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MONITORING AND EVALUATION OF THE VARIABILITY OF ORE QUALITY DURING PRODUCTION AT THE KOCH-BULAK DEPOSIT

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ANNOTATION

The article presents an analysis of scientific papers devoted to forecasting the quality indicators of ore raw materials during the development of deposits by underground method. The author analyzes the variability of the qualitative indicator in the Kochbulak mine, and based on the results of analytical calculations determines the variability of qualitative indicators and the complexity of the block by the geological factor.

Keywords: mine, quality, forecasting, ore discharge, ore, indicators, content, samples, technology, scheme.

INTRODUCTION

In the work (Research of technological and nanostructural properties of ores in solving problems of rational subsurface use. Petin A.N., Vasiliev P.V.) [1] the issues of a multi-scale study of the technological properties of ores of natural and man-made deposits to ensure rational and integrated development of the subsoil are considered. Using the example of the disclosure of finely interspersed minerals, a methodology for predicting the indicators of ore extraction and processing is described. The results are used in the geoinformation system of ore raw material quality management to optimize the stages of mining reserves of deposits with minimizing environmental consequences.

In the work (A method for assessing the technological properties and enrichment of mineral raw materials. Type: patent for an invention. Bashlykova T.V., Danilchenko A.Y., Chanturia E.L., Makavetskas A.R., Pakhomova G.A.) [2] Is used to predict express evaluation of technological properties and enrichment of mineral raw materials of natural and technological origin, as well as to identify technological errors in mining and processing production. The essence lies in the fact that the chemical and mineral composition of raw materials, the granulometric composition of the ore of the initial size and the granulometric composition of the product crushed to the maximum degree of disclosure of valuable components are determined. The structural and phase characteristics of mineral raw materials are evaluated, the physical properties of minerals and predictive technological indicators are determined. At the same time, the determination of quantitative values of structural and technological parameters, which include the structural element of disclosure, the boundary size of the ore classification in the grinding cycle, the degree of disclosure of ore minerals, the distribution of mineral phase accretions by quality, is carried out by automatic image analysis by optical-geometric methods. Technical result: improving the efficiency and reliability of the preliminary assessment of technological parameters and the enrichment of various mineral raw materials, reducing the time of technological research and identifying possible technological errors in the processing of mineral raw materials. 3 z.p. f-ly, 2 il.

In the work (Probabilistic assessment and optimization of the quality of transported ore mass in the combined development of deposits. Vereshchak V.Y., Kazikaev D.M.) [3] Describes one of the possible approaches to optimizing the quality of transported ore mass during combined (open-underground) mining of mineral deposits. Optimization is performed using the probabilistic Monte Carlo method. The main attention is paid to the determination of such initial parameters of production at each of several faces, which ensure the closest correspondence of the quality indicators of the total ore mass flow to the plan established by the concentrator.

In this paper (Development of a predictive model of the quality of semiconductor devices by extrapolation. Mishanov R.O., Piganov M.N.) [4] the method of developing a predictive model of the operator predicting the quality of zener diodes by extrapolation is considered. The results of the training experiment are presented. Quasi-deterministic linear, logarithmic, exponential and parabolic models were used to construct the prediction operator. A study of the developed operator was carried out. Probabilistic characteristics of its effectiveness are obtained.

In order to determine the qualitative and quantitative characteristics of the ore bodies under study at the Koch-Bulak mine, all quartz veins, veined and metasomatic quarrying zones, their backbands, as well as all encountered tectonic zones of crushing and crushing of rocks with hydrothermal elaboration and mineralization were tested.

Work was carried out on the selection of geological furrow, bulge and slurry samples and their processing.

