Экономические науки
Economic sciences

UDC 330.131
http://doi.org/10.21440/2307-2091-2025-3-120-128

Man-made deposits: intensification of development

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Abstract

Relevance. At present, the consideration of man-made deposits as a source for the development of the mineral resource base is becoming increasingly important. Among the main reasons, on the one hand, is the appearance of the first signs of loss of stability of the mineral resource base, on the other hand, is the constant strengthening of the man-made mineral resource potential, which is distinguished by the presence of various useful components, the content of which in some cases is higher than in the exploited deposits.

The purpose of the research is to improve the tools of the organizational and economic mechanism regulating the development of man-made deposits.

Research methods – systems approach, methods of analysis, systematization, comparison, analogies, structuring, criteria selection.

Results. The research confirmed the idea of the priority use of man-made mineral formations to maintain the sustainability of the natural mineral resource base and compensate for depleted mineral reserves. The increase in the mass of waste from mining and related processing industries, as well as the intensification of their use in solving the identified problems that complicate the introduction of man-made deposits into economic circulation, was proven. Measures have been developed to improve the efficiency of the organizational and economic mechanism regulating the development of man-made deposits. The proposed measures concern the expansion of the tools of the organizational and economic mechanism through the introduction of new regulatory instruments and an economic instrument with appropriate methodological support. The proposed methodological support involves the development of fundamental principles for assessing the efficiency of man-made deposits development and proposals for taking them into account when performing appraisal operations. An important area of regulating measures is the methodological approach, which is reflected in the author's algorithm for choosing the most acceptable option for state support for activities to replace primary raw materials with secondary ones.

Conclusion. The use of recommendations for expanding the toolkit of the organizational and economic mechanism with the corresponding methodological support, as well as the choice of the most acceptable option of state support will contribute to the activation of the development of man-made deposits, considered as the primary sources for the development of the mineral resource base.

***Keywords*:** man-made deposits, mineral resource base, development, sustainability, tools, methodological support, government support.

Introduction

As practice shows, the most popular natural resources are subsoil resources. The need for mineral raw materials only increases over the years, and the scale of extracted minerals grows accordingly. Suffice it to say that the rate of growth of extraction significantly exceeds the rate of population growth. In parallel with extraction, the volumes of rock brought to the surface also grow. According to experts, the volume of production and consumption waste today is about 100 billion tons, with more than 90% of this waste coming from mining and related processing industries.

For a long time, waste was perceived only from the position of sources of negative impact on the environment, and the implementation of the policy for handling it was reduced to its destruction and reclamation work. The experience of their implementation dates back to the 1950s, when the first section of oil shale was leveled at the Kohtla quarry in the Estonian SSR, and in 1960, forest crops were laid on an area of 4.58 hectares. During the same period, work on the reclamation of the Aleksandrovsky brown coal basin was initiated on

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its own initiative. Since 1964, reclamation work began at manganese quarries, and in 1968 – at the open-pit mines of the Moscow coal basin, etc. The early 1970s saw the emergence of the concept of eco-development, which involves the prevention of an environmental disaster, the primacy of environmental goals over economic ones, and ensuring environmental and economic balance. Its implementation required a change in attitude towards waste – its disposal "at the end of the pipe". The problem of waste-free production requires its solution [1, 2], which in relation to production waste means a policy of its use. However, the actual level of its use remained low, no more than 10–14%.

Over time, already in the 1990s, the mineral resource aspect of waste gradually began to acquire priority, which is reflected in the concept of cleaner production. The policy of waste elimination is replaced by a policy of preventing it "at the beginning of the pipe". With regard to waste containing useful components, the problem of the most complete extraction using the best available technologies is solved. In recent decades, the mineral resource aspect has become increasingly significant due to the emergence of signs of loss of stability of the existing mineral resource base (MRB). Among the reasons for the loss of stability are: a decrease in the volume of financing for geological exploration, revaluation of balance reserves taking into account the specifics of market relations, the collapse of the USSR, due to which a number of important deposits ended up outside of Russia, a decrease in the quality of natural

