Exploring Hydroxyapatite's Capacity for Uranium Sorption and Desorption

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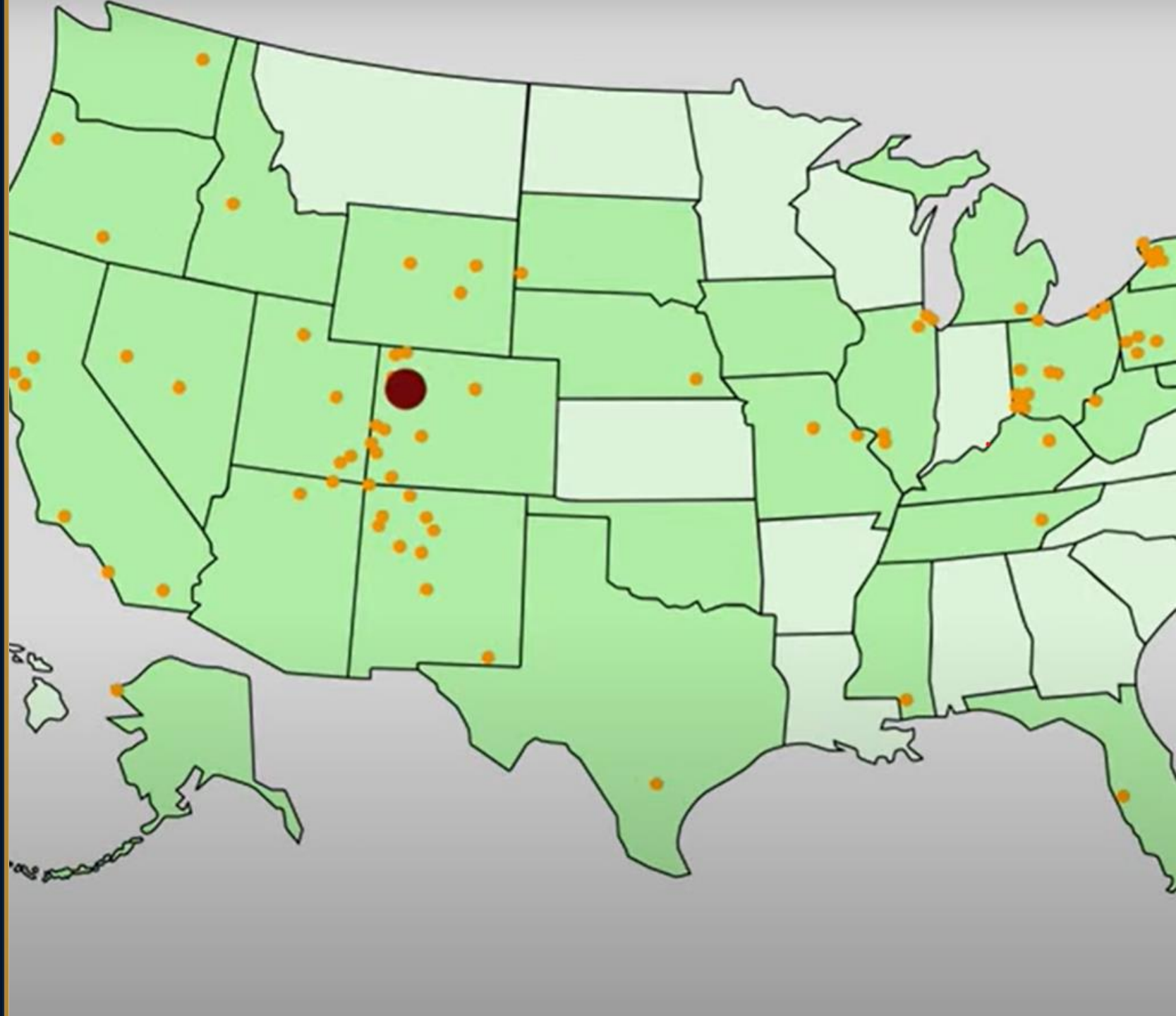
Background

- Old Rifle site in Rifle, CO. Functioned as an ore-processing plant to produce Uranium ore.
- The ore-processing operation led to the groundwater, surface water, and sediments becoming contaminated.
- Uranium contamination in groundwater and surface water can lead to acute health effects, including cancer and kidney damage.
- Hydroxyapatite $Ca_{10}(PO_4)_6(OH)_2$) was utilized in attempts to remediate this site and others with similar circumstances.



