ANNOTATION

of the dissertation work presented for the degree of Doctor (PhD)

on the specialty 6D070700 - "Mining"

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JUSTIFICATION OF RESOURSE SAVING TECHNOLOGY FOR MINING OF COMPLEX STRUCTURED ORE BLOCKS ON OPEN PITS

Relevance of the research topic. Most of the deposits of non-ferrous metal ores that are being developed and planned for commissioning have been represented by rocky types and have a complex geological and morphological structure. They are characterized by uneven mineralization, having presentedby different in volume and configuration of ore bodies. The boundaries between ore bodies and enclosing rocks are visually indistinguishable. In order to effectively master thecomplex-structure deposits, it is necessary to have sufficient information about the mutual arrangement of ore bodies and host rocks in the massif.

In the development of complex structural blocks, drilling and blasting and loading and unloading, the operations play a significant role in shaping the quality of shipped ore. During blasting operations, ore bodies and enclosing rocks are transformed in volume and relative location, and when they are excavated, ore is often diluted or often shipped to rock dumps. The existing methods of selective breaking and excavating ore from complex structural blocks do not always give the desired results.

In this connection, great importance is attached to works aimed at ensuring the stable quality of ores, increasing the completeness of extraction of mineral resources from the bowels, involving ore in enhancement of different content of valuable components.

Effective management of mining operations and the rational use of mineral resources should be based on the establishment of regularities in the location of minerals in the massif and the collapse, measuring their quality indicators, and on-line management of blasting processes and the excavation of complex faces ensuring a stable quality of mined ore. A special role is played by the purposeful placement of ore bodies in disintegration, enabling them to carry out excavation and loading operations with the least loss and dilution of ore.

Therefore, the development of resource-saving technologies for working out complex structures on the basis of their typification on the character of mutual placement of ores and empty rocks, forecasting their mining and technological characteristics in disintegration which is an actual and important scientific and technical task by itself.

The purpose of the thesis is to substantiate resource-saving technologies for working out complex structures on quarries that ensure a significant reduction in quantitative and qualitative losses on the basis of established regularities in the location of minerals in disintegration.

The idea of work consists in forecasting the location of heterogeneous rocks of various configurations and sizes in the collapse of the blasted rock mass and its use for selecting resource-saving technologies for working out complex structures under different blasting conditions.

The main tasks of research.

1. Perfection of typification of complex structural blocks of developed deposits, as well as the establishment of their mining and technological characteristics.
2. Geometric modeling of the distribution of dissimilar rocks in the collapse with various methods of blasting complex-structure blocks of various configurations.
3. Creation of a technique for determining the internal structure of rock disintegration under various conditions of blasting of complex structural blocks.
4. Development of recommendations for minimizing quantitative and qualitative losses in the development of complex structure blocks.

Basic provisions to be prooved:

1. The placement of heterogeneous rocks of complex structural blocks in the collapse under different conditions of explosion obeys a certain regularity, the essence of which is revealed by geometric modeling of the complex structural block in the massif and collapse.
2. Forecasting the location of heterogeneous rocks of complex structural blocks in the disintegration allows to establish their mining and technological characteristics in the blown rock mass.
3. The use of the developed technique for determining the location of individual parts of complex-structural blocks in the blown mass and the recommended schemes for working out complex structures will significantly reduce the quantitative and qualitative losses of useful minerals in the open development of complex-structure deposits.

Scientific novelty

- new concepts are proposed in explosive and mining: the grid of the blasted block, the grid of the blown block, which serve as a tool for determining the position of various elements of the blasted block in the rock massif and the collapse of the blown rock mass.
- regularities are established for the variation of rock loosening coefficients in the corresponding horizontal and inclined layers of the blown block with different methods of blasting.
- using the above-mentioned coordinate grids, a new method has been developed for determining the location of various elements of the ledge in the collapse with different methods of blasting.
- based on the established regularities of the distribution of heterogeneous rocks of complex structural blocks in the collapse, recommendations for the selection of resource-saving technologies for working out complex structures on quarries, which predetermine the effective work of the handling equipment, are justified.

Methods of research. To solve the set tasks in the thesis, a set of methods was used, including: methods of analysis and generalization of theoretical and experimental studies; analytical and experimental methods, geometric and computer modeling of the internal structure of the collapse.

The validity and reliability of scientific provisions, conclusions and recommendations is provided by the analysis and generalization of references on the title of the dissertation, geometric modeling using computer programs, the use of the proposed methods for determining the internal structure of collapse and reducing quantitative and qualitative losses of minerals in the open development of complex deposits.

Scientific significance of the work:on the basis of the studies carried out, regularities were established for the placement of individual parts of the ledge of the blasted block in the collapse with various methods of blasting the rock massif; new concepts are proposed in the explosive case: "the coordinate grid of the blast block", "the grid of the blown block". Locations of fixed elements of the blast block in the collapse of the exploded rocks have been established. A method for reducing quantitative and qualitative ore losses during the mining of complex structural ore blocks has been developed.

Practical significance. Based on the developed technique for determining the configuration of various parts of the ledge in the collapse of blown rocks, boundaries are established between individual inclusions of ores and empty rocks in the collapse of blown rocks, their geometric characteristics with different methods of blasting. These forecast estimates serve as a basis for reducing quantitative and qualitative losses of minerals in the open development of complex deposits and increasing the productivity of mining transport equipment.

Realization of the results of work. They will be used in the educational process, in the project business and in mining enterprises in the development of complex structural blocks.

Approbation of work. The main provisions of the thesis were reported at the international scientific and practical conference "Innovative technologies and projects in the mining and metallurgical complex of their scientific and personnel support" (Almaty, 2014), at the international forum "Engineering Education and Science in the 21st Century: Problems and Prospects (Almaty, 2014), at the international conference "Resources-producing, low-waste and environmental technologies for subsoil development" (Moscow-Bishkek, 2015), The 15thInternationalConferenceonEuropeanScienceandTechnology (Munich, Germany, 2016)

The results of the development of the management of the level of loss and dilution of ore have been tested at the Ushkatyn-III mine of the Zhayremsky deposit.

Publications. In accordince of the thesistopic 8 printed workshave been published. One is in the scientific journal, which is indexed by Scopus database, 3 are in journals recommended by the Education Control Committee of the Ministry of Education and Science of the Republic of Kazakhstan, 1 is in the journal recommended by the Higher Attestation Commission of the Russian Federation, 4 are in conference proceedings.

Structure and volume of work. The thesis consists of an introduction, four chapters and conclusion, contains 120 pages, 7 tables, 56 figures and a list of references from 78 titles.

In the introduction the general characteristic of work is given. The urgency of the topic, the purpose and objectives of the research are formulated, scientific positions are put forward, which are put on the defense and practical significance of the work.

In the first chapter The peculiarities of the geological structure of a number of complex-ore deposits in Kazakhstan are analyzed.

From the above geological data of mineral deposits in Kazakhstan, it can be seen that most of them are complex structural. As a more thorough analysis shows, in conditions of open field development, complex blocks with respect to the nature of the location of ore formations in the massif and their geometric parameters can be combined into two types, which is justified by Boris Rakishev:

I type - blocks composed of solid ore bodies of various shapes and sizes with rectilinear (Fig. 1.1a) or curvilinear (Fig.1.1b) contacts with rock interlayers. Contact lines extend from one block boundary to the other. Straight-line contacts form angles with the horizon ranging from 0 to π. Curvilinear contacts have any spatial orientation and location, but do not overlap.

