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Applied Research
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DOE-FIU Cooperative Agreement Annual Research Review – FIU Year 1

Evaluation of Competing Attenuation Processes for Mobile Contaminants in Hanford Sediments

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*Worlds
Ahead*

Advancing the research and academic mission of Florida International University

Evaluation of Competing Attenuation Processes for Mobile Contaminants in Hanford Sediments

Overall Needs:

- Once active remediation is completed (pump and treat technology), a transition to more passive approaches, such as monitored natural attenuation (MNA), is required.
- Effective MNA necessitates a thorough understanding of the contaminant attenuation processes that affect their mobility in the vadose zone sediment.

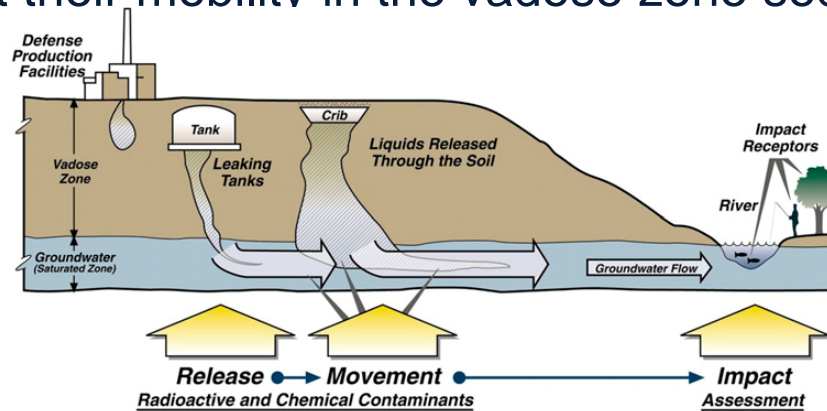
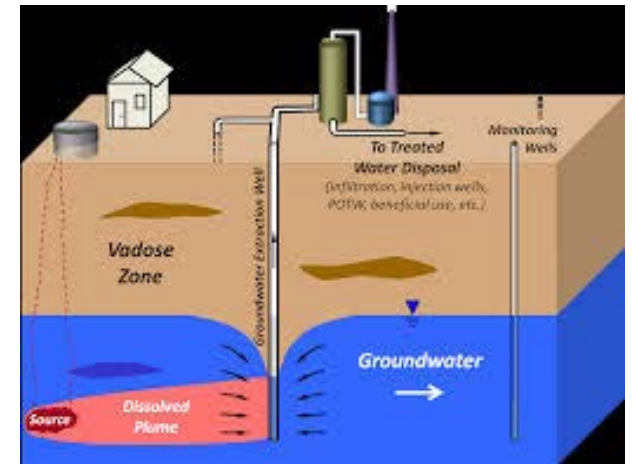


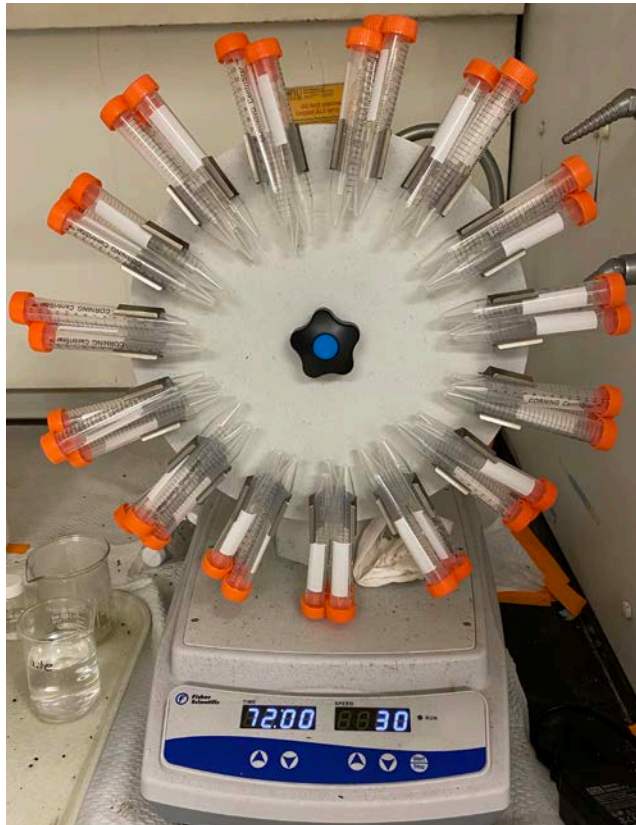
FIG. 2. Schematic diagram of waste discharges to the Hanford Site vadose



Objectives:

- Evaluate the adsorption of contaminants of concern (Cr, Tc-99, NO_3^- , U, I-127) onto Hanford Formation sediment at relevant aqueous concentrations in the absence and presence of each other.
- This research effort will provide (i) a better understanding of the species-dependent mechanisms of contaminant interaction with sediments in the absence and presence of co-contaminants (ii) the necessary parameters to predict contaminant mobility in the vadose zone; and (iii) the technical basis for MNA at the site.

