FORMATION OF AN INTEGRATED INFORMATION SYSTEM OF THE OBJECTS OF MINING AREAS THROUGH THE EXAMPLE OF THE URAL REGION

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ABSTRACT

The research paper deals with the method of forming an information system for mining areas management on the basis of conducting comprehensive monitoring and maintaining a cadastre of mining areas (MAs). Ensuring security and safe living conditions of the population when using such areas, especially in the interests of future generations, is a priority aspect of their sustainable development. Extraction of minerals is accompanied by active transformation and destruction of the earth’s surface, which leads to the formation of specific mining landscapes that have a significant impact on the sustainable development of such areas. The objective of this study is to provide information management of the sustainable development of landscapes of mining areas based on the formation of an integrated information system for monitoring these areas and the development of cadastral works of the objects of mining complexes (MCs). The method proposed by the authors for the
formation of an information database of MCs’ objects justifies the need to work on the classification of the objects of mining complexes, the formation of MCs real estate objects, the organization of comprehensive monitoring to obtain relevant and reliable information about MCs’ real estate objects and their cadastral registration

Keywords: Information Support, Mining Landscapes, Real Estate Objects, Sustainable Development, Cadastre, Monitoring


1. INTRODUCTION

The mineral resource base of any country is the basis of its economy, the strategic basis of the national economic activity. However, mining operations are accompanied by active transformation of the lithosphere, pollution of water bodies and watercourses in these areas, disruption of natural landscapes and the formation of new technogenic landforms, i.e. the formation of specific industrial landscapes - mining landscapes (MLs). Consequently, natural and anthropogenic landscapes interact and develop together in the mining area (MA), forming a complex natural technogenic system. In this case, rational use and protection of the lands of mining areas is possible only through an integrated approach [1, 2], which allows to identify features of the joint functioning of natural and technogenic systems, determine the indicator of acceptable anthropogenic environmental impact, assess the economic capacity of local and regional ecosystems, the excess of which leads to destruction of the natural biotic mechanism of environmental regulation and its profound qualitative changes [3].

Thus, today one of the main tasks is advancing from the ecological crisis of mining and adjacent territories in the context of their continuous territorial development [4-6], which should be based on up-to-date information necessary for the development of timely management decisions to ensure their sustainable development. In this connection, it is obvious that there is a need to develop a methodology for obtaining comprehensive information about their condition in identifying negative factors affecting the land based on the development of integrated monitoring of mining landscapes (MLs) and the cadastre of mining complexes (MCs).

The conducted research related to either narrowly specialized issues of geomechanics and geodynamics, or addressed these issues from a purely technological standpoint, and the studies were descriptive in nature and related to objects of technogenesis on the surface, although significant results were achieved in the geochemistry of landscapes located on the mining areas; besides that, an attempt was made to systematize them and make suggestions about the possibility of self-restoration of mining areas. These studies cover mainly the areas exposed to mining, but it is not possible to carry out a comprehensive assessment of these areas due to the lack of comprehensive information allowing reliable assessing the condition of the landscape taking into account zonal and regional features.

For the formation of an information database on the lands of mining areas based on the use of modern information and communication technologies, integrated monitoring of lands, cadastre in the areas of mining regions, an analysis of the existing information systems was carried out, including the monitoring of mining landscapes (MLs) and the cadastre of objects of mining complexes (MCs) through the example of the Ural region.
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The development of a methodology for obtaining comprehensive information on the condition of lands of mining areas, which are negatively affected by mining facilities, requires the collection and processing of a large array of diverse information [7-13]. We have analyzed the known methods of collecting and processing different information used in conducting monitoring of natural objects and phenomena, as well as methods of processing the information obtained using modern geographic information systems (GIS) [5, 14-16] for selected objects of research on the territory of the Ural region.

The Ural region is one of the largest mining regions of the Russian Federation. Its territory is 275,557.7 thousand hectares or 16.1% of the territory of the Russian Federation [18]. The region is famous for its huge reserves of various minerals, which predetermines its peculiarity, as well as problems that are increasing due to the development of mining, transportation and processing of minerals that have a negative impact on the environment. The collection and processing of comprehensive information about mining areas for the development of management decisions that ensure the sustainable development of these areas determine the objective of this study.

