The Sorption Properties of Humate Injected into the Subsurface System

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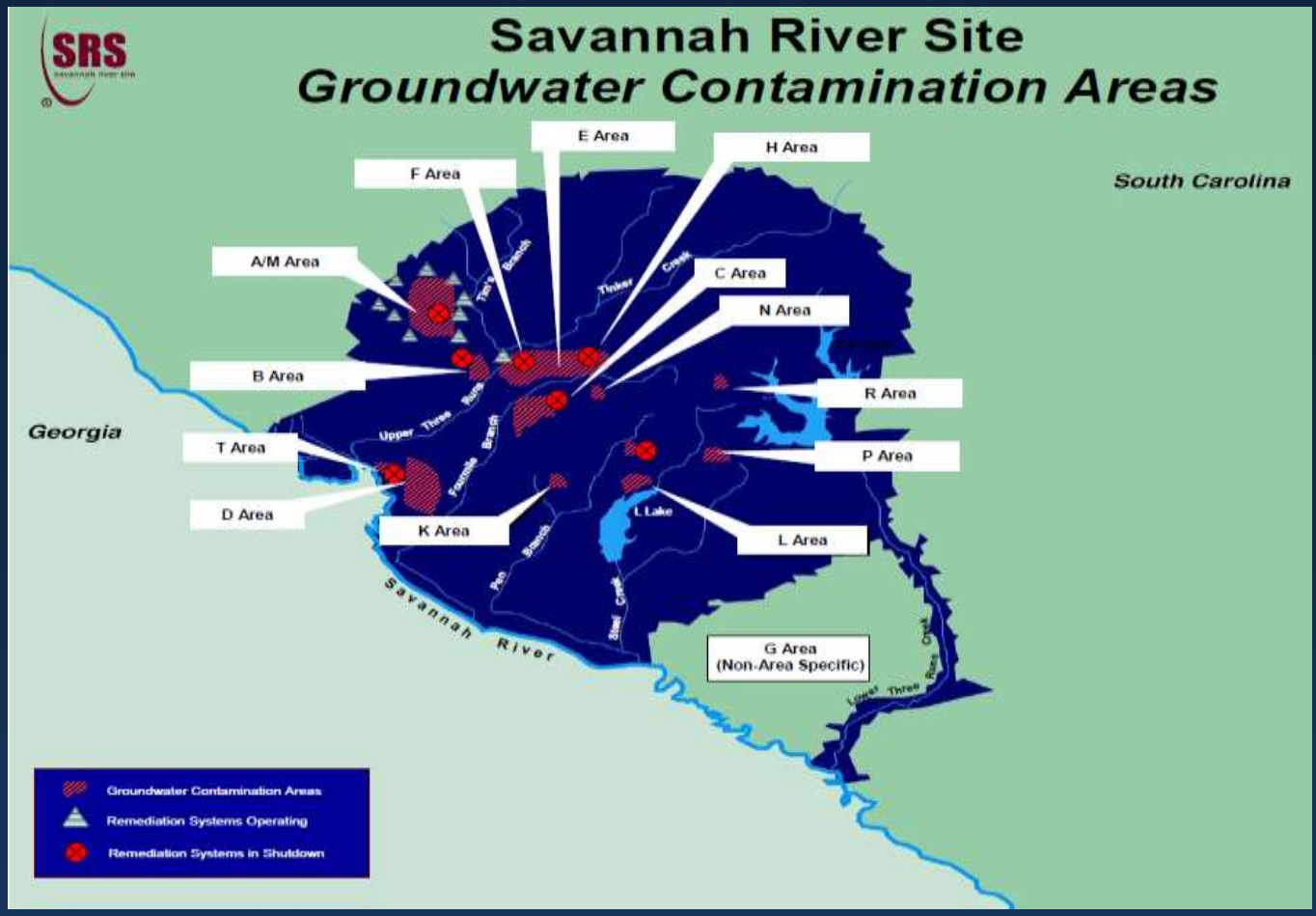
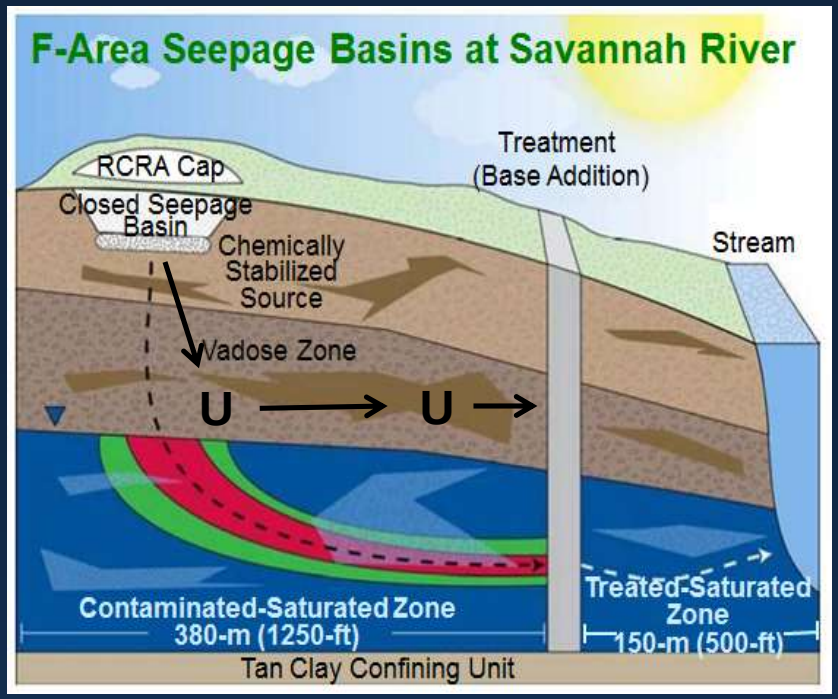
Background


