



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

Project 5 - Task 1

Hydroxyapatite Injection for Sequestering Uranium (U) in Groundwater

Olivia Bustillo (DOE Fellow)

Hydroxyapatite Injection for Sequestering Uranium (U) in Groundwater

Overall Needs:

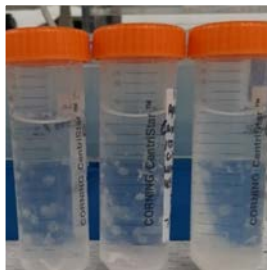
- Old Rifle, CO was previously a uranium/vanadium ore processing facility.
- Uranium that remained in the subsurface under the capped waste piles was predicted to be flushed by natural groundwater flow.
- Uranium has persisted at elevated concentrations in groundwater much longer than predicted.
- Several studies proved that injection of apatite into groundwater have shown to sequester uranium.
- LM has conducted a pilot study using a hydroxyapatite Permeable Reactive Barrier to remediate uranium at the DOE Old Rifle site in Colorado.
- While this process has proved to be effective, a better understanding of the mechanisms behind the interaction is required.

Objectives:

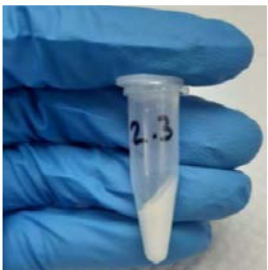
- Study the mechanism of U removal/sequestration from groundwater by apatite.
- Study the environmental factors that influence the stability of the removal of uranium.



FIU Year 1 Highlights: Hydroxyapatite

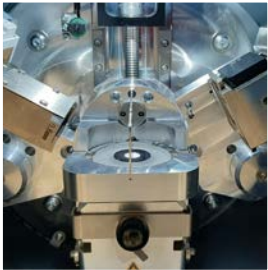


Synthesized hydroxyapatite at four varying Ca: Citrate: PO_4 ratios to determine optimum ratio

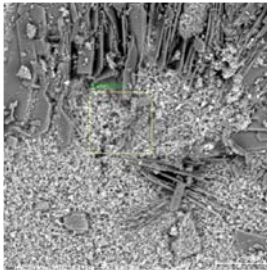


Determined average total precipitate; Scenario 2 and 4 yielding the highest amount

Characterized samples via XRD and EDS to confirm successful synthesis of hydroxyapatite through the elemental composition



Samples analyzed via SEM to identify the structure of the precipitate



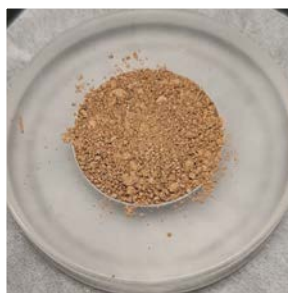
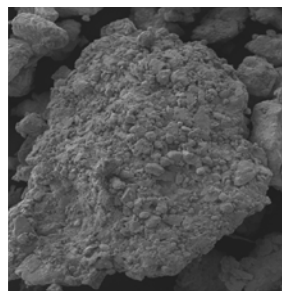
	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Calcium Concentration	40 mM	80 mM	80 mM	40 mM
Citrate Concentration	100 mM	200 mM	100 mM	100 mM
Phosphate Concentration	45 mM	90 mM	45 mM	90 mM
pH	7.37	7.26	6.96	7.29

FIU Year 1 Highlights: Soil Characterization



Received surface-level soil samples from Old Rifle; processed through 2mm sieve to remove rocks

Conducted SEM-EDS analysis for structural images of the sediment and elemental composition data



XRD and N2-BET analysis to confirm prominent elements in soil and determine surface area

Commander Sample ID (Coupled TwoTheta/Theta)

