The effectiveness of combining the stages of ore fields development

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Abstract

The characteristic of the staged development of ore fields by underground way is given. A strategy is formulated and economic and mathematical models to determine the effectiveness of the combination are proposed. The concept of increasing the utilization of mineral resources by the permanent exposure to minerals at all stages of field development is designated.

Key words: THE STAGE, DESIGN, ORE MINE, UNDERGROUND WAY, EFFICIENCY, COMBINING, SUBSOIL

Introduction

The development of ore fields is characterized by staging recess stocks with constant transfer of ore reserves in the inactive category. [1] At the last stage the primary ore dressing waste and stocks of sub-standard raw materials in the subsoil often become the raw material. So, gold is leached out of the poor and off-balanced ores containing 1,2-0,6 g/t and of waste of mountain and concentrating industry with the content of 0,6-0,3 g/t. Depending on the natural and economic conditions, the company is going through a mountain from one to several steps (Fig.1).

The first stage is characterized by advanced recess of rich field areas, and loss is compensated by increased issuance of rich ore. The second stage is characterized by a decrease in rich ore reserves, and a decrease in ore grades is compensated by an increase in production. The third stage is the extraction of metals from sub-standard ores and waste recycling.

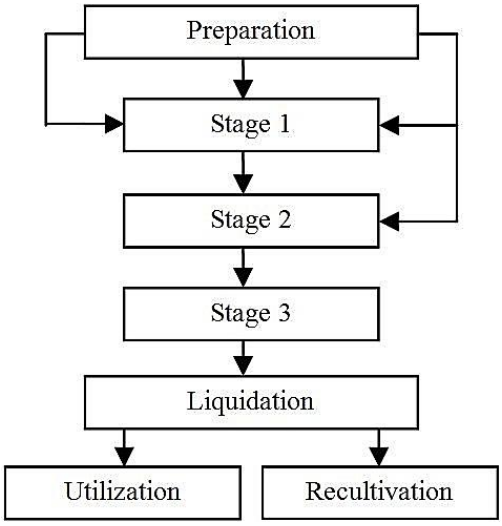

Figure 1. Field development stage

Materials and methods

If the issue of traditional technologies ore on the earth's surface is required, then a relatively new technology with underground leaching is released from the necessity of removing most of the ore [2]. The use of all stages in time and space is the optimal field development scheme.

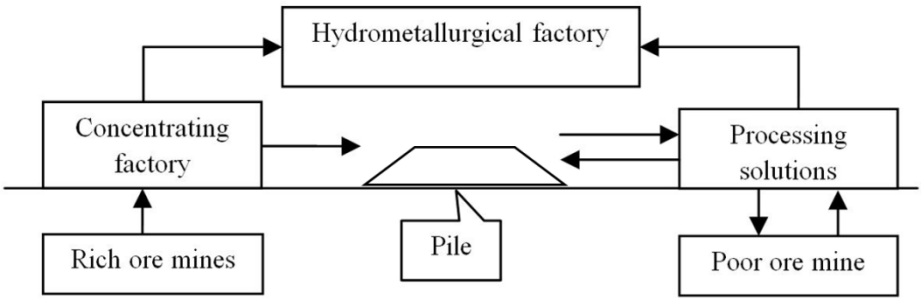

Figure 2. The optimized scheme of field development

A real opportunity to improve the efficiency of field development in most cases is reduced to engage in the production of sub-standard raw materials stocks [3]. The effectiveness of field development for phase 1 [4]:

$$\sum_{1}^{t} P_1 = \sum_{1}^{t_1} A_1 (v_1 - c_1) / (1+E)^{t_1 - 1}, \quad (1)$$

$$A_1 = f(B_б) = (B_o - B_{s+pb}),$$

where P_1 – is a profit, rub.; A_1 – is the production capacity, t/year; v_1 – is the recoverable value of the ore, rub./U; c_1 – is the cost of extraction and processing, rub./U; E – is the discount rate, the proportion of units; $B_б$ – is the balance ore reserves, ie; B_0 – is the estimated reserves, t; B_{s+pb} – are the stocks and poor balance ores.

The effectiveness of field development on the second stage:

$$\sum_{1}^{t} P_2 = \frac{1}{(1+E)^{\Delta t}} \sum_{1}^{t_2} A_2 (v_2 - c_2) / (1+E)^{t_2 - 1}, \quad (2)$$

$$A_2 = f(B_{s+pb}) = (B_o - B_б),$$

where B_{s+pb} – are the stocks and poor balance ores.

The effectiveness of field development on the third stage:

$$\sum_{1}^{t} P_3 = \frac{1}{(1+E)^{\Delta t}} \sum_{1}^{t_3} A_3(\nu_3 - c_3)/(1+E)^{t_3-1}, \quad (3)$$

$$A_3 = f(B_{or+t}) = (B_o - B_б),$$

where B_{or+t} – are the balance ores reserves and tailings.

The choice of technology is carried out in conjunction of such processes as exploration, extraction, beneficiation and metallurgical processing (Fig. 3).

The useful component separation of the grain from the waste rock grains becomes the goal of the destruction of ores for subsequent leaching, which is achieved by the charging of energy only to break atomic bonds. Excessive grinding of ore leaching reduces the filtration capacity of the array [5, 12-16].

The concept of increasing the utilization of mineral resources involves a permanent impact on the minerals at all stages of field development [6].

