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ESTABLISHING THE SPATIAL CONDITIONS AT THE SOUTH MINING DISTRICT MAJDANPEK TO ACHIEVE THE CONTINUITY IN ORE MINING: A PROPOSED TECHNOLOGY FOR SEDIMENT LAYER REMOVAL**

Abstract

Development of mining works at the South Mining District Majdanpek in the following short-term period requires removal of water, sludge and sediment from the water collector on the open pit bottom in order to create the necessary exploitation and spatial conditions for undisturbed operation of mining equipment.

This paper presents the technology of sediment removal from the inactive water collector on the bottom of open pit, which is a condition for maintaining the continuity of copper ore mining and processing at the South Mining District the Majdanpek Copper Mine. The technology is designed from the aspect of ensuring the maximum safety of people and mining equipment.

Keywords: *Majdanpek Mine South Pit, technology, water collector, sludge and sediment layer, safety*

1 INTRODUCTION

The South Mining District Majdanpek operates within the company Copper Mine Majdanpek, which is a part of the company Zijin Bor Copper doo Company (former Mining and Smelter Basin Bor Group).

The Copper Mine Majdanpek, in the production, technical and technological sense, represents a complex mining system that has the activities from geological explorations the mineral resources, ore exploitation and processing to a number of supporting activities as the necessary support to the core activities [1]. The ore production and processing in the Copper Mine Majdanpek is currently developed at the Open Pit South Mining District and is of great importance for the copper production in the system of company Mining and Smelter Basin Bor Group (RTB Bor Group) [2].

Mining activities at the open pit mine South Mining District of the Majdanpek Copper Mine currently take place in the eastern side of the open pit. The ore excavation currently takes place at the bench B 215. Based on the current exploitation conditions and situation on the site, the mining operations can be developed to the bench B 140. According to the planned capacity, the operation would take place over a period of six months. The amount of ore that can be excavated in that period is about 4,000,000 tons.

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In order to achieve the planned capacity of copper ore excavation and processing in the next short-term period of 600,000 t ore per month, it is necessary to provide the exploitation and spatial conditions for the undisturbed operation of mining equipment at the South Mining District Majdanpek [3].

This means that it is necessary to enable the development of mining operation at the benches B 215 to B 110. This requires the drainage and removal of materials from the inactive water collector at the level L+150 m to the bottom of the open pit, which is at the level of L+122 m. This is necessary in order to create the conditions for ore excavation to be carried out smoothly.

2 MATERIAL CHARACTERISTICS IN THE INACTIVE WATER COLLECTOR

Figure 1 shows the location of inactive water collector at the level L+150 m on the bottom of the South Mining District Majdanpek.

Figure 1 *Location of the water collector at the level L+150 m on the bottom of the South Mining District Majdanpek Mine (north side view)*

It is estimated that the three layers can be separated in the water collector:

- Clear water layer
- Sludge layer
- Sediment layer

It is estimated that the clean water layer is about 8 m deep with its solid phase concentration of below 20% and the total water volume of 350,000 m^3. The sludge layer is about 4 m deep; its solid phase concentration is 20% - 40%, and the total volume is 156,000 m^3. The sediment layer is about 18 m deep; its solid phase concentration is greater than 40%, and the total volume is 460,000 m^3.

Figure 2 shows a profile of accumulated layers.

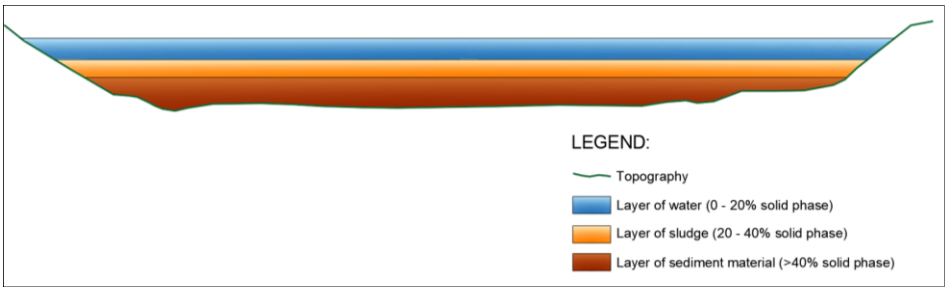


Figure 2 *Profile of the accumulated layers [3]*

3 TECHNOLOGICAL PHASES OF MATERIAL REMOVAL FROM THE INACTIVE WATER COLLECTOR

According to the defined layers, there are three phases:

1) Phase 1: Clear water layer dewatering
2) Phase 2: Slurry layer removal
3) Phase 3: Slurry layer removal.

