



U.S. Department of Energy
Office of Civilian Radioactive Waste Management



Ongoing and Planned Activities of the Office of the Chief Scientist – Science and Technology

Presented to:

Nuclear Waste Technical Review Board, Full Board Meeting

Presented by:

John L. Wengle

**Office of the Chief Scientist
U.S. Department of Energy**

January 24, 2007

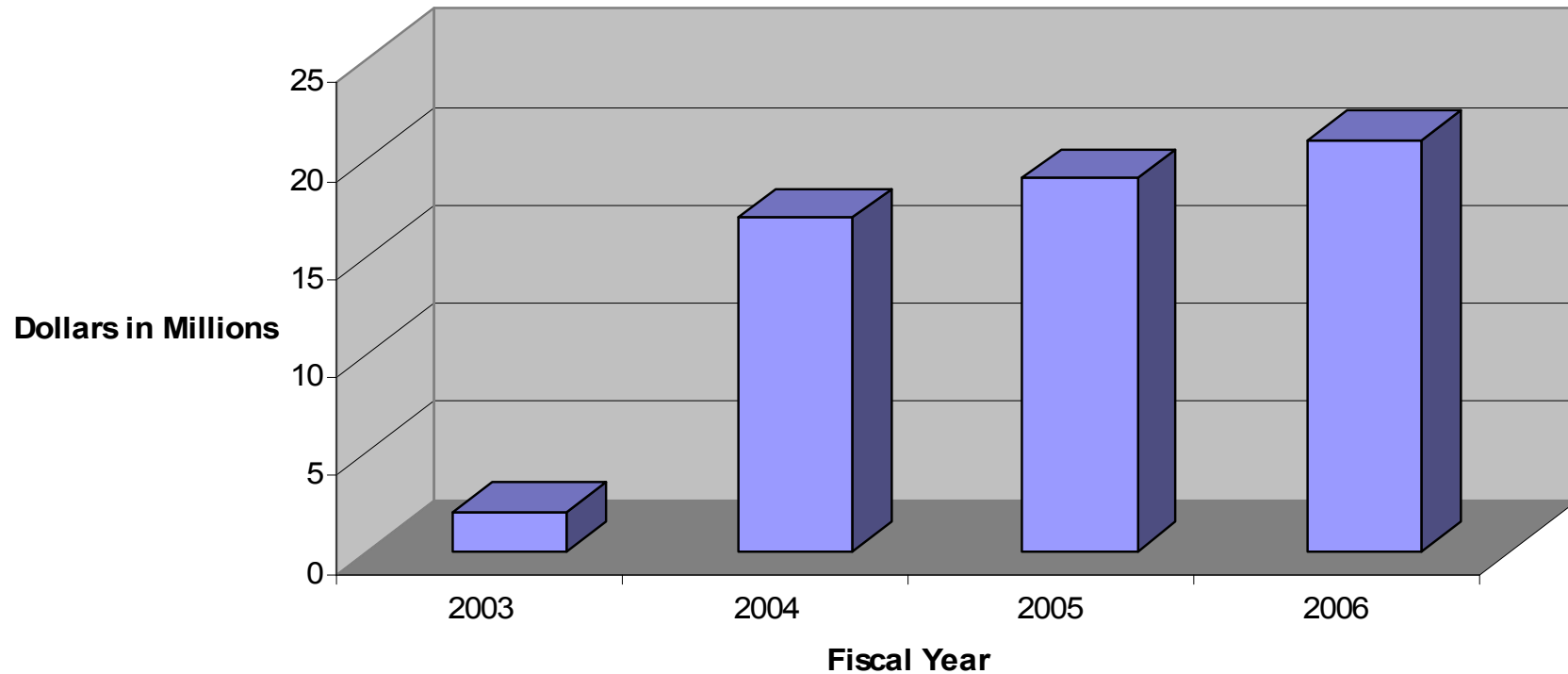
Las Vegas, NV

Overview

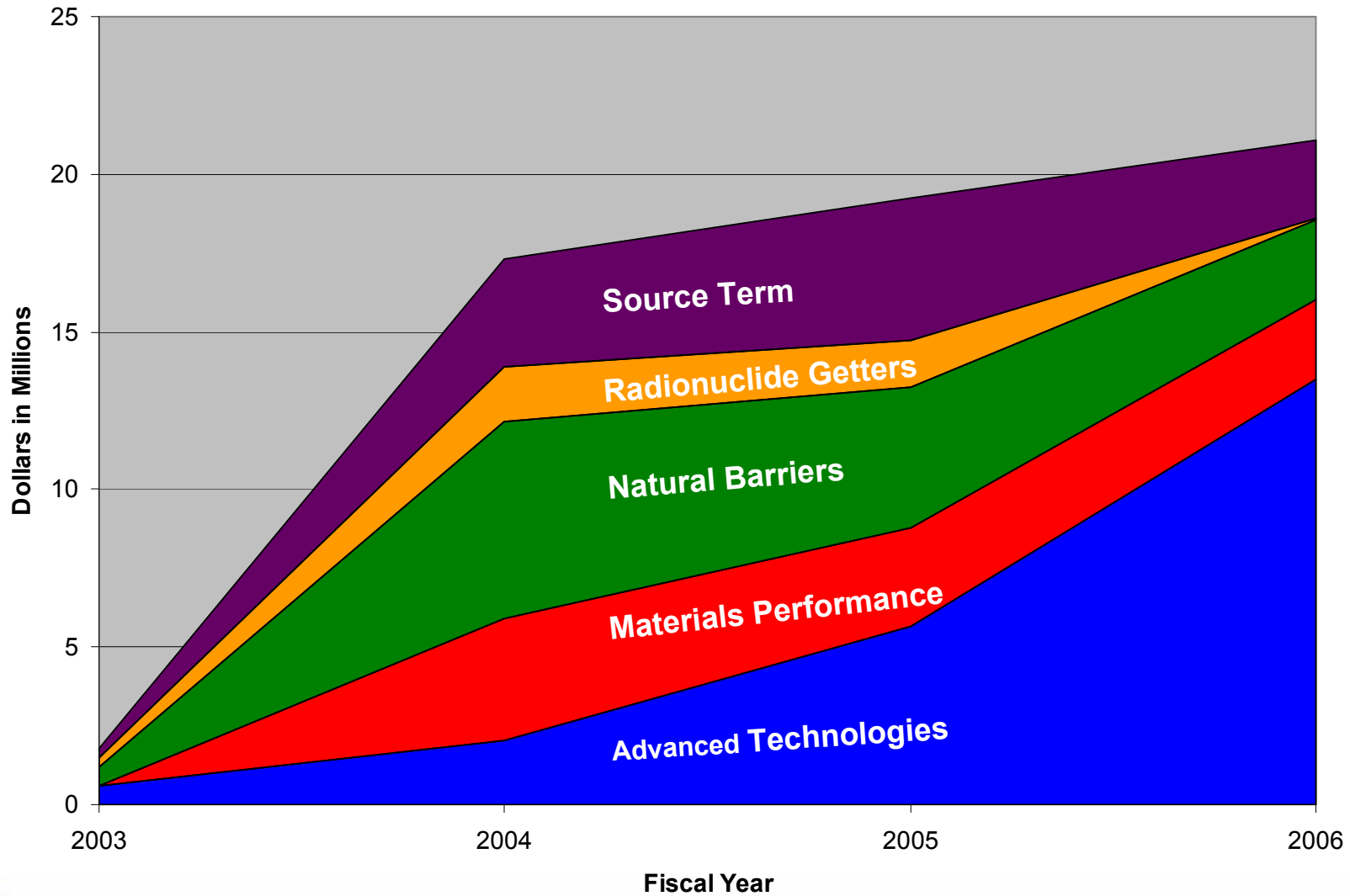
- **Science and Technology (S&T) Program Funding**
- **S&T Program Participants**
- **S&T Program Mission, Vision, and Drivers**
- **OCRWM Culture**
- **S&T Products, Interfaces, and Evaluation**
- **S&T Technical Research Areas**
- **Summary**



Historical S&T Program Funding



Historical Funding By Thrust



S&T Program Participants

Washington

Pacific Northwest National Laboratory
Washington State University

Idaho

Idaho National Laboratory
Nanosteel

California

Lawrence Berkeley National Laboratory
Lawrence Livermore National Laboratory
University of California, Davis
University of California, Berkeley
University of Southern California
BAE Systems
Pacific Gas & Electric

