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THE ESTIMATION OF MINERAL STOCKS AT THE EXPLOITATION PERIOD OF THE DEPOSITS

Bayan Rakishev & Abdigappar Kenzhebayev
***Kazakh National Technical** University, Almaty, Kazakhstan*

Abdrahman Begalinov
***National Joint Stock Company** ALTYNALMAS, Almaty Kazakhstan*

ABSTRACT: Solution of a great number of design and planned tasks in the mining industry of Kazakhstan is based on static methodology without considering their dynamic properties. For instance, assessment of useful minerals reserves is principally made by local and static criteria. Value of useful components is determined by the level of prices set up for mineral raw materials during geological prospecting. In determining the quality requirements for ores in the gold-ore mining industry out of the range of natural factors only extracting vein thickness and the content of one associated useful component are considered. Such important indices as occurrence depth, convergence and disturbance of ore bodies /veins/,prime cost of final products, need in them and the term of operating pits/mines/ are not taken into account.

CONTENT

The method of assessing useful minerals reserves devoid of the mentioned drawbacks should be based on predicting the scientific-technical progress (STP) in the industry and specify the interrelated development of individual productions of a single complex with continuous extension of the volume of products. The essence of the method as applied to the opencast mining of gold-ore deposits is as follows:

- based on the analysis of geological materials the versions of prior contours for working the deposits reserves are built up with different bank content,
- with an account of the supposed development of STP in the industry and the change of mining and geological conditions with time the selection of technological schemes, structure of comprehensive mechanization of mining works is made They are implemented in a stage -wise development of the deposit;
- for each of the defined stages of the deposit mining their contours are built, the reserves of useful minerals are determined by the types and grades, volumes of barren rocks and the reasonable productivity of the pit in rock and rock mass;
- in compliance with the accepted for each stage productivity of the pit in ore with the set quality the thickhness, technologv and technical facilities of the processing complex are determined.

The idea of stage-wise assessment of the deposit reserves consists in that the main design of the pit specified in advance its planned reconstruction caused by the changes taking place in the mining - and- geological and engineering -economic situations The stage-wise extraction of useful minerals reserves possesses the following properties

Operating expenses of ore mining and processing at the current stage should be more than at the subsequent stage, i e

$$Z_1 > Z_2 > \ldots > Z_t$$

The bank content of metal in ore by the stages follows the regularity

$$\alpha_1 > \alpha_2 > \ldots > \alpha_t$$

The same regularity is followed by: Jhe minimal commercial content of metal in or», i.e.

$$C_{min_1} > C_{min_2} > \ldots > C_{min_t}$$

Productivitv of the pit in ore

$$D_1 > D_2 > \ldots > D_t$$

Productivitv of the pit in stripping

$$B_1 > B_2 > \ldots > B_t$$

An average coefficient of stripping in stages

$$K_1 > K_2 > \ldots K_t$$

The novelty of the deposits reserves assessment concept consists in that the industrial quality requirements for ores are set up separately for each of the stages and are subsequently specified in compliance with the accepted development system,technology of the useful mineral resources processing. Such an approach enables the objective deposit assessment to be made with an account of development prospects for the industry, technical reequippment by stages, more complex and complete use of mineral raw materials.

Analysis of the activity of the mining-and-metallurgical complex enterprises shows that substantial reduction of costs and rise of the through coefficient of useful components extraction are achieved in radical technical reconstruction of the enterprise, its transfer to a more progressive technology of ore mining and processing, that enables to involve less rich ores into operation. Thus, the expediency of reducing the minimal industrial content appears on the border between the main stages of deposit development. Such regularity predetermines the necessity of dynamic/stage-wise substantiation of quality requirements. The value of the minimal industrial content of metal is to be determined by the formula:

$$C_{min} = Z_t / U_t \varepsilon_t, \quad g/t \qquad (1)$$

where *1^* are forthcoming expenses of mining and processing I t of ore for various processing stages established on the basis of predictive studies, dol/t;

U_t - cost of marketable products, dol/t

ε_t - through coefficient of the useful component extraction in the finished products for various development stages, unit fractions.

Current minimal industrial content *l£mJ* with an account of correction for mining dilution *Ißul* is determined from the expression

$$C'_{min} = C_{min}(1+\rho_{s.t}), \quad g/t \qquad (2)$$

The bank content in the lying wall of the ore body is determined by the formula

$$\alpha_{s.t} = Z_t (1+\rho_{s.t}) / U_t \varepsilon_t, \quad g/t \qquad (3)$$

In determination of the bank content in the hanging wall of the ore body only the dressing expenses are taken into account, as the hanging wall rocks will be worked and transferred to destinations irrespective of whether they are ore-bearing or barren.