3.1 Phase 1: Clear water layer dewatering

The drainage system of this water will be a cascade type. Submersible pumps will be installed in the accumulation to pump water to the water collector at the level L+180 m, from where it will be pumped by the stable pumps to the precipitator for the physical treatment of solid particles at the level L+350 m, next to the crushing plant. This purified water goes into the existing precipitator with zeolites from which it is discharged into the river Mali Pek.

3.2 Phase 2: Slurry layer removal

Slurry is planned to be transported by the slurry pumps. The main parameters of the slurry pumps: flow rate is 1271 m^3/h, lifting height is 64.6 m, rotation is 590 r/min, and mortar power is 355 kw. Slurry is transportted to the hydrocyclone system for classification. The processing rate (considering the fluctuation, coefficient 1.1) is 1019.46 m^3/h, feed size is not above 10 mm, concentration is 20 - 40%, pressure is 0.1 MPa, slurry concentration is 70%, settling rate is 221 m^3/h, overflow concentration is 7.5 - 20%, and overflow volume is 438.44 - 1240.48 m^3/h. The settled sediments will be disposed by the excavator loading + truck transportation. The overflowing water is pumped into the clear water drainage system and flow to the outside ditch by the relay submersible pumping and fixed pumping station.

3.3 Phase 3: Sediment layer removal - proposed technology

Sediment layer was formed by material deposition that collapsed from the mine slopes with a larger participation of small fractions, with the expected presence of a solid phase in the average of 65% (minimum 40%). The sedimentary layer thickness, depending of the bottom of excavation, and it is variable and assumed that the maximum thickness is 18 m, i.e. from L+138 m to L+120 m. Prior to the excavation, i.e. after water draining of the sludge layer and removal the sludge, it is necessary to make a paved path to the presumed sediment layer level of L+ 138 m, so that a direction of sediment excavation is from the north to the south.

A technology of sediment layer excavation, which enables the safe movement of machinery during operation, is proposed. This can be achieved by formation a ramp of about 8 m width and up to 5 m height from the bulk material, obtained from the waste excavation at the open pit. The bulk material would have reached the location by the trucks, and a ramp formation would be done by a bulldozer, gradually with the excavation progression of the sedimentary layer. The northern part of the sediment bed is optimal for the start of loading work. The ramp will be gradually made from the north to the south, i.e. from the level L + 138 to about L + 125, with a constant angle.

Considering that the real situation of the pit bottom in the area below the sediment layer is not known, but will be gradually discovered during the excavation of the sediment layer, the position of the ramp will be adapted to the situation on site. By analyzing the problem, the initial ramp can be constructed on the eastern side of the sediment layer, which would also serve to excavate the depressions for water accumulation. Depressions for water accumulation will be excavated in the area within the excavation radius of the loading equipment, while the equipment itself is on stable ground (excavation ramp), Figure 3. Accumulated water in depressions will be pumped out, unless the depressions are filled back with sediment material. During the material excavation from the sediment layer, the accumulation of water near the excavation ramp can be expected due to the proposed backhoe excavation technology. Also in this case, the water needs to be pumped out of the work site.

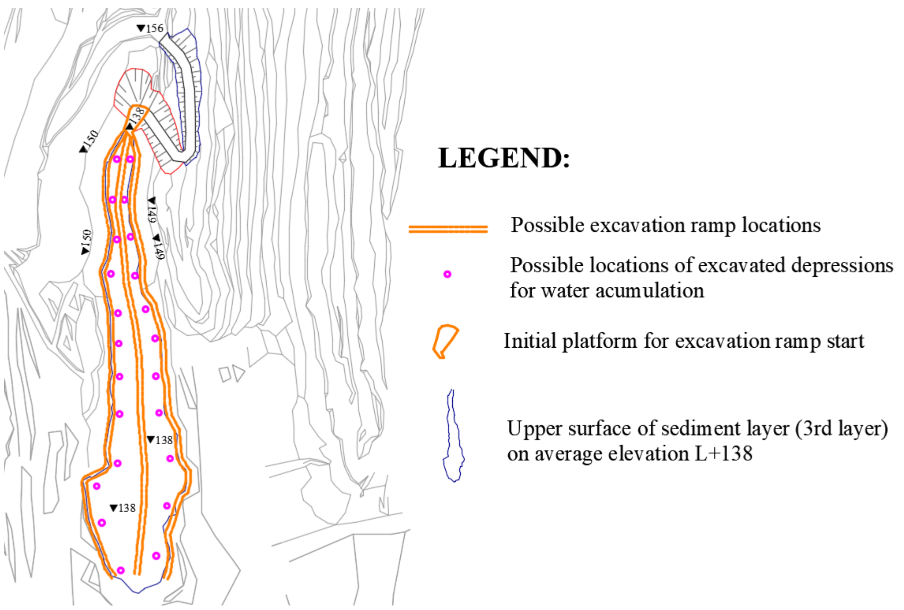
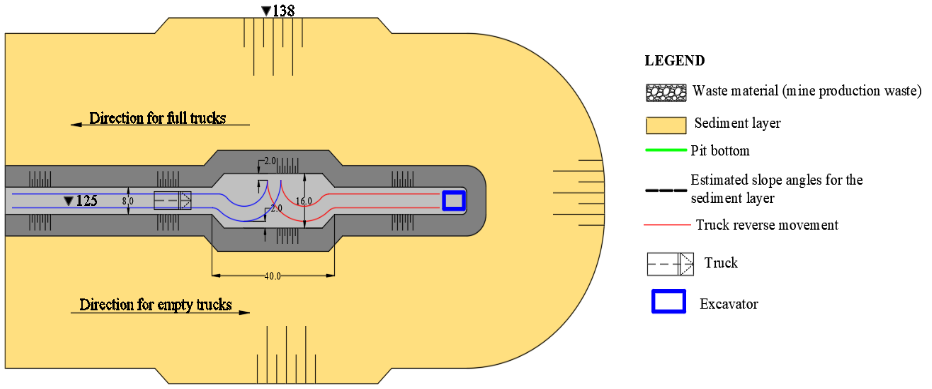


