

The role of oxyanions in the ageing rate of schwertmannite: insights into reactivity and mechanism

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Acid mine drainage (AMD) causes acidification of surface waters in combination with the release of trace elements, such as As, Cr, U, and Mo. The presence of secondary iron minerals can be considered of great importance in these areas, since they are naturally occurring scavengers and ultimately define the mobility of contaminants. However, additional microscopic information on the solid-phase is needed to establish the mechanisms through which contaminants are sequestered at the solid/solution interfaces in AMD systems.

Schwertmannite, $\text{Fe}_8\text{O}_8(\text{OH})_6(\text{SO}_4)_2$, is a poorly crystalline oxyhydroxysulphate that shows high specific surface area and high adsorption capacity towards contaminants such as arsenate or chromate, or nutrients such as phosphate. Our batch adsorption experiments showed high adsorption loadings of As, Cr and P on schwertmannite as compared to other iron oxyhydroxides such as goethite or jarosite. The adsorption was correlated to the liberation of sulphate ions to the solution. This suggested an exchange between the oxyanions and the sulphate ions present in the mineral. The latter was confirmed by FTIR measurements. The local structure of the adsorbed oxyanions (Cr, As and P) on schwertmannite was also evaluated using EXAFS.

The long-term immobilisation of the contaminants will be partially defined by the thermodynamic stability of the mineral. Schwertmannite is a metastable phase, transforming eventually into more stable phases such as goethite. Wet transformations in systems containing As and Cr at controlled pH showed that the presence of oxyanions retarded the transformation of schwertmannite to goethite. The changes in mineral structure, as well as the oxyanion speciation upon transformation, were followed by XRD, EXAFS and FTIR.