SRS
Savannah River Site
Groundwater Contamination Areas
E Area
H Area
F Area
South Carolina
A/M Area
C Area
N Area
B Area
R Area
Georgia
T Area
P Area
D Area
K Area
L Lake
L Area
Savannah River
G Area
(Non-Area Specific)
Groundwater Contamination Areas
Remediation Systems Operating
Remediation Systems in Shutdown

Background

- Approximately 1.8 billion gallons of acidic waste solution containing radionuclides and dissolved metals were discharged to a series of unlined seepage basins at the F/H Area.
- The constituents of concern (COCs) associated with the F-Area groundwater plume are tritium, uranium-238, iodine-129, strontium-90, curium-244, americium-241, technetium-99, cadmium and aluminum.
- Radionuclides such as are migrating into the groundwater creating an acidic plume pH between 3-5.5.



Uranium migration

Background

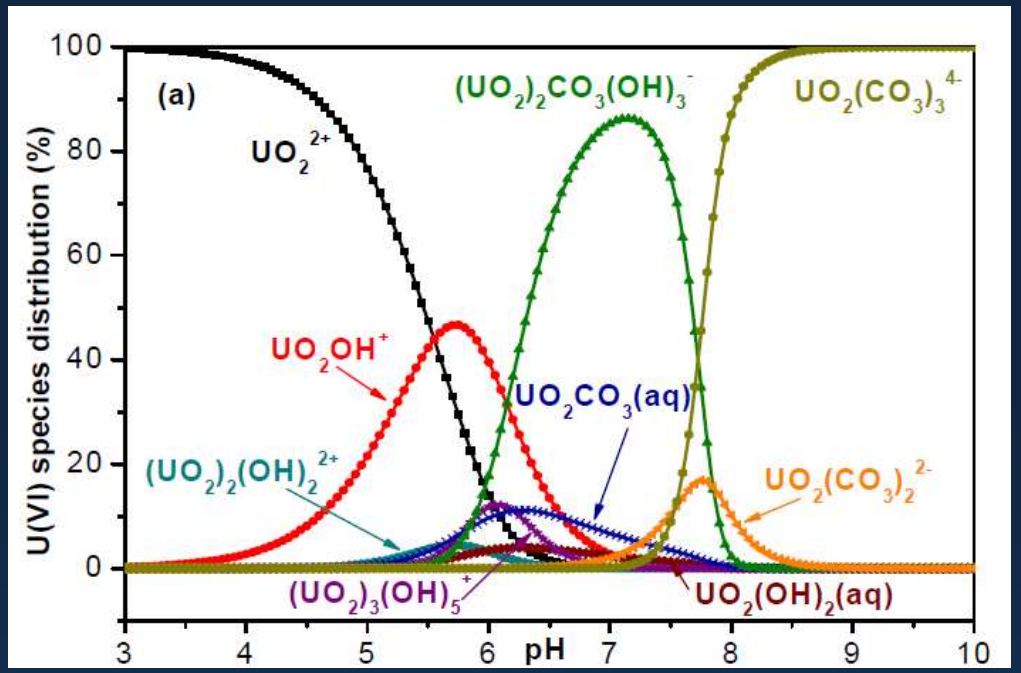
- The pump-and-treat water treatment unit designed and built in 1997 to remove metals and radionuclides.
  - Disadvantages: expensive to operate and generates large amount of radioactive waste.

