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# Characterization of uraninite nanoparticles produced by different *Shewanella*

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Microbially mediated in situ reduction of soluble U(VI) to insoluble U(IV) (as $UO_2$) has been proposed as a means of preventing the migration of that radionuclide with groundwater, but preventing the oxidative resolubilization of U has proven difficult. We hypothesized that relatively slow rates of U(VI) bioreduction would yield larger $UO_2$ precipitates that would be more resistant to oxidation than those produced by rapid U(VI) bioreduction. We manipulated U(VI) bioreduction rates by varying the density of *Shewanella putrefaciens* CN32 or *Shewanella oneidensis* MR-1 added to U(VI) containing solutions with lactate as an electron donor. Uraninite particles were characterized by high resolution transmission electron microscopy and extended X-ray absorption fine-structure spectroscopy. With *S. putrefaciens* CN32 we found that $UO_2$ nanoparticles formed by relatively slow rates of U(VI) reduction were larger and more highly aggregated than those formed by relatively rapid U(VI) reduction. In contrast, with *S. oneidensis* MR-1 we found that the $UO_2$ particle size was independent of U(VI) bioreduction rate. The reactivity of the biogenic uraninite products with dissolved oxygen was tested, and we found that particle size exerted an important control on re-oxidation kinetics. With CN32, uraninite particle size was controlled by the U(VI) bioreduction rate, and the larger $UO_2$ particles were re-oxidized more slowly. With MR-1, uraninite particle size was not controlled by the U(VI) bioreduction rate

and the subsequent uraninite re-oxidation rates were essentially constant. Factors that exert control on the particle size of biogenic mineral precipitates are discussed.