Effect of Acidic Plume on Soil's Properties & Capacity to Retain Uranium at the SRS

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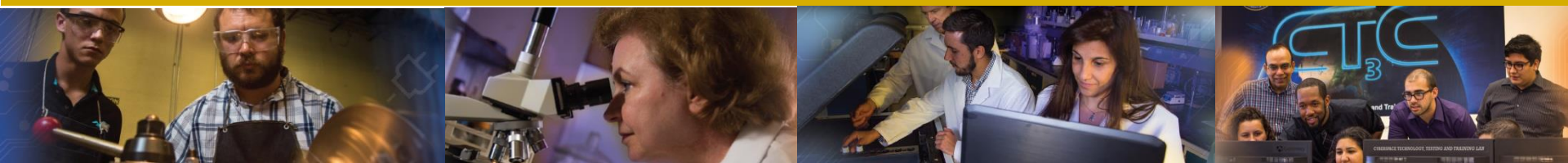

Research at ARC & SREL

FIU Applied Research Center

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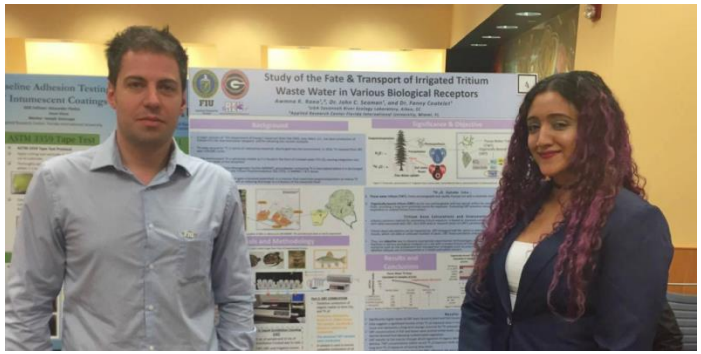


Past Mentor:
Mrs. Angelique Lawrence

Summer Internship Mentor: REU 2016
Dr. John Seaman (UGA SREL)

Project Description/Background

- Underground pipes at DOE's hazardous waste management facility, Savannah River Site (SRS), were used to transport **acidic radioactive effluents** to the basins and allowed to evaporate and seep into the underlying soil.
- Over time the acidic nature of the basin influent caused **mobilization of metals and radionuclides** resulting in localized contaminant groundwater plumes.
- **The SRS F&H Area** was selected by the DOE as a study site for understanding and predicting long-term ground-water plume mobility and natural attenuation.
- Sediment with long term exposure to highly acidic effluents **affect soil composition and physico-chemical properties** when compared to background soil.

Scope/Objective

- Assess the impact of the existing acidic waste plume at SRS F&H Area on the soil's morphological properties.
- Identify the changes in the soil's specific surface area and pore distribution.
- Understand how the acidification of the soil affects its ability to bind U(VI) and consequently understand better uranium's mobility in the environment.

Method / Approach

Soil acidification experiments **(November 2016-Febuary 2017)**

- Batch kinetic experiments, were conducted by bringing in contact background SRS F&H Area soil with nitric acid (pH 2.5) in triplicate polypropylene vials placed on a shaker.
- Different time intervals were set to sample following the respective exposure to nitric acid, during which an aliquot was isolated from the supernatant.
- Analysis for Al, Si and Fe concentration was performed by means of Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) and the dissolution soil's kaolinite and goethite was assessed.

Experiment Soil for Brunauer–Emmett–Teller (BET) **(March 2017)**

- The specific surface area and pore distribution of the different profiles of acidified soil samples obtained was performed by BET analysis.

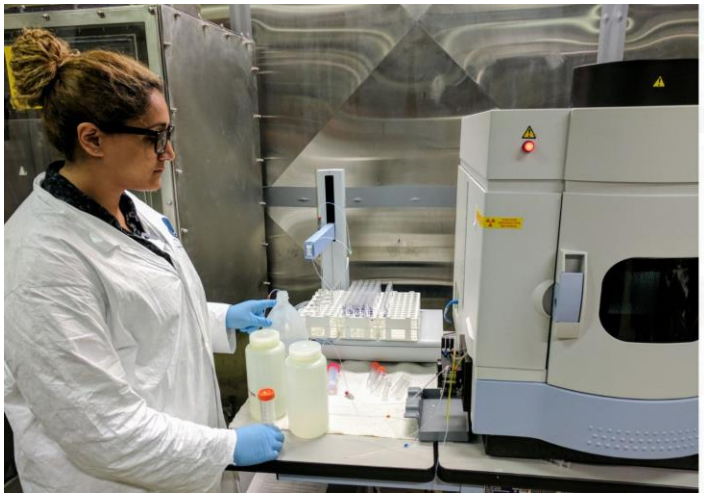
Soil Elemental Analysis with SEM-EDS **(April-May 2017)**

