Applied Research Center
FLORIDA INTERNATIONAL UNIVERSITY

U.S. DEPARTMENT OF ENERGY

ENVIRONMENTAL REMEDIATION

PROJECT: Environmental Remediation Science & Technology: *Remediation Research and Technical Support for Savannah River Site*

CLIENT: U.S. Department of Energy
PRINCIPAL INVESTIGATOR: Dr. Leonel Lagos
LOCATION: Savannah River Site, Aiken, SC

Description:

FIU's Applied Research Center (ARC) is supporting the U.S. Department of Energy's Savannah River Site in remediating uranium in F/H area seepage basins.

The F/H area seepage basins received approximately 1.8 billion gallons of acidic (pH 3.2-5.5) waste solutions contaminated with radionuclides and dissolved metals. The acidic nature of the basin waste solutions caused the mobilization of metals and radionuclides, resulting in contaminated groundwater plumes. The major constituent of concern is uranium (U). The pump-and-treat treatment system designed and built in 1997 became less effective prompting research for new remediation alternatives.

This project (i) investigates the effect of sodium silicate additions resulting in a pH increase leading to U(VI) sequestration, (ii) analyzes the soil and groundwater to verify the removal of U(VI) as well as mineralogical studies relating to the re-oxidation of a bioreduction zone, (iii) determines if the low cost Huma-K amendment can be used to facilitate uranium adsorption to control its mobility in acidic groundwater, (iv) investigates synergetic interactions between humic acid (HA) and colloidal silica that may influence the removal of uranium in the presence of SRS sediments, (v) studies the sorption of humic acid versus pH and studies the effect of HA on uranium mobility through porous media via flow-through column experiments.

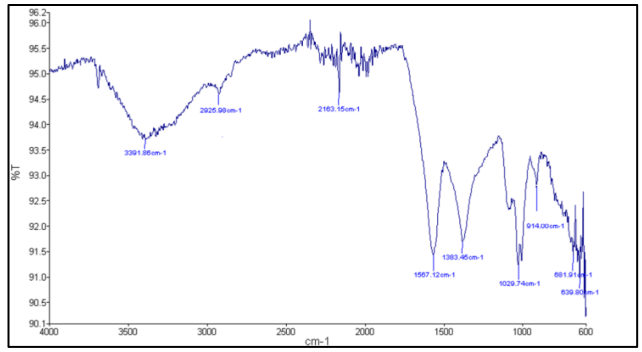

Fig 1. FTIR spectrum of Huma K which reveals aromatic functional groups

The main objectives are to:

- Evaluate whether a base solution of sodium silicate can replace the previously used carbonate base and determine if sodium silicate solutions have enough alkalinity to restore the pH of the treatment zone.
- Monitor the U (VI) bioreduction after the ARCADIS demonstration at the F-Area as well as the in situ addition of a carbohydrate substrate to create reactive zones for metal and radionuclide remediation via the EARP process and evaluate for changes in sulfate concentrations and pH.
- Understand the sorption and desorption of Huma-K and evaluate the effect of environmental factors that could possibly enhance desorption of Huma-K, in addition to studying the effect of Huma-K on the removal behavior of uranium.
- Investigate the hypothesis that some uranium in the current treatment zone is bound to silica and study if any synergy between humic acid (HA) and silica influences the behavior of uranium.
- Conduct column experiments to understand the sorption of humic acid (Huma-K) onto SRS sediments with varying pH to correlate results with HA injection tests and predict the migration and distribution of humic acid.

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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Benefits:

- Provides information on whether dissolved sodium silicate solutions have enough alkalinity to replace the carbonate base being used to correct the acidic nature of the contaminated sediments.
- Determines via microcosm studies whether reduced iron phases such as siderite and pyrite would arise in the reducing zone.
- Evaluate whether the sorption of Huma-K onto SRS sediments is a reversible process. Experiments will provide information on the stability of this remediation method to control uranium (U) mobility in the subsurface.
- Provides insight of synergetic interactions between humic acid and silica that influence U behavior.
- Understand the sorption of humic acid onto SRS sediments and its effectiveness on uranium mobility in the subsurface.

