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ABSTRACT TITLE: Uranium Transport across Ground Water Surface Water Interfaces: Effect of Wetland Plants on the Sediment Biogeochemistry

ABSTRACT: Discharges of uranium containing groundwaters to surface waters are a concern at several wetlands, including some at DOE facilities. Sharp biogeochemical transitions that occur near wetland plants may greatly affect the fate of many redox-sensitive metals and radionuclides, including uranium. Our research investigates how wetland plant roots affect sediment biogeochemistry and uranium mobility with respect to both short- and long- term goals.

We have formulated three primary hypotheses: (1) oxygen released by wetland plant roots oxidizes iron to Fe(III), providing favorable conditions for iron reducers that also reduce U(VI) to much less mobile U(IV), (2) microorganisms, including iron/uranium reducing microorganisms, are stimulated by organic carbon provided by wetland plants via root exudates and root turnover, and (3) U(IV) remains stable for extended time periods in wetlands that are often anaerobic and nitrate poor. Testing these hypotheses requires examining key iron and uranium reducing microorganisms, along with the spatial distribution and speciation of uranium and other important chemical species.

We have developed small-scale (700 mL) up-flow vegetated (*Typha latifolia* or *Scirpus acutus*) and non-vegetated mesocosms, and are operating them in our greenhouse in an up flow mode to simulate groundwater to surface water discharge and to test above hypotheses. The porous medium used was sand augmented with (0.2 wt-%) sediment collected from Savannah River Site (SRS) wetlands, in order to provide an appropriate microbiological seed. Siderite was supplied at the bottom of some of the microcosms for each plant treatment, in order to buffer the pH and provide an iron source since the sand had a very low iron content. To differentiate biogeochemical changes in sediments near roots and sediments that are not in direct contact with roots, several small bags (70 micron-mesh nylon) were filled with 1 to 3 grams of the sand/sediment mixture and placed at different locations in the mesocosms allowing for the retrieval of sediments from a root-exclusion zone. A modified Hoagland solution was pumped through the mesocosms at a rate of 100 to 150 mL per day. After the mesocosm plantings had been established, uranium was supplied into the influent via peristaltic pumps, resulting in an estimated 20 uM influent uranium concentration. Mesocosms were then operated for 80 days, and dissolved species were periodically sampled. The mesocosms were subsequently sacrificed and analyzed for solid-associated chemical species as well as microbiological characterization.

Results indicate differences between the mesocosms planted with *Typha latifolia* (common cattail), *Scirpus acutus* (hardstem bulrush), and no plant controls, as well as between mesocosms with and without the siderite iron source. Planted mesocosms showed increasing Fe concentrations in solution with elevation. *Typha latifolia* roots show larger proportions of Fe in the oxidized state than *Scirpus acutus* roots. Total bacterial populations as well as Geobacter sp. numbers were highest on roots (on a per gram basis), followed by sediments near roots, and lowest in the root-exclusion zones.