Consequently, for the hanging wall ofthe ore body we obtain

$$\alpha_{st} = (Z_t - Z_{tr})(1+\rho_{s.t}) / U_t \varepsilon_t, \quad g/t \qquad (4)$$

where Z/y>- are forth coming expenses equal to the difference between the costs of the mined ore transportation to the customer and the stripping to the dump with an account of the dump-formation costs, dol/t.

The useful minerals reserves in the openpit field are identified with an account of the stage-wise industrialquality requirements calculated by the folmulas (1 - 4).

During the operation of the deposit aiming at a fuller utilization of the useful minerals reserves it is expedient not only to revise their size regularly, but also make a differentiated technical and economic assessment of the quality of reserves in individual working areas of the deposit. The latter implies a part of the explored open-pit field reserves distinguishable according to the principles of geological, technological and technical-economic isolation to ascertain the expediency of its industrial use.

The geological isolation may be characterized by the conditions of the useful mineral occurrence within the working area and qualitative properties; the technological isolation is characterized by application of one technology for working the district reserves apart from the rest reserves contained in the developed rock mass

or by their exclusion from the mining; the technical and economic isolation - by the possibility of economic assessment of these reserves by their value and expenses for mining and processing prior to getting the final products

In the conditions of opencast mining the assessment of the quality requirements of reserves may be implemented for two working areas. In the working areas of the first type the assessment is made with respect to all reserves of the area and their quality is characterized by one index (content of a useful component and content of harmful admixtures.etc).

The second type comprises the working areas wherein incremental volumes of reserves ("sections") may be separated by the qualitative property (by the content of the useful component in the reserves). They are formed with an account of the useful component reduction and the possibility of its working separately from the remaining reserves of the working area. Each incremental volume is characterized by the quality and quantity of reserves, expenses for their mining and processing. The contours of the working area reserves and the "sections" are determined by the data of sampling and geological investigations carried out in the course of additional exploration, field prospecting and deposit development.

By using permanent quality requirements the assessment is made of the working area reserves where the conditions of the useful mineral mining and processing comply with those accepted in substantiation of these quality requirements.

The reserves of the working areas not meeting the parameters of permanent quality requirements, as well as the areas where the conditions of the useful mineral mining and processing differ from the adopted ones, are delineated on the basis of the method worked out. Among these reserves are those found:

- in the isolated deposits found by prospecting in the course of the deposit mining;
- in the contour of commercial reserves, characterized by irregular change of qualitative properties, by the presence of rock and useful minerals inclusions with a low content pf the useful component;
- in the contour of non-commercial reserves. The economic expediency of working such reserves is determined by the condition of all forthcoming expenses recoupment *12*1* for mining and processing of the usefulmineral by the accruable value of the final product / *Uu* /, i.e.

$$Ц_и > Z_{пр} \qquad (5)$$

The reserves of the working area may be assessed by such index as the coefficient of quality requirement. The latter is equal to the ratio of the accruable value of the final product and the forthcoming expenses for obtaining these products

$$K_{треб} = Ц_и / Z_{пр} \qquad (6)$$

The economically expedient for mining are the reserves which have. $K_{треб} > 1$

In assessment of the reserves ofseveral identical working areas as additional criteria are taken:

- for areas of the first type - the maximum permissible quality of the working area reserves of the deposit £W;
- for areas of the second type - the maximum permissible quality of the reserves in the contour /section/ of the working area /$C_{т3}$ /.

The maximum permissible quality of the working area reserves represents average quality of the useful mineral when the accruable value of the final product repays the forthcoming expenses for its mining and processing. The parameter in the case when concentrate is the final product is determined by the formula:

$$C_{т.э} = Z_{пр}(1+\rho_э) / \varepsilon_{об} \cdot Ц_0 \text{ , g/t} \qquad (7)$$

In a common case the value will differ from the value of a similar parameter of permanent quality requirements - the minimal industrial content of a useful component. The maximum permissible quality of reserves at the contour of the working area *ICtJ* represents the minimum average content of a useful component in the "section". The numerical value is established from the condition of the equality of expenses of mining and processing of valuable products, obtained from the incremental volume /of section/ of the useful mineral by the formula (7).

Assessment of the working area reserves meeting the specification consists in the comparison of the actual quality of the area reserves / <?*> / with the maximum permissible quality *I CM.» I.* The working area reserves are economically expedient for industrial use provided

$$C_ф \geq C_{м.э} \quad (8)$$

In development of complex useful minerals the actual quality of the working area reserves is expressed through the total gross value of a unit of reserves or conventional content of a useful component to which the associated useful components including utilizable ore-processing wastes are reduced. The reduction of the associated useful components to the content of the main component is performed according to the formula

$$C_{пр} = C_ф + \sum_{i=1}^{n} C_i K_{пi}, \quad (9)$$

where $C_п$, $C_ф$ are the reduced and the actual content of the main useful component respectively in the working area reserves /of the incremental volume/, g/t;