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Hydroxyapatite Functions

- Hydroxyapatite (HAp, $Ca_{10}(PO_4)_6(OH)_2$), is composed of calcium and phosphate.
- HAp can exchange its calcium ions (Ca^{2+}) with uranium species (such as: Uranyl Ion-UO_2^{2+}) making it effective for uranium remediation.
- Different scenarios were set up to view how varying stoichiometric ratios affect HAp formation. Scenario A and Scenario C were chosen for further experiments.
- Scenario B not used for following experiments due to impurities.

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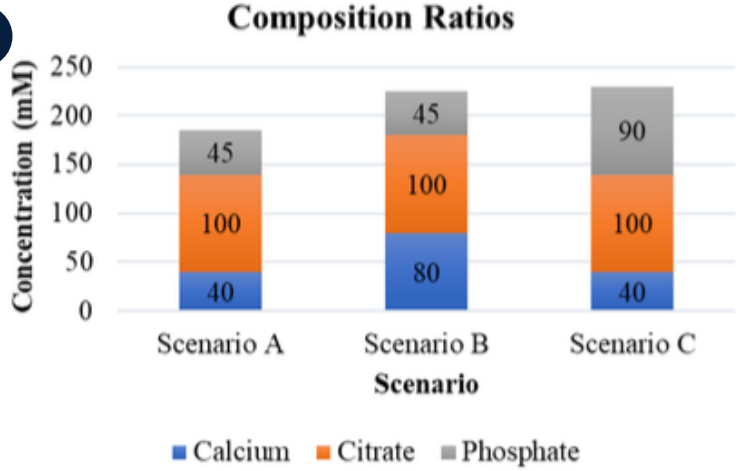

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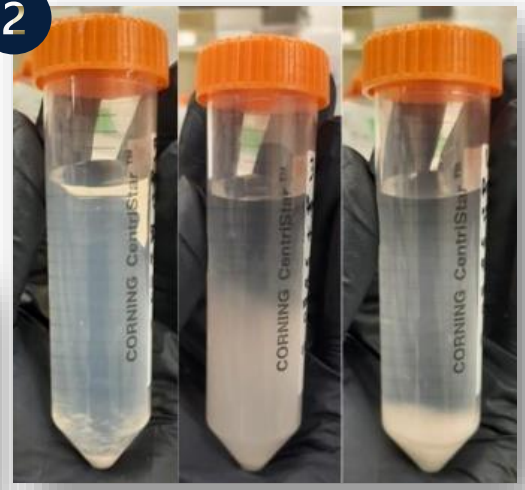

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1) Stoichiometric Ratios used for HAp Synthesis. 2) Precipitate formed after 6 weeks. 3) Dried HAp

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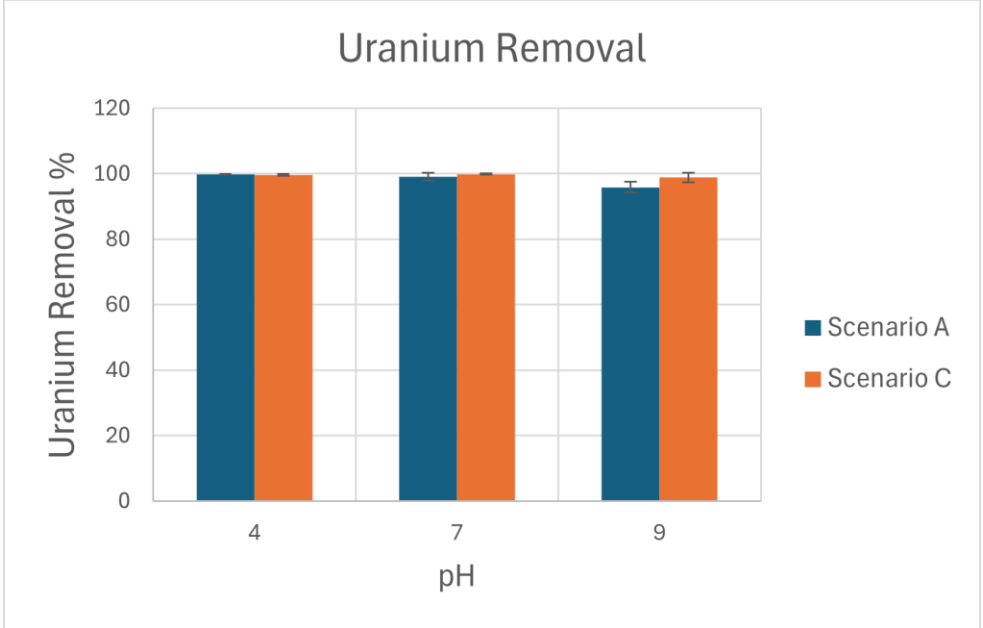
Desorption Studies

- Uranium sorbed onto HAp using solid-to-liquid ratio of 1.0 g/L with 0.02 g of HAp.
  - 250 ppb U
  - 0.02 g HAp
  - pH: 7
  - 0.1M HCl/NaOH
- Samples were collected and analyzed through Inductively Couples Plasma-Mass Spectroscopy (ICP-MS).
- Both Scenario A (SA) and Scenario C (SC) samples had average removal of 95-100%.