Table 1.The volume of work performed on testing

№	Types of work	Units of measurement	Provided	For Actually completed
1	Furrow testing in underground workings	shoulder strap meter	439	486,4
2	Furrow testing in open workings	shoulder strap meter	86	99,7
3	Slurry testing	test	120	200
4	Group sampling	test	5	1
5	Sample processing	test	1067	1133

The main method of testing in determining the reserves of metals of ore bodies is furrow. The cross section of the furrow is 5x10cm, and during the control testing 5x20 cm. the length of the section is from 0.3 to 1.2 m, on average 1.0 m, and when testing the backbands (when blocked

– Behind the intended contour of industrial mineralization) 2-3 samples were taken with a length of 0.5 m.
With the method of zadyrki, the width of the sample is equal to the power of the vein, length 1.0m, depth 5.0cm:
Ore bodies are steeply falling and, as a rule, were tested with a horizontal furrow. Depending on the type of mining and the conditions of its penetration, the selection was made along the walls, face or roof of the mine. Linking samples by surveying points. Samples were taken by rocks and ores of the XIV-XVI categories manually using a hammer, chisel and sledgehammer. The density of the sampling network in the workings tracing the ore body is on average 3m, and during operational work up to 5m. This network is used in the long-term work of Goskomgeo and the mine and has been experimentally confirmed by special case studies. With a large capacity of ore bodies exceeding the section of the drift or rising, the sampling interval depends on the density of through intersections (dissections, arrivals) and averages 20 m, with a thickening of up to 10m in areas with a complex geological structure. Both walls were tested in the workings opening the ore body across the strike.
In the process of furrow sampling, weight control was carried out by comparing the actual weight with the theoretical weight and control re-testing of ore intersections. Due to the small size of the "sample", the processing and comparison of the results of sampling control were not carried out.
Control over the correct location of samples, depending on the structure and conditions of occurrence of ore bodies, was carried out by the senior geological staff of the mine and was checked by the commission for the comparison of primary geological documentation with in kind.
Sludge testing consisted in sampling sludge from wells, drilling of which was carried out by pneumatic impact method. The testing was carried out by care; with a drilling diameter of 105mm, the length of the care, and therefore the length of the sample, was usually equal to 1m. When drilling with a diameter of 216mm, due to the significant amount of sludge, the lengths of the tested intervals were reduced to 0.5 m and even 0.2 m.
To determine the contents of associated and flux components, one group sample was selected for ore body 14; group samples were not taken for the rest of the ore bodies, because the proven ore reserves for them are insignificant. The group sample is made up of attachments selected from duplicates of furrow samples included in the counting sections, the so-called "through" samples. The total weight of the group sample is 200 g, summed up from private attachments proportional to the lengths of the samples.
Sample processing дро crushing and grinding of the material was carried out in the assay separation department of the AGC according to the scheme adopted for the Kochbulak deposit. The samples were successively crushed in jaw crushers, disk and vibration grinders during quality control of crushing equipment cleaning. Mixing and reduction of the sample material was carried out by the "ring and cone" method using cross-shaped metal dividers.
The initial weight of furrow and slurry samples, depending on the length of the section, is 2-15 kg; the final weight of the sample material with a particle diameter of 0.074 mm is 700-1400 g.

The calculation of the weight during the stage reduction in the mining process is carried out according to the Richards-Chechott formula:
Q= Kd2, where, K is the coefficient of unevenness of mineralization (0.7), d is the diameter of the particles of the sample material (mm).
Documentation of exploration workings is carried out in field journals and consists of a sequential and continuous sketch of mining workings with a detailed geological description of them.
The scale of the sketches is 1:100, and in areas with a complex geological situation – 1:50. The sketches give maximum information in conventional signs. Sketches of horizontal and inclined workings are given in the form of a straight sweep. In the rising ones with an angle of inclination of more than6060〗 ^0, all four walls are drawn in the form of a straight sweep. In addition to continuous sketching of workings, if necessary, a sketch of the faces is given. The sketches are accompanied by a detailed point-by-point and layer-by-layer description of geological observations according to the accepted scheme.
Field documentation is the primary source material for the compilation of consolidated documentation: 1:200 scale testing plans, geological plans and sections of 1:500 and 1:2000 scales, projections on vertical and horizontal planes of 1:200, 1:500 scales, etc.
Taking into account the dependence of variability not only on the difference in the values of the indicator at neighboring points, but also on the distance between the points, we write a general expression of the coefficient of variability at equivalent scales along the axes (g = 1ed/m). (fig. 1-2):

