Products of abiotic U(VI) reduction by biogenic magnetite and vivianite

HARISH VEERAMANI[1]*, DANIEL S. ALESSI[1],
ELENA I. SUVOROVA[1], JUAN S. LEZAMA-PACHECO[2],
JOANNE E. STUBBS[2], URS DIPPON[3], ANDREAS KAPPLER[3],
JOHN R. BARGAR[2] AND RIZLAN BERNIER-LATMANI[1]

[1]Swiss Federal Institute of Technology, CH-1015 Lausanne, Switzerland (*correspondence: harish.veeramani@epfl.ch)
[2]Stanford Synctrotron Radiation Lightsource, Menlo Park, CA, 94025 USA
[3]Center for Applied Geoscience – Universität Tübingen

Reductive immobilization of uranium by stimulation of dissimilatory metal-reducing bacteria (DMRB) has been extensively investigated as a remediation strategy for subsurface U (VI) contamination. These bacteria gain energy by reducing oxidized metals as terminal electron acceptors, often using organic electron donors. Thus, when evaluating the potential for *in situ* uranium remediation, it is important to understand how the presence of alternative electron acceptors affects U (VI) remediation and the long term reactivity of reduced uranium. Iron, an abundant metal in the subsurface, represents a substantial sink for electrons from DMRB, and the reduction of Fe (III) leads to the formation of dissolved Fe^{2+} or to reactive biogenic Fe (II)- and mixed Fe (II)/Fe (III)-mineral phases. Consequently, indirect abiotic U (VI) reduction by reactive forms of biogenic Fe (II) minerals could be a potentially important process for uranium immobilization.

The DMRB *Shewanella putrefaciens* CN32 was used to synthesize two biogenic Fe (II)-bearing minerals: magnetite and vivianite, which were characterized by XRD, HRTEM and Mössbauer spectroscopy. The present work elucidates abiotic molecular scale redox reactions between biogenic magnetite, vivianite and uranium. While both biogenic magnetite and vivianite reduced U (VI) completely, XAS analysis indicated dramatic differences in speciation of the reduced uranium phase in each case. Biogenic magnetite favored formation of structurally ordered crystalline UO_2 and biogenic vivianite led to the formation of a molecular adsorbed U (IV) species, even though UO_2 has generally been considered to be the sole end product of U (VI) reduction. Molecular U (IV) species is potentially more labile than UO_2 in sub-oxic environments and thus may affect the long-term stability of reduced uranium species post-remediation. This observation suggests that the the speciation of reduced uranium is strongly influenced by the bulk mineralogical composition in the surrounding environment.

Options for management of produced water

J.A. VEIL*

Argonne National Laboratory, 955 L'Enfant Plaza, SW, Suite 6000, Washington, DC 20024, USA,
(*correspondence: jveil@anl.gov)

Produced Water

Produced water is the largest byproduct stream resulting from oil and gas development. Management of the billions of barrels (1 barrel or bbl = 42 U.S. gallons = about 0.16 m^3) of produced water generated each year is costly for the industry. For example, in 2007, an estimated 21 billion bbl of produced water were generated in the United States [1].

Management Options

Companies have a wide range of options for managing produced water. The lecture describes many produced water management options using the concept of a 3-tiered water management/pollution prevention hierarchy: a) minimize water production, b) recycle or reuse, and c) treatment and disposal. There are many different technologies that can be used to manage produced water around the world. Although some options are used more often than others, there is no one technology that is always best.

PWMIS Website

The lecture also describes the web-based Produced Water Management Information System (PWMIS) that was developed by the author and his colleagues for the U.S. Department of Energy in 2007 [2].

[1] Clark & Veil, **2009**, available at http://www.ead.anl.gov/pub/dsp_detail.cfm?PubID=2437, accessed January **28**, 2010. [2] Available at http://www.netl.doe.gov/technologies/PWMIS/. Accessed January **28**, 2010.