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FEATURES OF THE APPLICATION OF GEOTECHNICAL METHODS OF AMBER EXTRACTION FROM SAND AMBER-CONTAINING DEPOSITS

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Abstract

In the work, an analysis of scientific and technical information related to amber mining processes was carried out, which revealed that the main direction of development and improvement of amber mining technology, which is implemented by the borehole mechanical-hydraulic method with the use of water, air and vibration as the main influencing factors. A potential source of amber production can be exhausted deposits with off-balance reserves, which are man-made deposits, but this requires the development of a technological process. Due to the imperfection of the existing technologies, losses of minerals in targets and dumps significantly exceed 50%. Existing technologies for extracting amber from sandy amber-bearing deposits are highly energy-intensive, destroying rocks, and segregation requires improvement of technology and equipment to increase the efficiency of the final product extraction process and reduce energy, water, and air consumption. The proposed technological schemes do not provide for an ecological component, the possibility of reclamation of mining waste. Man-made influence requires additional research taking into account various mining and geological characteristics and host rocks and the develop-

ment of recommendations for technology and equipment taking into account the environmental component.

Introduction

The main direction of development and improvement of amber extraction technology is carried out by the borehole mechanical-hydraulic method using water, air and vibration as the main influencing factors. But so far, the experience of its use is limited due to the huge difference in the mining and geological characteristics of deposits and host rocks.

Taking into account the shortcomings of the technology of amber extraction at the final stages by mechanical or hydraulic methods, when amber with a size of -5.0 mm is not extracted in the process of processing the rock mass, but goes to the landfill, then the potential source of its extraction can be depleted deposits with off-balance reserves, which are artificial deposits, but this requires the development of a technological process.

Despite the well-known advantages of borehole-hydraulic mining, losses of useful components in tailings and landfills exceed 50%, so the problem of developing amber as a component of geotechnological methods of mining requires identifying the shortcomings of the existing technology and eliminating them. at a higher scientific and technical level.

In the existing technologies for the extraction of amber from sandy and sandy-clay rocks, there is no mechanism for reducing its costs.

Currently, the energy intensity of rock destruction and their segregation require the improvement of technology and equipment in order to increase the efficiency of the final product extraction process and reduce energy, water and air consumption.

The proposed technological schemes do not provide for an ecological component, the possibility of mining waste reclamation, and their man-made nature requires additional research and the development of recommendations for technology and equipment taking into account the ecological component.

Ukraine has significant reserves of amber, the deposits of which are located in conditions of various mining and geological characteristics and host rocks, which requires additional research to improve the extraction technology, taking into account technogenic and ecological circumstances.

Therefore, in order to increase the efficiency of the process of extraction and extraction of amber, additional studies are needed to determine the dependence of the influence of factors on the process of processing amber-containing mass, the development of amber extraction methods, in order to solve the problem of improving the geotechnology of the development of amber deposits in specific conditions, which requires a significant reconstruction of the technological process taking into account mining and geological conditions, environmental requirements in a complex with technical solutions for the implementation of the proposed processes.

The purpose of the work is to study the peculiarities of the application of geotechnical methods of extraction of amber from sandy amber-bearing deposits, technology and equipment for layer-by-layer extraction of amber by a complex method, and improvement of technology and equipment to increase the extraction of amber from amber-bearing rock mass with the selection of rational parameters of the technological scheme taking into account the ecological conditions of the region.

1. The practice of applying geotechnological methods of amber extraction

The conducted research aimed to determine the direction of development of systems for the development of amber-containing deposits and the equipment used for their performance. At this time, the experience of studying the processes of amber extraction, the use of equipment and the determination of regularities in the geotechnical characteristics of their interaction is insignificant. In addition, it largely depends on the mining and geological characteristics of deposits and host rocks, therefore it requires specific research and technical solutions for the perfection of technological processes and technical means. Therefore, there is a need for a systematic approach based on the principles of scientific analysis of amber hydro mining systems to identify the nature of the relationship between technological indicators in specific mining conditions and the characteristics of the equipment used.

The possibility of working out the deposit by geotechnological methods is determined by physical and geological factors.

The success of the development of deposits by geotechnological methods depends primarily on physical and geological factors.