IItype - blocks composed of dispersed ore inclusions in the form of geometric figures of various shapes and sizes (polygons, ellipses, etc.) with rectilinear (Fig. 1.1c) or curvilinear (Fig.1.1d) contacts with enclosing rocks. The contact lines are either completely located inside the block, or partially intersect the boundaries of the block.

The diagrams in Fig. represent geometric models of complex structure blocks in single, double and three-row arrangement of the well on the ledge.

Based on these models, it is possible to calculate the mining and technological parameters of complex structural blocks. As such we have taken comparatively easy measured values:

- the unit's saturation coefficient;
- an indicator of the complexity of the structure of the block.

It is known that the blocks are primarily characterized by a level of saturation of their minerals. This property for the block cut in the array in question can be estimated by the block saturation factor (krn), calculated by formula

$$k_{rn} = \sum S_i / S_b \ , \qquad (1.1)$$

where S_i is the cross-sectional area of the i-th ore inclusion in the given section of the block;

S_b is the area of the cross section of the complex structure block under consideration

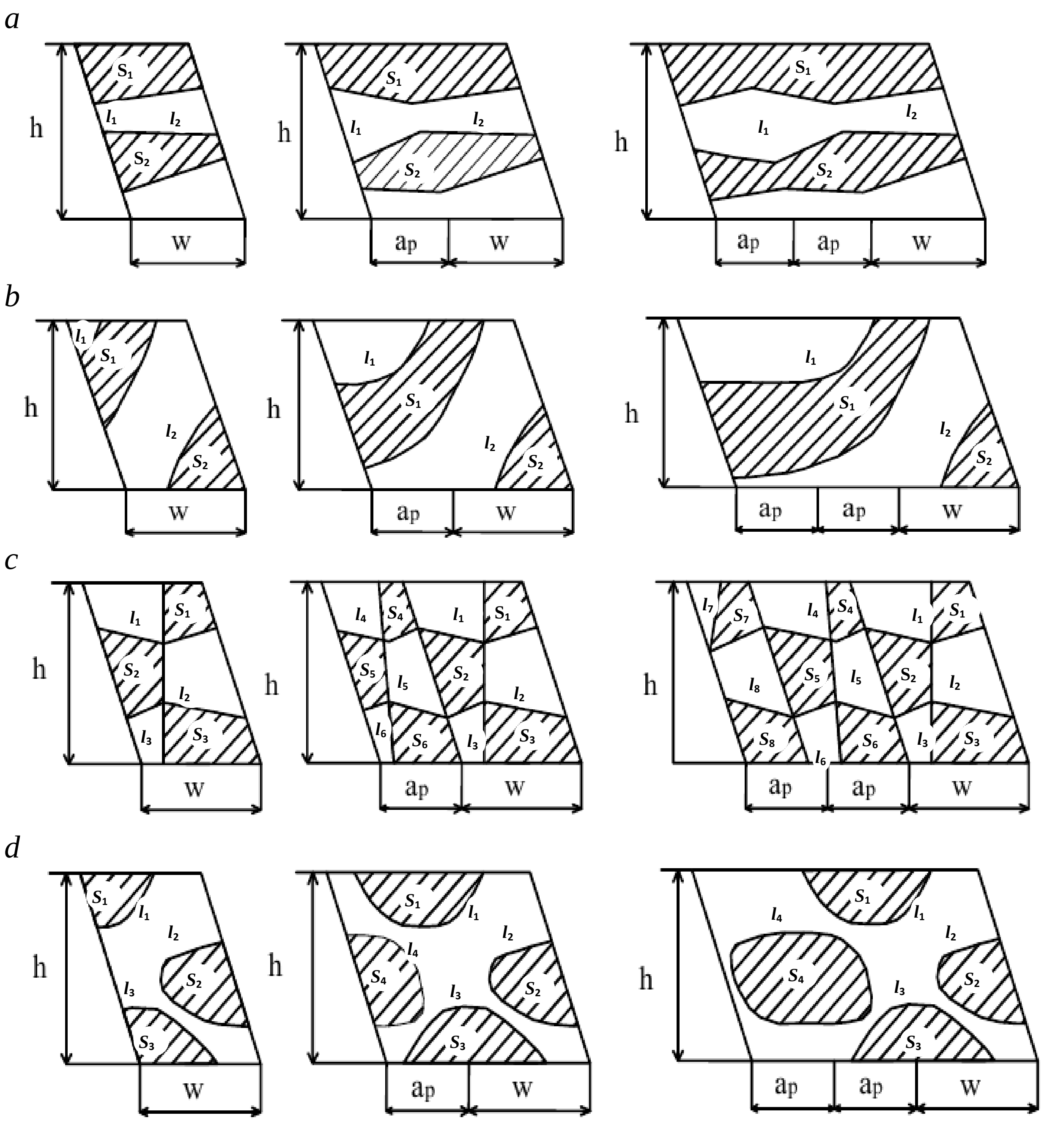


Figure 1 - Geometric models of complex structure blocks in single-row (left), double-row (in the middle) and three-row arrangement of wells (on the right)

The number of sections depends on the extent of the complex structure block. Each section covers an area of the same length as, as a rule, the distance between the wells in the row. The S_i values are easily calculated from the selected cuts on the computer using the AutoCAD program.

The relationship between the geometric dimensions of ore inclusions and characterizes the degree of complexity of the structure of the block. This sign can be estimated by the complexity factor of the geological-morphological structure of the block k'_{sl}, determined for the section under consideration in the dependence:

$$k'_{sl} = \sum l_i / S_i \qquad (1.2)$$

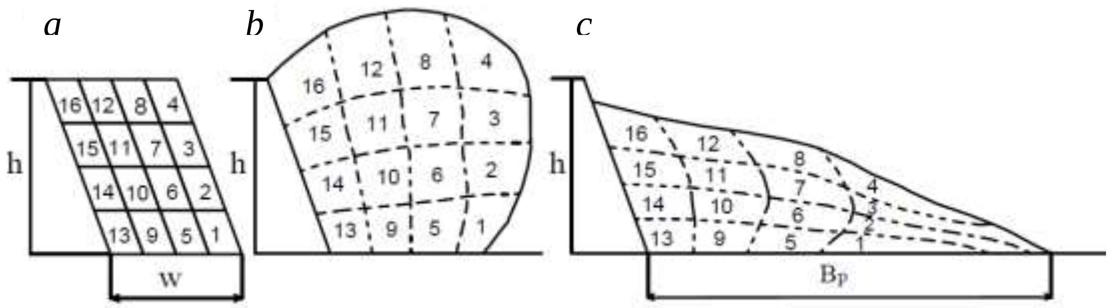
where l_i is the length of the contact lines of the i-th ore inclusion with the enclosing rocks in the given section; S_i is the cross-sectional area of the i-th ore inclusion at the given section of the block in the collapse.

The carried out analysis of the state of blasting during the development of complex structural blocks shows that there is a need to develop criteria for the structure of complex structural blocks in the blown state. They should reflect the actual location of dissimilar rocks in the collapse and serve as a basis for selecting the most effective drilling and blasting and loading and unloading technologies in the given mining and geological conditions, which can significantly reduce the quantitative and qualitative losses of the mineral.

In the second chapter A critical analysis of literary sources on the formation of the collapse of blown rocks was carried out. In view of the urgency of the problem under consideration, the work of the coryphaeuses of mining science of academicians is devoted to it, such as N.V.Melnikov, V.V. Rzhevsky, professors E.F. Sheshko, B.P. Bogolyubov, B.P. Yumatov, E.G. Baranov, and others. In many works, much attention is paid to the placement of individual layers of ore in the collapse of blown rocks. Efforts have been made to theoretically determine the size of rock disintegration and predict the internal structure of the collapse.

