Office of Science
Notice DE-FG01-05ER05-05

Natural and Accelerated Bioremediation Research Program

Department of Energy

Office of Science Financial Assistance Program Notice DE-FG01-05ER05-05: Natural and Accelerated Bioremediation Research Program

AGENCY: U.S. Department of Energy

ACTION: Notice inviting grant applications.

SUMMARY: The Office of Biological and Environmental Research (OBER) of the Office of Science (SC), U.S. Department of Energy (DOE), hereby announces its interest in receiving applications for research grants in the Biomolecular Science and Engineering element of the Natural and Accelerated Bioremediation Research (NABIR) Program. The goal of the NABIR program is to provide the fundamental science that will serve as the basis for understanding the relationships among biological, physical and chemical factors affecting the subsurface fate and transport of metals and radionuclides at DOE sites in the context of remediation and long-term stewardship. Research should address biological aspects of the remediation of uranium, technetium, plutonium, chromium or mercury. NABIR is focused on subsurface sediments below the root zone and includes both the vadose (unsaturated) zone and the saturated zone (groundwater and sediments). Applications are only being accepted in the following program element: Biomolecular Science and Engineering.

DATES: Researchers are strongly encouraged to submit a preapplication for programmatic review. Preapplications should be submitted by December 21, 2004, to allow sufficient time for review for programmatic relevance and for preparation of the full application. A brief preapplication should consist of no more than two pages of narrative describing the research objectives and methods.

The deadline for receipt of formal applications is 4:30 p.m., Eastern Time, March 3, 2005, to be accepted for merit review and to permit timely consideration for awards late in Fiscal Year 2005 or in early Fiscal Year 2006.

ADDRESSES: Preapplications referencing Program Notice DE-FG01-05ER05-05 should be sent by E-mail to arthur.katz@science.doe.gov.

Formal applications referencing Program Notice DE-FG01-05ER05-05, must be sent electronically by an authorized institutional business official through DOE's Industry Interactive Procurement System (IIPS) at: http://e-center.doe.gov (see also

http://www.science.doe.gov/grants/). IIPS provides for the posting of solicitations and receipt of applications in a paperless environment via the Internet. In order to submit applications through IIPS your business official will need to register at the IIPS website. **IIPS offers the option of using multiple files, please limit submissions to one volume and one file if possible, with a maximum of no more than four PDF files.** The Office of Science will include attachments as part of this notice that provide the appropriate forms in PDF fillable format that are to be submitted through IIPS. Color images should be submitted in IIPS as a separate file in PDF format and identified as such. These images should be kept to a minimum due to the limitations of reproducing them. They should be numbered and referred to in the body of the technical scientific grant application as Color image 1, Color image 2, etc. Questions regarding the operation of IIPS may be e-mailed to the IIPS help desk at: HelpDesk@pr.doe.gov or you may call the help desk at (800) 683-0751. Further information on the use of IIPS by the Office of Science is available at: http://www.science.doe.gov/grants/IIPS-Instructions.html.

If you are unable to submit an application through IIPS, please contact the Grants and Contracts Division, Office of Science at: (301) 903-5212 or (301) 903-3064, in order to gain assistance for submission through IIPS or to receive special approval and instructions on how to submit printed applications.

FOR FURTHER INFORMATION CONTACT: Dr. Arthur Katz, Environmental Remediation Sciences Division, SC-75/Germantown Building, Office of Biological and Environmental Research, Office of Science, U.S. Department of Energy, 1000 Independence Ave., SW, Washington, D.C. 20585-1290, telephone: (301) 903-4932, E-mail: arthur.katz@science.doe.gov, fax: (301) 903-8521. The full text of Program Notice DE-FG01-05ER05-05 is available via the Internet using the following web site address: http://www.science.doe.gov/grants/.