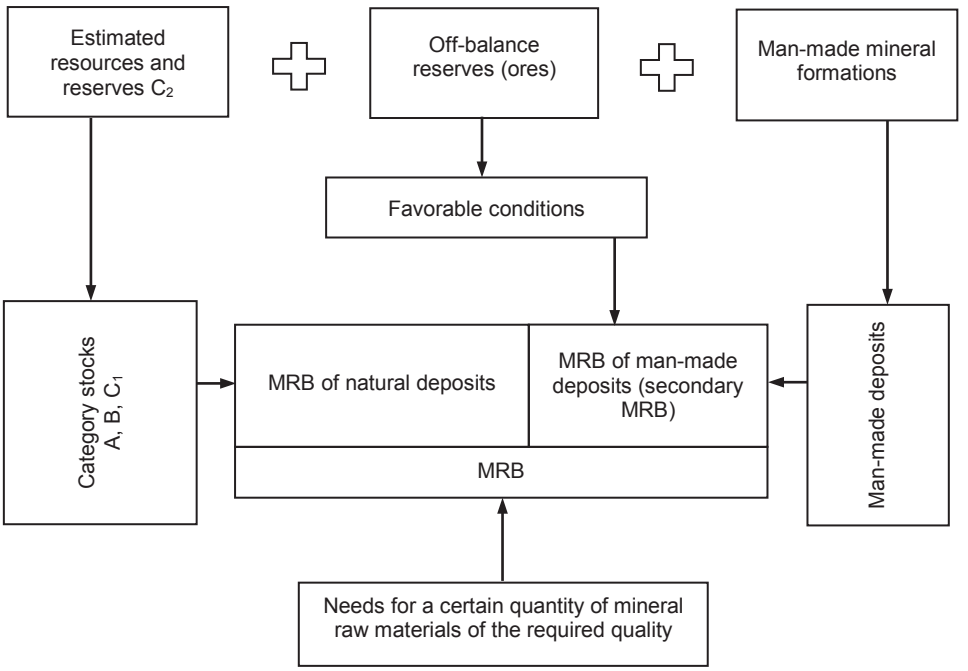

Figure 1. MRB expansion process
Рисунок 1. Процесс расширения МСБ

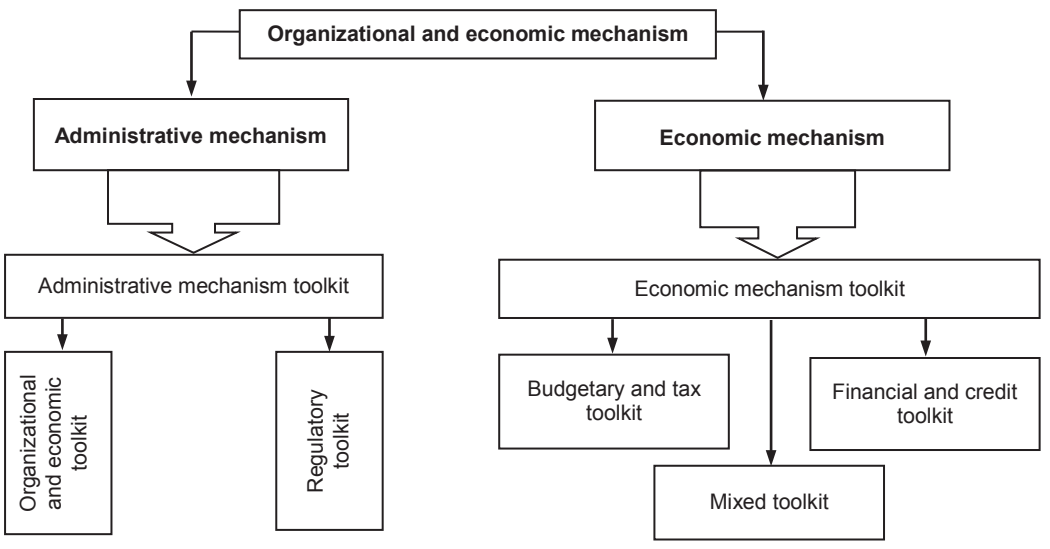

Figure 2. Structure of the organizational and economic mechanism
Рисунок 2. Структура организационно-экономического механизма

