


Unrefined Humic Substances as a Potential Low-Cost Remediation Method for Acidic Groundwater Contaminated with Uranium

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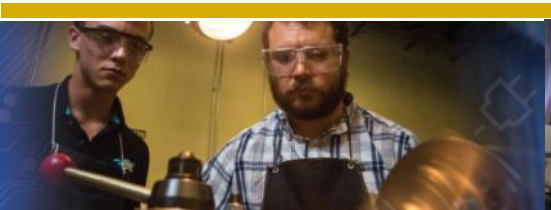
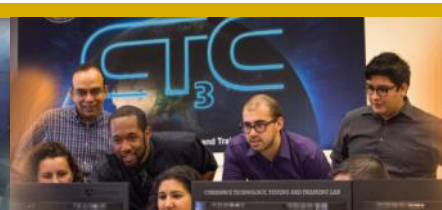
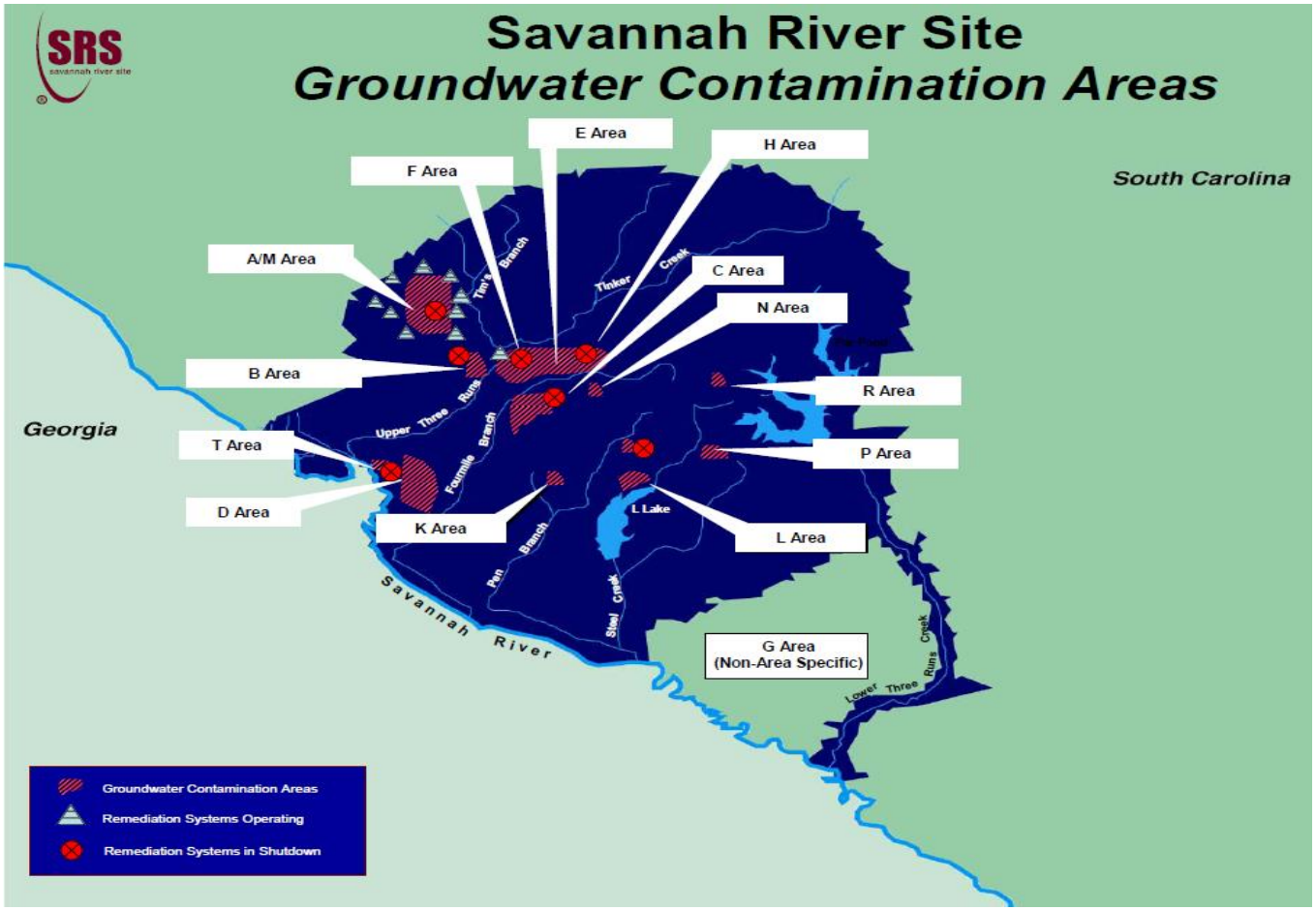


