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NATURAL GEOGRAPHICAL FEATURES OF MOUNTAINOUS AREAS IN THE SOUTHWESTERN PART OF KASHKADARYA REGION AND SPECIFIC ASPECTS OF THE USE OF MINERALS

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Abstract

This article analyzes the natural geographic features of mountainous regions, with a particular focus on the geological, hydrogeological, stratigraphic, and engineering-geological conditions of the Tubegatan deposit located in the southwestern part of the Qashqadaryo region. The study examines the relief of the area, the composition of geological strata, the distribution of underground waters and their influence on mining operations, as well as karst-related risk factors. The article highlights the technological and ecological challenges associated with the exploitation of mineral resources in mountainous areas and addresses geodynamic conditions encountered during underground mining. The findings contribute valuable scientific and practical insights for the sustainable and safe development of mineral deposits in mountainous terrains.

Keywords: Mountainous region, geological structure, Kashkadarya region, minerals, stress zones, karst, hydrogeology, Tyubegatan deposit.

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QASHQADARYO VILOYATII JANUBI-G‘ARBIY QISMIDA TOG‘LI HUDUDLARNING TABIIY GEOGRAFIK XUSUSIYATLARI VA FOYDALI QAZILMALARDAN FOYDALANISHNING O‘ZIGA XOS JIHATLARI

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Annotatsiya

Mazkur maqolada tog‘li hududlarning tabiiy-geografik xususiyatlari, xususan, Qashqadaryo viloyatining janubi-g‘arbiy qismida joylashgan Tyubegatan konining geologik, gidrogeologik, stratigrafik va texnik-geologik shart-sharoitlari tahlil qilinadi. Tadqiqot davomida kon maydonining relyefi, geologik qatlamlar tarkibi, yer osti suvlarining tarqalishi va ularning kon ishlanmalariga ta’siri, shuningdek, karst jarayonlari kabi xavf omillari o‘rganildi. Maqolada tog‘li hududlarda foydali qazilmalardan foydalanishning texnologik va ekologik jihatdan murakkabligi, yer osti kon ishlari jarayonida yuzaga keladigan geodinamik holatlar va ularni boshqarish mexanizmlari ko‘rib chiqilgan. Olingan natijalar tog‘li hududlardagi konlarni barqaror va xavfsiz o‘zlashtirish bo‘yicha ilmiy-amaliy tavsiyalarni ishlab chiqishda muhim ahamiyat kasb etadi.

Kalit so‘zlar: Tog‘li hudud, geologik tuzilish, Qashqadaryo viloyati, foydali qazilmalar, kuchlanish zonalari, karst, gidrogeologiya, Tyubegatan koni.

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ПРИРОДНО-ГЕОГРАФИЧЕСКИЕ ОСОБЕННОСТИ ГОРНЫХ РАЙОНОВ ЮГО-ЗАПАДНОЙ ЧАСТИ КАШКАДАРЬИНСКОЙ ОБЛАСТИ И СПЕЦИФИКА ИСПОЛЬЗОВАНИЯ ПОЛЕЗНЫХ ИСКОПАЕМЫХ

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Аннотация

В статье анализируются природно-географические особенности горных регионов, особое внимание уделяется геологическим, гидрогеологическим, стратиграфическим и инженерно-геологическим условиям месторождения Тюбегатан, расположенного в юго-западной части Кашкадарьинской области. В исследовании рассматриваются рельеф местности, состав геологических пластов, распространение подземных вод и их влияние на горные работы, а также факторы риска, связанные с карстом. В статье освещаются технологические и экологические проблемы, связанные с эксплуатацией полезных ископаемых в горных районах, и рассматриваются геодинамические условия, возникающие при подземной добыче полезных ископаемых. Полученные результаты вносят ценную научную и практическую информацию для устойчивого и безопасного освоения месторождений полезных ископаемых в горных районах.

Ключевые слова: Горный регион, геологическое строение, Кашкадарьинская область, полезные ископаемые, зоны напряжения, карст, гидрогеология, месторождение Тюбегатан.

Introduction

Mountainous regions differ sharply from other geographical zones with their complex relief, geological structure, climatic conditions and diversity of natural resources. In these regions, an uneven arrangement of geological layers, strong tectonic activity, erosion processes and karst phenomena are observed. The process of developing deposits in mountainous regions, especially rich in minerals, requires a unique approach.

The Tyubegatan deposit, located in the southwestern part of the Kashkadarya region, is one of such complex mountainous geological regions. This deposit contains potash salts (sylvinites) of high industrial importance, and their geological-stratigraphic location, hydrogeological conditions and technical-geological factors are of great scientific importance.

