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IMPROVEMENT OF MINERAL EXTRACTION UNDER THE CONDITIONS OF THE KHANDIZA POLYMETALLIC DEPOSIT

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Abstract:
The article presents the results of research aimed at improving the efficiency of the development of the Khandiza polymetallic deposit. Various mining systems are recommended that help reduce ore losses and dilution. Options involving the use of self-propelled equipment are proposed, which make it possible to significantly improve the key technical indicators in the mining of complexly structured deposits.

Keywords: Ore, development system, loss, dilution, explosion, subfloor, excavation, contour, explosives, block, floor, deposit, ore release.

Introduction

The Khandiza polymetallic deposit of Khandiza is distinguished by favorable mining and technical conditions. The physical and mechanical properties of the surrounding rocks and ores are characterized by high strength, stability, and low water content.

The rock strength of the host rocks and ores on the M.M. Protodyakonov scale ranges from 12 to 19. The host rocks consist of strong, generally stable tuffs of liparite and liparite-dacite porphyries, as well as quartz sandstones. The ore bodies are composed of very strong and stable silicified tuffs with vein-disseminated and massive mineralization.

The reinforcement of mine workings will mainly be provided at junctions and in zones of tectonic disturbances. Based on the experience of driving exploratory workings, the volume of reinforcement will be approximately 20% of the total volume of workings.

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For the underground extraction of ore body reserves in the Khandiza deposit, the project employs a sublevel caving system with front draw of ore. During the preparation process, the 40 m high level is divided into 4 sublevels, each 10 m high. The general direction of work is from the center to the flanks. Access drifts to the ore body (crosscuts) are driven every 50 meters.

The main processes of cleaning extraction are carried out from drilling and delivery drifts driven along the ore body at a distance of 10 m between the shaft axes. Blast hole drilling is carried out by self-propelled drilling rigs SIMBA N157 (Figure 1).

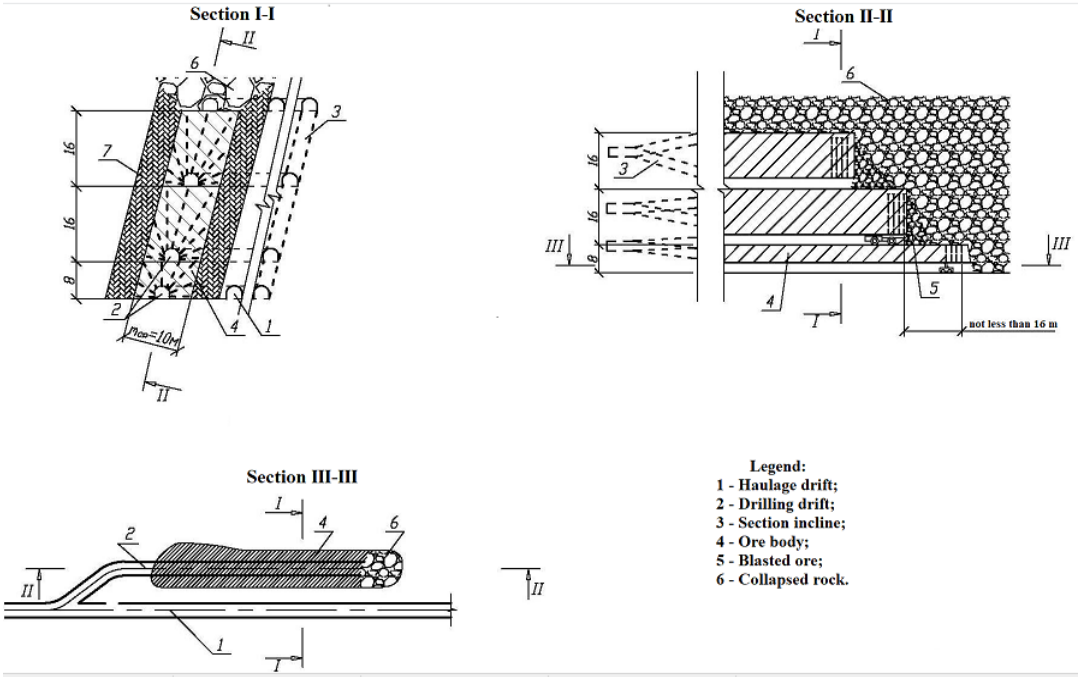

Figure 1. Sublevel caving system with end ore draw.