The subject of the research is the formation of information on the condition and use of land in mining areas based on the use of modern methods of obtaining data in the integrated monitoring of these areas and processing the information obtained using modern GIS technologies to ensure the sustainable development of MAs subject to the negative impact of mining.

1.1. The area of research
The territory under consideration is the Ural region, located at the junction of Europe and Asia, and captures, in addition to the highland, the Urals, the East European and West Siberian plains [19]. The analysis of the mineral resource base of the Ural region allows us to draw the following conclusions: at present, the Urals have significant reserves of minerals, many of which are prognostic and will eventually add to the list of mineral deposits ready for development; in addition, each subject of the Ural region has a fairly diverse common commercial minerals, which determines the possibility of developing small mineral deposits, as well as a fairly large distributed fund of the subsurface resources that predetermine the development of large mineral deposits.

Hence, it follows that the problem of forming an information base on the condition and use of land occupied by objects of the mining and processing industries in the region is quite burning and the formation of reliable and timely information is urgent. Studies were conducted based on materials of opencasting and underground mining in the Ural mining region.

2. MATERIALS AND METHODS
In this study, the authors used publicly available materials on the mining areas (MAs) of the Ural region, as well as data from state information systems and funds that allow analyzing the monitoring of the MAs and creating the inventory base of the cadastre of mining complexes (MCs) in accordance with the current legislation of the Russian Federation. This allows creating a database for updating and obtaining objective, complete and reliable information using modern means and methods of monitoring the MAs, and also using the accumulated data in the future to build stochastic models of forecasting the possible occurrence of emergency situations in the studied areas taking into account their features. The available information is scattered and not always accessible, and besides that, this information requires additional actions related to its conversion, while there is no certainty that reliable results will
be obtained due to the incompatibility of the source data processed. Therefore, there is a problem of obtaining up-to-date information on the condition and use of lands and natural resources utilized by mining facilities to make timely management decisions. All this requires the improvement and development of methodological approaches to the formation of the up-to-date real-time information base on the territory of the MC.

To solve this problem, the authors analyzed the information contained in the documents of the monitoring of the stability of the pit walls, carried out from 1970 to 1990 at such MC facilities as: No. 1 Gaisky Ore Mining and Processing Enterprise, Public Joint Stock Company; Sibay Open Pit Mine (Bashkirian Copper and Sulfur Plant); Open Pit of the Uchaly Ore Mining and Processing Enterprise; Mednorudnyansky Quarry (Nizhny Tagil); Open Pits of Uralasbest Industrial Complex, Public Joint Stock Company [20, 21]. In addition, we studied the materials of observation of the deformations of the slopes of the dumps at: Uralasbest Industrial Complex, Public Joint Stock Company; Orenburgasbest Industrial Complex and slag disposal of Sredneural'sky Copper Smelter [22]. The carried out studies were examined in greater details using the example of the Bazhenvovskoye Chrysotile-Asbestos Deposit [14, 23] and Novo-Kalinsky North Ural Bauxite Mine [24], also in the territory of impact of the old underground mining of the 19th century (1800's) of the former Turinski Copper Mines in the town of Krasnoturyinsck [14] of the Ural region.

For the formation of the information base, studies of the mining landscapes (MLs) were previously performed and the necessary elements for monitoring the MLs were identified, such as the design, composition and content of monitoring points, the concentration of the monitoring points on the monitored territory. As a result, the choice of measuring instruments was made; a methodology has been developed to carry out surveys, observations and measurements at monitoring points; the frequency of observations and the accuracy of observations (the error of measurement results) were determined, as well as the method of processing the results of instrumental data and the prediction of the expected values of the determined indicators [4, 14, 20, 21, 23, 25, 26].

The research was based on the basic provisions of monitoring, which were described in the work of R. E. Munn: Global Environmental Monitoring System, published in Toronto in 1973 [9], as well as in the works of one of the major domestic researchers in the field of monitoring development, Yu. A. Israel [7]. When conducting research in the field of the existing developments, it was noted that national systems of land monitoring in different countries have significant differences, which are due to the peculiarities of their natural geographical position and the pace of socio-economic development. It has been established that in most developed countries, such as Austria, Hungary, Germany, the Netherlands, Norway land monitoring has been carried out for more than 30 years and is reduced mainly to soil monitoring and differs in goals and objectives, work performance technology, a set of indicators, details, etc. depending on national interests. The results of land monitoring, along with other data, are further integrated into GIS and are mostly open for free use [28]. In addition, such indicators as soil contamination with pesticides or fertilizers, the degree of erosion processes, soil loss of organic matter as a result of various degradation processes occurring in them, as well as changes in land use patterns are observed most often in the course of land monitoring.

