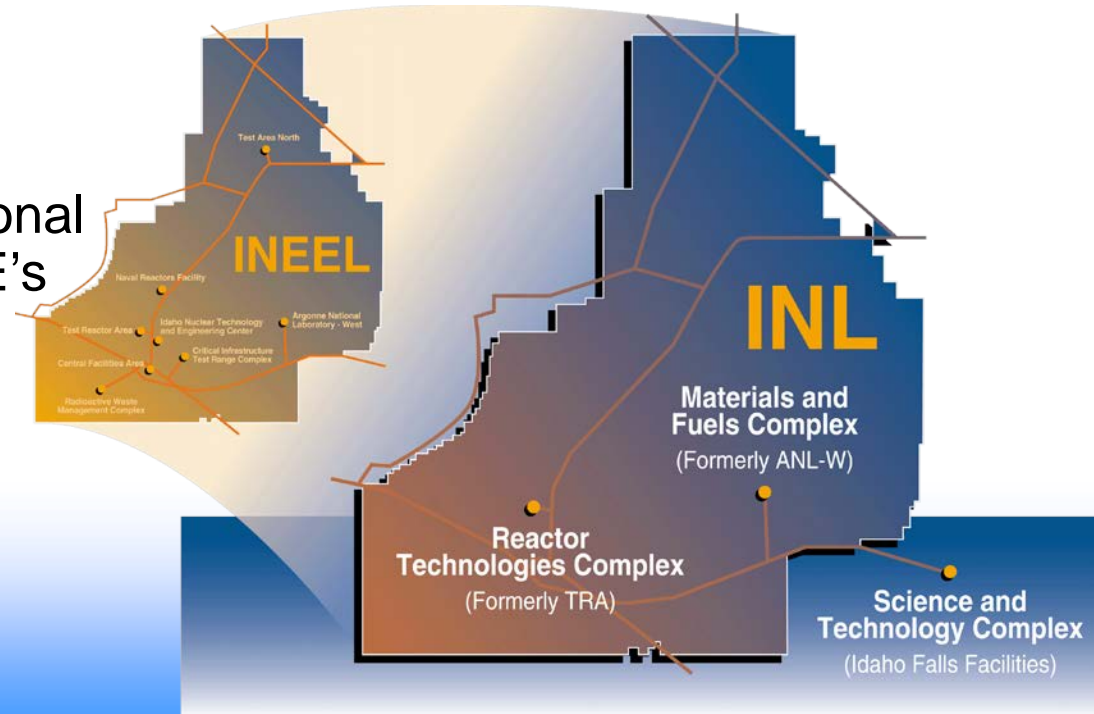


Biological Sciences at Idaho National Laboratory

Melinda Hamilton
Division Director
Life and Earth Sciences

Multiprogram National Laboratory

- Leverages science and engineering technologies to underpin DOE's missions
- Assures the nation's energy sustainability
- Delivers nuclear research capabilities and safe testing of nuclear energy, materials and systems
- Develops solutions for the nation's critical infrastructure
- Forms national and international partnerships to address DOE's R&D needs



Accomplishing the INL Mission

- **Building recognized capability in five distinctive areas**
 - **Materials and Nuclear Fuels Science and Technology**
 - **Separations and Actinide Science**
 - **Instrumentation, Control, and Intelligent Systems**
 - **Modeling and Simulation of Physical Systems**
 - **Microbiological and Geological Systems Science**
- **Standing up CAMS- The Center for Advanced Modeling and Simulation**

Complexity

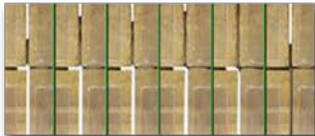
Unique capabilities such as the geocentrifuge allow us to accomplish temporal scaling

Metabolic pathway models are at the forefront of predictive biology



Modeling
System Behavior

Physical processes such as pore scale fluid flow will be linked to microbial metabolic activity



Microbial communities within complex environments possess diverse capabilities

Systems Microbiology

Experimental Geoscience



DNA provides the blueprint for microbial function



Intermediate scale column experiments bridge the gap between molecular scale processes and field scale observations



Vision: By 2015 INL will lead the science to understand, predict, and control microbial metabolic systems in complex geologic environments.

