MINING AND METALLURGY INSTITUTE BOR
and
TEHNICAL FACULTY BOR, UNIVERSITY OF BELGRADE

IOC2022
International October Conference

53rd International October Conference on Mining and Metallurgy

PROCEEDINGS

Editors:
Ana Kostov
Milenko Ljubojev

3 – 5 October 2022. Hotel "Albo" Bor, Serbia

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Publisher: Mining and Metallurgy Institute Bor

Printed in: "GRAFOMED-TRADE" Bor

Text printing preparation: Vesna Simić

Circulation: 100 copies

CIP – Каталогизација у публикацији
Народна библиотека Србије, Београд

622(082)
669(082)

INTERNATIONAL October Conference on Mining and Metallurgy (53 ; 2022 ; Bor)
Proceedings / 53rd International October Conference on Mining and Metallurgy - IOC 2022, 3 % 5 October 2022, Bor ; [organizer] Mining and Metallurgy Bor and Technical Faculty in Bor, University of Belgrade ; editors Ana Kostov, Milenko Ljubojev. - Bor : Mining and Metallurgy Institute, 2022 (Bor : Grafomed-trade). - XV, 251 str. : ilustr. ; 25 cm

Tiraž 100. - Bibliografija uz svaki rad. - Registar.

ISBN 978-86-7827-052-9

a) Рударство - Зборници b) Металургија - Зборници

COBISS.SR-ID 74763529

Bor, October 2022

Conference is financially supported by the
Ministry of Education, Science and Technological
Development of the Republic of Serbia

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FORMATION OF A REACTIVE MATERIAL DUMP FROM THE "ČUKARU PEKI" MINE NEAR BOR

Radmilo Rajković[1], Daniel Kržanović[1], Miomir Mikić[1], Milenko Jovanović[1], Emina Požega[1]

[1]Mining and Metallurgy Institute Bor, Zeleni bulevar 35, 19210 Bor, Serbia,
E-mail: radmilo.rajkovic@irmbor.co.rs

Abstract

In the underground exploitation of the "Čukaru Peki" deposit near Bor, a reactivate material – waste is excavated that should be disposed on the terrain surface. This work presents a way to form a waste site like this that would be the subject to the legal regulation for such facilities, with a view of protecting the environment and living environment.

***Keywords**: "Čukaru Peki" mine, reactive material, dump*

1 INTRODUCTION

The "Čukaru Peki" mine covers the terrain that is located at about 6 km southeast of Bor. This is a relatively flat area with altitudes 350-400 m, where the dense forests and pastures are represented. The location of the mine is near the Bor airport, and it is located between the roads Selište - Bor - Zaječar and Vodna – Resava's cave.

The exploitation of copper and gold from the "Čukaru Peki" deposit has officially started in 2021. The estimated quantity of ore in the upper part of the deposit is 46.1 million tons, with a copper percent in the ore of 2,71% and gold of 1.7 grams per ton.

For the surface disposal of materials, which is a product of underground mining operations, a landfill O1, consisting of two parts, is provided. Most of the pieces are intended for disposal of unreactive material. A small part supporting a protective foil on a support is intended to dispose the reactive materials where minimal mineralization may be expected from time to time.

2 CHARACTERISTICS OF MATERIALS TO BE DISPOSED

In determining the quality of mineral raw materials, mineral composition, content of useful and harmful components, physical-mechanical properties and technological characteristics that condition the possibility of preparation and application of mineral raw materials are determined.

The contents of useful and harmful components in the "Čukaru Peki" deposit was determined by a chemical analysis of individual samples taken from drills, drilled from the surface of the ground. Individual samples were chemically analyzed on 62 elements. The total number of individual tests taken is 53.898. Individual samples taken in the mineralized zone were analyzed for: Au, Cu, Ag, Al, As, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Fe, Ga, Ge, Hf, Hg, In, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, Re, S, S_sulfates, S_sulfides, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti, Tl, U, V, W, Y, Zn, Zr, Al_2O_3, CaO, Cr_2O_3, Fe_2O_3, K_2O, MgO, MnO, SiO_2 i TiO_2. All individual analyses in the contour of the specified limit content of 0.30% Cu, were treated as samples from an armed interval intersected by the drills. The lower limit mineral content is 0.30% Cu.

The excavated material from the underground works with a lower Cu content than the lower limit content, where mineralization can be expected, is disposed on the O1 dump. Due to this reason, a landfill was designed with all the elements of soil protection from the penetration of potentially contaminated water from the dump [1].

3 PROTECTION OF SOIL AND GROUNDWATER FROM THE IMPACT OF DUMP

Protection of soil and groundwater from the impact of dump is defined by the Regulation on waste disposal on the landfill (Official gazette of RS No. 92/10), which is in line with the EU directives on waste, 75/442/EEC and 1999/31/EC.

The bottom and sides of the dump body should consist of a natural geological barrier that meets the permeability and thickness requirements with a combined effect in terms of protection the soil, groundwater and surface water, at least equal to the effect resulting from the following requirements:

- Hazardous waste dump: $K \leq 1 \times 10^{-9}$ m/s, layer thickness ≥5 m;
- Non-hazardous waste dump: $K \leq 1 \times 10^{-9}$ m/s, layer thickness ≥1 m;
- Inert waste dump: $K \leq 1 \times 10^{-7}$ m/s, layer thickness ≥ 1 m.

