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RECONSTRUCTION OF THE NORTHWESTERN SLOPE OF THE OPEN PIT SOUTH MINING DISTRICT MAJDANPEK FOR THE PURPOSE OF RECONSTRUCTION THE ACTIVE LANDSLIDE***

Abstract

The exploitation of copper ore in the Majdanpek Copper Mine takes place at the open pit South Mining District. The operation takes place in the complex conditions, and a special feature is that the capital infrastructure facilities: the state road M24, 35 kV transmission line and ri-verbed of the Mali Pek River are located in the northwestern contour of the open pit. Due to the occurrence of landslide in this part of the open pit, the continuity of the ore exploitation process in the mining system of excavation-processing was endangered, as well as the stability of infrastructure facilities.

Reconstruction of the northwestern slope of the open pit will eliminate all existing and potential risks and create the conditions for functioning of the mine and town of Majdanpek.

Keywords: *material landslide, infrastructure facilities, Geovia Gems software*

1 INTRODUCTION

The town of Majdanpek is located in the northern part of eastern Serbia, in the narrow valley of the Mali Pek River. The open pit South Mining District Majdanpek is located in the south of the town of Majdanpek, in its immediate vicinity. The open pit operates within the company Majdanpek Copper Mine, which is a part of the company Serbia Zijin Copper doo (former Mining and Smelting Basin Bor Group).

The Majdanpek copper mine, in terms of production, technical and technological sense, is a complex mining system that has activities from the geological explorations of mineral resources, exploitation and processing of ore to a number of accompanying activities as the necessary support to core business [1]. Production and processing of ore in the Majdanpek Copper Mine is of a great importance for the copper production in the system of the company Serbia Zijin Copper doo.

One of the specifics that affects the complexity of exploitation at the open pit is that the capital infrastructure facilities are in the northwestern contour of the open pit: state road M24 Pancevo - Kovin - Požarevac - Majdanpek - Negotin - Bulgarian border, 35 kV transmission line and Mali Pek riverbed. The occurrence of landslide in this part of the open pit jeo-pardizes the conti-

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nuity of the ore exploitation process in the mining system of excavation - processing, as well as the infrastructure facilities, which may adversely affect the functioning of the town of Majdanpek [2].

Figure 1 shows the landslide in the northwest slope of the open pit South Mining District with the disposition of infrastructure facilities.

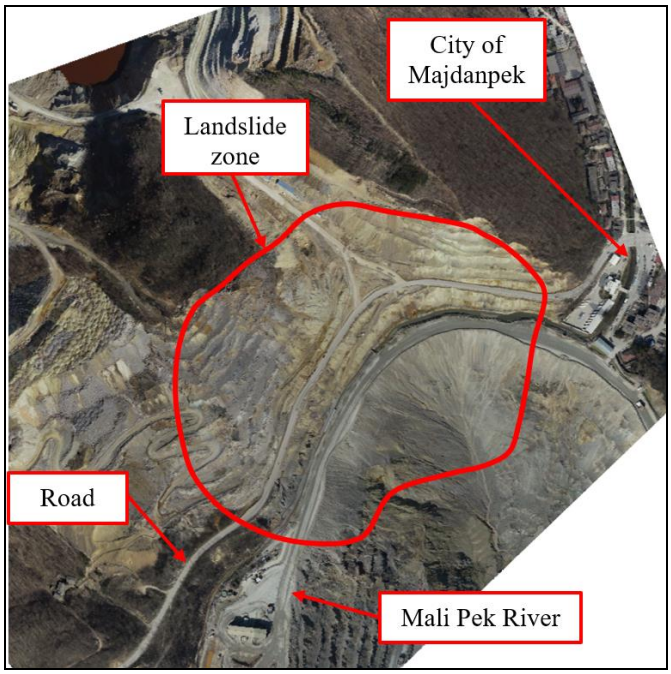

Figure 1 *View of the landslide in the northwest slope of the open pit South Mining District with the disposition of infrastructure facilities*

2 GEOTECHNICAL CHARACTERISTICS OF THE NORTHWESTERN PART OF THE OPEN PIT

A landslide is located in the northwestern part of the open pit South Mining District, characterized by the complex geometry and dynamics of movement.

Based on the conducted engineering geological explorations at the open pit, the geotechnical profiles were defined and modeling of the sliding body was performed. As an unstable terrain, a part of the terrain with approximate dimensions of 450 × 420 m was set aside, while the dimensions of moved material (colluvium) are 320 × 330 m. The material affected by the colluvial process are: the man-made formations (road embankment), complex of medium and completely degraded shales and gneisses and medium and completely degraded andesites.

