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# Analysis of Development of Low-Power and Man-Made Gold Deposits

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***Abstract:*** *The current state of open-pit mining is characterized by increasing complexity of mining and geological conditions associated with increasing the depth, size and production capacity of quarries, involvement in the extraction of poor ores. The situation is aggravated by the depletion of rich ore reserves in traditional mining areas with developed infrastructure. At the same time, only on the territory of Central Kyzylkums, more than 2 billion tons were extracted from the subsoil. $m^3$ of rock mass, which are currently man-made deposits.*

**Keywords:** Technogenic deposit, rock mass , low-power fields, resource saving, mining and processing complexes, containing gold, natural-technological zone, the amount of ore.

## Introduction

In this regard, the further development and improvement of mining technology at quarries is associated with an increase in the effective development of fields that provide resource conservation in open-pit mining: drilling and blasting operations (BWR), which are one of the most important components of modern technology for preparing rock mass; increasing the share of resource-saving cyclical flow technology (CPT), based on the use of powerful complexes with conveyor delivery of ore and overburden; the need to develop the potential raw material base of the existing mining and processing complexes (GPC) of the Navoi and Almalyk mining and metallurgical plants (MMC) by developing small-scale and man-made deposits on the existing production areas [1].

The results of solving these problems are directly related to the economic efficiency of field operation.

To implement these objective factors, it is necessary to implement large-scale measures to justify the methods of effective development of deposits that ensure resource conservation in open-pit mining. With this approach, in modern economic conditions, the cost of gold production can be reduced by 1.5-2.0 times.

## Material and Methods

In General, for the MMC of Uzbekistan, which are characterized by a high resource intensity of the work performed, the problem of resource saving when implementing innovative equipment and technology in open-pit mining is of paramount importance. In this regard, the justification of ways to effectively develop deposits that ensure resource conservation in open-pit mining in the Republic is an urgent scientific and technical problem. The urgency of its solution is due to the growing demand for products that are in stable demand on the international market and have significant national economic significance for the Republic of Uzbekistan.

Expanding the mineral resource base of mining and processing complexes is possible by developing new small-scale and man-made deposits with the formation of infrastructure for primary processing of mineral raw materials at the site of its occurrence [2].

Each natural-technological area of this object by the volume of the developed mountain weight, the amount of extracted metal and its reserves in the subsoil used for the mining and transport equipment and opening schemes of work space distance from each other and the processing plant can be considered as an independent field. The quarry is divided into natural and technological zones, and zones are divided into dredging blocks according to the General functional purpose: overburden operations, mining operations with associated and main production, targeted work (carrying out opening workings, creating sites for in-pit warehouses, etc.). At the same time, work in zones and on blocks is performed cyclically, consistently stopping and resuming [3]. Changing the priority and significance of natural and technological zones over time requires periodic adjustment of their development plans, and the presence of heterogeneous cargo flows requires coordinated mining operations. To solve these problems, the Muruntau quarry uses the method of continuous design and planning of mining operations.

An analysis of the operation of mining and processing complexes of the Navoi mining and metallurgical combine with an assessment of the potential of transport, water and energy resources shows that there are not fully realized opportunities to expand

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the mineral resource base by involving small-scale and man-made gold deposits in the development. With appropriate design of effective technological schemes and equipment in the future may partially offset the decline in ore extraction from large deposits by selecting the most optimal options for greater participation in the commercial operation of small-scale and man-made deposits located in the zone of influence of a major mining and processing facilities [4].

Thus, for the further growth of the gold potential of the Republic and the extension of the period of stable operation of the Navoi mining and metallurgical complex, it is necessary to involve small-scale and man-made gold deposits in the complex natural conditions of Kyzylkum.

When developing small-scale and man-made gold deposits in difficult natural conditions of Kyzylkum, some features of the socio-economic and natural character should be taken into account: the presence of large mining and processing complexes of Zarafshan, Uchkuduk, Zarmitan, Navoi with a developed infrastructure that can process various types of gold-containing raw materials; the variety of technological properties of ores and host rocks of deposits; the lack of roads, electricity, water, housing, etc.

Let's consider in more detail the organization of development of small-scale gold deposits on the example of Zarafshan Mountain processing complex as a base plant (center). To raw material base of the Zarafshan mining and processing complex may include, in addition to developing deposits Muruntau, Myutenbay and man-made resources off-balance and poor content of ore, small deposits of Espanto, Bolik, Triad, Aristata, Balanta, Tomdibuloq within a range of from 1 to 70 km from the base of the plant, HMP-2, technogenic resources "tails" processing SQ and "Stripping" career Muruntau containing gold, as well as involvement in the future processing of ores beyond the contour of the joint of the quarry "Muruntau – Mutenbei" subject to the development of open-underground and underground methods [5].

It is proposed to consider all small-scale and technogenic deposits that tend to be processed at the large Zarafshan mining and processing complex by their location and material composition as a kind of natural and technological zones of the Muruntau quarry. At the same time, work in natural and technological zones is performed without the involvement of additional equipment and personnel. The released equipment and personnel are attracted from other less priority natural and technological zones at the moment. Thus, the development of small-scale and man-made gold deposits by natural and technological zones on a large existing mining and processing complex allows reducing overall costs, maneuvering the main and working capital and, as a result, reducing the cost of production of commercial products [6].

