CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Fall American Geophysical Union Meeting (20.01402.861)

DATE/PLACE: December 10–14, 2001; San Francisco, California

AUTHOR: R. Fedors, L. Browning, L. McKague, D. Pickett, and S. Painter

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PERSONS PRESENT:

Randy Fedors, Lauren Browning, David Pickett, Scott Painter, David Ferrill, Brittain Hill, and H. Lawrence McKague of the Center for Nuclear Waste Regulatory Analyses (CNWRA) participated in the American Geophysical Union Fall 2001 meeting held in San Francisco, California, December 10–14, 2001. More than eight thousand earth and planetary scientists, including many representatives of universities, national laboratories, and the U.S. Geological Survey attended the meeting.

BACKGROUND AND PURPOSES OF TRIP:

The purposes of this trip were to present CNWRA and Nuclear Regulatory Commission (NRC) research to the scientific community and to assess methods, tools, and conclusions presented by other researchers that could be useful to meet the objectives of CNWRA and NRC. The American Geophysical Union Fall Meeting is also an excellent place for interviewing prospective candidates for hydrology and geology positions at CNWRA.

MEETING SUMMARY:

Recruitment

L. McKague interviewed a number of prospective hydrologists, seismologists, and volcanologists for future employment at the CNWRA. A total of 22 applications were received from 20 students, including 8 from hydrologists, 4 from seismologists, 2 from volcanologists (1 also counted in seismologist category), 7 for the quantitative geologist position, and 1 that would be suitable for a post-doc structural geologist position. Several were rejected after review of their résumés. Six were interviewed. In addition, another two were invited to interview, but never reestablished contact. In general, there appeared to be more interest in interviewing and seeking jobs than in past years. Several students near graduation indicated they would prefer a job to a post-doc position. All but one appeared to be interested in learning more about Southwest Research Institute/CNWRA.

McKague also gave a presentation in the special session "Geoscience Graduate Degrees: Preparation for a Global Market?" entitled "Working for a not-for-profit Research and

Development Organization in the Earth Sciences." The session was divided into two parts. In the first part, several speakers reviewed employment data submitted to American Geophysical Union by recent graduates for the period 1995 to 2000. One basic conclusion was that the period time between completion (graduation) of a degree and finding a job decreased by more than 50 percent between 1995 and 2000. The total length of time spent in a post-doc programs also decreased over the same period. In the second part of the session, four speakers addressed the job market from the perspective of an employer. Speakers were from Southwest Research Institute, Shell, C&C Technology (a marine survey company), and the University of Washington. Basically, most organizations want technically sound employees, but there is much more interest in good communicators and team players. The Shell speaker stated that they would provide the advanced technical training, and preferred to hire people who were trained or experienced in the soft sciences.

Presentations and Posters

Selected topics pertinent to CNWRA's objective of evaluating Department of Energy's characterization of Yucca Mountain and anticipated engineered barrier design for the potential repository are discussed in the following paragraphs.

A poster by K. Smith (University of Neveda-Reno) discussed the results of earthquake relocation in the Yucca Mountain region. The relocations of earthquakes, in the period between 1992 and 2000, were a result of a high density of seismic stations active in that time frame as analog stations were phased out and digital stations introduced. The relocations tend to more narrowly define the seismic zones in the region, with the Rock Valley Fault zone continuing to dominate the seismicity near Yucca Mountain. One new trend that appeared as a result of the relocations was a narrow 100 km long north-south band of seismicity along the west side of Bare Mountain. This zone appears to bound the west side of the north-south southern Nevada gravity low. A similar but less well defined trend occurred along the east side of the gravity low. In addition, small magnitude earthquakes tend to outline the Timber Mountain caldera. This suggests that minor adjustments may still be taking place along the caldera borders in the deeper parts of this mid- to late-Miocene caldera system, perhaps as a result of density contrasts in the lower crust or upper mantle.

