

THE POSSIBILITY OF LONG-TERM EXPLOITATION OF COPPER ORE ON ORE BODIES OF THE MAJDANPEK COPPER MINE

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Abstract

The additional mining projects for the exploitation of deposits in the Northern area and the Southern area of the Majdanpek copper mine defined the optimal pits and the dynamics of exploitation. It is planned that the exploitation of ore at the North area open pit will take place until 2042 and at the South area open pit until 2037. This paper presents an overview of the remaining ore reserves with a proposal for further exploration, as well as preparatory activities for the period after the end of exploitation according to the existing project documentation.

Keywords: Majdanpek copper mine, ore reserves, long-term exploitation

1. INTRODUCTION

The basic driving goal of any mining activity is the realization of profit, but in addition to this, the exploitation of mineral raw materials can be motivated by other more specific factors such as the maximum (or as large as possible) utilization of resources and the economic development of the local community where the project is located, etc. Profitable exploitation of mineral deposits requires a certain economic assessment and exploitation planning. Strategic long-term planning generally determines the production value of a mining company, by defining the basic elements of mining production: the limit content that defines the material as ore or waste, the exploitation limit of the surface mine, i.e. the total reserves of ore and tailings, the general development of mining works with the aim of meeting the qualitative and quantitative conditions of production, methods and technologies of exploitation and processing, production capacity, i.e. the life of the mine [1].

1.1 North area and South area open pits

In the Majdanpek copper mine, two open pit mines are in exploitation. The long-term planning of the development of open pit mines in the North area and South area is based on the valid Elaborations on reserves for these deposits. Copper ore resources and reserves in the studies were estimated based on the developed geological block models of deposits. Optimization and selection of the final contour of surface mines and planning and design of the phased development of works was carried out using Gemcom Gems and Whittle software, which in modern mining represent a standard for strategic planning and design of surface mines.

1.2 Optimization of open pit mines

The optimization was done using Whittle Four-XTM algorithms (LG 3D), whereby a series of open pit mine shells was determined based on different revenue factors with an iterative step of changing the price of the metal in relation to the base price. The optimization criterion is based on the determination of the maximum net present value of income (NPV), that is, the discounted

difference between income from metal sales and total operating costs [1-3]. The block models of the deposit were taken from the study on reserves. The limit copper content in the ore is 0.10%. Techno-economic parameters for optimization: annual ore mining capacity, utilization during exploitation and processing, costs and sales prices, are defined by the investor. The general end slopes of surface mines are defined on the basis of previous geotechnical tests.

Based on the optimization results, the exploitation life of the South area open pit mine is until 2042, and of the South area open pit mine until 2037 [4,5].

2. ORE RESERVES

2.1 Ore reserves of the North area deposit

Based on an overview of all available data on geological research carried out until the end of 2011, given that there is no data available on research of a later date, it can be concluded that the North area deposit has not been explored to a sufficient extent, primarily in terms of depth, and it is necessary to conduct additional geological research in order to increase the mineral raw material base of this deposit [6].

The remaining ore reserves of the North area deposit after 2042 in the 0.10% Cu contour are shown in Table 1.

Table 1 - Ore reserves that remain unmined after the end of exploitation in 2042

Ore	Volume, m ³	Volumetric mass, t/m ³	Reserves, t	Cu, %	Cu, t	Ag, g/t	Ag, kg
Cu	40.196.992	2,708	108.839.913	0,279	303.492	1,614	175.678
Pb+Zn+Cu	4.166	3,150	13.124	0,043	6	3,496	46

Ore	Au, g/t	Au, kg	S, %	S, t	Zn, %	Zn, t	Pb, %	Pb, t
Cu	0,202	21.976	2,640	2.873.226	0	0	0	0
Pb+Zn+Cu	0,331	4	4,841	635	1,207	158	0,173	23

The eastern rim of the Tenka 3 ore body remained "open", and in order to more precisely outline this orebody, further exploration of the eastern rim should be carried out. Further exploration also needs to be carried out in depth in the north direction, since the ore body remains undefined in that direction as well, as indicated by the results of the underground exploration works.

