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THE COMBINED MINING METHOD OF UNDERGROUND AND OPEN PIT EXPLOITATION OF THE POLYMETALLIC ORE BODY "TENKA" IN MAJDANPEK COPPER MINE

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ABSTRACT: Existing rest parts of the polymetallic ore body "Tenka", after finished open pit mining, content the significant amount of very rich polymetallic ore. In accordance with that, we decided to find out whether is possible to mine out this ore using the combined mining method of underground and open pit exploitation. Combined mining method is consisted of open pit technology in the phases of drilling and blasting operations and underground technology in the phases of loading and haulaging the ore to the ground of the terrain. In the paper is presented the basic elements of the technological solution in the both technologies. Such solutions is determined by the mining, geological and geomechanic circumstances and conditions in the Majanpek Copper Mine.

КОМБИНИРАН МИНЕН МЕТОД ЗА ПОДЗЕМЕН И ОТКРИТ ДОБИВ НА ПОЛИМЕТАЛНО НАХОДИЩЕ «ТЕНКА» В МЕДНА МИНА МАЖДАНПЕК

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РЕЗЮМЕ. Наличните останали части от полиметалното находище «ТЕНКА», след приключването на добива по открит начин, съдържат значителни количества богата полиметална руда. В съгласие с това, бе решено да се установи дали е възможно използването на комбиниран метод на открит и подземен добив. Комбинираният минен метод се състои от технология на открит добив във фазите на проучването и взривяването и подземна технология във фазите на натоварването и превозването на рудата до повърхността на терена. В доклада са представени основните принципи на технологичното решение в комбинираната технология. Тази технология обхваща добива, геоложките и геомеханичните обстоятелства и условия в медна мина Мажданпек.

Introduction

Polymetalic deposit "Tenka" is located in North part of Majdanpek deposit zone. Productive zone has shape of irregular trapezium directed from North to South. It is steeply dipping ore body, consisted of veins and lentiles from level +540 m to level +400 m. The most prevailing minerals are pyrite, sfalerite and chalcopyrite. Average content of profitable metals are the following:

- Zinc – 2.59 %;
- Lead – 0.40 %;
- Copper – 0.39 %;
- Silver;
- Gold; etc.

This deposit is divided in two ore bodies – "Tenka 1" and "Tenka 2".

Since the Majdanpek deposit is mined out by open pit technology, the same technology was applicated for exploitation of "Tenka" from level +540 m to level +485 m. Practically, open pit "Tenka" was a North part of Majdanpek open pit with common infrastructure and equipment for exploitation.

After finished open pit mining of the polymetallic ore body "Tenka", a part of this ore body remained below the level +485 m with 870000 t of ore reserves.

In accordance with this, it is investigated out whether is possible to mine out this ore. It is considered a few alternatives and finally, it is chosen the combined mining method of underground and open pit exploitation as the most profitable method.

Development

Basic development of ore body "Tenka" must provide to exploitation function properly. In accordance with that, it is accepted the following concept for development, which should provide:

- maximal usage of existing infrastructure of open pit Majdanpek (roads, electricity, etc.);
- minimal length of excavations in order to reduce development costs;
- approach to level +400m;
- location of excavation out of destruction zone due to applied stopping method.

Basic development includes the transport & haulage ramp, the ventilation drift and the ventilation shaft (figure 1). The transport & haulage ramp will connect the transport road on surface (open pit) with the underground (the ventilation drift and the ventilation shaft). The ventilation drift will be connection between the

transport & haulage ramp and the ventilation shaft in order to enable circulated ventilation.

The secondary development is intimately connected with the mining method. Since the applied method require division the ore body in two sections (two phases of exploitation), the secundary development includes excavations in two levels - +440 m and +400 m.

In the I phase of exploitation, development includes the service ramp (from the transport & haulage ramp to the level drift +440 m), the level drift (from the service ramp to the ventilation shaft), the drifts made in ore body for draw point loading, the gate roads which connect the level drift with the drifts, the loading crosscuts which connect the level drift with the ore passes and the two ore passes.

In the II phase of exploitation, development on level +400 m will have the same pattern of excavations as development in the I phase.

