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Preconcentration of Co and Ni from aged mine tailings: exploring mineral processing techniques

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A wide variety of secondary sources contain key elements for the energy transition (*e.g.* Co and Ni). The repurposing of mine residues could be a promising approach for both economic and environmental reasons. However, several challenges must be met, related to particle size (*e.g.* fine particle), weathering (*e.g.* presence of passivation layer on the minerals of interest), and mineralogy (*e.g.* presence of secondary minerals with a complex structure), which can affect the effectiveness of mineral processing techniques conventionally used for preconcentration. The previous chemical leaching tests to assess the potential for the recovery of Co and Ni from aged mine tailings have shown moderate efficiencies, while requiring a high consumption of inorganic acids due to the presence of neutralizing minerals.

This work aims to assess the potential to preconcentrate Co-, Ni- and As-bearing minerals present in aged mine tailings using several mineral processing techniques combined or not with pre-treatments. First, a physico-chemical and mineralogical characterization of an aged mine tailing was carried out. Then, preliminary tests were conducted to evaluate the effectiveness of various preconcentration techniques (i.e. flotation, gravity and/or magnetic separation) alone or in combination with physical and chemical pre-treatments (i.e. quartz attrition, regrinding, sonication and leaching with EDTA) used to remove Fe-oxides from the surface of the minerals of interest.

The results showed that the selected mine residue was mainly composed of fine particles (D80 = 55 μm) and contained 1310 mg kg^{-1} Co, 943 mg kg^{-1} Ni and 5245 mg kg^{-1} As. Safflorite, skutterudite, cobaltite and erythrite, strongly altered and associated with silicate minerals (albite, quartz and chlorite), were identified as the main Co- and As-bearing minerals. Flotation tests combined with physical and chemical pre-treatments have shown that the preconcentration of Co-bearing minerals is challenging, while As-bearing minerals are somewhat more concentrated. The efficiency of the tested techniques, especially flotation, in separating minerals of interest from silicate gangue minerals remained relatively low. Overall, the preconcentration of Co-, Ni- and As-bearing minerals from aged mine tailings using conventional mineral processing techniques is significant but requires optimization for implementation at larger scale.