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OPTIMIZATION OF THE LONG-TERM DEVELOPMENT OF THE MAJDANPEK COPPER MINE THROUGH THE ANALYSIS OF PRODUCTION CAPACITIES AND ORE RESERVE MANAGEMENT SCENARIOS

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Abstract

The paper analyzes the long-term development of the Majdanpek Copper Mine, based on increasing mineable reserves and considering several scenarios for managing the production capacities of the South and North Revir open pits. Optimization of the ultimate pit limits, performed using Whittle software, identified the potential to increase the reserves from 148.5 to 298.5 Mt. On this basis, three development scenarios were analyzed, differing in production dynamics, mine life, and economic performance. The results show that the scenario based on balancing the capacities of the two open pits ensures stable production throughout the exploitation period and achieves the highest NPV of USD 3.92 billion. Based on the production and economic indicators, this scenario represents the most favorable basis for the long-term development of the Majdanpek Copper Mine.

***Keywords**: optimization, mineable reserves, capacity, NPV*

1. INTRODUCTION

The Majdanpek Copper Mine operates within Serbia Zijin Copper doo and represents a complex mining system in which ore extraction is carried out at the Juzni Revir and Severni Revir open pits. The long-term development of the mine is based on a reliable assessment of the available mineable reserves, the definition of appropriate production capacities, and the coordination of mining development at both open pits [1].

Strategic mine planning involves the assessment of technical and economic parameters that affect the open-pit boundaries, the quantity of mineable reserves, production capacity, the dynamics of mining development, and the mine life. Modern software tools enable the optimization of pit limits and the analysis of different mine development options from both production and economic perspectives.

This paper analyzes the long-term development of the Majdanpek Copper Mine through the potential increase of mineable reserves in the Juzni Revir and Severni Revir open pits and through different scenarios for managing their production capacities. Pit limit optimization was performed using GEOVIA Whittle software, while the optimization results were used to define expanded pit outlines and assess the potential for further development of mining operations. Particular attention was paid to production continuity, mine life, and the economic effects of the analyzed scenarios.

2. METHODOLOGY

2.1. Current State of Mining Operations

The current state of mining operations at the Majdanpek Copper Mine is characterized by the following key technical indicators:

According to the existing technical documentation, the mineable ore reserves within the designed pit limits amount to 96.5 Mt at the Juzni Revir open pit and approximately 52.0 Mt at the Severni Revir open pit, giving a total of 148.5 Mt for the Majdanpek Copper Mine [2,3].

The current ore production capacity is 15 Mt/year at the Juzni Revir open pit and 3.3 Mt/year at the Severni Revir open pit, resulting in a total production capacity of 18.3 Mt/year for both open pits.

At these production rates, the available reserves of the Juzni Revir open pit provide a remaining mine life of approximately 6.4 years, while the mine life of the Severni Revir open pit is approximately 15.8 years.

If the current production capacities are maintained, the completion of mining operations at the Juzni Revir open pit would result in a significant decline in the total ore production of the Majdanpek Copper Mine. Specifically, production would decrease from 18.3 Mt/year to 3.3 Mt/year, representing a reduction of as much as 82%.

These data indicate that the current mining concept does not ensure long-term production continuity, as clearly illustrated in Figure 1.

