FEATURES OF BULK EXTRACTION OF COMPLEX ORE BODIES WITH INTERLAYERS AND ROCK INCLUSIONS AT THE "ZARMITAN" DEPOSIT

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Abstract: *This article has developed a technology for the gross excavation of complex ore bodies with interlayers and rock inclusions, which provides an increase in the completeness and quality of mineral extraction from the subsoil, ensuring safe treatment conditions and eliminating the likelihood of blast hole destruction.*

Key words: *ore, losses, block, ore body, well, exploration, capital construction, preparation, mining.*

Introduction. When developing low-grade deposits, justifying bulk mining is one of the main and most complex aspects. Bulk and selective mining under the same geological conditions yield different quantities of ore, varying in quality and characterized by different costs.

The development of low-grade deposits has several features that must be considered in calculations. Varying ore thickness leads to changes in system parameters, primarily in the width of the stoping area. As studies [2-10] show, the economic indicators of the applied mining methods largely depend on the width of the stoping area. To correctly select system parameters for specific conditions and compare indicators of selective and bulk mining, it is necessary to first establish the optimal parameters for stoping operations under a given mining method.

Methods and Results. The primary parameter to be optimized is the width of the stoping area. There is an opinion [11] about the need to reduce the width of the stoping area, but there is no generally accepted methodology to determine the feasibility of this viewpoint. The optimal width of the stoping area is selected and justified based on the total national economic costs for extraction and processing of ore obtained from 1 ton of reserves. The calculation is carried out according to the formula:

$$Q = q_P + (q_Д + q_T + q_O + \eta_{KB} q_{МП})\eta + \sum_1^k (n_{\max} - n_i) A_k \rightarrow \min, \qquad (1)$$

where n_{max} is the maximum possible quantity of extractable metals under given conditions, kg; n_i is the quantity of metals from 1 ton of reserves extracted into the finished product at a given stope width, kg; *k* - is the number of metals extracted.

The quantity of metals extracted into the finished product is determined by the formula:

$$n_П = \eta_П \beta_1 Q_1 \varepsilon_{O1} \varepsilon_{M1} + \eta_П \beta_2 Q_2 \varepsilon_{O2} \varepsilon_{M2} + \text{K} + \eta_П \beta_n Q_B \varepsilon_{On} \varepsilon_{Mn}, (2)$$

where ηΠ is the ore mass yield from a unit of reserves in selective mining, expressed as a fraction; β (1...n) is the proportion of each ore grade in the extracted ore mass, expressed as a fraction; $Q_{1, 2}$ are the costs for obtaining metals per unit of reserves, in sum; ε_M (1...n) and ε_O (1...n) are the recovery rates during ore beneficiation for each grade and metallurgical processing, expressed as fractions; Q_V is the cost for obtaining metals per unit of reserves during bulk mining, in sum;

To substantiate losses and dilution at different widths of the extraction space, actual indicators are used or calculations are performed using formulas.

$$г = \frac{m_O - m_Ж}{m_O}; \; г'' = \frac{m_O - m_Ж}{m_Ж}, \qquad (3)$$

where $г$ and $г'$ are coefficients of dilution and admixture, respectively, during bulk mining; m_O is the width of the stope, m; $m_ж$ is the thickness of the ore body (vein), m.

$$q_Д = \frac{C_{ПОСТ}}{m_O} + C_{ПЕР}, \qquad (4)$$

where $C_{пост}$ the semi-fixed part of costs (expenses for exploration, capital construction, opening, preparation, and stoping) attributed to a unit of extracted ore mass, which decreases with an increase in the width of the stoping space, sum; semi-variable part of expenses (costs for transportation, hoisting, and overhead). With a constant annual production capacity, these remain approximately constant per unit of extracted ore mass, in sum.

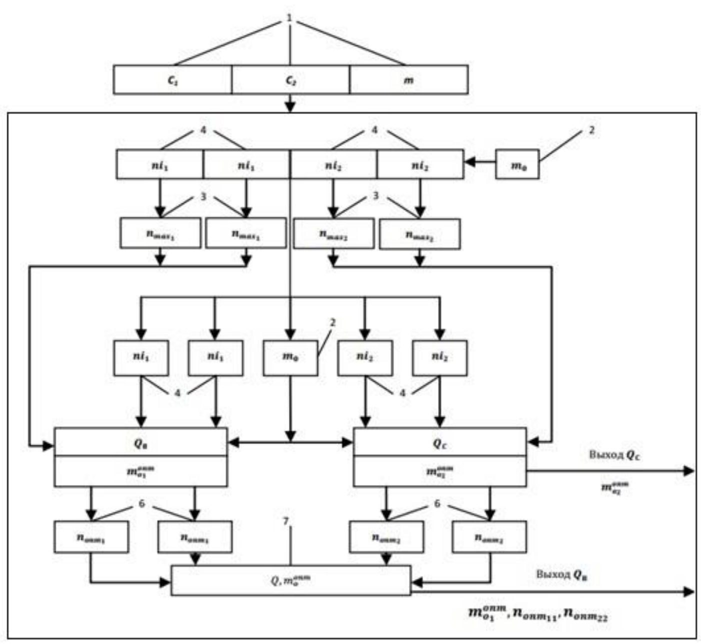

Fig. 1. Flow chart for comparing separate and bulk mining options for complex ore bodies with interlayers and rock inclusions

1 - Initial data generation unit; 2 - Unit for generating current values of the stope width; 3 - Unit for comparison and selection of the maximum possible quantity of metals; 4 - Unit for calculating the amount of metals recovered into concentrate n; 5 - Unit for calculating the costs of finished products when operating in optimal modes; 6 - Unit for calculating the amount of metals obtained through systems when operating in optimal modes $n_{опт}$; 7 - block for calculating the total costs of metal production Q_B,, Q_C (c - metal content in reserves; to - width of the stope; m - vein thickness)

The costs of processing 1 ton of ore are also approximately constant and depend little on changes in its metal content.The variable and fixed components of the costs are determined by analyzing the cost calculation for 1 ton of ore mass or through special observations in the extraction blocks.Expression (3.1), taking into account formula (3.4), will have the following form:

$$Q = \left(\frac{C_{ПОСТ}}{m_O} + C_{ПЕР}\right)\eta + \sum_{1}^{k}(n_{\max} - n_i)A_K \to \min. \quad (5)$$

The minimum value determines the optimal width of the extraction space under given conditions.

Calculations for comparing selective and bulk mining options can be performed using a computer. The flowchart of such calculations is shown in Figure 1.

CONCLUSIONS

1. A technology for bulk extraction of complex ore bodies with interlayers and rock inclusions has been developed. This technology ensures increased completeness and quality of mineral extraction from the subsoil, provides safe conditions for stoping operations, and eliminates the possibility of blast hole destruction. The developed technology contributes to the formation of stable chamber walls. Simultaneously, it eliminates the risk of uncontrolled collapse of weakened ore and rock masses, reducing the levels of primary and secondary ore dilution and operational losses.

2. Studies have established the relationship between the cost of extracting 1 ton of ore mass and the width of the stoping space during bulk extraction of complex ore bodies, taking into account the costs of exploration, capital construction, development, preparation, and stoping.

3. The bulk extraction of complex ore bodies with interlayers and rock inclusions has been economically justified, resulting in the development of a block diagram for comparing various options.

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