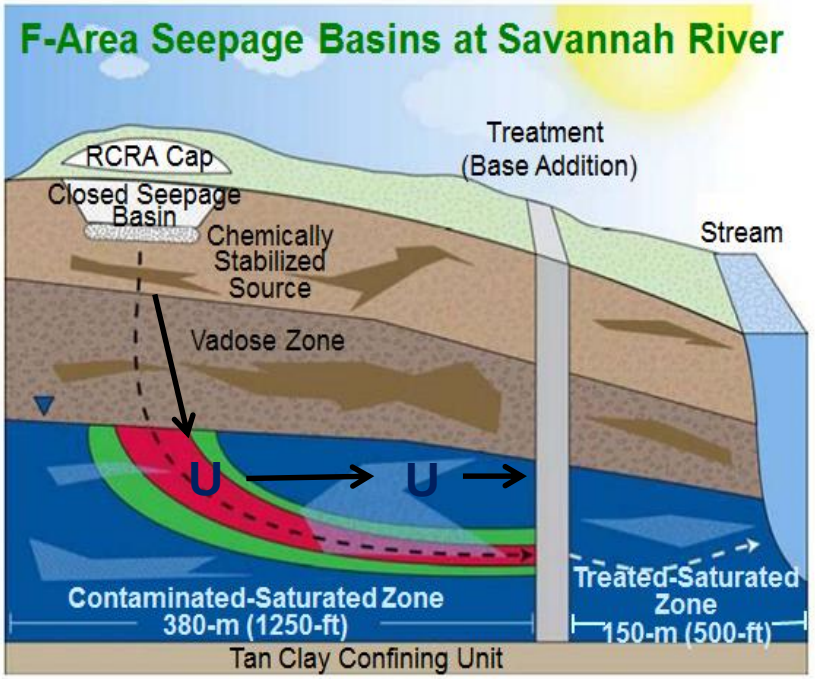



Background


SRS
savannah river site
Savannah River Site
Groundwater Contamination Areas
South Carolina
Georgia
E Area
H Area
F Area
A/M Area
C Area
N Area
B Area
R Area
T Area
P Area
D Area
K Area
L Area
L Lake
G Area
(Non-Area Specific)
Savannah River
Upper Three Runs
Fourmile Branch
Pen Branch
Steel Creek
Tinker Creek
Tim's Branch
Lower Three Runs Creek
Groundwater Contamination Areas
Remediation Systems Operating
Remediation Systems in Shutdown

Background

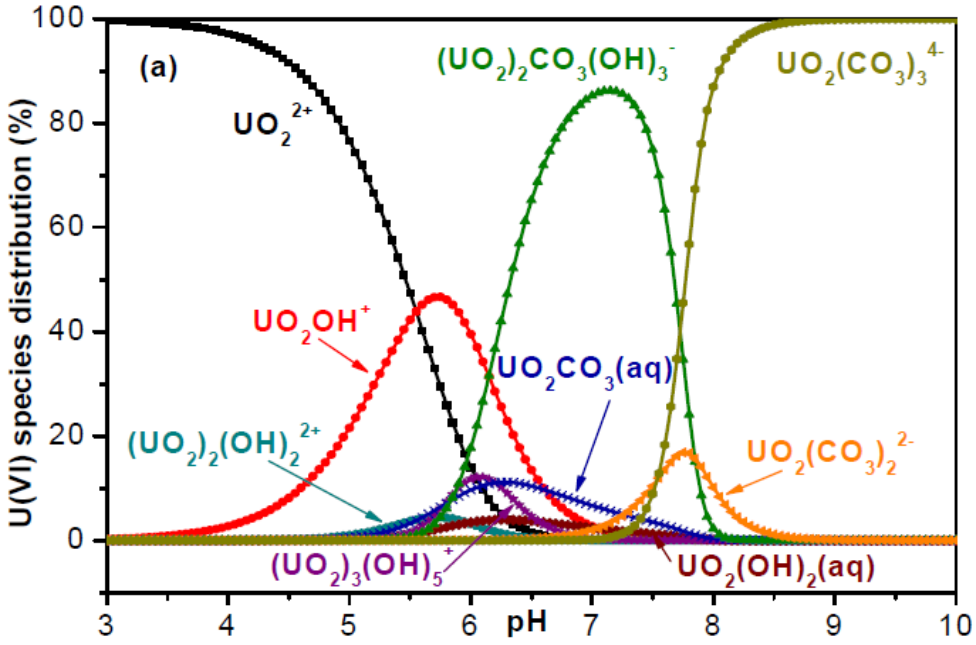
- Approximately 1.8 billion gallons of acidic waste solution containing radionuclides and dissolved metals were discharged to a series of unlined seepage basins at the SRS F/H Area.
- The constituents of concern (COCs) associated with the F-Area groundwater plume are tritium, uranium-238, iodine-129,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



Uranium migration

Uranium

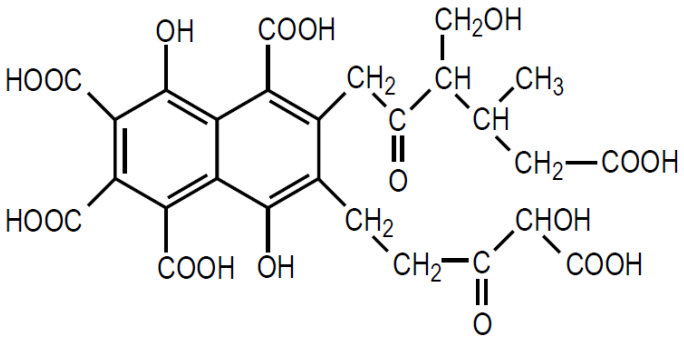
- Uranium is a key contaminant of concern in the basin's groundwater.
- Its mobility is of great concern in the SRS F-Area groundwater.
- Uranium is a weakly radioactive heavy metal.



