Direct and Indirect Microbial Interactions with Pu and Colloids

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Microorganisms are associated with a variety of radioactive materials at DOE sites and it is becoming known that they can influence Pu speciation and solubility. However, few attempts have been made to identify the microbial populations existing at Pu contaminated DOE sites. In addition, there is a general lack of knowledge concerning the impact that microbial direct mechanisms (e.g., diversity, reduction capacity) or indirect mechanisms (e.g., exopolymer production potential) have on the subsurface mobility of Pu. These knowledge gaps limit progress on understanding the role of microbes affecting the environmental transport of Pu. *Pseudomonas sp* strain EPS-1 was isolated from Nevada National Security Site (NNSS, formerly Nevada Test Site), cultured, and its EPS extracted and purified. The interaction of Pu with *Pseudomonas sp*. strain EPS-1 and the EPS isolated from this strain was investigated to identify the role of EPS in Pu-microbe interactions and redox transformations.

EPS, a major organizational element of microbial biofilms, provides an overall protective structural stability to the microbial community. Cell-bound EPS, serving as the outermost layer of the cell surface, is likely to play a major role in cell interaction with Pu. Pu(V) complexation studies using bound-EPS isolated from *Pseudomonas sp*. strain EPS-1 confirmed that EPS rapidly reduces Pu(V) to Pu(IV). Identification of EPS component responsible for this reduction is under investigation.

To determine the redox behavior of Pu in the presence of whole cells, a series of Pu-sorption experiments was carried out with *Pseudomonas sp*. strain EPS-1 at pH 6.8 using both Pu(IV) and Pu(V). Pu concentrations were held at 10^{-10} M (below solubility) and the concentration of Pseudomonas cells varied between 10^8 and 10^6 cells/mL. In the Pu(IV) experiments, Pu sorbed to both cells containing bound-EPS and cells that had their bound-EPS removed. At cell concentrations of 10^8 cell/mL, approximately 75% of the Pu(IV) attached to the surface of cells regardless of the presence of EPS. In the Pu(V) experiments, over 80% of Pu sorbed to cells containing bound-EPS while only 22% of Pu sorbed to cells that had their bound-EPS removed. The relatively low percentage of Pu(V) sorbed to the cells without bound-EPS suggests that EPS drives the reduction of Pu(V) to Pu(IV) and the subsequent association of Pu(IV) with the cells. TEM imaging of Pu(IV) and Pu(V) associated with *Pseudomonas sp*. strain EPS-1 indicates that the initial oxidation state of Pu will lead to morphologically distinct Pu-EPS associations.