Alkaline treatment of contaminated acidic leachates from the phosphogypsum stack of Huelva (SW Spain)

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This study focuses on laboratory experiments as a first step to optimize an alkaline treatment system at field-scale for the contaminated acid leachates from a phosphogypsum stack in SW Spain. The treatment involved the addition of an alkaline reagent (0.01 M solution of $Ca(OH)_2$) to phosphogypsum leachates to increase the pH and decrease the solubility of dissolved contaminants. The proposed alkaline treatment had a high degree of success in the removal of anions (phosphates and fluorides), reaching percentages of 100% and 90%, respectively. Concerning the retention of toxic metals and other elements of high economic interest, values close to 100% were reached for Fe, Al, Cr, Cd, U, Zn, rare earth elements and Y (REY). However, the treatment seems not to be totally effective for other elements such as As (removal of 57-82%) or Sb (removal of 4-36%).The removal of elements from solution occured by co-precipitation and/or adsorption onto phosphate minerals, as well as precipitation of fluorides. The precipitates formed (around 7-98 g per litter of treated acidic solution) during the treatment were subjected to two standard leaching tests (EN 12457-2 from the EU and TCLP from the US) to classify and manage them according to their hazardousness. In this way, some of the solids formed during the treatment would be classified as hazardous wastes, due to the high concentration of As leached. Nevertheless, the precipitates generated during the experiment contain high concentrations of critical raw materials such as REY with concentrations up to 25 mg/kg and 34 mg/kg of light (ΣLREE; La-Sm) and heavy rare earth elements (ΣHREE; Eu-Lu, plus Y), respectively. In fact, a proper study for the recovery of elements of economic interest contained in high concentrations in the solids formed could help to offset the costs associated with the treatment.