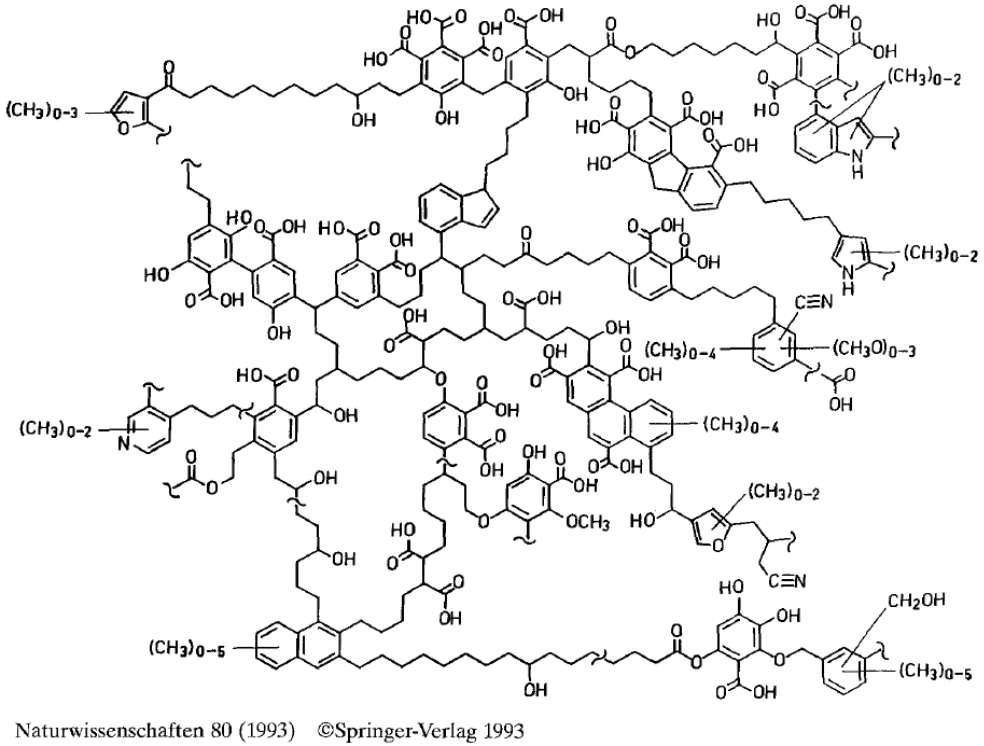
Krepelova (2007)

- 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 the presence of inorganic ligands.

Humic Substances



Fulvic Acid



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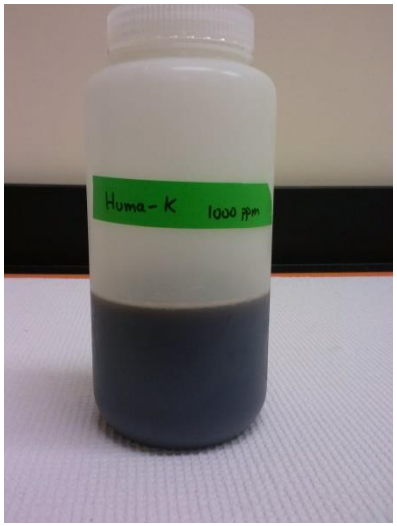
Humic Acid

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

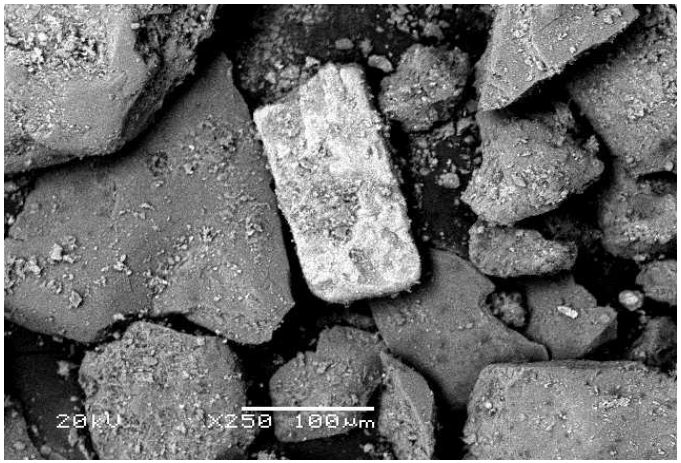
- The principal objective of this study is to determine if the low cost unrefined humate solution known as Huma-K can be used to facilitate uranium adsorption to control the mobility of uranium in acidic groundwater.
- This objective will be fulfilled by completing the following specific aims:
  1. Characterization of Savannah River Site sediments and Huma-K.
  2. Sorption behavior of Huma-K on Savannah River Site sediments.
  3. Removal of uranium using Huma-K coated sediments.

