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ПРИМЕНЕНИЕ ЧЕТЫРЕХЭТАПНЫХ ГИС-ТЕХНОЛОГИЙ ДЛЯ ПРОГНОЗИРОВАНИЯ ПОСЛЕДСТВИЙ ОПАСНЫХ ГЕОМЕХАНИЧЕСКИХ ПРОЦЕССОВ НА ХВОСТОХРАНИЛИЩАХ ОБОГАТИТЕЛЬНЫХ ФАБРИК

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АННОТАЦИЯ

В связи с увеличением объемов хвостов в хранилище отходов тела плотины статические и динамические воздействия на перепуск дамбы значительно возрастают. В результате резко развивается деформация в теле плотины. Важную роль играет изучение этих процессов с помощью личного наблюдения. По этому наблюдение за деформациями в теле плотины с использованием современных методов маркшейдерского надзора, в том числе, система спутникового позиционирования позволяет решить проблему в этой области и разработать предложения по обеспечению устойчивости плотин. В статье раскрыты возможности наборов многозональных космических снимков для построения спектральных снимков различных природных и геологических объектов, прослеживающих под мощным покровом осадочных пород глубоких разломов и мега- и мезотрещин, непосредственно влияющих на физико-химический состав. -геомеханические свойства горных пород и, соответственно, существенно ослабляют устойчивость участков строительства и эксплуатации плотин хвостохранилищ обогатительных фабрик. В статье описаны научные, теоретические и практические основы использования «четырехэтапной ГИС-технологии» для прогнозирования последствий геомеханических процессов при проведении горных работ.

АННОТАЦИЯ

Тўсиқ танасининг чиқиндиларни сақлаш жойидаги чиқиндилар ҳажмининг кўпайиши туфайли тўғонни айланиб ўтишга статик ва динамик таъсир сезиларли даражада ошади. Натижада, тўғон танасида деформатсия кескин ривожланади. Ушбу жараёнларни шахсий кузатув орқали ўрганиш муҳим рол ўйнайди. Шу сабабли, тўғон корпусидаги деформатсияларни кузатиш замонавий маршрутлаш усулларини, шу жумладан сунъий ёълдошни аниқлаш тизимини қўллаган ҳолда, ушбу соҳадаги муаммони ҳал қилишга ва тўғонларнинг барқарорлигини таъминлаш бўйича таклифларни ишлаб чиқишга имкон беради. Мақолада физик-кимёвий таркибига бевосита таъсир кўрсатадиган чўкинди жинсларнинг қалин қопламаси остида чуқур ёриқлар ва мега ва мезо ёриқларни кузатувчи турли хил табиий ва геологик объектларнинг спектрал тасвирларини яратиш учун кўп спектрал сунъий ёълдош тасвирлари тўпламларининг имкониятлари очиб берилган. - тог ъжинсларининг геомеканик хусусиятлари ва шунга мос равишда контсентратсион ўсимликларнинг чиқинди уялари тўғонлари қурилиши ва ишлашининг барқарорлигини сезиларли даражада сусайтиради. Мақолада қазиб олиш пайтида геомеканик жараёнларнинг оқибатларини башорат қилиш учун "тўрт босқичли ГИС технологияси" дан фойдаланишнинг илмий, назарий ва амалий асослари тасвирланган.

ABSTRACT

Due to the increase in volumes of tails in a dam body storehouse of waste static and dynamic actions on a dam rerun considerably increases. As a result deformation in a dam body develops sharply. Studying of these processes with the help of mine supervision plays the important role. On it supervision over deformations in a body of a dam with use modern mine-surveying supervision methods, including, system of satellite positioning allows to solve a problem in this area and to develop offers of maintenance of stability of dams. In the article, the possibilities are revealed of sets of multi-zonal space images for the construction of spectral images of various natural and geological objects, tracing under the powerful cover of sedimentary rocks of deep faults and mega and meso fractures that directly affect the physico-geomechanical properties of rocks and, accordingly, significantly weaken the stability areas of construction and operation of dams of tailing dumps of concentrating factories. The article describes the scientific, theoretical and practical basis for using the "four-stage GIS-technology" in predicting the consequences of geomechanical processes in mining operations.

Ключевые слова: маркшейдерское дело, хвостохранилища, безопасность плотин, геоинформационные системы, тектонические объекты, многозональные космические снимки, ГИС-технологии.