- In 2004 a hybrid funnel-and-gate system was constructed to create a treatment zone in which the acidic nature of the contaminated sediments could be reversed.

- A solution with high carbonate alkalinity was initially used to overcome the surface acidic conditions.
  - Disadvantage: the continuous use of high concentrations of a carbonate solution to raise pH could re-mobilized uranium previously adsorbed within the treatment zone.

Uranium

- Uranium is a key contaminant of concern in the basin's groundwater.
- Its mobility is of great concern in the SRS F-Area groundwater.
- Uranium is a weakly radioactive heavy metal.

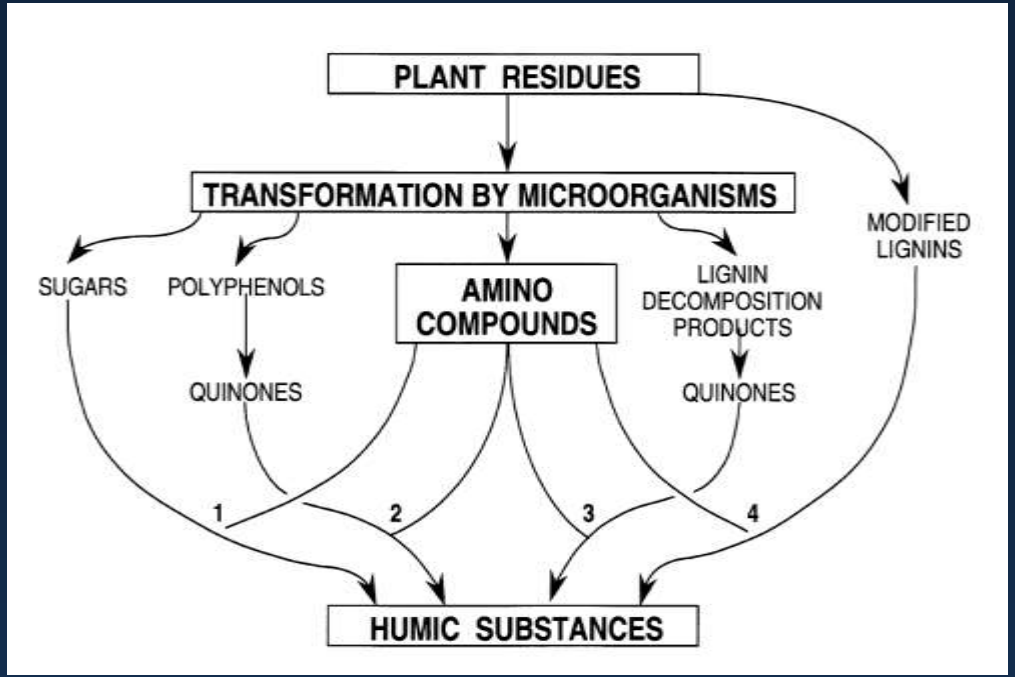


Krepelova (2007)

- U(IV) is commonly found in the form of a precipitate due to its low solubility.
- U(VI) form more stable aqueous complexes and is much more mobile.
- Uranium Speciation is affected by pH and presence of inorganic ligands.