Table 1. Distinctive features of the MMD material, geological study and formation of balance reserves
Таблица 1. Отличительные особенности материала ТМ, геологического изучения и формирования балансовых запасов

Distinguishing feature	Characteristic
Geological study of deposits	The staging of geological exploration work is limited to conducting revision and evaluation and exploration work. Revision and evaluation include office and field work. The paucity of practice in developing MMD does not allow for the preparation of substantiated recommendations for setting up exploration. Only approximate parameters of the exploration network and testing are available. Experts believe that the recommended exploration methods cannot ensure the reliability of the reserve assessment. The complexity of, for example, man-made gold placers is estimated even higher than the complexity of Group IV deposits. MMD are characterized by a high geological risk during development
Characteristics of the material of man-made deposits	– Minerals containing valuable components are in most cases in the form of fine grains that form a close relationship with rock minerals; – complex polymineral material with various textural and structural properties and mineral relationships; – minerals in man-made raw materials often have properties and compositions that differ from the properties of minerals formed in natural conditions, this is especially true for minerals that have been exposed to pyrometallurgical processes; – paragenetic associations that are not typical for natural mineral raw materials are encountered; – minerals that are part of man-made raw materials under surface conditions under the influence of atmospheric air and moisture tend to weather, decompose and transform [7]; – the material of tailings dumps is even finer-grained and finely dispersed, waterlogged to varying degrees (dry, wet, waterlogged, with internal quicksand zones). High dispersion complicates enrichment processes, man-made raw materials are difficult to enrich. Due to the complex chemical, mineralogical, granulometric composition, a wide range of valuable and harmful components, the absence of any patterns in the placement of useful components, difficulties arise in the adopted technological solutions related to the extraction of useful components
Waste storage	During storage, waste loses its natural properties and practical value. Useful components are washed out and weathered with atmospheric flows, oxidation and gradual crushing occurs. It is believed that after 30 years, waste turns into “metal trash”
Mineral reserves	Balance reserves of MMD are usually insignificant and correspond to reserves of small and very small natural deposits. They are located on the earth's surface (a minor exception is in mine workings), and in this case lands are withdrawn from economic circulation

Table 2. Distinctive features of MMD associated with their development
Таблица 2. Отличительные особенности ТМ, связанные с их освоением

Distinguishing feature	Characteristic
The process of development	Reduction of the development process due to the absence of business processes related to the extraction of minerals from the subsoil and transportation. Due to the location of MMD on the industrial sites of operating mining or mining and processing enterprises, their development does not require the construction of industrial infrastructure (with the exception of stale waste)
Environmental Impact	The presence of harmful components is more diverse than in natural mineral raw materials, their quantity increases during the transformation of man-made raw materials during storage (oxidation, leaching, etc.)
Technologies	The specificity of MMD requires an individual approach when developing technological solutions. Traditional technologies are most often ineffective and predetermine low profitability of MMD use. Technologies in the development of MMD are innovative. At present, they may often be absent or at the laboratory stage. A mandatory condition is the regulation of the impact on the environment, which should not exceed a similar impact of BAT (best available technologies)
Efficiency	The development of MMD ensures the receipt of economic and ecological effects. In ecologically disadvantaged areas, the ecological effect acquires special significance; its excess over the economic one transfers production projects to the category of environmental protection

characteristics of newly discovered deposits compared to those already in operation [3]. The share of difficult-to-enrich ores has increased, the ash content of coal deposits has increased, mining and geological conditions and the level of accessibility of these deposits have worsened.

