RESOURCE-SAVING TECHNOLOGY OF MAGNETITE QUARZITE UNDERGROUND MINING

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Abstract

The need to involve in the underground extraction the magnetite quartzite underground deposits, which lie in the fields of Kryvbas mines, in order to expand the raw material base of underground mines and reduce the intensity of the development of high-grade ore, is an actual problem.

The carried-out technical and economic analysis of surface-chamber system of development with ore breaking and vibrorelease showed that the technology of magnetite quartzites underground production, which is now applied on Ordzhonikidze mine is characterized by low technical and economic indicators in comparison with similar technology on the basis of dump techniques.

For change patterns establishment of ore extraction indicators from thickness of the cave floor pillar and distance between loading arrivals during the application of the block trench bottom and load-haul-dumpers, the laboratory researches which allowed to establish the floor pillars optimum parameters and the trench bottom design were conducted.

As a result of laboratory studies the regularities of change of indicators of losses and contamination of ore, which allowed to justify the size of the structural elements of trench bottoms blocks was established.

The passport of superficially chamber system of development of thick deposits of magnetite quartzites using load-haul-dumpers, which should be used in the design of underground mining of magnetite quartzite deposits at existing Kryvbas mines is developed.

The developed of high-performance surface-chamber system of development of steeply dipping magnetite quartzites thick deposits with drill carriages and load-haul-dumpers will allow to improve the technical and economic indicators of system in 1, 5-2 times.

Keywords: magnetite quartzites, block parameters, trench bottom, delivery orts,

breakage, loading, ore delivery, ore recovery indicators, equivalent materials, losses, ore contamination.

Actuality of the problem. The problem of expanding the mines resource base and the rational complex use of underground Kryvbas ore resources, which owns the developed infrastructure, established mining household and qualified staff engineers and technical workers, causes the necessity of attraction of magnetite quartzite to development, reserves of which are billions of tons. This will greatly expanding the raw material base of existing mines, reduces the intensity of underground mining of high grade iron ore and increase the lifetime of the mine, as well as playing an important role in the problem solution of complex use of iron ore deposits in the Kryvyi Rih basin. The reserves of magnetite quartzites located on the upper horizons of the operating mines can be fulfilled in the next years at implementation of the minimum reconstruction of main mining developments and cameras on the fulfilled horizons using the existing hoisting units.

Experience of Ordzhonikidze mine has confirmed that the development of magnetite quartzite, located on the upper horizons is possible with a minimum costs on lifting, pumping, ventilation and transportation. But it must be based on high-technology cleaning recess, created in accordance with modern global trends in the development of strong and persistent ores. Therefore, the development and introduction of new technological schemes and high performance systems of magnetite quartzite underground development based on the use of load-hould dumpers is an actual problem, which is of practical importance.

Scientific works of G.M. Malakhov, Yu.P Kaplenko, M.B. Fedko, B.I. Rimarchuk, E.G. Logachev, M.I. Stupnik, V.O. Kalinichenko, V. V. Tsarikovsky, and also mining engineers - production workers O.S. Kolodeznev, T.I. Karamanits, V.V. Peregudov, V.P. Protasov, S.S. Bashtanenko, etc. are devoted to a problem of underground mining of magnetite quartzites in Krivbass. They made the foundation of the theory and practice of ferruterous quartzites development on the operating mines of the basin.

The technical and economic analysis of the applied system of development. Currently, underground mining of magnetite quartzite in

Krivbass by surface-camera system is carried out only at the mine of Ordzhonikidze, which develops on the horizon 527 m of steeply dipping (60-65 °) thick (120-270 m) deposit of magnetite quartzites " Youzhny " of 1050 m long.

The floor pillar and bottom collapse – by fans of deep boreholes, and the pillar – by vertical concentrated charges (VCC). Ore release is processed by vibration installations VDPU-4TM.

For a technical and economic assessment of surface-camera system of development let's give the technological and technical indicators, which were received during the block mining (+22)(+34):

the costs of preparatory workings - 2,18 m/1000 tonnes;

the costs of rifled workings - 1,15 m/1000 tonnes;

ores yield of 1 m of the borehole - 13 tonnes/m;

the cost of explosives on the breaking of ore - 0.508 kg/tonne;

the cost of explosives for secondary crushing - 0.167 kg/tonne;

electricity consumption - 6,5 kW h/t;

VDPU-4TM performance- 500 t/shift;

the performance of one miner by development system - 51 tonnes/shift.

losses of magnetite quartzites during mining: cameras - 4%; "triangle" of the lying part - 36%; floor pillar - 42%; pillar - 46%:

contamination of magnetite quartzites during mining: cameras - 4%; "triangle" of the lying part - 14%; floor pillar - 17%; pillar-18%.