Scale

05-GA50010-178

Bioscience Capabilities

- Bioscience Department
 - 30 permanent staff, 2-15 students/post-docs
 - Nine standard microbiology/wet chemistry laboratories, a greenhouse, and a high-bay for scale up
 - Two Biosafety Level 2 certified laboratories
- Interdisciplinary Research
 - Geosciences
 - Physical Sciences
 - Engineering
 - Robotics
 - Modeling



Unique Assets – Where we do it



Unique Assets – Who's on the job



Disciplines Represented

- *Biology*
- *Microbiology*
- *Environmental Microbiology*
- *Chemical Engineering*
- *Molecular Biology*
- *Biochemistry*
- *Botany*
- *Environmental Toxicology*

Unique Assets- Capabilities to do the job

- \$1.5 M major equipment investment in molecular microbiology over past 5 years

DNA Sequencers

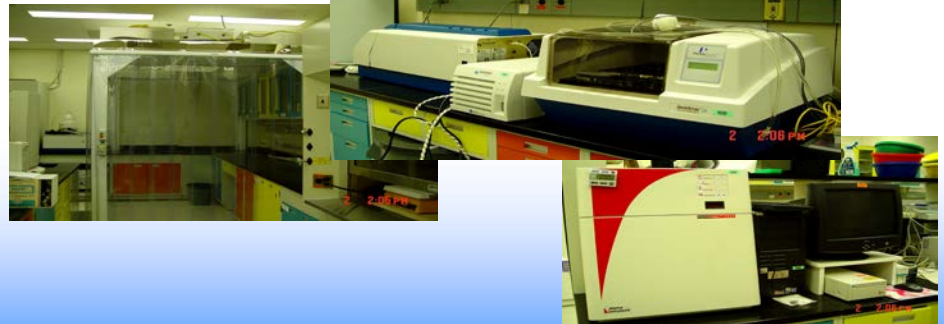
Microarray

Real-Time PCR

Mass Spectrometer

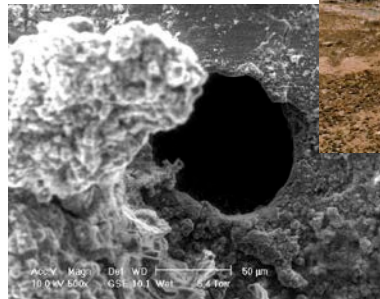
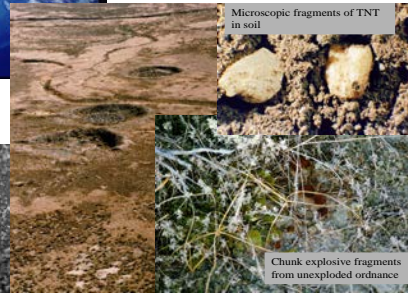


ABI PRISM 3700 DNA Analyzer
It's Time to Rethink Your DNA Strategy



Research Focuses on National and Regional Issues

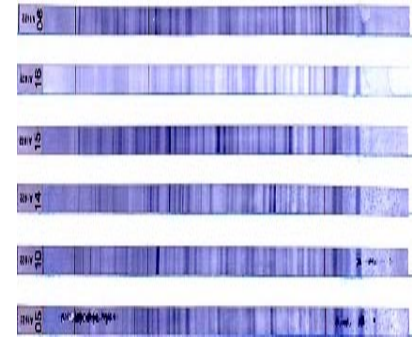
Energy Security



Chunk explosive fragments from unexploded ordnance

Environment

National Security





Chemicals from Renewables

Current processes for production of organic chemicals from petroleum feedstocks are energy intensive and produce large amounts of waste. Bioprocesses offer major improvements in these areas.

