

Fate of Arsenate during Abiotic Iron Oxide Transformation under the Impact of Fulvic Acid

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Poorly crystalline iron oxides such as ferrihydrite are abundant in soils and sediments and are crucial in controlling the biogeochemical cycling of carbon and heavy metals in natural environments. Although the inhibitory effects of arsenate (As(V)) or organic matter on the ferrihydrite transformation process have been studied previously, there is a lack of mechanistic and quantitative understanding on the fate of As(V) during the abiotic transformation of ferrihydrite in the presence of fulvic acid (FA).

The objective of this study is to, at both the mechanistic and quantitative levels, investigate the dynamic behavior of As(V) during the Fe(II)-catalyzed ferrihydrite-FA coprecipitate transformation. We employed a suite of techniques including kinetic experiments, the scanning transmission electron microscopy (STEM), X-ray diffraction (XRD), and X-ray absorption spectroscopy (XAS) to elucidate the mechanisms of the iron oxide transformation processes. Our results showed that the transformation of ferrihydrite to lepidocrocite or goethite was slower in the presence of As(V) and FA than directly ferrihydrite transformation. More As(V) can be extracted when FA was present due to the slow transformation of ferrihydrite-As(V) coprecipitates. STEM results indicated that FA was adsorbed on the surfaces of goethite or entered the layered structures of lepidocrocite. Portion of FA was gradually released during the transformation processes. XAS results provided molecular-level information of the As(V) can gradually incorporated into the lepidocrocite during the ferrihydrite transformation processes. Our results demonstrated that the rates of As(V) speciation changes within iron oxides are coupled with the ferrihydrite transformation rates, and overall reactions were slowed down by the presence of FA that coexisted with the iron oxides, which has significant environmental implications for understanding the dynamic behavior of As(V) during the iron cycling processes in the environment.