

Classification of reserves of upland ore deposits developed by the open-underground method

*Shukhrat Tadjiev**

Navoi State University of Mining and Technologies, Navoi, 210100, Uzbekistan

Abstract. The article considers reserves adjacent directly to the marginal contour of the quarry or located near it and subject to underground refinement. When classifying reserves of deposits developed by the open-underground method, different classification criteria are used: distance from the limit contour of the quarry, location in relation to the contour of the quarry, the method of developing reserves and the geomechanical effect of quarry excavation. Taking into account the above, a classification of reserves of upland ore deposits has been developed.

1 Introduction

Familiarization with the experience of developing open-pit deposits shows that some ore reserves almost always remain behind the marginal contours of quarries. With high value and significant volumes, they are involved in underground mining.

Reserves adjacent directly to the marginal contour of the quarry or located near it and subject to underground refinement are legal. The specific weight of these reserves in the total remaining beyond the limit contour of the quarry depends on the capacity of the deposits and the depth of open-pit mining. In terms of physical volumes, they can reach significant values and be the raw material base of underground mines.

When classifying reserves of deposits developed by the open-underground method, different classification criteria are used: distance from the limit contour of the quarry, location in relation to the contour of the quarry, the method of developing reserves and the geomechanical influence of quarry excavation [1].

2 Materials and methods

Since the position of the reserves being refined relative to the quarry field may be different, the degree of mutual influence of open and underground work is not the same. The need to take this feature into account is indicated by D.R. Kaplunov, V.P. Shuboderov and D.V. Gordin [2].

In [3, 4], it is proposed to classify reserves according to this feature into two groups: those located in the zone of influence of the quarry and beyond. For the option of joint development, the reserves in the area of influence of the quarry are called the entire security

* Corresponding author: sh_tadjiev@mail.ru

reserve. Conducting underground work within the influence of the quarry space is accompanied by the development of specific geomechanical processes, both in the elements of underground mining systems and the quarry. In addition, as an additional argument in favor of allocating these reserves to a separate group is the fact that the operation of these sites is associated with the possibility of using elements of the technology of an open-source development method.

Depending on the degree of mutual influence on the stability of open and underground workings and the characteristics of the technology of cleaning operations, it is advisable to divide the reserves of the first zone into two parts. The first is the contour or border reserves directly adjacent to the contour of the quarry in the sides or bottom, the second is the contour reserves located behind the contour and worked out under their protection or after the contour. The capacity of the near-circuit transition zone should be determined, on the one hand, by the size of the area of the greatest negative impact of the quarry space on the technology of underground work due to factors of mountain pressure and ventilation, and on the other - by technological considerations acting as limiting.

3 Results and discussion

Based on the research conducted by E.Y. Meshcheryakov, it was proposed to classify the reserves of the deposit according to the degree of influence of the quarry on the stress-strain state of the massif on the contour, during which the elements of underground mining systems are in conditions of increased shear forces - in the sides and compressive forces - at the base, and quarry, located in the area of significant influence of the quarry. Accordingly, it is necessary to differentiate technological solutions for managing the condition of the under-worked barrier array. A method for the construction of these zones is proposed [5].

According to the location relative to the quarry, sometimes the division of reserves in the near zone is used into on-board reserves located above the bottom of the quarry, and bottom reserves - below the bottom level. This separation is justified not only due to the specifics of the design of technological schemes of mining, but also due to the frequent linking of floor marks to the limit level of the bottom of the quarry. This separation simplifies the design, although there may be cases where it is advisable to allocate excavation blocks that include reserves above and below the bottom of the quarry [6].

The work [7] notes a significant influence on the choice of the method of development of the deposit sites of qualitative composition and mining and geological conditions of occurrence, as well as the location of reserves relative to the contour of the quarry and the need to take into account the latter factor when calculating the parameters of the elements of the development systems [8-10].

It is proposed to divide all reserves developed by open-underground technology into four groups:

- quarry reserves located within the quarry field and limited by the marginal contour of the quarry;
- open-ground reserves developed by a combination of technological processes, open and underground mining operations and directly entering the limiting contour of the quarry;
- mine reserves located within the mine field and developed by underground technology;
- off-balance sheet - substandard ores, the mining of which is economically impractical.

Quarry stocks are divided into two subgroups:

- remote from the contour of the quarry - the extraction of these reserves does not require a change in the open technology traditionally used in these conditions;

- and short-circuit reserves directly adjacent to the marginal contour of the quarry, the development of which requires a set of special measures to ensure the stability of the sides and the safety of conducting open-pit mining in the zone of influence of underground.

Considering that open-underground reserves are located near the boundary of the zones of application, open and underground methods, these reserves are commonly referred to as transition zones. Open-underground reserves are divided into reserves in the sides and in the bottom of the quarry according to their position relative to the bottom of the quarry.

