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Contaminated soils and waste from mining and metallurgical activities as a source of economically attractive elements: Assessment of their potential as part of a circular economy framework

ETZIGUERI GÓNGORA ÚBEDA[1], FRANCISCO MARTÍN ROMERO[2] AND MARGARITA EUGENIA GUTIÉRREZ RUÍZ[2]

[1]Universidad Nacional Autonoma de Mexico
[2]Universidad Nacional Autónoma de México
Presenting Author: etziguerigongora@gmail.com

Mining and metallurgical activities in the Matehuala area in central Mexico have been identified as the cause of soil and groundwater pollution; therefore, remediation actions are required to reduce human health risk.

Considering the need to manage the economic resources to perform the remediation in the Matehuala area, this research evaluates the potential of metallurgical mining wastes as a source of precious and base metals and rare earth elements.

Therefore, representative sampling was conducted to characterize mining waste, metallurgical slag, and smelter-impacted soils with an economical approach to evaluate their potential as a source of economically attractive elements.

The chemical and mineralogical characterization of the samples has been carried out. The total concentration of major elements was determined using X-ray fluorescence spectrometry. The total concentration of trace elements was determined by Instrumental Neutron Activation Analysis and Inductively Coupled Plasma-Optical Emission Spectroscopy. For mineralogical characterization, the samples were analyzed as bulk samples by X-ray diffraction. Thin polished sections from representative samples were prepared and analyzed by optical and scanning electron microscopy with energy-dispersive X-ray spectrometry.

The chemical analysis results indicate anomalous concentrations of Ag, Cu, Bi, Pb, Sn, Sb, W, and rare earth elements.

Mineralogical analyses indicate that metals with a possible economic interest, determined in the mine tailings, seem to be sorbet in secondary iron minerals such as jarosite, goethite, and hematite. However, in metallurgical slag and smelter-impacted soils, the mineralogical analyzes have yet to allow us to identify the solid phases with which chemical elements with economic interest could be associated; therefore, these samples continue to be analyzed with other techniques, such as transmission microscopy.

When the solid phases of the chemical elements with a potential economic interest are duly identified, metallurgical tests will be executed to determine the recovery rate and possible associated environmental problems.

The study of mining and metallurgical waste as a potential source of precious metals, basic metals, and rare earth elements; is a promising vision from the point of view of the circular economy, which will allow better management of mining and metallurgical waste; to reduce impacts on the environment and human health.