

Zinc Release, Reimmobilization, and Isotope Fractionation during Fe(II)-Catalyzed Ferrihydrite Transformation

JINSHU YAN*, JEFFREY G. CATALANO, KUN WANG, AND HENG CHEN

Department of Earth and Planetary Sciences, Washington University, Saint Louis, MO 63130, USA
(*jinshu@wustl.edu)

Iron oxide minerals are ubiquitous in soils, sediments, and aquatic systems and often have great influence on the fate and availability of trace metals. Zinc is a common trace metal which is essential for a number of biological processes, but can be toxic at higher concentration. Zinc cycling and availability is affected by its adsorption on, incorporation in, and release from iron oxides. Ferrihydrite is a common form of iron oxides in many systems. Due to its poorly crystalline structure and small particle size, ferrihydrite is thermodynamically unstable and will transform to other more crystalline iron oxides under anoxic condition in the presence of Fe(II). While such reactions have been widely studied, the effect on solid-associated trace metal speciation and the impact of metals on ferrihydrite phase transformation are poorly studied. In addition, it is unknown when repartitioning during such transformations fractionated metal stable isotopes.

To better understand the behavior of zinc during Fe(II)-induced ferrihydrite transformation and whether this results in fractionations of zinc isotopes, we have investigated the phase transformations of Zn-substituted ferrihydrite at pH 7 under different Fe(II) concentrations. X-ray diffraction patterns of the reaction products reveal that that low Fe(II) concentration (200 μ M) favors the formation of hematite and lepidocrocite whereas high Fe(II) concentration (1 mM) promotes the production of magnetite and lepidocrocite. Both transformations processes are associated with the transient release of Zn to solution, which during aging is taken up by the mineral products. Control experiments with Zn-free ferrihydrite observes no hematite formation, indicating that Zn alters ferrihydrite transformation pathways. EXAFS and XANES spectroscopy show that zinc coordination within the mineral structure changed during the Fe(II)-catalyzed phase transformations. Zinc isotope results will also be presented to explore the fractionations generated by metal redistribution.