File

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP), 2000 Conference
(20.01402.861)

DATE/PLACE: February 20–24, 2000.
Hyatt Regency, Crystal City, Virginia, USA

AUTHORS: David A. Farrell

DISTRIBUTION:

CNWRA	NRC-NMSS	SwRI Contracts
W. Patrick	J. Linehan	T. Nagy (Contracts)
CNWRA Directors	D. DeMarco	P. Maldonado
CNWRA Element Managers	B. Meehan	
	J. Greeves	
	J. Holonich	
	W. Reamer	
	K. Stablein	
	D. Brooks	
	B. Leslie	
	N. Coleman	

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP), 2000 Conference
(20.01402.861)

DATE/PLACE: February 20–24, 2000.
Hyatt Regency, Crystal City, Virginia, USA

AUTHOR: David A. Farrell

PERSONS PRESENT: International community of applied geophysicists representing various disciplines (gravity, seismic, electrical, electromagnetic, and magnetic among others). Attendance was approximately 1000 persons.

BACKGROUND AND PURPOSE OF TRIP:

This trip report summarizes the SAGEEP 2000 Conference held in Arlington, VA. The primary purpose of the conference is to allow applied geophysicists from a broad range of disciplines to present new concepts and applications that may be of interest to the geo-environmental community. Presentations ranged from applications of single techniques, such as seismic, gravity, and magnetics, to more integrated approaches that combined several approaches. Although a variety of disciplines were represented, electrical and electromagnetic methods formed the basis of most of the presentations. Within these disciplines there was considerable discussion regarding the application of inverse tomographic methods for mapping subsurface properties. In keeping with the theme of the conference most presentations focused on environmental and engineering problems.

U.S. Nuclear Regulatory Commission (NRC) and Center for Nuclear Waste Regulatory Analyses (CNWRA) staff were actively involved in various aspect of the conference's organization. Abou-Bakr Ibrahim of the NRC acted as one the conference organizers, while Bret Leslie (NRC) and David Farrell (CNWRA) acted as session chairs. Bret Leslie co-chaired a session entitled "Site Characterization and Waste Containment", and David Farrell chaired a session entitled "Geophysical Studies-Site Characterization".

A copy of the conference proceedings may be obtained from David Farrell (dfarrell@swri.edu; Tel: 210-522-5208).

SUMMARY OF PERTINENT POINTS:

There were two presentations specific to Yucca Mountain. One by Tim Daley et al. (Lawrence Berkeley National Laboratory) and the other by David Farrell et al.

Daley et al. presented work related to a surface–to–tunnel seismic survey designed to map fracture intensity and distribution in the units (mainly the middle-nonlithophysal unit of the Topopah Spring tuff) surrounding the potential nuclear waste repository at Yucca Mountain. The survey consisted of 161 source locations, covering 5 km at 30 m spacing, along Yucca Mountain ridge, and 224 receivers, covering 3 km at 15 m spacing, along the exploratory studies facility. Using the seismic data generated, two-dimensional tomographic images of velocity and attenuation were developed for the repository horizon. Using various assumptions, the velocity tomographs were converted to fracture-density tomographs. The results of the fracture-density tomographs showed the distribution of fractures within the potential repository site. The results indicated (i) the repository horizon appears to be heterogeneously fractured, with the southern part of the surveyed area being more intensively fractured than the northern part; (ii) the alignment of fractures varies from the north to the south; and (iii) the East-West Cross-Drift appears to be in an area of very little fracturing.

Farrell et al. presented work related to two geophysical surveys performed in the Yucca Mountain region, (i) a magnetic survey designed to map the tuff- valley-fill contact, and (ii) an integrated electromagnetic/electrical-resistivity/induced polarization survey designed to map the watertable and the near-surface geologic structure.

The magnetic survey was performed along Fortymile Wash, extended from north of well J-13 to approximately 1–2 km north of NC-EWDP-Washburn 1X. Models fitted to the data indicate a south dipping interface between the tuff and overlying valley-fill beneath the southern part of Fortymile Wash. Superimposing the watertable on the developed model allowed the transition of the watertable from the tuff to the valley-fill to be approximated. The approximate distance from the respository location is 15.5 km.

The electromagnetic/electrical-resistivity/induced polarization surveys were performed at several general locations in the Yucca Mountain region, (i) the Fortymile Wash/NTS region, (ii) the Amargosa Desert region, and (iii) the southern part of the Fortymile Wash, parallel to U.S. Highway 95. Watertable estimates from the surveys generally showed good agreement with measured watertable elevations at nearby wells and indicated no significant hydraulic gradients in the regions surveyed. The surveys also indicated the subsurface resistivity in the region to be quite heterogeneous, reflecting spatially varying thicknesses of clays, sands and tuff units.

Members of the U.S. Geological Survey (USGS) expressed interest in the resistivity work. Since returning from the conference, I have received a paper from Jeffrey Roberts at the USGS which details electrical conductivity measurements performed on cores taken from the Topopah Spring tuff at Yucca Mountain [Water Resources Research, 33(4), 1997, p. 577-58].