CONVENTIONAL UNITS

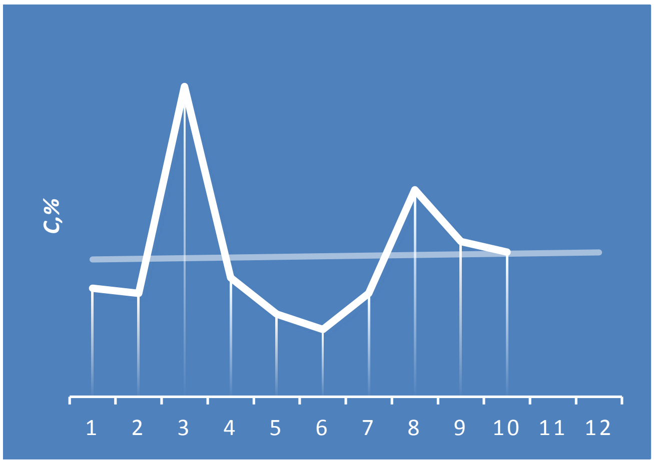

Fig. 1. Variability of the qualitative indicator of gold.

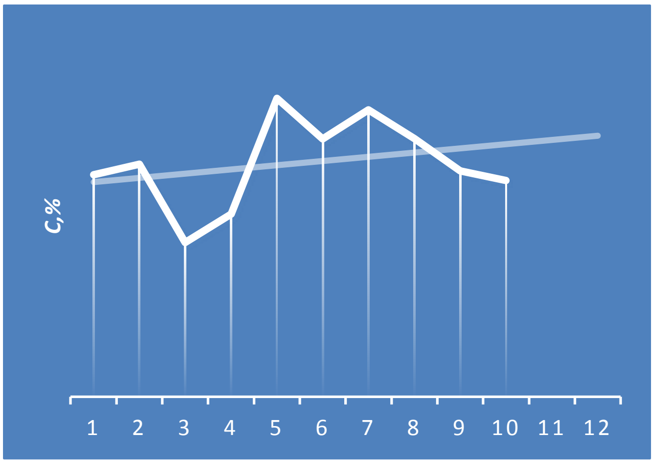

Fig. 2. Variability of the qualitative indicator silver.

1) gold
dk = 1.3
D = 11

2) silver
dk = 0.7
D = 9.3

$L = 10$	$L = 9$
$\mu_c = 7.6$	$\mu_c = 7.2$
$\mu_l = 10$	$\mu_l = 9$
$R = 6$	$R = 3.6$
$\alpha = 3^0$	$\alpha = 5^0$

$$u_{g=1} = \int_{(k)} dk/D - 1, \tag{1}$$

where, $\int dk -$ is a curved integral of the first type taken along the curve K - in this interval (curve length), mm; D – is the hypotenuse of a pentagonal triangle with legs equal to the projection length of the curve span, mm:

$$D = \pm\sqrt{(\mu_l L)^2 + (\mu_c R)^2}; \tag{2}$$

$\mu_l -$ scale by intervals (1mm corresponds to M_l, m):

$\mu_l = 1: M_l$;

L – is the length of the curve projection, m; R – is the implementation span – the difference between the maximum and minimum values of the indicator on this profile, units; $\mu_c -$ is the scale along the axis of the indicator values (1mm corresponds to M_l units of the indicator):

$\mu_c = 1: M_c$.

