

Classification of systems for opening reserves beyond the limit contour of the quarry of upland deposits

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Abstract. The article considers the systems of opening the contiguous reserves of upland deposits and develops their classification. Proposed classification takes into account the development of both portside and sub-quarry reserves in an open-underground way using the quarry space. Opening workings of sub-quarry reserves are carried out outside the boundaries of the quarry.

1 Introduction

Practical experience in the development of deposits by the open-underground method shows that in most cases, traditional methods of opening workings located outside the displacement zones are used to open reserves to be mined underground. Therefore, they are characterized by increased volumes of capital works, increased construction time of mines due to the need to place shafts at a remote distance from the development site due to the occupation of the territory by open-pit mine facilities and the geomechanical influence of the quarry space on the processes of rock movement [1].

When developing upland deposits, these shortcomings can be eliminated with the integrated design of the development of reserves of open-underground methods with the linking of design solutions for development methods, including in terms of the placement of opening workings, taking into account the prospects for the development of mining operations in the quarry and mine and their functioning at all stages of development.

It is impossible to achieve a significant reduction in costs and construction time using traditional methods of opening. The way out, according to the authors, is to use the quarry as an opening mine and to create a unified transport scheme for the export of ore mass [2].

In domestic and foreign practice, there are examples of the use of a quarry as an ore mine or an auxiliary opening mine, or an auxiliary mine at the construction stage of non-upland deposits [3].

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2 Materials and methods

Reserves in the sides of upland deposits are proposed to be opened by tunnels with the creation of capital portals. At the same time, the quarry space is used for the supply and delivery of a ventilation jet, preparation and supply of laying material to underground workings, as well as for the delivery of ore. Reserves lying below the bottom of the quarry, in most cases, are opened by the main vertical and inclined trunks, passed from the surface and used for issuing ore, lowering and lifting people. For the delivery of loading and transport and drilling equipment, materials to the horizons of the underground mine, preparation of the upper horizons, as well as for auxiliary purposes, inclined ramps passed from the bottom and ledges of the quarry are used. The advantages of these opening schemes are a significant reduction in the construction time of an underground mine and a reduction in capital costs by reducing the length of the main and auxiliary underground workings [4].

When mining the reserves of upland deposits by open-underground methods, the joint use of transport workings for the extraction of ore mass from the quarry is widely practiced.

The use of a quarry as an opening work for the development of underground reserves involves the construction of transshipment nodes in it, the placement of ventilation installations, the maintenance of quarry exits and communications for a long period of operation of sub-quarry reserves.

In order to use the quarry as an ore-mining mine, tunnels, vertical or inclined shafts, inclined underground ramps for self-propelled equipment pass from the horizontal berm sides or from the bottom of the quarry.

Based on the analysis of the applied and design solutions for opening, the following classification of opening systems for the development of reserves of upland deposits by the open-underground method is proposed in the work (Figure 1). The method of opening and formation of ore flow is accepted as the main classification feature.

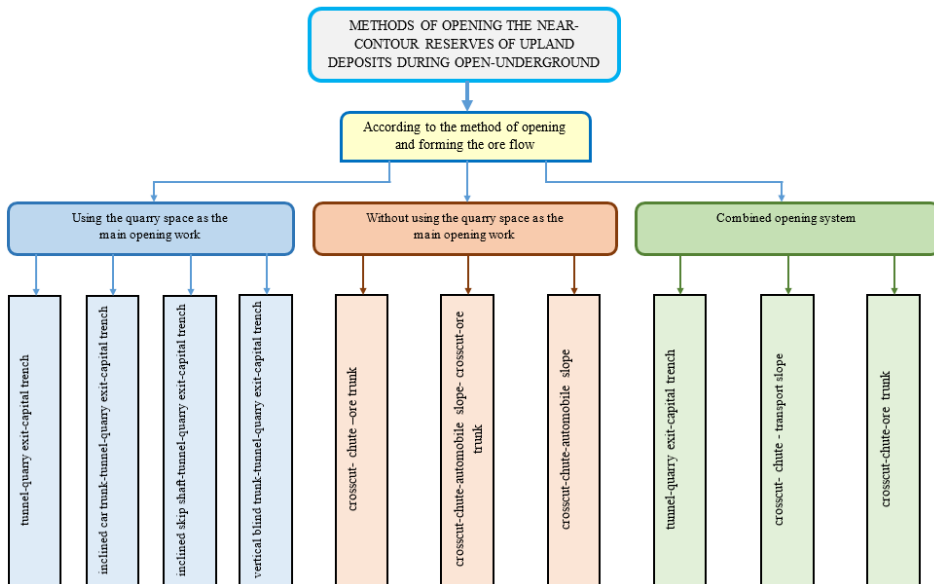


Fig. 1. Rational scheme of opening during the development of reserves of upland deposits.

