A REALIST'S VIEW OF FLUID TRANSPORT MODELING AT YUCCA MOUNTAIN

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WHY MODEL TRANSPORT

- Complexity of Processes
- Regulatory Requirements
- Uncertainties May Be Estimated
- Experiments/Data Collection May Be Optimized

WHAT IS A MODEL

- Model is a Conceptual Approach to the Coupled Transport in Hetergeneous Media Under Influences of:
  - A. Gravity Forces
  - B. Surface Forces
  - C. Bouyancy Forces
  - D. Thermal Forces
  - E. Tectonic Forces
  - F. Osmotic Forces
  - G. Others ?
- Model is NOT a Computer Program!!

WHAT PROCESSES (Currently Known) NEED TO BE MODELED TO ESTIMATE TRAVEL TIME

- Liquid Flow in Both Porous and Fractured Media
- Chemical Transport (Advection, Diffusion, Sorption, Decay) in Liquid Phase
- Gaseous Transport (Diffusion, Advection, Convection)
- Heat Transport (Conduction, Convection)
- Rock Mechanics (Stress/Strain, Hydrofracturing)

All Five Processes Are Highly Coupled!

SCP PERFORMANCE ASSESSMENT METHODOLOGY

"Darcian flow with dispersion in fractured porous media is the process that will be used as a baseline case to describe water movement through unsaturated and saturated hydrogeologic units."

SCP 8.3.5.12-11

Let's Examine the Baseline Understanding

UNCERTAINTIES IN FLOW

"The ability to characterize and model media composed of both a matrix and a fracture component is in the development stage."

Evans and Nicholson (1987)
AGU Monograph 42

"A major problem that must be faced is that of determining the location of all fractures and describing their properties. We can at most hope to describe the fractures and derive the properties of the network in a stochastic sense."

Witherspoon and Long (1987)
Symposium on Rock Mechanics

UNCERTAINTIES IN FLOW
(continued)

"Field experiments . . . . . called attention to the fact that the parallel plate assumption of a single fracture may be incorrect in describing the fluid moving through it."

Tsang and Tsang (1987)
WRR 23(3)

". . . The theoretical analysis has clearly shown that, in general, channel geometry and the frequency of channels have a very strong impact on the transport of dissolved species. Such data are largely not available."

Rasmussen and Neretnieks (1986)
WRR 22(8)

UNCERTAINTIES IN FLOW

(continued)

"One of the more important directions of future research is to explore the validity of the model assumptions and preferentially substitute them with more realistic ones."

Andersson and Dverstorp (1987)
WRR 23(10)

"A major message of this paper is our belief that present work on flow and transport lacks a unified approach that includes all pertinent physical, chemical, and biological processes operative in the unsaturated zone."

Nielsen, van Genuchten &
Biggar (1986)
WRR 22(9)

UNCERTAINTIES IN TRANSPORT

"The last decade (1976–1986) has seen rapid developments in theoretical research treating groundwater flow in a probabilistic frame work, but actual field application has been very limited."....

"New theoretical approaches will also be required to treat the extreme heterogeneity of some natural permeable media."

L. Gelhar
WRR 22(9)

"The conclusions show that the estimated dispersivity value is significantly affected by sampling procedures, sampling frequency, and monitoring network and that the classical advective dispersion equation provides adequate representation of column and field scale experimental data."

Moltyaner and Killey (1988)
WRR 24(10)

UNCERTAINTIES IN TRANSPORT

(continued)

"The stochastic convection–dispersion model has not yet proved useful in shedding fundamental light on the scale effect (of dispersion) . . . . The assumption of homogeneity and ergodicity in the random hydraulic conductivity function need more experimental verification. . . ."

Sposito, Jury & Gupta (1986)
WRR 22(1)

". . . . Inspection of the concentration (contaminants) spatial distributions in the two examples mentioned leads to the conclusion that it is extremely difficult, if not impossible, to predict accurately the point value of concentrations."

