CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Unsaturated Zone Interest Group (UZIG) Meeting (20.06002.01.131)

DATE/PLACE: October 8-10, 2003
Pacific Northwest National Laboratory
Richland, Washington,

AUTHORS: Chandrika Manepally

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PERSONS PRESENT:

Participants in this meeting included several researchers and modelers from the U.S. Geological Survey, Pacific Northwest National Laboratory, Nuclear Regulatory Commission (Hans Arlt) Lawrence Livermore National Laboratory, Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, Desert Research Institute, U.S. Department of Agriculture's Agricultural Research Service National Sedimentation Laboratory, University of Nevada, the State of Idaho, Washington State University, and Stanford University.

BACKGROUND AND PURPOSE OF TRIP:

The Unsaturated Zone Interest Group was created within the U.S. Geological Survey to facilitate communication and collaboration among scientists involved in unsaturated zone investigations throughout the organization. In the early years, nearly all of the participants were from the U.S. Geological Survey. However, as the group has evolved, attendance by researchers from outside the U.S. Geological Survey has steadily increased. The meeting now includes attendees from many different organizations. The main objective of this trip was to share information with various researchers regarding work related to unsaturated flow.

SUMMARY OF PERTINENT POINTS:

Issues associated with unsaturated flow are an important part of flow studies at Yucca Mountain. At this meeting, investigators shared issues and concerns regarding various unsaturated flow topics including presently available methods of modeling unsaturated flow and characterization of unsaturated flow regions. As the meeting was hosted by Pacific Northwest National Laboratory, many presentations focused on the research work associated with the Hanford site characterization and modeling. This trip report appendix contains a copy of the oral and poster presentation schedule. Further details including Unsaturated Zone Interest Group's past and future activities, and membership contact information can be obtained from the website at http://mn.water.usgs.gov/uzig/index.html.

SUMMARY OF ACTIVITIES:

Oral and poster presentations were scheduled for the first two days followed by a field trip to the Hanford site and the Environmental and Molecular Sciences Laboratory at Pacific Northwest

National Laboratory. Participation in the field trip was not possible becauseof site access restrictions on foreign nationals. There was no formal proceedings for this meeting. A copy of the meeting schedule has been attached to the report and a summary of all the abstracts can be obtained from the author.

Roy Gephart (Pacific Northwest National Laboratory) provided an overview of Hanford and cleanup issues facing the nuclear weapons complex. His presented extensive information regarding the history of the site and current issues associated with Hanford's management, environment, radiation, waste, cleanup, and economics. Further details can be obtained from his book titled *Hanford: A Conversation About Nuclear Waste and Cleanup.* Raz Khaleel presented a talk about the methodology used to estimate effective unsaturated media properties for Hanford sediments. This approach involves representing a heterogeneous unsaturated medium by its homogeneous equivalent; stochastic theory-based analytical formulas and numerical Monte Carlo simulations are used to obtain upscaled (effective) flow and transport properties. George Last (Pacific Northwest National Laboratory) discussed the use of lithofacies mapping to estimate the spatial structure of physical and chemical transport properties.

John Nimmo's (U.S. Geological Survey) presentation focused on preferential flow in unsaturated media and the speed of macropore flow based on the available field and laboratory evidence. His study was based on 36 published field tests involving macropores and other preferential channels, and concluded that the values of maximum transport speed vary surprisingly little. Analyses indicated that the supply of water that generates the flow significantly affected transport speed. A sporadic supply of water at the land surface, as from natural rainfall, causes markedly slower preferential flow than a continuous supply, as from steady irrigation. Laboratory experiments were used to explain and support these field results. Visualization studies showed that unsaturated macropore flow occurs in four distinct modes, descriptive names for which are film, continuous rivulet, snapping rivulet, and pulsating blob. To degrees that vary among these flow modes, imposed changes in normally dominant influences such as driving force and water content seem to cause less change in water and solute fluxes than conventional theory predicts. Compensating mechanisms that cause this behavior may also cause field observations to vary little in maximum transport speed. Collectively these results suggested, in contradiction to Darcy's law, that there may be a natural speed limit for water in unsaturated macropores. Such a limit would seem to depend mainly on basic earth and water properties. The generalization that certain transport speeds are nearly constant for similar water input conditions, even if true only in an approximate sense, could facilitate the prediction of worst-case contaminant travel times and other quantities of hydrologic importance.

David DiCarlo's (Agricultural Research Service) talk pertained to the constant flux infiltrations into confined porous media (laterally smaller than the finger diameter, thus essentially 1-dimensional) that are found to produce saturation overshoot identical to that found in gravity driven fingers. This work showed that saturation overshoot ceased below a certain minimum infiltrating flux. This minimum flux depended greatly on the grain sphericity and initial water content of the media and slightly on the grain size. The observed saturation overshoot was inconsistent with a continuum description of porous media, but qualitatively matched observations and predictions from discrete pore-filling mechanisms. This suggested that pore-scale physics controls saturation overshoot and in turn gravity driven fingering.

David Stonestrom (U.S. Geological Survey) presented results from a DC-resistivity profiling study of ground-water recharge near the Amargosa Desert Research Site, Nevada. The apparent resistivity cross sections obtained from the sites complemented and extended borehole and surface studies of spatial and temporal subsurface water flow and helped to define both thickness and extent of distinct alluvial layers.

Kari Winfield's (U.S. Geological Survey) poster focused on a multiple linear regression analysis used to construct simple property-transfer functions for estimating the water retention curve for deep sediments at the Idaho National Engineering and Environmental Laboratory. Maria Caputo (U.S. Geological Survey) presented a poster showing laboratory measured unsaturated hydraulic conductivity and water retention properties for porous carbonatic rock based on Wind's evaporation method and quasi-steady centrifuge method. David Hudson and Tom Kostalek (U.S. Geological Survey) presented a poster on the Large Plot Test from the Alcove8-Niche 3 location at Yucca Mountain. The fractures within the large plot were mapped prior to the start of infiltration. They found a high correlation (0.95) between mapped fractures and infiltration rate.

CONCLUSIONS:

This meeting was an effective opportunity to interact with researchers involved with flow in the unsaturated zone. Such exchanges enhance staff's understanding of issues relating to unsaturated flow and transport at a potential repository at Yucca Mountain. More specifically, information from this meeting will improve our reviews of unsaturated flow/seepage model, preferential flow in fracturers, and characterization of the unsaturated properties of the hydrostratigraphic units in the unsaturated zone. It is also a good platform to present unsaturated zone studies at CNWRA to receive peer community feedback.

PROBLEMS ENCOUNTERED:

None.

PENDING ACTIONS:

None.

RECOMMENDATIONS:

Recommend presenting work related to unsaturated flow and transport studies at CNWRA in future UZIG meetings.

SIGNATURES:

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Title

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