Uranium Removal % of Scenario A and Scenario C Samples.

Desorption Process at Varying pH

- Subsequently supernatant was removed and replaced with 20 mL DIW at pH 4, 7, and 9.
- pH was monitored and adjusted with 0.1M HCl/NaOH.
- Scenario A samples exhibited higher amounts of average uranium desorption %.
  - Scenario A had a regularly higher amount of desorption at all pHs.
  - Highest average desorption % at pH 4, with a range of 42-44% desorption.

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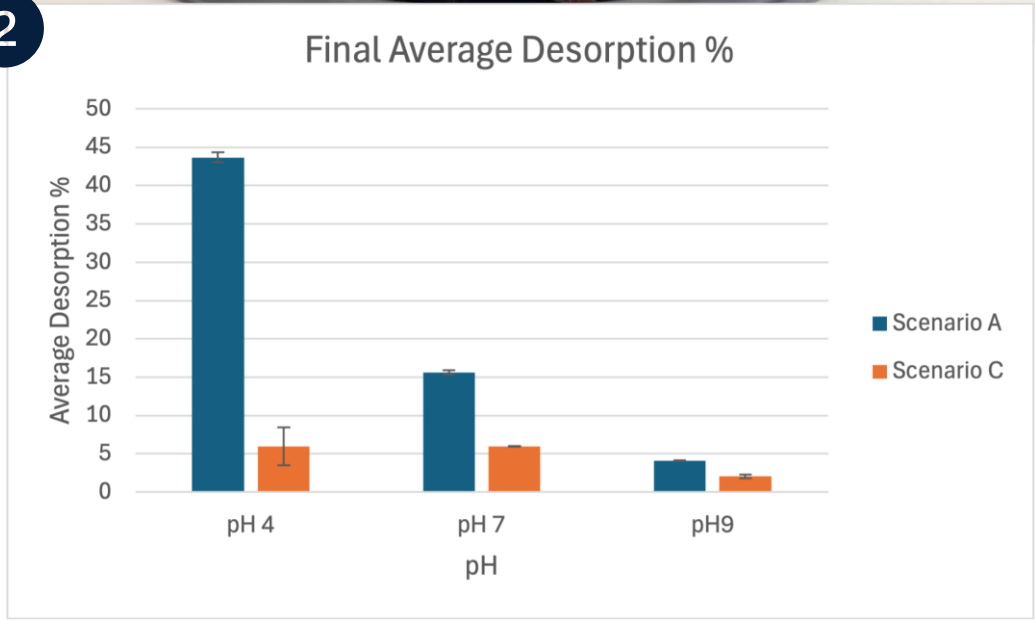

1) Samples Being Prepared to be Centrifuged at 2700 RPM for 30 Minutes. 2) Final Average Desorption Percentage of Scenario A and Scenario C.

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Conclusions & Path Forward

- Future experiments will continue working with 250 ppb Uranium solution and 0.02 g Hydroxyapatite.
- Alter environmental conditions of samples to explore how desorption of Uranium from HAp is affected.
  - Temperature:7°C
  - Anoxic Conditions