- Elemental analysis of the acidified soil, as well as the plume soil from the SRS F/H Area by means of Scanning Electron Microscopy / Energy Dispersive X-Ray Spectroscopy (SEM-EDS) was performed at the Florida Center for Analytical Electron Microscopy.

Method / Approach

Batch Experiment with U(VI) for KPA **(May-July 2017)**

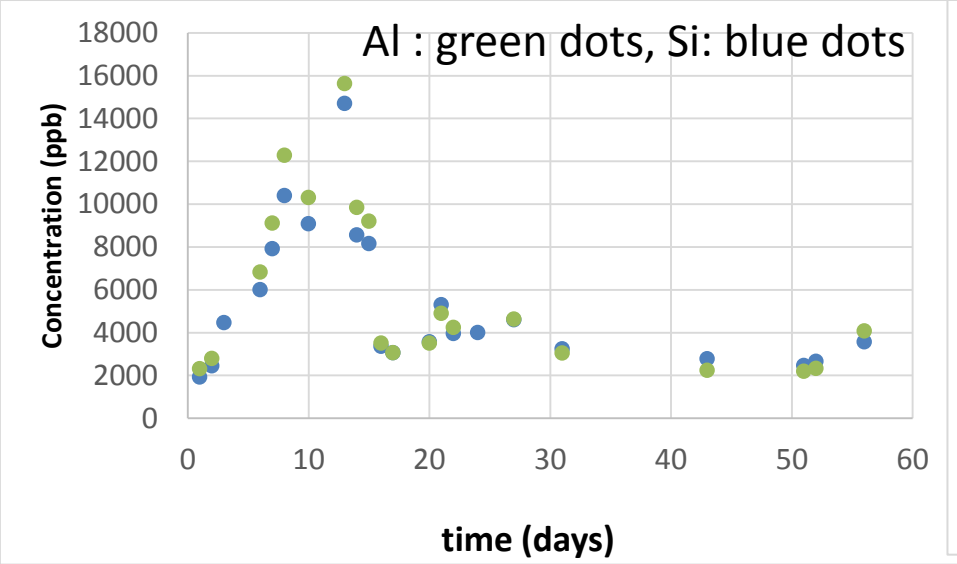
- Batch kinetic experiment was conducted by bringing in contact SRS F&H Area acidified and plume soil with 0.5 ppm U(VI) at pH values 3, 4.5, 7 and 8, in triplicate polypropylene vials and placed on a shaker.
- After equilibration, an aliquot was isolated from the supernatant and U(VI) concentration was measured by means of Kinetic Phosphoresces Analysis.
- Analysis for Al, Si and Fe concentration in the supernatant was performed by means of Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES).