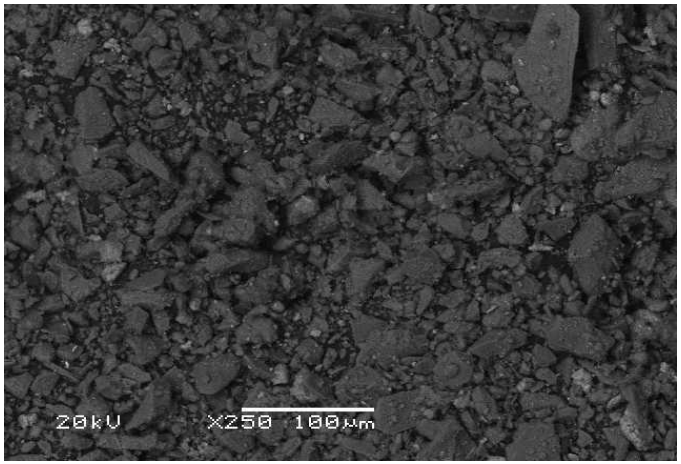
SEM/EDS

- Scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM/EDS) was used to investigate the surface morphology and elemental composition of SRS sediments from the F-Area and Huma-K.
- A JOEL-5910-LV with acceleration potentials ranging from 10 to 20 kV was used for the SEM analysis

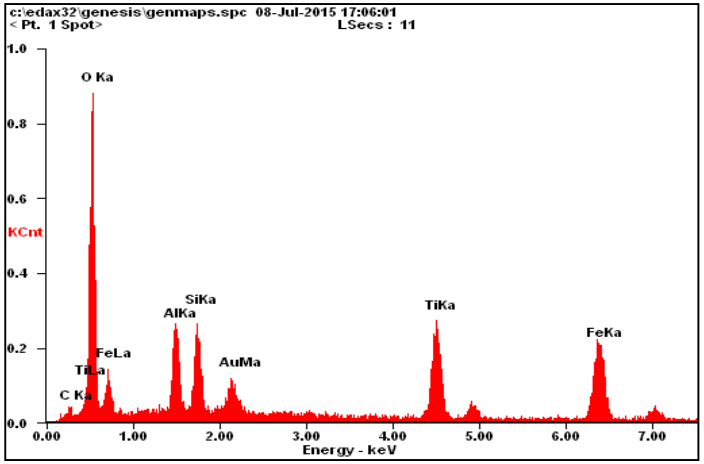
Samples coated with gold/palladium for SEM/EDS analysis