When the natural geological barrier does not meet the prescribed values, it shall be ensured by covering the underground of the landfill with synthetic materials or a natural mineral buffer, which shall be consolidated in such a way as to obtain an equivalent value of the soil in terms of its waterproof properties. The natural mineral tampon should not be less than 0.5 m. An additional bottom protection should also be provided on the landfill to prevent the migration of processing water into the subsoil of landfill, Table 1.

Table 1 *Applied protection measures*

Measures applied in terms of forming a layer for dump protection	Dump class	
	Non-hazardous waste	Hazardous waste
Artificial sealing lining - foil	It requires	It requires
Impermeable mineral layer ≥ 5 m	It requires	It requires

Other methods and techniques that ensure the conditions set out in Table 1 may also be used for the sealing of the bottom and side sides of substrate of the dumps. These conditions relate to the natural geological barrier which, in the case of wastewater deposits on the "Čukaru Peki" site, are not met.

Since the natural base on the site intended for the dump, due to its geomechanically characteristics, does not meet the above requirements of the regulations (EU and national) related to the protection of water and land from the impact of dumps, the installation of synthetic protective materials is used. The bottom and inside of the dump base are covered with a waterproof foil over a layer of bentonite geomembrane [2,3,4,5].

The first layer of protection was designed from the geotextile composites with bentonite powder joined by the sewing (GCL foil). The thickness of the GCL foil is adopted depending on the category of waste, and the condition is that the water permeability coefficient of this artificial coating meets the criteria prescribed by the Regulation, to replace the layer of natural clay with a minimum thickness of 1 m, whose water permeability coefficient is 10^{-9} m/s. The second layer of protection is designed from smooth polyethylene film of high density (HDPE) 2.0 mm thick.

Due to the seepage of water in the dump, a drainage system should be built. Also, this system should accept the atmospheric water that falls on the previously prepared

surface of the dump in the initial phase of waste disposal for the purpose of drying the active surface. Collected leachate and atmospheric polluted water are led to the built accumulation space of the pyrite tailing. The protection of the dump from the effect of external atmospheric water is solved by an open perimeter concrete channel around the body of the future dump. Water from this sewage is also drained to the accumulation space of the pyrite tailing dump. The whole system is shown in Figure 1.

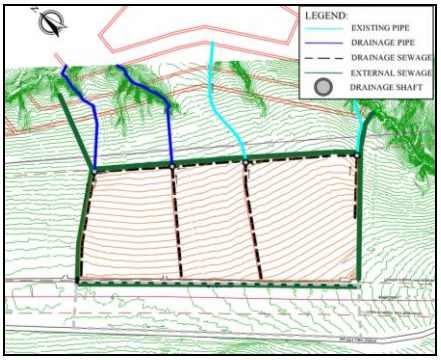

Figure 1 *Water protection system*

4 DISPOSAL TECHNOLOGY

Loading of material from a decline is carried out by a loader from the dump on the plateau formed in the immediate vicinity of the entrance to the decline. The transport of loaded material is carried out by the AT trucks. The technological disposal operation consists of unloading of trucks and planning the landfills with a bulldozer.

The dump of reactive material is formed in one floor to the final elevation. The dump is formed by removal the material from the level of an access path, advancing the deposition to the final contour at that level, and then forming the next level higher by 0.5 m in the same way. This progresses successively until the final contour of the dump is reached.

In order to monitor the quality of waste materials on the dump, a laboratory analysis of waste materials is mandatory in order to identify and categorize the potentially hazardous waste.

The construction of the dump was carried out using the computer program Gems. Based on the situation map of the site, and the state of work carried out on the site, a 3D model of the initial state was created. After that, the 3D model of the site was created after the work on preparation the dump floor, and then 3D models of the dump at the end of each landfill year. Figure 2 shows the final view of the dump.

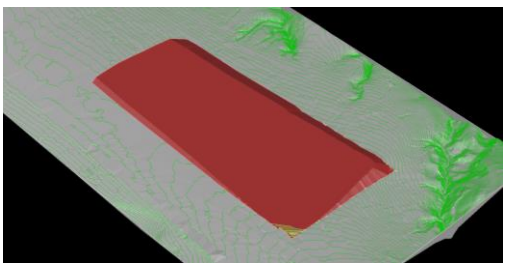

Figure 2 *Final view of the dump*

When performing the mining works, in order to protect the working environment, it is necessary to comply with the applicable laws, regulations and standards applicable to the surface excavations, in particular:

- Law on Safety and Health at Work (Official Gazette of RS, Nos. 101/2005, 91/2015 and 113/2017 - other law);
- Law on Mining and Geological Explorations (Official Gazette of RS, No. 101/2015 and 95/2018 - other law);
- Law on environmental protection (Official Gazette of RS, Nos. 135/2004, 36/2009, 36/2009 - other law, 72/2009 - other law, 43/2011 - US Decision, 14/2016, 76/2018, 95/2018 - other law and 95/2018 - other law);
- Ordinance on Technical Requirements for the Surface Exploitation of Mineral Deposits (Official Gazette of RS, No. 96/2010).

The protective measures during waste disposal, according to the above documents, primarily relate to the stability of the dump and technological phase of drainage.

5 CONCLUSION

During the design of the dump for the reactive material of the "Čukaru Peki" mine, all protective measures were applied, both during the preparation of the dump base in order to protect the land and watercourses from the impact of water entering the dump, and in disposal of the underground works.

It is necessary to fully comply with the design documentation at all technological phases of preparation and disposal, and to establish the planned monitoring of the dump impact on the working environment.

ACKNOWLEDGEMENTS

This work was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, Grant No. 451-03-68/2022-14/200052.

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