On the basis of the work of Academician B.R. Rakishev, we modernized the schemes for the formation of the internal structure of the collapse of the exploded rocks.

From the analysis it follows that the locations, geometric characteristics of the elements of the blown block in the collapse are closely interrelated with the position of their contour lines in the collapse of the exploded rocks.



a-in the array, b-in inertial flight, c-in the collapse of rocks

Figure 2 - Layout of the parts of the ledge in single-shot blasting

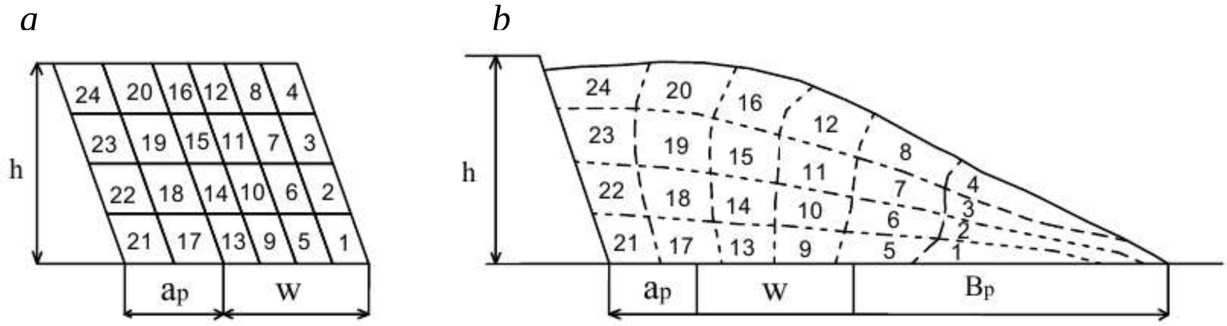
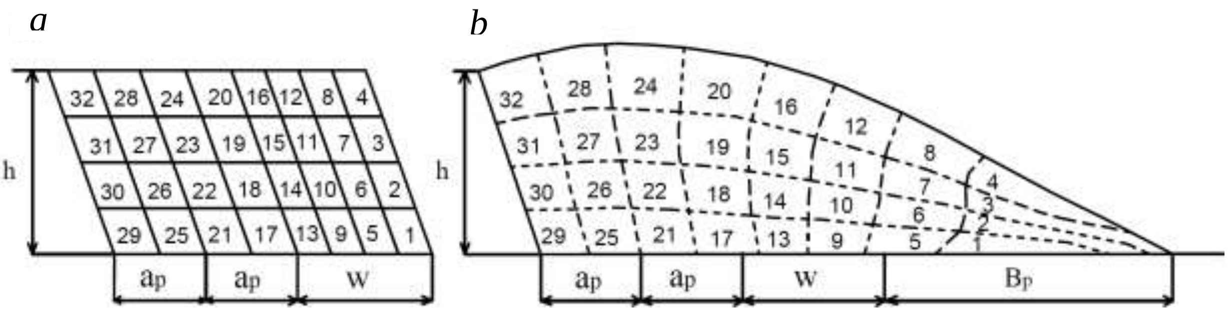
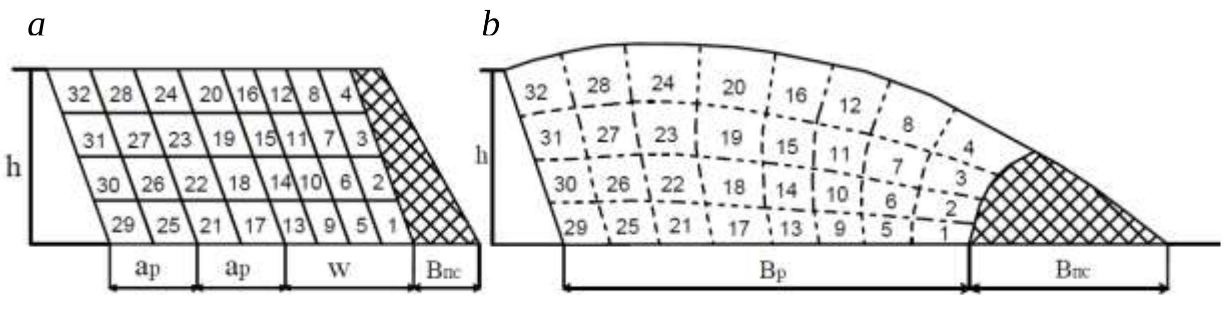


Figure 3 - Scheme of placement of the parts of the ledge in the array (a) and the collapse of rocks (b) in the case of two-row KZV



(a-in the array, b-in the collapse)

Figure 4 - Scheme of placement of parts of the ledge in the array (a) and rock collapse (b) with a three-row fault on the free surface



a-in the array, b-in disintegration

Figure 5 - Scheme of placement of parts of the ledge in the array (a) and rock collapse (b) with a three-row fault on the retaining wall

To identify these relationships, the set of mutually intersecting horizontal and oblique contour lines of parts (elements) of the blasted array block (in a section) will be called the grid of the blast block. The set of mutually intersecting deformed horizontal and inclined contour lines of the ledge parts in the collapse is called the coordinate grid of the collapse or the blown block (in the section). The deformed contour lines in the collapse generally have an irregular geometric shape, their lengths and distances are different (see Fig. 2-5).

The joint use of these coordinate grids has made it possible to locate the parts of the ledge in the massif and rock decay in single-row (Fig. 2), double-row (Fig. 3), three-row earth fault on a free surface (Fig. 4) and a three-row earth fault with a retaining wall (Fig. 5).

To do this, the contours of the figures under consideration on the chosen scale must be applied to the coordinate grid of the blasted block, and on the grid of the blown block to establish their deformed contours. Then proceed to solve specific tasks.

The geometric characteristics of the elements of the blast block are determined: the area of the elements of the blown block, the length of the contouring horizontal and inclined lines, the coefficients of loosening the rocks of the corresponding ledge elements in the collapse.

a) *b)*

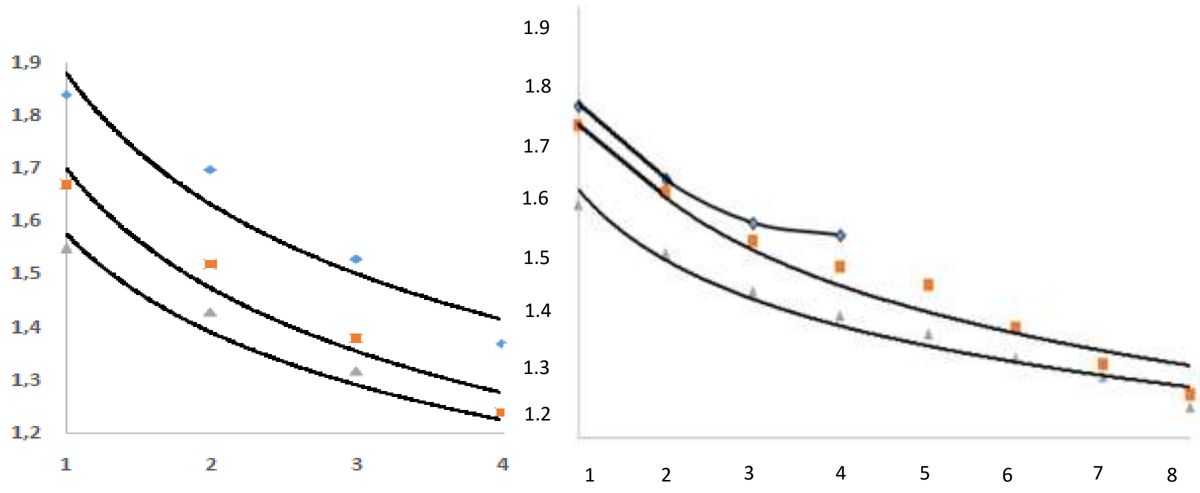


Figure 6 - Values of rock loosening coefficients in horizontal (a) and inclined (b) layers of the blown block in the collapse: -◆in single-shot blasting, ◻ - with three-row earth fault on a free surface,△ - with a three-row earth fault with a retaining wall

Dependences of the coefficients of loosening of rocks in the corresponding horizontal and inclined layers of the blown block are shown in Fig. 6Here, along the abscissa axis, are the numbers of rock layers, the ordinate is the rock loosening coefficient. As it can be seen from them, the coefficient of loosening of rocks in all cases of blasting decreases as the layer in question approaches the unexploded part of the massif. It reaches its maximum value for single-row blasting, the smallest value for a three-row earth fault with a retaining wall.

