Sandia National Laboratories

Arid Environmental Technology Center

The Arid Environmental Technology Center at Sandia National Laboratories develops and applies technologies that solve subsurface environmental problems and protect water quality in arid regions. Benefits include reduced cost, time, and regulatory liability. This center provides a unique range of capabilities and experience specific to arid region subsurface environmental problems, spanning research, technology development, decision analysis, and site remediation.

Water - A Critical Resource in Arid Regions

Arid regions are one of the fastest growing population areas in the United States and other regions of the world. Integrity of water supplies in these areas are the focus of increasing attention and concern. Most U.S. environmental regulations are based on humid region conditions and technologies, and concentrate primarily on conditions beneath the water table with little or no consideration of conditions above the water table that play a critical role in many arid settings. Both the U.S. government (e.g. DOE, DOD) and private sector (e.g. petroleum, mining industries) have large numbers of facilities in arid regions, many of which are involved in major environmental pollution prevention and remediation efforts. Throughout the world, arid region issues related to water resources are important at national and multinational levels. Resolution of these types of fundamental issues are critical to long-term economic growth and, in some cases, resolution of disputes.

In situ sampling of hazardous constituents in the vadose zone in arid regions using Seamist™ technology

Sandia is a multiprogram laboratory operated by Sandia corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.

Sandia National Laboratories

Site Assessment and Remediation at Arid Sites

Application of many established characterization and remediation technologies developed for humid climates requires significant changes and/or alternative approaches for effective application to arid settings. Under arid conditions, physical and chemical conditions controlling contaminant migration, waste isolation, and subsurface remediation are fundamentally different in ways that render technologies for humid conditions ineffective, inefficient, and less reliable. For example, movement of water and contaminants above the water table is significantly different in thick unsaturated (vadose) zones because vapor-phase and fast-path, liquid-phase processes control transport. The chemical characteristics of the arid subsurface are different: pH is generally higher; carbon dioxide pressures are lower, but the supply is relatively large; fewer organic acids are present, but what is present may be more important. Geophysical imaging techniques are more complex because of the presence of salts (for electrical techniques) and variable moisture contents (for seismic techniques). These important underlying differences drive corresponding differences in the design and implementation of site assessments and remedial actions. The Arid Environmental Technology Center provides a single point of contact to a broad range of unique research, technology development, decision analysis, and site remediation capabilities that provide more effective solutions to arid region site assessments and remediation problems.

Full scale testing of alternative landfill covers for arid climates, designed and demonstrated by Sandia

Arid Environmental Technology Capabilities at Sandia

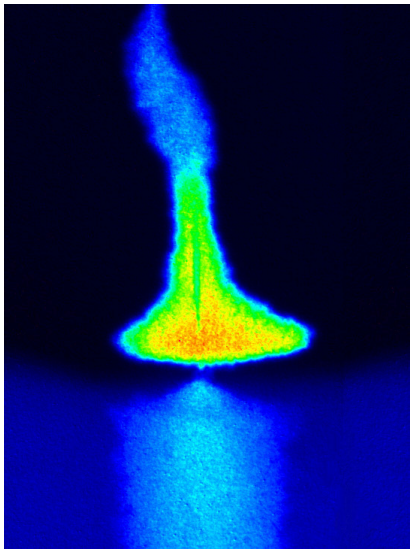
Research

Flow Visualization and Processes Laboratory research determines processes controlling flow and transport of water, vapor, and contaminants in fractured and heterogeneous porous media under partially saturated, fully saturated, and multiphase flow conditions.

Geochemistry research determines contaminant-mineral interactions that control retardation and natural attenuation of heavy metals and radionuclides in arid subsurface environments and for a variety of *in situ* remediation conditions.

Geophysics research develops enhanced techniques for cost effective geophysical imaging of subsurface contaminant location and migration in unsaturated, highly heterogeneous deposits.

Geomechanics research characterizes coupled mechanical-flow processes in stress sensitive media that may impact design of remedial actions.



