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About the Equivalence of Ore Deposit Development Indicators

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Abstract: The relevance of ore deposit qualitative parameters determination is characterized. The evaluation of operation assessment is given for the mining companies with a traditional production cycle. The results of technology indicator simulation are provided with the filling of voids by hardening compounds and an open mine goaf with the quantitative values of equivalence. It was shown that there are adequate equivalent ratios between the indices of the mountain redistribution which are the basis for ore quality management and the increase of subsoil resource extraction completeness. The combination effectiveness of traditional techniques with innovative ones is denoted.

Key words: Development, ore, field, modeling, technology, hardening compounds, equivalence, quality, extraction, stocks, subsoil

INTRODUCTION

Up to 40% of investments is spent on mineral extraction in Russia, one third of production resources and about 20% of the country labor force. At that the bulk of expenditure is spent for underground development.

Due to the mining operation increase and the increase of development conditions complexity the correctness of field development parameter determination becomes an actual problem of mining science and practice. If the capacity of mines makes few million t/year the permissible error of 10% will bring a huge loss.

Often the designed capacity of a plant during an operation is developed only by 60-70% and only 50% of a final product. The main drawback of project economic efficiency indicators is that they are estimated differentially without the equivalent ratio consideration (Golik *et al*., 2015b).

Due to the complexity of mineral deposit geological structure the value of ore and metal reserves are often supported only by 60-90%, so companies are not operated at full capacity and use raw materials of improper quality.

When you choose the method and the technology of a field development one has to find the compromise solutions on the priority of certain indicators. The greatest influence on the amount of costs during mining is performed by mining pressure control method, the result of which are the main indicators of the mining process: loss, the dilution along a contour block; the dilution from domestic rock inclusions; the productivity of treatment works; unit performance; the work productivity of an operational mining plant.

These indicators, ceteris paribus, determine not only the performance of mining companies but also the economy of recycling mining enterprises using products (Yeo and Qiu, 2003; Mun, 2006; Adibi *et al*., 2015).

MATERIALS AND METHODS

If the data on stocks and their metal content are confirmed by 100%, the cost of a field operation results for the current period is calculated as follows:

$$P_t = \sum_{t=t_N}^{t_K} p_t \alpha_t$$

Where:

P_t = The cost valuation in the t-th year of the accounting period (rub)

t_N and t_K = An initial and a final year of the reporting period

α_t = The reduction coefficient of expenses from different periods

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Table 1: Basic data for modeling

Indicators	Unit	Values
Performance of block by ore	t. t unit-g^{-1}	25
Performance of ore mine by ore	t. t year^{-1}	1000
Ore losses at treatment works	Shares of unit	0.01
Ore losses on mine	Shares of unit	0.06
The content of metals in lost ore	kg t^{-1}	15
The ore content ratio for ore bodies	Shares of unit	0.8
Contour dilution ratio	Shares of unit	0.07
Full dilution ratio	Shares of unit	0.18
Dilution ratio by mine	Shares of unit	0.16
Metal in diluting mass along a contour	kg t^{-1}	10
Metal in block diluting mass	kg t^{-1}	10
The output of machines for balance ore	Shares of unit	0.5
The same from diluting mass	Shares of unit	0.6
The bulk density of ore	t m^{-3}	2.5
Conventional-variable production costs	rub. t^{-1}	8.0
The same for the filling by hardening compounds	rub. m^{-3}	50
Conditional permanent production costs	t. rub. year^{-1}	1000
Conditional permanent transporatation costs	t. rub.un.-g.$^{-1}$	15.0
Labor expenditures at treatment works	men cmm^{-3}	0.2
Cost-effectiveness ratio	1 rub.$^{-1}$	0.12

The cost of company operation results in the t-th year:

$$p_t^0 = A_t Ц_{Дt}$$

Where:

A_t = The production capacity in the year (t. t year^{-1})
$Ц_{Дt}$ = The recoverable value of raw materials produced in the year (t. rubles t^{-1})