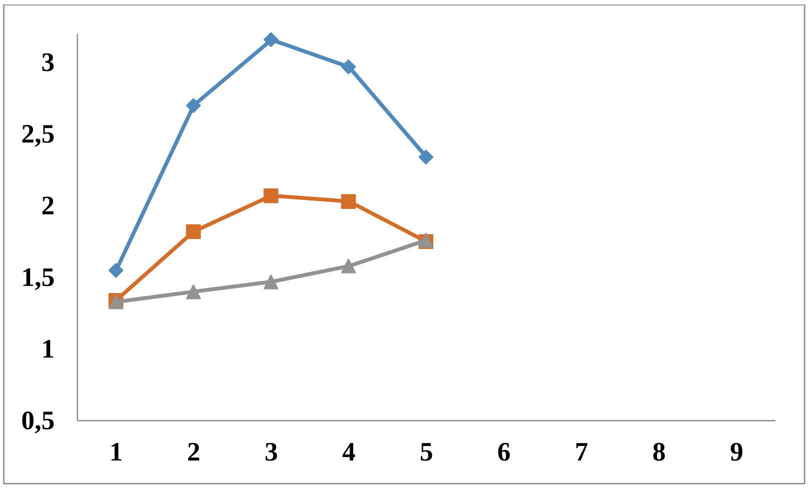


Figure 7 - The values of the coefficients of changing the length of the contour lines of the ledge elements in the collapse of the horizontal layers:
◆ - in single-shot blasting,
■ - with a three-row earth fault on a free surface,
△ - with three-row earth fault with retaining wall

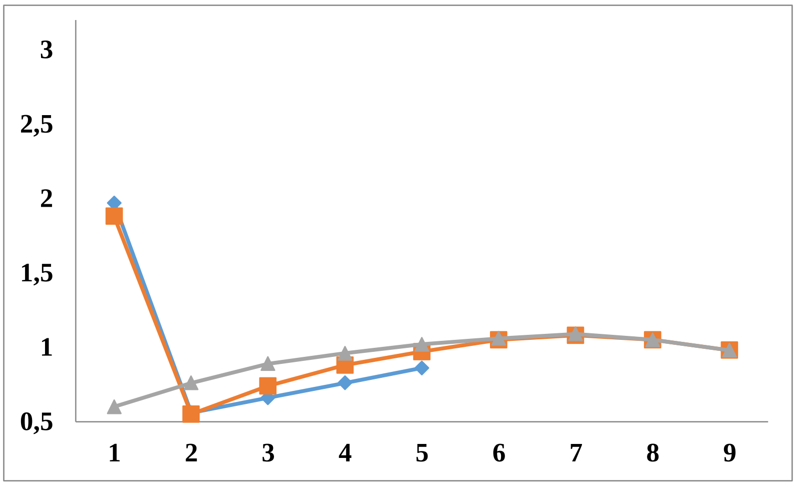


Figure 8 - The values of the coefficients of changing the length of the contour lines of the ledge elements in the collapse of the inclined (b) layers:
◆ - in single-shot blasting,
■ - with a three-row fault on a free surface,
△ - with three-row earth fault with retaining wall

As for inclined contour lines, they, except for the slope of the ledge, increase from layer to layer. Graphical representation of the coefficients of elongation of contour lines is shown in Fig. 7 and Fig. 8. On the abscissa, the numbers of the corresponding rock layers are plotted, along the ordinate axis is the coefficient of change of the contour lines.As for inclined contour lines, they, except for the slope of the ledge, increase from layer to layer. Graphical representation of the coefficients of elongation of contour lines is shown in Fig. 7 and Fig. 8. On the abscissa, the numbers of the corresponding rock layers are plotted, along the ordinate axis is the coefficient of change of the contour lines.

In the third chaptera method for determining the location of elements of complex structural blocks of the first and second types in the disintegration of blasted rocks has been developed. It is based on the use of coordinate grids of an exploded and exploded block. The technique gives good results with contact lines of different curvature and a diverse form of ore bodies.

On the basis of the proposed models of collapse (see Fig. 2-5), using the technique of determining the location of elements in the collapse, the expected positions of ore bodies after the explosion for the adopted types of complex blocks are modeled.

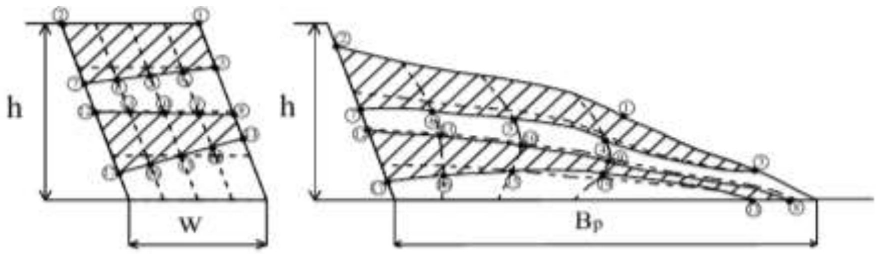


Figure 9 - Geometric model of the complex block "a" before and after the explosion in single-shot blasting

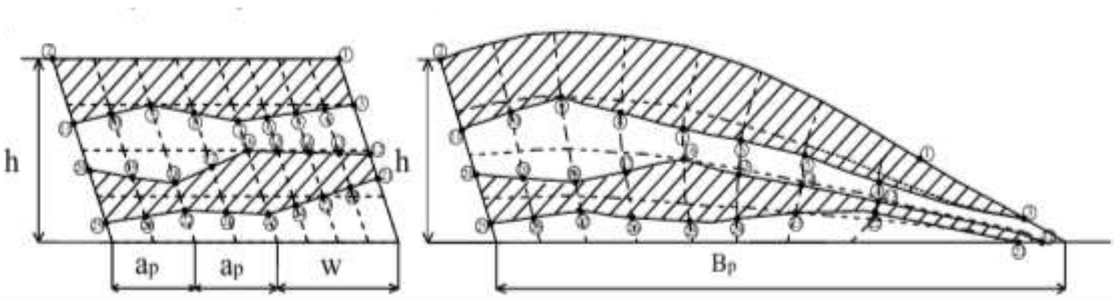


Figure 10 - Geometric model of the complexity block "a" before and after the explosion with a three-row earth fault on a free surface

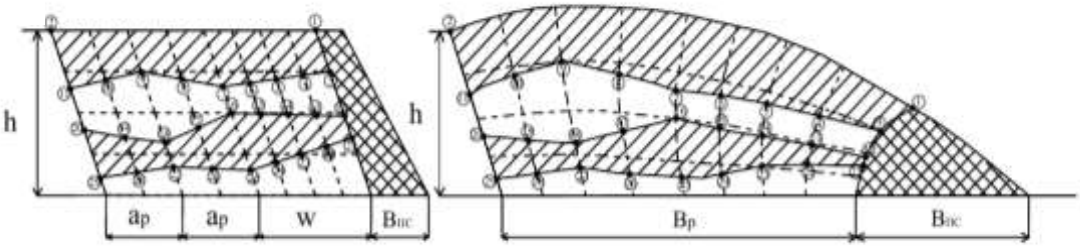


Figure 11 - Geometric model of the complex block "a" before and after the explosion with a three-row earth fault s retaining wall

In the case of complex structural blocks of the first type "a" with rectilinear contacts, the layout of ore bodies in the collapse, in single-shot blasting, with a three-row fault on a free surface and with a retaining wall is shown in Figs. 9, 10 and 11.