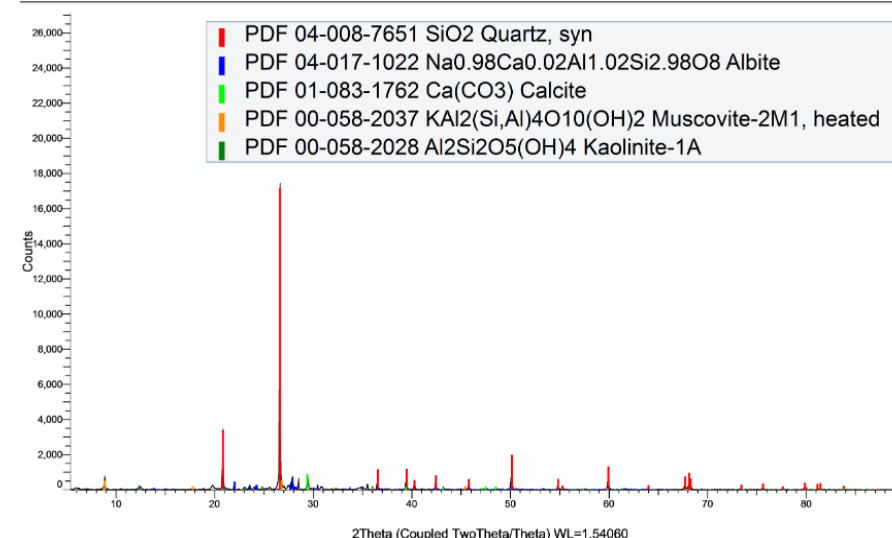


Figure 1-1. Matched XRD Pattern for Plot 4.

Present minerals:

- Quartz
- Albite
- Calcite
- Muscovite
- Kaolinite

FIU Year 1 Highlights: Conferences



Figure 1-2. FIU Participants at Waste Management Symposia 2020.

- Presented at Waste Management Symposia 2021
- Submitted Professional Abstract for Waste Management Symposia 2022

Sampling Activities



- Durango, Old Rifle, Rocky Flats
- Groundwater/surface water sampling activities
- Sampling used to monitor sites to assist LM in identifying and addressing potential site issues
- Ensuring data quality so data is defensible is vital

Site Inspections



- Durango and Naturita
- Required to ensure site remains protective
- Many collaborating for a common goal
- Exposed to Erosion Risk Project from Applied Studies and Technology Program

Environmental Sciences Lab



- Importance of data quality and integrity from field to lab
- Ion Chromatography System and Kinetic Phosphorescence Analyzer
- Assembled column test and perform minor maintenance repair of analytical equipment

Site Leader Responsibilities



- Collaborates to ensure long-term stewardship and management of the sites for future protection of human health and the environment
- Continuous clear communication and transparency with stakeholders is vital to gain trust and support

DOE Interactions



- Ensure safety of human health and environment
- Maintain long-term protectiveness and reduce long-term costs
- Know the interests of the stakeholders
- Understanding history of the site
- Comply with applicable laws and regulations

LM Mission



- Goal 4: Sustainably manage and optimize the use of land and assets
- Witnessed firsthand at:
 - Old Rifle Remote Control Park
 - Rocky Flats National Wildlife Refuge
 - Durango Dog Park

FIU Year 1 Highlights: Graduation



Figure 1-3. Fellow Olivia Bustillo at Graduation.

- Received Bachelor's Degree in Environmental Engineering
- Accepted to Environmental Engineering Master's Program at FIU
- Thesis track- continuing research
- Expected graduation: Fall 2023

Future work

Determine the kinetics of the formation of hydroxyapatite through analysis of aliquot samples using ICP-OES.



Finalize the synthesis and characterization studies of the formation of apatite at varying Ca:Citrate:PO₄ ratios.



Conduct experiments to examine how uranium interacts with HA when immediately injected, while in the process of precipitation.



Coordinate studies to investigate how uranium interacts with HA after it has precipitated and is interacting with flowing groundwater.

Acknowledgments

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Thank You. Questions?