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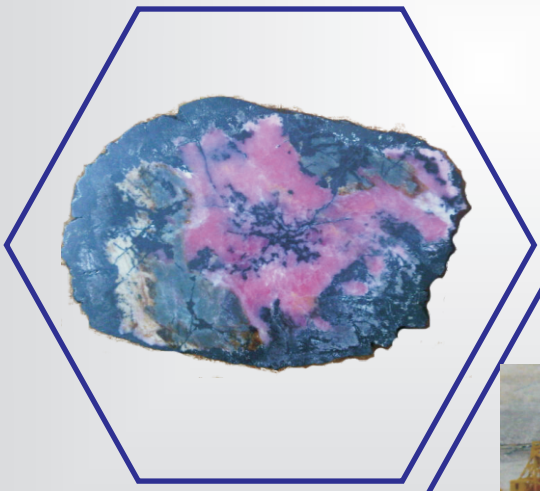

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Saša Mitić[*], *Nenad Makar*[*], *Nenad Radosavljević*[*], *Zoran Despodov*[**]

EXCAVATION BETWEEN THE LEVELS H-910 AND H-830 IN THE "SVINJA REKA" MINE DISTRICT OF THE "SASA" MINE - MAKEDONSKA KAMENICA

Abstract

In this paper, the principles of mining between the levels H-910 and H-830 in the "Svinja reka" Mining District of the „Sasa" lead and zinc mine located in the M. Kamenica, are presented. Excavation has to be realized by implementation the sublevel caving mining method, while temporarily leaving the safety pillars, which have to be blasted in the second phase of excavation. The paper presents development works, as well as works for the ore blasting, based on the designed mining method. Also, the techno-economic parameters of mining method and work organization are presented.

Keywords: *lead and zinc, Svinja reka mine, sublevel caving method*

INTRODUCTION

Exploitation in the "Sasa" mine is done according to the approved documentation [1, 2, 3, 4]. In order to secure the amount of ore required for the designed capacity of 750,000 t/year, it was decided that the excavation should be intensified in the Mining District "Svinja Reka", primarily between the levels H-XIVb and H-830. This part of the mining basin was chosen for excavation intensification primarily due to the mining-geological ore qualities and waste rock, as well as due to the acceptable metal content in the ore. Having in mind the metal content in this part of the basin, as well as the present metals prices in the world market, it was concluded that intensifying the excavation of this part of the basin would provide the satisfactory economic effects. This paper presents the first excavation stage of the aforementioned part of the basin, between the levels H-910 and H-830.

ORE RESERVES BETWEEN THE LEVELS H-910 AND H-830

Geological explorations the ore mass between H-XIV and H-830 were done by the surface exploration drilling, pit exploration drilling and pit exploration operations. The shape and dimensions of the ore masses are changeable; by the way they extend and drop. Geological explorations identified three ore masses - shelf, middle and roof [3].

After conducting the explorations, the ore reserve amounts were calculated for levels between H-910 and H-830 in the mining district "Svinja reka", and displayed in the verified study of mining reserves, i.e. Table 1.

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Table 1 *Ore reserves between the levels H-910-H-830 between the profiles 1350-400*

Category	Q (t)	Pb (%)	Zn (%)	Pb (t)	Zn (t)
A+B	1,795,582	4.83	3.28	86,727	58,895
C_1	3,572,025	4.41	3.27	157,526	116,805
Total A+B+C_1	**5,367,607**	**4.55**	**3.27**	**244,253**	**175,700**

OPENING AND BREAKING IN

Opening and breaking in of the "Svinja reka" basin was done with the Central mineral loose and export shaft, i.e. multiple excavation sites, ramps and raises. All opening and breaking in pit area are designed and made in accordance with the engineering standards, as well as law and regulations [1].

The pit areas are designed based on the dimensions of equipment to be used during excavation, designed production capacity for individual arts of the basin, as well as the necessary transport capacity and transport of blasted materials - ore and waste. The technology of construction of all pit areas of opening and breaking in was designed by application the classic technology of drilling-blasting operations, using loading and transporting powered by diesel fuel, in combination with rail transport - pit locomotive and cars [1, 2].

EXCAVATION BETWEEN H-910 AND H-830

Based on data obtained during the exploitation of higher areas of this basin, between H-XIVb – 990 and H-990-910 [2,3], this appears to be a stable work environment, with a solid ore, which is partially crushed, while the trace waste rocks cannot bear large loads so the building of supports is necessary.

Based on this data, in order to excavate this part of the basin, a **sublevel caving method was adopted from the lowest level to highest.**

Depending on the richness of ore mass (up to 10 m and over 10 m), the variants will be applied in stages - I stage is comprised out of excavation beneath the protective plate, while the II stage encompasses the ore excavation beneath the protection plate.