In some countries, methodological approaches have been developed and full-fledged networks are functioning, and in some countries only individual observations are made, i.e. it can be said that in most countries a uniform methodology has not yet been created, there are no agreed programs and networks for monitoring, monitoring does not develop at a pace that
would contribute to the creation of a comprehensive up-to-date information base, which is confirmed by the analysis of foreign and national publications [10, 15, 22, 23, 28-30].

For example, in the studies of R. Robertson, as well as a number of Dutch scholars [31-33], it was noted that the intensive development of mining areas in the context of globalization necessarily leads to the formation of disturbed areas of the earth's surface, the formation of the so-called mining landscapes (MLs). The authors proposed to divide MLs into three groups for the study: static; dynamic; mixed.

The first group implies that the current state of the monitoring object or its element is compared with the critical one. In this case, the forecast is the possibility (probability) of a negative event.

The second group implies that the forecast is made on the basis of the available dynamic series of measurements of the characteristics of the monitoring object condition. In this case, the expected value of the studied characteristic is interpolated for a certain period of time with a certain probability.

The third group implies that there is confirmation of the probability of a negative event with its further development or attenuation in time.

The formation of an information base for predicting the state of mining landscapes can be comprehensively carried out, in our opinion, on the basis of monitoring and cadastral work. For this purpose, ML objects involved in the production process of mining and their primary processing were proposed to be considered as technological objects of MCs requiring special record, which is the cadastre of MC objects, formed as a subsystem of the cadastre. It has been established that, unlike the existing state record systems, the formed sub-system has certain features, which include:

- the subsurface plot - a mining allotment - should be included in the structure of the cadastre of MC objects with information characterizing the mineral deposits and enclosing rocks;
- it is necessary to take into account the time factor that characterizes the constant change in the characteristics of individual objects of the MC;
- it is necessary to formulate and implement the principle of identifying real estate objects among the objects of the MLs;
- the environmental impact of mining should be taken into account.

Basing on the above, it was suggested to determine the cadastre of MC objects as a systematized collection of documented information on technological and other purposes, natural, technical, economic, ecological and legal status, as well as spatial position of MC objects, which represents mainly the following groups of objects and phenomena of the MC: the subsoil, the earth’s surface, engineering infrastructure and related technological, environmental and economic aspects.

Taking into account the instability of the state of the MLs during their formation and functioning, including development in the post-production period, and also the fact that most of the MLs are dangerous, technological control and supervision of their condition is established which is aimed at preventing emergency situations and mitigating their effects on the earth’s surface and within the mining allotment. All this leads to the need for integrated monitoring of the state of mining landscapes (MLs), updating information for the timely development of management decisions, that can be realized on the basis of comprehensive monitoring of mining landscapes (MLs) [34-37].
The information subsystem of monitoring MLs can be divided into two groups based on the following conditions:

- the first group is characterized by conditionally definite information about the properties, composition and content of monitoring objects, which suggests the change in the characteristics of monitoring objects from the influence of external and internal factors and substantiate the method of monitoring and processing the results of observations;
- the second group is characterized by indefinite information about the monitoring object, which implies a forecast of the development of the process of changing the characteristics of such an object in the future only on the basis of prepared and conducted observations.

The first group, for example, may include monitoring of emissions of harmful substances from the facilities of the MCs to the atmospheric air, since the following data are known: the source of emission, the volume and estimated directions of transfer of the pollutants mass and the area of soil contamination, i.e. dust and gas dynamic mechanism of the process of changing environmental characteristics.

The second group may include monitoring of the ML objects at liquidated MC facilities, especially those for which information was not preserved for one reason or another.

The current legislation provides that hazardous production facilities include the objects where mining operations are conducted, mineral processing activities are carried out, for which the mandatory requirement is the need to “create observation, warning, communication and support systems in the event of an accident and keep these systems in a proper condition”.

At present, it is also possible to refer newly created artificial land plots - specific objects of anthropogenic landscapes - to such facilities, for the purpose of monitoring the condition of which, according to Art. 10 of the Federal Law “On Artificial Land Plots ...”, it is necessary to prepare a list of measures to prevent emergency situations of natural and technogenic nature and prevent their negative impact on water bodies and eliminate such consequences.