Objective

Develop bioprocesses for production of value added products from renewable feedstocks

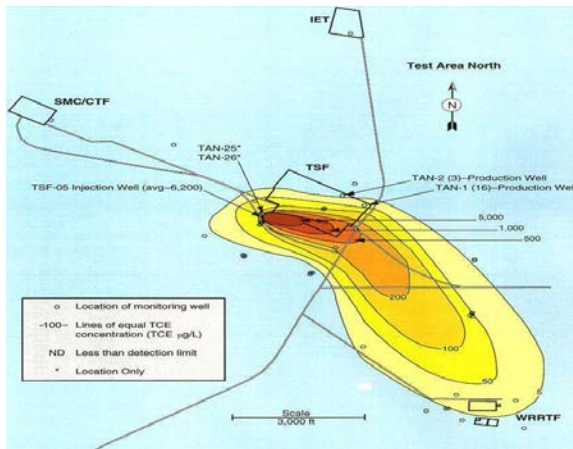
Approach

Use of genetic engineering techniques and microbial optimization to efficiently converting substrate to desired product- focused on wheat straw for regional value

Results

- Demonstrated microbial production of plastics monomer from cellulosic feedstock
- Developed microbial pretreatment approach to increase wheat straw value for multiple products

Bioremediation and Natural Attenuation



Objective

Assess the rate, define the mechanism, and optimize natural microbial processes that degrade contaminants.

Approach

Sample and monitor natural microbial degradation at distal areas of plume and provide electron donors (energy supply) to microorganisms at contaminant source.

Results

- Aerobic microbes sampled and characterized from subsurface TCE plume at TAN
- Demonstrated TCE degradation by methane metabolizing microbes *in situ*, i.e. *natural attenuation*
- Anaerobic microbes were stimulated to degrade TCE at source and process optimized

Biofiltration of Gases & Vapors



Approach

Engineer a contained gas distribution system with an inert bed medium to support microbial growth and optimize microbial activity for degradation of vapors



**R&D
100
Award
Winner**

Industrial Customers

Weyerhaeuser
General Electric
Idaho Asphalt

Objective

Treat hydrocarbons, chlorinated solvents, NO_x emissions, and other toxic vapors in line, generating CO₂ and H₂O as byproducts

Results

- Cost effective treatment
- Mobile design
- Treatment fast- Retention time, few seconds to minutes
- Complete degradation i.e., Reaction products: water, carbon dioxide



Blackbird Mine, Cobalt, ID

Mining-related R&D

Objectives

- Optimize heap, dump and tank leaching
- Develop new bioleach technologies to reduce and stabilize wastes
- Develop new biotechnologies for mine remediation and closure

Results

- Numerous publications
- Involvement in international consortium to study *Acidithiobacillus*
- US Patent for passive mine remediation technology
- Working relationships with regional and international mining industry

Approach

- Classic microbiology and molecular techniques to monitor microbial communities at work
- Combined biological and geologic strategies (hydrology, geochemistry, biochemistry) to manipulating and controlling bioleaching with predictable and desirable outcomes
- Engineered, self-sustaining bioremediation techniques



DNA-based Detection of Pathogens

Approach

This research initiative employs the sensitive molecular diagnostic technique, polymerase chain reaction (PCR), in the analysis of bison blood and other environmental samples.

Objective

- Development of rapid, reliable, and sensitive assays to be used in screening the wild bison population in Yellowstone for *Brucella abortus*, the causal agent of brucellosis.

Results

- Real Time PCR probes and techniques have been developed
- Technique also being applied to Elk in Idaho, working with State Vet
- New research adapting technique for homeland security applications

Summary

- **Bioscience Department does approximately \$5M R&D annually for DOE, other federal agencies, and industry**
- **Partnerships include other national labs, universities, and private sector**
- **Research focuses on national and regional issues**
- **Opportunities to advance Biotechnology in Idaho include:**
 - **Establish a regional biomining R&D center**
 - **Build bioinformatics and data sharing infrastructure**
 - **Revolutionize education for the next generation of biological scientists**