Figure 3 *Possible excavation ramp locations for the sediment layer excavation [3]*

The ramp will also enable the safe operation of mechanization during drainage of the sedimentary layer. Figure 4 (a, b and c) presents the technological scheme for loading material from the sediment layer.

a)



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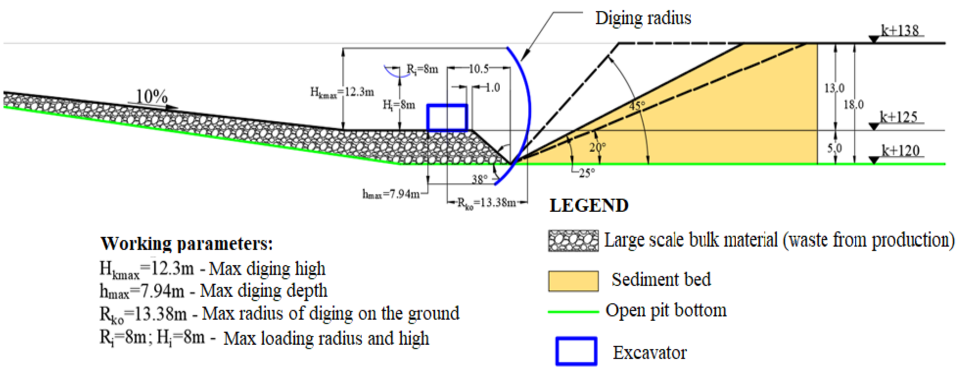

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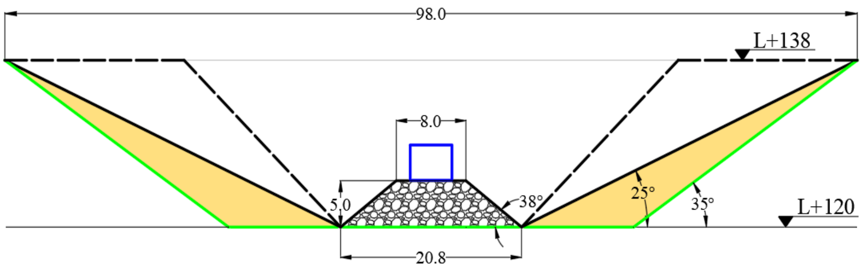

Figure 4 *Technological operating scheme excavator-truck system on the loading material from the sediment layer (a, b and c) [3]*

According to the sedimentary layer, made of a non-cohesive material, where a certain amount of sludge can be expected, as well as the climatic conditions in the Republic of Serbia in the spring period, the slopes of sedimentary layer in the excavation process will be at the estimated angle of 20-45°.

Due to the simulation and calculation of loading and transport operations, the equipment for loading and transport the sediments, i.e. a hydraulic excavator (backhoe) with a bucket capacity of 6.5 m^3 and trucks with a capacity of 70 tons, will be used. The same trucks will be used to estimate the bulk material with a large-granulation for ramp construction. The loading of sediments will be carried out above and below the excavator level, in accordance with the ground conditions, as described by the technological scheme. Considering the length of the open pit bottom, where the sediments will be loaded (max. up to 500 m), and according to the working conditions, the ramp should be constructed with width from 8 m to 16 m on a part with length of about 40 m, for every 50-100 m. These parts should provide a passage and turning of trucks near the loading area. In a part of the open pit bottom, due to the terrain conditions, with a larger width of the sedimentary bed, where it is difficult to excavate from one central ramp; two or three parallel ramps can be formed from the central one. With these parallel ramps, the sedimentary bed would be covered in the entire width.