First of all, they include the geotechnological properties of the mineral, which provide the possibility of transferring it into a mobile state. Such factors as porosity, permeability, mineralogical composition and other characteristics of the massif and fluids largely determine the economic performance indicators and must be taken into account when evaluating geotechnological methods. In a number of cases, to ensure the success of the application of geotechnological methods, it is necessary to implement technical measures that will allow to manage certain properties of minerals and rocks containing them. The study of physical and geological factors affecting the effectiveness of the application of geotechnological methods is a complex, complex problem, as it depends on many factors. Some factors have the same importance as in conventional mining methods. These are, first of all, mineral reserves, geographical and economic conditions, and the depth of occurrence. Geotechnological methods, as a rule, require less capital investment for the construction of a mining enterprise, so the scale of the deposit and the depth of mineral deposits are less important than with conventional development methods. At the same time, a number of methods can be implemented only at great depths.

Since the main factor in the use of geotechnological methods is the possibility of economically transferring a mineral into a mobile state, the study of any deposit should begin with the study of this factor, as well as those factors that ensure the spread of working agents in the subsoil and the movement of the mineral to the mining sites.

The parameters of the mining process are significantly influenced by the following physical and geological factors.

The chemical and mineralogical composition of deposits and host rocks determines the nature of their interaction with working agents (solvent, coolant, oxidizer, etc.). The most favorable is the composition of deposits that ensures selective interaction of the working agent with minerals containing a useful mineral.

Rock-forming minerals interact with the working agent without the formation of solid products, chemical reactions cause a large consumption of the mineral. The presence of minerals interacting with the working agent can lead to serious complications (for example, clogging of the pore space).

The content of the useful component in deposits, other things being equal, determines the efficiency of the mining method.

The mechanical properties of the deposit and containing rocks in some cases determine the possibility of transferring the mineral into a mobile state (hydraulic erosion) using hydraulic fracturing. In addition, they determine the course of the process of displacement of the layer of overlying rocks.

The chemical composition of groundwater, as well as the density and viscosity associated with it, determine the speed and nature of the spread of working reagents over the deposit.

The conditions of feeding and discharge of groundwater, their connection with different horizons determine the size of leaks of working and productive agents. Most deposits are flooded. From a hydraulic point of view, they can be characterized by a closed structure, partially closed and hydraulically opened. Proximity of groundwater supply and discharge areas, as a rule, complicates the extraction process.

The porosity, texture and structure of the deposit determine the degree of availability of minerals for the working agent. The permeability of deposits for many geotechnological methods is a necessary condition for the mining process. The heterogeneity of the permeability of deposits, as a rule, complicates the mining process, since permeable areas serve as channels for the movement of working agents, and impermeable areas remain outside their scope.

It follows from the above that the range of main factors affecting the conditions of mineral extraction by geotechnological methods covers many properties of deposits.

In this regard, one of the most important tasks is to find out the degree of influence of each factor on a specific geotechnological method and to find their qualitative and quantitative assessment. And this, in turn, will provide an opportunity to establish correlations between factors and economic indicators of field development. Thus, the fundamental possibility of using geotechnological methods depends on the degree of influence of one or another natural factor on the technological regime of the extraction method.

Therefore, to support the operation of the system, it is necessary to carry out preliminary technical measures to eliminate the influence of adverse natural factors, that is, it is necessary to prepare the deposits for development.

At the same time, the following goals are pursued: improving the geotechnological properties of the mineral, increasing or decreasing the permeability of the deposit, isolating the deposit.

By geotechnological properties, minerals are divided into dispersive, soluble, combustible, extractable, and fusible. To increase the dispersion, the following can be used: dissolution with chemical reagents or microbiological methods, disruption of the natural structure by explosion or vibration, increasing the ability of minerals to form a stable aqueous mixture by adding surface-active substances (surfactants) or by the influence of bacteria. Improving the solubility of minerals can be achieved by mixing the composition of minerals. Improvements in flammability, melting, or mineral recovery can be achieved by intensification of the reactant feed process. In order to increase the permeability, mass crushing by explosion is widely used in practice. In some cases, the permeability can be increased by dissolving individual components, but for this the array must have at least a small initial permeability. Improving access to the mineral for the working agent can also be carried out by heating them in an electromagnetic field.

Much less often, artificial permeability reduction is required. Most often, it is necessary in the case of a massif that is significantly heterogeneous in structure, when the presence of karst cavities or tectonic disturbances makes it difficult to control the movement of working agents. In the presence of a connection with the surface or with other aquifers, which can be an obstacle to the ongoing processes at high temperatures and pressures, isolation of the deposit is required. Many methods of artificially reducing the permeability of rocks are known. The simplest method is based on filling voids with inert or binding materials (clay, tailings from beneficiation plants, cement mortar, lime solution, hot bitumen, various polymers, etc.).