As for other ML objects, namely, landfill sites, i.e., mainly dumps, as well as liquid waste storages: sludge ponds, sludge dumps, etc., similar requirements are imposed on owners of wastes regarding monitoring of the condition of facilities.

An analysis of the existing state monitoring of the condition of natural and anthropogenic objects shows that none of them can fully satisfy the conditions imposed on obtaining complete and objective information about the ML objects, and also cannot meet the requirements for creating a system of observations of the state of the ML objects. They do not fully provide all the information on ML objects and are of a general nature. All this determines the need for the development of a subsystem for comprehensive monitoring of the state of the ML objects on the territory of the MC, which has a close relationship with the existing monitoring.

To this end, it is proposed to create a subsystem of departmental integrated (local) monitoring of the condition of the earth’s surface within the MC and the MA, taking into
account the condition of the ML objects and subsurface areas affecting the condition of the earth’s surface, and, ultimately, making decisions on managing ML objects.

The organization of the ML monitoring begins with the development of a project to monitor the ML. When developing a project for the implementation of the ML monitoring, the following information [27] is needed, which is substantially supplemented by the following provisions for the research purposes:

- the way of developing the mineral deposit, which determines the composition of the ML objects, the condition of which is being monitored;
- the characteristics of the ML objects, including the determination of the location of the ML objects, approximate dimensions, the purpose of the ML object in the production process, its identification as a source of pollutants in the environment, or the area of accumulation of pollutants, or a potential area of possible manifestation of technogenic accidents or emergency situations, or a source of physical effects (noise, electromagnetic, etc.) on the environment;
- carry-over of pollutants characterizing the processes of atmospheric transport, processes and migration in the aquatic environment (in the field of surface and groundwater);
- processes of landscape geomechanical redistribution of energy, determining changes in the stress state of the mountain massif, namely, the processes of rock deformations in the form of displacement of rocks, rock pressure, rock bumps in the course of underground mining of mineral deposits, violation of stability of pit walls and slopes of dumps during open mining of mineral deposits, as well as dams for liquid waste storages;
- processes of landscape geochemical redistribution of substances that form the migration of substances, including pollutants, along the soil profile to the groundwater level, migration of pollutants along the landscape geochemical junction taking into account geochemical barriers and biochemical cycles;
- data on the state of anthropogenic emission sources (the volume and frequency of substances intake) determining the power of the emission source and its location, dust-and-gas and hydrodynamic conditions for the emissions’ enter to the environment.

The objective of the monitoring being created is the synthesis, analysis, selection and improvement of the available monitoring means, methods and techniques for developing a unified integrated monitoring of the ML objects in order to obtain reliable comprehensive information about their condition for their effective management.

Sections of monitoring of the MLs can be formed on the basis of the relation to the study of the condition of its objects, namely:

- a section for the changes of the ML objects located on the earth’s surface, i.e. disturbed land monitoring system;
- a section for the changes of GPL objects located in the subsurface, i.e. a system for monitoring the condition of underground mines;
- a section for changes of the qualitative condition of lands, i.e. land pollution monitoring system;
- a section for changes of the natural condition of the lands, i.e. land degradation monitoring system.
In general, if a ML monitoring subsystem is accepted, which is characterized by conditionally definite information about the monitoring object, the sequence of ML monitoring consists of the following steps:

- Identification of the monitoring object and possible external and internal factors affecting the changes in its characteristics;
- Formation (development) of theoretical provisions of changes in the characteristics of the monitoring object under the influence of external and internal factors;
- Building a model of a specific monitoring object and its environment;
- Determining the probability (risk, danger) of the occurrence of a negative event in time and space;
- Choice of methodology, methods and means of monitoring (measurements), including the accuracy and frequency of observations (measurements), implementation of monitoring;
- Processing of the results, confirmation of theoretical conclusions or their correction, forecast of the process of changing the characteristics of the object;
- Making management decisions on the further condition of the monitoring object.

In case when we deal with indefinite information about the monitoring object, the sequence of the ML monitoring is as follows [14]:

- Identification (detection) of processes of negative changes in the characteristics of the monitoring object;
- Choice (by analogy or on the basis of the possibility of obtaining the most complete and accurate information about the monitoring object) of the methodology, methods and means of monitoring;
- Processing the results of observations, interpretation of the process of changes in the characteristics of the monitoring object, building forecasts for the development of the process of changing the characteristics of the monitoring object;
- Making management decisions on the further condition of the monitoring object.