G. Dagan (1988)
WRR 24(9)

CONCLUSIONS

1. Current directions in flow and transport research are toward stochastic or probabilistic methods.

2. Stochastic methods require a detailed understanding of hydraulic property variation within the simulated region. Particular emphasis is on spatial correlation of properties.

3. Current theoretical approaches have not been significantly tested due to lack of controlled field experiments.

SCP DATA COLLECTION FOR GROUND WATER TRAVEL TIME

- 11 deep boreholes in the repository block for unsaturated zone data.
- 16 boreholes for the saturated zone for detailed hydraulic property data.
- 3 unsaturated boreholes in the Calico Hills unit beneath the repository block.
- 1 (2?) multiwell field tracer equipment (<100 meter scale) in the saturated zone.

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EDUCATION

B.S. Mechanical Engineering, University of Connecticut; Storrs, Connecticut - 1978

M.S. Hydrology, New Mexico, Institute of Mining and Technology; Socorro, New Mexico - 1983

MEMBERSHIPS

Pi Tau Sigma Honorary Society
American Geophysical Union
Soil Science Society of America
Chairman USDA Western Regional Research Project and Nevada Representative

EXPERIENCE

1983 - Present

Assistant Research Soil Scientist, Water Resources Center, Desert Research Institute. Specializing in water and contaminant transport through the vadose zone. Concurrently pursuing a doctoral degree in Hydrology at the University of Nevada, Reno.

Mr. Tyler is currently involved with the application of fractal mathematics to the understanding of transport behavior in heterogeneous soils and aquifers.

As task leader for DRI unsaturated zone studies at the Nevada Test Site, involved with research programs dealing with many forms of radionuclide migration in the vadose zone. These studies include subsidence crater moisture studies, flow and transport through fractured tuff and large scale tracer studies in unsaturated alluvium. These studies include the use of innovative drilling and sampling systems as well as detailed laboratory analysis.

Also involved with the assessment of radioactive waste disposal at Yucca Mountain in southern Nevada, the water supply potential and development programs for several clients in southern Nevada and subsurface monitoring in the vadose zone for hazardous waste and leaking underground storage tanks.

1982 - 1983

Research Engineer, Battelle Pacific Northwest Laboratory. Conducted research in the fields of waste disposal on ground-water quality. The following studies were completed at Battelle.

Project Manager of a two-year study for the evaluation of leachate production from closed hazardous waste landfills for the U.S. Environmental Protection Agency. The study included analytical and numerical analysis of the fluid flow characteristics of landfills as well as extensive field studies at operating landfills. This study provided data on the effectiveness of the regulations under the Resource Conservation and Recovery Act of 1976.

Also developed a set of analytical solutions to ground-water flow for verification and benchmarking of three-dimensional numerical ground-water flow codes. These solutions were prepared for use in the Basalt Waste Isolation Project (BWIP).

In order to simplify data input to saturated/unsaturated numerical ground-water flow codes, procedures and computer codes were prepared. The package allows the user to fit functional representations to experimental soil water characteristic data as well as generate partially saturated hydraulic conductivity data.

In support of the Uranium Mill Tailings Remedial Action Program (UMTRAP), prepared a document describing methodologies applicable to the design of leak detection and leak monitoring at line uranium mill tailings disposal sites. In addition, several uranium mill tailings pond liner and substrata designs to enhance lateral spreading of fluids for leak detection systems are discussed.

1978 - 1980 Sanitary Engineer, Connecticut Department of Health Services. Conducted investigations and overseeing of clean-up operations of public and private drinking water supplies contaminated by petroleum fluids, chlorinated organic compounds, and heavy metals. These contaminations were the result of industrial discharges, sanitary landfill leachates, and leaking chemical storage tanks. In addition, duties included inspection and sampling of public water supplies in compliance with the Safe Drinking Water Act. While with the State of Connecticut, participated and completed the U.S. Environmental Protection Agency's Surface Impoundment Program for the State.

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