Accomplishments:

- Evaluated the influence of sodium silicate on the pH of a solution containing Savannah River Site (SRS) soil, synthetic groundwater, and U (IV).
- Examined mechanisms of uranium removal from the aqueous phase after sodium silicate additions.
- Monitored the pH of sediments augmented with a mixture of basal media, sulfate, and molasses with and without pH adjustments. The overall pH of the samples was observed to decrease over time.
- Studied the sorption/desorption behavior of Huma-K on SRS sediments (FAW-1: 70'-90') at different pH values from 4 to 8.
- Evaluated the influence of environmental effects such as pH (from 4 to 7.5) and presence of $NaNO_3$ salt on the desorption behavior of Huma-K from SRS sediments.
- Investigated the interaction of uranium with the major mineral phases of SRS soil.
- Investigated the effect of humic acid (HA) and colloidal Si on uranium removal by studying the synergetic interactions between humic acid and silica that influence the behavior of uranium.
- Modeled injection scenarios to predict sorption of humic acid onto SRS sediment at various concentrations and flow rates.
- Studied the sorption and desorption of Huma-K on sediment at different pH values (3.5 and 5.0).

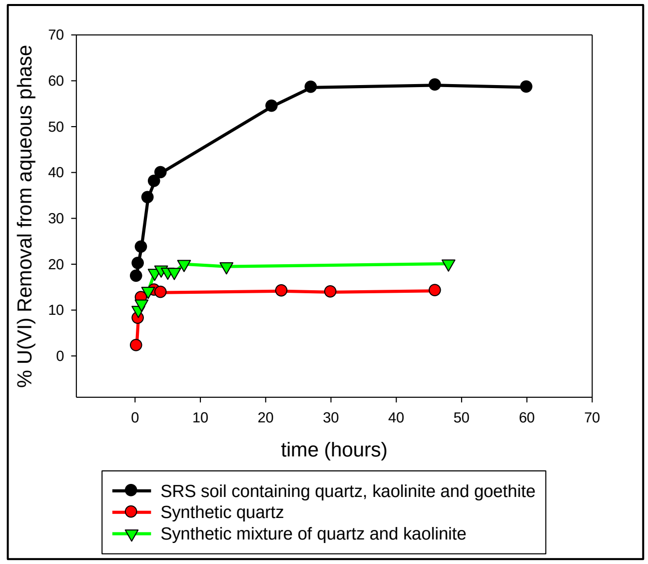

Fig 2. U (VI) removal by different mineral phases present in SRS sediments as a function of time. Results indicate that goethite plays the major role in U (VI) sequestration.

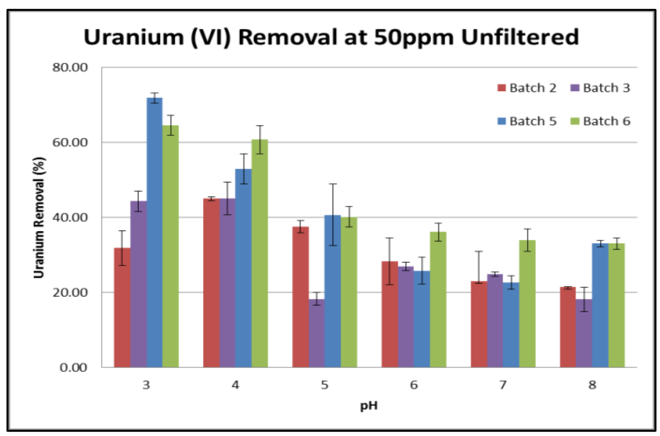

Fig 3. U (VI) removal at different pHs in the presence of 50ppm HA

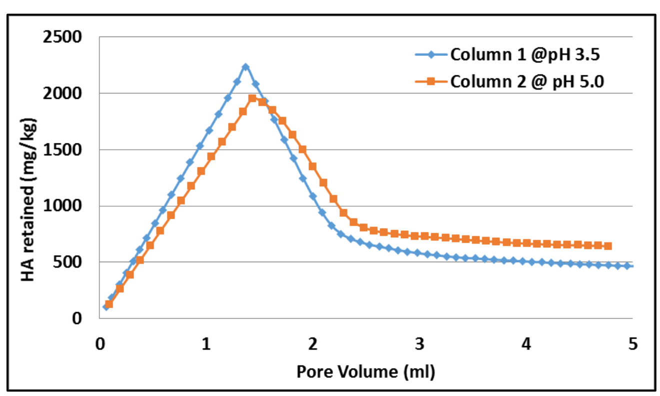

Fig 4. Retention of humic acid in the columns at different pH values