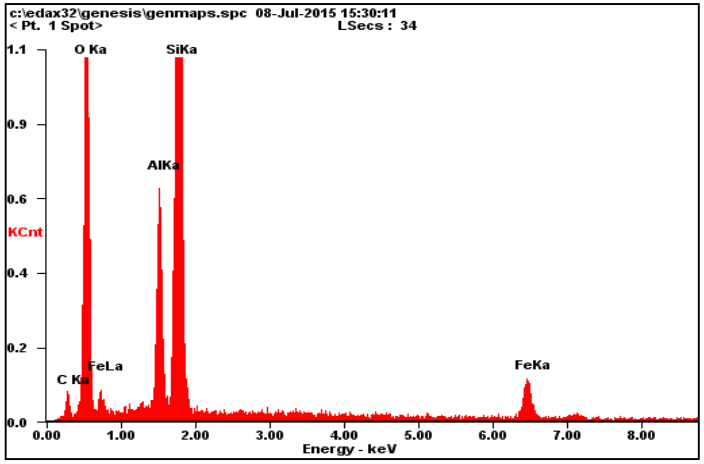
Results





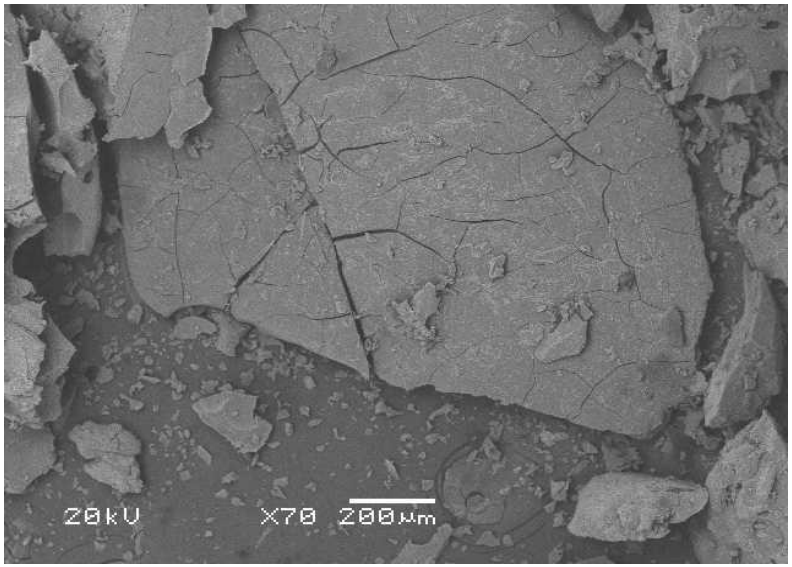
SEM of SRS sediments coarse fraction (left image) and fine fraction (right image)

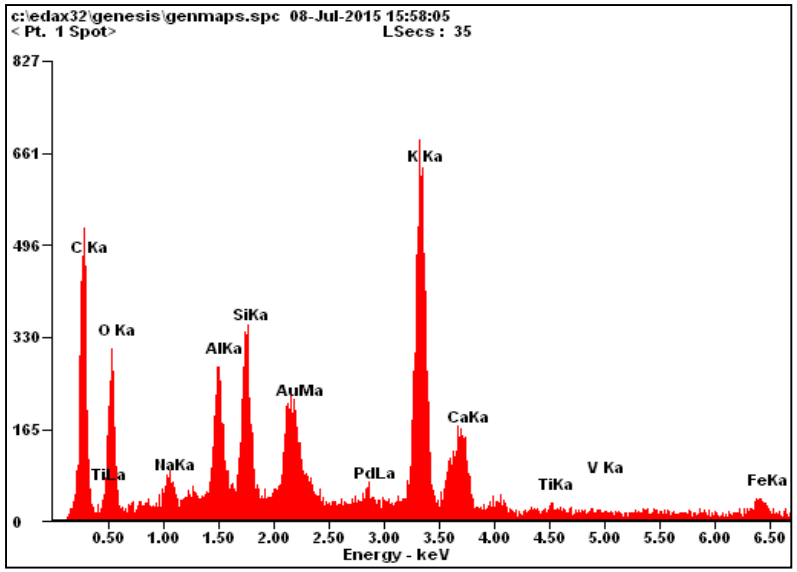




EDS results of SRS sediments coarse fraction (left image) and fine fraction (right image)

Results

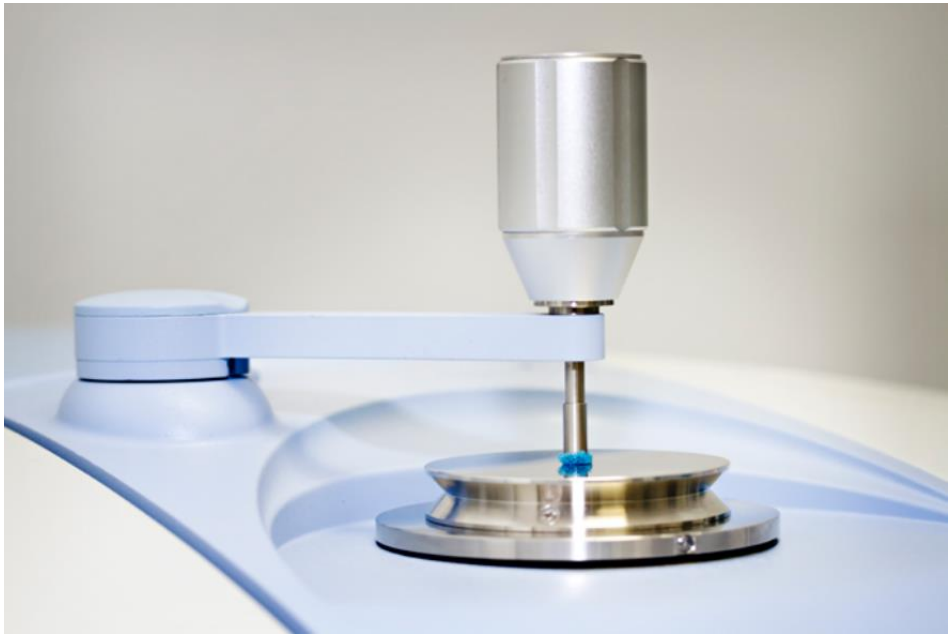




SEM of Huma-K (left image) and EDS analysis (right image)