Nevada

University of Nevada, Reno
University of Nevada, Las Vegas
Desert Research Institute
Bechtel SAIC
Booz Allen Hamilton
Nye County

Arizona

Arizona State University

Colorado

United States Geological Survey

New Mexico

Los Alamos National Laboratory
Sandia National Laboratories

Michigan

University of Michigan

Minnesota

University of Minnesota
Itasca Consulting Group

Wisconsin

University of Wisconsin, Madison

Missouri

University of Missouri

Illinois

Argonne National Laboratory
Northern Illinois University
Illinois State Water Survey
Caterpillar

Indiana

Notre Dame University

Ohio

Case Western Reserve University
Ohio State University

Iowa

Iowa State University

Canada

University of Toronto
University of Western Ontario
Atomic Energy Canada Limited

United Kingdom

University of Manchester

New York

City University New York

Massachusetts

Massachusetts Institute of Technology

Pennsylvania

Pennsylvania State University
OLI Systems

Virginia

Virginia Tech University, Blacksburg
University of Virginia

New Jersey

Joseph Oat Corporation

South Carolina

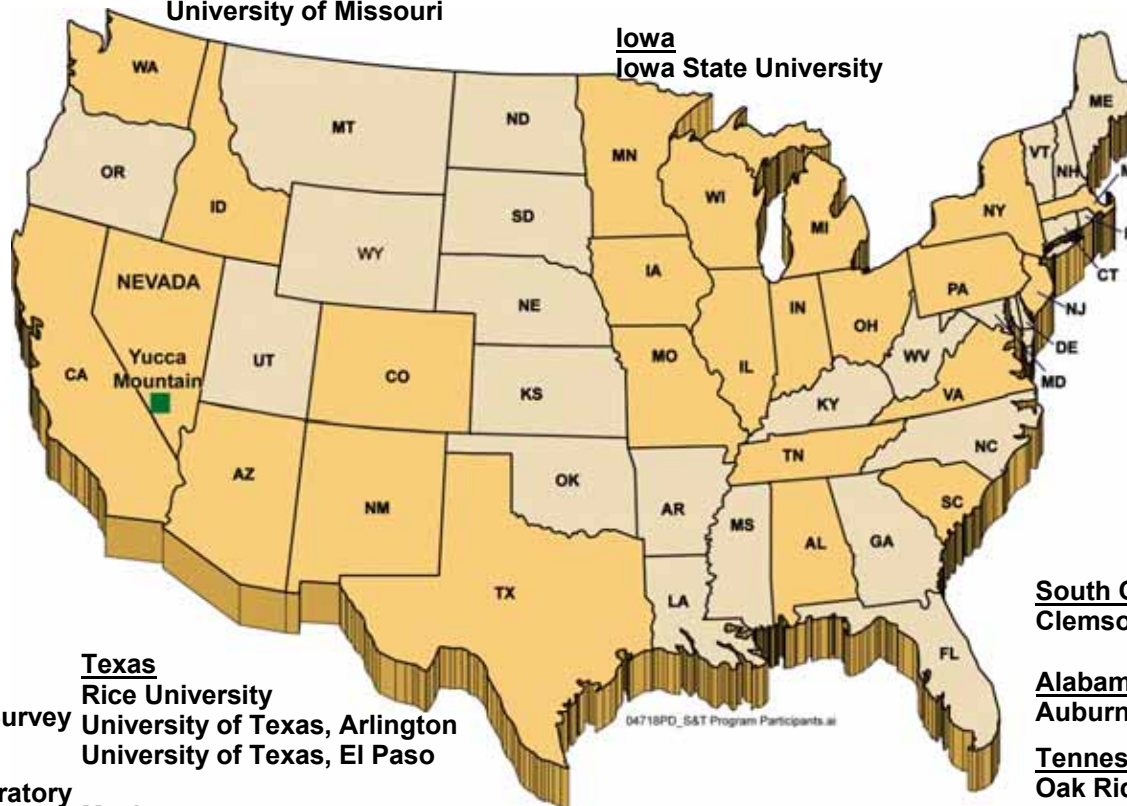
Clemson University

Alabama

Auburn University

Tennessee

Oak Ridge National Laboratory
University of Tennessee, Knoxville



■ Project Locations

Texas

Rice University
University of Texas, Arlington
University of Texas, El Paso

Mexico

Autonomus University of Chihuahua



S&T Program Mission, Vision and Drivers

- **Mission**

- **“Provide advanced science and technology to continually enhance our understanding of the repository system and to reduce the cost and schedule for the OCRWM mission.”**