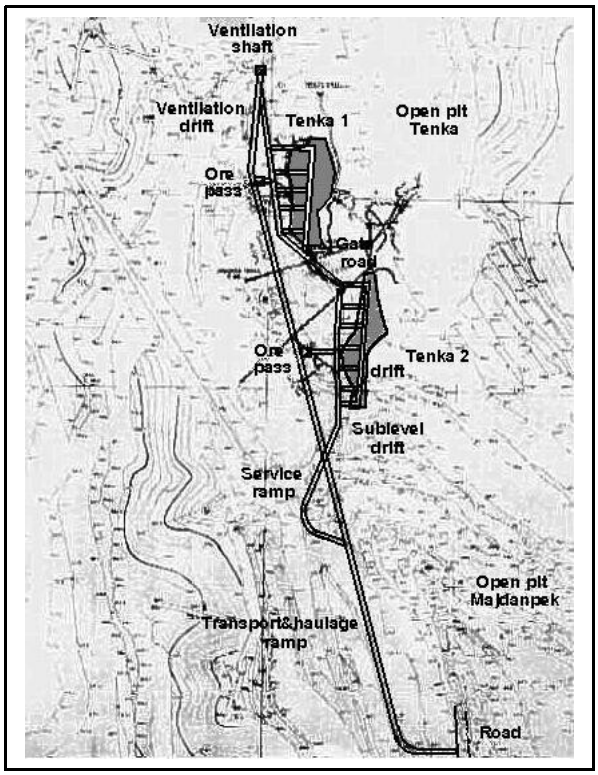

Fig. 1. Development of ore body Tenka

Cross sections of excavation are following:

- 8.5 m^2 (the transport & haulage ramp, the service ramp, the level drift, the drifts, the gate roads and the loading crosscuts);
- 5.4 m^2 (the ventilation drift);
- 9.0 m^2 (the ventilation shaft and ore passes).

Mining method

As mentioned above, exploitation of ore body "Tenka" will be carried out in two phases. I phase comprises section of ore body between level +485 m and level +440 m (60% ore reserves). II phase comprises section between level +440 m and level +400 m (40% ore reserves).

Ore output will be 35000 t per year.

I phase

Drilling in the I phase will be carried out from surface of open pit. Blasted ore will be loaded by loaders and transported to the ore passes. From the ore passes ore will be haulaged by trucks to the surface. Surraunding rock will fracture during the loading and create a caving on the surface above the ore body – figure 2.

Drilling will be carried out by existing drilling rigs for open pit exploitation – type Bucyrus Erie 45 R with three-conical bits - diameter ϕ229 mm. Drilling will be in normal pattern. Hole depth will be 30 m and burden and spacing will be 4m.

Explosive SLURRY will be used for blasting. It will be charged 2/3 of hole depth and 1/3 is for stemming. Iniciation of charge will be done by detonator (interval 30 ms between holes and 50 ms between rows) and booster (350 g). Blasting will be carried out in sections consisted of 3 rows (12m slice of ore). Next section is blasted after loading 20 % of blasted ore from previous section. Loading will be carried out by diesel loaders Wagner St 2D. There will be two loaders (one in "Tenka 1" and one in "Tenka 2"). Draw point loading will be carried out in gate roads. Loaded ore will be, after that, transported to ore passes.

Haulage will be carried out on level +385 m (in the transport & haulage ramp) by two trucks – type Normet PK 600. Haulaged ore will be transported onwards to crusher by open pit trucks.

Ventilation will be circulated (system the transport & haulage ramp – the service ramp – the level drift – the ventilation shaft) as well as separated by fans in gate roads.

II phase

Exploitation in II phase will be started from level +400 m – figure 2. Drilling will be carried out by Simba rig with button bits – diameter ϕ 89 mm. Ore volume will be drilled with longholes in a fan-shaped pattern. Number of longholes depends of ore body section in a place of drilling (average 12). Burden will be 2.5m. Longhole depth will be different (from 12 m to 30 m) as well as its drilling angle.

AN-FO explosive will be used for blasting. Iniciation of charge will be done by detonator (interval 30 ms between longholes and 50 ms between fans) and booster. Blasting will be carried out in sections consisted of 2 fans (5 m slice of ore). Next section is blasted after loading 20 % of blasted ore from previous section. The blasting breaks up a slice of ore and ore caves into the drift (draw point system) where is loaded and transported to ore passes. The surrounding waste rock breaks up continously and caves into the void. This can be noticed in the drift during the loading as a waste dilution. Allowed ore dilution is 15 % and ore losses 10 – 15 %.

Ore loading, transporting and houlaging, as well as ventilation will be done in the same way as in I phase.