Калит сўзлар: маршрутлаш, чиқиндиларни йиғиш жойлари, тўғон хавфсизлиги, географик ахборот тизимлари, тектоник объектлар, кўп спектрал космик тасвирлар, ГИС технологиялари.

Key words: mine-surveying, tailings dumps, safety of dams, geoinformation systems, tectonic objects, multi-zonal space images, GIS-technology.

INTRODUCTION

Tailings (or slurries) are wastes produced as a result of the extraction of minerals and metals from mined ore rocks.

In our country and abroad, the construction of special alluvial hydraulic structures — tailings dumps, for storing waste from the mineral enrichment process, is carried out on a large scale, the operation of which requires the provision and observance of strict technological control, the failure of which leads to serious accidents and even catastrophes. Tailings ponds range in size from small pools to reservoirs covering an area of more than 1,000 hectares.

The analysis and generalization of experience of construction and operation of dams of tailings dumps of concentrating factories shows that at the present stage of development of the mining industry one of the aspects of a problem is the task of organization of comprehensive monitoring of alluvial enclosing constructions for all term of their construction and operation [1].

The mining and metallurgical industry faces the task of reducing to zero the number of deaths and large-scale disasters. In this regard, the rational use of tailings is an integral part of the corporate operating strategy and risk management strategy.

Critical control management is defined as an approach to managing unlikely events with large-scale disruptive consequences, such as catastrophic tailings accidents.

In the absence of proper management, tailing dumps have primarily a devastating impact on the environment and can threaten health and safety, as pollution from wastewater and dust emissions is potentially toxic to humans, animals and plants, and secondly unplanned economic costs. This damage is multiplied many times in the case of physical damage to the tailings. Flooding with waste from tailings dumps and mountain dumps can cause severe environmental pollution and even lead to loss of life.

Dam of the tailings pond at mount Polly in Canada (2014), for the mining company Samarco in Brazil (2015), “Ammofos”, “Yevrazruda” in Russia (2010), and a dam in March 2010 in the village of Kyzyl-Agash Almaty region of Kazakhstan, and also dam in Aksu and Karatal areas, which led to catastrophic damage to businesses, agriculture, road and housing and communal economy and population relevant questions to predict the stability of levees and dams hydraulic structures [17].

The adopted “Law on safety in the industry of hydraulic structures” provides: to provide control (monitoring) of the state of the hydraulic structure; to systematically analyze the reasons for reducing the safety of the hydraulic structure and to timely develop and implement measures to ensure the technically sound condition of the hydraulic structure, as well as to prevent the accident of the hydraulic structure [12].

Materials and methods. It is known that the Geodynamic conditions created in Central Asia, including in the region of Uzbekistan during the Pliocene period, that is, under the influence of the closure of the paleotetis Ocean, led to the disruption of ore deposits zones and oilgaz regions, the formation of new structures from the ball, and the sharp change in the geomechanical properties of the mountain [1].

In the field of mining, the formation of ore rocks and ore Mountain Ash adjacent to them, changes in their physical and geomechanical properties, as well as various dangerous consequences are controlled by land cracks and Megas and mesocracks of the same scale: global, regional and local.

In this article, - What are the dangerous consequences in the conduct of mining operations today, what are the most optimal methods of distinguishing and observing these tectonic disorders, when the global, regional and local scale earth cracks, Mega - and mesocracks that form them?,- we will try to answer a number of interrelated pressing questions.

The first topical question: What dangerous consequences form global, regional and local - scale land cracks, various Mega-and mesocracks in the conduct of mining work in the ore mining zone?

First, earth cracks of different sizes, especially Mega - and mesocracks, lead to a violation of the physical and geomechanical properties of the ore rocks and the ores mountaingins adjacent to them, and to a sharp change in the self-sufficiency of all mountaingins.

Secondly, according to the theory of larin, the core of the Earth is solid, and under the influence of geochemical and geophysical processes under the ground, constantly different flyoid currents and gases rise on the earth from global and regional - scale earth cracks, as well as from deep Mega-and mesocracks. If mining in the ore mining zone is carried out in a closed way, then it can be carried out horizontally (staff, crosscut, barricades, orts, etc.), vertically (mine, shurfs, etc.) and Incline (incline, slope, etc.).) in mining facilities, extremely dangerous gas collections are formed for a person.

In the third, in the layers of the mountain rocks crossing global, regional and local scale land cracks, various Mega - and mesocracks, water movement is disrupted, and along these land cracks and cracks, water flows accumulate in the mining facilities, making geological exploration, extraction and exploitation processes difficult.