The need to prevent a decline in the sustainability of small and medium-sized businesses and to compensate for depleted mineral reserves has determined the consideration of waste from mining and related processing industries (man-made mineral formations – MMMF) as a primary source for the development of small and medium-sized businesses [4–6], fig. 1.

The priority of the MMMF in the development of the MRB is confirmed by the trends in the formation of the latter, which indicate an annual increase in the mass of accumulated MMMF [7], strengthening the man-made mineral resource potential, characterized by the presence of a huge variety of useful components. The successful involvement of man-made

The toolkit of the organizational and economic mechanism aimed at attracting subsoil users to the development of MMD	
Administrative	Economic
Introduction of new regulatory instruments governing the stages of development of man-made deposits related to their geological study, licensing and exploitation	Introduction of a new tool – assessment of the ecological and economic efficiency of development of man-made deposits with corresponding methodological support

Figure 3. Expansion of OEM toolkit
Рисунок 3. Расширение инструментария ОЭМ

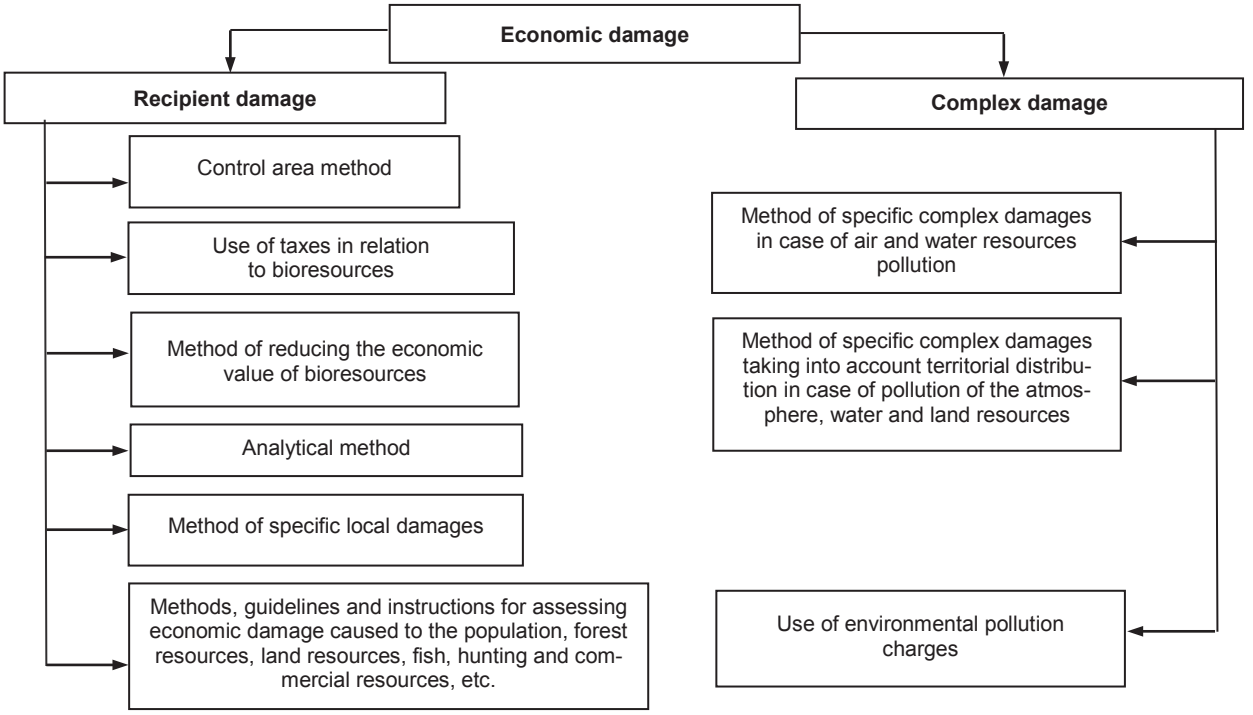

Figure 4. Methodological approaches to assessing economic damage
Рисунок 4. Методические подходы к оценке экономического ущерба