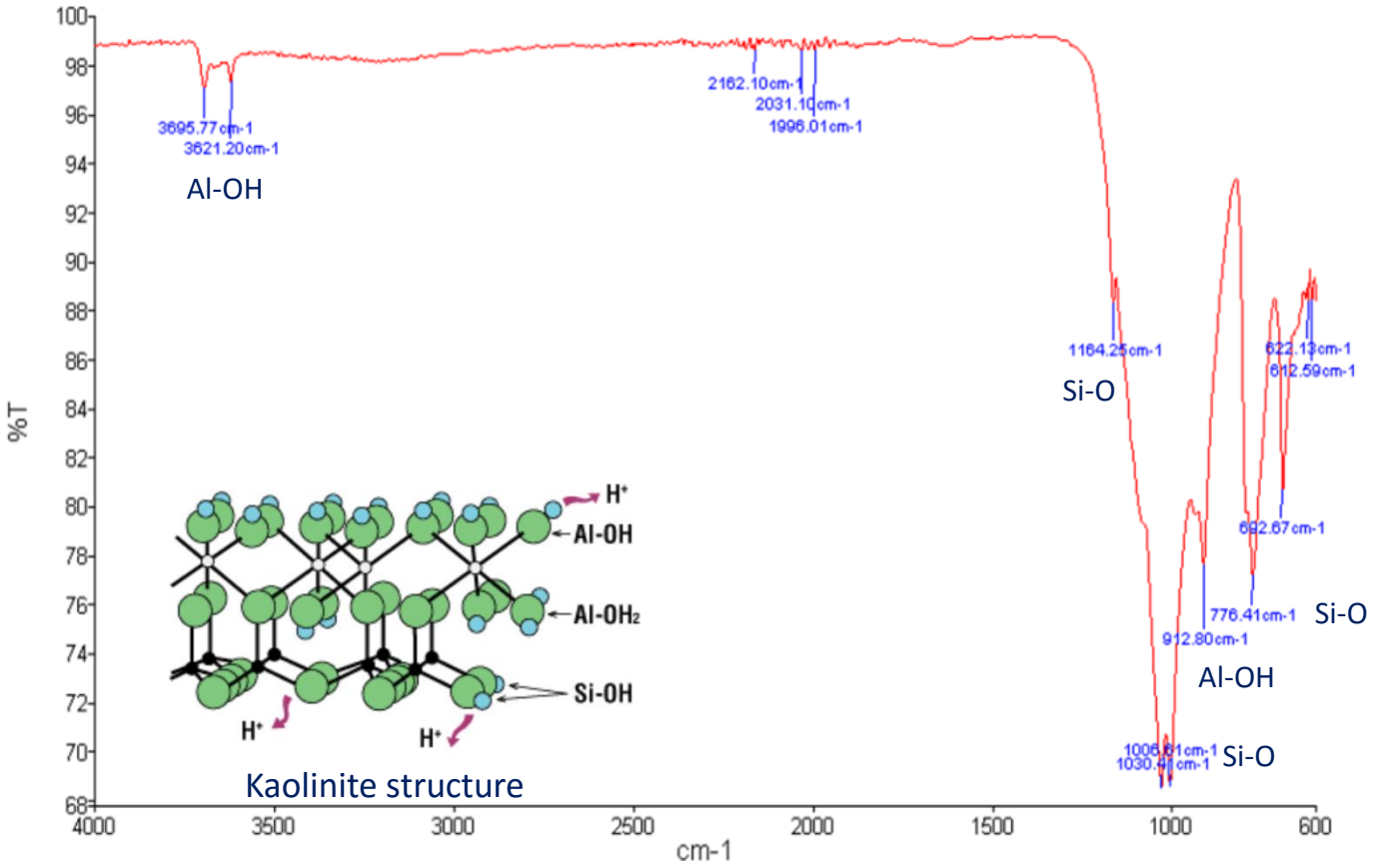
Fourier Transform Infrared Spectroscopy (FTIR)

- For the Fourier transform infrared (FTIR) analysis, a Perkin Elmer Spectrum 100 FT-IR spectrometer coupled with an attenuated total reflectance (ATR) was used.
- The spectrum of the samples were collected from 4000 to 600 cm-1.