The positions of the fixed points 1,2, ..., 29 of the blown blocks in the blown state (in the collapse) are determined from the coordinate grids of the blown block by connecting these points of the smooth curve to the positions of the ore bodies in the collapse of the rock mass.

In the case of complex structural blocks of the first type "b" with curvilinear contacts, the arrangements for placing ore bodies in the collapse,
single-row explosion, with a three-row fault on a free surface and with a retaining wall is shown in Figs. 12, 13 and 14.

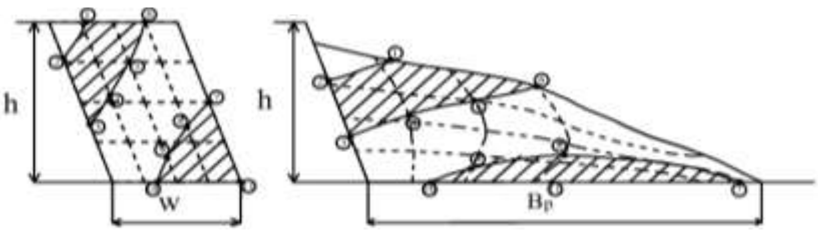


Figure 12 - Geometric model of the complex block "b" before and after the explosion in single-shot blasting

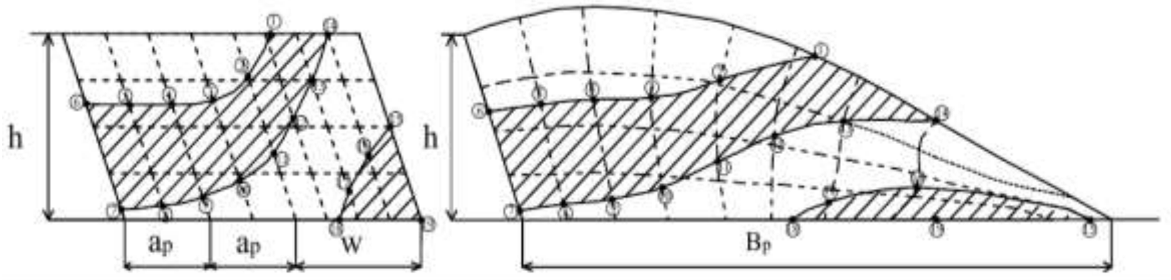


Figure 13 - Geometric model of the complex block "b" before and after the explosion with a three-row fault on a free surface

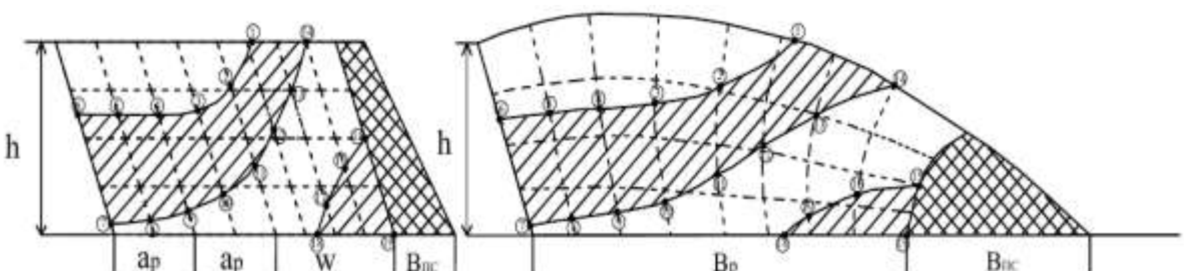


Figure 14 - Geometric model of the complex block "b" before and after the explosion with a three-row earth fault with a retaining wall

The positions of the fixed points 1,2, ..., 19 of the blown blocks in the blown state (in the collapse) are determined from the coordinate grids of the blown block by connecting these points of the smooth curve to the positions of the ore bodies in the collapse of the rock mass.

In the case of complex structural blocks of the second type "c" with rectilinear contacts, the layout of the ore bodies in the collapse, in single-shot blasting, with a three-row fault on a free surface and with a retaining wall is shown in Figs. 15, 16 and 17.

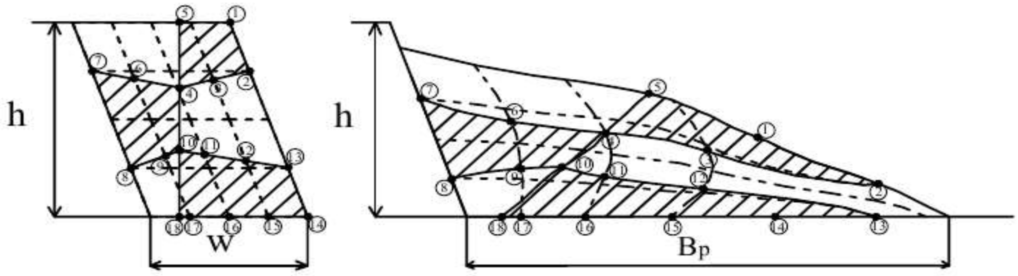


Figure 15 - Geometric model of the complex block "c" before and after the explosion in single-shot blasting

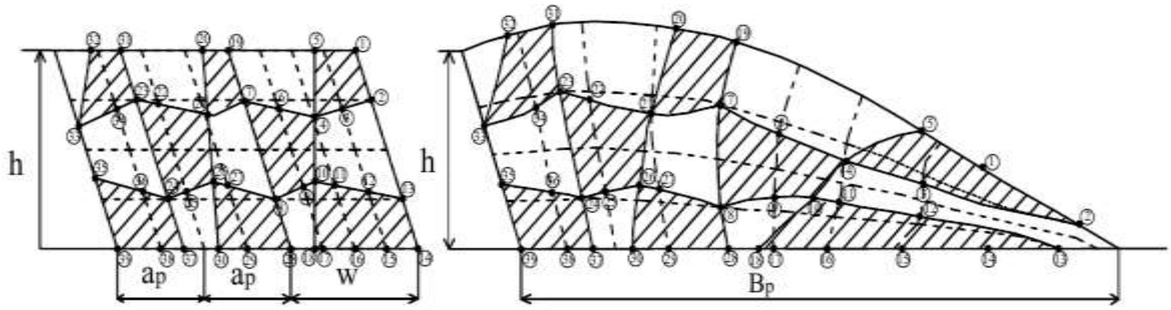


Figure 16 - Geometric model of the complex block "c" before and after the explosion with a short wave on a free surface

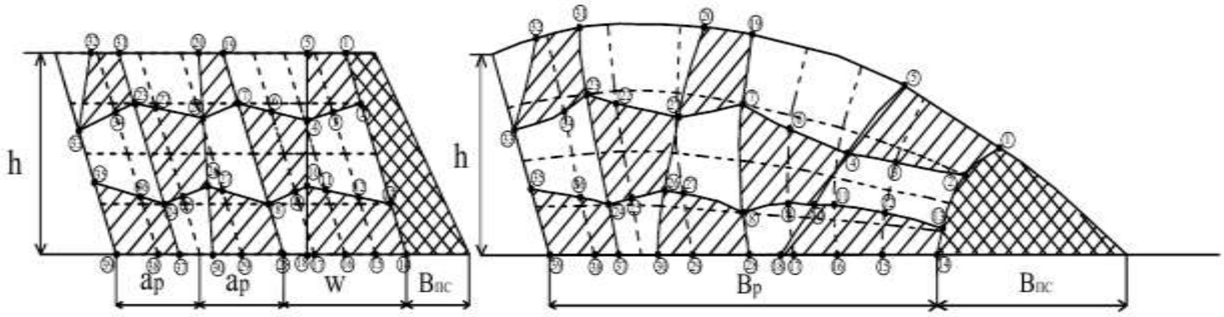


Figure 17 - Geometrical model of the complex-structural block "c" before and after the explosion at the earth fault with a retaining wall

The positions of the fixed points 1,2, ..., 39 ore bodies and their positions in the blown state (in the collapse) were found by the method described above.