Humic Substances

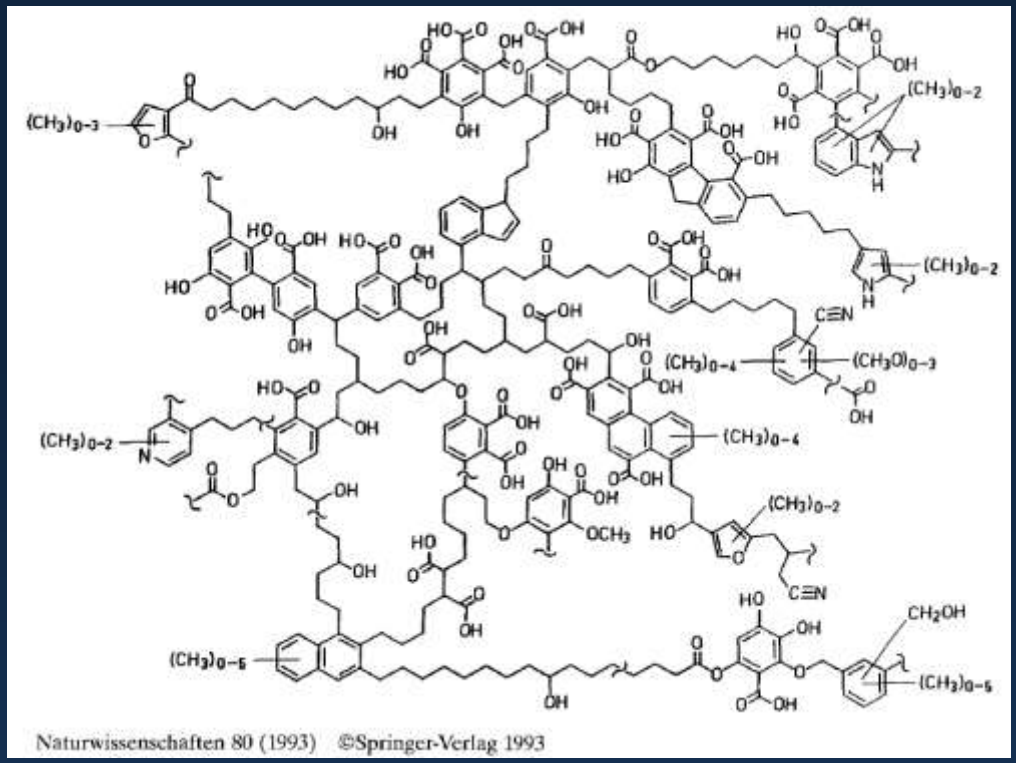
- Humic substances are ubiquitous in the environment, occurring in all soils, waters, and sediments of the ecosphere.
- Humic substances arise from the decomposition of plant and animal tissues.
- Fulvic acid soluble at all pH values.
- Humic acid insoluble at pH < 2.
- Humin insoluble at all pH values.



Environmental Soil Chemistry 2nd Edition

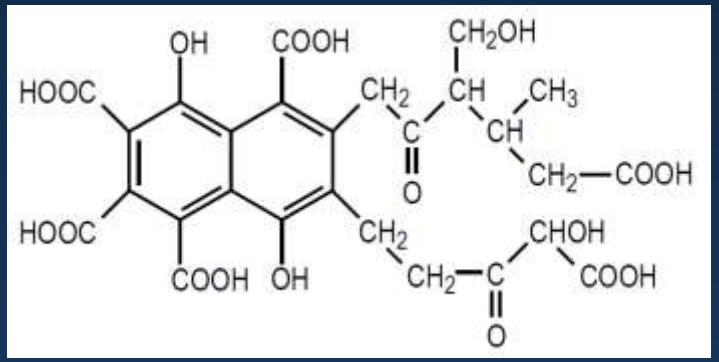
Fulvic and Humic Acid Model Structure

FIU Applied Research Center



Schulten and Schnitzer (1993)

Buffle (1977)



Huma-K

- Huma-K is an organic fertilizer that comes from the alkaline extraction of leonardite (a low-rank coal).
- Huma-K has a high content of humic substances.

Objective

- The objective of this study is to know how Huma-K sorbs to aquifer sediments when it is injected, in order to understand its sorption behavior; the maximum sorption loading capacity of humate on sediments.
- Study the effects of different environmental variables such as pH and concentrations of humate on the sorption process.
- This study can assist in evaluating whether Huma-K can be used as an in situ amendment for the remediation of groundwater contaminated with uranium.