Analysis of technical and economic indicators of the block mining (+22)÷(+34) horizon. 527 m by surface-chamber system of development with ore breakage by deep boreholes and ore vibrorelease compared with indicators of similar development system, but with the use of load-hould mining dumpers at foreign mines, showed such shortcomings of development system applied at Ordzhonikidze mine:

very complex structure of the block bottom with the ore vibration release with not enough effective ventilation of workplaces;

danger of works at elimination of jams of ore in ore chutes;

big expenses of preparatory and cut developments (3,33 m/1000 ton) compared with systems which apply the load-hould equipment (1,6-1,8 m/1000 ton):

explosives significant costs on the cutting and secondary crushing of ore (0.675 kg) compared with systems that use the load-hould dumpers (0,450-500 kg / t);

low productivity of vibrorelease and delivery of ore (450 - 500 ton / shift);

low productivity of the drilling foreman on the NKR-100M machine (50 - 60 m/shift) compared with load-hould drilling rigs (90-110 m/shift);

low productivity of one miner on system (50-51 ton/shift) in comparison with systems which apply load-hould dumpers (70-80 ton/shift):

cost value of production of 1 ton of magnetite quartzites in 1, 5-2 times higher compared with systems using load-hould dumpers.

So, the carried-out technical and economic analysis of surface chamber system of development with ore breakage by vertical fans of boreholes and ore vibrorelease allows to draw such conclusion.

The technology of underground production of magnetite quartzites applied now on mine of Ordzhonikidze is characterized by low technical and economic indicators compared with technology on the basis of load-hould boring and delivery equipment.

For the purpose of efficiency increase of magnetite quartzites underground production technology in Krivbass it is necessary to develop and enter the systems of development with use of high-performance load-hould mining dumpers.

Establishment of trench bottom optimum parameters. Floor pillar processing and pillar with the surface-chamber system of development, as mentioned above, it is characterized by significant losses and blockage of ore.

In order to establish the laws of the ore extraction indicators changes from the cave floor pillar thickness and the distance between the loading drives when applying the block trench bottom and load-hould dumpers the laboratory tests, which allow to optimize the floor pillar settings and trench bottom construction were conducted.

Laboratory tests were made on stationary model with the front glass wall constructed in scale 1:100. The bottom of model imitated the trench bottom of the camera 40 m wide and 15 m high, prepared with a bilateral arrangement of loading drives from delivery orts.

As magnetite quartzites of the cave floor pillar the crushed magnetite ore with fineness of 2-3 mm with a volume weight of 2,3 t/m^3 was used, and the cave waste rocks, which covered the floor pillar, were provided by the crushed gray granite with fineness of 3-4 mm.

Horizontal contact "ore -gangue" was created by use of the crushed chalk to the sizes of 0,05-0, 1 mm.

Edge ore release from model on a bottom of the loading drives, which located at distance 10, 12, 14 cm was carried out by doses of 250 g.

The ore release mode – is uniform and consecutive. Release and delivery of ore from model were simulated by the load-hould dumper of firm " Atlas Copco" of EST-3,5 with a loading capacity of 6000 kg with a standard ladle spaciousness by 3 m ^{3}. On the basis of the received indicators the dependences of losses and a contamination of the released ore from distance between loading drives are established at a different floor pillar thickness (fig. 1).

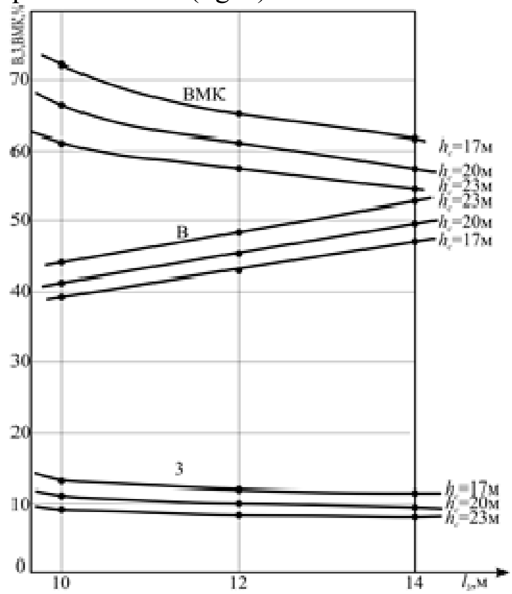

Fig. 1. Dependences graphs of losses *In*, a contamination Z and recovery of the BMK magnetite quartzites when developing by surface chamber system from thickness of a floor pillar of *hc* and distance between loading drives of l_3

Dependency graphs analysis showed that at the same distance between the loading drives with increasing distance between the loading drives with the same floor pillar thickness the ore losses increase with an increase of floor pillar thickness. Ore losses by increasing the distance between the loading drives with the same floor pillar thickness also increased. This is because the thicker floor pillar and the greater the distance between the loading drives, the larger will be the ridges between the exhaust ore workings at the bottom of the trench.

