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Effect of microorganisms on migration of radionuclide - Sorption of actinides on microbial cells in aerobic condition -

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Introduction:

The actinides (An) may migrate through fracture in the components of geologic formation. Microorganisms exist in these fractures, and consequently, Ans released are adsorbed by microorganisms.However, whilst there are considerable data on the sorption and retention of Ans by inorganic components of fracture, the effects of microorganisms on the migration of Ans are not fully understood.

The structure of cell surface of microorganism differs between Gram-negative and Gram positive microorganisms. The adsorption of actinides may differ between Gram-negative and Gram positive microorganisms. In this study, we have studied the adsorption of U(VI) by *Shewanella putrefaciens* (Gram-negative) and *Bacillus subtilis* (Gram-positive).

Experimental:

The cells of the microorganisms were grown for 2 days in medium solution at 30^{o}C were washed three times with 0.1 mol/L NaCl solution. Harvested cells were contacted with aqueous solution containing 1.0x10^{-5} mol/L U(VI) and 0.01 mol/L NaCl. The pHs of the exposure solutions were adjusted to 3, 4, 5, and 6. The cell density was changed from 0.02 g/L to 0.5 g/L. The effect of the presence of Ca^{2+} ions, citrate ions, and glucose was examined. The chemical states of the adsorbed U(VI) on the cell of S. putrefaciens were determined by U_{LIII} EXAFS spectrum measured at BL-27B at photon factory of KEK, Tsukuba.

Results and discussion:

The concentration of U in the solution was the same between 2 and 4 h after exposure of the cells to U(VI), indication that the adsorption was attained to equilibrium within 2 h. At pH 3 the concentration of U after exposure of two kinds of microorganisms of 0.02 g/L to U containing solution was approximately 2x10^{-6} mol/L. The concentration of U decreased with increasing solution pH. The charge of the cell surface increased negatively with increasing solution pH, resulting in the ascent of adsorption of U with increasing pH. The EXAFS analysis indicated that U was associated with phosphoryl functional groups. These results indicated that U was adsorbed on the functional groups of the cell surface.

Presence of Ca^{2+} ions between 0.01 and 0.05 mol/L in the solution did not affect the adsorption of U by *S. putrefaciens*. Adsorption of U by *B. subtilis* decreased with increasing concentration of Ca^{2+} ions. Presence of citrate ions reduced the adsorption of U(VI) by *S putrefaciens* and *B. subtilis*. The presence of glucose did not affect the adsorption U(VI) on *S. putrefaciens*, but decreased the adsorption of U(VI) by *B. subtilis*. These results suggest that the presence of cations and organic acids affect the adsorption of An by microorganisms, and the adsorption of U(VI) are different between Gram-negative and Gram-positive microorganisms.

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Keywords: Geological disposal, adsorption, microorganism, long-lived radionuclides, migration