Among the existing criteria of mining enterprise activity the priority is given to the earning index (RUR t^{-1}):

$$П_P = \frac{1-П}{1-P}(Ц_Д - c_Д)$$

Where:

$Ц_t$ = The recoverable value of extracted ore mass (rub.)
$c_д$ = Ore production and processing costs (rubles t^{-1})
$П$ = Ore losses (shares of units)
P = Ore dilution (shares of units)

The gross value of the ore, rub./t:

$$Ц_{я3} = \sum_{j=1}^{m} C_j \frac{Ц_{Kj}}{\beta_j},\ Ц_{B3} = 0,01$$
$$\sum_{i=1}^{n} C_i Ц_i,\ Ц_{B3} = \sum_{i=1}^{n} C_i Ц'_i$$

Where:

C_i and C_j = The contents of the ith and jth metal in the ore of balance reserves (% g t^{-1}, kg t^{-1})
β_i = The content of metals in the jth final product (%)
$Ц_{kj}$ = The price of j-th final product (rub. t^{-1})
$Ц_i$ and $Ц'_i$ = The price of i-th metal in the ore of balance reserves (rub. t^{-1})
n = The amount of useful components in ore
m = The number of final products

The criterion of the ore mass value is the difference between its recoverable value and the cost of extraction and processing:

$$d_Д = Ц_Д - c_Д$$

Where:

$c_Д$ = Ore production and processing costs (rub. t^{-1})
$d_Д$ = Profit from ore extraction (rub. t^{-1})
$Ц_д$ = Recoverable value of mined ore mass (rub. t^{-1})

The link between losses, dilution and productivity is determined by the simulation in a company operating under the traditional cycle scheme (Fig. 1). The initial data for modeling are presented in Table 1.

The modeling of polymetallic mine indicators, applying the technologies with the filling of voids by hardening compounds and with a worked out open space, determined that the loss of 1% of the balance ore with the metal content of 20 kg t^{-1} are equivalent ones (Fig. 2):

- The 5% of dilution along a block contour with the metal content of 10 kg t^{-1}
- The 17% of ore dilution due to seams with the content of 10 kg t^{-1}
- The 24% of labor productivity reduction at treatment works

