

Fate of arsenic during the interaction of dissolved Fe(II) with Mn substituted iron oxides

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Arsenic is a worldwide groundwater contaminant, causing substantial human health effects around the globe. Iron oxides are common natural adsorbents that remove arsenic from solution and retain it in the solid phase. Among various iron oxides, goethite (α -FeOOH) is uniquely important because of its widespread abundance, high adsorption capacity, and high affinity for As. Natural goethite is ubiquitous in soils and always contains other elements. The existence of Mn in goethite is anticipated to affect the sorption behavior and speciation of arsenic due to the oxidation capacity of structurally-bound Mn(III). And the redox-driven reactions between aqueous Fe(II) and goethite could affect the trace element cycling.

In this study, the behaviors of As in anoxic condition during the interaction of goethite and Fe(II) at pH 4 and 7 were investigated with kinetic experiments and extended X-ray absorption fine structure (EXAFS) spectroscopy. Results showed that at pH 7 with 1 mM Fe(II) and 0.3 mM As(V), As(V) could be rapidly removed from solution after adding Fe(II). However, when goethite contained Mn substituted into the structure the As(V) that initially has adsorbed was gradually re-released into solution. The amount of released As(V) increased with the content of substituted Mn. In contrast, at pH 4, the concentration of aqueous As(V) did not change after adding Fe(II) with pure goethite. But for Mn-goethite, adding Fe(II) promoted the removal of arsenic from solution and the amount of adsorbed arsenic is equal to pure goethite. EXAFS spectroscopy showed that As(V) formed inner-sphere surface complex and no evidence was found for redox reactions between Fe(II) and As(V).

This work provides new insight into the complex environmental processes controlling the fate of a global water contaminant, As, during redox-driven geochemical cycling.

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