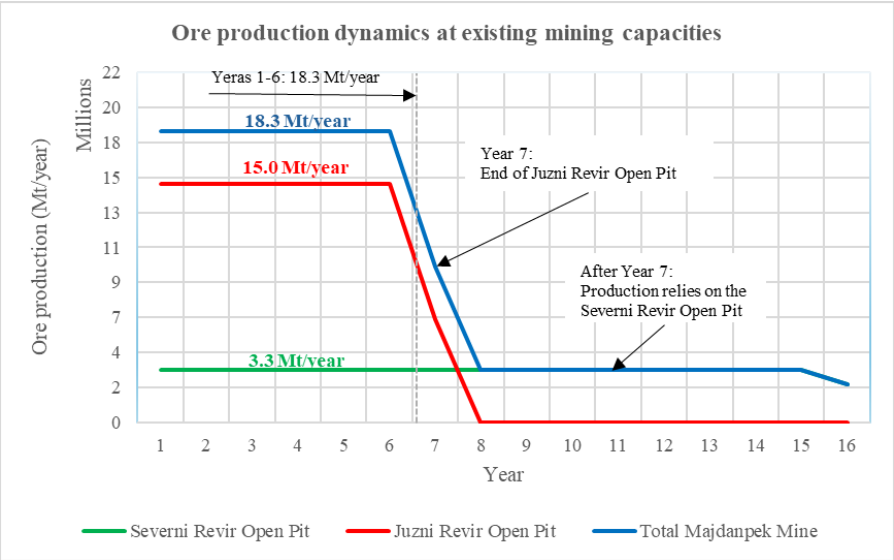


Figure 1. *Ore production dynamics at existing mining capacities*

2.2. Analysis of the Potential for Increasing Mineable Reserves

Further analysis of the strategic development of the Majdanpek Copper Mine involves assessing the potential for increasing the existing mineable reserves by expanding the current open-pit limits both laterally and at depth. To evaluate the potential for expansion of the existing pit limits, the GEOVIA Whittle software package was used to optimize the ultimate pit limits based on the available geological, technical, and economic parameters, while considering existing infrastructure constraints. Based on the optimization results, expanded pit limits, the corresponding mineable reserves, and a strategy for the further development of mining operations were defined.

The analysis showed that the key prerequisite for increasing the reserves of the Juzni Revir open pit is the relocation of the ore and waste crushing facilities, which would enable the addition of approximately 60 Mt of mineable ore reserves. At the same time, expansion of the Severni Revir open-pit limits requires the relocation of the ore crushing facility and the ore transportation system and would provide an additional 90 Mt of ore reserves. Overall, the proposed pit expansions would increase the mineable reserves by approximately 150 Mt, resulting in total mineable reserves of 298.5 Mt.

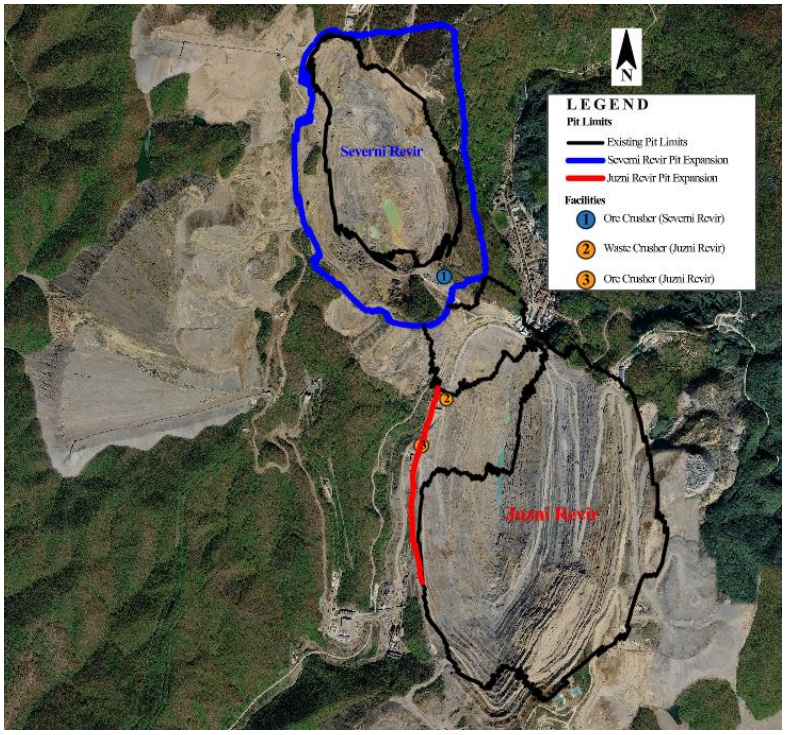


Figure 2. *Existing and Expanded Pit Limits of the Juzni Revir and Severni Revir Open Pits*

The results of the analysis indicate that the Majdanpek Copper Mine has sufficient resources to sustain long-term production and that the key to achieving this lies in establishing a new development concept based on the optimal management of production capacities and mining schedules at the open pits.

2.3. Definition of Long-Term Mine Development Scenarios

The long-term mine development concept is based on considering the Juzni Revir and Severni Revir open pits as an integrated mining system, with the aim of coordinating their production capacities and ensuring long-term stability of ore production.

Accordingly, three development scenarios were analyzed, differing in terms of the production schedule and the distribution of ore mining capacities between the Juzni Revir and Severni Revir open pits:

- Scenario A – continuation of mining at the Juzni Revir open pit at a capacity of 15 Mt/year, with the Severni Revir open pit operating at 3.3 Mt/year;
- Scenario B – maintaining the current distribution of production capacities until the depletion of the Juzni Revir open pit, after which the Severni Revir open pit takes over ore production at a capacity of 18.3 Mt/year;
- Scenario C – phased balancing of production capacities between the Juzni Revir and Severni Revir open pits. In the first phase, covering a period of 3 years, production capacities are maintained at 15 Mt/year at Juzni Revir and 3.3 Mt/year at Severni Revir. In the second phase, the production capacity of Juzni Revir is reduced to 10.0 Mt/year, while the capacity of Severni Revir is simultaneously increased to 6 Mt/year. In the third phase, beginning in Year 15 of mining operations, Severni Revir reaches a production capacity of 16 Mt/year and becomes the primary source of ore production.

