

Distribution and fractionation of rare earth elements in a passive treatment system installed in a legacy polymetallic sulfide mine

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The geochemical behavior of rare earth elements (REE) in a passive treatment system (PTS) might give an insight of the understanding of REE transport and fractionation in water (dissolved and particulate) and in sediments in remediation systems for acid mine drainage (AMD). In this work, the distribution and mobility of REE in AMD, superficial water, sediments, and efflorescent salts (ES) in a PTS installed under the environmental remediation works of a legacy mine in Portugal are presented. The REE and other trace metals concentration was determined with ICP-MS for the water samples, INAA coupled with ICP-MS for the sediments, and with hotplate digestion and ICP-MS for the efflorescent salts. The iron oxidation state and compounds in sediment samples were studied by Mössbauer spectroscopy. The results show that REE behave conservatively in acidic water (pH < 3), whereas, in areas where mixing of acidic and circumneutral waters occurs, the REE are partially removed from the solution, by either co-precipitation or adsorption to newly formed Al and Fe precipitates, due to the change in the pH (above 5). The sorption onto the precipitates is not the same across the REE, with a depletion of light REE (LREE) and a preferential fixation of heavy REE (HREE). The sediments collected in the acidic ponds have an enrichment of middle REE (MREE) and LREE when compared to HREE. Meanwhile, samples collected in the wetland and in circumneutral water show a flat pattern with a slight enrichment of MREE. Goethite/ferrhydrite are the most abundant Fe oxyhydroxides identified in the sediment samples which are mostly found as nanosized. The high surface area of these nanosized oxides increase their ability to absorb REE. Among the ES, gypsum has the highest concentration of REE with an enrichment of MREE and LREE compared to HREE. The concentration of REE is lower in Fe and Al sulfate salts with an enrichment of HREE and MREE compared to LREE.

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