The advantages of this system variant include the simplicity of constructive execution, reliability, and the ability to use a standard set of well fans, which contributes to the automation of the drilling process.

The results of observations on the process of lateral discharge of ore from the workings, located in accordance with the design parameters of the system adopted in the project, are presented in Table 1.

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Table 1

№	Name of indicators	Unit of Measurement	Value
1	Average Thickness of the Ore Body	m	14.0
2	Industrial Ore Reserves in the Block	m^3	45590
3	Volume of Ore Extracted from the Block	m^3	41481
4	Volume of Development Work	m^3	10708
5	Volume of Development Work per 1000 Tons of Ore	m^3	294
6	Waste Rock Output per 1000 Tons of Ore at Extraction Operations	m^3	53
7	Waste Rock Output per 1000 Tons of Ore at Development Work	m^3	20,8
8	Operational Ore Losses under the Mining System Ore Dilution under the Mining System	%	15÷22
9		%	20,5÷25

Indicators for the Sublevel Caving Mining System for Block C1-31

The analysis of the observation results shows that the main disadvantages of the adopted sublevel caving design with end ore draw from rhomboid panels are the high consumption of preparatory and development workings and the onset of dilution at the early stages of ore extraction. This, in turn, leads to increased ore losses.

The latter is related to the technology, which provides for the vertical development of sublevels starting from the hanging wall. In this case, during the extraction of ordinary ore, the rocks of the hanging wall approach the zone rich in valuable components, which leads to a significant deterioration in ore quality due to dilution and losses within the corresponding sublevel.

Research Methods

The underground mining system for mineral extraction using sublevel caving with end ore draw beneath the caved rocks is considered one of the most efficient systems for large-scale ore mining. This system is often referred to as the "Swedish" method. According to this approach, the mined block is divided into sublevels, each of which has its own extraction horizon. Sublevels are mined in a

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descending order, forming a rhomboid shape in vertical cross-section. The ore body is drilled with vertical or steeply inclined fans of upward-directed boreholes along the entire length of the panel from drifts. Blasting is carried out layer by layer in a retreating sequence. Each subsequent layer is blasted only after the ore mass from the previous layer has been extracted. The transportation of the blasted ore to the ore passes is carried out using load-haul-dump machines[1].

Swedish mining experts note that the gradual increase in dilution during the extraction of the blasted layer, which is typical for model experiments, is rather an exception than a rule under the conditions of large-scale sublevel caving systems. Mines in the CIS countries that have adopted the Swedish variant of the sublevel caving system in an almost copied form face the same difficulties [2, 3].

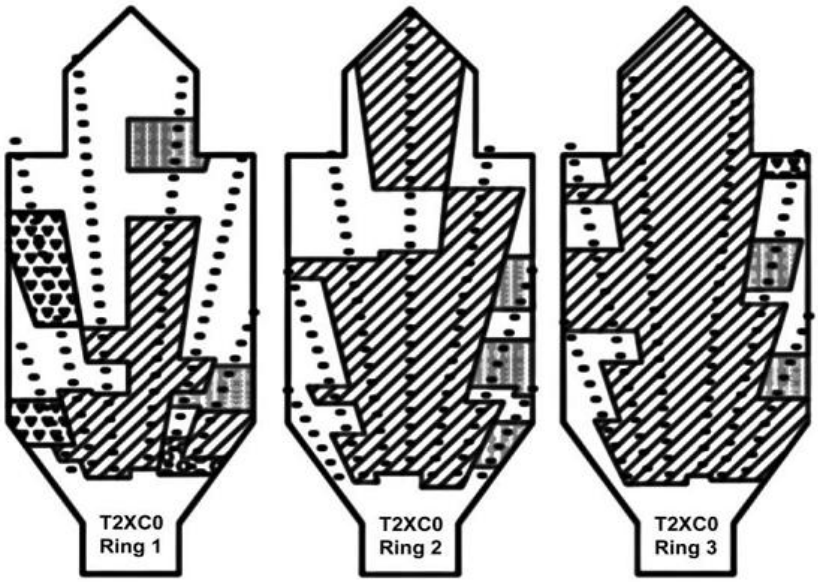

Fig. 2. The configuration of the production areas in the stripped layer in three planes parallel to the blast hole plane and separated from it by: 1) 1.95 m; 2) 1.3 m; 3) 0.65 m;

The latest industrial experiments have shown that, given the geometric dimensions, the shape of the ore draw zone differs from an ellipsoid, is irregular, and changes from layer to layer. As an example, Figure 2 shows three cross-sections of the ore draw zone obtained during one of the field experiments.