Geophysics in Federal Agencies

A session on the use of geophysics by federal agencies was convened. Among the federal agencies participating were the USGS, the Defense Threat Reduction Agency (DTRA), the Defense Advanced Research Projects Agency (DARPA), and U.S. Bureau of Land Reclamation.

The presentations by the USGS focused on several geophysical surveys performed by the agency. The most interesting of these surveys was performed in the Rio Grande Basin, NM. In this survey both electromagnetic and aeromagnetic surveying techniques were applied to address concerns about water resources in this region (http://rmmcweb.cr.usgs.gov/public/mrgb/airborne.html). The survey delineated several faults as well as a pipeline with cathodic protection. Using the aeromagnetic data the electrical current flow along the pipeline

was estimated. The computed estimate compared favorably with known current flow along the pipeline. The USGS also presented geophysical work by one of its sub-divisions, the Branch of Geophysical Applications and Support (BGAS; cf. http://water.usgs.gov/ogw/bgas). Recent applications of geophysics by BGAS include (i) identification of fracture flow in bore holes that are equipped with collapsible liners and packer assemblies, (ii) monitoring of tracer test and remediation activities, and (iii) characterization and mapping of sediments in shallow-water environments.

DTRA's presentation provided information about the agency and its applications of geophysics. DTRA was established approximately 16 months ago, and is made up of the Defense Special Weapons Agency (formerly the Defense Nuclear Agency), the On-Site Inspection Agency, the Defense Technology Security Administration, and elements of the Secretary of Defense. One of the missions of DTRA is arms control treaty monitoring in accordance with the U.S. Department of Defense requirements. As part of its monitoring activities, DTRA funds geophysical research in the areas of hydro-acoustics, infrasonics, radionuclide detection, and seismology.

DARPA investigates science and technology applicable to characterizing underground facilities such as orientation of, and depth to underground structures, and operation tempo of underground facilities. To accomplish these goals DARPA employs geophysical techniques. The focus of geophysical activities at DARPA is to define the performance limits for various techniques and to evaluate of the improvement in information from combining several methods.

The U.S. Bureau of Reclamation uses geophysics (i) to aid design, (ii) for safety analysis, and (iii) to improve facility performance. Geophysics is commonly applied to (i) seepage, piping, and internal corrosion of structures, (ii) liquefaction, (iii) foundation characterization, and (iv) determining regional geologic structure. The bureau is also utilizing geophysics in its risk analyses. In this activity, geophysics is used to (i) estimate confidence limits, (ii) better characterize loading conditions on structures, and (iii) provide site specific data on which to formulate engineering judgements. Geophysical research activities currently being pursued by the bureau include seismic tomography, electrical resistivity tomography, seismo-electric effects, and seepage evaluation using temperature measurements.

Other Presentations of Note

Several applications of electrical resistivity tomography (ERT) were presented. Some of the more interesting hydrological applications were presented in a suite of presentations by Douglas LaBrecque of SteamTech, and co-workers. Among the suite presentations were applications of ERT to infiltration monitoring and modeling.

DUALEM presented a recently developed portable, single user, EM system (DUALEM-4) for measuring subsurface electrical conductivity. The application of the instrument is similar in principle to the application of the GEONICS EM-31 class of instruments. The external design of the DUALEM-4 is similar to the GEONICS EM-31 class of instruments, however, the internal design of the two instruments differ. Unlike the GEONICS EM-31 class of instruments, the DUALEM-4 contains two receivers, that allow it to measure electrical conductivity simultaneously to depths of approximately 2.3 m and 6.0 m. To date, this instrument has not been widely employed in environmental surveys.

Several presentations explored the use of geophysics for subsurface void detection. Maris and coauthors presented work related to the application of EM and ground penetrating radar to subsurface imaging of voids

(snake dens in Narcisse, Manitoba) in karstic limestones. Phillips and coworkers applied spectral methods to analyze surface waves in an attempt to identify voids in the subsurface. In their approach, the spectral density of the surface wave is directly measured and analyzed using an oscilloscope. Powers and coworkers presented work related to automatic waveform interpretation of ground penetrating radar data to detect void spaces beneath concrete highways.

Hodges presented work related to helicopter EM surveys designed to characterize the apparent subsurface electrical conductivity in regions where pipelines were to be located. The survey was performed over an area approximately 130 km × 400 m. Ground conditions of interest included the depth to shallow bedrock and the presence of high electrical conductivity units that may enhance pipeline corrosion.

Finally, Scuilly and co-authors presented a paper outlining the application of geographic information systems (GIS) to the management and evaluation of remedial activities at a site in New Jersey.

CONCLUSIONS:

Overall, the meeting was well attended and sessions were very informative in both an academic and a practical sense. In many of the sessions, ideas were presented which are applicable to many problems encountered at Yucca Mountain. Participation in the meeting should be encouraged.

SIGNATURES:

David A. Farrell — 4/20/2000
Geohydrology and Geochemistry

CONCURRENCE:

English C. Pearcy — 4/19/2000
Manager, Geohydrology and Geochemistry

Budhi Sagar — 4/21/2000
Technical Director