The analysis of production function in modern models of economic growth is done to compare the effectiveness of variants of fields working off. 40% of metal recovery ratio of 0.93 will be extracted from the source of the raw material in the steel works. 39% of the metal will be obtained of the remaining leaching for 50% of balance reserves in the recovery factor of 0.8, and taking into account losses in processing solutions. When the content of the metal ores in the off-balance 1g / m of them in the final product 2.3% of removed metal will be extracted and the coefficient of extraction ratio will be 0.88.

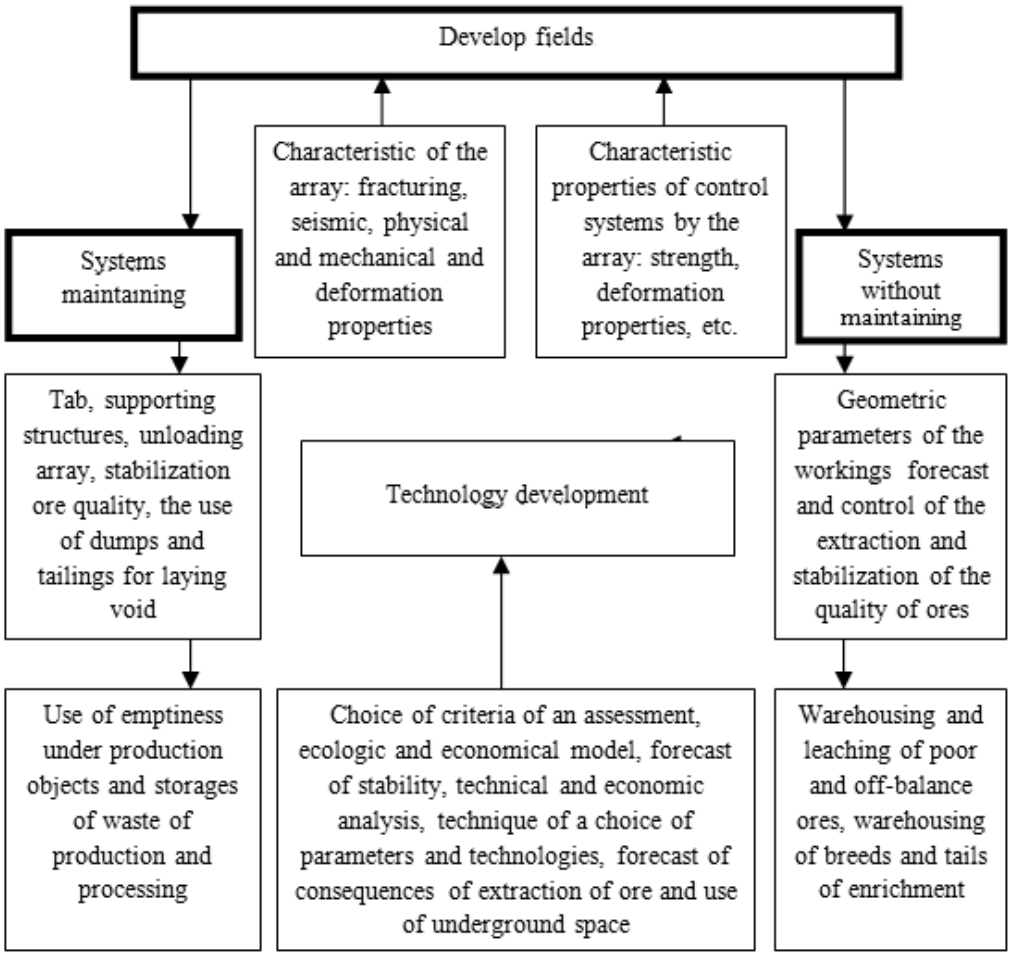

Figure 3. Strategy of a choice of technology of field development

The maximum values of the target function are associated with a combination of traditional technology and underground leaching in stage 2. With the average metal content of the most effective combination of technologies is the ratio of 15% - traditional technology (TT), and 85% - underground leaching (UL). An optimal

ratio with rich ores technology is 40% of TT and 60% of UL.

Productivity by metal is 2 times higher in the case of combined technology, when 40% of the ore is given to the surface, while 60% of the ore is leached under the ground, and the same production of rock mass than in the case of traditional method. The desktop productivity of mining plant for metal is increased by 1.5 times. By increasing the productivity of the metal mine by 1.5 times the performance of the mine for the issuance of the rock mass is only 40% of that of the traditional method. To increase the annual downward mining in accordance with the increase in productivity of 1.5 times ore areas that are in working out simultaneously, increase 3 times.

Main production reduces commercial products from waste [7, 8, 9]: metals and non-metals in the form of salts and oxides; secondary tails with the content of ingredients below the MRL; demineralized water for heating, cooling and other purposes; the gaseous products such as chlorine, hydrogen and oxygen.

Combining the development phases is an element of an integrated system of utilization of mineral resources in the run-up of co-evolution [10, 11].

Conclusion

The combining of the phases of the development of fields by the economic feasibility criteria ensures the effectivity of development of reserves that are large compared with working separate stages. Considering that in Phase 1 of mining it is produced not more than 15-20% of the reserves, and in Phase 2 it is still produced for about 50% of low-grade ores, the main prospects for the expansion of production can be secured by the involvement in the recycling of industrial stocks in the form of substandard raw materials. The involvement in the production of substandard raw materials at the stages of development of the field is not yet mastered the direction of the humane treatment of mineral resources and have prospects for the implementation of the mass with increased demands to the state of the environment in the use of natural resources.

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