Role of *Chromohalobacter* on the potential transport of lanthanides and cesium in a dolomite mineral system

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DOE-FIU Science and Technology Workforce Development Program
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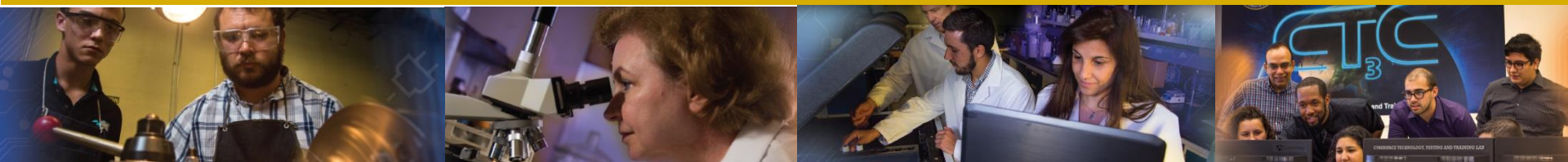
Florida International University



Summer 2017 Internship at CEMRC/LANL

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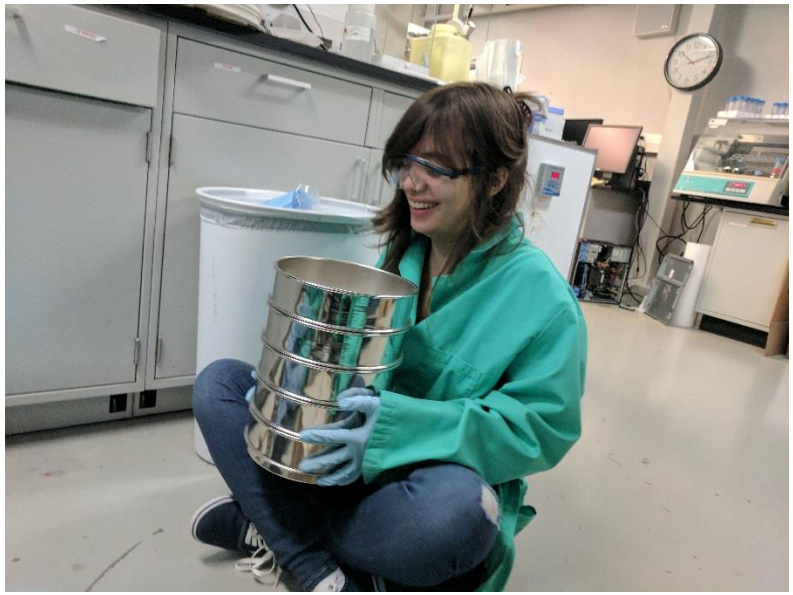

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Undergraduate
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The Waste Isolation Pilot Plant

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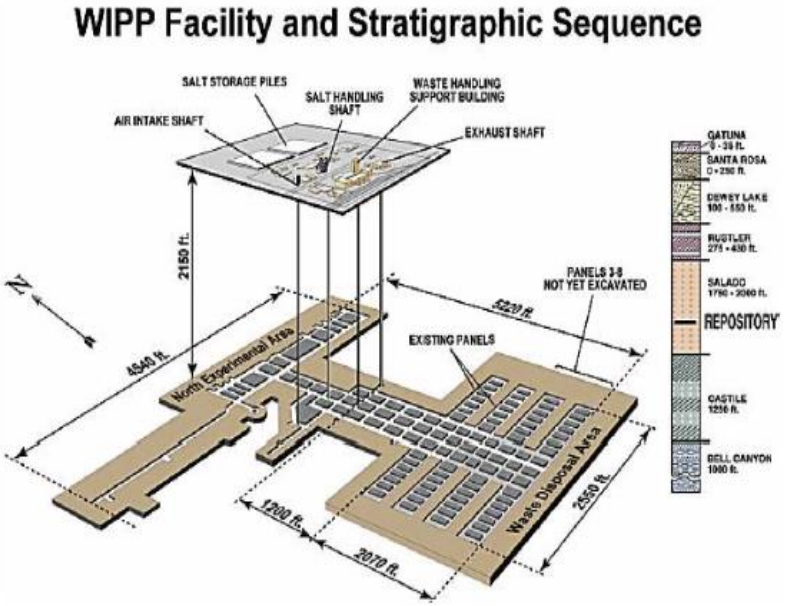
- The WIPP is a deep geologic repository for the permanent disposal of radioactive waste that is a byproduct from the nation's nuclear defense program.
- In the most likely WIPP release scenario, human intrusion (cuttings, cavings, spallings) can lead to direct and/or long-term brine release (U.S.DOE 1995, U.S.DOE 1996, Perkins, Lucero et al. 1999).

