Biogeochemical influences on uranium speciation in the Mulga Rock sedimentary uranium ore deposit, Western Australia

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The fate of uranium (U) is strongly influenced by its oxidation state, i.e. U(IV, VI), where U(VI) has greater solubility and therefore mobility in groundwater. Reduction of the uranyl ion to U(IV) by bacteria or natural organic matter (NOM) can immobilise uranium into soils and sediments. The relationship between U and NOM is not well understood, particularly how NOM (or microbial activity) may influence U speciation in U deposits.

Sediment cores from the Mulga Rock U deposit in Western Australia were studied with respect to U distribution, mineralogy, crystallinity, speciation and redox state *via* transmission electron microscopy (TEM) and synchrotron X-ray fluorescence microscopy and x-ray absorption near edge structure (XFM-XANES). Uranium is present within finely dispersed phases in the NOM matrix, and as precipitates along pyrite grain boundaries. SEM imaging revealed U concentrated into ellipsoids and rods within the NOM–clay matrix which may represent biomineralized microbial cells. TEM and XFM-XANES analyses of focused ion beam (FIB)-prepared cross sections revealed U present only as U(IV) in ~10 nm particles. Results indicate that the NOM acted as a sink for mobile uranium U(VI) ions. Under reducing conditions, redox changes and/or microbial processes resulted in precipitation of U(IV) in the matrix and around both detrital and authigenic mineral boundaries.