Uranium bioreduction in the presence of Fe(III)-bearing clay mineral and organic acids

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Microbial reduction of soluble U(VI) to insoluble U(IV) has been proposed as a method for remediation of uranium contamination in the environment. However, little is known about the kinetics and mechanisms of U(VI) bioreduction in systems with both organic ligands and Fe(III)-bearing clay minerals. In this study, U(VI) bioreduction experiments were conducted with a common metal-reducing bacterium (*Shewanella putrefaciens* CN32) in the presence of Fe(III)-rich nontronite (NAu-2) and different concentrations of citrate or EDTA.

In binary U(VI)-bacteria systems, low concentrations of each ligand (0.1 mM) decreased the initial rate of U(VI) bioreduction, likely due to the formation of a stable U(VI)-ligand complex. A high ligand concentration (1mM) increased the bioreduction rate, likely because of decreased toxicity of the U(VI) complex to CN32 cells. In ternary U(VI)-bacteria-clay systems, the rate of U(VI) bioreduction was enhanced by the organic ligands relative to the binary systems, likely because Fe-ligand complexes served as electron shuttles between the bacteria and U(VI) to accelerate U(VI) bioreduction.

In the presence of citrate and NAu-2, the bioreduced U(IV) formed a soluble U(IV)-citrate complex, because of strong complexation ability of citrate with U(IV). In contrast, U(IV) precipitated as a solid in the presence of EDTA and NAu-2. Our results suggest that organic ligands and Fe(III)-bearing clays can significantly affect microbial reduction of U(VI) and provide new information for the development of uranium remediation strategies.