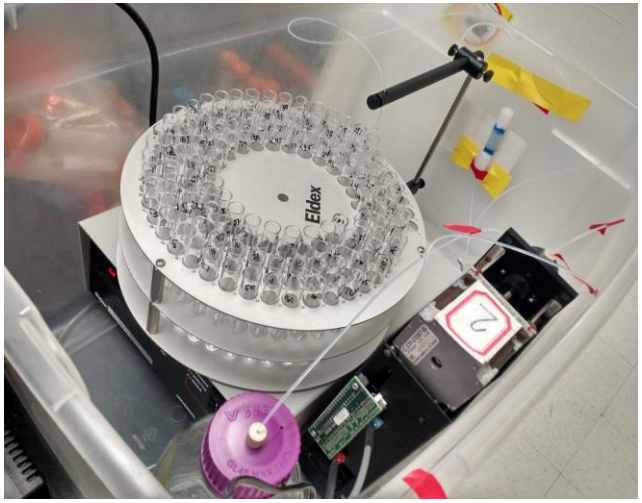


Uranium migration

Motivation

FIU ARC Experiments

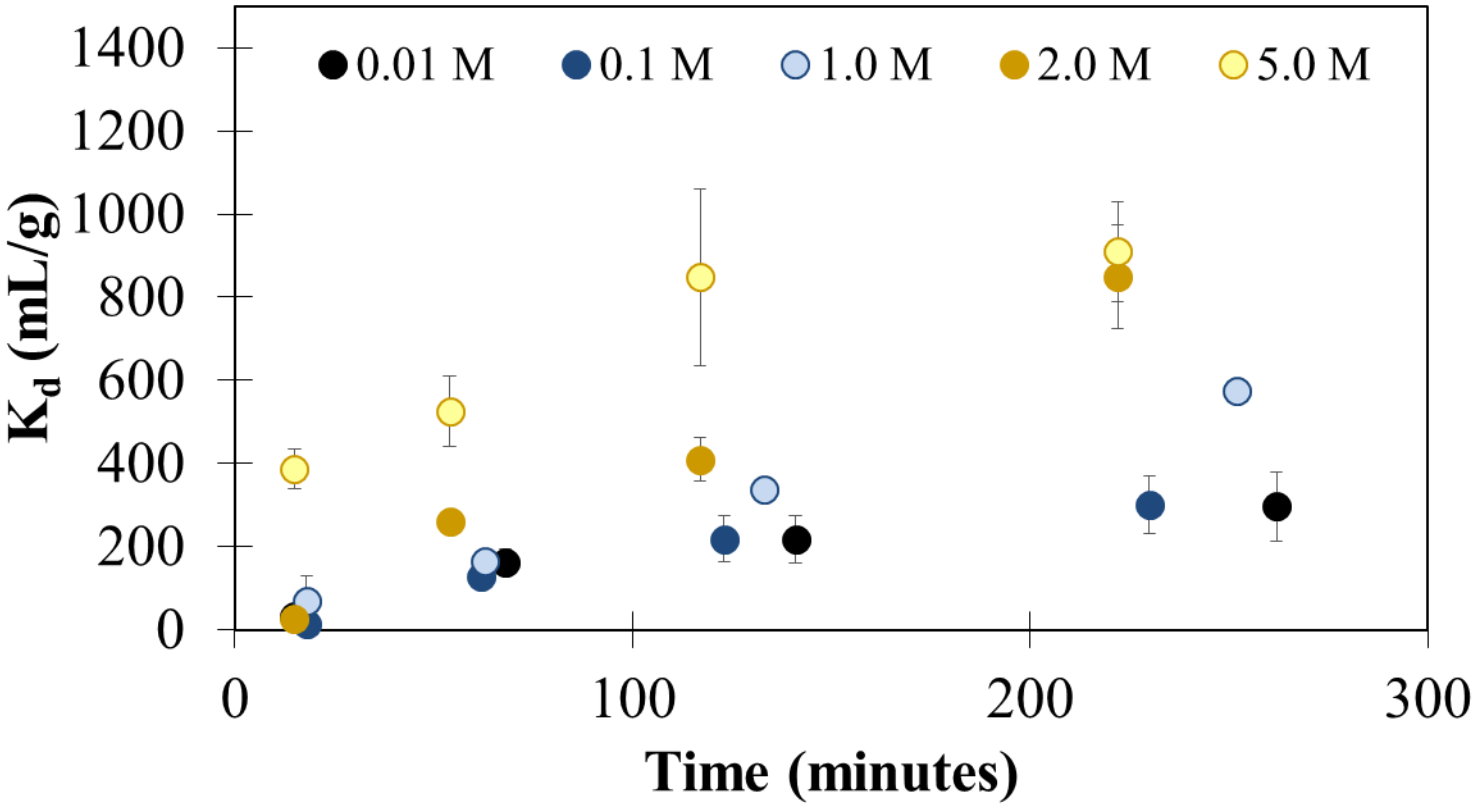
- Under Dr. Hilary Emerson
- The focus of my FIU project is to investigate the sorption processes of neodymium to dolomite minerals from the Rustler formation above the WIPP repository. Neodymium is used here as an analog for the trivalent actinides.
- Conducted mini-column saturation and batch kinetics experiments to observe sorption processes of Nd at variable ionic strength.