This article, along with the general natural-geographical characteristics of mountainous regions, provides an in-depth analysis of the technological and environmental aspects of the use of minerals in the Kashkadarya region using the example of the Tyubegatan deposit. At the same time, it is studied how factors such as karst, groundwater movement, and stress zones affect the safety and efficiency of mining operations.

Natural geographical features of mountainous areas. The Tyubegatan deposit is located in the southwest of the Kashkadarya region, on the border of the Republic of Uzbekistan and the Chardjou region of Turkmenistan, the territory is naturally divided into two by the Shordarya (or Darya) River. The deposit occupies a distance of 24 km from southwest to northeast, of which 14 km falls on the territory of Uzbekistan. The relief of the region is complex, the highest point is 1200 meters, and the lowest point is 930 meters (Tuyasoy River Valley).

The morphology of the mountainous area is represented by the Gaurdak-Tyubegatan mountain ranges, which have formed cuesta formations as a result of varying degrees of erosion of monoclinal deposits. This mountainous relief is not only an important geological factor in the development of underground minerals, but also creates technological complexity.

The hydrographic network is poorly developed and consists mainly of temporary water flows of a seasonal nature. The most important water source in the area of the

Tyubegatan deposit is the Tuyasoy River, which is the right tributary of the Shor Daryo. The river's waters are formed mainly as a result of melting snow and glaciers, and rainfall plays a secondary role. In the spring months, floods and mudflows occur in the river, which poses a serious hydrogeological threat to the deposit area.

The natural geographical features of the territory - susceptibility to geological disturbances, the possibility of karst processes, and the seasonality of the water balance - require special attention when developing mineral deposits. It is these features that are the decisive factor in choosing mining technology and ensuring environmental safety.

Geological structure. The geological structure of the Tyubegatan deposit is characterized by Upper Jurassic, Lower Cretaceous and Quaternary deposits. These layers have complex stratigraphic and lithological characteristics, which play an important role in determining and assessing the mineral reserves of the deposit.

The Jurassic Gaurdak suite consists of three main sections: anhydrite, transitional (anhydrite-halite) and halite (salt) layers. Among these layers, especially halite (KCl and NaCl) deposits are the most important from an industrial point of view. The main mineral discovered at the Tyubegatan deposit is sylvinite (a mixture of KCl and NaCl), which has a high concentration (average 33.5%) and is being mined on a large scale.

Other rocks widely distributed in the area include:

Halite (NaCl): is mainly a rare mineral, occurring in many layers together with sylvinite.

Anhydrite ($CaSO_4$): has high mechanical strength and acts as a reinforcing layer in some layers.

Dolomite and limestone: occur at stratigraphic boundaries and as hydrogeological barrier layers.

Lower Cretaceous deposits are represented by sandstones, siltstones and carbonate rocks. Their geological significance is mainly determined by their permeability properties, which is important in assessing hydrogeological conditions.

Quaternary deposits are located in the surface parts of the mining area and consist mainly of clay, sand and gypsum mixtures. These layers were formed as a result of karst processes and pose certain risks to mining operations.

The geological complexity of the area - monoclinal arrangement of layers, variable pipeability and different concentrations of minerals - requires an integrated approach to the development of deposits. Therefore, geological modeling of the deposit, the accuracy of interlayer differences and structural-geological faults ensure a reliable assessment of mineral reserves.

Hydrogeological conditions. The hydrogeological conditions of the Tyubegatan deposit are relatively favorable and vary depending on the composition of the geological layers and the degree of water permeability. Although water-permeable horizons of the Quaternary and Lower Cretaceous periods have been identified in the area, groundwater outflow is practically not observed in the main deposit zone - that is, in the layers where deposits of potassium salts are developed.

Quaternary water horizons are located mainly along river valleys, in particular, along the Tuyasoy River, and their water content is seasonal. These horizons contain clay, sand, gypsum and stone fragments, and their water capacity and flow are very low. These layers are mainly filled with surface water in the deposit area, as a result of which there is a risk of flooding in the spring months.

Cretaceous aquifers are usually associated with carbonate rocks - dolomites and limestones, which are strongly fractured, but in some places act as barriers. These layers may be under water pressure in some geological zones.

