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MODERNIZATION OF GOLD-BEARING ORE EXTRACTION TECHNOLOGY DEPENDING ON GEOLOGICAL AND MINING CONDITIONS

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The article presents options for modernizing the technology for extracting gold-bearing ore, depending on geological and mining conditions, and discusses various technological solutions to improve technologies. Based on review, analysis and generalization in specific geological and mining conditions, the optimal width of the working site was proposed. Continuous geotechnical monitoring should be carried out at all stages of quarry development, including visual inspection of slope conditions, crack mapping, and collection of deformation and groundwater data. The following information should be recorded during monitoring: geological characteristics of the slope, engineering-geological characteristics for classifying the rock mass, slope geometry, monitoring of damage as a result of drilling and blasting operations, water seepage, quality and efficiency of cleaning, monitoring of existing cracks and collapses.

Keywords: mining technology, working platform width, bench height, geotechnical monitoring, bench cleaning, gold-bearing ore.

ГЕОЛОГИЯЛЫҚ ЖӘНЕ ТАУ КЕН ТЕХНИКАЛЫҚ ЖАҒДАЙЛАРЫНА БАЙЛАНЫСТЫ ҚҰРАМЫНДА АЛТЫН БАР КЕНДІ АЛУ ТЕХНОЛОГИЯСЫН ЖАҢҒЫРТУ

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Мақалада геологиялық және тау-кен жағдайларына байланысты алтын кендерін алу технологиясын модернизациялау нұсқалары келтірілген, технологияларды жақсарту үшін әртүрлі технологиялық шешімдер қарастырылған. Нақты геологиялық және тау-кен жағдайларында шолу, талдау және жалпылау негізінде жұмыс алаңының оңтайлы ені ұсынылады. Карьерді дамытудың барлық кезеңдерінде беткейлердің жай-күйін визуалды тексеруді, жарықтарды картаға түсіруді, деформациялар мен жер асты сулары бойынша деректерді жинауды қамтитын үздіксіз геотехникалық мониторинг жүргізілуі тиіс. Мониторинг кезінде мынадай ақпарат тіркелуі тиіс: борттың геологиялық сипаттамалары, тау жыныстары массивін жіктеуге арналған инженерлік-геологиялық сипаттамалар, борттың геометриясы, бұрғылау-жару жұмыстарының нәтижесінде жойылуларды бақылау, судың ағуы, тазалаудың сапасы мен тиімділігі, бар жарықтар мен құлауларды бақылау.

Түйін сөздер: өндіру технологиясы, жұмыс алаңының ені, жиектің биіктігі, геотехникалық мониторинг, жиектерді тазарту, құрамында алтын бар кен.

МОДЕРНИЗАЦИЯ ТЕХНОЛОГИИ ВЫЕМКИ ЗОЛОТОСОДЕРЖАЩЕЙ РУДЫ В ЗАВИСИМОСТИ ОТ ГЕОЛОГИЧЕСКИХ И ГОРНОТЕХНИЧЕСКИХ УСЛОВИЙ

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В статье приведены варианты модернизации технологии выемки золотосодержащей руды в зависимости от геологических и горнотехнических условий, рассмотрены различные технологические решения для улучшения технологий. На основе обзора, анализа и обобщения в конкретных геологических и горнотехнических условиях предложена оптимальная ширина рабочей площадке. На всех этапах разработки карьера должен проводиться непрерывный геотехнический мониторинг, включающий в себя визуальный осмотр состояния откосов, картирование трещин, сбор данных по деформациям и подземным водам. При мониторинге должна фиксироваться следующая информация: геологические характеристики борта, инженерно-геологические характеристики для классификации массива пород, геометрия борта, наблюдение за разрушениями в результате буровзрывных работ, просачивание воды, качество и эффективность зачистки, наблюдения за имеющимися трещинами и обрушениями.

Ключевые слова: технология добычи, ширина рабочей площадки, высота уступа, геотехнический мониторинг, зачистка уступов, золотосодержащая руда.

Introduction. Novodneprovskaya territory is located 40-70 km southwest of the city of Shchuchinsk. The area of the geological allotment is 44.3 square km.

Within the geological allotment, two isolated gold-bearing ore fields are distinguished - Novodneprovskoe and Raigorodskoe, which includes the Northern Raygorodok and Southern Raygorodok gold-bearing deposits.

Industrial development of the Northern Raygorodok deposit has been ongoing since 2010, and the Southern Raygorodok deposit since 2015. Oxidized ores of the deposits are processed by heap leaching.