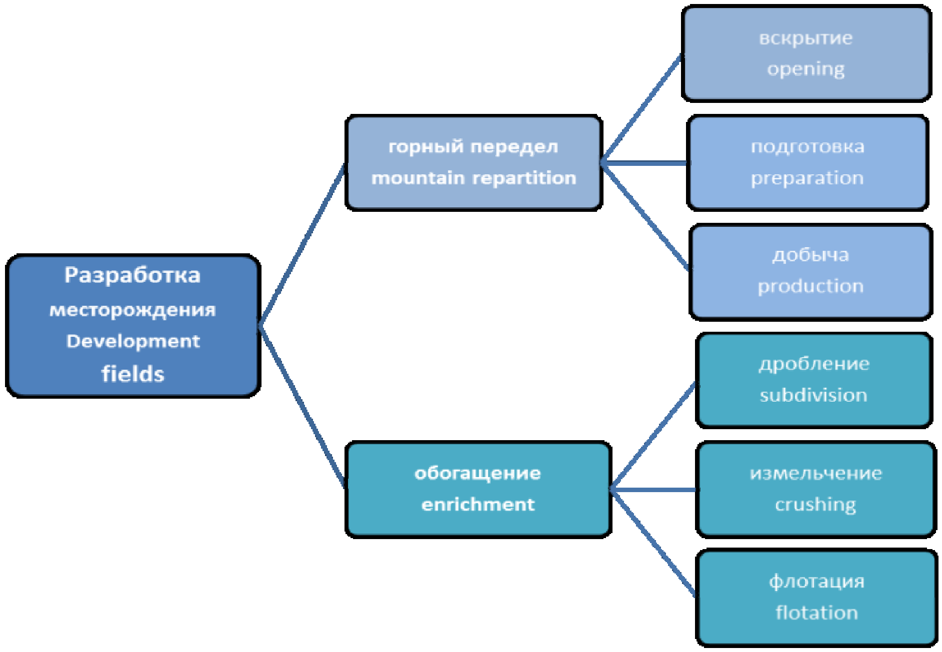

Fig. 1: Technological scheme of mountain repartitions

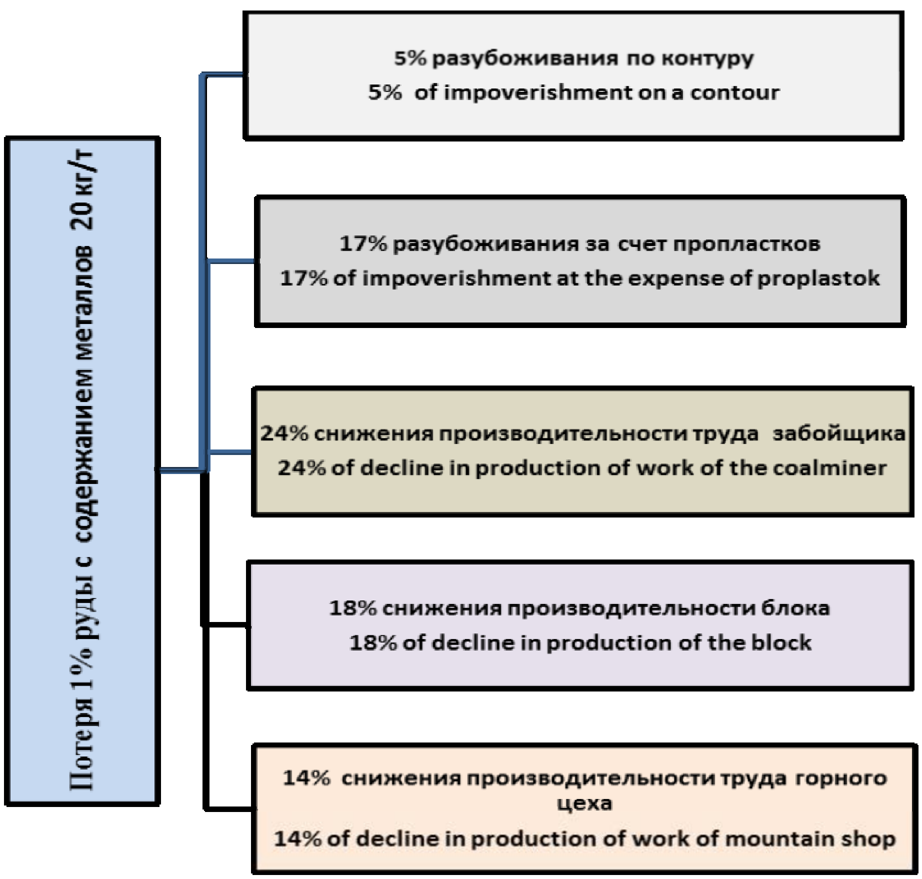

Fig. 2: Equivalent ratio of ore extraction indicators

Table 2: Basic data for modeling

Indicators	Unit	Options 1	Options 2
Balance reserves of ore	thous. t	50	50
Metal content in ore	kg t^{-1}	20	20
Losses at the extraction of ore	shares	0.09	0.03
Metal content in lost ore	kg t^{-1}	20	20
Ore dilution by rocks	shares	0.3	0.1
Metal in diluting weight	kg t^{-1}	5	5
Yield of machine ore	shares	0.60	0.54
The same from diluting mass	shares	0.66	0.66
Conditional-variable production costs	rub. t^{-1}	5.7	7.2