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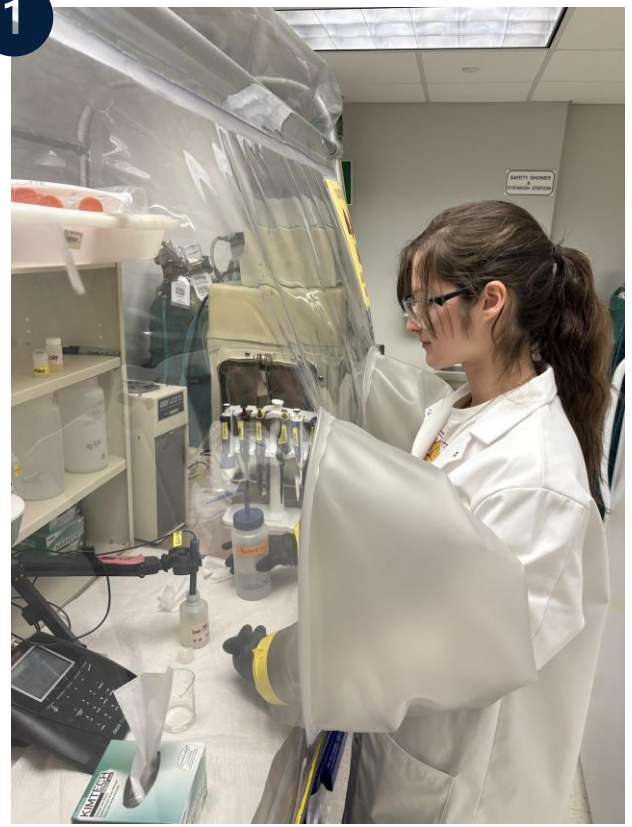

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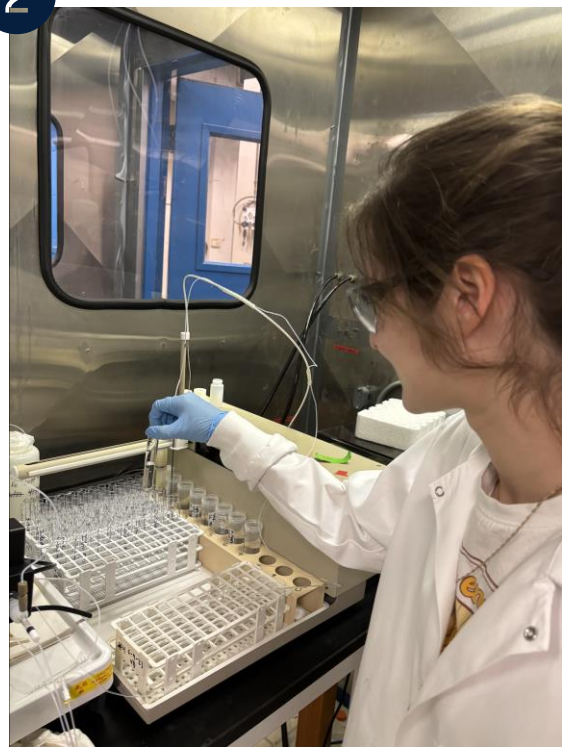

1) DOE Fellow working in glove box.
2) Fellow working with ICP-MS.

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Internship Site Background

- Grand Junction, CO site operated as a refinery to produce uranium oxide. The refinery managed to produce an estimated 2.36 million pounds of uranium oxide.
- Uranium mill tailings from ore-production caused Uranium contamination in surface water, groundwater, and sediments.
- Column experiments were performed with HAp to examine how sediments would react when brought into contact with HAp.

Department of Energy Office of Legacy Management, Grand Junction, CO

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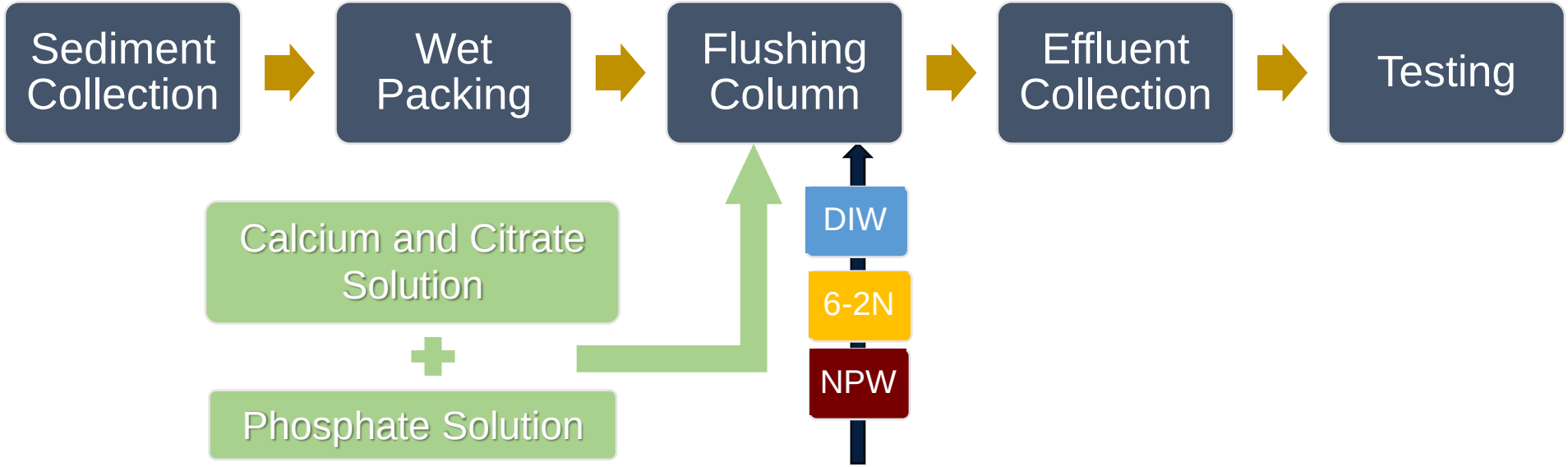
Column Setup