In the case of complex structural blocks of the second type "d" with curvilinear contacts, the layout of the ore bodies in the collapse, in single-shot blasting, with a three-row fault on a free surface and with a retaining wall is shown in Figs. 18, 19 and 20.

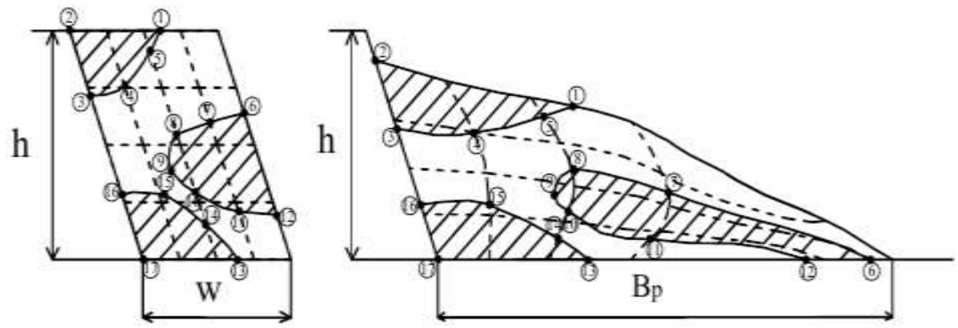


Figure 18 - Geometric model of the complex block "d" before and after the explosion in single-shot blasting

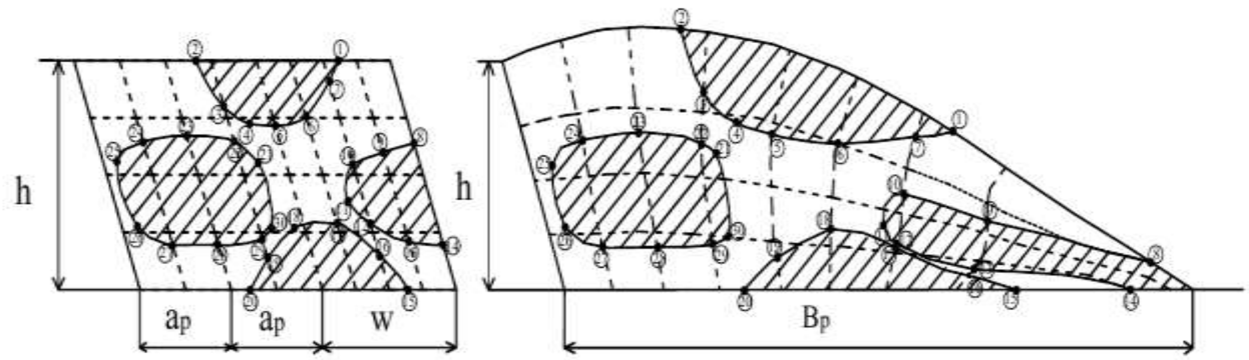


Figure 19 - Geometric model of the complex structure block "d" before and after the explosion with a three-row fault on a free surface

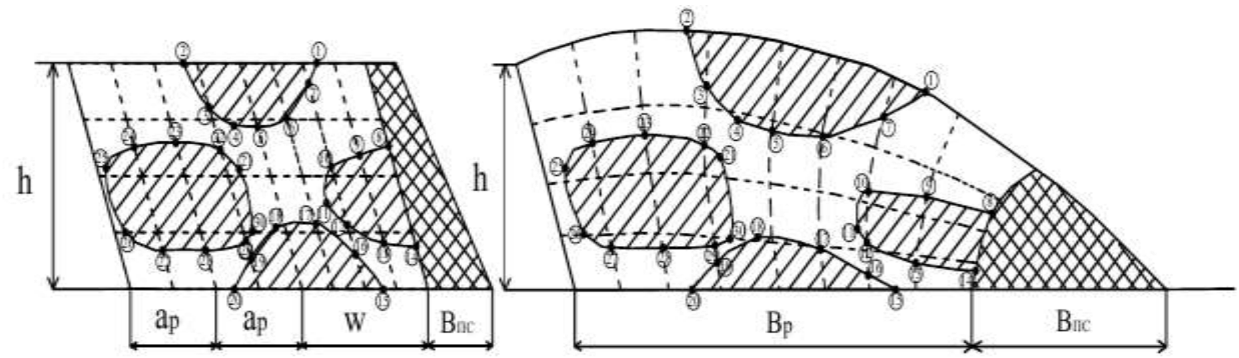


Figure 20 - Geometric model of the "d" complex block "before" and after the explosion with a three-row earth fault with a retaining wall

The positions of the fixed points 1,2, ..., 25 ore bodies and their positions in the blown state (in the collapse) were found by the method described above.

The developed technique for establishing the mining and geological characteristics of complex structural blocks after the explosion allows us to

Table 1. Technological characteristics of complex structures in the collapse

Options	Blocks			
	а	б	в	г
Insingle-shotblasting				
$S'_{бл}$	1893,44			
$S'_{р}$ $(l'_{р})$	695,157(162,1)	930,615(37,5)	756,249(86,17)	867,131(132,81)
$l'_{р} / S'_{р}$	0,23	0,04	0,11	0,15
$S'_{1}(l'_{1})$	40,317	366,798	318,592	222,923
$S'_{2}(l'_{2})$	654,84	300,520	437,657	388,194
$S'_{3}(l'_{3})$		263,297		256,014
$k'_{рн}$	0,36	0,47	0,39	0,45
$k'_{сл}$	0,23	0,04	0,11	0,15
With a three-row fault on a free surface				
$S'_{бл}$	4041,915			
$S'_{р}$ $(l'_{р})$	2507,6(265,25)	2136,66(115,49)	1923,35(146,85)	2011,69(292,02)
$l'_{р} / S'_{р}$	0,10	0,05	0,07	0,14
$S'_{1}(l'_{1})$	898,93	393,269	323,4047	239,519
$S'_{2}(l'_{2})$	1608,67	353,547	1599,955	674,183
S'_{3} (l'_{3})		308,895		637,957
$S_{4}(l'_{4})$		223,597		460,037
$S_{5}(l'_{5})$		203,518		
$S_{6}(l'_{6})$		234,772		
$S_{7}(l'_{7})$		201,636		
$S_{8}(l'_{8})$		217,412		
$k'_{рн}$	0,61	0,48	0,47	0,49
$k'_{сл}$	0,10	0,05	0,07	0,14
With three-row KZV with retaining wall				
$S'_{бл}$	3824,052			
$S'_{р}$ $(l'_{р})$	2599,89(203,3)	2148,05(115,3)	1841,38(110,21)	1890,23(286,57)
$l'_{р} / S'_{р}$	0,07	0,05	0,06	0,15
S'_{1} (l'_{1})	825,669	288,721	218,136	266,852
S'_{2} (l'_{2})	1774,227	339,779	1623,249	672,043
S'_{3} (l'_{3})		337,445		633,784
$S_{4}(l'_{4})$		227,485		317,555
$S_{5}(l'_{5})$		318,855		
$S_{6}(l'_{6})$		218,620		
$S_{7}(l'_{7})$		201,081		
$S_{8}(l'_{8})$		216,067		
$k'_{рн}$	0,67	0,54	0,48	0,49
$k'_{сл}$	0,07	0,05	0,06	0,15

calculate the areas of individual elements of the block and the length of the contour lines in the collapse of the exploded rocks using the program Autocad. On their basis, the ore saturation coefficient and the complexity index of the block structure after the explosion are determined.