Spectrum of Standards

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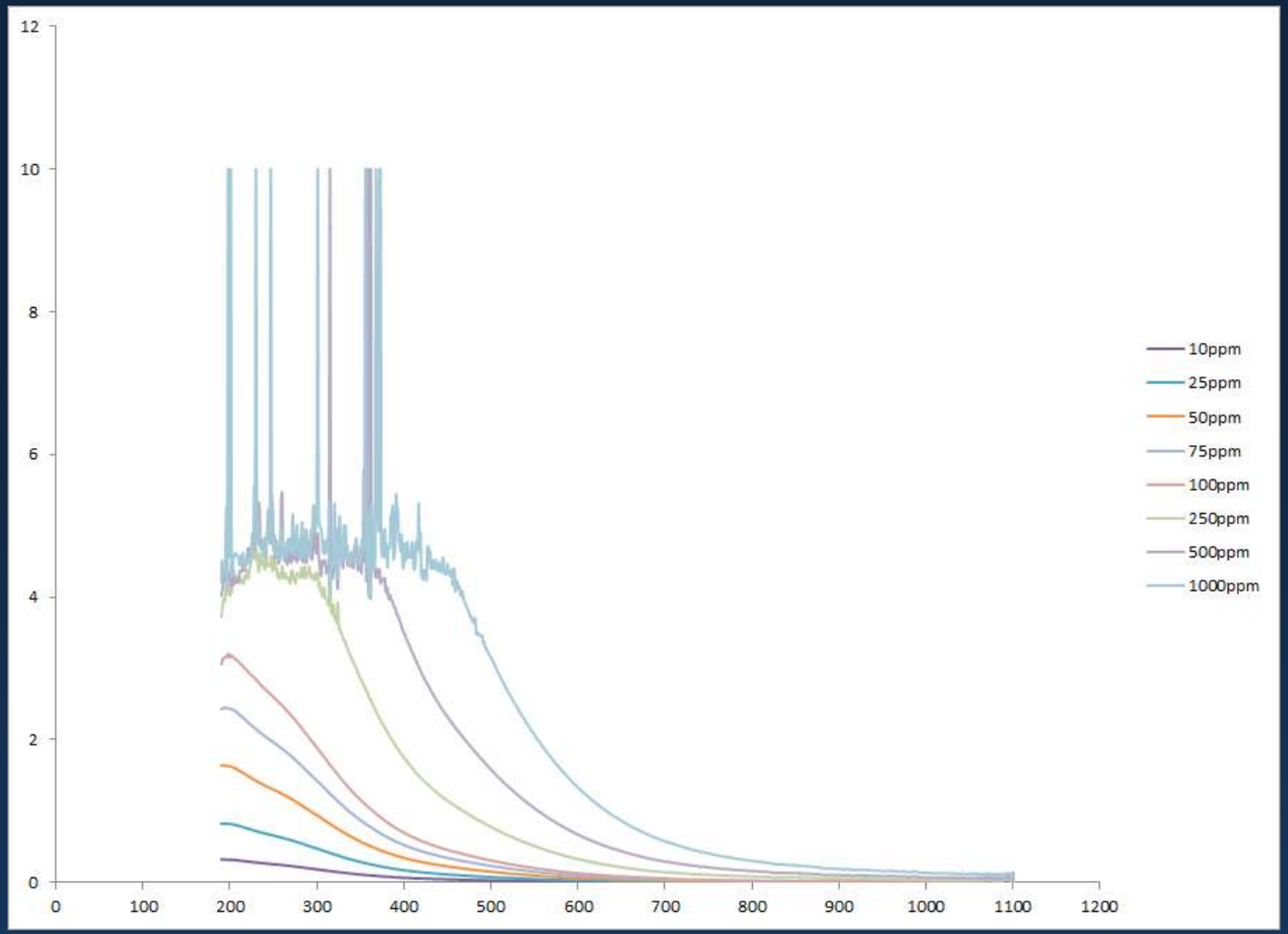

Experimental Approach

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- Sediments from Savannah River Site (FAW1 70'-90') were disaggregated and sieved to a particle size of ≤ 2 mm.
- For the sorption experiment, the following concentrations (in ppm) were used: 10, 25, 50, 100, 150, 200, 250, 300, 350, 400, 450, and 500.

