

PROJECT REASONING: CHARACTERIZATION AND TECHNOLOGICAL PROCEDURES FOR RECYCLING AND REUSING OF THE RUDNIK MINE FLOTATION TAILINGS

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Introduction

The project "Characterization and technological procedures for recycling and reusing of the Rudnik mine flotation tailings" (REASONING) is implemented through the "Prism" program of the Science Fund of the Republic of Serbia. The primary objectives of this project are the mineralogical-geochemical characterization of the flotation tailings of the mine "Rudnik", the development of technological methods for the efficient extraction of useful metals and other elements from the tailings, and the assessment of the possibility of using this tailings as raw material for the construction industry.

The project will be implemented using geological, mineralogical, geochemical, geophysical, chemical, metallurgical and technological investigation. Researchers from six scientific research institutions from Serbia and one from Germany will participate in these complex multidisciplinary investigations.

Key Words: Prizma project, REASONING, Rudnik, flotation tailings

Methodology

Tailings flotation represent material of different composition that is created in the process of extracting useful elements from the ore. This mining by-product accumulates in flotation tailings which, due to the nature of the material and the method of disposal, are designated as a potential environmental hazard. The tailings created by the processing of polymetallic Pb, Zn, Cu and Ag ore from the "Rudnik" mine is one of the most famous tailings ponds in Serbia. It is composed of fine-grained (-0.40+0.00 mm) aluminosilicate minerals quartz and feldspar (>60%), smaller amounts of clay minerals (5-10%), while the rest is represented by Pb, Cu, Zn, Fe minerals with the presence of heavy metals up to 1%. According to the REASONING project, the measurement and tracking of changes in the physical and chemical conditions along the vertical profile of the tailings body will be carried out, the distribution of mineral associations will be determined, the magnetic susceptibility of the tailings will be measured and correlated with the content of heavy metals, along with the definition of enrichment zones, variations and trends in the composition of pore water, heavy metals and accompanying elements will be tracked. The distribution of stable mineral association and elements will be determined through theoretical geochemical modeling. An optimal scheme for the extraction of elements using a theoretical approach, electrochemical separation of elements from synthetic and leached solutions, as well as a technological procedure for the valorization of useful components will be developed.

Research will be carried out through three work packages:

1. Mineralogical and geochemical characterization of the tailings- physical and chemical parameters will be measured using a multi-parameter instrument and different analyzes will be applied that will provide a comprehensive understanding of changes in physical and chemical properties at different depths of the tailings. The obtained information will be important for determining the stability of mineral associations, the distribution of metals and other elements. The research will contribute to the correlation between magnetic susceptibility and heavy metal concentration, and measurements will focus on 10 cm intervals to identify areas of enrichment in high resolution. The high resolution data obtained from this survey will provide information for subsequent analyzes (carried out at a lower resolution), related to the enriched zones. The obtained results will serve as input parameters for theoretical modeling of stable mineral associations under normal conditions.

2. Electrochemical separation and extraction of elements- includes theoretical modeling of extraction of elements from leached solution, as well as testing of electrochemical separation and extraction. The goal of theoretical modeling of elements from leached solutions is to determine the most effective methods for the extraction of these elements. The process of electrochemical separation and extraction will be carried out on prepared solutions containing the desired elements in the form of sulfates (e.g. Pb, Zn, Cu, Fe, Mn, Al, Cd, Ni) in ratios determined from chemical analyzes of pore fluids. The results of this work package will make it possible to determine the most efficient methods for the separation and extraction of elements.

3. Technological research and procedures for valorization of useful components from tailings- consist of three separate subgroups, each focused on specific procedures related to valorization of PGE (platinum group of elements) and non-ferrous metals, as well as recycling and application of flotation tailings in the road industry. Samples of 150 kg will be collected for PGE evaluation and subsequent magnetic separation, grinding, and laboratory shaking table processes. Procedures for evaluating the valorization of non-ferrous metals, will be performed on samples of 350 kg, include leaching that is carried out under natural atmospheric climatic conditions. During the experiments, the pH, salinity, temperature and concentration of elements in the solution will be monitored over time. The separation of clay minerals will be done using a sieve. The deslited sample will go through magnetic separation using different parameters of magnetic separators. Finally, physical and mechanical testing of the recycled tailings will be performed to determine its suitability for the road industry for road construction.

Figures 1-4. Photos taken during data/sample acquisition and laboratory measurements



Table 1. List of team members and institutions

Institution	Team member
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University of Belgrade Technical Faculty in Bor	Dragana Marilović
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Conclusion

The proposed methodology of the REASONING project has not been previously utilized in the study of flotation tailings in Serbia. The project aims to analyze the vertical and horizontal distribution of major and microelements, as well as their geochemical association, in the flotation tailings of the "Rudnik" mine. The findings will serve as a foundation for implementing suitable technological methods to process the tailings and ensure their safe utilization in road industries.

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