The block diagram of the ML monitoring is given in Figure 1.

An integral part of monitoring are methods and means of obtaining information on the condition of objects. Considering the specific type of the object of study, there is no doubt that not only generally accepted, but also special methods and means of monitoring which are the most rational and effective in particular cases, can be applied.

On the basis of the conducted research, the following necessary elements of the organization of ML monitoring were identified:

- Design, composition and content of monitoring points, concentration of monitoring points on the observation territory;
- Choice of survey, observations and measurements tools;
- Methods of performing surveys, observations and measurements at monitoring points;
- Frequency of observations;
- Accuracy of observations (measurement error).
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Figure 1 ML object monitoring structure

- Frequency of observations;
- Accuracy of observations (measurement error)

The most important elements of the organization of ML monitoring - the frequency and accuracy of observations - are chosen so that according to the results of observations that have passed the appropriate mathematical processing it was possible to trace the dynamics of development of the processes of changing the state of the ML objects and predict their condition for the expected period or calculate the probability of the occurrence of negative emergency event.

As a result of monitoring the objects of mining landscapes, information is accumulated about the condition of the monitoring objects located within the ML. The data resulting from MLs monitoring about their condition, changes in their properties and characteristics, forecast of the condition of the MLs objects and data on the implementation of forecasts should be formed in the record system, which is the cadastre of the MCs objects for their further management.

The stages of the formation of MLs, as well as the impact of the components of natural and technogenic environments, determine the need to use modern GIS technologies as an integrated system to study the functioning and development of the MLs and to manage them. The created subsystem for records and observations of changes in the condition of the mining landscape objects, including the cadastre of the mining complex objects and the ML monitoring is characterized as a complex, combining local level (MC at the mining area (MA)) and impact level, i.e. recording the processes of changes in the ML objects, depending on anthropogenic factors, often of an extraordinary nature, and having a timeframe and frequency of observations from basic to retrospective [5; 9; 10; 27]. Such an information subsystem must necessarily be accompanied by monitoring compliance with current
legislation, as well as the ability to display the information obtained using GIS technologies [11].

3. FINDINGS

Thus, in the case of the operating MC, the objects of information support are mining and land allotment, areas with special conditions for the use of territories, as well as the ML objects located there. In this case, a complete, reliable, objective, up-to-date information about the ML objects and MC objects plays a primary role in managing ML objects and, undoubtedly, the corresponding complex information subsystem performs the same role - a systemic collection of information about ML objects and MC objects, formed as a result of the ML monitoring and cadastre of the MC objects, allowing to summarize, structure, process, save and output up-to-date information in the requested form.

The creation and maintenance of such an integrated information subsystem - the monitoring of the MLs and the cadastre of the MC objects - confirms the urgency of creating a special structure at the mining enterprise - the Cadastral Service in the MC.

The peculiarities of the development of mineral deposits of various types of minerals (solid, liquid, gaseous) by different methods (open-pit, underground, borehole, underwater, etc.) and in various conditions (climatic, environmental, urban planning, etc.) allow forming the basic principles of creating the MC’s Cadastral Service:

- the monitoring of MLs and the MC objects cadastre should be maintained according to a uniform methodology within the framework of the current technological system for developing mineral deposits, taking into account the specifics of their development [15];
- the process of creating and maintaining monitoring of MLs and the cadastre of the MC objects should be automated to account for large flows of heterogeneous information and the formation of responses to various consumer inquiries;
- the monitoring of MLs and the cadastre of the MC objects should ensure full interrelation with state authorities and local self-government bodies in order to ensure the exercise of rights to use real estate on the territory of production and economic activities of a mining enterprise;
- the cadastral service of the enterprise should be separate, i.e. the subsystem of the ML monitoring and the cadastre of the MC objects should be centralized.

The put forward principles determine the appropriate conditions both for servicing internal information flows from various departments and services of the MC, and when interacting with external information flows from government bodies, local governments, legal entities and individuals.

Ensuring the put forward principles of monitoring the MLs and the cadastre of the MC objects is also possible through the formation of electronic document management. For effective interaction in this case, two conditions must be met:

1. ensuring the convertibility of exchanged data formats;
2. availability of electronic digital signature of a legal entity.