Centrifuge tube with sediment and humate solution

Samples in shaker table for 24 hours (100rpm)

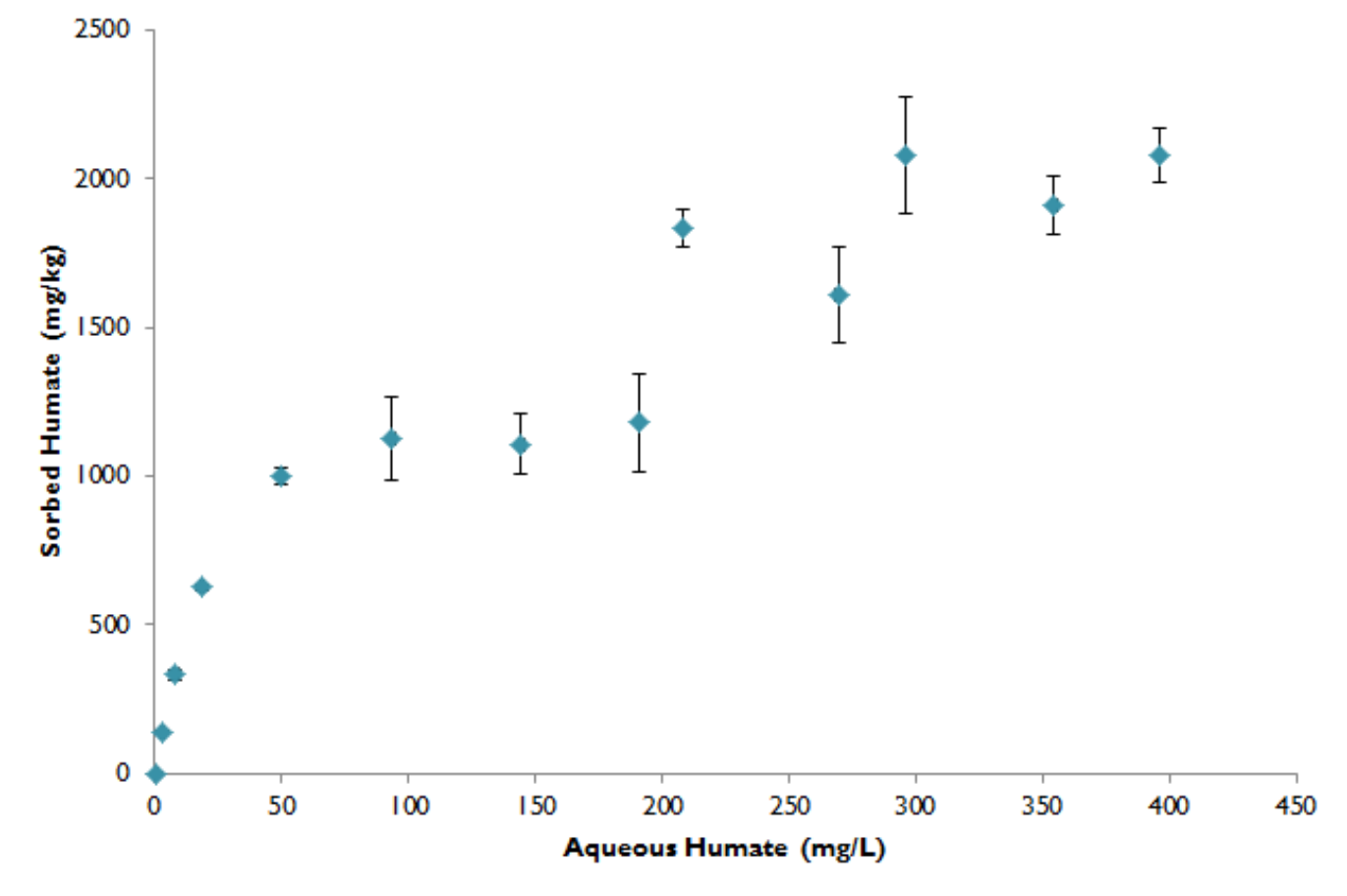
Centrifuge at 2700rpm (30min)

Experimental Approach

Liquid phase was analyzed using a Thermo Scientific Genesys 10S UV-Vis spectrophotometer.

