

Investigation of organic matter in Uranium-enriched sediments

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River-floodplain sediments, enriched with U from former U ore processing mill facilities, such as those at Rifle, CO continue to contaminate the groundwater with U. Organic matter in these anoxic sediments was shown to accumulate U(IV), acting as a source of U. Oxidation of the U(IV) to U(VI) as a result of changing redox conditions (i.e., reducing to oxidizing), due to periodic changes in the water table, can remobilize the U(VI). Recent model studies suggest that both abiotic and biotic reduction pathways operate but U(VI) reduction is dominantly accomplished through biological activity [1]. The model included a mixture of degraded plant materials and microbial biomass. In the model study scanning transmission X-ray microscopy (STXM) showed that U adsorption to organic carbon and organic-coated clays dominates U(IV) speciation.

In this study, we used STXM to examine sediments collected from a field site in Rifle, CO. Using the C K-edge we identified that plant materials (e.g., lignin) were present in the sediments. Microbial decay of the plant materials was evident from the colocalization of protein and lipids with the plant materials. The Fe L-edge and the Al and Si K-edges showed that the microbial decay products were mainly associated with the clay minerals. Our results sharpen the model by clarifying the types of organic matter that are present under field conditions, and in particular emphasizes the importance of the clay minerals. This information is critical to advancing our ability to better manage and remediate these U contaminated sites.

[1] Bone et al. (2017) PNAS 114, 711-716

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