Table 3. Government support toolkit differentiated by project groups
Таблица 3. Инструменты господдержки, дифференцированные по группам проектов

Project Group	State support toolkit
I	Investment tax credit Bank loans Preferential taxation (income tax, mineral extraction tax, one-time payment) Write-off of expenses for studying MMD
II	Investment tax credit Preferential taxation (income tax, mineral extraction tax, one-time payment) Write-off of expenses for studying MMD State guarantees
III	Subsidies Rent reduction Loans Preferential taxation (income tax, mineral extraction tax, one-time payment, property tax, land tax)

deposits in economic circulation is served by the prevention of problems that complicate this process, which are reflected in the work [8]. Among the identified problems, one of the first places belongs to the imperfection of the organizational and economic mechanism (OEM) regulating the activities of enterprises of the mining complex for the development of man-made deposits.

Results

The generalization and analysis of materials concerning the formation and use of the organizational and economic mechanism in the sphere of subsoil use showed that there is no consensus on the construction of its structure and the list of regulatory instruments used. The author's definition of the OEM, taking into account the substantive content of the concept of "mech-

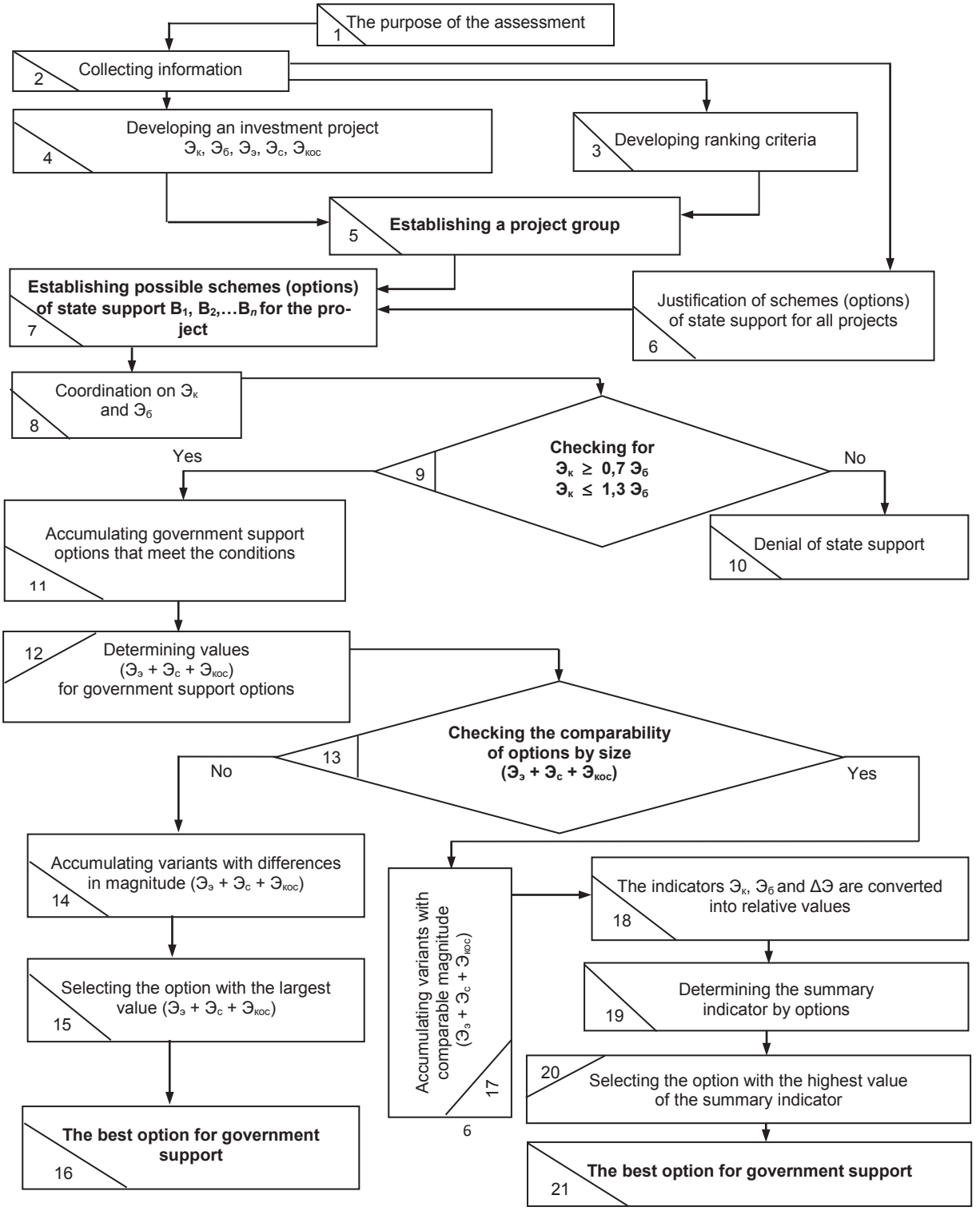

Figure 5. Algorithm for choosing the best option for government support
Рисунок 5. Алгоритм выбора наилучшего варианта господдержки

anism", comes down to the following: the organizational and economic mechanism is a set of elements, measures, methods, ways, levers (instruments) and their interrelations, which is used to influence the regulated object in order to change the trajectory of its activity in the direction of achieving the set goal. Fig. 2 shows the recommended structure of the OEM.

In turn, an instrument is a way, method, approach, technique that influences the regulated object directly in a compulsory manner or through its economic interests in order to change the activity of the regulated object in a direction that ensures the achievement of the set goal. The set of instruments characterizes the toolkit of economic or administrative mechanisms. Mixed instruments in the structure of the OEM carry aspects of both administrative and economic nature (environmental programs, environmental insurance, public-private partnership).