The contamination of released ore at an equal distance between the loading drives decreases with increasing the floor pillar thickness. This is because the smaller the floor pillar thickness, the greater the accuracy of the waste rock displacement to the ore during release. As we can see the regularities of changes of the released ore contamination values has an opposite character to change the quantities of ore losses. The established change patterns of losses indicators determined as a result of laboratory researches and ore contamination allowed to prove the sizes of constructive elements of the blocks trench bottoms. The optimum size of the trench bottom in specie should be considered: the height of the bottom - 15 meters, the distance between the delivery orts - 20 m, distance between the loading arrivals - 12 m, the distance between the trench and the delivery orts – 10 m.

Development of high-performance surface-chamber development system of magnetite quartzites thick deposits using load-hould mining dumpers.

In the design of the surface-camera system, the following block design parameters are accepted:

camera width behind extension of a deposit-	40 m;
camera height-	50 m;
width of interchamber pillars-	20 m;
thickness of the trench bottom-	15 m;

floor pillar thickness to the level of the retractable horizon above the placed floor of-15 m;

floor pillar thickness considering the cameras bottom part of the abandoned floor - 20-25 m.

Considering the patterns of change in ore extraction indicators at distances between loading drives of 10, 12 and 14 m (see. Fig. 1), as well as requirements of durability ensuring and saving of loading and delivery workings of block trench bottom, the reasonable distance between the loading drives is 12 m.

According to reasonable parameters of the block and constructive elements of the bottom of the camera the following sizes are established:

distance between delivery orts-	20 m;
distance between the delivery and boring orts-	10 m;
distance between boring orts-	20 g.

The functional workings cross sections for operation of load-hould mining dumpers in them, considering dimensions of load-hould mining dumpers and safety requirements was determined. In development system designing such cross-sectional dimensions of the main workings was dopted:

delivery ort -	3,6×3,8 m
loading drive -	3,8×3,8 m
boring ort-	4×4 m
delivery strike of the main horizon	3,8×3,0.

Development of the recommended design of superficially chamber system using load-haul-dumpers is based on the following assumptions:

camera is placed with the long side crosswise to extension of a deposit;

the block bottom – is trench (fig. 2);

ore recovery – is edge on loading drives;

loading and delivery of ore is carried out by load-haul-dumpers NDM TORO 400 E of Sandvik firm which has big productivity compared with EST-3,5 of firm "Atlas Copco" (fig. 3);

drilling of deep boreholes is carried out by "Sandvik" DL 410-10 or "Sandvik" DL 421-15 drilling rigs;

magnetite quartzites breaking is carried out by vertical fans of deep boreholes from subfloor boring orts;

form of a cleaning stope – is stepped, with an advancing of an upper subfloor in relation to lower;

drilling of a floor pillar is carried out from developments of the bottom of the fulfilled floor blocks.

Calculations of the BPR parameters are executed according to the Instruction of NDGRI [15]. With a diameter of deep boreholes of 110 mm of LNO - 2,65 m, distance between boreholes in a fan - 3,2 m.

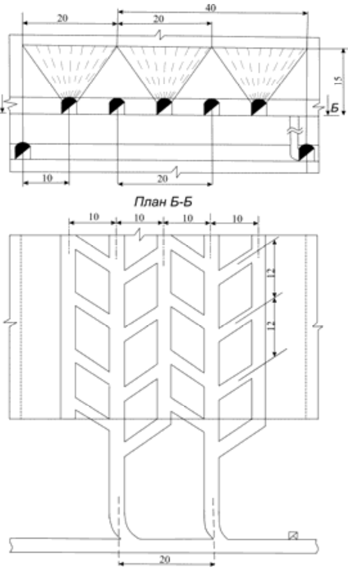

Fig. 2. A design of the block trench bottom at superficially chamber system of development using load-haul-dumpers

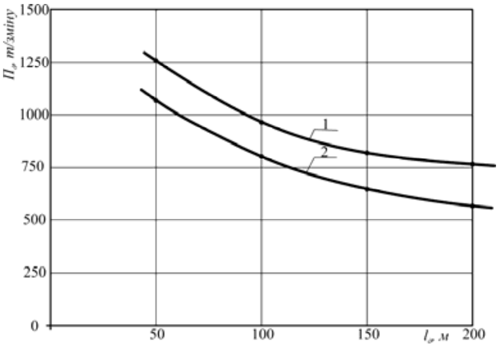

Fig. 3. Schedules of productivity dependence of load-haul-dumpers *of* $П_з$ from l_d *ore* delivery distance: *1* - TORO400E; *2* - EST-3,5

The developed design of highly productive surface and chamber system of development of magnetite quartzites thick deposits are shown in fig. 4.

