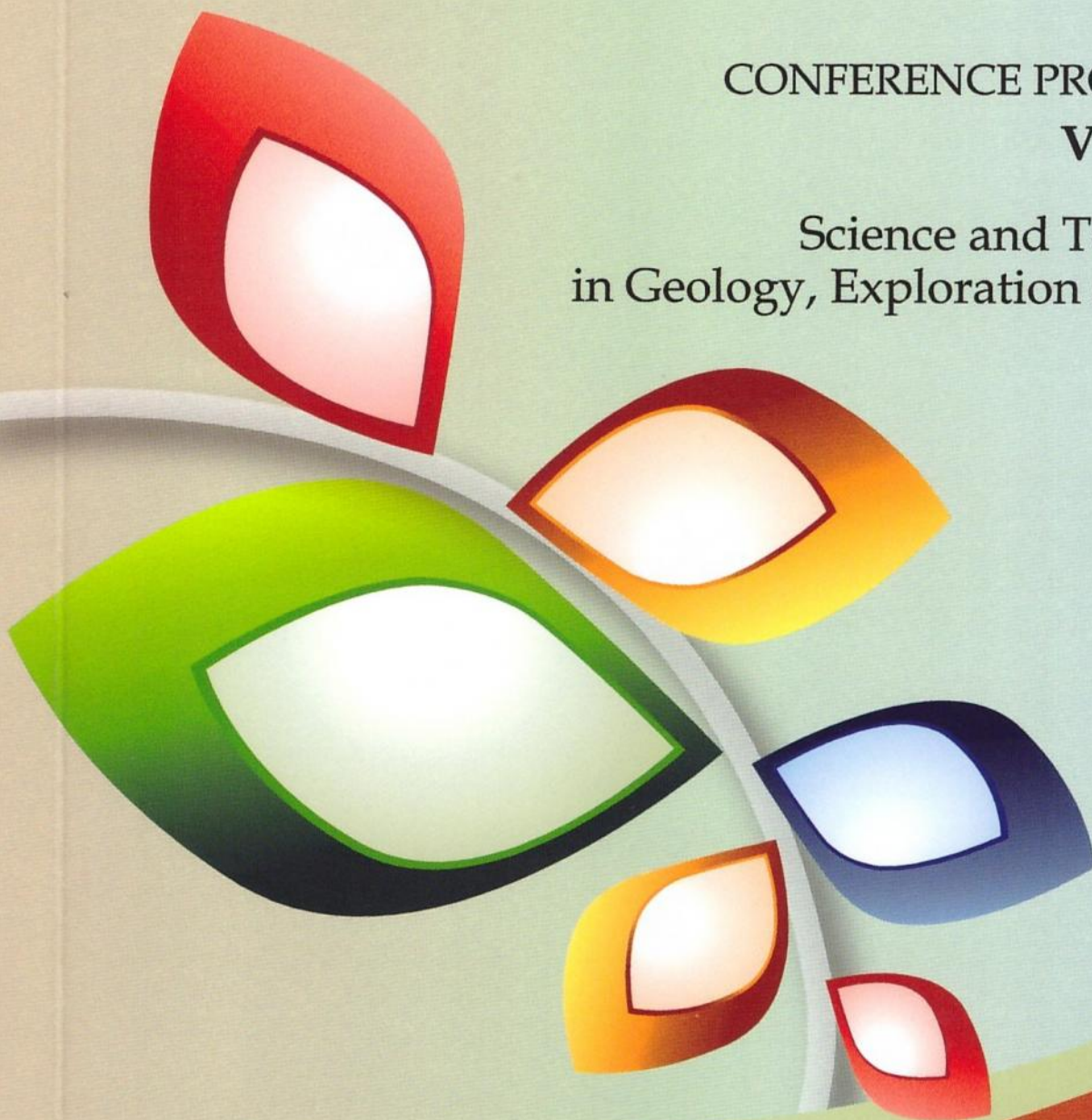


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ANALYSIS OF DISTURBED LANDS AND ENVIRONMENTALLY SAFE TECHNOLOGIES OF MINING IN PERMAFROST

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ABSTRACT

The paper presents information about the mineral resource base of the Republic of Sakha (Yakutia)-one of the richest regions of Russia in minerals and severe climatic conditions of their development, the presence of almost universal permafrost causes a particular vulnerability of the environment in mining. In this regard, the methods and results of studies of the geocological state of the landscape in the development of Geosciences, including space surveys of mining operations, the regime of their restoration by natural means, and the main directions of reclamation of disturbed lands are analyzed.

New technologies of mining operations associated with the simultaneous reclamation of disturbed lands, which initially reduces the area of violation by much reducing the cost of their reclamation, have a particular interest. The assessment of the degree of land disturbance by mining operations was carried out by laser scanning, which significantly reduced the complexity of the work, increased the accuracy of measurements and contributed to the development of rational technological solutions for the reclamation of disturbed lands.

Keywords: northeast of Russia, permafrost, disturbance by mining operations, laser scanning, ecologically safe technologies.