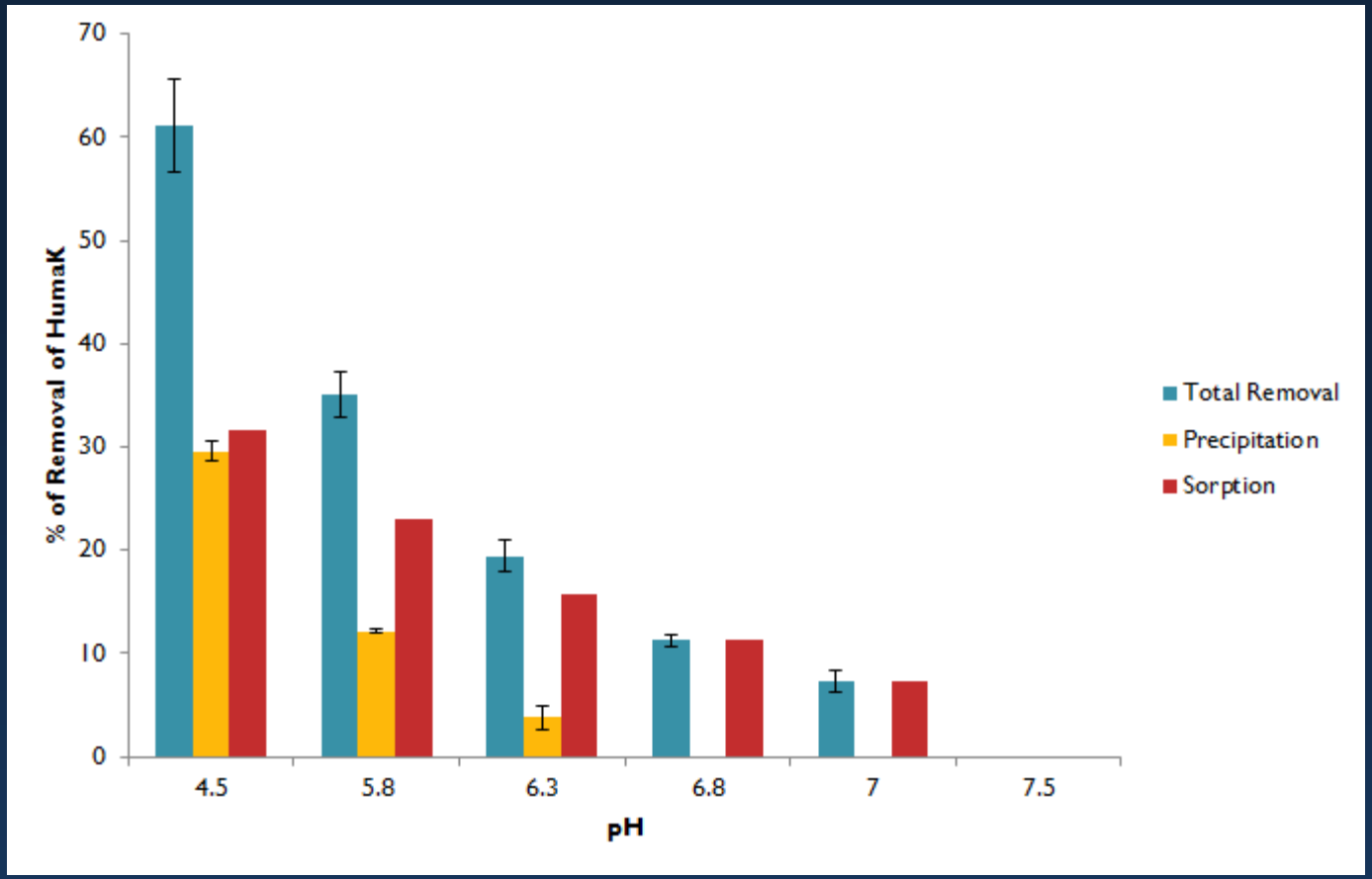
Results

Sorption Experiment at pH 4



Results

Sorption and Precipitation at different pH



Conclusions

- Sorption of Huma-k on Savannah River Site sediments follows a Langmuir adsorption up to a concentration 250 ppm.
- After all the binding sites have been occupied in the sediments, there is probably another mechanism of sorption of Huma-K
- In the sorption study at different pH values, it was seen that sorption and precipitation is decreased with increasing pH.

Future Work

- Kinetic experiment for sorption and desorption of Huma-K
- Kinetic experiment for sorption of Uranium on Savannah River Site sediments with and without Huma-K

Acknowledgements

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