Applying EMSL Capabilities to Biogeochemistry and Environmental Research

**Determining Chemical Forms in Sediments and Solutions**

**Iron determination (Mössbauer Spectroscopy)**

- Mössbauer spectra and isomeric shifts were obtained for Shewanella and Pseudomonas aerugi- nosa.
- The impact of these different coatings on mineral dissolution was monitored using (a) XPS, (b) SIMS, and (c) XRD.

**Determining proteins in the outer microbial membrane (Atomic Force Microscopy)**

- Atomic force microscopy (AFM) images revealed adsorption of bacterial membrane proteins to quartz surfaces.
- Concept: The impact of solution composition on iron coatings of quartz surfaces.

**Characterizing Biological Systems**

**Visualizing the closest-to-native-state cellular morphology of hydrated bacteria**

- Cryo-transmission electron microscopy (Cryo-TEM) was used to visualize the outer membrane and cytoplasm of Shewanella oneidensis.

**Elongated crystals.**

**Shewanella Lipid membrane**

**Approach = 415 nm**

**99Tc (EMSL Radiological NMR)**

**10**

**Microbial activity was monitored by measuring**

**Research was performed in Support of the U.S. Department of Energy’s Office of Biological and Environmental Research**

**Andy Felmy, EMSL Chief Scientist**

**EMSL’s four Science Themes, which represent growing areas of research:**

- Science of Interfacial Phenomena.
- Geochemistry/Biogeochemistry and Subsurface Science.
- Energy Biofuels.
- Materials in Environment.

Researchers are encouraged to submit a proposal centered around one of the four Science Themes and technologies.

**Subsurface Flow and Transport**

**Examining the impacts of microbial growth**

**Intermediate Scale Flow Cell**

**Uranium determination (Laser Fluorescence Spectroscopy)**

- 1.0 ppm uranium in quartz solution.
- 0.1 ppm uranium in water.

**Unraveling molecular mechanisms and providing ideas for macroscopic experimentation (Molecular Simulation)**

- Molecular Dynamic model of many binding to the outer membrane of Paracoccus denitrificans.
- Current work: Change in binding mechanism with pH.

**Mineral Surface Chemistry**

**Combining techniques for unique insight (Atomic Force Microscopy)**

- The impact of solution composition on redox cycling of Fe phases.
- Surface morphology to examine the Fe coatings.

**Surface morphologies for Fe coating in 0.1 M NaCl (air dried)**

- The impact of solution composition on Fe coatings of quartz surfaces.
- After coating (a) before, (b) after, (c) after washing with DI.

- Protein spots on silver-stained gels show the impact of solution composition on Fe coatings of quartz surfaces.

**Dissociation of the key proteins being determined.**

**Before coating (deflection image)**

**After coating (deflection image)**

**After coating and rinsing**

**Rinsing with room temperature DI water and DI water**

**Determining surface chemical composition (Secondary Ion Mass Spectrometry and X-Ray Photoelectron Spectroscopy)**

- SIMS - Scan map of surface composition.

**XPS – Surface Emission image**

- The relative intensity of the various elements present in the sample.

**Effect of solution composition on redox cycling of Fe phases.**

The impact of different coatings on mineral dissolution was monitored using (a) XPS, (b) SIMS, and (c) XRD.