INTRODUCTION

The mineral resource base of the North-East of Russia is inextricably linked with the mineral resources of the Republic of Sakha (Yakutia), where more than 16 thousand manifestations of various types of mineral raw materials [1, 2] are established, including 35 natural gas and gas condensate fields, 54 diamond deposits, including 17 indigenous and 37 placer deposits, 12 gold-bearing areas, where 810 deposits with total reserves of 1.7 thousand tons of gold, 55 silver objects with balance reserves of 19 thousand tons, 48 coal deposits with balance reserves of 14.3 billion tons, 18 uranium deposits with reserves of 383 million. t, 14 iron ore deposits in the amount of 6 billion tons, in addition found large deposits of tin, antimony, tungsten, lead, zinc, rare metals (niobium, rare earth), building facing materials. Many of these fields are in the process of being exploited, and investment projects have already been established for some.

However, the intensive development of the above-mentioned fields leads to a sharp increase in anthropogenic impact on the natural environment.

The paper considers the violation of land in the development of placer gold deposits, provides an analysis of environmentally safe technologies for their development and methods for assessing the violation of land using ground laser scanning.

For more than 90 years of development of placer deposits in the Republic of Sakha (Yakutia), more than 250 thousand hectares were disturbed with an annual increase of 4 - 6 thousand hectares, and no more than 2% of the area of disturbed lands was restored. Under the existing technology of overburden reclamation of disturbed lands is carried out separately and requires additional costs for its implementation, which led to the trend of their accumulation. Thus, according to the results of studies [3], quarries, more than 500 – 600 m deep with significant dumps in height and area, remained open during the development of diamond tubes. Reclamation of such quarries is associated with high costs associated with the return of their external dumps in the spent quarry field. Water reclamation by creating a pond in the quarry field is impossible due to the strong acidity of the host rocks. Now, experiments carried out only on biological reclamation of dumps.

Currently, only the spatial organization of landscapes, the degree of violation of the land by mining and other human activities, the vulnerability of the landscape depending on the location in the designated areas of environmental vulnerability taken into account [4]. The paper presents the results of work on the degree of transformation of the natural environment by anthropogenic influence. Territories with rather homogeneous intensity of anthropogenic influence allocated and schemes of zoning on degree of transformation of natural environment are developed.

In recent years, work on the assessment of disturbance and land rehabilitation with the use of space has appeared [5, 6]. At the same time, the authors present the possibility of using multi-temporal earth remote sensing resources in assessing the formation of ecosystems in mining landscapes. This work aimed only at assessing the degree of violation of land and not aimed at reducing the area of violation in the process of mining, directly generated space, dumps, technological roads, industrial buildings and structures.

In work [7] the method of an estimation of disturbance and restoration of biota by results of remote sensing of the Earth is offered. The authors also propose an integrated approach to the study of landscape disturbance, combining research and analysis of ecosystem changes in the areas of field development in an open way, using the indicator of phytotoxicity, i.e. reducing plant productivity.

In addition to ecological disruption of the landscape, mining operations in the conditions of cryolithozone cause thawing of permafrost, which is a hidden phenomenon and therefore more catastrophic [8]. Thawing permafrost leads to deformation of the sides of pits and dumps, their collapse, as well as to violation of the landscape, the destruction of buildings and structures, the emergence of thermokarst phenomena.

All the above works are devoted to the assessment of the degree of violation of land, their pollution, but not aimed at reducing the violation of land in the process of mining. In conditions of long-term permafrost it is extremely important to reduce the disturbance of land in the process of mining.

There are studies on the environmental impact assessment quarries and dumps in the open mining and to create the prerequisites for samlesbury technology mining [9, 10]. It is established that the choice of land-saving technology is influenced not only by the development system, but also the parameters of the sides of the quarry and dump: the height and number of mining and overburden, the location, the type and size of the opening workings, the direction of the movement of the front of mining. The area of the returned disturbed natural and reclaimed lands is defined by the area of a horizontal surface of excavations and dumps of overburden rocks.

In work [10] systematization of objects of open development of fields, on classification signs of the form and the sizes of the field in the plan and on depth of occurrence is executed. According to the authors, this approach ensures the creation of a rational technology of opening, development and refinement of the field and provides a smaller area of land violations for mining and dumps, as well as provides a large surface area of internal dumps for mining reclamation.

The most environmentally safe technologies of mining operations in conditions of permafrost are technologies with internal dumping using various technologies of their laying and leveling the surface [11]. However, these technologies only provide for the handling of overburden in the internal dump with the help of draglines that has limited application.

Thus, at present, there are no new technologies and concepts of mining using resource-saving technologies, which led to the exclusion of hundreds of thousands of hectares of disturbed land from the economic turnover, has preserved for decades the mineral resources of man-made deposits.

In this regard, it is necessary to radically change the traditional technology of development of permafrost placer deposits in order to create environmentally safe technology that allows restoring disturbed lands.

It is for these geological and natural conditions that the method of open development of permafrost placer deposits with internal dumps with the formation of large blocks of overburden rocks is proposed. The method involves the formation of large blocks of one of the known methods, such as drilling and blasting, mechanical. Then make overburden works with placement of breeds of overburden in the form of large-size blocks in the developed space [12]. Thus, simultaneous internal dumping of large-sized blocks is achieved.

