, it is expected to achieve high investment performance indicators.

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