Until now, artificial changes in the properties of rocks have been widespread mainly in the construction industry, where considerable experience has been accumulated in carrying out such activities. Now the task arises to manage the properties of rocks on a large scale, at great depths. This is the way to further development of geotechnological methods.

The study of the influence of physical and geological factors on the conditions of application of geotechnological methods of field development allows us to formulate the requirements for deposits developed by these methods, as well as to establish the necessary degree of their study.

On this basis, it is expedient to carry out studies not only of physical extraction processes, but also of those occurring in the system elements associated with the features of the equipment, with the detection of the mechanism of formation of losses of the useful component.

2. Assessment of the possibility of integrated extraction of amber from sand-bearing deposits

Today, geotechnical methods of amber extraction are developing in Ukraine, therefore there is a need to develop existing and create new technologies. There is a significant number of industrially significant amber deposits that are developed, and those that are not involved in development due to the impossibility of their exploitation by traditional methods, because they are located in difficult mining and geological conditions.

In almost all of the named deposits, amber lies in sandy or sandy-clay soils at a depth of up to 15 m. Therefore, its extraction is carried out by a mechanical method, which includes mechanical development of the soil massif by preparing the massif for the extraction of amber, opening the productive layer of the soil, excavation works, transportation of the rock from the place of development to the site of classification on the screen, where amber is separated from the rock by washing it with water on the screen, land reclamation. At the same time, sand and clay are washed away with water, and pieces of amber are selected and sent for sorting and further use.

Today, this mining method is used at the "Klesivske" and "Vilne" fields in the Rivne region. This method of extracting amber is now obsolete. Excavators with a return shovel of extraction equipment in mechanical mining systems are associated with the maximum depth of their use. At the same time, there are large operating and economic costs, and the removal of rock to the surface has a negative environmental impact on the environment.

In addition, when sorting the amber-bearing rock mass on sieves with a cell size of 5.0 mm on sieves, there are large losses of amber of a shallow fraction, because the washed rock mass together with fine amber (-5.0 mm) is waste. These dumps are man-made deposits, but they are not developed.

At this stage of technology development, hydraulic mining is the most common, where the energy of a water jet is used for destruction, erosion, disintegration, gravity transport of erosion products of amber-bearing rocks, as well as other operations in the general complex of delivering amber to the surface.

Scientists: Bulat A.F., Nadutyy V.P., Malanchuk Z.R., Lustyuk M.G., Korniyenko V.Ya., Malanchuk E.Z., Sierdobolskyi B. N., Krynytska M.V. and others [1-16].

The hydraulic method is used to wash away the productive layer of the soil with high-pressure jets. At the same time, the amber along with the containing soil is brought to the surface of the deposit by water flows.

The disadvantage of the method is: high energy costs, incomplete extraction of amber, when it is used, the structure of the soil changes, cavities are formed, which creates a significant negative man-made impact on the environment.

Two types of hydraulic production are used: borehole and underground. In the process of borehole hydraulic production (BHW), minerals at the place of occurrence are brought into a mobile state by the influence of the hydraulic mixture and its delivery to the surface through wells, which are the opening productions. When using underground hydraulic extraction (UHE), the hydraulic mixture is fed to the surface through underground mining operations.

A dispensing device is used to remove the pulp to the surface. After the formation of an undercutting gap, the hydromonitor is brought to the level of the first undercutting layer of the productive horizon. As the sloping undercut crevice deepens, the layer of the productive horizon collapses into the created space of the undercut crevice. During the operation of the hydromonitor, after connecting the undercut slot with the upper end of the casing pipes, the rise of the pulp is stopped and erosion of the collapsed soil layer begins. In the operating mode, the clay fraction together with the amber passes into the pulp, and the sand precipitates as a heavier fraction. The layer-by-layer erosion operation is repeated until the entire productive horizon is fully developed [1].

Another method of borehole hydraulic production with a mixture of different viscosity is used.

The specified methods of well production have the following disadvantages: they require a significant amount of water; energy intensive; in the process of work, a lot of soil is brought to the surface of the well, which creates cavities at the bottom of the well; create a negative impact on the environment; do not ensure complete extraction of amber [1; 3-15].

Mechanical-hydraulic mining (MHM) involves bringing a mineral into a mobile state at the place of occurrence by the influence of a mechanical executive body, after which it is released with a hydraulic mixture to the surface through vertical mining operations that open the deposit.