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The authors note [4, 5, 6] that one of the most significant factors negatively affecting the stability of the ore flow process is the uncontrolled fragmentation of the ore during blasting, which leads to the presence of oversized fragments in the extracted material. These negative factors are compounded by inherent shortcomings of the system itself. These include: the large contact area between the blasted ore and the caved waste rock, as well as the proximity of this contact zone to the loading point of the broken rock mass.

Recommendations

In order to reduce losses and dilution at the Khandiza mine, taking into account the complex mining and geological as well as mining and technical conditions of the Khandiza polymetallic deposit, it is recommended to apply a mining system with end ore draw from drifts located in direct contact with the ore.

In this case, it becomes possible to achieve high-quality and high-quantity indicators for metal extraction from the subsoil by positioning the draw points closer and ensuring the priority extraction of ore from zones with higher concentrations of valuable components. Such zones can be mined with minimal losses and dilution, as they can be extracted practically without contamination by substandard waste, remaining within the boundaries of the ore body.

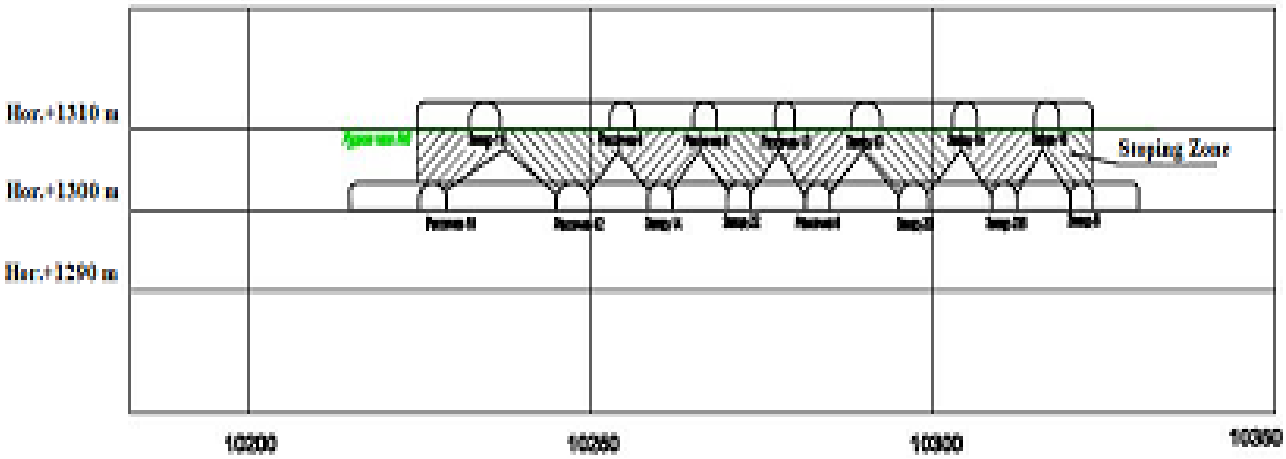

Figure 3. Frontal View of Experimental Block C1-31

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When applying the proposed variant of sublevel caving, the sublevel height is also taken into account. Analysis of the data from field experiments, as well as from physical and computer modeling, shows that under these conditions, uniform ore draw is ensured when the opening angles of the draw zone are approximately 50°. At the same time, to facilitate ore movement towards the draw workings, it is necessary to undercut the rocks of the footwall. By adjusting the spacing between adjacent draw drifts in the proposed variant with end ore draw — both in height and width — it is possible to reduce dilution indicators, as shown in Figure 3.

Thus, for the extraction of reserves at the Khandiza polymetallic deposit, taking into account the complexity of the mining and geological as well as mining and technical conditions, it is advisable to abandon the traditional variant of sublevel caving, which provides for the placement of drilling drifts in the footwall at the ore-rock contact or within the host rocks. This approach will not only reduce the volume of preparatory and development work but will also enable ore extraction from zones with higher concentrations of valuable components without early dilution by off-balance rocks from the hanging wall. As a result, it will significantly improve the recovery of valuable components from the subsoil.

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