In the above classifications, the method of development is taken as the main feature, and the location of reserves relative to the contour of the quarry is considered as secondary. The influence of the developed space of the quarry of upland deposits on the technology of work was not reflected in the classification.

From the point of view of designing systems for opening and technology for developing reserves of upland deposits, taking into account the developed space of the quarry, as well as the need to take into account the above-listed features, we have developed a classification for mining reserves of upland deposits in an open-underground way, according to location relative to the contour and distance from the contour of the quarry (Figure 1).

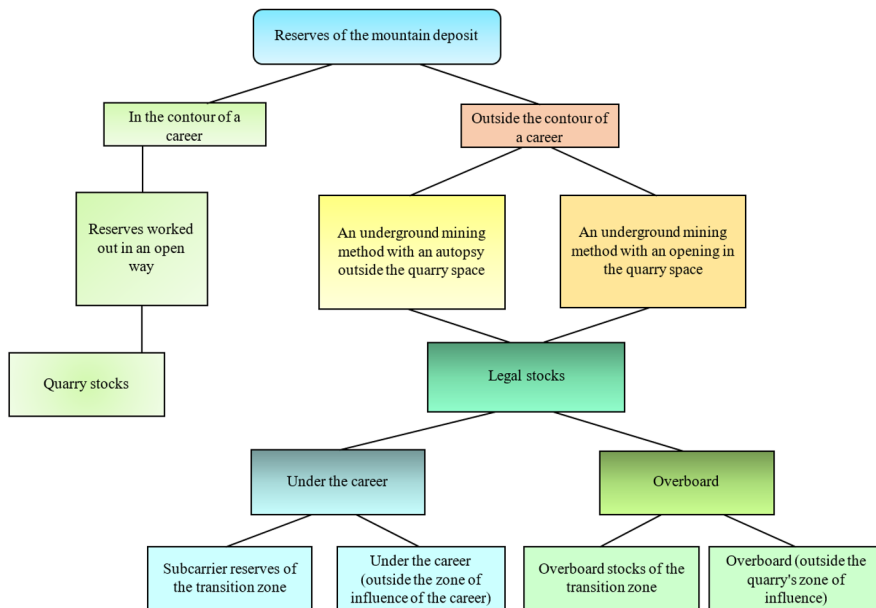
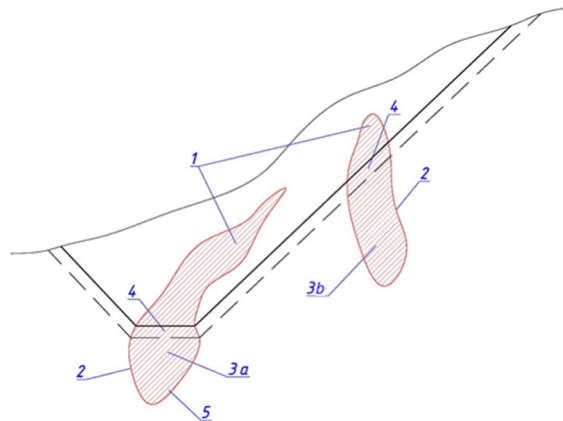


Fig. 1. The developed classification of mining reserves at mining ore deposits by the open-underground method.

Due to the fact that the degree of influence on the technology of underground mining is a function of the distance of reserves from the contour and their location, the subcarriers are divided, according to the first feature, into subcarriers (transition zones) and subcarriers (outside the zone of influence of the quarry), and according to the second - on the outboard ones.

According to the proposed scheme for the classification of upland deposits, all reserves worked in an open-underground way are divided into two classes according to their location relative to the contour of the quarry: in the contour and outside the contour of the quarry (Figure 2).



1 - reserves worked out by the open-pit mining method; 2 – reserves of the underground method (with opening in and out of the quarry space) of development; 3 - legal reserves (3a – under the career, 3b – overboard) outside the zone of influence of a career; 4 – near-contour reserves, transition zones; 5 - contour reserves; sub-quarry reserves, below the level of the bottom of the quarry.

Fig. 2. Scheme for the classification of reserves in mining ore deposits developed by the open-underground method.

4 Conclusion

In turn, these classes are divided into groups according to the methods of development, the first is for reserves developed in an open way, and the second is an underground method with an opening outside the quarry space and development with an opening in the quarry space. It is also proposed to divide the reserves of the underground mining method into two subgroups based on the influence of the quarry space and on mining technology: that is, those outside the zone of influence of the quarry are sub-quarry, and outboard, that is, located beyond the zone of influence of the quarry space.

The developed classification of mining reserves by the open-underground method allows the extraction of rare metals from the depths of gold-ore upland ore deposits, which is fundamentally different from the well-known classification of mining by the open-underground method of deposits of non-upland type.

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