For the defined scenarios, a comparative analysis was performed in terms of production performance, mine life, and the economic effects of mining operations.

3. RESULTS AND DISCUSSION

Ore production and discounted cash flows over the mine life for the analyzed development scenarios of the Majdanpek Copper Mine are presented in Figure 3.

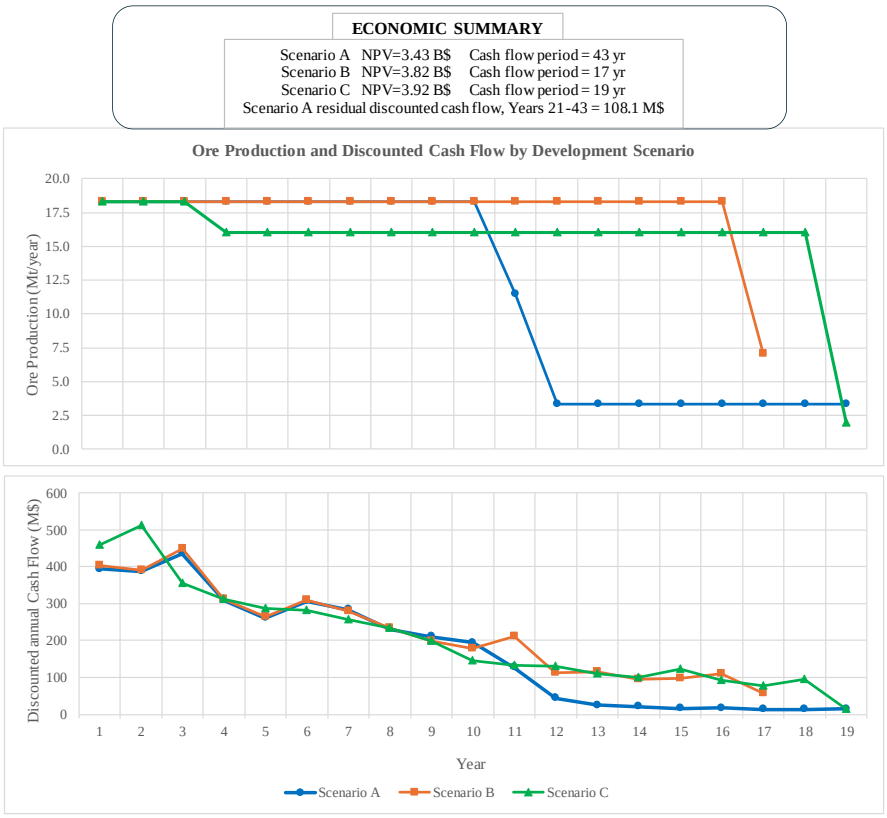


Figure 3. *Comparative Overview of Ore Production and Discounted Cash Flows for the Analyzed Development Scenarios*

Scenario A enables ore production to be maintained at 18.3 Mt/year until the completion of mining at the Juzni Revir open pit, after which production declines to the level that can be sustained by the Severni Revir open pit at its current production capacity. Under Scenario B, production is maintained at approximately 18.3 Mt/year, provided that the Severni Revir open pit reaches a production capacity of 18.3 Mt/year after mining at the Juzni Revir open pit is completed. Scenario C involves a gradual balancing of the production capacities of the two open pits, with total ore production stabilizing at approximately 16 Mt/year after the first three years.

The key production and economic indicators of the analyzed scenarios are summarized in Table 1.

Table 1. *Comparative overview of the key indicators for the analyzed development scenarios2*

Indicator	Scenario A	Scenario B	Scenario C
Juzni Revir production capacity, Mt/year	15.0	15.0	15.0 for the first three years; then 10.0
Severni Revir production capacity, Mt/year	3.3	3.3 until completion of mining at Juzni Revir; then 18.3	3.3 for the first three years; 6.0 from Year 4; 16.0 from Year 15
Total mine production capacity, Mt/year	18.3; 3.3 after completion of mining at Juzni Revir	approximately 18.3 throughout the mine life	18.3 for the first three years; then 16.0
Mine life, years	approximately 43	17	19
NPV, US$ billion	3.43	3.82	3.92

In addition to differences in production capacities and mine life, the analyzed scenarios also differ in terms of their economic performance.