Evaluation of Competing Attenuation Processes for Mobile Contaminants in Hanford Sediments

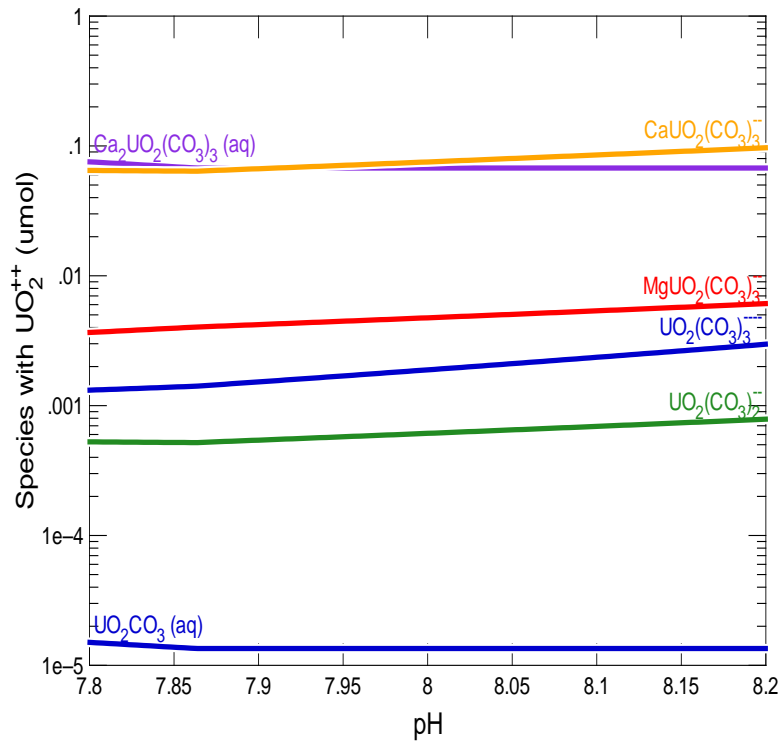


U(VI)
μg/L
9000
5000
2500
1000
100
50

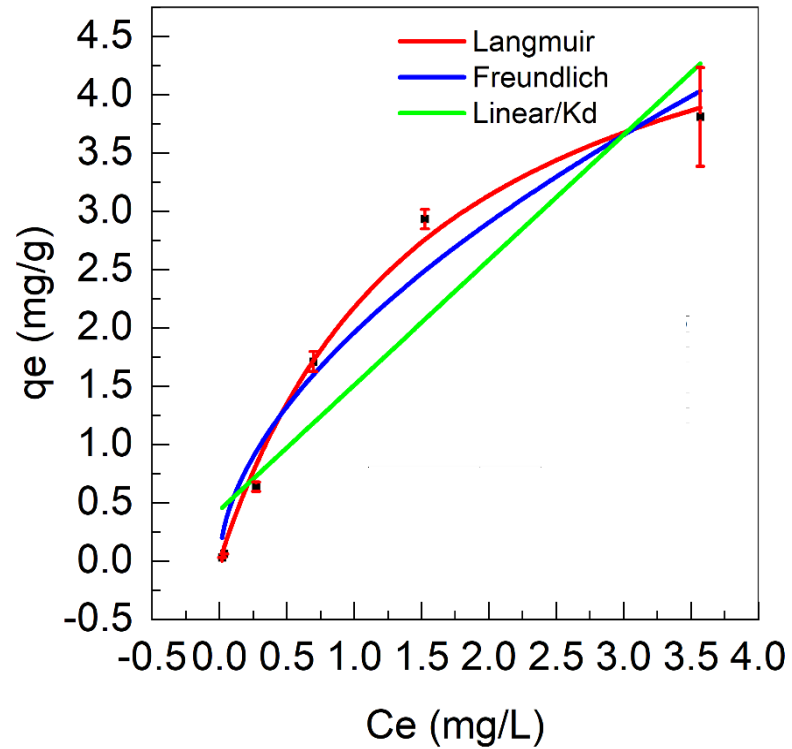
- Solid uranyl nitrate hexahydrate as source of U
- High sediment/artificial groundwater and porewater ratio as 1:1 (up to 5:1)
- Placed sediment samples in an end-over-end tube revolver at 8 rpm
- Analyzed batch samples at 1 hour, 3 hours, 8 hours, 1 day, 2 days, 3 days, 4 days, 5 days, 7 days, and 14 days to attain equilibrium conditions
 - Centrifuge (Sorvall ST Thermo Scientific Centrifuge) for 30 minutes at 4,500 RPM
- Sample preparation 2% HNO₃
- Ran samples on ThermoFisher Scientific iCAP RQ inductively coupled plasma-mass spectrometer (ICP-MS).
 - Calibrated instrument with standards diluted with 2% HNO₃. Use 5 ppb internal standard solution with Y,Tb,Bi, Sc,In