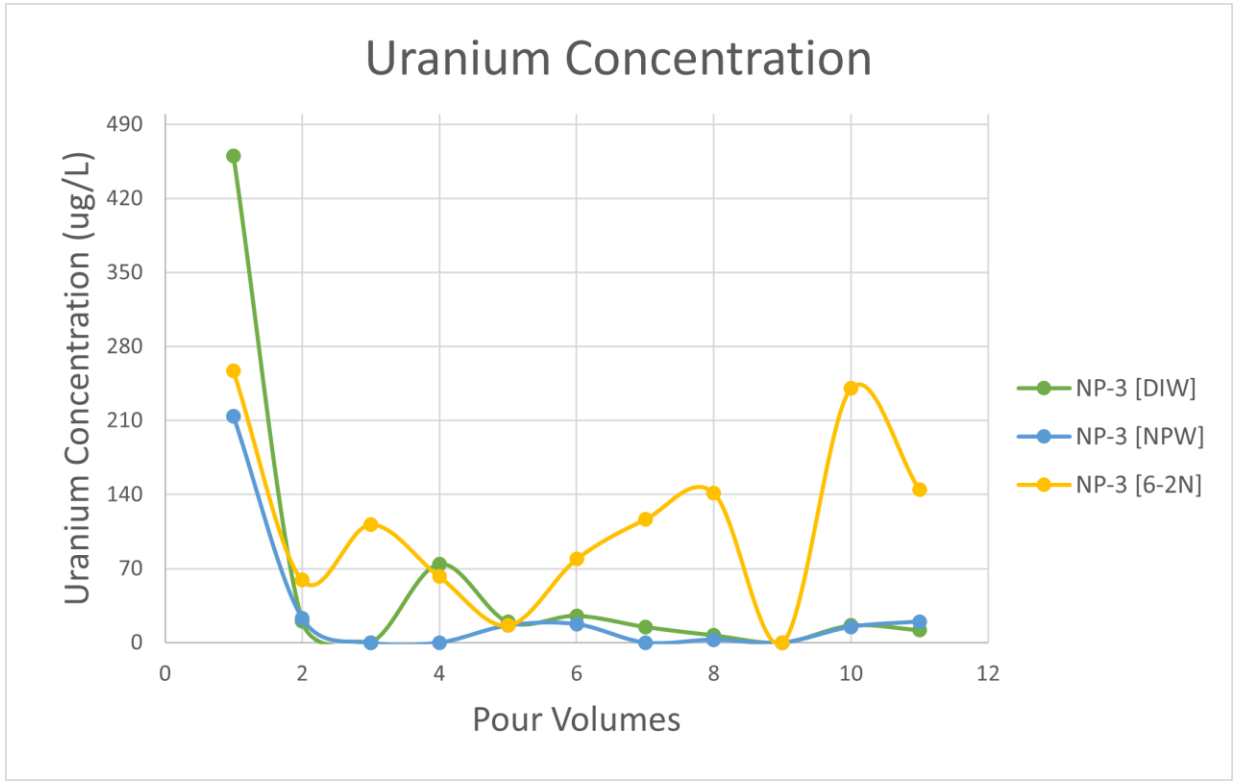
Valeria Ocampo (left) and Daniel Ohlson (Right) mixing Calcium-Citrate and Phosphate Solutions.

Columns in Oxic Conditions



Results of NP-3 [DIW]

Pour Volume	1	2	3	4	5	6	7	8	9	10	11
DIW	460.285	20.482	0	74.26	19.468	25.4	14.8	6.386	0	16.127	11.757
NPW	213.9	23.178	0	0	16.239	17.462	0	2.788	0	14.995	19.91
6-2N	256.81	59.227	111.805	62.506	16.239	78.977	116.53	141.617	0	240.312	144.426



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Thank You. Questions?