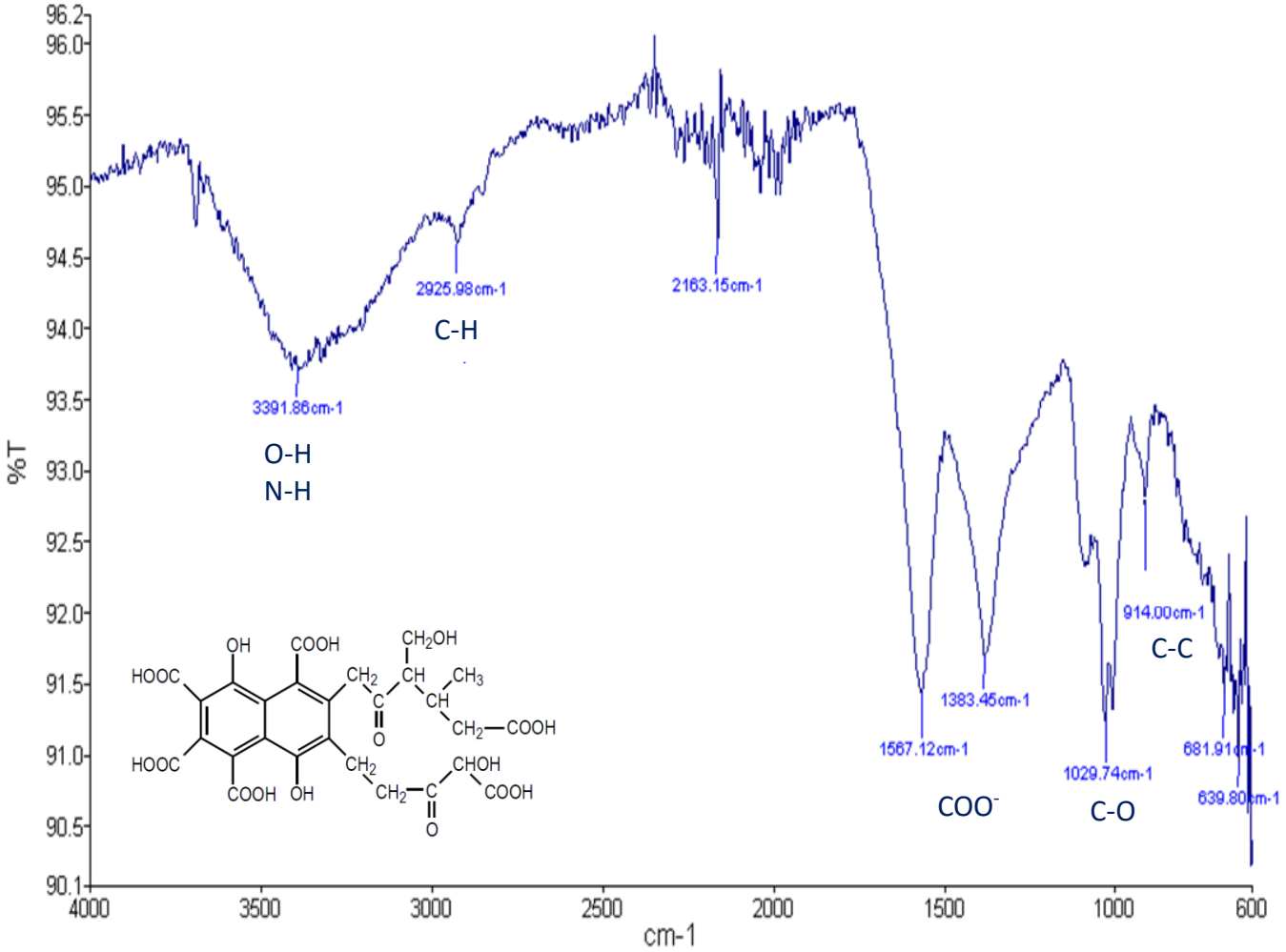
http://www.seallabs.com/cmss_files/imagelibrary/FTIR2.jpg

Results



FTIR of SRS sediments (fine fraction)

