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Sequential extraction and DXRD applicability to poorly crystalline Fe- and Al-phase characterization from an acid mine water passive remediation system

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Abstract

Iron and Al precipitates play very important hydrochemical and environmental roles in aquatic environments affected by acid mine drainage. Despite their great importance, reliable characterization of these precipitates is problematic due to the high proportion of amorphous or poorly ordered mineral phases comprising these precipitates and because of their coexistence with intermediate to highly crystalline phases. To facilitate and improve the characterization of poorly ordered Fe and Al phases, a coupled differential X-ray diffraction (DXRD) and sequential extraction (SE) study was performed on a set of samples from an acid mine water passive treatment system. The results of these techniques indicate the presence of schwertmannite and goethite in the upper 5 cm of the passive treatment reactive material. Furthermore, a progressive decrease of the SO_4^{2-} adsorbed to the schwertmannite surface is suggested by one of the SE steps. The presence of hydrobasaluminite and amorphous $Al(OH)_3$ is suggested on the basis of SE and thermodynamic modeling analysis. These techniques also allow a quantitative estimation of the proportion of each mineral present. As a result, a complete study of the distribution of each mineral throughout the reactive material profile and the role of each phase in removing metals from the mine water can be obtained. This information is useful, not only to improve the reactive material design, but also to understand the natural processes taking place in aquatic systems affected by mining.

Keywords: Sequential extraction, DXRD, schwertmannite, hydrobasaluminite, amorphous $Al(OH)_3$, acid mine drainage, passive treatment system