So, from the foregoing it follows that the proposed methods of cognition, including a number of general scientific and special, as well as the proposed methods, can solve the overwhelming majority of general issues on the implementation of energy-efficient invariant control of grinding-classification of ores based on indirect predictive estimates of the characteristics of raw materials and equipment. At the same time, the main nodal solutions are more related to invariance methods.

UDC 622.274.3: 622.831

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IMPROVENEMT OF ORE DRAWING TECHNOLOGY AND MINED IRON ORE GRADE IN UNDERGROUND MINING

In underground mining, deterioration of the mined iron ore grade as compared with their natural one occurs due to many reasons, the main of which is losses of rich ores and their dilution with waste rocks.

Major ore losses and dilution are observed during breaking and subsequent ore drawing. Therefore, this work is devoted to investigation of losses and dilution of broken ore at its drawing from stopes.

When drawing broken ore, the largest ore losses remain on the footwall of the ore body [1,2,4,6]. These reserves can sometimes reach 25-30% of the total reserves of the stope. Their extraction requires significant costs for driving additional workings and other technical and technological measures. Again, such additional measures lead to deterioration of the ore grade [1,2,6].

Thus, development and improvement of the technology for broken ore drawing, especially from the ore body footwall, is an important task in developing modern technologies of underground mining of rich iron ores.

Fig. 1 presents the technology developed by the authors to draw broken ore from the ore body footwall.

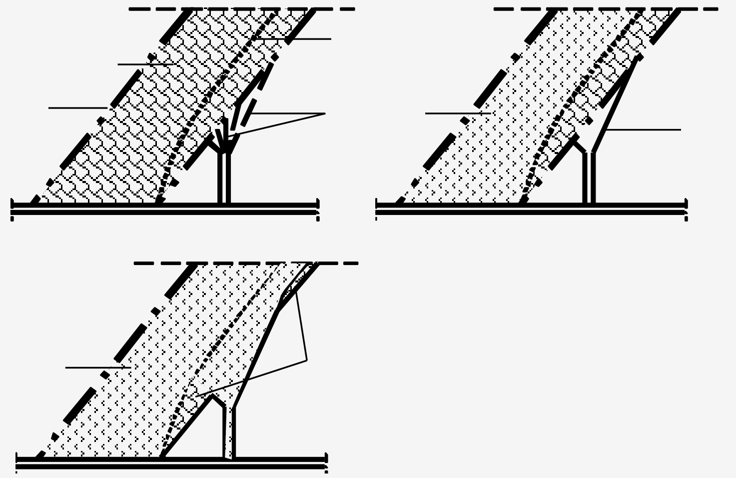
Fig. 1. Broken ore drawing from the dead area of the ore body footwall

As is known, to extract broken ore from the footwall, there are used drawing technologies that involve:

- footwall rocks blasting, their immediate drawing and subsequent drawing of the broken ore from the dead area of the ore body footwall [2,6]. The major disadvantage of this technology is significant costs for blasting, drawing, *haulage*, hoisting and waste rock dumping on the daylight surface, these resulting in significant rise of ore mining costs;

Fig. 1 - driving additional collecting levels (sublevels) in the footwall rocks.

The number of such sublevels depends on a level height and a dip of the ore body and includes driving a scraper drift in the footwall rocks, additional draw cones in the footwall rocks and additional discharge, ventilation-service and manway raises [6].

The major disadvantage of the technology of this type is a significant amount of work on driving additional collecting levels resulting in increased mining costs, retardation of stoping, reduction of concentration of operations due to introduction of additional sublevel stopes at different levels.

The proposed technology for drawing broken ore from the dead area of the ore body footwall is intended to eliminate the above-mentioned and existing weak points in current ore drawing technologies and is named “the technology of drawing ore through stope collecting cones”, Fig. 1.

The proposed technology is about the following. A raise is driven from workings of the main draw level in the footwall rocks.

Longholes drilled from the raise form stope collecting cones as is shown in Fig. 1.

Versus the current ones, the proposed technology provides for decrease in blasted waste rock volumes, reduction of costs for workings of additional collecting levels, for broken ore drawing and additional decrease of costs for waste rock hoisting and dumping on the daylight surface.

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UDC 622.86: 622.26.004.5

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EFFICIENT WORKING CONDITIONS OF STOPING FACES

The use of mechanized stoping complexes of a high technical level characterized by increased reliability, power-to-weight ratio and resource, necessitated the development of technological schemes adequate to them with design parameters that provide a favorable operating mode for such mechanization equipment with the full use of their technical potential to obtain the maximum economic effect from their use.

The main parameters that determine the dimensions of the extraction pillar are its length and the length of the stoping face. In recent years the average length of the extraction pillar in Germany and Great Britain has fluctuated between 1.1 and 1.3 km, in Australia it is 1,874 m, and in the USA 2,570 m. The longest extraction pillar in the world was mined in the USA at the Twentymile mine: 5365 m [1]. The parameters of the extraction pillar length are affected by the technical level of the longwall equipment. The productivity of Russian mechanized complexes begins to decline when the length of the extraction pillar is over 1.2-1.5 km, and for foreign complexes it is over 2.2-2.5 km. Taking into account the costs of assembling and dismantling the complexes, the efficiency of the mechanized complex is ensured when the pillar length reaches 2.8-3.0 km.

The world experience shows that the optimal pillar length, depending on the seam thickness, can be in the range of 3.5-6.0 km. The longer the length of the longwall, the lower the unit costs; and there is no optimal value. Considering that the service life of the equipment of the new generation of powered roof supports is 8-10 years, of shearers 5-7 years, of face conveyors at least 2-3 years, it is impractical to take the length of the excavation field that is lower than the last parameter. And since the scope of use of high-performance longwalls with optimal parameters along the length of the extraction pillar (up to 5-6 km) is very limited in the Karaganda basin, this value should