SUPPLEMENTARY INFORMATION:

Background

For more than 50 years, the U.S. developed and operated a network of more than 113 facilities for research, development, testing and production of nuclear weapons. As a result of these activities, subsurface contamination has been identified at over 7,000 discrete sites across the U.S. Department of Energy complex. The DOE has shifted its emphasis to remediation, decommissioning, and decontamination of contaminated groundwater, sediments, and structures at its sites. DOE currently is responsible for remediating 1.7 trillion gallons of contaminated groundwater and 40 million cubic meters of contaminated soil. It is estimated that more than 60% of DOE facilities have groundwater contaminated with metals or radionuclides. More than 50% of all DOE facilities have soils or sediments contaminated with radionuclides and metals. While virtually all of the contaminants found at industrial sites nationwide can also be found at DOE sites, many of the metals and most of the radionuclides are unique to DOE sites. The NABIR program aims: 1) to provide the fundamental knowledge that may lead to new remediation technologies or strategies for radionuclides and metals; and 2) to advance the understanding of the key microbiological and geochemical processes that control the

effectiveness of *in situ* immobilization as a means of long term stewardship, and how these processes impact contaminant transport.

While bioremediation of organic contaminants involves their biotransformation to benign products such as carbon dioxide, bioremediation of radionuclides and metals involves their removal from the aqueous phase (immobilization) to reduce risk to humans and the environment. Microorganisms can directly affect the solubility of radionuclides and metals by changing their oxidation state to a reduced form that leads to *in situ* immobilization. Microorganisms also can indirectly immobilize radionuclides and metals through the reduction of inorganic ions that can, in turn, chemically reduce contaminants to less mobile forms. The long term stability of these reduced contaminants is a topic of ongoing research.

Currently, the fundamental knowledge that would allow cost-effective deployment of *in situ* subsurface bioremediation of radionuclides and metals is lacking. The focus of the NABIR program is on radionuclides and metals that: 1) pose the greatest potential risk to humans and the environment at DOE sites; and 2) are amenable to immobilization by means of bioremediation. Thus, research is focused on the radionuclides uranium, technetium and plutonium and the metals chromium and mercury. Radioactive contaminants such as tritium and cobalt are not a focus because of their relatively short half lives, and strontium and cesium are not addressed because they are not readily amenable to biotransformation. Research is focused on subsurface sediments below the root zone and includes both the vadose (unsaturated) zone and the saturated zone (both groundwater and sediments). NABIR research is oriented toward areas that have low levels of widespread contamination because remediation with existing technologies is prohibitively expensive. Uranium, technetium, and chromium can be especially mobile in the subsurface under certain conditions; and are risk-driving contaminants at some DOE sites. The effects of co-contaminants such as nitrate, complexing agents (such as EDTA) and chlorinated solvents (such as trichloroethylene and carbon tetrachloride) on the behavior of radionuclides and metals in the subsurface is also of interest to the NABIR program.

NABIR Program

The goal of the NABIR program is to provide the fundamental science that will serve as the basis for understanding the biological, physical and chemical factors affecting the subsurface fate and transport of metals and radionuclides at DOE sites in the context of remediation and long-term stewardship. The NABIR program is focused on subsurface sediments and includes both the vadose zone and the saturated zone, and encompasses both intrinsic bioremediation by naturally occurring microbial communities, as well as accelerated bioremediation through the use of biostimulation (addition of inorganic or organic nutrients). The NABIR Program supports hypothesis-driven, basic research that is more fundamental in nature than demonstration projects. Research on phytoremediation will not be supported by this solicitation.

Naturally occurring subsurface microbes may be involved in intrinsic bioremediation of radionuclides and metals by reduction and immobilization, either directly or indirectly. However, these natural processes typically occur at fairly slow rates, and there may be a need to use biostimulation to enhance the rates. The primary focus of the NABIR program is on biostimulation strategies, due to the ubiquity of metal-reducers in nature. Immobilized

radionuclides and metals are not removed from the subsurface as may occur with excavation, pump and treat, or biodegradation of organic contaminants. Immobilization is focused on containment in vadose zone and groundwater plumes. As such, it may be a strategy applied to prevent the discharge of deep or widely distributed contaminants from the vadose zone to groundwater, or from groundwater to a receiving water body (e.g., the Columbia River at Hanford). *In situ* immobilization of contaminants is one approach to long term stewardship, which is the post-closure responsibility of DOE at its contaminated sites. Long term stewardship involves long-term monitoring and other maintenance activities to ensure that residual in-ground contaminants do not spread further. Therefore, an important aspect to the NABIR program is to assess factors controlling the long-term stability of the immobilized contaminants and to devise approaches (biological/chemical) to maintain their immobilization through the stewardship phase.