In these schemes (see Fig. 9-20), the areas of the cross section of the complex structure block in the collapse, the area of the ore inclusion section at a given section of the block and the length of the contact lines for each element were measured.

Further, by calculation of areas and lengths, calculate the saturation coefficient of the block (k'_{rn}) and the complexity index of the block structure (k'_{sl}).

The calculated values of $\sum S'_{bl}$ for each block for a single-row, three-row fault on the coving surface and on the retaining wall are given in Table 1.

Numerical values of the technological characteristics of the structure of complex structure blocks in the collapse are summarized in Table 1.

From the analysis of the data of Table. 1. It can be seen that the heterogeneous blocks of all types considered are moderately ore intensive (k'_{rn}=0,45-0,67) and complex-structural (k'_{sl}=0,05-0,23).

The proposed criterion for the complexity of the geological and morphological structure of the block k'_{sl} serves as the basis for deciding on the selective excavation of dissimilar inclusions and the assignment of parameters, drilling and blasting technologies, and schemes for excavating ore from complex blocks.

In the fourth chapter indicators of quantitative (Φ_p)and qualitative losses (Φ_r) are offered as characteristics of working off of various faces.

The loss indicator is represented by the ratio of the total area of ore bodies falling into the rock to the area of the ore body in question. It is determined from the relation:

$$\Phi_p = \frac{\sum S'_{kn}}{\sum S'_{pj}}, \qquad (1.3)$$

where is the area of the k-th ore section in the collapse, falling into the rock; - the area of the j-th extractable ore layer from the collapse.

The dilution index is represented by the ratio of the total area of empty rocks falling into the ore mass to the area of the ore body under consideration. It is determined from the relation:

$$\Phi_r = \frac{\sum S'_{kp}}{\sum S'_{pj}}, \qquad (1.4)$$

where is the area of the k-th section of the rock in the collapse, falling into the ore.

Values and are determined for each excavator blast separately, only then summed for the block as a whole. At the same time rock breaks are broken into excavator blades, the width of which depends on the complexity of the structure of the face. When analyzing the question, the maximum number of slides was taken for the block "c" (N = 8) with three-row blasting, the minimum (N = 3) - for single-row blasting of blocks. In turn, the excavator belts are broken in height into 2-4 layers. Based on these schemes (in Chapter 4), the areas for each cell are measured.

For the practical verification of the suitability of the proposed method for determining losses and dilution of ore at the Ushkatyn-III quarry of Zhayremsky GOK, three experimental-industrial explosions were conducted in rocks of explosions III-IV with a total rock mass of 285,000 m3 at horizons + 312-300, + 324- 312.

Explosion No. 1 was conducted on the horizon + 312-300 block No. 4. The block consists of two dispersed ore bodies with curved contours. Mining technical characteristics of the block in the massif and face in a scale $M_1 = 1:375$ (linear), $M_S = 1:140625$ (area) in a three-row explosion atfree surface (see Fig. 21): h = 15m, a = 7.5m, W = 11m, S'_{bl} = 1893.44 mm^2, S_1' = 1754.88 mm^2, S_2' = 700.75 mm^2, ΣS '= 2455.63 mm^2.

With the predicted arrangement of ore bodies in the collapse, the slaughter was proposed to work out four pitches with a width of 17.0 and 5 m (see Fig. 21), and with the proposed arrangement of ore bodies in the collapse, the slaughter was suggested to be worked with four stitches with a width of 17.0, 13.0, 12.0 and 10.0 m (see Fig. 22).

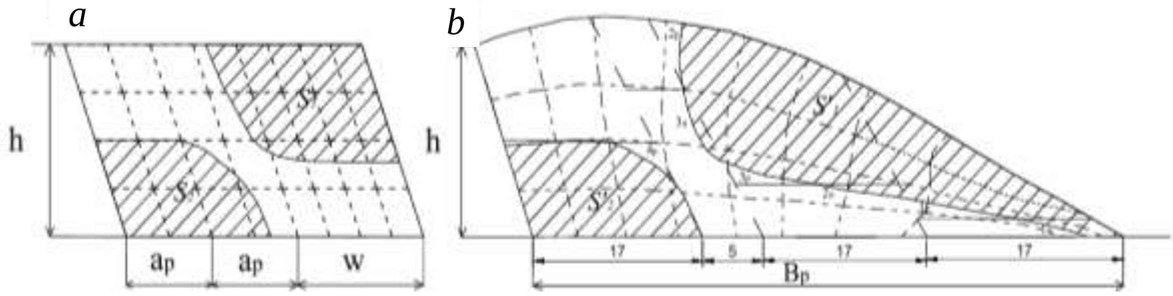


Figure 21 - Predictable location of two ore bodies in disintegration with a three-row fault on a free surface

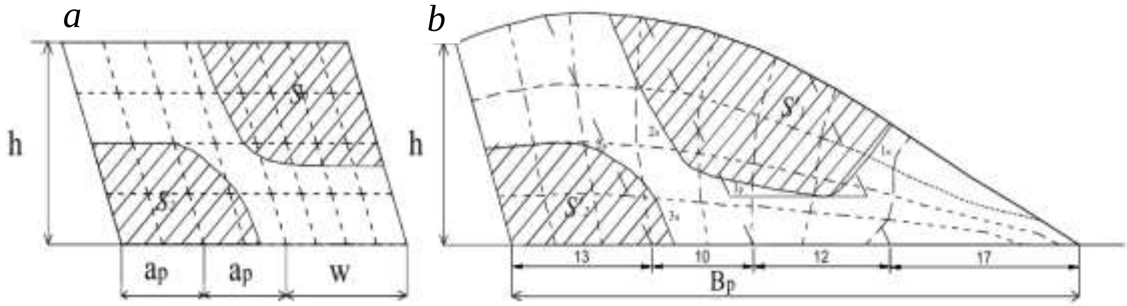


Figure 22 - Alleged location of two ore bodies in disintegration with a three-row fault on a free surface

In general, according to the proposed technology for slaughtering (1.3) and (1.4), the total ore loss is $\sum S'_l$ = 82,05 mm^2, and the dilution is $\sum S'_d$ = 107,05 mm^2. The coefficient of ore loss is Φ_l= 0,03, the dilution factor is Φ_d= 0,04.

As can be seen from the comparison of the ore shipment from the complex fissures on the proposed technology losses were 3%, and with the accepted technology at the mine, 6%. were halved.

Explosion No. 2 was conducted on the horizon + 324-312. The block is represented by three inclined ore body with rectilinear contacts. Mining technical characteristics of the block in the array and face on a scale $M_l = 1:375$ (linear), $M_S = 1:140625$ (area) with three-row explosion on a free surface (see Figure 23):
h = 15m, a = 7.5m, W = 11m, S'_{bl}= 1893,44 mm^2, S_1'= 1754,10 mm^2, $\sum S'$= 1754,10 mm^2.

