Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.29184

Weathering of scorodite by root exudates: Arsenic Dissolution, Speciation and Coordination Environment

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Scorodite is a ferric arsenate mineral with low water solubility that effectively immobilizes arsenic under aerobic and acidic conditions, making it a key stabilizer in acid mine drainage systems. However, its long-term stability may be influenced by interactions with organic matter in productive ecosystems. This study examined the effect of plant roots employing Fe acquisition strategies I and II on scorodite stability and transformation, using humic acid as a model electron shuttle. Wheat (*Triticum aestivum*) and harsh hakea (*Hakea prostrata*) roots exuded primarily ascorbic acid when grown with scorodite, along with minor quantities of fumaric, succinic, and tartaric acids. Organic acid fluxes from both plants increased significantly in the presence of humic acid, which also modified the composition of root exudates, stimulating succinic acid in wheat and fumaric acid in harsh hakea. X-ray absorption near-edge spectroscopy analysis showed no change in the oxidation state of As. However, scanning and transmission electron microscopy indicated the formation of new non-crystalline phases. Linear combination fits of extended X-ray absorption fine structure (EXAFS) data demonstrated the incongruent formation of ferrihydrite, which removed As from solution as sorbed As(V). Additionally, amorphous ferric arsenate, although likely transient, was indicated by EXAFS and selected area diffraction patterns. The most significant transformation of scorodite was observed in the harsh hakea and humic acid systems, with up to 20% of scorodite transforming into nanocrystalline Fe phases within two weeks. These findings reveal that organic matter and plant root exudates can significantly influence scorodite stability, promoting its dissolution and transformation into metastable ferric arsenate phases. This suggests that organic-rich environments and productive ecosystems may enhance the mobility of As in acid mine drainage landscapes, with important implications for arsenic management and remediation strategies.