Characterization and impact of organic-rich sediments on uranium behavior in the Rifle aquifer, CO

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Uranium contamination in aquifers is a common, persistent and expensive problem at U.S. DOE legacy sites across the Colorado River Basin, such as the Old Rifle former uranium ore processing plant (Colorado, USA). A better understanding of the potential subsurface reservoirs and the biogeochemical reactions governing uranium in such environments is needed to improve our forward projections of uranium mobility in groundwaters. The Rifle aquifer contains organic-rich, fine-grained sediment lenses that are naturally enriched in uranium, with concentrations up to 100 ppm as reduced U(IV). These organic-rich zones also contain sulfide, and consequently were referred to as naturally reduced zones (NRZs).

The study of muliple well cores located within 2m from each other shows sharp variations of sediment color and texture with depth and horizontal position. Distributions of trace and minor elements abundances such as uranium, sulfur and organic carbon show well-defined layers of enriched material. This study shows that NRZs are low permeability structures with high interfacial areas with the surrounding aquifer, and contain large fractions of the total uranium inventory.

Vertical core sections profiles exhibit sharp gradients of redox status and sediment textures at the centimeter scale. Sulfur K-edge XANES provide insights on the sulfur biogeochemical cycling in such systems. Results show the importance of both organic carbon and establishement of lasting reducing conditions in the accumulation of uranium.