Loaded material from the sedimentary layer will be transported by trucks to the location of disposal, so called the "Bugarski potok", south-west of the southern part of the open pit. In case of material loading with a higher amount of liquid phase, it is suggested that the trucks would not be loaded up to maximum, but 50% of the "struck" volume of the truck's hopper. This scale of loading can be increased if it is permitted by the material characteristics.

At the place of disposal, the formation of ramps and safety ramparts with 1-2 m height is proposed. This would protect the trucks in a case of unloading the grain material, and also, to make place for maneuverring the trucks on the unloading point easier to maintain. The disposal site can be divided into several unloading locations, which will allow more efficient drying of the unloaded material.

Figure 5 shows the locations for loading and unloading of sedimentary material, the location for loading the ramps for ramps construction and the transport lines for transport the sedimentary material and waste.

4 CONCLUSION

In order to ensure the realization of the 600,000 tons of excavation and processing copper ore monthly, it is necessary to create the exploitation and spatial conditions at the Open Pit South Mining District Majdanpek.

To fulfill these requirements, it is necessary to remove the layers of water, sludge and sediment from inactive water collector at the level L + 150 m. Materials will be removed in three stages. First, clear water layer will be dewatered, then slurry layer will be removed and finally slurry layer will be removed.

The proposed technology envisages the operation of existing equipment for loading and transport of materials. Also, the proposed technology was designed from the aspect of ensuring safe operation of people and equipment during the mining operations.

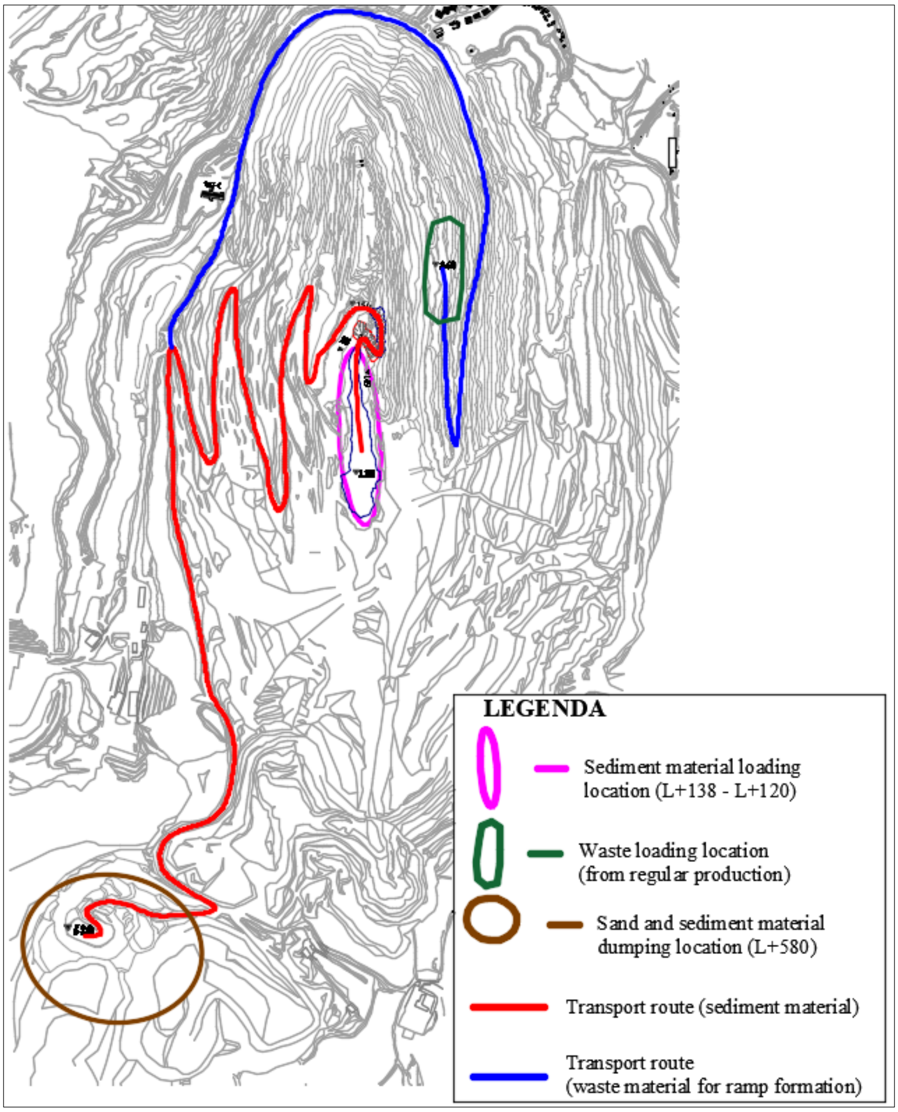

Figure 5 *Transport lines for material from the sedimentary bad (pink) and waste form the ramp construction (orange) [3]*

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