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Re-purposing BDAS System as a Green technology to concentrate REE from mine tailings

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Mine tailings with apatite and other REE-bearing minerals, as well residues generated by the phosphoric acid industry, including phosphate flotation tailing, phosphogypsum and phosphoric acid drainages could be considered as new potential resources of REE (0.01–0.3 wt% REE)[1]. The development of green technology to concentrate REE from those mine tailings and drainages is essential to develop a circular economy model for the mining and fertilizer industry. Alkaline REE-rich tailing (0.14 wt% REE) from Phalaborwa Igneous Complex (South Africa) and acid wastewater (7.2 mg REE/L) generated by a nearby plant of phosphoric acid have been selected to concentrate REE in a sequential semi-passive system based on Dispersed Alkaline Substrate (DAS) technology[2]. The results showed that approx. 90% of REE contained in the wastewater was concentrated in the first reactor (6.5 mg/L), filled with mine tailing. The mineralogical characterization of the substrates identified brushite and CaAlF-phosphate as major minerals. The latter acts as a sink for REE in the first reactor with up to 0.5 wt% of REE. At the end of the experiment, the concentration of REE in the substrate increased by 2.1 g/kg. This agrees with the geochemical model, which predicted that the immobilization of the anions and cations would be mainly controlled by the precipitation of phosphate minerals. In addition, newly-formed gypsum and oxide minerals were found throughout the system and they were associated with the removal of Fe > Al > Cr > Cu > Cd > Mn > Ni > As. However, U was mainly immobilized in the second reactor (0.7 mg/L) filled with barium carbonate. The re-purpose of DAS technology has proved to remediate acidic wastewater and concentrate REE concomitantly. Its implementation as the first concentration step of a process to obtain a marketable REE product could recover up to 0.4 Mt of REE from the acidic wastewater and the tailing. Furthermore, the mine produces about 18 Mt of tailing per year. Therefore, the reprocessing of the tailing could sustain a yearly production of 23000 tons of REE per year.

[1] Brahim et al. (2022) Minerals Engineering, 177, 107351

[2] van Heerden et al. (2015) WO2016035045A1