Redox-Linked Conformation ChangeObserved for Adsorbed Metal-Reducing Bacterial Cytochromes

L. V. Sycheva

Carrick Eggleston
University of Wyoming, carrick@uwyo.edu

PJ. S. Colberg

T. S. Magnuson

L. Shi

Follow this and additional works at: http://repository.uwyo.edu/geology_facpub

Part of the Geology Commons

Publication Information
Fate of ferric-hydroxide associated U(VI) during biological magnetite formation

A.L. SWINDLE1, A.S. MADDEN1, M.J. BEAZLEY1, J.-W. MOON2, B. RAVEL3 and T.J. PHELPS2

1Univ. of Okla., Norman OK 73019, USA (aswindle@ou.edu, amadden@ou.edu, mbeazley@ou.edu)
2Oak Ridge National Laboratory, Oak Ridge TN 37830, USA (moonj@ornl.gov, phelpstj@ornl.gov)
3National Institute of Standards and Technology, Brookhaven National Laboratory, Upton NY 11973, USA (bravel@bnl.gov)

In situ microbial metal reduction for the immobilization of toxic metals and radionuclides is an area of current research as a means of remediating contaminated ground water. The reduction of iron may result in the formation of magnetite concurrent with the reduction of soluble uranyl ions. The fate of adsorbed or co-precipitated uranium during iron reduction and magnetite formation remains was investigated.

Uranium-doped biogenic magnetite slurries were produced during fermentative reduction of uranium-doped ferric hydroxide precursor by cultures of Thermoanaerobacter strain TOR-39 [1]. The resultant suspensions were incubated at 65°C followed by room-temperature storage in crimp-sealed serum bottles with butyl rubber caps. Subsets of samples were analyzed by U LIII-edge X-ray absorption near edge spectroscopy (EXAFS) at the Advanced Photon Source and dropped onto TEM grids in an anaerobic chamber.

TEM imaging of the slurries revealed the presence of magnetite, unreduced FeOOH precursor, as well as needle-like crystal structures of akaganéite. Electron diffraction patterns confirmed the presence of magnetite and akaganéite in the slurries. Additionally, diffraction patterns were used to identify the presence of uraninite. EDS spectra of isolated magnetite crystals indicated small amounts of associated uranium.

EXAFS data indicate the presence of a biogenic UO₂ phase. Theoretical model fits identify 5 to 6 nearest-neighbor uranium atoms (compared to 12 in the standard UO₂ structure) suggesting the formation of UO₂ nanoparticles. The model fits also identify a uranyl-Fe phase suggesting the sorption of uranyl to magnetite or the FeOOH precursor and a uranyl-carbon signal possibly due to organic-U complexes.