A comparison of the analyzed scenarios indicates that the long-term development of the Majdanpek Copper Mine cannot be assessed solely on the basis of mine life. Scenario A has the longest mine life, but results in a significant decline in production following the completion of mining at the Juzni Revir open pit. Scenario B enables production to be maintained at a higher level but requires the Severni Revir open pit to reach a production capacity of 18.3 Mt/year within a relatively short period. Scenario C is based on the gradual development of the Severni Revir open pit and the balancing of production capacities between the two open pits, while maintaining ore production at approximately 16 Mt/year throughout most of the mine life.

4. SOCIO-ECONOMIC IMPORTANCE OF PRODUCTION CONTINUITY

Production continuity at the Majdanpek Copper Mine is of particular importance to the local community. According to the 2022 Population Census, the Municipality of Majdanpek has a population of 14,663 [4]. At the same time, out of a total of 4,078 registered employees in the municipality in 2025, 1,443 were employed in the mining sector [5], representing more than 35%.

These data indicate that mining is the key industrial sector in the municipality, with a major impact on local employment and the overall stability of its economic development. Therefore, long-term stable production at the Majdanpek Copper Mine is important not only from the perspective of the mine's production performance, but also has broader socio-economic significance in terms of job security, the operation of local businesses engaged in the mining sector, and the overall stability of the local community.

5. CONCLUSION

The existing mining concept at the Majdanpek Copper Mine, with production capacities of 15 Mt/year at the Juzni Revir open pit and 3.3 Mt/year at the Severni Revir open pit, does not ensure long-term production stability. Following the completion of mining at the Juzni Revir open pit, total ore production would decrease from 18.3 to 3.3 Mt/year, representing a reduction of approximately 82%, despite the availability of reserves at the Severni Revir open pit for continued mining operations.

wBy optimizing the pit limits and expanding the existing open-pit outlines, it is possible to increase the mineable reserves from 148.5 Mt to 298.5 Mt. This provides the basis for defining a new concept for the long-term development of the mine, based on balancing the available reserves, production capacities, and development schedules of the Juzni Revir and Severni Revir open pits.

The analysis of the defined scenarios reveals significant differences in production schedules, mine life, and economic performance:

1. Scenario A provides the longest mine life of 43 years. However, following the completion of mining at the Juzni Revir open pit, production declines significantly, with the Severni Revir open pit continuing at a substantially lower production rate. This scenario also generates the lowest NPV, amounting to US$3.43 billion.
2. Scenario B enables production to be maintained at approximately 18.3 Mt/year and generates an NPV of US$3.82 billion, with a mine life of 17 years. However, implementation of this scenario requires the Severni Revir open pit to increase its production capacity from 3.3 to 18.3 Mt/year within a relatively short period following the completion of mining at the Juzni Revir open pit.
3. Scenario C is based on balancing the production capacities of the two open pits. After the first three years, total production stabilizes at approximately 16 Mt/year, with a gradual increase in the contribution of the Severni Revir open pit and a corresponding reduction in production from the Juzni Revir open pit. With a mine life of 19 years, this scenario generates an NPV of US$3.92 billion, representing the highest economic value among the analyzed scenarios.

Based on the combined assessment of production, mine-life, and economic indicators, Scenario C represents the most favorable basis for the long-term development of the Majdanpek Copper Mine. Its advantage is not based solely on achieving the highest NPV, but also on the gradual development of the Severni Revir production capacity and a more stable transition of ore production from the Juzni Revir to the Severni Revir open pit.

The proposed development concept also contributes to the long-term stability of mining operations, which is particularly important considering the role of the Majdanpek Copper Mine in local employment and the overall socio-economic development of the local community.

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REFERENCES

[1] Kržanović, D., Rajković, R., Jovanović, M., Mikić, M., Milutinović, S., Strategic long-term planning of ore exploitation in the Majdanpek copper mine, Republic of Serbia. 15th International Symposium "Sustainable Development in Energy and Mining—Mining 2024", Vrnjačka Banja, Serbia, 21–24 May 2024, pp. 53–61. Proceedings of the 15th International Symposium "Sustainable Development in Energy and Mining—Mining 2024", 2024. Plenary Lecture.

[2] Kržanović, D., et al., Supplementary Mining Design for the Juzni Revir Open Pit at the Majdanpek Copper Mine for an Annual Ore Production Capacity of 9.9 Mt, Mining and Metallurgy Institute Bor, 2025.

[3] Kržanović, D., et al., Supplementary Mining Design for Ore Extraction at the Severni Revir Open Pit of the Majdanpek Copper Mine, Mining and Metallurgy Institute Bor, 2023.

[4] https://stat.gov.rs/

[5] https://publikacije.stat.gov.rs/