Research carried out in the field of development and improvement of borehole hydraulic production made it possible to modernize the method of mechanical hydraulic production due to the fact that the massif, saturated with water, is activated by mechanical excitation (vibration excitation) to the formation of a solid suspension layer of such a density that a repulsive (Archimed) force occurs, which raises the amber to the surface of the deposit. To do this, rods in the form of pipes, from which water is supplied and on which vibration exciters are fixed, are immersed in the amber massif using the vibration method. At the same time, the massif is saturated with water and vibration exciters are brought into oscillating motion. Amber is freed from connections with the environment and floats to the surface. This allows you to exclude the release of mineral rock to the surface of the deposit and thereby reduce the negative man-made impact on the environment, intensify the process, increase labor productivity with a decrease in overall economic costs [16-25].

The process of rearrangement of partially liquefied sand is accompanied by a partial transfer of stresses from the soil's own weight while maintaining contacts between particles. During the entire rearrangement period, the position of particles changes - some particles lose contacts, others gain and lose again.

Thus, the particles are in an unstable position, shifting relative to each other, successively losing and gaining contacts. The number of simultaneous contacts between particles determines the degree of destruction of the soil structure.

In contrast to the case of complete liquefaction, compaction of incompletely liquefied sand can occur simultaneously in the entire soil layer.

It is usually difficult to imagine the case of partial liquefaction of sand and the possibility of the existence of a temporarily incompletely destroyed structure, i.e. a structural mesh of sandy soil, capable of absorbing part of the stresses from external loads and grains of sand embedded in it, which do not have or have lost part of the contacts. This question is caused by the usual consideration of a static picture of the relative arrangement of sand particles. If we consider all the particles in motion and alternately lose and form contacts, then this kind of representation of the structure of partially liquefied sand does not cause complications. Over time, the number of contacts between particles increases, the soil is compacted, and when all contacts are fully combined, the liquefaction phenomenon stops.

It should be noted that the loss of contacts between particles means not only the absence of points and planes of contact of one particle with another, but also the absence of stress transmission in these contacts.

Complete liquefaction of sand can be observed even with a degree of structure destruction less than unity, but with a fairly small number of temporarily preserved contacts.

In this case, the number of contacts between particles is not enough to create a temporary structure of the soil, which perceives stresses from the external load and part of the soil's own weight.

At the last moment of time after the application of dynamic influence, the contacts are broken, and the sand goes into a completely liquefied state. The change in density, accompanied by the squeezing of water from the sand pores, depends not only on the degree of destruction of the structure, but also on the conditions of rearrangement of particles determined by the density of the sand and its stress state. As the initial density and stress state increase, the possibility of mutual displacement of soil particles decreases. Due to the fact that the self-weight of the soil significantly affects the stress state, it can be assumed that the amount of porosity depends on the depth of the location of this section of the soil.

Further development of this direction of modernization of mechanical hydraulic production with vibration excitation of the array in the well is directed to the intensification of the process due to justification and selection of the shape and spatial distribution of vibration emitters of the vibrohydraulic intensifier [1].

The main direction of development and improvement of amber extraction technology is realized by the borehole mechanical-hydraulic method using water, air and vibration as the main influencing factors.

A potential source of amber production can be exhausted deposits with off-balance reserves, which are man-made deposits, but this requires the development of a technological process.

Establishing the dependence of the influence of dominant factors on the process of extraction of amber in the process of processing amber-containing mining mass, the order of interaction and the sequence of amber mining operations in the conditions of sandy and sandy-clay deposits by the method of system analysis and the development of methods for calculating process parameters, taking into account the economic feasibility of using the proposed complex extraction method to increase the layer-by-layer extraction of amber from amber-bearing rock mass is an urgent issue today.

Conclusions

In the work, an analysis of scientific and technical information related to amber mining processes was carried out, which revealed that:

1. The main direction of development and improvement of the technology of amber extraction, which is implemented by means of a borehole mechanical-hydraulic method using water, air and vibration as the main influencing factors.

2. A potential source of amber production can be exhausted deposits with off-balance reserves, which are man-made deposits, but this requires the development of a technological process.

3. Due to the imperfection of the existing technologies, losses of minerals in targets and dumps exceed 50%.

4. Existing technologies for extracting amber from sandy amber-bearing deposits are highly energy-intensive, which destroy rocks, and segregation requires improvement of technology and equipment

to increase the efficiency of the final product extraction process and reduce energy, water, and air consumption.

5. The proposed technological schemes do not provide for an ecological component, the possibility of reclamation of mining waste, while their man-made nature requires additional research taking into account various mining and geological characteristics and host rocks and the development of recommendations for technology and equipment taking into account the ecological component.

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