Kohlen Pump and Eldex fraction collector

FIU ARC

Nd Sorption Data



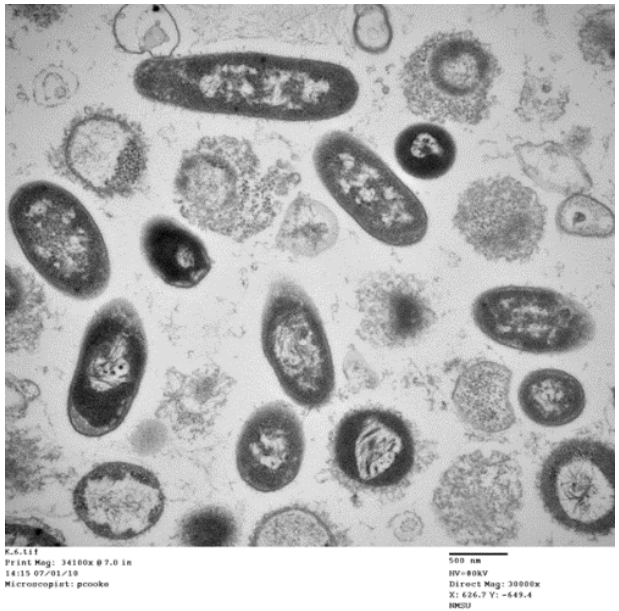
Sorption (as K_d in mL/g) with respect to ionic strength for 5 g/L dolomite and initially 20 ppb Nd, Note: sorption increases with ionic strength

LANL ACRSP
Summer Research Objective

FIU Applied Research Center

MAIN GOAL: To observe the behavior of *Chromohalobacter* and its effect on the mobility of lanthanides and cesium on dolomite minerals from above the Waste Isolation Pilot Plant

* *Chromohalobacter* is used in this experiment because it has been isolated from near the WIPP site and can thrive in high salt concentrations which is relevant to WIPP-related conditions.