Ci- the content of the i-th associated useful component in the working area reserves, g;

i - ordinal number of the associated useful component;

K+- the coefficient of reducing the content of the i-th useful component to the content of the main useful component,unit fractions,

$$K_{пi} = \varepsilon_{обi}\varepsilon_{пi}(Ц_{оi} - З_{пi}) / \varepsilon_{обо}\varepsilon_{по}(Ц_{по} - З_{по}) \quad (10)$$

$\varepsilon_{по}\varepsilon_{обо}$ coefficients of extracting the main and the i-th associated useful components in dressing and metallurgical process stage,respectively, unit fractions;

/^-marketable price for a unit of the main and the i-th associated final products, dol/g;

$З_{по}З_{пi}$ total expenses on production of a unit of the main and the i-th final products, dol/t.

The experimental checking of using the stated method has been made at the Akbakaisky Pit of the National Joint StockCompany ALTYNALMAS. Within the selected experimental block /37 m in size along the strike and 30 m down the pitchof the deposit/based on the data of detailed and field prospecting the reserves of useful minerals are delineated at the bank content of 1.5 conv. units/t.In this case the commercial reserves made up 3485 t at an average content of the useful component 11.2 conv. units/t. To specify the contours of the ore body additional field prospecting was conducted. In the ore portion theblock was drilled by wells according tothe net 4x4 m, in the rock portion - according to the net 5x5 m. Besides, the grooves were made at the top platform of the scarp with the section of 10x5 cm, with the length up to 2 m and the distance between the grooves - 5-6 m. The groove samples were taken with aninterval of 1 m.

By the, results of the field prospecting the contours of reserves in the horizon plan were built with the content of the useful component in the section between two adjacent contours respectively,!.8, 1.5, 1.2, 1.0, 0.8, 0.3 conv. units/t. As a result of specifying the spreading mineralization in the block it was found that:

- at the value of the maximum permissible quality of reserves equal to 1.5 conv. units/t in the section located at the contour of the assessable reserves their value increases by 62 % as compared with the data used in planning mining works;

- at the values of the maximum permissible quality of reserves below 1.5 conv. units/t the reserves in the block due to the new ore body accordingly increase: at 1.2 conv.units/t - by 124 %, at 1.0 conv. units/t - by 255 %, at 0.8 conv. units/t - by 273 %.

- at the value of the maximum permissible quality equal to 0.03 conv. units/t the mineralization within the block is continuous and the reserves of the useful mineral increase by 4.3 times.

The maximum permissible quality of reserves at their contour was determined by the formula *111* and by the method of versions using actual data from the Akbakaisky Pit.The calculated value of parameter equal to 0.95 conv. units/t is sufficiently close to its value found by the method of versions /see Table 1 /.

As it is clear from Table at equal tol.O and 0.8 nearly a similar economic effect is achieved and the deposit resources are better used and the coefficient of extracting the useful component from the interior part of the earth increases from 1.008 up to 1.102 ,i.e. by 9.3 % and the quantity of the obtained final products increases approximately by 14 %.

Thus, the approach under discussion to the assessment of useful minerals reserves in dynamics facilitates the scientifically substantiated planning of the mining-and processing enterprises operation and accelerates the processes of the enterprises reconstruction as a result of the breakthrough of scientific and-technical progress in the industry and revision of industrialrequirements, promoting the prudential development of mineral resources and the

Table I. Results of calalculating the indices by the method of versions

Indices, %	At the values of parameter, conv.units/t							
	1.8	1.5	1.2	1.0	0	8	0	3
Reserves of:								
.useful mineral	100	106.1	146.3	167.6	172.6	281		
useful component	100	100.8	109 2	113 8	113 8	114.2		
Value of final products	100	100.8	109.2	113.0	113.8	114.2		
Expenses on final products	100	101.5	117.3	123 8	126.4	133.1		
Economic effect	100	100.4	105.3	107 9	107.8	105.1		
Dilution coefficient	21.4	20.4	20.6					
20.6 19.6 - Coefficient of losses	0.7							
0.65 0.9 0.9 1.0 -								

complex utilization of mineral raw materials. At the stage of the current and operative planning of mining works the discussed methodic points may be used to substantiate the expediency of involving in mining the reserves earlier attributed to noncommercial and not meeting the requirements.

REFERENCES

Akataev, S.A. & Alipov, K.N. & Kenzhebayev, A.K. & Shitarev, V.T. 1992 Prudential utilization of useful minerals resources at opencast mining of ore deposits of Kazakhstan. Almaty:KAZNIINTI.

Begalİnov, M.B. & Kenzhebayev, A.K. & Shitarev, V.T. 1994The problem of prudential extraction of useful minerals from the interior of the earth in developing gold-ore deposits - In a collection of transactions "Topical questions of contemporary science and technique". Part 1:171-174. Almaty: KAZNTU.