Improving the OEM involves expanding its toolkit. This primarily concerns administrative tools. The difference between man-made deposits (MMD) and natural ones has been proven (Tables 1, 2).

The identified specificity of MMD requires their allocation to a separate category of legal regulation, i.e. the introduction of new regulatory and legal instruments into the administrative toolkit that regulate geological exploration, licensing and exploitation of MMD. In turn, the economic toolkit provides for the introduction of a new instrument – assessment of the ecological and economic efficiency of MMD development. The instrument for assessing the value of deposits is already present in the economic toolkit, the newly introduced instrument will enable the owner (the state) to receive timely reliable information on the efficiency of exploitation by the subsoil user holding the license. Thus, the expansion of the OEM toolkit for the conditions of MMD development has the following form (Fig. 3).

The effective use of the newly introduced economic instrument required the appropriate methodological support, which was reflected in the author's recommendations for taking into account the proposed fundamental principles of assessing the effectiveness of MMD development in the process of performing assessment procedures. The recommended fundamental principles are as follows: the use of an ecological-economic approach in assessing the effectiveness of MMD development, supplemented by an ecosystem approach, consideration of the commercial economic effect primarily as resource-saving, the use of recipient and comprehensive assessment methods in assessing the environmental effect due to the prevention of negative environmental consequences, which was reflected in the proposed classification (Fig. 4).

Estimates of the indirect economic effect due to savings in geological exploration work in new development areas, and changes in the discounting procedure (refusal to discount in relation to prevented economic damage) [9].

The fundamental principles concerning the assessment procedure include: principles of the relationship between the reliability of the assessment and the stages of its implementation, the specifics of the formation of costs and income when using multicomponent mineral raw materials, geological risk for MMD, and limitations of the calculation period [10]. Taking into account the author's principles when assessing the ecological and economic efficiency of MMD development makes it possible to increase the reliability of the assessment of the results by reflecting the specifics of MMMF processing.