This paper presents the variant which will be used in the most of ore mass, and relates to the sublevels - intervals PE 910-7 to PE 910-70, which are beneath the protective plate.

The excavation geometry is shown in Figure 1 [4,5].

The excavation starts with the raise for kerf (RK), constructed between two sublevels, using a classic technology of mining-blasting operations. The construction is done in segments of 2 m. The segment number depends on the richness of ore vein and its geometry angle [4,5].

After the construction of U3, the ore blasting begins, with drilling-blasting operations. Excavation is conducted using the Rocket Boomer 281 (Atlas Copco, Sweden) car type from the raise for the kerf, in retreat, towards the access stope (PrH). Drilling of the sublevel plate is done in segments. The length of the mining drill holes is 3.0 m and the drilling is done with an angle of 40°. The number of production mine drill holes depends on the thickness of ore vein - width of the stope.

The stope-room b=15 m wide is located between two safety pillars (SS), and is divided into several excavation drifts (OH) between the excavation pillars are placed (OS). The excavation pillars are of minimal

width b_{os}=3.0 m. All of these areas, as well as the demolishing of the excavation pillars is done with the drilling car Rocket Boomer 281 (Atlas Copco, Swe). Depending on width of the stope-room, the number of excavation drifts (OH) and excavation pillars will differ, and in this sense their proper designing is necessary, as well as constant geological and mining exploration works during excavation, so as to enable proper excavation. This is especially important due to maximum decrease in depletion and maximum use of ore. This means that the excavation drifts (OX) and excavation pillars (OS) do not have to be of equal dimensions [1].

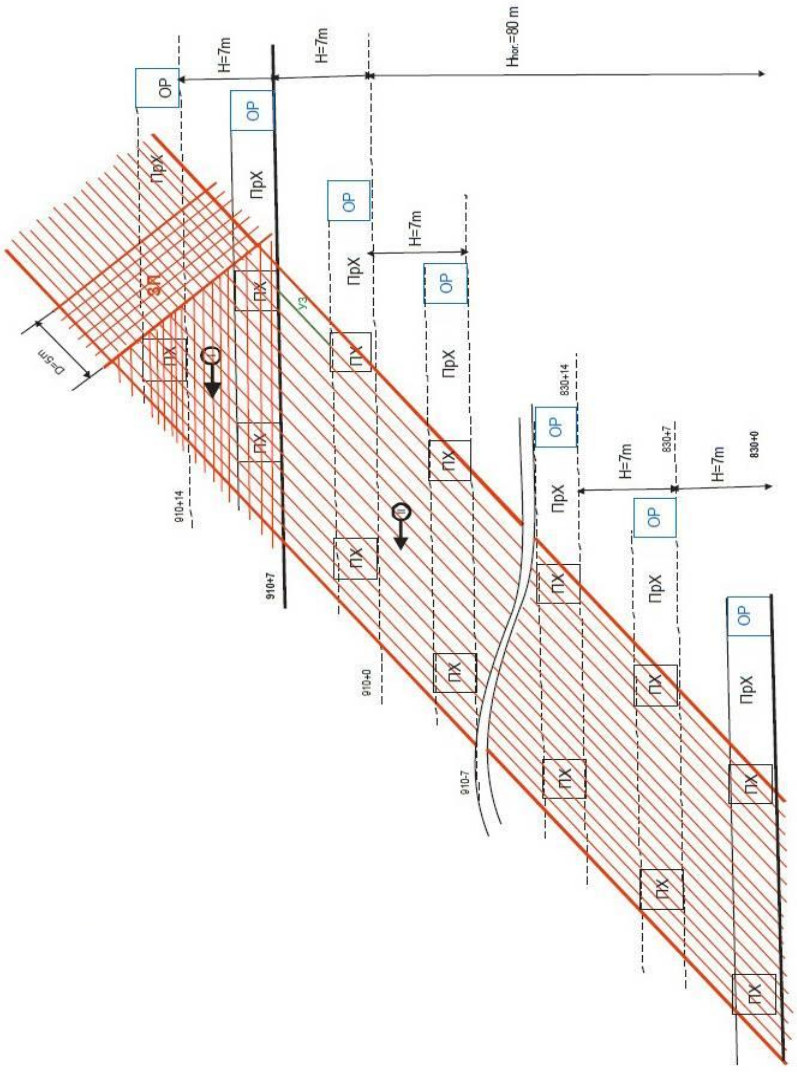

Figure 1 *Stages of preparation and mining block excavation*

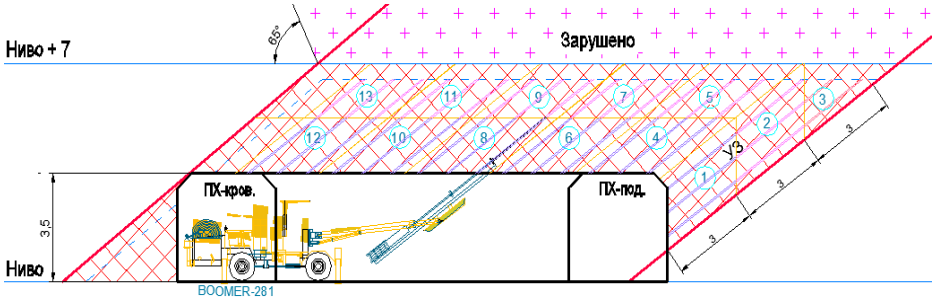

Figure 2 *The ore blasting schedule in applying the sublevel caving method for excavation the ore mass, thickness of over 10 m*