A. Flint and others, J. Blainey and others, and J. Hevesi and others presented different aspects of the U.S. Geological Survey bucket model for estimating shallow infiltration, INFIL, as applied to arid southwest of the United States. This is the same model used to predict shallow infiltration for use as input for the unsaturated zone and saturated zone models at Yucca Mountain. In addition to applying the model to the Yucca Mountain area and the Death Valley watershed, INFIL has also been applied to the Great Basin, which includes most of Nevada and parts of Utah, California, Arizona, Idaho, and Oregon. Flint and others presented a general discussion of the primary drivers for shallow infiltration. Precipitation, soil thickness, and soil and bedrock permeability play important roles in dictating whether evapotranspiration can extract water before gravity drainage can move water down the porous media column. Long-term records of meteorology are needed as input because shallow infiltration events are estimated to occur once every few years; short-term records may not be indicative of long-term records and short-term averages of simulation results may be biased. Meteorological data, primarily precipitation and temperature, are the most important drivers for shallow infiltration. Blainey and others discussed the difficulties of using spatially distributed precipitation data from the PRISM model

and from interpolations of the existing meteorological stations. The PRISM model creates precipitation maps at 4-km pixel resolution. Hevesi and others pointed out that runoff from steep slopes into colluvial wedges was an important location regionally for shallow infiltration that eventually becomes recharge. This environment is analogous to the upper washes above the repository block at Yucca Mountain where runoff from steep slopes feed runon to small colluvial wedges, thin alluvium, or bare bedrock channels. Additionally, the INFIL model does not account for precipitation occurring on channels, hence infiltration would be underpredicted in channels.

D. Woolhiser, R. Fedors (CNWRA), and S. Stothoff simulated rainfall-runoff using the kinematic wave approximation and Smith-Parlange infiltration model, instead of the simple routing between pixels and the plug-flow assumption implicit in the bucket model of INFIL. The KINEROS2 model used by Woolhiser and others explicitly includes channel elements and is currently being modified to include rainfall directly on channel elements. The KINEROS2 model includes only the upper Split Wash watershed and uses much finer temporal resolution of precipitation (15 minute) than the Flint and others model (2-hr resolution in the summer and 12-hr resolution in the winter). About 30 percent of the area in the upper Split Wash watershed has significant runon according to the results of Woolhiser and others, which is approximately the same as calibrated value in the Flint and others model for similar watersheds. In another comparison of results from the two models, the overall average shallow infiltration rates are approximately the same, however, the distribution appears to differ. The Flint and others model predicts less channel infiltration in the upper wash channels that directly overlie the repository as compared to the Woolhiser and others model.

J. Wilson and others (New Mexico Tech) presented work on fault characterization in the Bandolier Tuff near Los Alamos National Laboratory and the Calico Hills Formation at Busted Butte. Six categories of fault types were delineated by nature of deformation. Mechanical grain deformation and fracturing associated with faults in nonwelded to partially welded tuff should lead to increased capability to conduct water vertically under unsaturated conditions in near vertical faults. Fedors and others (CNWRA) focused more on the effect of fractures in conducting water through the nonwelded Bishop Tuff, an analog of the nonwelded PTn at Yucca Mountain. Field dye tracer tests in the Bishop Tuff exhibited a 2-fold increase in vertically conducted water and tracer transport in fractured nonwelded tuffs as compared to unfractured nonwelded tuffs. For unsaturated conditions, fractures (filled or open) will cause a focusing of flow in the matrix. This focusing effect will be more prominent for low dip angle fractures than for vertically oriented fractures, such as were part of the dye tracer test. Both the Wilson and others and Fedors and others work are important for understanding unsaturated flow through the PTn. The current reliance on the PTn for spatially and temporally dampening focused, episodic flow is the basis for the steady state flow assumption at Yucca Mountain. The assumption of steady state is uncertain because of the presence of ^{36}Cl below the PTn and the dilute water chemistry of the perched water and the water entering the saturated zone under Yucca Mountain.