Under the condition $\mu_c R < 0.1\mu_l L (\alpha < 6^0)$, we can take $D = \mu_l L$, then expression (1) takes the form

$$U_{g=1} = \int_{(k)} dk/(\mu_l L) - 1. \tag{3}$$

1) Provided $\mu_c R < 0.1\mu_l L(\alpha < 6^0) = 7.6 \cdot 6 > 0.1 \cdot 10 \cdot 10 \cdot 3) = 45.6 > 30$; $u_{g=1} = \frac{1.3}{11-1} = 0.13$

2) Provided $\mu_c R < 0.1\mu_l L(\alpha < 6^0) = 7.2 \cdot 3.6 < 0.1 \cdot 9 \cdot 9 \cdot 5 = 26 < 40.5$ you can accept $D = \mu_l L = 81$; $u_{g=1} = \frac{0.7}{81-1} = 0.01$

1) gold	2) silver
$\alpha_i = 0.8$	$\alpha_i = 0.8$
$\rho_\lambda = 1.3$	$\rho_\lambda = 0.7$
$\bar{\Delta}_q{}' = 0.3$	$\bar{\Delta}_q{}' = 9$
$\bar{\Delta}_{max} = 2.7$	$\bar{\Delta}_{max} = 90.3$
$k = 10$	$k = 10$
$M = 10$	$M = 10$

Definition The geological complexity of the V_j $j-$ th exploration cell of a site bounded by exploration workings is defined as the sum of the complexity of the v_{ij} of this site for each $i-$ th geological factor or indicator:

$$V_j = \sum_{i=1}^{N} v_{ij}. \tag{4}$$

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$V_j = 0.007$

The complexity v_{ij} $j-$th of the section by the $i-$th factor is found from the expression

$$v_{ij} = \alpha_i \rho_{ij} J_i, \quad (5)$$

$1) v_{ij} = 0.8 \cdot 0.11 \cdot 0.08 = 0.007$

$2) v_{ij} = 0.8 \cdot 0.10 \cdot 0.95 = 0.076$

where, $\alpha_i -$ is the information weight of the $i-$th geological factor $\alpha_i = 0.8$. It is determined on the basis of expert assessments. It varies from 0 to 1. In the absence of data, it is assumed to be equal to one; $\rho_{ij} -$ is the diversity coefficient of the $i-$th geological factor in the $j-$cell. Defined from the expression

$$\rho_q = \frac{\frac{\sum_{n=1}^{n_q-1} |X_i - X_{i+1}|_q}{n_q - 1}}{\left(\frac{\sum_{n=1}^{n_q-1} |X_i - X_{i+1}|}{n-1}\right)_{max}} = \frac{\bar{\Delta}_q{}'}{\bar{\Delta}_{max}}, \quad (6)$$

$1) \rho_q = \frac{0.3}{2.7} = 0.11$

$2) \rho_q = \frac{9}{90.3} = 0.10$

where $q -$ is the number of the geological cell ($q = 1, 2, \ldots, k$); $n -$ is the number of values of the studied geological indicator in the cell ($i = 1, 2, \ldots, n$); $X_i, X_{i+1} - i - (i+1)$-th values of the indicator; $\bar{\Delta}_q{}' -$ is the average first difference in the $q-$th cell; $\bar{\Delta}_{max} -$ is the average maximum difference in the studied (horizon, deposit); $J_i -$ is the informativeness of the $i-$th geological factor, determined from the expression

$$J_i = -\sum_{\lambda-1}^{k} \rho_\lambda \log_2 \rho\lambda + \frac{(k-1)}{M}, \quad (7)$$

$1) J_i = 1.3 \cdot \log_2 1.3 + \frac{(10-1)}{10} = 0.08$

$2) J_i = 0.7 \cdot \log_2 0.7 + \frac{(10-1)}{10} = 0.95$

where $k -$ is the number of class intervals ($\lambda = 1, 2, \ldots, k$): $\rho_\lambda -$ is the probability of the $\lambda-$th interval of the values of the $i-$th geological factor; $M -$ is the total number of values of the $i-$th factor in the studied area; $(k-1)/M -$ is the correction for the incompleteness of the value of the total entropy of the geological indicator.

The following conclusions should be drawn from the above analysis:

1. The variability of gold in ore is 0.13
2. The variability of silver in the ore is 0.01
3. The difficulty of gold in ore is 0.007
4. The difficulty of silver in ore is 0.076

LITERATURE

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