In addition to sliding, the following modern geodynamic processes and phe-

nomena are present in the subject area, such as the surface disintegration, scattering and landslides.

Figure 2 shows the engineering geological section in the landslide zone on the northwest side of the open pit South Mining District.

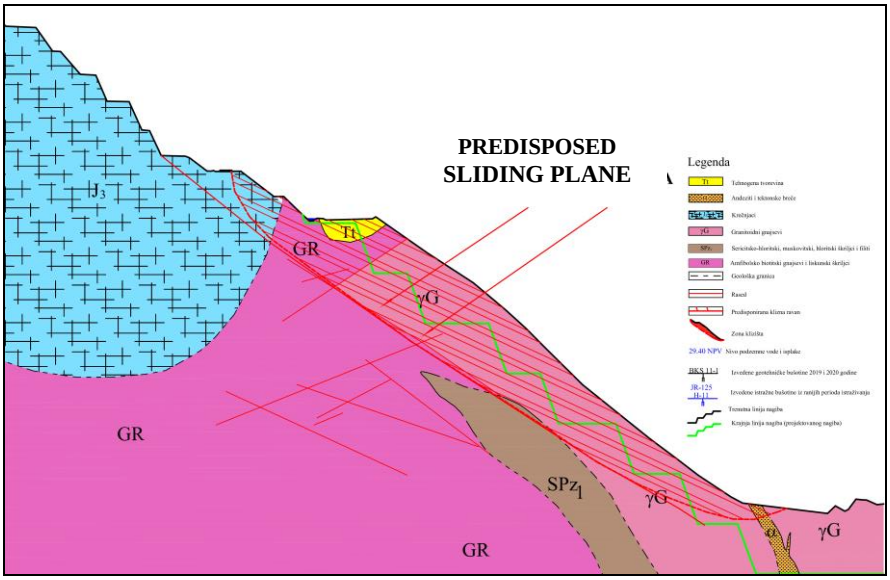

Figure 2 *Engineering geological section in the landslide zone on the northwest side of the open pit South Mining District [3]*

3 MODELING OF LANDSLIDE SOLID

Design of the final project boundary, i.e .the northern and northwestern boundaries of the open pit, was done on the basis of a defined solid landslide in the area limited by the terrain, as the upper surface and sliding plane boundary as wsell as the lower limiting surface.

Solid is made on the basis of geotechnical interpretation of a landslide, i.e. using the defined vertical geotechnical profiles, which represent the closed polygons (3D rings). A solid is a part of an irregularly shaped space bounded by a surface obtained by the triangulation. Solid has its own characteristics such as volume, bulk density, color, etc.

Solid, formed by the TIN (Triangle Irregular Network) method, represents a triangulation by a network of irregular triangles based on the geotechnical interpretation of a landslide by the vertical profiles and solid characteristics (solid volume, surface (envelope), number of nodes in the formed surface, number of triangles, etc.) [4] .

Figure 3 shows the generated solid landslide in the northwestern zone of the South Mining District in the Gems software.

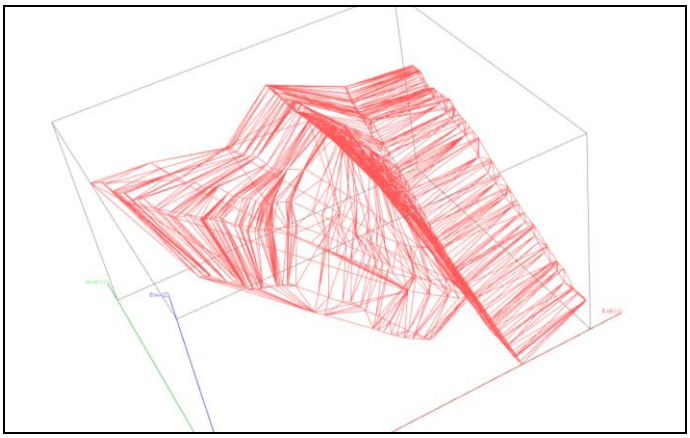

Figure 3 *Shows a 3D view of landslide position in the northern and northwestern zones of the open pit South Mining District*

Figure 4 shows a 3D view of landslide position in the northern and northwestern zones of the open pit South Mining District.