Table 3: Basic data for the modeling of void filling efficiency

Indicators	Units	Technology options 1	2	3	4
Ore value	rub. t^{-1}	75.64	75.49	75.42	75.38
Operating costs	rub. t^{-1}	5.68	7.21	7.50	7.64
Damage from balance ore reserve loss	rub. t^{-1}	5.84	1.81	1.52	1.38
Damage caused by the dilution of masses	rub. t^{-1}	3.75	3.75	3.75	3.75
Damage to reserves from diluting mass	rub. t^{-1}	0.85	0.19	0.10	0.05
Expenses for the filling of voids	Shares	-	50	65	80
Costs taking into account damages and filling	rub. t^{-1}	11.97	9.36	8.94	8.81
The economic effect according to an option	rub. t^{-1}	-	2.61	3.03	3.16
The economic effect according to the option per year	thous. rub.	-	522	606	632

- The 18% of unit productivity reduction
- The 14% of labor productivity reduction

Within the option 1 the increased losses and the dilution of ore at low operating costs is inevitable without the filling of voids. Within the option 2 the losses and the dilution of ore are minimized but the production costs increase at the filling of voids.

The option with the filling of voids by hardening compounds is more preferable by 2.6 rubles t^{-1} of redeemable balance reserves in the prices of 1990. The damage reduction from ore losses (5.8 - 1.8 = 4 rub. t^{-1}) and the dilution (0.8-0.2 = 0.6 rub. t^{-1}) compensates for the increase of production costs due to the use of a hardening filling (7.2 - 5.7 = 1.5 rub. t^{-1}).

The parameters of stock mining technologies differing by the share of filling operations, ceteris paribus: without void filling with 50% filling; filling with mixtures by 65%; filling with mixtures by 80% at ore mining within 200 t $year^{-1}$ are determined by simulation.

The simulation results show that the indicators of extracted ore quality and the increase of subsurface reserve extraction completeness are associated with the developed space state which allows you to manage a set of variable and constant factors, making the field development technology (Lyashenko, 2015; Dubinski, 2013; Wang, 2009).

The establishment of indicator equivalents allows to perform a real assessment of traditional technique and new technology combination. For example, the amount of hardening compound use can be increased during the utilization as the components of ore concentration tail compounds which becomes possible after the extraction of metals from them by the leaching in a disintegrator. (Golik *et al.*, 2015a; Golik *et al.*, 2014)

CONCLUSION

The arrays of metal deposits is the environment with irregularly varying properties, the violation of geodynamic balance of which is accompanied by the increase in the value of losses up to 30% and the dilution up to 60%. There are adequate equivalent ratios which are the basis for the management of ore quality and the increase of subsoil reserve extraction completeness between ore losses and dilution, an enterprise productivity and production capacity.

REFERENCES

Adibi, N., M. Ataee-Pour and M. Rahmanpour, 2015. Integration of sustainable development concepts in open pit mine design. J. Cleaner Prod., 108: 1037-1049.

Dubinski, J., 2013. Sustainable development of mining mineral resources. J. Sustainable Mining, 12: 1-6.

Golik V.I., Y.I. Rasorenov and A.B. Efremenkov, 2014. Recycling of ore mill tailings. Applied Mech. Mat., 682: 363-368.

Golik, V., V. Komaschenko, V. Morkun and Z. Khasheva, 2015a. The effectiveness of combining the stages of ore fields development. Metallurgical Mining Ind., 5: 401-405.

Golik, V.I., Z.M. Hasheva and S.V. Galachieva, 2015b. Diversification of the economic foundations of depressive mining region. Soc. Sci., 10: 678-681.

Lyashenko, V.I., 2015. Environmental technologies of complex structure mineral deposit development. FSUE Giprotsvetmet, Surveying Bulletin No. 1, pp: 10-15.

Mun, J., 2006. Real Options Analysis Versus Traditional DCF Valuation in Layman's Terms. Wiley and Son, New Jersey, pg: 134-139.

Wang, X.Z., 2009. Actively respond to challenges of the financial crisis, promote healthy and sustainable development of coal industry: International Coal Summit. China Coal Industry Association, Beijing, pp: 231-239.

Yeo, K.T. and F. Qiu, 2003. The value of management flexibility-a real option approach to investment evaluation. Int. J. Project Manage., 21: 243-250.