Also for similar mining-geological conditions, the technology of development of deposits with filling of the developed space by ice-bearing entirely is offered [13]. The idea of the method of recultivation in cryolithozone is that in order to significantly reduce the cost and intensify the work, the filling of the developed space made by ice-bearing material produced on site. The technology of creating ice and rock block material is in the irrigation water to the inner blade in the winter, cover next, the insulating layer of overburden, with a thickness that ensures stability of the negative temperature.

Thus, the proposed technologies of reclamation of disturbed lands allow, with a significant reduction in costs, to fully mechanize the process, ensure the filling of the developed space and preserve the landscape in the mining zone.

At the same time, it is recommended to carry out the assessment of land disturbance, geocological state of man-made impact zones with the help of a modern measuring system of ground laser scanning "Leica HDS-8800" [14,15]. by high-precision determination of the volume of dumps in open-pit gold mining and comparison with design solutions.

As an experiment, in 2017, field studies were conducted in the Aldan and Neryungri districts using the modern measuring system of ground laser scanning "LeicaHDS 8800". The technology of surface laser scanning allows to improve the quality of volume determination due to the high density and accuracy of obtaining the spatial coordinates of the surface of rocks and to achieve the error of their determination within 0.5%. At the same time, the time spent on filming is reduced tenfold. Such a detailed description of the wrong figures, what are the dumps, allows special software to build a geometric model in detail, and therefore as accurately and quickly as possible to carry out the necessary calculations. While tacheometric survey determines the volume of materials produced with an accuracy of no more than 5-10%. In addition, the main limitation in the work with the use of total stations is the low measurement speed and the physical impossibility of detailed shooting of large volumes. With this method of measurement, the shooting of dumps is performed only by characteristic contour points, the calculation of the volume is made by the formulas geometrically correct bodies, the angle of the dump is taken as constant. Also, there is another drawback when shooting with a total station: when filling the dump, it is necessary to observe the shape of the geometric body, monitor the homogeneity of the distribution of the breed, the height of the filling, etc.

The measuring system of terrestrial laser scanning "Leica HDS8800" was filmed heaps of footage of placer gold deposits and using software MaptekI-SiteStudio 6.0 to determine the level of the dumps. The obtained data compared with the design solutions of the fields (Fig.1).



Figure 1. The appearance of the subject

The dumps were scanned from 5 positions. Before start shooting outlines the position settings of the scanner relative to the subject from the calculation of the coverage survey as possible of the surface of stacking. Because of scanning the surface dumps obtained point model with spatial coordinates (Fig. 2).

The main stages of post-processing the following: joining of scans, quality control, cross-linking, visual inspection, and removal of "random noise", the construction of a triangulated surface and volume calculation.

Stitching produced by the characteristic points, a method soon that requires no installation marks. Removal of "random noise" run manually and the output was cleaned "point cloud" dumps.



Figure 2. Scan result-point model

Further, an irregular triangulation network was built, it simulates the surface of the dumps (Fig. 3). The volumes calculated automatically.



Figure 3. The triangulated model

As shown by the studies carried out to determine the values of the dumps with the help of three-dimensional laser scanning technologies, in comparison with their design solutions, the captured volumes generally correspond to the planned indicators. It is recommended to monitor the activities of the subsoil user in terms of compliance with the implementation of mining reclamation with the planned design solutions. This requires a fundamental change in traditional technology development of permafrost alluvial deposits with the aim of creating environmentally friendly samlesbury technology to reduce disturbance of land.

The analysis of mining and technological conditions of mining operations at placer deposits shows the necessity and urgency of developing new technological solutions, including justification of methods of preparation of permafrost rocks for dredging, softening of hard and frozen rocks, and generally improving the technology of Stripping and mining with simultaneous reclamation of disturbed lands. Technological solutions should ensure the reduction of environmental load on the environment, the creation of favorable conditions for mining and transport equipment, increasing the duration of the working season and the subsequent restoration of disturbed lands for their further effective use.

CONCLUSION

1. Intensive development of mineral resources of the North-East of the country for many decades in the conditions of permafrost, led to extensive violations of the landscape mining, dumps, technological roads and industrial waste, almost without its restoration and reclamation of disturbed lands, and their further accumulation and exclusion from agricultural turnover.
2. The analysis of research works in the field of monitoring, assessment of land disturbance during their industrial development showed that these works are aimed mainly only at the study of the geo-ecological state of the disturbed lands and not numerous technological solutions for their technical and biological recultivation. Extensive violation of the landscape in the conduct of mining operations leads to the need for reclamation of vast areas with significant funds, and if possible in the coming years.
3. The most acceptable of these are the proposed technologies combining mining with simultaneous reclamation of disturbed lands, which significantly reduces the scale of their violation and greatly simplifies the process of reclamation.
4. To assess the violation of the land in their industrial development, it is advisable to use the measurement system of ground-based laser scanning "Leica HDS-8800". The experience of the application of this system in the study of the developed space and dumps showed a fairly high accuracy of measurements and efficiency of work.

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