Microbial oxidation and reduction of iron - implications for the environmental fate of Cd and As

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The two most important redox states of iron in the environment are Fe(II) [ferrous iron] and Fe(III) [ferric iron]. Redox transformation of iron, i.e. either reduction of Fe(III) to Fe(II) or oxidation of Fe(II) to Fe(III), is used by many microorganisms to produce energy and to grow and leads either to dissolution, transformation or precipitation of iron minerals. This presentation will give an overview about iron redox transformations catalyzed by neutrophilic microaerophilic, nitrate-reducing and even phototrophic Fe(II)-oxidizing as well as by Fe(III)-reducing microorganisms. I will then discuss the implications of these iron minerals transforming processes for the fate of trace metals. The presentation will focus in metal(loid)s such as cadmium and arsenic using examples from laboratory experiments with cultures of Fe(II)-oxidizing and Fe(III)-reducing bacteria as well as from field studies in cadmium-contaminated soils and drinking water filters used to purify arsenic-contaminated water. It will in particular be shown how Fe(II)-oxidizing bacteria can contribute to Fe(III) mineral formation and sorption and co-precipitation of other metal ions such as arsenic. Additionally, it will be shown that depending on the geochemical conditions, Fe(III) reducing activity in the presence of cadmium-loaded iron(III) oxyhydroxides minerals (ferrihydrite-like minerals) can either lead to cadmium mobilization by Fe(III) mineral dissolution or to cadmium immobilization by the formation of stable secondary iron mineral phases such as magnetite or iron carbonates.