

more of the following DOE user facilities:

Applicants may be interested in the capabilities offered at the Environmental Molecular Sciences Laboratory (EMSL), which is located at the Pacific Northwest National Laboratory in Richland, WA. EMSL provides users with unique and leading edge instrumentation for molecular-level studies, including a wide variety of capabilities in spectroscopy and microscopy, particle characterization and imaging, and meter-scale reactive transport. These experimental capabilities are located within EMSL's high field magnetic resonance, high performance mass spectrometry, interfacial and nanoscale science and optical imaging and spectroscopy facilities. In addition, the high-performance molecular science computing facility within the EMSL includes an 11.8 TeraFlop supercomputer for use in reactive transport and flow modeling. See <http://www.emsl.pnl.gov> for further information.

Applicants may also be interested in the molecular-level capabilities for studying the speciation, properties or behavior of contaminants that are available through DOE's synchrotron radiation facilities. Information concerning the types of analytical techniques available at specific synchrotron facilities is available through EnviroSync, a national organization that represents molecular environmental science at the synchrotrons. See <http://www.cems.stonybrook.edu/envirosync/> for further information.

Current Request for Applications

Research projects should address the scientific aims of: (1) Individual NABIR elements including Biogeochemistry, Biotransformation, Community Dynamics and Assessment; (2) Integrative, interdisciplinary studies that involve research from more than one element; or (3) Field research projects to be performed at the NABIR FRC in Oak Ridge, Tennessee. The focus is on field research, or laboratory studies that can be scaled to the field, to provide supporting information for current or future field research. The NABIR FRC provides an opportunity for researchers to work at a DOE site in collaboration with scientists from different research elements. Studies at the NABIR FRC show that microbial reduction of radionuclides and metals is affected by the presence of nitrate and low pH. Thus, research into microbial mechanisms involved in the reduction of radionuclides and metals in this type

of subsurface environment is of special interest.

Biogeochemistry: The goal of this element is to understand the fundamental biogeochemical reactions that would lead to long-term immobilization of metal and radionuclide contaminants in the subsurface, and the potential for remobilization. The focus is on reactions that govern the concentration, chemical speciation, and distribution of metals and radionuclides between the aqueous and solid phases. Biogeochemical reactions in subsurface environments are influenced by a wide variety of factors, including the availability of electron donors and acceptors, the nature of the microbial community, the chemical species or form of contaminant, the hydrogeology of the site, and the nature of the environmental matrix. Often several competing redox reactions make the prediction of the substrates, products, and kinetics difficult. The biogeochemical reactions are further complicated by the sorption of contaminants and reaction products to mineral surfaces, and the presence of natural organic matter and co-contaminants. The research challenge is to identify and prioritize the key biogeochemical reactions that are needed to predict the rate and extent of reactions that result in the immobilization of radionuclides and metals. New and creative scientific approaches are sought that address the following fundamental research questions:

- To increase immobilization of radionuclides and metals, what are the principal biogeochemical reactions that govern the concentration, chemical speciation, and distribution of metals and radionuclides between the aqueous and solid phases (with an emphasis on natural geological matrices)? What are the thermodynamic and kinetic controls on these reactions? How do factors, such as co-contaminants, sorption processes, and terminal electron acceptors (e.g., nitrate, iron, sulfate), influence these reactions?
- Under what conditions would the contaminants remobilize, and what alterations to the environment would increase the long term stability of metals and radionuclides in the subsurface?
- What influence do hydrological processes such as reactive transport, advective/dispersive transport and colloidal transport have on the biological availability, biotransformation, and movement of radionuclides and metals?

Biotransformation: The goal of this element is to understand the

mechanisms of microbially mediated transformation of metals and radionuclides in subsurface environments leading to *in situ* immobilization and long term stability. Physiological studies of the biotransformation of metals and radionuclides by subsurface microorganisms will provide the knowledge base needed to understand intrinsic bioremediation and to stimulate biotransformation *in situ*. DOE subsurface sites encompass a range of redox environments where contaminants, such as uranium are present. One challenge is to understand the impact of these environments on microbial physiological processes involved in the biotransformation of radionuclides and metals to an immobilized form. Knowledge of the metabolic pathways for biotransformation of these contaminants by naturally occurring microbial communities in vadose zones, saturated zones and the waste plume is needed. A second challenge is to accelerate the rates of these physiological processes *in situ*, in complex subsurface environments. Biotransformation of metals and radionuclides in the subsurface is poorly understood, and predictive models based on laboratory studies have not always accurately simulated the observed fate of metals and radionuclides in the field. It is important to understand the kinetics of desirable metal and radionuclide biotransformations and the physicochemical factors affecting those kinetics in the field. Research is needed to address questions, such as:

- What are the primary metabolic pathways for biotransformation of radionuclides and/or metals by subsurface microorganisms at DOE sites, such as the FRC? Physiological processes studied at the laboratory scale will need to demonstrate how results will be scaled to the field.
- How can metal reduction be harnessed or accelerated to immobilize radionuclides and/or metals in the subsurface? Can *in situ* production of organic acids, chelators, or extracellular polymers affect contaminant mobility?
- What environmental controls affect microbial physiological processes involved in radionuclide and metal biotransformations leading to immobilization in vadose and saturated zones? What factors inhibit these biotransformations *in situ*?
- How can we quantify *in situ* biotransformation kinetics so that these parameters can be applied to numerical models of field scale bioremediation?

Community Dynamics and Microbial Ecology: The goal of this element is to