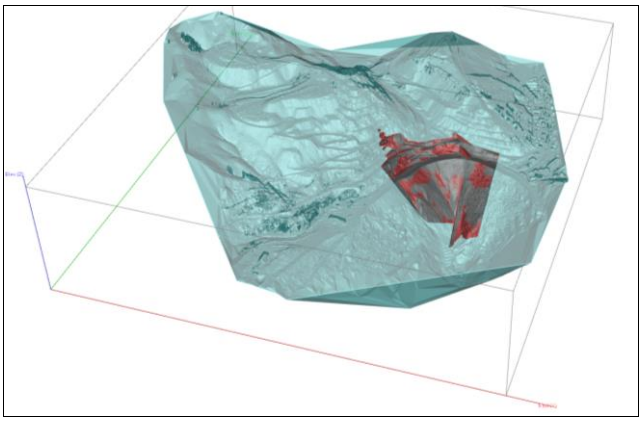

Figure 4 *3D view of a landslide solid in the northern and northwestern zones of the open pit South Mining District*

4 CONSTRUCTION OF THE FINAL BOUNDARY OF THE NORTH-WESTERN SLOPE

The basic condition that had to be met during the reconstruction of the final contour of the northwestern part of the South Mining District is to provide a stable slope of this part of the open pit, to enable relocation of the existing transmission line route, highway and Mali Pek riverbed, which are endangered by the

active landslides on the Andesite finger. An additional condition is that the transport system for ore transport from the open pit North Mining District must not be endangered [5].

Based on the defined conditions, adopted geometric elements of the open pit and generated landslide solid, the final contour of the reconstructed northwestern part of the surface area of the South Mine District was constructed. The final contour was constructed in the **Gems** software, in the Pit Design module [4].

Figure 5 shows a 3D view of the final northwestern reconstructed contour of the open pit South Mining District with a characteristic cross-section.

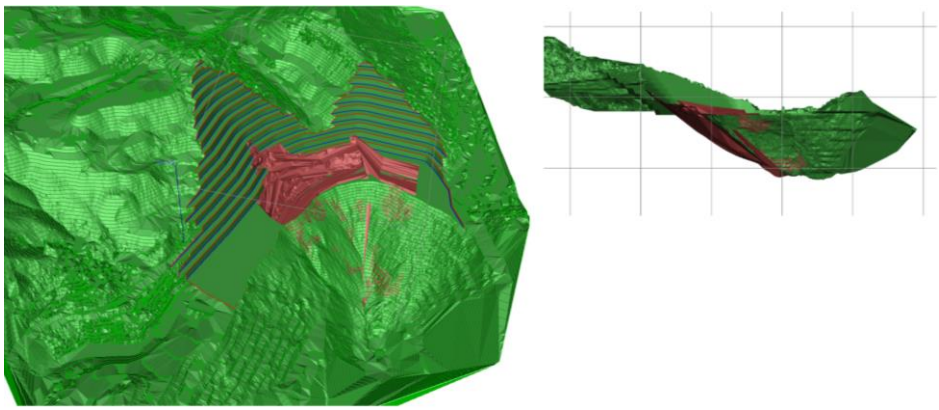

Figure 5 *3D view of the final northwestern reconstructed contour of the open pit South Mining District with a characteristic cross-section*

5 CONCLUSION

The appearance of a landslide on the northwest side of the open pit South Mining District endangered the process of ore exploitation in the Majdanpek Copper Mine, as well as the safety and health of people, and also the safety of process equipment. In addition, the landslide endangers the civilian infrastructure facilities, such as the high-voltage transmission line, the Majdanpek-Kucevo highway and the Mali Pek riverbed, which are located in the northwestern contour of the open pit, thus endangering the normal functioning of Majdanpek.

By reconstruction of the northwestern slope of the open pit, the material was removed from the landslide zone, thus eliminating all existing and potential risks to the functioning of the mine and the town of Majdanpek.

REFERENCES

[1] Kržanović D., Vušović N., Ljubo-jev M., Rajković R., Importance of Planning the Open Pits in the Conditions of Contemporary Mining - A Case Study: The Open Pit South Mining District Majdanpek, Mining & Metallurgy Engineering Bor, No. 1-2 2017, pp. 15-22.

[2] Kržanović D., Kostić V., Rajković R., Jovanović I., Establishing the Spatial

Conditions at the South Mining District Majdanpek to Achieve the Continuity in Ore Mining: A Proposed Technology for Sediment Layer Removal, Mining and Metallurgy Engineering Bor 1-2/2019, ISSN 2334-8836, pp. 1–8

[3] Project Study on the Stability of Designed Final Condition of the Open Pit South Mining District, Mining and Metallurgy Institute Bor, 2020 (in Serbian)

[4] GEOVIA GEMS™ Manual

[5] Rajković R., Kržanović D., Mikić M., Jovanović M., Calculation of Safety Distance for the Operation of Mining Equipment in the Working Environment with Weakened Characteristics at the Open Pit "North Mining District" of the Copper Mine Majdanpek, 52nd International October Conference on Mining and Metallurgy, November 29th-30th, 2021, pp. 79-82