- **Vision**

- **“OCRWM and the affected public will value the contributions that scientific and technological advances have made toward safer, more expeditious, and more cost-effective waste isolation.”**

- **Drivers**

- **Reduce costs**
- **Further understanding**
- **Enhance safety**
- **Keep current with nuclear industry best practices**



OCRWM's Director Cultural Change Initiative

- **OCRWM cultural values are**
 - **Safety**
 - **Integrity**
 - **Quality**
 - **Accountability**
 - **Teamwork**
 - **Continuous improvement**
- **Moving from an attitude of not wholly embracing a discretionary S&T Program to one of valuing challenges to the technical baseline**
- **Recognized as a valuable component in continuous improvement and teamwork**



S&T Products

- **Objective – dissemination of S&T products to a wide audience including OCRWM principal investigators, external organizations, academia, international community**
- **S&T products are conducted using a transparent and defensible scientific approach resulting in “good science”**
- **S&T products that need to be “qualified” will be done under the appropriate QA program and subject to external peer review**
- **Product dissemination**
 - **OCS annual science program review**
 - **Annual report**
 - **OCRWM website**
 - **Peer-reviewed journals**
 - **Technical symposia/conferences**
 - **Institutional reports**



Evaluating S&T Products

- **Lead Lab and M&O functions**
 - **New information evaluated for**
 - ◆ **Impacts on Features, Events, and Processes that may have been screened out of the performance assessment**
 - ◆ **Impacts on models**
 - ◆ **Impacts on input parameters for models**
 - **Evaluations may be qualitative or quantitative, and may focus on local aspects of process models or on overall system performance**
 - ◆ **Level of detail and complexity commensurate with significance of potential impact**
 - **Prepare an annual report on the potential impacts of new information**
- **For significant impacts, DOE evaluates possible need to update the license application, however at this time, it is not anticipated that any S&T data will be directly used in the technical basis of the license application**



Evaluating S&T Products

(Continued)

- **Data evaluation for**
 - Unexpected test conditions (e.g., Reportable Geologic Condition AP-REG-009)
 - “Outside” parameter and/or model uncertainty bounds
 - Indications that conceptual and/or numerical models could be enhanced
- **When the above occurs**
 - Condition Report (CR) generated
 - Causal analysis and corrective action plan initiated by Chief Scientist including S&T Program, M&O, and Lead Lab to assess impact (regulatory and technical)
 - CR dispositioned in Corrective Action Program



S&T Program Interfaces

S&T Program

OCS-RS&I

Lead Lab

Chief Scientist (R. Dyer)

Sr. Program Manager (A. Orrell)
Chief Scientist (P. Swift)

S&T Manager (J. Wengle)
Advanced Technologies
(J. Walker)

RS&I Manager (C. Newbury)
Project Specific

Chief Scientist (P. Swift)
Performance Confirmation
Manager (F. Hansen)

Source Term (M. Peters / R. Ewing)

Technical Lead (A. Van Luik)

Near Field Manager (G. Freeze)
Technical Lead (P. Brady)

Materials Performance (J. Payer)

Technical Lead (P. Russell)

Engineered Systems Manager
(C. Howard)
Technical Lead (D. Wall)

