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Arsenic Interactions with Iron Oxyhydroxides in Groundwater

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Arsenic represents a serious threat to the human health in the southern parts of Bangladesh and West Bengal, where millions of people are drinking groundwater contaminated with naturally high levels of arsenic. The key to an effective remediation strategy is a precise knowledge of the mechanisms governing the physical state and thus the mobility of As these systems. Preliminary field experiments showed that iron-arsenic interactions and redox conditions play a major role in controlling the As speciation.

Adsorption and stability of arsenate, As(V), and arsenite, As(III), onto highly reactive hydrous ferric oxides have already been well investigated. However, relatively little is known about the coprecipitation mechanisms between arsenic and iron at a molecular level.

We analyzed the atomic environment of Fe in a series of synthetic Fe(III)-As(V) and Fe(III)-As(III) coprecipitates with varying As/Fe molar ratios (0 - 0.01 - 0.05 - 0.1 - 0.5 - 1) and aging times ranging from 0 days to 6 months. We also started the As k-edge EXAFS analysis of the same samples

Quantitative and modeling of the data are still in progress. However, some trends can already be observed. The first EXAFS results clearly demonstrate that the Fe-Fe contributions progressively decrease with increasing As/Fe ratio in both Fe(III)-As(V) and Fe(III)-As(III) systems. As an example, the figure below shows the RDF"s for "fresh" Fe(III)/As(V) precipitates at 3 As/Fe values: the peaks above 2Å (which correspond to Fe-Fe edge and corner linkages at As/Fe=0) strongly decrease when As is added, thereby indicating a hindered polymerization of Fe. Furthermore, Fe-Fe corner-sharing linkages, which are common in FeOOH polymorphs are no longer detected for the highest As/Fe ratios.

Aging of the samples generally results in increased Fe polymerization. No clear trend can be stated at this point of the data treatment, as this phenomenon appears to follow different kinetics depending on the As/Fe ratio and the oxidation state of As. However these larger species are more likely to settle or being filtered out. Therefore, a delay between pumping of the water and its consumption might be a way to alleviate the As toxicity.