The NABIR program consists of four interrelated Science Elements (Biogeochemistry, Biotransformation, Community Dynamics and Microbial Ecology, and Biomolecular Science and Engineering), and three cross-cutting elements (Assessment, BASIC and Integrative Studies). The Assessment Element supports innovative method development for the science elements. The Bioremediation and its Societal Implications and Concerns (BASIC) element addresses ethical, legal and societal issues, and the Integrative Studies element requires an integration of research from more than one NABIR research element through laboratory and/or field research. The NABIR program strongly encourages researchers to integrate laboratory and field research at DOE or DOE-relevant sites. More information on the NABIR program may be found at: http://www.lbl.gov/NABIR.

User Facilities and Other Specialized Resources

For molecular-level studies, applicants may want to explore opportunities to use the wide variety of instrumentation available at the Environmental Molecular Sciences Laboratory (EMSL) at the Pacific Northwest National Laboratory (http://www.emsl.pnl.gov) in Richland, Washington. As a national scientific user facility, EMSL provides users with unique and state-of-the-art resources including facilities for high field magnetic resonance, high performance mass spectrometry, single molecule spectroscopy, interfacial and nanoscale science, and molecular science computing. See the EMSL web site or contact Mr. Paul Bayer (301-903-3524, paul.bayer@science.doe.gov) for further information.

For genome sequencing and related studies, applicants may want to examine the sequence information and resources available through DOE's Joint Genome Institute (JGI) Production Genomics Facility (PGF) in Walnut Creek, California. The PGF provides high-throughput DNA-sequencing capabilities to the scientific community. Beyond genomic sequence information for completed microorganisms (http://genome.jgi-psf.org/), JGI also accepts new applications for microbial sequencing through its Community Sequencing Program (CSP). See the JGI web site (http://www.jgi.doe.gov/), or contact Dr. David Thomassen (301-903-9817, david.thomassen@science.doe.gov) for further information.

Applicants may want to investigate opportunities to conduct a portion of their research using beamlines at synchrotron light sources. Synchrotron experimental stations often provide

information about chemical analysis, including speciation, and sample structure in a shorter time and with greater sensitivity than conventional sources of x-rays. Beamlines suitable for environmental research are available at the Department of Energy synchrotron light sources: The Advanced Light Source (ALS) at Lawrence Berkeley National Laboratory (http://www-als.lbl.gov/), the Advanced Photon Source (APS) at Argonne National Laboratory (http://www.aps.anl.gov/index.html), the National Synchrotron Light Source (NSLS) at Brookhaven National Laboratory (http://www.bnl.gov/envirosuite/default.asp), and the Stanford Synchrotron Radiation Laboratory (SSRL) at the Stanford Linear Accelerator Center (http://ssrl.slac.stanford.edu/). For further information, contact Dr. Roland Hirsch (301-903-9009, roland.hirsch@science.doe.gov).

For studies on DOE-relevant microorganisms, applicants may want to obtain samples from the Oak Ridge Field Research Center (FRC) in Oak Ridge, Tennessee. The FRC provides a site for investigators to obtain DOE-relevant subsurface samples for laboratory-based studies as well as opportunities to conduct field-scale experimental research. The FRC is located on the U.S. Department of Energy Oak Ridge Reservation in Oak Ridge, Tennessee, and it is operated by the Environmental Sciences Division of the Oak Ridge National Laboratory. The contaminated and background (uncontaminated control) areas are located in Bear Creek Valley (BCV) within the Y-12 Plant area. See the FRC web site (http://www.esd.ornl.gov/nabirfrc) or contact Mr. Paul Bayer (301-903-5324, paul.bayer@science.doe.gov) for more detailed information on the FRC. In addition, applicants may be interested in obtaining cultures from the Subsurface Microbial Culture Collection (SMCC). Contact Mr. Paul Bayer for further information about cultures available through the SMCC.