Thus, in the case of mining in the ore mining zone, global, regional and local-scale land cracks and Mega - and mesocracks form the following dangerous consequences:

1) the physical and geomechanical properties of all mountaineers crossing the Earth's cracks and cracks are disrupted, and their uniformity changes dramatically;

2) in the ore mining zone, if mining is carried out in a closed way, then in all mining facilities there are extremely dangerous gas collections for a person;

3) water movement is disrupted in the layers of Mountain Ash, where the earth cracks and cracks are crossing, and they accumulate in mining facilities, adversely affect the processes of geological exploration, mining and exploitation.

The second urgent question: When did land cracks, Mega - and mesocracks of different scales, which formed different dangerous consequences in the conduct of mining in the ore mining zone?

Who does not deny that the cracks and cracks of different scale, which control the various dangerous consequences of the formation in all geological exploration, extraction and exploitation processes in the Central Asia, including the region of Uzbekistan, are exactly the product of the neotectonic movement. However, the timing of the new neotectonic behavior, which determines the formation of today's modern landscape, the authors believe, still remains unclear.

It should be noted that the formation of modern relief by most geologists and neotectonists of Central Asia is considered to be the period of the upper neogen – lower antropogen (N2-Q1). It is true that during the Pliocene the Paleotetis Ocean was closed. However, the geotectonic and Geodynamic movements that took place during the Neogen. Even lower entropy period were not a decisive factor in the formation of modern landscapes and redefs in Central Asia and the region of Uzbekistan.

This is how our opinion is interpreted, contrary to the opinion of many Middle-Earth geologists and specialists engaged in New tectonics.

In the 80 years of the XX century, one of the authors of this article was involved in the expedition of the Pamir as a young specialist.

The transition from Tyanshan mountaineering to Pamir Mountains surprised to see the lower antrop conglomerates (Q1 sh) in the belt. Because in all geological literature on neotectonics, the formation of modern relief in Central Asia and the region of Uzbekistan was associated with the neotectonic and Geodynamic movements that took place during the period of N2-Q1.

During the passage of the field conglomerates lying on the belt of Tyanshan – Pamir Mountaineers, the author saw that the stones that formed them, although large, are sufficiently rounded, they are strongly cemented among themselves and have a thickness of more than several dozen meters, came to the following conclusion.

First, the relief surface in the Tyanshan – Pamir regions was not only high neogen, but also significantly lower than the water level even in the lower antropogen period.

Secondly, strong water flows in these regions have rounded stones of different sizes and brought them over long distances.

Thirdly, the complete cementing period of the conglomerates of different sizes of the sphere (Q1 sh) rounded at the influence of strong water flows is at least the lower anthropogen time.

Thus, we can say for sure that the time of formation of modern landscapes and relays in Central Asia and the region of Uzbekistan is relatively young and their emergence is explained by the tectonic and Geodynamic movements that occurred during and after the Q_2 period.

The third topical question: What are the most optimal methods of distinguishing and observing tectonic disturbances that cause various dangerous consequences in the case of mining in the ore mining zone?

It should also be noted that the most optimal way to distinguish and observe tectonic disturbances that cause various dangerous consequences on the body is the distance Aero - and the various geometrical data in the form of ARCs, straight lines, linear splits, obtained from space images.

But this important information is expressed in different way from the set of multi-spectral space images (SMSSI).

For example, in the research carried out at the Institute of mineral resources, Institute of Geology and exploration of oil and gas fields distance Research Laboratory and GIS technology center, organized under the Ministry of Uzbekistan, great importance was attached to the work on the differentiation and observation of geometrical data in the form of ARCs, straight lines, linear splits obtained from A-and space frames and images. Almost all specialists working at these enterprises claim that these geometric-shaped tectonic elements are clearly manifested in the A-and space images obtained in infrared electromagnetic Foxes, but they can not explain the reason for the non-divergence of the visual range of these important tectonic disturbances.

Given that there is currently no clear model of the mechanism of deformation of the slopes of tailings dams. As noted above, the study of the deformation mechanism, the development of methods for monitoring and evaluating the stability of tailings dams is a very urgent task. To date, we have developed GIS-technology based on the ability to solve four-tiered in forecasting the dangerous consequences of geomechanical processes in the conduct of mining.