The central ore body is the largest ore body of the North area copper deposit. This ore body is very well contoured laterally, however its depth limit remains open.

The number of boreholes with which the deeper levels of this ore body were drilled is very small, amounting to 12 boreholes. It is suggested to explore the deeper levels of this ore body.

The Dolovi 1 ore body, like the Central ore body, is very well contoured laterally in the east-west direction, in the south direction its contour remains "open", so further exploration east and west of these boreholes is recommended.

2.2 Ore reserves of the South area deposit

Based on an overview of all available data on geological research carried out until the end of 2011, given that there are no available data on research from a later date, it can be concluded that the South area deposit has not been explored to a sufficient extent, primarily in terms of depth [7].

The remaining ore reserves of the South area deposit after 2037 in the 0.10% Cu contour are shown in Table 2.

Table 2 - Ore reserves that remain unmined after the end of exploitation in 2037

Ore	Volume, m ³	Volumetric mass, t/m ³	Reserves, t	Cu, %	Cu, t	Ag, g/t	Ag, kg
Cu	105.444.585	2,650	279.428.159	0,283	790.943	1,262	352.522

Ore	Au, g/t	Au, kg	S, %	S, t	Zn, %	Zn, t	Pb, %	Pb, t
Cu	0,157	43.919	1,170	3.269.098	0	0	0	0

A certain quantity of reserves is located below the -100 m level, which is why it is necessary to conduct additional geological research in order to outline the deposit below this level as well. Further explorations are also needed in the north, east, south and west.

2.3 Dynamics of geological research

The proposed geological research should be started as soon as possible. The geological research itself is preceded by the preparation of the Project of detailed geological research in the subject area. The project should not work for a period of time that is shorter than three research years. After the expiration of three research years, and the submission of the Final Report on the completed geological research, it is possible to extend the research two more times for two years, which would make the total time for geological research equal to seven research years. After the completion of the geological research, it is necessary to prepare the Elaboration on Resources and Reserves.

3. PREPARATORY ACTIVITIES FOR THE PERIOD AFTER 2037 AND 2045

After the investigations, it will be necessary to contour in the 0.1% Cu contour, since the parameters for the economic assessment have changed drastically since 2011. It is possible to have a positive economy even in this context of marginal content. It is necessary to perform a new calculation of reserves within the contour of the limit content of 0.1% Cu. It is also necessary to recategorize the reserves and create a new economic evaluation of the deposits with the evaluation parameters valid at that moment.

After additional geological research, depending on the results, three scenarios are possible for the period after 2037, i.e. 2045:

The first scenario is the continuation of surface exploitation with the expansion of the open pit mines according to plan and depth.

The second scenario is the underground exploitation of the Nort area deposit using one of the mass excavation methods, such as the Block caving method - self-destruction. Extraction of ore from the Nort area ore body would be carried out from the excavated area of the South area open pit mine. Underground exploitation of the South area deposit using the block crushing method, due to the low content of copper in the ore.

The third scenario is the closure of surface mines. For this scenario, it is necessary that every year, starting from the eighth year until the end of the exploitation period for the Nort area, that is, starting from the fourth year until the end of the exploitation period for the South area, the investor allocates funds for the process of closing surface mines. The project documentation would define the technology of closing surface mines, as well as the operation of the water treatment plant as long as it is necessary. For this scenario, it is necessary to prepare the North area and South Area open pits mine closure programs.

4. CONCLUSION

It is necessary to carry out geological investigations on the deposits of the Nort area and South area of the Majdanpek copper mine in order to determine the remaining ore reserves quantitatively, qualitatively and spatially.

Depending on the results of the geological investigations, three scenarios for the further development of the mine are possible, which would be decided after the feasibility study:

1. Continuation of surface mining exploitation;
2. Continuation of exploitation by underground excavation;
3. Closure of open pit mines.

For all three scenarios, the preparation of technical documentation is required in accordance with the legislation of the Republic of Serbia.

All the mentioned documentation, depending on the scenario, must be done and approved before the end of the exploitation according to the valid project documentation.

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