Extensive, direct microbial reduction, sequestration and enrichment of uranium in natural near-surface sediment

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Fate of uranium in the environment is of great environmental importance. In shallow fresh-water sediment at an open pit in an inactive uranium mine, U(VI) was reduced to U(IV) as determined by X-ray absorption near-edge spectroscopy. Direct electron-microscopic observations of the sediment particles and microbial cells unveiled that uranium was reduced at microbial cells that precipitated iron sulfide. However, a subset of microbial cells precipitating FeS, were not associated with uranium, indicating neither aqueous sulfide nor FeS catalyze reduction of U(VI). Phylogenetic analyses based on rRNA and dissimilatory sulfite reductase gene sequences obtained from the sediment revealed the presence of bacteria capable of U(VI) reduction and precipitation of iron sulfide through sulfate, Fe(III) or sulfur reduction, in addition to sulfate-reducing bacteria incapable of U(VI) reduction. In a black layer buried in dried surface sediment near the water edge, uranium was as highly enriched as economically important uranium ores and the majority of uranium persisted as U(IV). These findings provide the first evidence for microbial reduction, sequestration and enrichment of uranium in complex natural settings and imply direct microbial roles in formation of uranium ore deposits via U(VI) reduction .