Dave and Tonia at the FRC Trailer

Field Research Center (FRC) Scientific Advisor

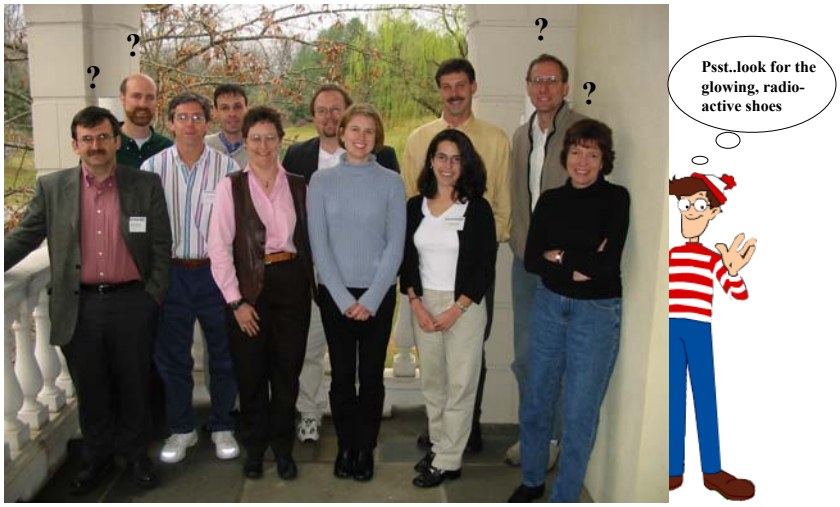
DOE's NABIR program was in need of an individual that could serve as a scientific advisor, whose role would be to foster enhanced collaborations between existing and future laboratory- and field-based research projects as they related to the Field Research Center (FRC).

Such an activity was deemed critical to the success of the NABIR program whose ultimate goal is to provide an improved understanding and predictive capability of microbially mediated in-situ immobilization of redox sensitive toxic metals and radionuclides at scales pertinent to the mission of DOE (e.g. field-scale).

Defining attributes:

- Field experience.
- Knowledge of soil chemical and hydrological processes.
- Ability to work with the FRC site manager and DOE headquarters staff.
- Knowledge of subsurface microbial processes not required, but a bonus.

Can you find the FRC Science Advisor?



Role of FRC Science Advisor

The key role of the NABIR FRC Science Advisor is to provide scientific leadership and coordination among NABIR research projects, sampling activities, and characterization efforts at the FRC. This includes:

- Efforts to foster appropriate sharing of data and information among projects.

- Identification of common goals among projects and elimination of unnecessary redundancies.

- Improvements in the quality of data collection by encouraging sharing of samples and standardization of protocols among projects, where appropriate.

- Identification of opportunities for future research at the FRC.

- Work effectively with FRC Manager (David Watson) and Field Activities Managers (Paul Bayer / Anna Palmisano) in developing a long term scientific strategy for the FRC.

Enhancing project collaborations and linkages to the FRC

Status:

Reviewed overall program structure and long-term mission.

Reviewed individual projects focusing on goals, scientific questions addressed, use of, or ability to adapt to, heterogeneous media and groundwater, choice of metals and rads., relevance to FRC activities, and loyalty to the DOE mission.

Formulated draft concept paper showing existing and perceived project linkages within the NABIR FRC.

NABIR FRC Strategic Plan

Status:

Identification of specific scientific needs associated with the FRC

- **Hydrological and physical processes**
- **Geochemical processes**
- **Microbial processes**
- **Coupled processes**
- **Modeling**

DOE-based programmatic linkages

- **EMSP**
- **EM S&T Alternative projects**
- **Advanced Subsurface Simulation Initiative**

Draft Strategic Plan – Bayer

Short-term, mid-term, long-term goals

Existing linkages for specific topical areas

- Microbial Community Analysis
- Geochemical/Geophysical Characterization/Monitoring
- Biogenic Fe(II) Reduction of Metal Contaminants
- Microbial Activity Screening/Monitoring Techniques
- Microbial Metal Reduction Mechanisms

Example:

Microbial Community Analysis

Description: Project specific and general site characterization endeavors involving the development of bacterial clonal libraries, purification of microbial isolates, and research on enrichment strategies. Common use of molecular techniques and protocols.

Fields (Criddle/Jardine)	Groundwater, Areas 1/2/3, Sediments Area 3 (linkage to Stanford/ORNL project).
Cummings Geesey/Peyton	Coupons, Areas 1/3, Background (linkage to Istok and Criddle projects).
White/Peacock	Bug-traps Areas 2, 3 (linkage to Stanford/ORNL project).
Kostka	Sediments, Area 1 (linkage to Istok project).
Kuske	Acidobacterium focus (general linkage).
Barkay	Gene transfer mechanisms (general linkage).

Analysis:
Extremely well organized, with minimal redundancies, and common use of various protocols. Open competition promotes motivation and productivity. Very tight linkage to general FRC characterization and field-projects at FRC.