The hydrogeological situation in some places deserves special attention. For example, in well 2-G (around the Lyalmkan anticline), groundwater under pressure was detected, which is not usually observed in the mining zone. The emergence of aquifers under pressure indicates the presence of fracture zones and tectonic faults in the mine from a geological point of view. Of particular importance in this regard are the fault zones located in the southeastern part of the mine, along which water can flow from the upper layers to deeper salt layers.

In general, the salt layers in the mine have strong waterproofing properties, which plays an important role in ensuring the safety of mining operations. However, due to the possibility of water seepage in some local areas, hydrogeological monitoring within the mine is necessary.

Karst and environmental hazards. The presence of widespread sulfate (mainly anhydrite and gypsum) and chloride (halite and sylvinite) rocks in the area of the

Tyubegatan deposit creates favorable geological conditions for the development of karst processes. Especially in hydroactive zones, these rocks interact with water and dissolve, forming underground cavities - caves, caverns and emerging karst formations.

The karst processes observed in the area manifest themselves in two forms:

Covered (closed) karst: this condition often develops on the upper part of salt layers, where caverns filled with clay and gypsum mixtures are formed. They are often not discovered, but are detected using geophysical surveys.

Open karst: in some parts of the deposit, especially in the slope areas, as a result of the approach of salt layers to the surface of the earth, melting and the formation of caverns are observed under the direct influence of surface waters.

Karst processes create a number of environmental and technological risks in mining.

The presence of underground voids:

increases the instability of rocks;

increases the risk of spontaneous subsidence in mining roads;

as a result of dissolved rocks, water passages open up, causing groundwater to move in new directions.

In addition, due to geodynamics associated with karst processes, the chemical composition of groundwater changes - they contain high amounts of chloride and sulfate ions. This has a negative impact on the environment, in particular, increases the risk of contamination of groundwater and surface water.

Therefore, the level of development of karst phenomena should be constantly monitored, their impact on mining operations should be assessed, and, if necessary, geotechnical measures should be taken to prevent them.

Specific aspects of mineral exploitation. In the mountainous regions of the Kashkadarya region, in particular, at the Tyubegatan deposit, mineral exploitation is complicated by a number of geological, hydrogeological and technological factors. These factors create certain limitations, risks and technological problems in the process of mining.

1. Geological complexity. The layers in the region are mainly located in a monoclinic state, and their dip is reduced by an angle of up to 10–15°. However, structural-destruction zones (especially strong fractures and interblock shifts)

formed as a result of tectonic activity directly affect the strength and stability of the deposit mass. This is an important factor in planning safe routes within the deposit and developing technological schemes.

2. Risk of water leakage and hydrogeological uncertainties. Although the main production layers of the deposit — potash salts — are covered with impermeable saline rocks, groundwater leakage under pressure has been recorded in some tectonic zones. This situation poses a threat to mining safety, especially in areas where water flow may occur in fracture zones or through karst cavities. Therefore, it is necessary to conduct preliminary hydrogeological monitoring and geophysical surveys.

3. Technological difficulties. The ore mass of the Tyubegatan deposit is heterogeneous, and the concentration of KCl in different layers varies significantly (from 25% to 41%). This situation leads to instability in the quality of the mined ore. Also, stress zones, interlayer changes, and cavities exposed to karst can lead to technological disruptions in mining operations. For optimal mining of the mineral, it is necessary to model it taking into account structural changes in the layers.

Comprehensive consideration of the above factors is a key condition for ensuring the safety, efficiency and environmental sustainability of the mining process. In this regard, the use of modern geotechnical and digital monitoring technologies is relevant.

Conclusion

The mountainous regions of the Kashkadarya region, in particular the Tyubegatan deposit, are characterized by their complex geological structure, uncertain hydrogeological conditions and active geodynamic processes. This limits the use of minerals in this area with a simple technological approach. In-depth scientific analysis, the participation of highly qualified specialists and the use of modern technologies are of great importance in conducting mining operations.

Potassium salts in the Tyubegatan deposit are of high industrial importance, and their extraction requires in-depth study of factors such as the heterogeneity of the composition of the layers, karst and fracture zones, the risk of water seepage and variability of KCl concentration. In such conditions, the following approaches are important for the sustainable and effective development of deposits:

- geological models refined on the basis of modern geophysical surveys;
- three-dimensional (3D) geostructural maps;
- groundwater monitoring and identification of hydrogeological hazard zones;
- assessment of the efficiency of mining through technological modeling;
- development and implementation of environmental safety measures.

On this basis, it can be said that the development of minerals in mountainous regions is a complex, but strategically important process in many respects, requiring a scientific approach, advanced technologies, and sustainable resource management.

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