W. Dam (NRC) helped organize a special session titled "Environmental Colloids," which was comprised of oral and poster sessions on Thursday. G. Hornberger (University of Virginia) opened the oral session with a description of field experiments designed to study the dynamics of colloids in the vadose zone, but the remainder of the oral session focused on colloid-facilitated radionuclide transport. S. Painter presented CNWRA sensitivity analyses designed to address the significance of kinetics for radionuclides sorption on colloids. The methods developed will be

used to assess future Department of Energy (DOE) modeling studies. D. Pickett (CNWRA) presented a poster on the regulatory significance of colloidal assisted transport. P. Reimus described recent Los Alamos National Laboratory experiments on Pu(V) and Pu(IV) sorption on colloids. These were meant to address issues related to plutonium migration at the Nevada Test Site, but also have significance for the Yucca Mountain Project. A. Wolfsberg (Los Alamos National Laboratory) described modeling studies of colloid assisted transport at the Nevada Test Site. T. Schaefer (Institute for Nuclear Waste Management, Germany) described laboratory studies demonstrating the importance of humic content, iron phases, and kinetics to colloidal americium transport. An invited presentation on colloid-assisted transport at the proposed Yucca Mountain repository was canceled.

Highlights of the afternoon Environmental Colloids poster session included presentations of Yucca Mountain Project studies. Some posters were directly relevant to Key Technical Issue NRC/DOE agreements. A poster by Anghel and others (Los Alamos National Laboratory) claimed that carboxylate-modified latex microspheres are appropriate for field tests for predicting colloid mobility. Kung and others (Los Alamos National Laboratory) presented new data on colloid concentrations in the alluvial aquifer along the Yucca Mountain flow path. A poster by G. Moridis (Lawrence Berkeley National Laboratory) presented semianalytical models that suggest, for example, potentially more rapid plutonium colloidal transport than shown by other models. Other posters discussed analytical approaches and modeling techniques. A poster on the basis for NRC interest in colloids, presented by CNWRA staff, was well received and generated significant discussion. The session provided a useful forum for NRC/CNWRA staff to observe the latest Yucca Mountain Project results and discuss the most up-to-date approaches to colloidal transport issues with staff from other institutions.

E. Sonnenthal (Lawrence Berkeley National Laboratory) gave an invited presentation entitled, "Effects of Water-Rock Interaction on Unsaturated Flow in Heterogeneous Fractured Rock" in a Friday session on the dynamic behavior of preferential flow channels due to coupled processes. This was a review of his published work on Yucca Mountain, but introduced a modification to the active fracture model. The modification adjusts the initial estimate of reactive surface area to allow for more realistic assessment of reaction progress in the unsaturated condition near residual saturation. Application of the modified active fracture model led to the conclusion that preferential flow pathways in the unsaturated zone may initiate due to mineral precipitation preferentially clogging small-aperture fractures first.

S. Levy, S. Chipera, and M. Snow (Los Alamos National Laboratory) presented a poster entitled, "In-Progress Sampling for Rock Alteration in an Underground Thermal Test, Yucca Mountain, Nevada." These authors used a new sidewall-sampling tool to collect mineral deposition samples from the boiling zone of the Drift Scale Heater Test. The main conclusion of the work was that textural and mineralogical observations support the local migration of dissolved silica. Coupled thermal-hydrological-chemical models used by the Department of Energy in the Supplemental Science and Performance Analyses document indicate that silica mobilization and reprecipitation is probably inadequate to produce a significantly thick silica cap above the repository drift.

P. Dobson and T. Kneafsey (Lawrence Berkeley National Laboratory) presented a poster describing numerical simulations of tuff dissolution and precipitation experiments. The experiments were designed to evaluate mineral dissolution by condensate in fractured tuff. Tuff-

equilibrated waters were percolated through a hydraulic aperture of 31 microns in a block of welded Topopah Spring Tuff. The temperature at the top of the column was 80°C, and the outlet temperature was fixed at 130°C. Within 5 days, the fracture began to seal with amorphous silica. Numerical simulations using the TOUGHREACT code predicted a 2 order of magnitude decrease in fracture permeability in less than 6 days, consistent with results of their laboratory experiments.

IMPRESSIONS/CONCLUSIONS:

The Fall American Geophysical Union meeting continues be a prime avenue for research staff to gain credibility in the scientific community by presenting research and interacting directly with national and international scientists. Discussions with meeting participants consistently have resulted in useful insights into CNWRA research topics and alternative modeling and approaches that will aid staff in the review of Yucca Mountain Project documents.

PROBLEMS ENCOUNTERED:

None.

PENDING ACTIONS:

None.

RECOMMENDATIONS:

None.

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