Introduction

Hypothesis:
- Bacterial cells and extracellular polymeric substances associated with decaying plant biomass will to reduce uranium (VI) bound to its surface functional groups to uranium (IV).

Objectives:
- Determine if decaying plant biomass will reduce uranium
- Measure amount of uranium decaying plant biomass will absorb from solution
- Determine which functional groups of the biomass bind with uranium, in particular if it is the bacteria

Background

- Uranium is one of the most common and problematic groundwater contaminants at Department of Energy legacy sites
- The oxidation state of uranium helps determine its mobility and behavior in the aquifer:
  - Uranium (VI) dissolves easily and is relatively mobile
  - Uranium (IV) is much less soluble and thus less mobile
- The site of interest in this study is a former uranium ore processing plant at Rifle, Colorado
- Organic rich sediments, decayed plant biomass, have been found to contain the majority of aquifer uranium
- Stream banks in Rifle provide a depositional model to explain the mechanism by which naturally reduced sediment layers formed
- Slow release of uranium from organic rich sediments is believed to be responsible for ground water uranium plumes
- Stream bank in Rifle where naturally reduced sediments are deposited
- Plant roots and leaves can be seen mixed in with the sediments

Experimental Set-up

The following experiment was performed to simulate the reaction that occurs in organic rich sediments of the Rifle aquifer:

- Ground roots and leaves incubated in Rifle ground water
- Glucose and lactic acid added to some solutions as food for microorganisms
- Uranium (VI) dosed into solutions
- Solid biomass harvested from solution

Data & Results

- At the end of the incubation period solutions without added glucose and lactic acid turned black in color, indicating sulfate reduction, while those with remained unchanged
- Carbon X-ray absorption spectroscopy (XAS) was used to measure uranium in the biomass
- There appears to be a few subtle changes in the C XAS resonances that correlate with the presence of U, particularly in the glucose/lactic acid samples
- Uranium L$_\text{III}$-edge XAS was used to determine the oxidation state of uranium in the solid phase
- The spectra shows that the uranium in the samples is U(IV)

Conclusions

- Biomass promotes the growth of sulfate reducing bacteria
- Glucose/lactic acid promotes the growth of metal reducing bacteria
- Biomass does reduce U(VI) to form U(IV)
- Subtle differences in the C XAS spectra suggest that uranium bound to carbon does affect the carbon speciation
- Less noisy data would improve the spectra comparison, so in future studies more counts should be taken in the 290-295 eV range
- Future measurements should further assess the impact of U on the C spectra by optimizing the experimental and measurement conditions based on the results of this study

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