Status Rationale:
Investigators actively communicate, share data and results, and openly discuss ways to avoid duplicative research. Investigators actively pursue scientific opportunities with field-scale projects at the FRC.

Suggested improvements:

- Investigators encouraged to watch and learn about new field-projects (e.g. Scheibe/Brooks, Istok/Gu/Krumholtz) and establish linkages as in the past.
- Formulating a Working Group within this science area, with an assigned point of contact, could strengthen these linkages even more.
- Enhance dissemination of knowledge to other NABIR investigators through improved data transfer and display on FRC website.
- More direct linkage and information from Brockman (samples shipped) and Chandler (no FRC samples requested yet).

Example: **Geochemical/Geophysical Characterization/Monitoring**

Description: Project specific and general site characterization endeavors designed to quantify select physical, chemical, and mineralogical properties of the FRC groundwater and solid phase.

Francis/Gillow	U XANES and EXAFS analysis on groundwater and core material, Area 3
Fendorf (no direct funds for effort)	Synchrotron based XRD for Fe-oxide mineralogy, Area 3.
Doll (FRC funded)	Electrical resistivity and seismic refraction tomography for non-invasive mapping of subsurface plumes and corresponding subsurface consolidation, Area 3 and near Area 2.
Hubbard	Use of downhole seismic and radar tomography techniques to enhance hydrogeological characterization and monitoring during biostimulation experiments in Area 3
Blake	Application of field-portable Immunosensor to monitor removal of U(VI) from groundwater (general FRC application).
Zachara	Use of mossbauer spectroscopy and other high-resolution surface spectroscopy techniques for quantifying Fe mineralogy on select FRC material.
Zhu (no direct funds for effort)	TEM analysis of U on Area 3 sediment.

Analysis:
Fairly good coupling of numerous high-resolution geochemical and geophysical techniques for characterizing subsurface media. Direct linkage to field projects and general FRC characterization efforts.

Status Rationale:
Investigators appear to be operating independently where FRC manager or field project PI provides link to larger *in situ* efforts. Sometimes this is driven by funding limitations. No duplicative research.

Comments/Suggested improvements:

- Formulation of a Working Group could enhance the effort and data transfer among investigators. An assigned leader could better coordinate the common usage of select subsurface sediments and establish a tighter link between the geochemical and geophysical research endeavors.
- Enhance dissemination of knowledge to other NABIR investigators through improved data transfer and display on FRC website.

Current FRC Field Research Projects

- Istok/Krumholz (OSU/UO)
  - Area 1 and 2
- Criddle/Jardine (Stanford/ORNL)
  - Area 3
- Istok/Gu/Krumholz (OSU/ORNL/UO)
  - Area 2
- Scheibe/Brooks/Roden (PNNL/ORNL/UA)
  - Area 2

Field projects with their existing and potential linkages

Criddle/Jardine Project (Area 3)

Research Effort	Project Investigators	Existing Linkages	Potential Linkages
Hydrology	Jardine/Watson/ Kitanidis		
Geochemistry	Gu/Brooks/Watson/ Jardine/Criddle	Francis Zhu	Blake Fendorf
Microbiology	Fields/Zhou/Criddle	Geesey/Cummings White/Peacock/ Marsh	Halden/ Lowe
Geophysics	Doll/Watson	Hubbard	
Transport Modeling	Kitandis/Fienen Cirpka		Scheibe
Mineralogy	Fendorf	Watson/Roh Fendorf / Zachara Cummings / Zhu	
Data Management	Brandt		

- Near source U bioreduction strategies.
- Coupled biogeochemical transformation during manipulated flow.
- Multiprocess fate and transport scenario in high/low pH regimes.

Istok/Gu/Krumholz (Area 1 and 2)

Research Effort	Project Investigators	Existing Linkages	Potential Linkages
Hydrology	Istok		
Geochemistry	Gu/McKinley		Blake Francis Fendorf Zhu Zachara
Microbiology	Krumholz	Cummings Halden/Lowe	White/Peacock
Transport Modeling			
Data Management			Brandt

- In situ biostimulation via push-pull method for enhancing U and Tc reduction.
- Toxicity, humics, pH, nitrate effects.
- Coupled biogeochemical transformations

Scheibe/Brooks/Roden (Area 2)

Research Effort	Project Investigators	Existing Linkages	Potential Linkages
Hydrology	Scheibe/Brooks		Criddle/Jardine
Geochemistry	Brooks		Francis Fendorf Blake Zhu Zachara
Microbiology	Roden	Lehman	Geesey/Cummings
Geophysics	Doll/Watson		Hubbard
Transport Modeling	Scheibe		Kitandis
Data Management			Brandt

- Field biostimulation north end Area 2
- Fracture/matrix interactions on U bioreduction
- Coupled biogeochemical transformations during natural hydrodynamic flow.

Data Presentation and Sharing

- Develop better approaches for presenting data and sharing it with NABIR investigators.
- Is the data adequate and how can it be effectively disseminated to others (particularly in situ research).
- Pfiffners "Description of NABIR Investigator Research on FRC Samples and Field Sites" is an excellent start.