Water finger in dry sand spreads across a micro-heterogeneity before entering sand drained to field capacity

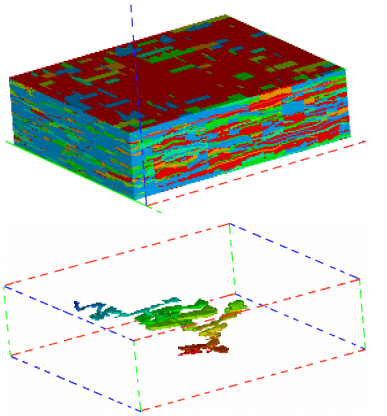
In situ electrokinetic remediation of heavy metals in the vadose zone developed at Sandia

Technology Development

Design, field testing, and performance evaluation develops advanced, cost effective, containment technologies (e.g., subsurface barriers and surface caps) for arid climate landfill and spill sites.

Design, field testing, and performance evaluation of *in situ* remediation technologies (e.g., electrokinetics, vapor extraction, and valence reduction) develops innovative, cost effective technologies for *in situ* treatment of hazardous contaminants within the unsaturated zone.

Design, field testing, and performance evaluation of innovative characterization, monitoring, and sensor technology systems (ranging from individual contaminant or geophysical property sensors to complete systems for entire site characterization or post-remediation monitoring) for application to arid sites.



Probabilistic simulation of geologic conditions (top) and chlorinated solvent migration (bottom) using new simulation approach on massively parallel computer

Decision Analysis

Simulation-based methodologies and tools are developed and tested to support risk-based decision making for highly regulated environmental problems (CERCLA, RCRA, radioactive waste disposal, D&D, UMTRA).

Innovative approaches for integrating cost/benefit into risk assessment, prioritizing site characterization, selecting and designing remediation strategies, and designing monitoring activities are developed as direct tools for decision makers to reduce cost and time required for remediation activities and resource management.

Extensive, real-site application of probabilistic performance assessment to radioactive waste disposal decision making at arid region sites (WIPP, Yucca Mountain, Greater Confinement Disposal Site) provide knowledge and experience base for development of second and third generation decision and assessment tools.

Implementation and Regulatory Interaction Strategies

Efficient and cost effective regulatory, technical, private-sector teaming, and public participation approaches have achieved accelerated assessment, remediation, and closure of a variety of hazardous and radioactive waste sites at Sandia.

Integrated, rapid turn-around capabilities link field sampling, chemical, and hydrologic environmental sample analysis with Geographic Information System data management.

Experience, research, and regulatory interactions resolving arid region site issues provide insight and strategy development for working in a regulatory climate that is primarily based on humid climate concepts.

Installation of landfill cap with geomembrane at Sandia field test site

Contacts

Sandia services are available to industry, government agencies, and international entities to develop cost-effective solutions to environmental problems in arid regions. Solution of specific problems are developed by drawing on the most appropriate tools from a broad range of unique capabilities. A variety of partnership opportunities are available to organizations who want to work with Sandia. Partnerships can take the form of shared research, licensed technology, consortia, cooperative agreements, technical assistance, or other mechanisms. As a DOE national laboratory, Sandia offers industry and other government agencies an unbiased, impartial atmosphere for research, development, testing, and evaluation, while providing protection for proprietary work.

For information on specific Arid Environmental Technology capabilities, contact:

Research

Erik K. Webb
Sandia National Laboratories
P.O. Box 5800, MS 0735
Albuquerque, New Mexico 87185

Phone: (505) 844-2479
Fax: (505) 844-7354
E-mail: ekwebb@sandia.gov

Technology Development

Susan Howarth
Sandia National Laboratories
P.O. Box 5800, MS 0719
Albuquerque, New Mexico 87185

Phone: (505) 284-4011
Fax: (505) 844-0543
E-mail: smhowar@sandia.gov

Decision Analysis

David Gallegos
Sandia National Laboratories
P.O. Box 5800, MS 1138
Albuquerque, New Mexico 87185

Phone: (505) 844-5277
Fax: (505) 284-3850
E-mail: dpgalle@sandia.gov

Implementation and Regulatory Interaction Strategies

Dick Fate
Sandia National Laboratories
P.O. Box 5800, MS 1089
Albuquerque, New Mexico 87185

Phone: (505) 284-2568
Fax: (505) 284-2617
E-mail: refate@sandia.gov