With the forecasted arrangement of ore bodies in the collapse, the slaughter is proposed to work out with five notches with a width of 17 and 9 m (see Figure 23), and with the proposed location of ore bodies in the collapse, the slaughter is suggested to be worked by four notches with a width of 17.0, 13.0, and 11.0 m (see Figure 24).

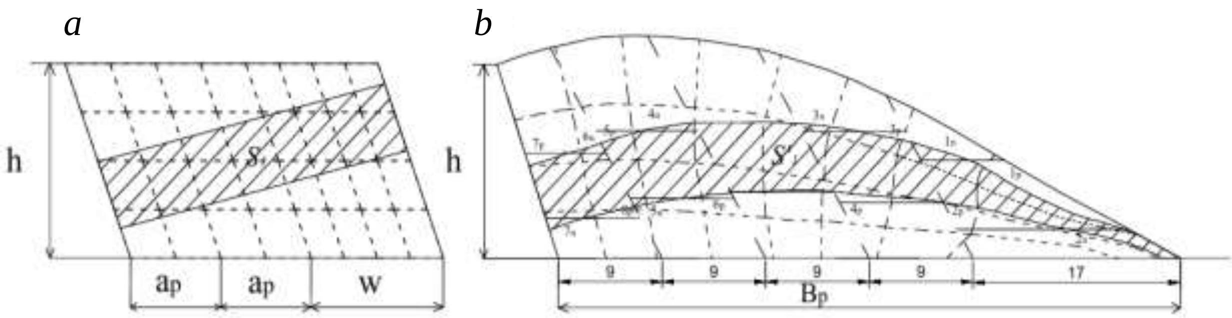


Figure 23 - Predicted location of the ore body in the collapse
with a three-row fault on a free surface

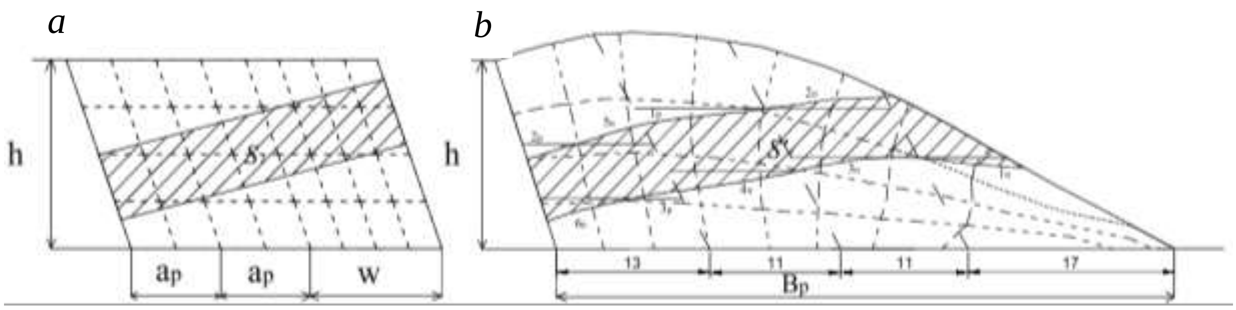


Figure 24 - Alleged location of the ore body in disintegration
with a three-row fault on a free surface

In general, according to the proposed technology for slaughtering (1.3) and (1.4), the total ore loss is $\sum S'_l$ = 90.58 mm^2, and the dilution is $\sum S'_d$= 252.37 mm^2. The coefficient of ore loss is Φ_l = 0.03, the dilution factor is Φ_d= 0.15.

As can be seen from the comparison of the ore shipment from the complex fissures on the proposed technology losses were 3%, and with the accepted technology at the mine, 6%. were halved.

Conclusion

The thesis contains new scientifically grounded results on the determination of the location of dissimilar rocks in the collapse of the blasted rock mass. They allow to purposefully manage mining and technological characteristics of resource-saving complex structural blocks in the collapse and decrease of quantitative and qualitative losses of ore of complex-structure deposits.

The performed researches allowed to reach the following conclusions:

1. The features of the geological structure of a number of complex-ore deposits in Kazakhstan are analyzed. On the basis of the analysis carried out, typing of complex structural blocks was performed and their mining and technological characteristics were determined.

2. Geometric models of complex-structural blocks are proposed for single-row, three-row earth faults on a free surface and a three-row earth fault with a retaining wall.

3. For the first time in mining science, the concepts "grid of the blast block", "grid of the blown block" were introduced. The joint use of these coordinate grids has made it possible to locate the parts of the ledge in the massif and the collapse of rocks in single, double, three and four rows.

4. Based on the coordinate grids of the exploded and blown up block, a method for determining the location of elements of complex structural blocks in the collapse of the blasted rock mass was developed. The technique gives good results with contact lines of various curvatures and various shapes.

5. Geometrical characteristics of the elements of the blown block are determined: the area of the fixed elements of the blown block, the length of the contouring horizontal and inclined lines, the coefficients of loosening the rocks corresponding to the step element in the collapse using the program Autocad.

6. These methods are used as the basis for predicting the location of dissimilar rocks in the collapse and management of quantitative and qualitative losses in the development of complex-structure deposits due to appropriate resource-saving technologies for the development of such blocks.

7. The results of the development of loss management have been tested at the Ushkatyn-III mine of the Zhayremsky deposit. The economic effect of introduction is given. The overall economic effect from the use of new technologies for mining the complex blocks of the Ushkatyn-III deposit at Zhayremsky GOK amounted to 15 228 000 tenge.

List of published works on the topic of the thesis:

1. Shampikova A.Kh. Economic evaluation of the effectiveness of the use of mineral raw materials. Collection of Proceedings of the MPPK "Innovative technologies and projects in the mining and metallurgical complex, their scientific and human resources". March 18-19, 2014 - Almaty, 2014. - P. 294-298.
2. Shampikova A.Kh. Application of rare earth metals in high-tech industries. International Forum "Engineering Education and Science in the 21st Century: Problems and Prospects", dedicated to the 80th anniversary of KazNTU named after K.I. Satpaev. Almaty, 2014.-p. 320-324
3. Shampikova A.Kh., K.Seytuly. Open mountain ore works development process Mining magazine of Kazakhstan, №9. Almaty, 2014.-p. 18-20
4. Rakishev. B.R., ShampikovaA.Kh. The configuration of various parts of the ledge in the collapse of the exploded rocks. Bulletin of KazNTU, №4. Almaty, 2015. - p. 450-455.
5. Rakishev B.R., Shampikova A.Kh., Kazangapov A.E. Forecasting the configuration of different bodies in the form of a collapsed rock. XIV International Conference "Resource-producing low-waste and environmental technologies for subsoil development", Moscow-Bishkek, 2015.- p. 111-113.
6. Rakishev B.R., Shampikova A.Kh., Kazangapov A.E. Placement of zones of small, medium and large crushing in the collapse of rocks. Explosive case number 114/71. Moscow, 2015.-P.45-56.
7. Rakishev B.R., Shampikova A.Kh., Kazangapov A.E. The reason for choosing practical schemes of selective ore mining from complex structured blocks. International Conference on European Science and Technology, Munich,Germany 2016.-p.72-77.
8. Rakishev B.R., Shampikova A.Kh., Kazangapov A.E.Geometric features of different parts lost in the collapse of the blasted rock. International Journal of Applied Engineering Research. Volume 11, Number 21,2016. p. 10447-1045 (Scopus)