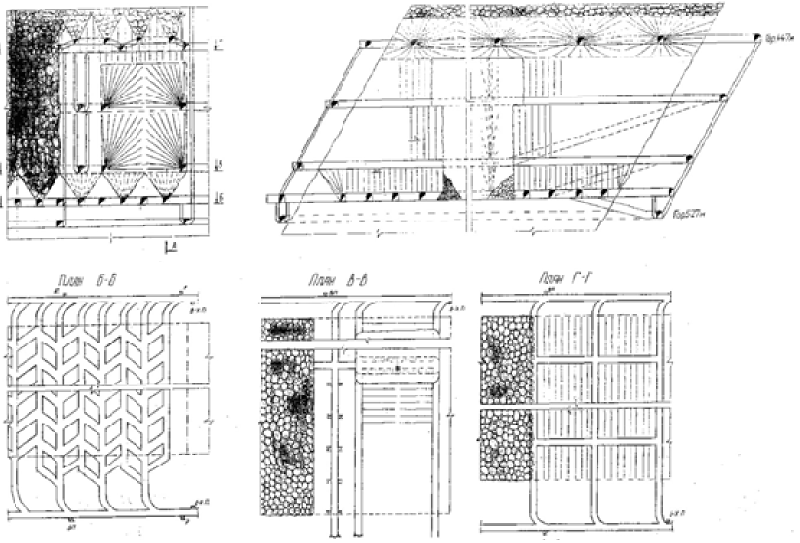

Fig. 4. Surface and chamber system of development of magnetite quartzites thick deposits using modern load-haul mining dumpers

The main calculation technical and economic indicators of the developed system

Chamber reserves of the block, thous. tones	2448
Total length of preparatory developments, m	2925
Total length of cut developments, m	1500
Specific expenses preparatory developments, m/1000 ton	1,19
Specific expenses of cut developments, m/1000 ton	0,61
Total length of boreholes on the block, m	126 648
Recovery of magnetite quartzites from 1 m boreholes,ton	17
Specific expenses of explosive, kg/ton	0,480
Productivity of the master of the Sandvik DL 421-15 drilling rig, m/shift	90-110
Productivity of the driver of a load-haul-dumper, TORO 400E at delivery distance in the ore chute of 120-150 m, t/shift	1000-1200
Productivity of one miner on system of development, t/shift	76
Cost value of 1 ton of magnetite quartzites, UAH/ton	115
Total losses of magnetite quartzites, %	37
General contamination, %	13.

On the basis of the offered technology the passport of surface and chamber system of development of magnetite quartzites powerful deposits using dump techniques which should be used at design of underground mining of magnetite quartzites deposits on the Krivbass operating mines is developed.

Conclusions. Expansion of a raw materials source of underground Krivbass for the purpose of increase in term of iron ore mines existence and reduction prevention of commercial ores production in case of attracting to magnetite quartzites underground production, which lie on the upper horizons in fields of the operating mines, which have sufficient lifting opportunities, the developed infrastructure and the qualified mining personnel.

The development technology of a deposit "Youzhny magnetite", which is currently applied at the Ordzhonikidze mine is still uniform mine of magnetite quartzites underground production in Krivbass and characterized by low technical and economic indicators and insufficient level of safety on release and delivery of ore vibroinstallations in comparison with the advanced foreign mines.

In order to improve the efficiency of ore underground production technology the high-performance surface and chamber system of development with the block trench bottom and with the ore delivery by load-haul-dumpers which is characterized by high technical and economic rates was developed.

Implementation in practice of Krivbass mines operation of the recommended technology of magnetite quartzites underground production will allow to increase the work productivity of one miner by the system of development by 1,5-1, 7 times, to reduce costs of preparatory and cut developments for 1000 ton of stocks in 1,8-2 times, the explosives costs of ore secondary crushing in 1,2-1,3 times and to reduce the cost value of 1 ton magnetite quartzites production by 1,5-1,75 times.

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