Open-pit mining of oxidized and mixed ores is carried out. The climate of the area is sharply continental with dry and cool summers (with some hot days) and cold, with prolonged frosts and strong winds in winter.

The described area belongs to the North Kazakhstan gold-bearing province, which is a product of tectonic and magmatic events that occurred during accretionary collision processes in the early Caledonian period on the eastern border of the ancient Kokchetav massif and the Seletino-Stepnyak system of island arcs of the early Paleozoic. An important role in these processes was played by the processes of redistribution and concentration of metals from Precambrian rocks and island arcs. The Northern and Southern Raygorodok gold-bearing deposits are a type of porphyry-epithermal ore-magmatic system in the accretionary continental margin. The Raigorod ore field is confined to the volcanotectonic structure of the same name.

In regional terms, the work area is located in the border area between two large first-order structures - the Kokchetav middle massif and the Teniz depression, which are fundamentally different in geological structure and development history.

This led to the complex geological structure of the area, intense magmatism and widespread development of faults. Weathering crusts of areal and linear types are widely developed in the area of the deposit. The thickness of the areal weathering crusts reaches 70 m, linear (in the eastern part of the deposit) 120-180 m. The boundary of the oxidized ore zone follows the boundary of the weathering crust and is located at depths of about 40-100 m, which made it possible to mine the first stage of the quarry with a depth of up to 80-100 m without the use of drilling and blasting operations. In stockwork bodies, the two noted morphological types often accompany each other in various combinations and combinations [1, 2]. Ore zones and bodies have a linear morphology with a steep dip.

The length of individual ore bodies varies from tens to 645 m, and thickness - from a meter to 65 m, while vein-like ore bodies usually have an insignificant thickness of up to 3 m and a small extent (up to 100 m) with pinching out along strike and dip.

The depth of mineralization exceeds 750-850 m, and with depth there is no tendency for ore bodies to pinch out, and the gold content increases.

Materials and Methods. There is a certain pattern in the distribution of ore bodies - the center of the mineralized strip is maximally saturated with closely spaced ore bodies of irregular shape, on the flanks they are less common and spatially separated. This is explained by the development of a predominantly stockwork type in the center, and vein and isolated stockwork type on the flanks. The gold content changes literally at a distance of the first meters [3].

Extraction unit is the smallest economically and technologically optimal section of a deposit with a reliable calculation of initial reserves (block, panel, longwall, part of a ledge), the development of which is carried out by a unified development system and technological scheme of extraction, according to which the most accurate separate accounting of production can be carried out in terms of quantity and quality of minerals [4,5].

Taking into account the peculiarities of the geological structure of the deposit, the most optimal excavation unit will be a ledge (horizon) with a height of 7.5 m, during the development of which it will be possible to most accurately ensure the accounting, condition and movement of reserves, losses and dilution.

The concept of a ledge - as an excavation unit corresponds to the definition and functions of a minimum section and meets the requirements for an excavation unit, because:

- economically and technologically justified optimal mining geometric unit by the project;

- with reliable calculation of initial ore reserves;

- development of which is carried out by a unified development system and technological scheme of excavation;

- by which an accurate separate accounting of the extraction of ore mass can be carried out according to the quantity and content of metal (useful component) in it [6].

For each mining unit, the subsoil user creates a passport reflecting the state and movement of mineral reserves, the actual fulfillment of loss and dilution indicators, and the state of mining operations.

The provision of a quarry with ore reserves and volumes of overburden ready for extraction are expressed for the period of operation in months or fractions of a year, based on its planned productivity in the next year; When putting capacity into operation, the availability of the quarry is calculated: for minerals - based on the amount of capacity introduced and introduced in the next year, for overburden rocks - based on the planned productivity for overburden rocks for the coming year.

With year-round operation, the quarry’ s supply is:

- ready-to-excavate ore reserves – at least 2.5 months;

- volumes of overburden rock ready for excavation - at least 2.5 months;

- volumes of loose overburden ready for excavation - at least 1.8 months.

Based on the design capabilities of the adopted type of equipment, the height of the working benches is assumed to be 7.5 m.