At first glance, a fundamentally new four-stage multispectral GIS technology for geomechanical control of the stability of tailings dams differs little from traditional surveying, including profile lines, ash lines, geodetic serifs, photogrammetric methods, automatic stations, and GPS satellite geodesy complexes.

Multispectral GIS technology is primarily based on the peculiarity of changing phototonic (i.e. photogrammetric) characteristics of natural and geological objects, the regularity of which is subject to the laws of optical physics.

Four-stage multispectral GIS technology consists of sets of multi-zone space images (MZSI) of small, medium, large and super-large scales. Not only can spectral images of natural and geological objects be compiled for each set of MZSI, but also the independence and stability of phototonic (optical) characteristics can be scientifically justified for them, but deep faults and fractures of different ranks cannot be traced using non-geological and geophysical methods. In other words, mega-and meso-fractures of rocks that can be traced on small- and medium-scale MZSI sets, even under a powerful sedimentary cover, directly affect the physical and geomechanical properties of rocks and, accordingly, the stability of tailings dams.

Here we should note the following detail of the information content of small and medium scale MZSI kits [1,2]:

1. On sets of MZSI in the visible part of the spectrum (0.5-0.7 microns), geological and geomorphological formations of the earth's surface are well differentiated by their reflectivity. Elements of Quaternary Geology and relief correlated with lithological-stratigraphic complexes and surface structures are deciphered.

2. In the part of the spectrum of 0.7-0.8 microns, the reflectivity of surface geological and geomorphological structures is close, so that their contours are blurry. On these MZSI, the mountainous border of the territory with the exits of the Paleozoic Foundation is well outlined.

3. In the near-infrared parts of the spectrum (0.8-1.1 microns), information about surface geological and geomorphological features is minimal. However, there are lines, bands, and areas that correlate with deep fault zones, uplifts, and depressions of the buried base.

It should be emphasized that the results and conclusions presented here are based on visual interpretation. For a more reliable assessment of the spectral characteristics of geological images and other natural objects that are decoded on multi-zonal MZSI, as well as to verify the above conclusions, we have developed a unified phototonometer [3]. It is intended for quantitative measurement of the photo-density of a set of multi-zone space images using the visual Express method – this is an alternative basis for creating an unconventional method of space, Aero-and ground-based spectral prediction technology, primarily for ore-bearing objects and areas of oil and gas accumulation, and on the other hand, for identifying deep faults and mega- and meso-fractures of different ranks, which directly affect the physical and geomechanical properties of rocks and, accordingly, significantly weaken the stability of the construction and operation areas of tailings dams of processing plants.

It is well known that both the Institute of mineral resources, Institute of Geology and exploration of oil and gas distance laboratory staff and the staff of the GIS technology center, the main focus of which is being carried out, will be limited to a large collection of large mass spectral space images obtained from American Landsat satellites.

It should be noted that only in space images taken in a spectral range close to infrared rays at a small mass, the morphostructures of the Paleozoic Foundation under the mezo-kaynozoic coating, even 8-10 km thick, are manifested. If we take into account the representation of geomorphological and geological objects mainly related to the Earth in space images obtained, then we will be able to compare and analyze the information on geological and geomorphological objects close to the Earth's surface (space images obtained in the spectral range 0,5-0,7 μm) with the data on the Paleozoic bases (space images obtained). This is one side of the issue.

Secondly, only in small mass images, the traces of the closure of the paleotetis ocean are clearly visible, allowing a methodological study based on the theory of tectonics of modern lithospheric plates of ore deposits and oil, gas regions.

Thirdly, exactly in small mass images, the main tectonic units of ore deposits and oil, gas geological zoning, that is, the largest structural elements, are observed.

And, finally, it is possible to distinguish between the four in exactly small mass-shaped images from the information that the deep ground cracks and distortions of the region, the nodes on which they intersect, that is, the depth hot mass of which is naturally summarized one of the most important diagnostic signs of the moving channel.

Thus, the "GIS-technology based on the ability of a four-storey solution", whose resolution capacity is 1000 m and greater, is extremely important. A collection of fine-mass spectral space images and the results of their deciphering are obliged to be linked to 1:1 000 000 and 1:500 000 topographic cards.

The ability to solve the second layer of the proposed new concave is 250-350 m, consisting of two: 0,5-0,7 and 0,7-1,0 spectral rangeonlarda performing medium-sized space images. This collection of space images plays an important role in the comparison of geological information obtained mainly in small mass images with information that differs in large mass images.