Conclusion

Characteristic of this stopping method is combination of open pit exploitation (drilling process) in I phase and underground exploitation in I phase (loading, transporting, haulaging, ventilation) and in whole II phase of stopping.

This provides a minimum development and the lower costs of exploitation in order to ensure profitability of this ore body.

This paper gives one of possible solution for exploitation of rest parts of ore bodies below the open pit bottom. This situation is characteristically for almost all open pits in Eastern Serbia as well as worldwide.

Recommended for publication by the Editorial board of
Section "Mining and Mineral Processing"

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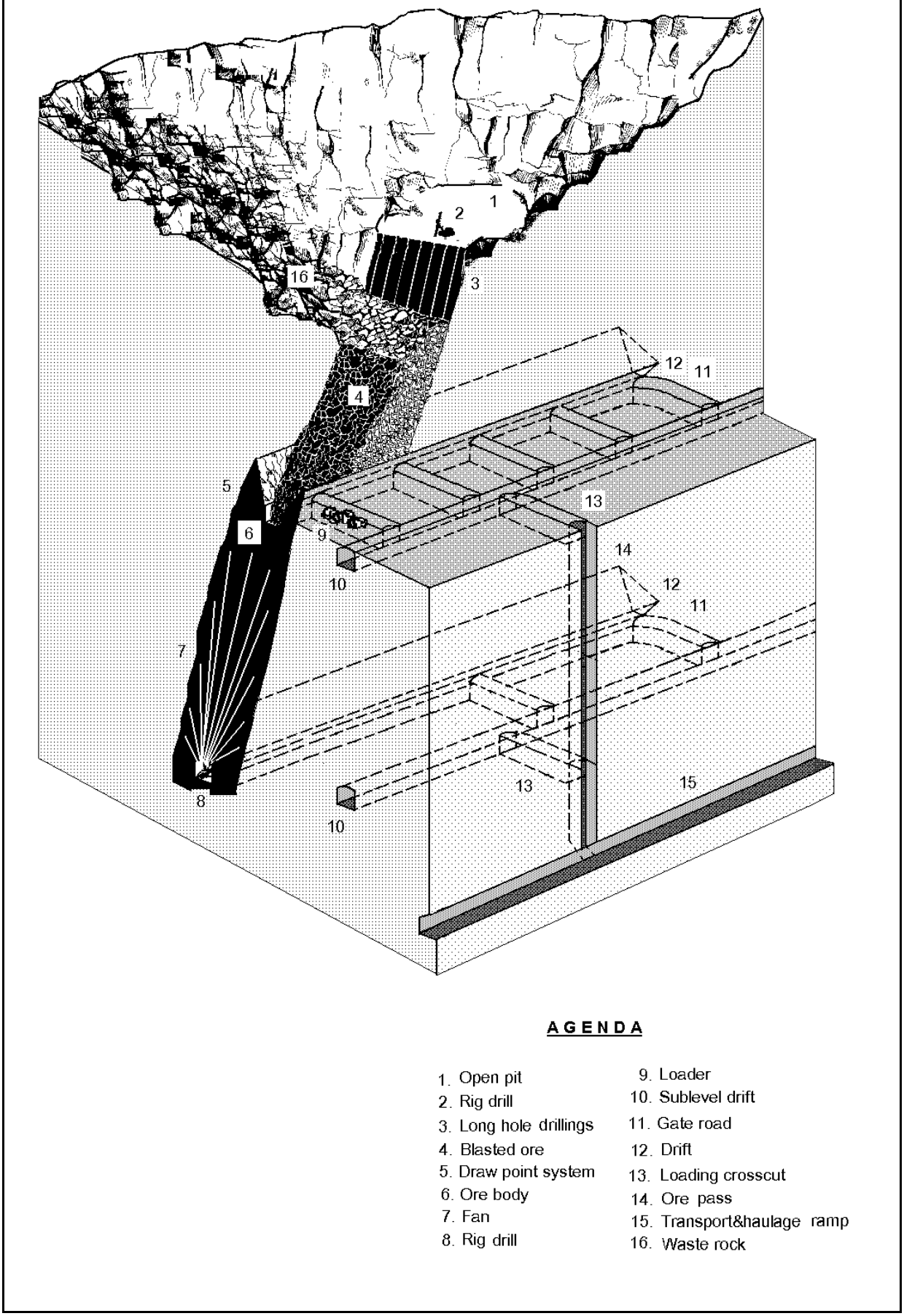

Fig. 2. Scheme of mining method