In many ways, the activation of MMD development depends on the effectiveness of the state support system. A methodological approach has been developed for selecting the most acceptable option for state support for activities to replace primary raw materials with secondary ones, taking into account domestic experience in this area of activity [11–16]. The algorithm characterizing the proposed methodological approach is shown in fig. 5. At the first stage, the criteria for differentiating investment projects for MMD development according to the priority of receiving state support are substantiated. Among the criteria are: economic profitability and environmental impact. Three groups are subject to identification, reflecting the greatest significance of the mineral resource aspect. At the second stage, using the experience of experts, a list of possible options for state support for each of the identified groups is established (Table 3). At the third stage, the options for state support are assessed based on the agreement of commercial and budgetary effects. Agreement is achieved when the difference between these effects does not exceed ± 30%.

The final stage is the selection of the best option for state support, which, firstly, involves comparing the options by the total value of all effects in addition to the commercial one. There are two possible situations when these values are incomparable, and then the option with the maximum value of the total effect is recognized as the best, and the second situation is when the compared values are the same. In this case, the mechanism of relative indicators is used. The commercial and budgetary effects and their difference are subject to assessment. The option of state support with the largest value in relative units is recognized as the best.

Conclusion

The priority of using MMMF for the development of the mineral resource base, which has shown the first signs of losing stability, has been proven. Activation of the introduction of MMD into economic circulation assumes, firstly, the expansion of the OEM toolkit through new regulatory and legal instruments and an economic instrument – an assessment of the ecological and economic efficiency of MMD development with the corresponding methodological support, and secondly, an increase in the efficiency of the state support mechanism through the use of the proposed methodological approach to choosing the most acceptable option for state support.

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The article was received on 01 July, 2025

УДК 330.131

http://doi.org/10.21440/2307-2091-2025-3-120-128

Техногенные месторождения: активизация освоения

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Аннотация

Актуальность. В настоящий момент становится все более приоритетным рассмотрение техногенных месторождений в качестве источника развития минерально-сырьевой базы. В числе основных причин, с одной стороны, появление первых признаков потери устойчивости минерально-сырьевой базы, с другой – постоянное укрепление техногенного минерально-сырьевого потенциала, отличающегося наличием разнообразных полезных компонентов, содержание которых в ряде случаев оказывается более высоким, чем на эксплуатирующихся месторождениях.

Цель исследования – совершенствование инструментария организационно-экономического механизма, регулирующего деятельность по освоению техногенных месторождений.

Методы исследования – системный подход, методы анализа, систематизации, сравнений, аналогий, структуризации, критериального выбора.

Результаты. В процессе исследований была подтверждена идея первоочередности использования техногенных минеральных образований для поддержания устойчивости природной минерально-сырьевой базы, компенсации погашенных запасов полезных ископаемых. Доказано возрастание массы отходов горнодобывающего и связанных с ним перерабатывающих производств, а также активизации их использования при решении выявленных проблем, затрудняющих введение техногенных месторождений в хозяйственный оборот. Разработаны меры, способствующие повышению эффективности применения организационно-экономического механизма, регулирующего освоение техногенных месторождений. Предлагаемые меры касаются расширения инструментария организационно-экономического механизма за счет введения новых нормативно-правовых инструментов и экономического инструмента с соответствующим методическим обеспечением. Предложенное методическое обеспечение предполагает разработку основополагающих принципов оценки эффективности освоения техногенных месторождений и предложения по их учету при выполнении оценочных операций. Важное направление регулирующих мер – методический подход, получивший отражение в авторском алгоритме по выбору наиболее приемлемого варианта господдержки деятельности по замене первичного сырья вторичным.

Заключение. Использование рекомендаций по расширению инструментария организационно-экономического механизма с соответствующим методическим обеспечением, а также выбору наиболее приемлемого варианта господдержки будет способствовать активизации освоения техногенных месторождений, рассматриваемых в качестве первоочередных источников развития минерально-сырьевой базы.

***Ключевые слова*:** техногенные месторождения, минерально-сырьевая база, развитие, устойчивость, инструментарий, методическое обеспечение, господдержка.

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Статья поступила в редакцию 01 июля 2025 года