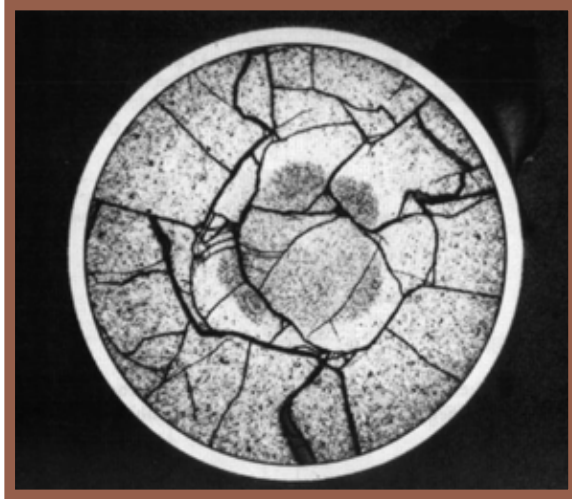
Natural Barriers
(Y. Tsang / D. Duncan)

Technical Leads
(D. Coleman/E. Smistad/M. Tynan)

Natural Systems Manager
(S. Kuzio)
Technical Lead (C. Ho)



Source Term Thrust



- **Objective – enhance the understanding of the release mechanisms of key radionuclides from spent nuclear fuel (SNF) and explore technical enhancements**
- **Four major research areas**
 - SNF dissolution mechanisms and rates
 - Formation and properties of U^{6+} secondary phases
 - Waste form – waste package interactions
 - Integration of in-package chemical and physical processes



Source Term Thrust (Continued)

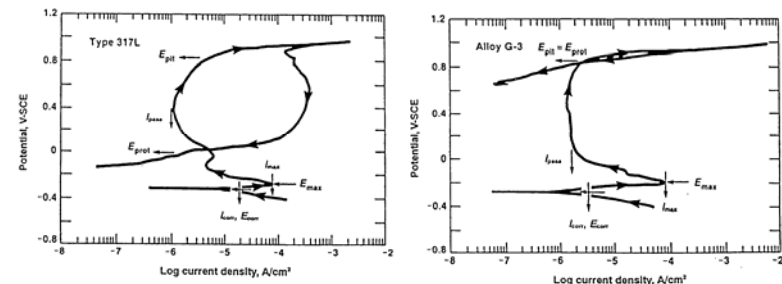
- **In FY05-FY06, a coordinated set of experimental and modeling projects was initiated to address source term issues**
 - Seven universities and six national laboratories
 - International collaborations established
 - Research program is focused on the changing conditions over time, investigating the critical processes within each time interval, and with attention to the radionuclides that are the potential major contributors to dose
 - Source Term efforts integrated with Natural Barriers and Materials Performance Thrusts to develop unified in-drift models, leading to enhanced understanding, greater transparency, and defensibility
- **In FY07 and FY08, the emphasis is on continued experiments and integration and consolidation of findings into process models to realize benefits of enhanced understanding of source term processes**
 - Deliverables are:
 - ◆ Determine processes of SNF dissolution
 - ◆ Determine processes of actinide and fission product incorporation into SNF alteration phases and EBS degradation products
 - ◆ Develop conceptual and numerical models for mechanistic, in-package chemical and physical processes
 - S&T product evaluation process will be implemented for all deliverables



Materials Performance Thrust

Key Topic Areas

- Long-term corrosion rate of passive metals, e.g. Alloy 22
 - 16,000 yrs/quarter at 0.1 $\mu\text{m}/\text{yr}$
- Damage evolution by localized corrosion
 - Crevice corrosion is most important
- Composition of moisture in contact with metal surfaces
 - Waste packages will not be immersed
 - Dust/particulate, deliquescence, seepage