Relevance to Mission

A Key consideration in the evaluation of research applications will be applicability to the Environmental remediation Science Division (ERSD) mission of DOE environmental remediation. Applicants will need to identify specific areas of scientific need and make a strong case for the value of the proposed research in helping resolve those needs. The application should explain how resolution of these needs could improve capabilities in site stewardship and/or contaminant remediation. Therefore, all applications submitted in response to this Notice must explicitly state how the proposed research will support the accomplishment of the ERSD Long Term Measure to *develop science-based solutions for cleanup and long- term monitoring of DOE contaminated sites.*

Current Request for Applications

Research projects that address the scientific aims of the Biomolecular Science and Engineering element are solicited in this announcement.

Biomolecular Science and Engineering: Research in this element seeks to advance our understanding at the biomolecular level, of the processes leading to the *in situ* immobilization of radionuclides and metals by indigenous subsurface microorganisms. The primary goal of this element is to understand the genetic, biochemical, and regulatory processes that mediate biotransformation of these specific radionuclides and metals, leading to their immobilization.

Characterization of genes, gene products, and genetic regulatory networks associated with these biotransformations are key to this understanding. Detailed studies of the enzymatic mechanisms for reduction of radionuclides and/or metals are needed to increase our understanding of *in situ* processes and to identify gene targets for better molecular assessment of radionuclide and metal reduction. Secondary goals include: 1) understanding molecular mechanisms of resistance of subsurface microorganisms to radionuclide and metal toxicity; 2) understanding, at a molecular level, the processes of lateral transfer between microbes of genes involved in biotransformation of these radionuclides and metals; 3) developing novel technologies to provide insights into biomolecular mechanisms of metal and radionuclide biotransformation; and 4) understanding, at the molecular, the regulation of pathways and enzyme systems that mediate biotransformations of metals and radionuclides.

DOE subsurface sites encompass a wide range of environments with a diversity of microbial communities and contaminants. One of the challenges of the Biomolecular Science and Engineering Element is to select microbes for studies that are active members of subsurface microbial communities and that exhibit evidence of impact to critical processes controlling contaminant mobility. A second challenge is to extrapolate laboratory findings on pure cultures under laboratory conditions to complex *in situ* environmental conditions. This extrapolation is especially critical in studying gene expression, which may be modified by changes in local cellular environments in the subsurface. A third challenge is to take advantage of genomic and other data derived from the DOE Microbial Genome Program (http://microbialgenome.org) on subsurface microorganisms to increase our understanding of how genes relevant to bioremediation are expressed in the environment. Research is needed to address questions such as:

- How are genes regulated in subsurface microorganisms that are responsible for biotransformation and immobilization of radionuclides and metals? How are genes regulated in these microorganisms to promote survival in the presence of potentially toxic levels of these contaminants?
- What are the effects of key environmental parameters on regulation and expression of genes involved in metal/radionuclide reduction? For example, how do pH and co-contaminants such as nitrate impact the biochemistry and gene expression and regulation of uranium and technetium reduction?
- What are the basic biomolecular mechanisms of uranium, technetium and chromium reduction and reoxidation in microorganisms, primarily those indigenous to the subsurface? What is the pertinent physiology of microorganisms involved in the reduction of these metals and radionuclides in subsurface environments? What are the biomolecular mechanisms involved in lateral transfer of metal/radionlucide reduction genes in subsurface microbial communities that could effect reduction and reoxidation processes? Can biomolecular processes be influenced to enhance the sustainability of immobilization of uranium, technetium or chromium? Are there novel biomolecular mechanisms that can be used to immobilize mercury or plutonium?

Applications should primarily focus on indigenous subsurface microorganisms that have been shown to precipitate and immobilize these radionuclides and metals under real world conditions. Preference will be given to applications that study microorganisms that have been isolated from,

or associated with, metal and radionuclide-contaminated sites. Microbial community data are available from the FRC (http://public.ornl.gov/nabirfrc/frcwg3.cfm), and several Uranium Mill Tailing Remediation Action (UMTRA) sites (http://www.pnl.gov/nabir-umtra/). The ultimate goal of this element is to improve our ability to predict and affect the activities of microbes in situ, particularly in an *in situ* immobilization scenario.

