FIU | Applied Research Center
FLORIDA INTERNATIONAL UNIVERSITY

U.S. DEPARTMENT OF ENERGY

ENVIRONMENTAL REMEDIATION

PROJECT: Rapid Deployment of Engineered Solutions to Environmental Problems:
Investigation of Microbial-Meta-Autunite Interactions - Effect of Bicarbonate and Calcium

CLIENT: U.S. Department of Energy
PRINCIPAL INVESTIGATOR: Dr. Leonel Lagos
LOCATION: Hanford Site, WA

Description:

FIU's Applied Research Center (ARC) is supporting the U.S. Department of Energy's Hanford Site in developing a strategy to improve the efficiency of the uranium stabilization process through polyphosphate injection technology.

Tripolyphosphate injected in aqueous solutions in order to sequester uranium, undergoes hydrolysis to orthophosphate forms, which serve as readily available nutrients for the various micro-organisms that thrive under these specific conditions and may even lead to an increase in their growth. The presence of rapidly adapting bacterial populations in sediment could strongly influence the migration/dissolution of uranium by dissolution and desorption due to the secretion of protons and various ligands. Therefore, understanding the role of bacteria in phosphate remediation technology and the interactions between meta-autunite and the microbes is very important. Of particular concern is the long-term stability of the sequestered uranium in the subsurface that may undergo subsequent remobilization. This task is designed to investigate bacteria-U(VI) interactions under oxygen restricted and anaerobic conditions, and study the potential bicarbonate-assisted U(VI) release from autunite minerals and uranium reduction by bacterial cells.

Objectives:

- Examine the ability of oligotrophic dissimilatory metal reducing bacteria (DMRB) to influence the dissolution pathways of U(VI) present in the groundwater as stable meta-autunite.
- Investigate the bacterial interactions with uranium and study the potential role of bicarbonate, which is an integral complexing ligand for U(VI) and a major ion in the pore water composition.
- Inspect bacterial surfaces after exposure to U(VI) in the bicarbonate-bearing synthetic groundwater solution via Scanning Electron Microscopy (SEM).
- Determine the difference between microbial effect on uranium release from synthetic and natural autunite.
- Evaluate for bacterial viability in the presence of bicarbonate ions.

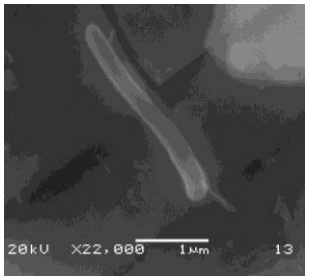
Benefits:

- Evaluates the role of bacteria in the bio-enhanced release of U(VI) from autunite in the presence of various concentrations of HCO_3 up to 10 mM.
- Evaluates the effect of bicarbonate on the bacterial viability in the presence of toxic U^{6+} ions.
- Yields insights on bacterial-U(VI) interactions under oxygen-restricted and anaerobic conditions and the ability of *Shewanella oneidensis* to influence the dissolution of natural and synthetic autunite in the presence of bicarbonate.

Accomplishments:

- Experiments under oxygen restricted conditions revealed that in the absence of bicarbonates, U(VI) concentration decreases dramatically, most probably due to the reduction of U(VI) by *Shewanella.*

In higher bicarbonate concentrations under oxygen restricted conditions, no reduction was observed, probably due to the speciation of U(VI) found in the form of negatively charged carbonate complexes that are electrostatically repelled by negatively charged bacteria. Under anaerobic conditions, for all bicarbonate concentrations studied, no reduction of U(VI) was observed.



Rod shaped *Shewanella oneidensis* MR-1 on the surface of natural autunite viewed under Scanning Electron Microscopy

ABOUT

Since 1995, the Applied Research Center at Florida International University has provided critical support to the Department of Energy's Office of Environmental Management mission of accelerated risk reduction and cleanup of the environmental legacy of the nation's nuclear weapons program. ARC's research performed under the DOE-FIU Cooperative Agreement (Contract # DE-EM0000598) can be classified as fundamental/basic, proof of principle, prototyping and laboratory experimentation.

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