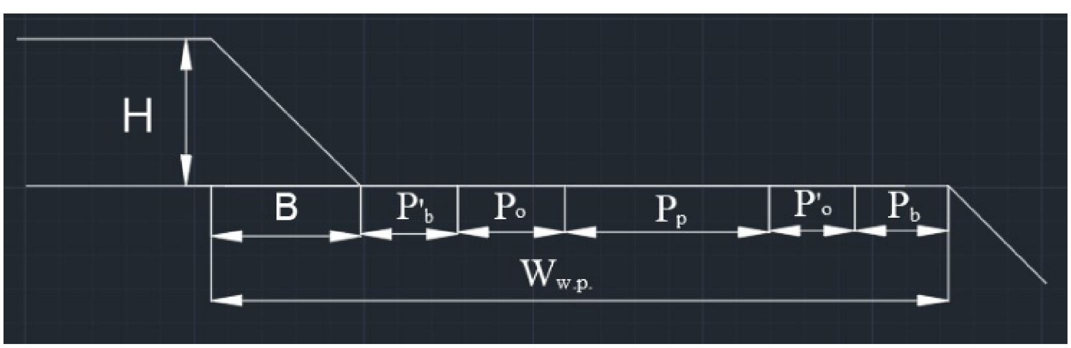

Fig. 1 - Working platform width

The calculated value of the minimum permissible width of working platforms under standard conditions was determined taking into account the regulations for the placement of the excavator entry, the width of the shoulders, safety strips and the safety shaft was 50 m (Figure 1) [7].

The width of the working platform is determined by the formula:

Ww.p.= B+Pp+Po+P' o+Pb+ P' b, m

where B - Full width of rock collapse after explosion;

P'_b - Width of the safety strip between the first row of wells and the edge;

P_o - Upland shoulder width;

P_p - Roadway width;

P'_o - Downstream curb width;

P_b - Collapse prism width.

When driving entry and cutting trenches, as well as when working in difficult, cramped conditions, working with a dead-end face is used [8].

The width of a dead-end face, as a rule, corresponds to two excavator radii. If the width of the dead-end face is less than two digging radii, the possibility of turning the excavator and safely placing vehicles in the trench is checked. The turning radius and length of the dump truck must correspond to unimpeded entry and loading at the face.

Results and Discussion. In areas prone to deformation, it is recommended to carry out blasting operations in a gentle or controlled mode. Blasting can have a significant and often decisive impact on the behavior of slopes. Drilling and blasting with a controlled perimeter is recommended for all sides of the final pit contour provided for in the project. Controlled perimeter drilling and blasting technologies must be developed and their effectiveness verified before the beads are formed to the final design position [9]. The performance of each controlled explosion must be monitored and analyzed to ensure it remains consistent with changing conditions.

An important factor in ensuring the stability of the pit walls is the management of groundwater pressure. Groundwater pressure inside the edge and along structural differences can increase destabilizing (destructive) forces. These forces can be mitigated by using appropriate measures. Measures to reduce pressure in slopes should include the installation of drainage ditches. To stabilize slopes, wells for pumping water around the perimeter and horizontal drainages are recommended [10].

An important activity is clearing the ledges. Cleaning involves removing suspended rocks from the surface of the slopes and subsequent cleaning at the base of the slope. Cleaning should be the final operation of each excavation cycle when constructing both permanent and temporary pit walls. This procedure allows you to maintain order and reduce the risk of rock collapse.

At all stages of quarry development, continuous geotechnical monitoring should be carried out, including visual inspection of the condition of slopes, mapping of cracks, collection of data on deformations and groundwater.

Information collected during monitoring should be documented and processed by a competent geotechnical professional. When monitoring, the following information should be recorded: geological characteristics of the wall (lithology, deformation, weathering), engineering-geological characteristics for classifying the rock mass, geometry of the wall (including deformations and factors causing them), observation of damage as a result of drilling and blasting operations, water infiltration, quality and efficiency of cleaning, monitoring of existing cracks and collapses.

The opening of the designed quarries is carried out using both external and internal entrance trenches.

The design of the opening scheme in quarries is carried out taking into account a number of conditions and factors, including: ensuring the minimum range of hauling the rock mass along intra-quarry roads with ensuring a minimum volume of overburden in the contours of the quarries; locations of ore stockpiles and overburden dumps.

The opening of each new horizon is carried out depending on the parameters of the section of the ore zone to be mined by creating a temporary dead-end or permanent ramp in a place convenient for the unhindered development of its reserves and preparing the site for opening a new underlying horizon.

Conclusion. At all stages of quarry development, continuous geotechnical monitoring should be carried out, including visual inspection of the condition of slopes, mapping of cracks, collection of data on deformations and groundwater. In areas prone to deformation, it is recommended to carry out blasting operations in a gentle or controlled mode. An important activity is clearing the ledges. Cleaning involves removing suspended rocks from the surface of the slopes and subsequent cleaning at the base of the slope. Cleaning should be the final operation of each excavation cycle when constructing both permanent and temporary pit walls. This procedure allows you to maintain order and reduce the risk of rock collapse.

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