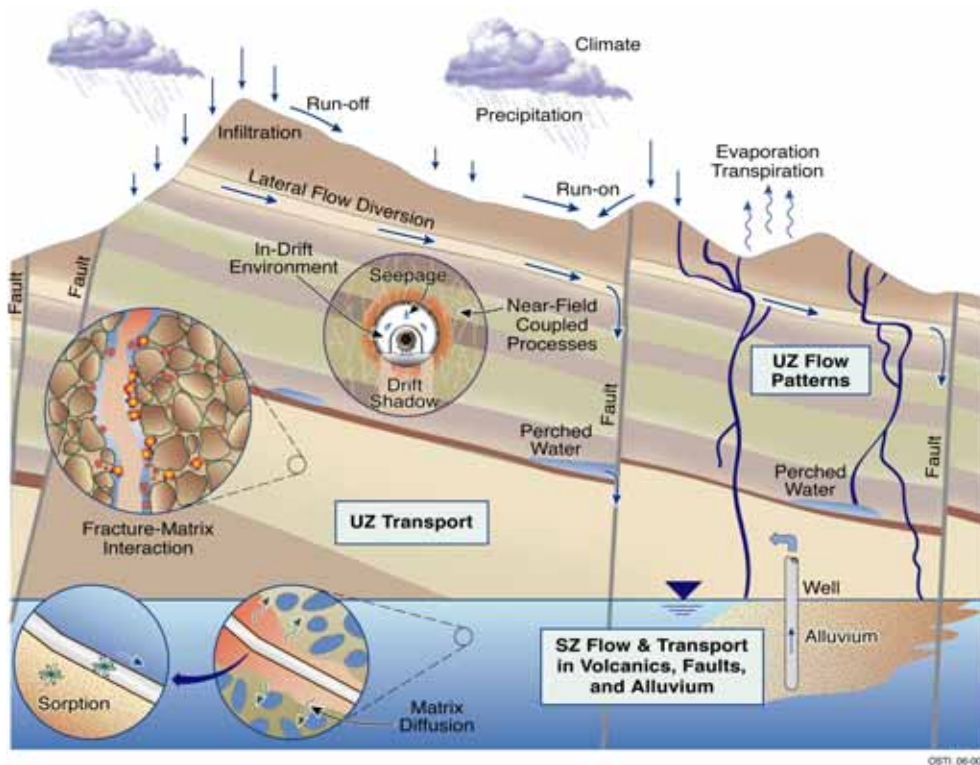
Materials Performance Thrust (Continued)

- **In FY05-FY06, a coordinated set of projects was initiated to address corrosion issues**
 - **Multi-University Cooperative**
 - ◆ **Cooperative Agreement DE-FC28-04RW12252; June 2004 to May 2009**
 - ◆ **9 Institutions, 14 Principal Investigators with ~20 grad students and researchers**
 - **National Laboratories**
 - **Materials Performance efforts integrated with Natural Barriers and Source Term to favor coupled and consistent treatment**
- **In FY07 and FY08, the emphasis is on integration and consolidation of findings into process models to realize benefits of enhanced understanding**
- **Deliverables are improved predictive capabilities for corrosion processes that impact**
 - **waste package (WP) failure rates and times**
 - **form and distribution of penetrations**
 - **radionuclide releases and doses**
 - **S&T product evaluation process will be implemented for all deliverables**



Natural Barriers Thrust

Objective: Enhance understanding of the natural system to support multiple-barrier concept for geological isolation of nuclear waste



Major research areas

- Seepage (emphasis on thermally-driven coupled processes)
- Near- and in-drift environment: closely integrated with the Source Term and Materials Performance Thrusts
- Drift Shadow
- Unsaturated zone (UZ) and saturated zone (SZ) transport-testing and modeling of physical and chemical retardation processes



Natural Barriers Thrust (Continued)

- **Research results are providing a better understanding of natural system performance**
- **FY06 scientific accomplishments**
 - 16 papers published and submitted to journals, 12 in preparation
 - 16 papers published in peer-reviewed conference proceedings, in addition to numerous conference talks and abstracts
- **Projects funded from the FY05 solicitation are progressing well**
- **Many projects funded prior to 2005 conclude in FY07, exceptions are the integrated thermal-hydrological-chemical (THC) in-drift modeling and the natural analog field studies on shadow zone, both are yielding promising results**



Advanced Technologies Thrust

- **Waste Package Technology**
 - **Materials – Iron-based structurally amorphous metal coatings**
 - **Reduced Pressure Electron Beam Welding**
- **Subsurface Operations**
 - **Construction Material – silica-based cements**
 - **Engineered Backfill as an Alternative Approach to Closure**
- **Surface Operations**
 - **Reduction of Seismic Hazard – nonlinear ground response model for extreme ground motions**



Summary

- **Our investment in S&T is generating additional insight into the potential performance of the repository's natural and engineered systems and the waste form**
- **Several potentially useful technology enhancements appear to have been identified and are being evaluated**
- **The diversity and quality of program participants brings new ideas and approaches to the forefront**
- **Call for proposals may be issued for FY08 new starts**
- **Fostering of cultural change and intellectual continuity**