A set of medium-mass spectral space images and the results of their deciphering are obliged to be linked to 1:500 000 and 1:200 000 massographic cards.

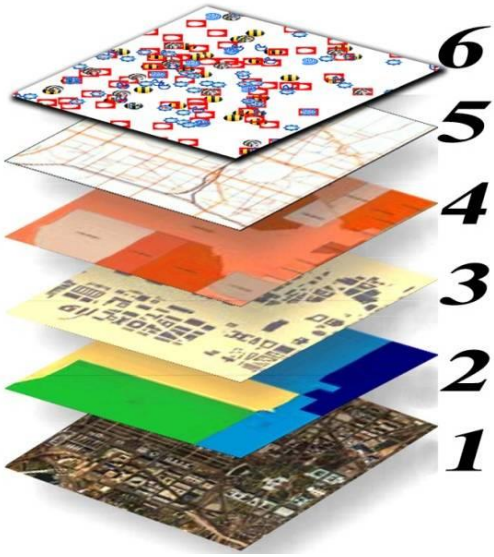

Figure 1. The appearance of layers of different thematic cards in GIS

The ability to solve the third floor on the new sidewalk is 30-60 m, four: 0,5-0,6, 0,6-0,7, 0,7-0,8 and the spectral range 0,8-1,0onlarda is made up of large mass-packed space images. Today, space images with this solution capability are being implemented in a 7-Channel range from Landsat 8 and 11 satellites.

On the basis of these kits, the following steps can be followed:

1. The sets are made up of cosmophotometric cards, which are expressed by means of 10 points of photography;

2. On the basis of cosmophotometric cards with 10 points of photography, spectrometric images and classifiers of natural and geological objects are created;

3. On the basis of spectrometric images and classifiers of identified natural and geological objects, a material card of the region is drawn up;

4. On the basis of comparison of the material card of the region on the basis of spectrometric images and classifiers of natural and geological objects with ore and oil-gas deposits, as well as moving depth hotmass channels, under the influence of flyoids and UV rising up on these areas, geothermal and geochemical changes in the vegetation and soil cover, i.e. photoanomials, are;

5. Under the influence of ores and oil fields, as well as flyoids and UV rising on moving depth hotmass channels, photosynthesis of geothermal and geochemical changes in plant and soil cover is determined and spectral classifiers of photoanomials are developed;

6. New tectonic objects are predicted and searched using spectral classifiers of photoanomials determined on the basis of geothermal and geochemical changes formed under the influence of flyoids and UV on the ore and oil-gas deposits and moving depth hotmass channels, forming dangerous consequences in the conduct of mining operations.

A large collection of mass-packed multi-spectral space images and the results of their deciphering are necessarily tied to 1:200 000 and 1:100 000 mass-based topographic cards.

The ability to solve the fourth floor of the proposed new sidewalk is 1 m and smaller, four: 0,5-0,6, 0,6-0,7, 0,7-0,8 and the spectral range 0,8-1,0 is made up of extremely large mass-packed space images. This collection of space images allows the application of geological information obtained mainly in large-scale images, including Ruda deposits and petroleum collections and classifiers reflecting flyoids and UV rising through the moving depth hotmass channels, directly into the search work.

Large collection of mass-packed multi-spectral space images and the results of their deciphering must be tied to 1:100 000 and 1:50 000 mass-topographic cards (if there are 1:25 000 and 1:10 000 mass-topographic cards in the region, their use will give good results).

Thus, the application of GIS - technology, based on the ability to distinguish and monitor land cracks, Mega- and mesodarzes on the global, regional and local scale, which today form various dangerous consequences in the conduct of mining, provides the most optimal, affordable and high efficiency.

Conclusion. Our analysis of the methods allows us to draw the following conclusions:

- Of the above methods, the most appropriate is geometric leveling, the use of electronic total stations and GPS satellite positioning systems.

- The use of electronic total stations allows you to solve any serifs and perform the laying of moves in order to accurately determine the coordinates of points.

- The use of GPS satellite positioning systems allows to accurately determine the coordinates of points located at large distances from each other. In addition, GPS systems allow to determine the heights of points with a fairly high accuracy of about 1-2 sm.

- Four-stage multispectral GIS technology for geomechanical control of the stability of tailings dams by selecting deep faults and mega-and meso-fractures of different ranks that directly affect the physical and geomechanical properties of rocks.

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