Mineralization and recrystallization of cadmium-doped schwertmannite induced by Fe(II)

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Schwertmannite precipitated in acid mine drainage (AMD) environments usually retains high levels of cadmium (Cd) via two different mechanisms: co-precipitation and adsorption. The present study investigated the effects of mineral substituted or adsorbed Cd on the species of secondary minerals and phase partitioning of Cd during anoxic Fe(II)-induced transformation of schwertmannite. The mode of Cd incorporation affected the mobility of Cd during schwertmannite recrystallization. Goethite was found as the dominant mineral phase among the transformation products. Cd-substituted schwertmannite contained about 93% of total Cd adsorbed on the surfaces, and release of Cd was strongly dependent on pH and less so on the extent of mineral transformation. But for Cd-absorbed schwertmannite, adsorbed Cd was released from schwertmannite immediately after adding aqueous Fe(II) followed by a slow decrease in aqueous Cd over 72 hours. A slight retardation of mineral transformation with increasing Cd levels was indicated by the rate of SO_4^{2-} release. Cd substitution may not certainly impact goethite formation and hematite nucleation, while Cd adsorption diminished secondary mineralization and altered transformation pathways, resulting in the formation of intermediate products lepidocrocite. The amount of lepidocrocite increased in proportion to the amount of Cd initially bound by the schwertmannite. The occurrence of secondary minerals such as goethite, lepidocrocite, and hematite controlled the phase partitioning of cadmium during schwertmannite transformation. The study has explored the mobility of Cd during secondary mineral transformation, and is helpful to the development of treatment strategies for controlling heavy metals in acid mine drainage.

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