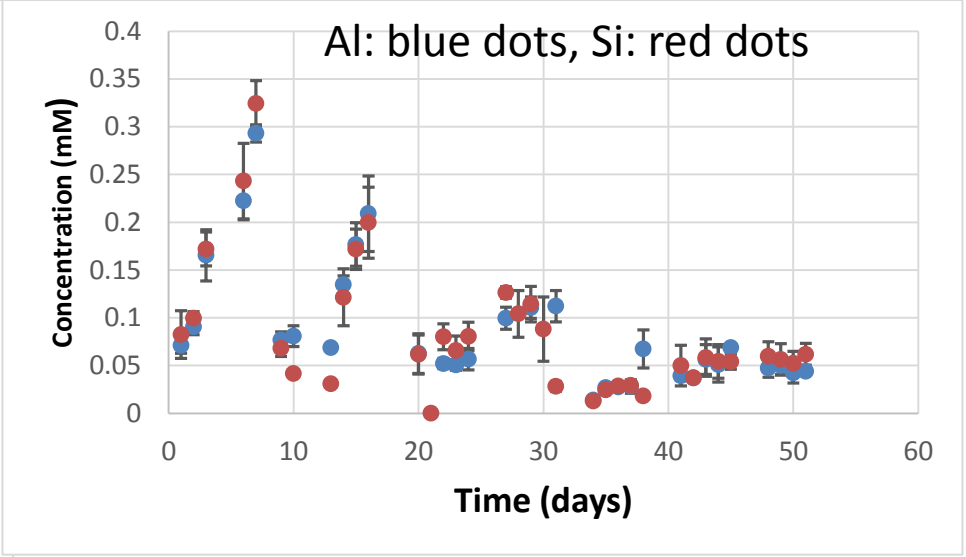


Running ICP-OES

Preliminary Results/Discussion

- Creation of acidified soil in the lab in batch experiments with occasional monitoring of Al, Fe and Si in the supernatant, due to kaolinite and goethite dissolution, with and without the formation of secondary precipitates (hematite and amorphous silica)

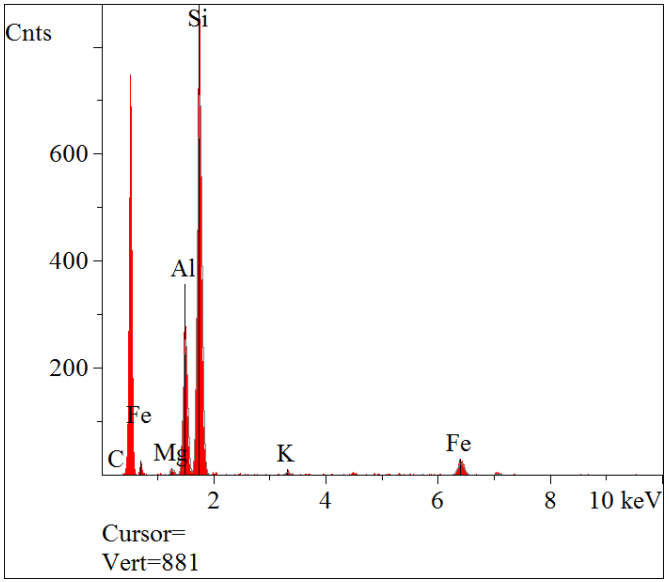




Leachate monitoring in the aqueous phase during acidification experiments

Preliminary Results/Discussion

- Elemental analysis by Scanning Electron Microscopy – Energy Dispersive Spectroscopy revealed the different percentage of Fe in the different types of soil to be the most important factor in U(VI) retention by the soil.



Elt.	Line	Intensity (c/s)	Conc	Units	Error 2-sig	MDL 3-sig	
C	Ka	0.00	0.000	wt.%	0.000	0.000	
Mg	Ka	11.14	0.863	wt.%	0.302	0.388	
Al	Ka	254.64	18.876	wt.%	0.795	0.412	
Si	Ka	740.49	70.337	wt.%	1.668	0.505	
K	Ka	7.84	0.985	wt.%	0.405	0.518	
Fe	Ka	36.04	8.939	wt.%	1.074	0.789	
			100.000	wt.%			Total

Elemental analysis of plume soil by SEM-EDS

Conclusions

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Highlights

- Prolonged exposure of soil to acid strips away the fine particle coating (kaolinite and goethite)

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Decrease of specific surface and Fe content

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Decrease of U(VI) sorption at both acidic and circumneutral conditions

- Plume soil exhibits higher Al and Si content compared to background soil, but the same Fe content and exhibits same U(VI) sorption at all pH values studied

Future Work

Experiment Plume Soil for Brunauer–Emmett–Teller (BET) (Upcoming)

- The acidified soil samples set aside from above will undergo BET analysis technique for the measurement of the specific surface area of each soil profile.

Kinetic Experiments of Acidified Soil and Plume Soil (Upcoming)

- Apart from equilibrium experiments performed so far, kinetic experiments of the actual plume soil and the soil acidified in the lab will follow in order to understand better each soil's sorption capacity

EMORY STEM Career Symposium (Oct 1-3, 2017)

- Competitively selected and awarded partial travel scholarship to present experimental research at the STEM symposium at Emory, Atlanta, GA.

Acknowledgements

- **FIU ARC Mentors**
  - Drs. Vasileios Anagnostopoulos, Yelena Katsenovich, Leonel Lagos
  - **SRS Contacts: Miles Denham**

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