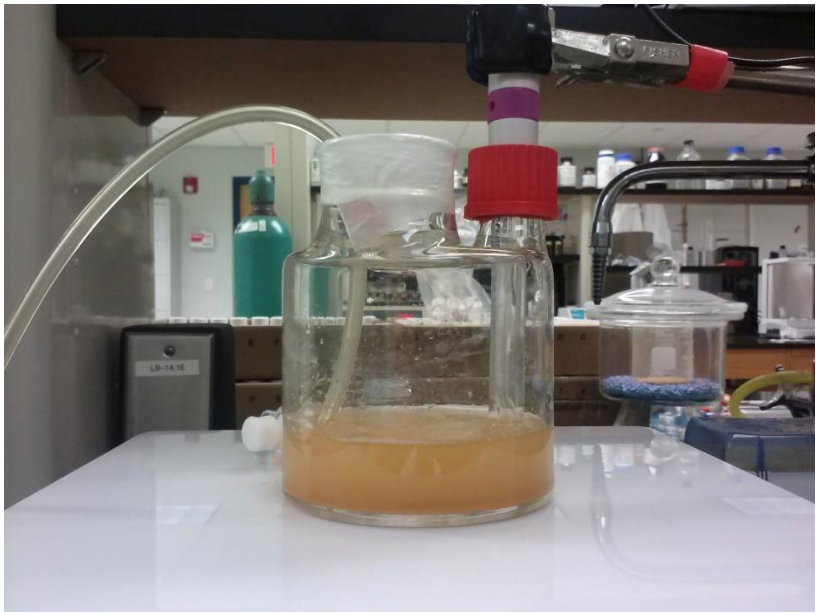
Results

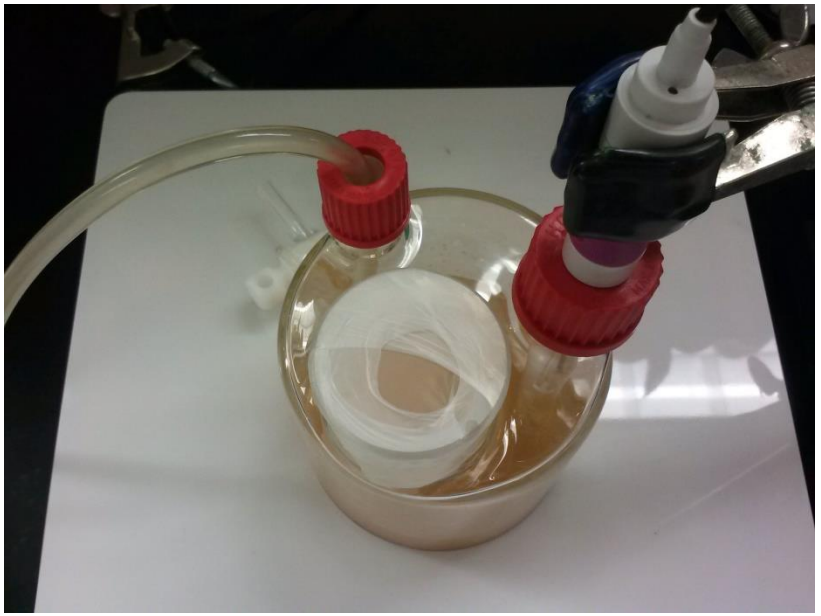


FTIR of Huma-K

Potentiometric Titrations

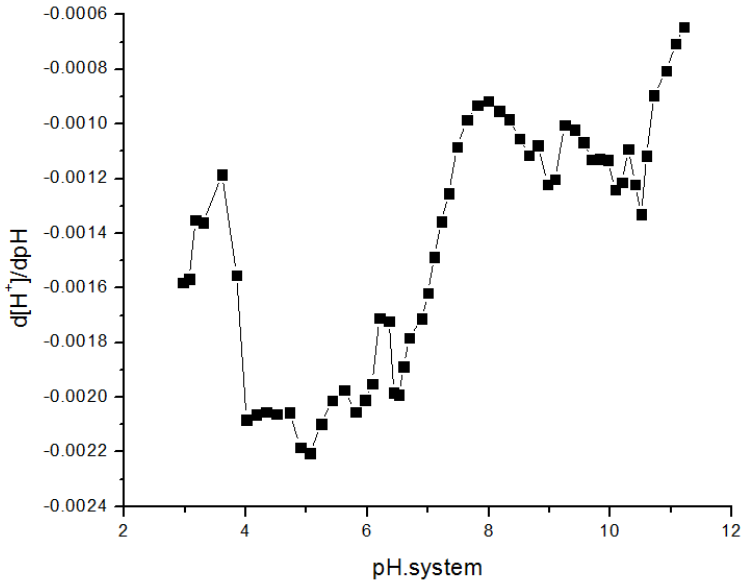
- Potentiometric titrations provide useful information on the protonation/deprotonation properties of HumaK and SRS sediments.



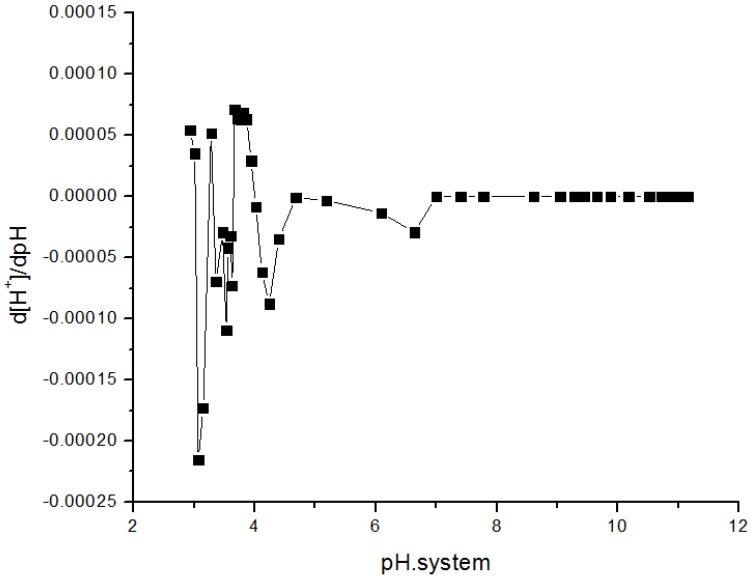


Setup for the potentiometric titration

Results



Potentiometric titration of Huma-K



Potentiometric titration of SRS sediments

Conclusions

- EDS analysis, FTIR, and potentiometric titrations clearly revealed the presence of humic substances in Huma-K.
- EDS and FTIR confirmed the presence of kaolinite in the fine fraction of SRS sediments. Potentiometric titrations indicate that sediments have similar acido-basic properties as quartz mineral.

Future Work

- First manuscript for publication that will include all the experimental work done with Huma-K as a low-cost remediation method.
- Kinetic experiment for sorption of uranium on Savannah River Site sediments with and without Huma-K.

Acknowledgements

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  - Dr. Yelena Katsenovich

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