Effect of Hematite Morphology on Arsenic(V) Adsorption

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Arsenic contamination of surface and subsurface aquatic systems is a critical problem affecting access to safe drinking water supplies. Adsorption onto iron oxides is an important control on arsenic concentrations in aquatic systems and is used is water filtration processes. Iron oxide minerals are often modeled as having their reactivity towards adsorbates dominated by a single surface site type. However, surface functional groups in multiple coordination states exist on iron oxide surfaces and these may display different adsorption affinities and rate for a given adsorbate. Predictive models of arsenic adsorption will be more accurate if they account for differing affinities among surface sites. This project investigates the importance of distinct surface site by studying As(V) adsorption onto hematite particles displaying two different morphologies under neutral conditions.

Hematite particles with pseudocubic and platelet morphologies were synthesized using established methods. The psesudocubic particles are bound by six {012} surfaces of approximately equal surface area; adsorption to {012} surface occurs at singly coordinated functional groups. In contrast, the platelets are enclosed by two {001} basal faces and six {012} side faces in a roughly 2:1 proportion. {001} surface may only display doubly coordinated surface functional groups. The platelets should thus show distinct As(V) adsorption behavior from the pseudocubes if adsorption affinity varies with surface site coordination state. As(V) adsorption isotherms were measured on each particle type at pH 7. X-ray adsorption fine-structure (XAFS) spectroscopy was then used to determine if As adsorption mechanisms differed between the two particles. XAFS analyses show that both bidentate and monodentate surface complexes form on the platelets but only bidentate complexes form on the pseuocubes. These results suggest that surface functional group coordination state affects As(V) adsorption affinity and mechanism.