

Hydrobiogeochemical transformations of Fe and U in sediment, stream, and rhizosphere environments within riparian wetlands

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The redox cycling of C, Fe, and contaminants within wetlands is driven largely by microbial activity, and is a significant component of major and minor elemental cycling and energy flux. However, the explicit hydrologically driven wetland biogeochemical functions that control C, Fe, and contaminant (U) cycling and water quality are still not understood well enough to be adequately modeled. This is due in part to deficiencies in our current understanding of the heterogeneous and dynamic hydrologically-driven biogeochemical processes that occur within wetlands.

In this work we examined the spatial distributions of the concentration and speciation of Fe and U within sediment cores, stream particulate matter, and rhizosphere environments from a U-contaminated riparian wetland (Tims Branch watershed at the Savannah River National Laboratory). Using spatially resolved (20 micron resolution) synchrotron XRF elemental mapping and Fe K-edge and U L_{III}-edge XANES spectroscopy we observed concentration and redox gradients of Fe and U within sediment cores and rhizosphere samples over mm to m length scales. Examination of particulate matter gathered from the stream and resulting from laboratory-based alternating oxic/anoxic incubations indicate a facile and reversible transition between reduced and oxidized Fe and U illustrating the potential for very dynamic redox transitions resulting from complex interactions between biological and hydrological components. These spatially heterogeneous and temporally dynamic redox states within wetland sediment, stream, and rhizosphere environments indicate a need to understand these critical components from the molecular to core scale to adequately develop models of hydrobiogeochemical processes within wetlands that control water quality.