BARRIER MONITOR USING ELECTRICAL RESISTANCE TOMOGRAPHY

TECHNOLOGY NEED

The cost for remediation of contaminated soil and groundwater at U.S. Department of Defense (DoD) facilities has been estimated to exceed $200 billion. Similar remediation at Department of Energy (DOE) sites is estimated to significantly exceed DoD costs. Over 3,000 inactive waste sites are known to exist in DOE. A study by U.S. Environmental Protection Agency has demonstrated that a majority of landfills fail resulting in soil and groundwater contamination. A sensitive and flexible monitoring technology is needed to monitor the effectiveness of emplacing containment systems. Emplacing subsurface barriers to contaminant transport is a cost-effective approach to blocking contaminant migration. However, evaluating the performance of subsurface barriers is often difficult and a real-time, three-dimensional imaging system is needed to adequately assess their effectiveness.

TECHNOLOGY DESCRIPTION

Electrical Resistance Tomography (ERT) is a technology that can be used to monitor the subsurface for numerous contaminants. ERT has such broad applicability that it can do the job of several alternative technologies. For example, ERT can be used to detect leaks from tanks or waste ponds, monitor the progress of a steam flood, or image a subsurface barrier as it is being installed. The strategy is to image the subsurface before and after the barrier emplacement for comparison. The ERT technique being developed is based on the automated measurement and computerized analysis of electrical resistance changes caused by natural or man-made processes. For surface water infiltration, underground tank leaks, and steam heating during soil cleanup, ERT technology has been successfully demonstrated and transferred to industry.

The primary emphasis in FY 1998 is to demonstrate the ability of ERT to successfully monitor the emplacement and performance of waste migration barriers and to test a code for rendering ERT more user-friendly for site characterization. The first task is to complete the data analysis and interpretation from the imaging of the viscous liquid barrier emplaced at Brookhaven during the last part of FY 1997. The second task is to complete the fieldwork started in FY 1997 on the thin-wall barrier at Dover Air Force Base and complete the data analysis and interpretation. The third task is to plan and arrange for a field experiment to develop a method to map the extent of subsurface free-product DNAPL using cross borehole Electrical Impedance Tomography, an exciting new technology. The fourth task is to develop an automated ERT with an integrated hardware and software system, which will make subsurface monitoring with ERT simpler and less expensive.

BENEFITS

Since site characterization using ERT can do the job with about 67 percent less borings than conventional drilling and sampling methods:

- Risk to site personnel is reduced.
- Cost savings analysis has shown a reduction of 47percent.
- The time required for site characterization is cut at least 20 percent.

CAPABILITIES/LIMITATIONS

ERT has strong advantages over competing techniques:

- Provides unprecedented detail of subsurface structures and processes (its resolution is roughly equal to electrode spacing).
- Two- or three-dimensional imaging is possible.
- Updated survey images can be available in one to six hours.
- Effective at depths of 0 to 500 feet and on a size scale up to thousands of feet.
- Stainless steel electrodes are rugged, inexpensive, and easily emplaced. Electrode arrays can be inexpensively placed on the surface or underground using a cone penetrometer.

- Results have been demonstrated in both clay-rich and sandy soils.
- Works equally well in saturated or unsaturated soil or in hard rock.

The limitation is that ERT images map subsurface processes indirectly through the charge in resistivity due to surface processes. If multiple variables that affect resistivity (moisture level, temperature, water chemistry;) are all changing, it is difficult to deconvolute the contributions of any one variable.

COLLABORATION/TECHNOLOGY TRANSFER

ERT technology is currently being used by three companies for site characterization and remediation monitoring. The initial deployment of ERT for monitoring tank leakage and the deployment for barrier emplacement is expected to be done by these companies with likely consultation with this project's principal Investigators. The following complementary collaborations are being used for technology development and transfer:

- Yucca Mountain Site Characterization Project - Quantitative moisture mapping in fractured hard rock.
- Steam Tech - Automated, autonomous data collection and code development.
- University of Lancaster - Code development for leak detection and impedance imaging.
- Westinghouse Hanford/PNNL - Vadose zone monitoring and leak detection in single shell tanks.
- U.S. Bureau of Reclamation - Characterizing earthen dams.
- California Transit Authority - Imaging of pavement structures.

ACCOMPLISHMENTS

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TECHNICAL TASK PLAN (TTP) INFORMATION

TTP No./Title: SF14C221 - Subsurface Monitor Using Electrical Resistance Tomography

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DNAPL remediation project at commercial site in Visalia, California, where Electrical Resistance Tomography was deployed to monitor and control the remediation process.