The further operations schedule of excavation is as follows:

1. With ore masses over 6.0 m thick, after construction the first excavation drift (OH), a floor sublevel drift is firstly excavated (PH), immediately next to the safety pillars (SS). This where special caution must be taken during the contour blasting in the CC zone, so as to properly form CC and avoid its weakening.
2. The second excavation drift is constructed OH, on an axial distance of 6.0 m which forms the excavation pillar (OS);
3. The ore gained through the construction of the raise for kerf (RK) is loaded and transported;
4. Drilling a fan of mine drill holes is done in the sublevel plate and the excavation pillar (OS), up to half of its width. It is recommended that in stope all of the excavation drifts (OH) be finished, and then to start the ore blasting in the sublevel floor, in retreat;
5. Mine holes are filled with explosives, according to the platform rule, for safety purposes;
6. The ore is mined-blasted;
7. The stope is ventilated;
8. Mine holes are drilled in the sublevel plate, the second half of the excavation pillar (OS). The width of the stope, in this case is b=6.0 m;
9. The ore is mined-blasted;
10. The stope is ventilated.

This is the manner in which the excavation of all stopes will be done in the individual mining block.

The demolition of roof rocks will be spontaneous, as the excavation progresses, from the roof towards the floor, and the angle under which the drilling and blasting is done does not allow large depletions of ore, i.e. a significant breach of waste rock from the roof of stope. In case that spontaneous collapse of waste rock does not occur, the secondary blasting will be conducted, after the loading and transport of previously blasted ore from the sublevel plate and excavation pillar (OS). In these cases, the remote controlled loaders are used so as to prevent the endangerment of employees.

After the separation ventilation of the work site, loading and transport of ore is done using a loader powered by diesel fuels. During loading, the amount of the blasted ore must be calculated in order to avoid increased dilution of the ore substance. The ore is transported to the mineral loose, and is then transported gravitationally to the transport level H-830 from where it is transported using trolley locomotives and "Gremby" carts to the bunker of the export-service shaft "Golema reka", and beyond, across the central transport system to the surface [1,6].

TECHNO-ECONOMIC EXCAVATION PARAMETERS

Techno-economic excavation parameters via the sublevel caving method from roof to floor in the Mining District "Svinja reka" of the "Sasa" mine - Makedonska Kamenica between H-910 and H-830 are shown in Table 2 [1].

Table 2 *Techno-economic parameters of excavation in the trial block*

Amount of ore in block ($T_č$)	1,795,582 t
Amount of ore to be excavated ($T_č$)	1,382,732 t
Exploitation coefficient (i_r)	0.77 (77 %)
Ore loss (g_r)	0.23 (23 %)
Dilution of ore substance (expected) (O_r)	0.22 (20 %)
Stope capacity (for production of Q_g=150.000t/year)	140.85 t/shift/block
Required daily production (Q_{dp})	1,268 t/day
Required amount of blasting per shift (N_{sf})	1
Excavation performance	10.3 t/wage
Excavation intensity	5.13 m/year
Required number of workers per day	36
Workforce norm	0.083 wage/t

CONCLUSION

Having in mind the mining - geological ore and waste rock characteristics between H-910 and H-830 levels, as well as based on the experiences gained so far during the excavation of the higher parts of the Mining District "Svinja reka" (between levels XIVb-990 and H-990-910), as well as the additional techno economic analysis, the conclusion is that the excavation of ore between H-910 and H-830 is technologically justified in using the *sublevel caving mining method from the roof towards the floor*, with temporary placement of excavation pillars. One of the main shortcomings of this method of excavation is the necessity of placement the protective plate for the purpose of support of surrounding rocks, in order to secure a safe and proper operation on the stopes - sublevels. The slanted protection plate is defined with the purpose that the excavated area can be properly filled with the blasted waste rock, for the purpose of reducing the loss of ore substance. According to the estimations, the slanted protection plate reduces the loss up to 50% compared to the horizontal plate. Also, the stability of stopes in its vicinity is also increased. Although the ore left in the protection plate cannot be excavated, the techno-economic analysis has shown that these losses are completely justified.

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