# Coupling between antimony mobility and iron cycling in the environment

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The environmental mobility of antimony (Sb) is strongly affected by interactions with iron (Fe) oxides. These phases can undego dynamic transformation and recrystallization processes in response to redox-dependent Fe cycling. Here we describe recent research on the behaviour and effects of co-associated Sb during (i) microbially-mediated reduction and transformation of ferrihydrite, (ii) abiotic Fe(II)-catalyzed transformation of ferrihydrite, and (iii) Fe(II)-catalyzed recrystallization of goethite.[1,2]

The Fe(II)-catalyzed transformation of Sb(V)-sorbed ferrihydrite – under both microbially-mediated and abiotic conditions – leads to rapid formation of goethite, lepidocrocite (at low Sb loadings) and feroxyhyte (at high Sb loadings). Formation of these secondary Fe(III) oxides is associated with significant decreases in Sb(V) mobility. Likewise, the Fe(II)-catalyzed recrystallization of Sb(V)-sorbed goethite, as quantified via isotope tracer experiments using $^{57}$Fe, also results in decreased Sb(V) mobility.

Shell fitting of Sb K-edge EXAFS spectra indicates that the decreases in Sb mobility are due to partial Sb(V) incorporation into the Fe(III) oxide structure. This occurs via partial heterovalent substitution of Sb(V)-O octahredra for Fe(III)-O octahedra, and likely protects Sb(V) against direct, short-term interactions with the aqueous-phase.

Our research shows that Fe(III) oxides are dynamic phases whose solid structure (not just the reactive surface) may be available for Sb(V) sorption via structural incorporation. It is also clear that Sb(V) itself plays an active role in controlling Fe(III) oxide transformation pathways and recrystallization rates.

**References:**

(1) Burton, E.D., Hockmann, K., Karimian, N., Johnston, S.G. (2019) Antimony mobility in reducing environments: The effect of microbial Fe(III) reduction and associated secondary mineralization. *Geochim. Cosmochim. Acta* 245, 278–289.

(2) Burton, E.D., Hockmann, K., Karimian, N. (2020) Antimony sorption to goethite: Effects of Fe(II)-catalyzed goethite recrystallization. *ACS Earth Space Chem.* (In Press).