Additional Information for Applications

It is anticipated that up to $1 million will be available for multiple awards to be made in late Fiscal Year 2005 and early Fiscal Year 2006 in the categories described above, contingent on availability of appropriated funds. An additional sum, up to $1 million, will be available for competition by DOE National Laboratories under a separate solicitation (Program Announcement LAB 05-05). This call is open to all interested parties. The NABIR program currently funds more than a dozen projects in this element, and expects to receive renewal applications in response to this announcement.

Applications may request project support up to three years, with out-year support contingent on availability of funds, progress of the research and programmatic needs. Annual budgets for projects are not to exceed $400,000 total costs. All applications should include letters of agreement to collaborate from included collaborators; these letters should specify the contributions the collaborators intend to make if the application is accepted and funded. DOE may encourage collaboration among prospective investigators to promote joint applications or joint research projects by using information obtained through the preliminary applications or through other forms of communication.

Merit Review

Applications will be subjected to formal merit review (peer review) and will be evaluated against the following evaluation criteria which are listed in descending order of importance codified at 10 CFR 605.10(d):

1. Scientific and/or Technical Merit of the Project;
2. Appropriateness of the Proposed Method or Approach;
3. Competency of Applicant's personnel and Adequacy of Proposed Resources;
4. Reasonableness and Appropriateness of the Proposed Budget.

For renewals, progress on previous NABIR funded research will be an important criterion for evaluation. As part of the evaluation, program policy factors also become a selection priority. Note, external peer reviewers are selected with regard to both their scientific expertise and the absence of conflict-of-interest issues. Federal and non-federal reviewers will be used, and submission of an application constitutes agreement that this is acceptable to the investigator(s) and the submitting institution.

Submission Information

Information about the development, submission of applications, eligibility, limitations, evaluation, the selection process, and other policies and procedures may be found in 10 CFR Part

605, and in the Application Guide for the Office of Science Financial Assistance Program. Electronic access to SC's Financial Assistance Application Guide is possible via the World Wide Web at: http://www.science.doe.gov/grants/. DOE is under no obligation to pay for any costs associated with the preparation or submission of applications if an award is not made. In addition, for this notice, the research description must be 20 pages or less, exclusive of attachments, and must contain an abstract or summary of the proposed research (to include the hypotheses being tested, the proposed experimental design, and the names of all investigators and their affiliations). **Applicants who have had prior NABIR support must include a Progress Section with a brief description of results, the funding history (i.e., number of years and amounts per year for all PI's and co-PI's), and a list of publications derived from that funding.** Attachments should include short (2 pages) curriculum vitae, QA/QC plan, a listing of all current and pending federal support and letters of intent when collaborations are part of the proposed research. Curriculum vitae should be submitted in a form similar to that of NIH or NSF.

The Office of Science as part of its grant regulations requires at 10 CFR 605.11(b) that a recipient receiving a grant and performing research involving recombinant DNA molecules and/or organisms and viruses containing recombinant DNA molecules shall comply with the National Institutes of Health (NIH) "Guidelines for Research Involving Recombinant DNA Molecules," which is available via the world wide web at: http://www.niehs.nih.gov/odhsb/biosafe/nih/rdna-apr98.pdf, (59 FR 34496, July 5, 1994,) or such later revision of those guidelines as may be published in the Federal Register.

Grantees must also comply with other federal and state laws and regulations as appropriate; for example, the Toxic Substances Control Act (TSCA) as it applies to genetically modified organisms. Although compliance with NEPA is the responsibility of DOE, grantees proposing to conduct field research are expected to provide information necessary for the DOE to complete the NEPA review and documentation.

Additional information on the NABIR Program is available at the following web site: http://www.lbl.gov/NABIR/. For researchers who do not have access to the world wide web, please contact Judy Nusbaum; Environmental Remediation Sciences Division, SC-75/Germantown Building; U.S. Department of Energy; 1000 Independence Avenue, S.W., Washington, D.C. 20585-1290; phone: (301) 903-4902; fax: (301) 903-4154; E-mail: judy.nusbaum@science.doe.gov; for hard copies of background material mentioned in this solicitation.

The Catalog of Federal Domestic Assistance number for this program is 81.049, and the solicitation control number is ERFAP 10 CFR Part 605.

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