FIU Year 1 Highlights:

Uranium Speciation



Adsorption isotherms of U (50-9000 ppb) in AGW ($NaHCO_3$, $KHCO_3$, $MgSO_4 \cdot 7H_2O$, $MgCl_2 \cdot 6H_2O$, $CaCl_2 \cdot 2H_2O$, pH: 7.90 ± 0.03) onto Hanford Formation Sediment

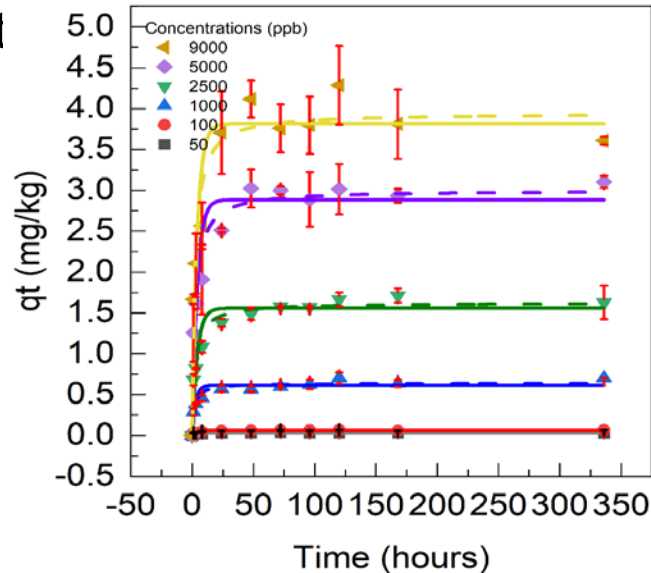


Q_{max} , mg/g	5.6
K_L , L/mg	0.64
Langmuir r^2	0.99
n	1.76
K_F , L/mg	1.96
Freundlich r^2	0.97
Linear r^2	0.87



FIU Year 1 Highlights:

Pseudo-first order (PFO,) and pseudo-second order (PSO) kinetics of U spiked AGW adsorption onto Hanford Formation sediment



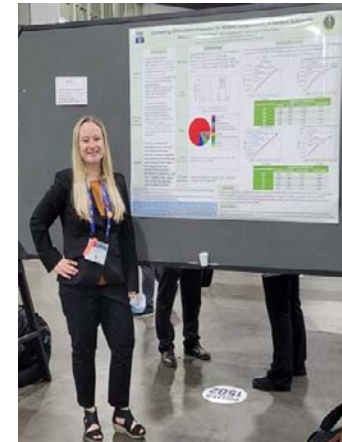
Concentration (ppb)	PFO r ²	PSO r ²
9000	0.91	0.95
5000	0.90	0.96
2500	0.91	0.96
1000	0.89	0.95
100	0.91	0.96
50	0.92	0.97

Completed batch adsorption experiments

- I-127
- Chromate
- Co-located I-127 and chromate
- Uranium low concentrations
- Tc-99

Other Accomplishments

- Remote summer internship under the mentorship of Dr. Nikolla Qafoku
- Poster presentation at Waste Management 2021 and ACS Fall 2021 meeting: Evaluation of Competing Attenuation Processes for Mobile Contaminants in Hanford Sediments



Future work

- Investigation of uranium batch adsorption studies in the presence of collocated contaminants (chromate, iodine-127, nitrate, and technetium-99)
- Speciation modeling of all contaminants using Geochemist Workbench program
- Solid phase characterization of post treated sediment (SEM-EDS and XRD analysis)
- Development of column studies to better understand uranium adsorption under site conditions.



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Thank You. Questions?