Investigation of the Spatial Distributions and Transformations of Cr, Pb and U Co-contaminant Species at the Bacteria-Geosurface Interface

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The microenvironment at and adjacent to actively metabolizing cell surfaces can be significantly different from the bulk environment. Cell surface polymers (lipopolysaccharides, extracellular polysaccharides), metabolic products, etc., can set up steep chemical gradients over very short distances. It is currently difficult to predict the behavior of contaminant radionuclides and metals in such microenvironments because the chemistry of these environments has been difficult or impossible to define. The behavior of contaminants in such microenvironments can ultimately affect their macroscopic fates. Information about biogeochemical interactions at the microbe-geosurface microenvironment is paramount to predicting the fate of contaminants and effectively designing bioremediation approaches. State-of-the-science x-ray microimaging and spectromicroscopy are powerful techniques for resolving the distribution and speciation of contaminants at the microscopic scale. The objectives of this research are (1) to use x-ray absorption spectroscopy, microimaging and spectromicroscopy to determine the spatial distribution and chemical speciation of Cr, Pb and U near the interfaces of *Pseudomonas aeruginosa* and *Shewanella putrefaciens* with iron (hydr)oxide, and (2) to use this information to identify the interactions among the contaminants, mineral surfaces and microbial extracellular materials that occur near these interfaces.

We have begun a series of experiments at Sectors 2 and 10 of the Advanced Photon Source to apply high-energy synchrotron x-ray microbeams to map the spatial distribution of elements associated with bacteria. Specifically, we have performed x-ray fluorescence (XRF) imaging of a hydrated *P. fluorescens* bacterium, adhered to kapton film at ambient temperature and pressure, with 0.15-_m resolution.

XRF imaging studies of a similar hydrated *P. fluorescens* bacterium, exposed to 1000 ppm Cr(+6) solution for 6 hours, has also been accomplished. In all cases, for the measurements made, the highest elemental concentrations occur at the point of adhesion of the bacterium to the kapton film. These results indicate that the combination of the high brilliance of the APS and the use of high-resolution zone plates for focusing enable the identification of the location of a hydrated bacterium on a film and the determination of the relative concentrations of the other elements at the same location. Measurements of quantified standards with known elemental concentrations have been undertaken to enable calculation of the elemental concentrations within and near the bacterium. These results, their implications to the biochemical interactions occurring between the extracellular polysaccharides and contaminant metals, and a discussion of the use of the x-ray spectromicroscopy to investigate the chemical interactions at, near and on a hydrated bacterium will be presented. A discussion of preliminary bulk x-ray absorption spectroscopy studies also will be presented.