Chromohalobacter

Dittrich, T.M., Swanson, J.S., Richmann, M.K., Reed, D.T., 2017. Role of biosorption and biocolloid enhancement factor parameters in radionuclide transport modeling. Presented at the ABC Salt V Workshop, Ruidoso, NM, March 26. *LA-UR-17-22516.*

Experimental Approach

Neodymium Microbial Transport Experiments

- **Purpose:** Quantify the mobility of contaminants in the presence of microbes under conditions relevant to the Waste Isolation Pilot Plant
  - Two experimental protocols were used to investigate:
    1. co-transport of Nd and microbes [in duplicate]
    2. re-mobilization of Nd by microbes [in duplicate]

Materials

- Four mini-columns packed, weighed, tightened and sealed with silicone, Teflon ~1 inch length, 60 cm outlet and 30 cm inlet tubings
- Culebra Dolomite (355-500 mm, [$CaMg(CO_3)_2$])
- Synthetic Brines: 15% NaCl by weight + 3 mM $NaHCO_3$ with and w/o *Chromohalobacter* +/- 20 ppb Nd
- Fraction collector and syringe pump

Mini-column experiment with four syringes connected to four mini.

Experimental Approach, cont'd

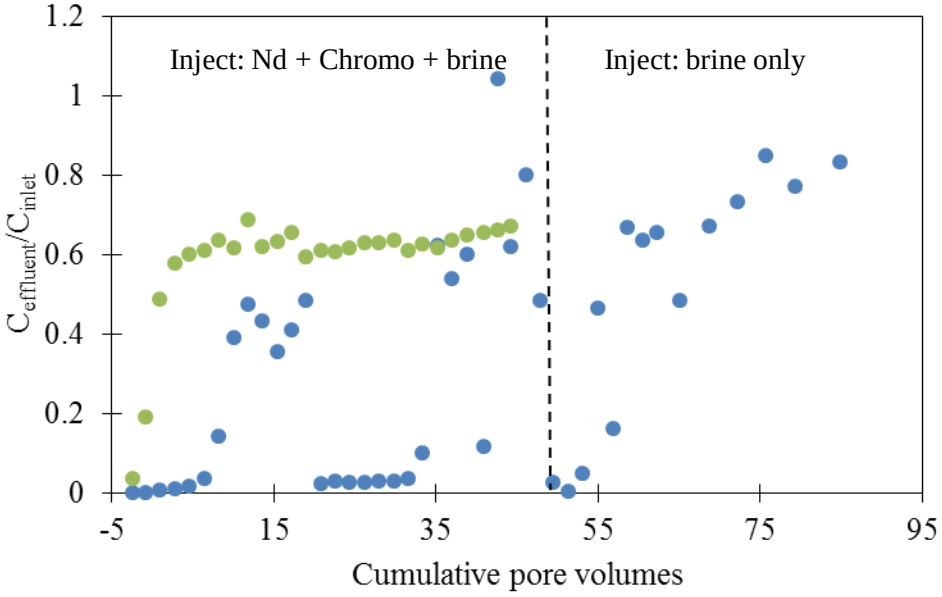
- Set #1:*Chromohalobacter* initially injected into duplicate mini-columns after reaction with Nd in brine. Then, injection solution was switched to only brine (without Nd or microbes) after approximately 9 hours.
- Set #2: Nd in brine initially injected into duplicate mini-columns. Then, injection solution switched to *Chromohalobacter* + brine without Nd after approximately 9 hours.
- Analysis: Effluent samples were analyzed for Nd by ICP-MS with and without filtration (100k MWCO) and microbial concentrations were tracked based on absorbance (spectrophotometer)
- Note: All four mini-columns are pumped at a rate of 0.013 mL/min