## Results

For this purpose, there are two main options for conducting work related to mining, transportation and processing of ore at the plant:

a) the extracted ore from the quarry is delivered to the plant in full without pre-processing on site, while depending on the average gold content $\rho_c$ C will be spent $\alpha_c$ from the sum, and the gold recovery will be the value of;

b) the extracted ore is pre-enriched on-site by heap leaching, after which the processed concentrate is delivered to the plant, while depending on the average gold content, $\alpha_к$ soums will be spent, and the recovery of gold will be the value of $\rho_к$.

This coefficient is usually determined depending on the average factory value $\rho_i$,, where the concentrate is sent. For conversion to 1 ton of ore, the $O_i$-indicator can be omitted. Thus, if the market price of one gram of gold is equal to the value of θ soums, then the amount associated with the loss of the metal will be equal to

$$e_i^n = \theta \cdot \rho_i \cdot \beta_{\boldsymbol{n}} \quad (1)$$

How many times will the gold content in the concentrate increase, how many times will the total amount of concentrate decrease relative to the processed ore. If $N_T$ Works are processed, the resulting amount of concentrate will be equal to $N_T/O_i$.

To calculate the amount of costs per ton of ore associated with the enrichment and transportation of ore mass from the i -th Deposit to the j -th plant, you can output the formula as follows:

$$C_{ij}^0 = e_i^T + e_i^n + C_{ij}^k / O_{\boldsymbol{i}} \quad (2)$$

The cost of the entire technological process of processing a ton of ore without preliminary enrichment will be equal:

$$d_{ij}^c = C_{ij}^c + \alpha \quad (3)$$

The cost of the entire technological process with pre-enrichment is calculated using the formula:

$$d_{ij}^к = C_{ij}^к / O_i + e_i^T + e_i^п + \alpha_к (1+\beta_п) / O_i \quad (4)$$

Using this criterion, you can evaluate each Deposit and find the minimum cost of transporting ore or concentrate Cij, which make up the elements of the price matrix for solving the transport problem of linear programming.

$$C_{ij} = \begin{cases} d_{ij}^c < d_{ij}^k & C_{ij}^c \\ d_{ij}^c \geq d_{ij}^k & C_{ij}^o \end{cases} \quad (5)$$

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If the value $x_{ij}$ denotes the amount of ore moved from the i-th Deposit to the j-th plant, you can enter the following restrictions for these variables:

$$\sum_{i=1}^{N} x_{ij} \le M_j^3 \qquad j = 1, 2, 3 \tag{6}$$

$$\sum_{i=1}^{3} x_{ij} \le M_i^m \qquad i = 1, 2, \ldots, N \tag{7}$$

where: $M_j^3$- capacity of each j-th plant; $M_i^м$- production capacity of the i-th quarry;
Total costs are determined using the following formula:

$$Z = \sum_{i=1}^{N}\sum_{j=1}^{3} C_{ij} \cdot x_{ij} + \alpha_c \cdot U^c + \alpha_k \cdot U^k \cdot (1 + \beta_n)/O_i \tag{8}$$

where: $U^c$- amount of ore processed by option (a), t; $U^к$- the same for option (b), i.e. The following equalities must be met

$$\sum_{i=1}^{N}\sum_{j=1}^{3} x_{ij} = U^c + U^k \tag{9}$$

They are the balance criteria for solving the transport problem.
Thus, a transport problem of the following nature is formulated: it is required to find such values of indicators $x_{ij}$ that meet the criteria (6) - (8) and (9) and give the minimum values for the target function (8).

## Discussions

The methods of rational development of small-scale and man-made gold deposits are proved. A method for selecting optimal options for developing small-scale and man-made gold deposits has been developed. All deposits that tend to be processed at the Zarafshan GPC by their location and material composition are proposed to be considered as a kind of natural and technological zones of the Muruntau quarry [7]. At the same time, work in natural and technological zones is performed without the involvement of additional equipment and personnel. The released equipment and personnel are attracted from other zones that are less priority at the moment, which allows you to reduce overall costs, maneuver the main and working capital, and ultimately reduce the cost of production of commercial products.

## Conclusions

The selection of optimal options for field development is carried out in several stages, with mutual coordination and clarification of previously made decisions. At the first stage, the reserves of small-scale and man-made deposits are estimated using a mathematical model [8]. At the second and third stages, an enlarged assessment of the main parameters of field development and the selection of rational options for the development of gold deposits by natural and technological zones is performed.

## Acknowledgements

Based on the methodology, a mathematical model for selecting the most optimal options for developing gold deposits that differ in the method of processing the extracted ore has been developed, and a computer calculation program has been compiled for selecting the optimal options for developing deposits. As a result of calculations, the following parameters are set:
– technical and economic parameters of development of small-scale and man-made deposits;
- distribution of small-scale and man-made deposits by their development options.

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