The first is ensured through appropriate software, and second, in accordance with current legislation, - through the preparation, transfer and servicing of an electronic digital signature of a mining enterprise by a special certified organization.
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When receiving external information in electronic form, it is carried out by interacting with the authorities in accordance with the approved administrative regulations for the provision of public services and the exercise of public functions.

The formation of a data bank of the MC objects also provides for the formation of digital information in the form of a package of planning cartographic materials heterogeneous in terms of topics, scales and the principle of compiling. For effective use, these materials should be spatially oriented and filled with the description of the objects depicted on them, characterized by features relating to the mining area and which are different systems of conventions of objects, processes and phenomena. These are topographic maps and plans, elements of cadastral division, mining graphic documentation, objects of landscapes, land management, grounds, as well as natural territorial complexes, as well as objects of town planning, etc. Such information requires the mutual coordination of various systems, the formation of specific libraries of symbol books and, most likely, coordination of the existing electronic cartographic material created for the MC with the structure of the general data bank. In this case, it is necessary to solve a number of the following issues:

1) ensure the convertibility of exchange data formats for cartographic material;
2) transform attribute information into electronic form and link it with spatial objects;
3) create a single library of symbol books, and also create a common structure for the representation of spatial information in the MC services, i.e. automated information system.

The solution of these issues involves the creation of an automated information system (AIS) which is based on the automation of information processes for collecting, organizing, processing, storing and outputting information. The system is created in the form of functional subsystems. There are three such subsystems: the subsystem of collecting, systematizing, processing and forming the primary model of the ML objects and cadastre, the data bank, the subsystem of preparing information for output on the consumers’ request (Fig. 2).

Figure 2 The functional structure of the integrated information system for monitoring the ML and the cadastre of the MC objects

consideration of these features
4. DISCUSSION

Based on the studies performed, the need to form an integrated information system based on obtaining ML monitoring data and the cadastre of the MA objects has been established. Different zones of impact of mining operations on the environment, the diversity of types and forms of the ML, the stages of their formation, as well as the impact of components of the natural and technogenic environment predetermines the need to use modern GIS technologies as integral systems to study the functioning and development of the ML in the development of mining complexes (MCs) [1; 26].

Taking into account the peculiarities of the life cycle of the MC’s real estate objects when developing mineral deposits, their temporary nature and possible changes in space, the emergence and termination of the existence of real estate objects and the ML, as well as a variety of rights and restrictions (encumbrances) of rights to them, prove the need to form an integrated information system in which data are actualized through monitoring and cadastre works. At the same time, when forming an information system it is necessary, in particular, to take into account that in case of external interaction information must be prepared in the form of duly executed documents approved by the relevant authority, as well as in internal interaction there can also be a relevant system of duly executed documents, since mining works are classified as hazardous objects. All this requires additional developments and consideration of these features.

5. CONCLUSION

Thus, the creation and maintenance of an integrated information system based on the monitoring of mining landscapes (MLs) and the cadastre of objects of the mining complex (MC) allow receiving, at any point in time, updated, complete and objective information on each ML object. A feature created by an integrated information system is its use after the completion of field development, i.e., after the liquidation of mining complex.

For this system, the development of monitoring of mining landscapes are proposed for this system, taking into account the rate of change in the properties of natural landscapes during their formation, which in this case is much higher than it exists in nature, and also taking into account the negative environmental impact of mining operations and primary fossil processing on all components of the natural environment.

The cadastre of objects of the mining complex is considered and proposed, designed to detect technological objects to be accounted and identified as real estate objects subject to state cadastral registration, was proposed and proposed. It has been proposed to introduce a subsoil plot into the cadastre of mining complex objects as immovable assets. In this regard, the basic information about the objects of mining landscapes subject to accounting using modern geo-information systems are identified, which allow comprehensive combining spatially-oriented information of different content, including the location of the objects of mining landscapes and their interaction, as well as condition, and depicting forecast of their condition.

In addition, the proposed structure of an integrated information system of the MAs objects, the content of monitoring of mining landscapes and maintaining the cadastre of the MC objects to the greatest extent allows taking into account the peculiarities of maintaining such a system in a mining enterprise, including receiving, processing, organizing, storing and outputting updated reliable information about the objects of mining landscapes and mining complex.
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