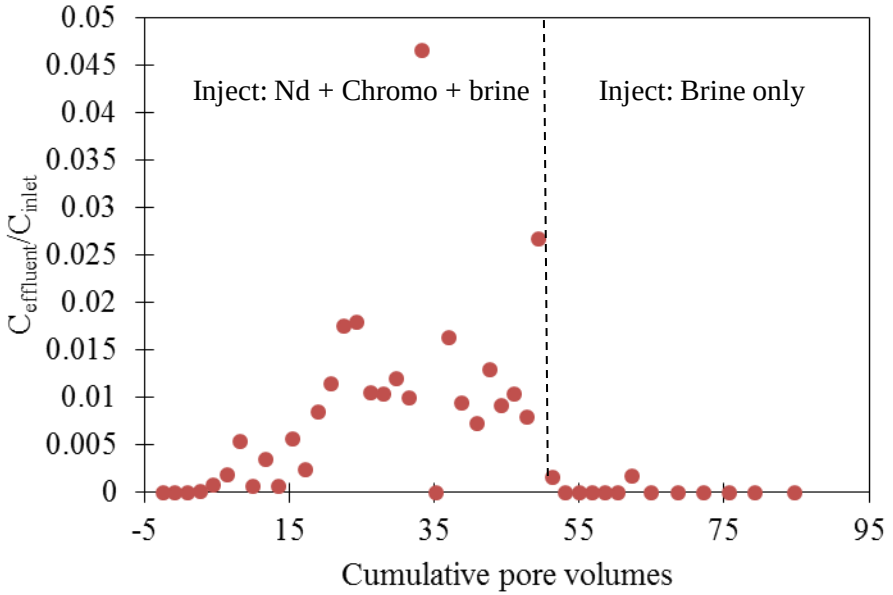
Preliminary Results

Results for Column with initial injection of *Chromohalobacter* + Nd + brine

- **Unfiltered Results:** Good correlation of Nd and Microbe recoveries
- **Filtered Results:** Suggest majority of aqueous neodymium is associated with microbes

Summary: No microbes, no mobility in the column due to strong sorption of Nd to dolomite





Blue = Unfiltered Nd recovery
Green = Chromohalobacter recovery (based on absorbance)
Red = Filtered Nd recovery

*Note change in y-axis between results

Conclusions & Future Work

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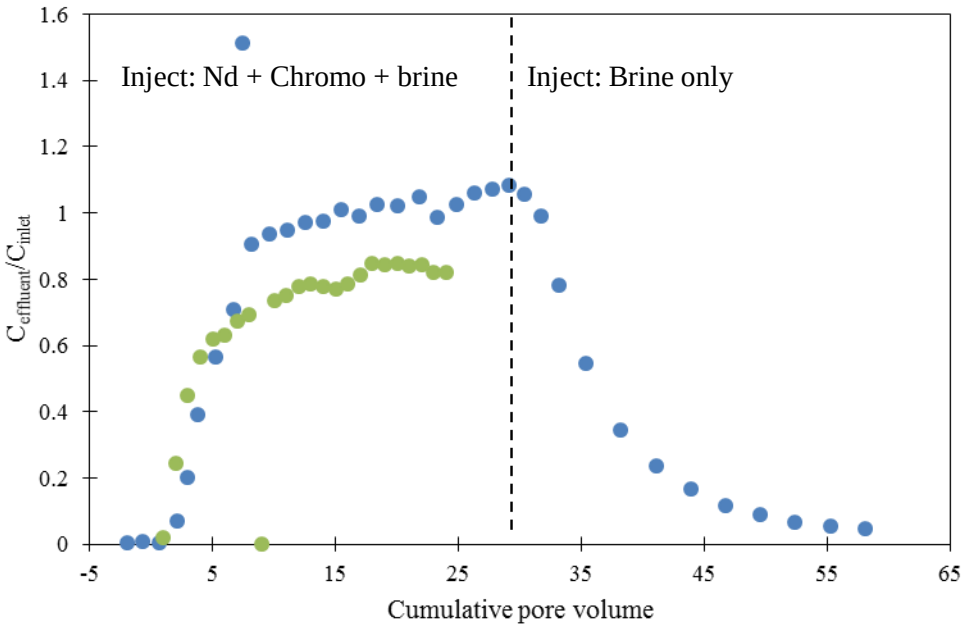
Preliminary Conclusions:

- Microbes have a strong effect on mobilization and sorption processes of Nd
- Experiments and analysis are still ongoing.

Future Work:

- Analysis of Cs and Nd results will continue.
- Microbes may have an effect on other lanthanides such as Eu and Ce. Therefore, mini-column experiments with Ce and Eu will be conducted to compare results to the current results from the Cs and Nd microbial transport experiments.



Blue = Unfiltered Cs recovery
Green = Chromohalobacter recovery (based on absorbance)

Acknowledgements

- **LANL Summer Mentors**
  - Tim Dittrich and Don Reed
- **FIU ARC Mentors**
  - Hilary Emerson
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The team taking a breather at Pratt cabin halfway through the McKittrick Canyon hike near Carlsbad, NM