The proposed rational scheme for opening upland deposits during the transition to underground mining is quite general, since the introduction of additional features, detailing options at all stages of development would lead to a complex, hard-to-read scheme.

In our opinion, it is necessary to single out in a separate block the options for opening the end-of-line reserves, assuming that the opening of quarry reserves is carried out using traditional opening options: general or separate capital congresses of various tracing.

3 Results

As the main classification feature, we propose to take the degree of use of the quarry space for the purposes of opening and preparation, and as secondary - the type of main and auxiliary opening workings. According to this classification, all opening methods are divided into five classes, and classes are divided into 5 groups according to additional features (Table 1).

Table 1. Methods of opening reserves beyond the limit contour of the quarry during open-
 underground mining of upland deposits.

Class	A sign of the use of career space	Inventory name	Type of opening workings	Features of opening options	Application conditions
1	Using the quarry space as the main opening work	Near-contour outside the zone of influence of the quarry	1.1. Career congress + tunnels 1.2. Career exit + vertical and inclined trunks, exits 1.3. Quarry exit + combination of underground workings	1. The main and auxiliary underground opening workings are carried out from the quarry. 2. The delivery of all ore is made through a quarry	Upland deposits worked out with the preservation of the sides of the quarry in a stable condition
2	Using the quarry space as the main opening work	Under the quarry outside the zone of influence of the quarry	2.1. Career congress + tunnels 2.2. Career exit + vertical and inclined trunks, exits 2.3. Quarry exit + combination of underground workings	1. The main and auxiliary underground opening workings are carried out from the quarry. 2. The delivery of all ore is made through a quarry	Upland deposits worked out with the preservation of the sides of the quarry in a stable condition
3	Using the quarry space as the main opening work	Instrument and sub-barrier outside the zone of influence of the quarry	3.1. Career congress + tunnels 3.2. Career exit + vertical and inclined trunks, exits 3.3. Quarry exit + combination of underground workings	1. The main and auxiliary underground opening workings are carried out from the quarry. 2. The delivery of all ore is made through a quarry	Upland deposits worked out with the preservation of the sides of the quarry in a stable condition
4	Without using the career space	Subcarrier, instrument out of the zone of influence of the quarry	4.1. Inclined and vertical trunks 4.2. Tunnels 4.3. Combination of underground workings	1. All opening workings are carried out from the surface. 2. Delivery is carried out through underground workings	Disconnected steep-falling and inclined ore upland deposits, worked out without preserving the sides of the quarry in a stable state

5	Combined opening system	Subcarrier, instrument out of the zone of influence of the quarry	5.1. Inclined and vertical trunks 5.2. Tunnels 5.3. Combination of underground workings	1. The main and auxiliary opening workings of the instrument stocks are carried out from the quarry space. 2. Opening workings of sub-quarry reserves are carried out outside the boundaries of the quarry. 3. Ore delivery is carried out separately	Upland deposits worked out with the preservation of the sides of the quarry in a stable condition
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The options of the first class include methods of opening the end-of-line reserves, which provide for the delivery of ore through the quarry space. As opening workings, a combination of opening workings of a quarry and underground is used: tunnels, inclined exits (trunks), ore outlets.

4 Conclusion

The second class includes methods of opening, in which the use of quarry ore-producing workings is provided for the issuance of a part of the ore mass. In this regard, an additional opening system is being designed at the deposit, which provides the possibility of parallel delivery of ore mass through underground workings and quarry exits. The equity participation of each of the ore-mining tracts may be different depending on the period of development of geo-resources. The peculiarity of the opening options of this class is the presence of two autonomous or structurally related opening systems.

The methods of opening the third class involve providing access to the deposit according to the traditional scheme, that is, by conducting underground opening workings: shafts, querclags, drifts, capital ore passes. The quarry space is not used at the same time, it acts as an unfavorable factor due to the increase in the size of the displacement zones.

The methods of opening the fourth class involve providing access to the deposit according to the traditional scheme, that is, by conducting underground opening workings: inclined and vertical shafts, tunnels and a combination of underground workings. The quarry space is not used at the same time, it acts as an unfavorable factor due to the increase in the size of the displacement zones.

The fifth class includes methods of opening, in which the use of quarry ore-producing workings is provided for the issuance of on-board ore mass. In this regard, an additional system for opening sub-quarry reserves is being designed at the deposit, which provides the possibility of parallel delivery of ore mass through underground workings. The equity participation of each of the ore-mining tracts may be different depending on the period of development of geo-resources. The peculiarity of the autopsy options of this class is the presence of two autonomous opening systems.

Classes are divided into groups according to the type of main ore-producing workings and their combination. Within the groups, it is possible to allocate options by types of underground facilities, auxiliary lifting, transshipment points, etc.

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