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APR 8 1985

JH/85/03/26

- 1 -

MEMORANDUM FOR: John T. Greeves, Acting Chief
 Engineering Branch, WM

Malcolm R. Knapp, Chief
 Geotechnical Branch, WM

Hubert J. Miller, Chief
 Repository Projects Branch, WM

FROM: Daniel J. Goode
 Geotechnical Branch, WM

Joel A. Hunt
 Engineering Branch, WM

SUBJECT: TRIP REPORT, 17th INTERNATIONAL ASSOCIATION OF
 HYDROGEOLOGISTS, JANUARY 7-12, 1985, TUCSON, ARIZONA

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The central theme of this Congress was "Hydrogeology of Rocks of Low Permeability." The papers represented a wide variety of approaches ranging from computer generation of fracture networks to regional studies for assessing vertical leakage. High-level waste repository siting studies and research from Canada, Sweden, Switzerland, France, and the U.S. received major attention.

Attached are some of the concepts that were presented and may have direct interest to the Division of Waste Management. Also attached is a list of papers that were presented. The proceedings will be published within three to four months.

LS

Dan Goode
 Geotechnical Branch, WM

LS

Joel Hunt
 Engineering Branch, WM

Attachments:
 As stated

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OFC	: WMEG <i>LS</i>	: WMGT	:	:	:	:	:
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JH/85/03/26/ATTACH.

- 1 -

Axel Mukurat, Norway, showed results from laboratory experiments where shear displacement of 1mm increased hydraulic conductivity along rough fractures by 2-3 orders of magnitude. He noted hysteresis of K versus stress and shear. A greater aperture did not correspond to volumetric flow rate (or K) increase.

Ron Green (NRC funded), University of Arizona, described a mechanism for aerosol transport of radionuclides in the unsaturated zone. He predicted a drying zone around waste and approaching steady state of thermal diffusion in 75 years. Estimated concentrations in waste required to meet EPA standards: If diffusion as in air; $7.8E-13$ Ci/cm³. If diffusion as in fissured rock; $1.7E-11$ Ci/cm³.

Gillan de Marsily, France, described coupling of percolation theory and fracture theory. He stresses: that each class of fractures must be studied individually, that colloidal transport along fractures can be faster than the average velocity, and that since fracture networks change shape and geometry with time fracture, network characterization may be meaningless.

Ivan Neretniks, Sweden, described the excellent ongoing program at Stripa. His description included the following observations: that only one fracture in ten conducts water at Stripa, that distinct transverse dispersion occurs laterally along channelled fractures, that matrix diffusion may be the totally dominating retardation factor, that fast channels or super conductors may play a dominant role in transport, and that the surface chemistry of clays in fractures will strongly effect transport.

Peter Fritz (Canada), S. Davis (University of Arizona), and B. Back (U.S.G.S), all stressed the importance of isotopic and chemical studies as means of extrapolating into both the past and geo-future. The need to understand reaction kinetics to predict mass transport was underscored.

Chin-Fu Tsang (Lawrence Berkeley Laboratory) described problems inherent with coupled processes expected to exist at repository sites. These included: decrease in fluid flow rates with time due to mineral precipitation, stagnation points that may result from multiple volume fluxes, a severe lack of chemistry data between 100°-250°C, and the difficulty in demonstrating reasonableness considering the slow processes and length of predictions.

J.E. Gale, Canada, reported results of many lab experiments on fracture flow in different size cores. The cubic law for flow was not appropriate for fractures with many contacts. The deviation increased with stress (pressure). The experiments were run with up to 4000 psi pressure. Gale also reported that turbulent flow conditions occurred in the fractures near the simulated

borehole. Monte-Carlo simulations were run with the NETWRK and NETFLO models. The equivalent porous media approach appeared to work for flow (flux) calculations.

Allen Moench, USGS, presented an analytical solution for open-hole and pressurized well tests with a finite thickness skin around the well. This skin is due to drilling. The conventional approach for this problem is to assume the skin has zero thickness, although its hydraulic properties are still included. Moench showed that the conventional approach is adequate for open-well tests due to the large storage volume, but that the analytical results deviate for pressurized well tests. He recommended running large volume (open-well) tests, but recognized the problem of extremely long times required for recovery in low permeability media.

Frank Spane, BWIP, reported results of over-pressure pulse and multi-step constant head pump tests at the DB2 well at Hanford. Tests were run before and after pumping 16,000 liters of drilling fluid into the borehole and then developing the well using 'standard' Hanford procedures. For phase I, prior to injection of drilling mud, the conductivities from the over pressure pulse test were more variable than K's from the constant head step test. For both techniques, S, storativity, was even more variable. K's ranged from $2E-11$ to $1E-12$ m/sec, with the step tests all within 1.1 to $1.4E-11$ m/sec. S was about $1E-6$. The only major difference after development (phase II), was an increase in S to $1E-5$. Again, K's from the step tests were all very similar. The conclusion was that drilling fluids have no effect on test results using standard development techniques. In response to questions, Spane offered no explanation for the increase in S, and stated that the development procedures used here are exactly like the standard techniques used at Hanford.

Ben Ross, Disposal Safety Inc., presented a modification to the Van der Kamp method which is more accurate for early time response of high transmissivity units. Ross reanalyzed RRL-2 data and got a better match.

Ken Raven, Chalk River Lab, Ontario, tested 90 intervals in 17 boreholes, and modeled with Snow's (?) model as 2D for site characterization Tracer tests gave smaller fracture apertures than the hydraulic tests. The most important transport pathway was in a subhorizontal fracture zone which could not be identified by surface techniques.

Gerry Grisak, GTC Ontario, described the deep drilling in Rhine River Valley for Swiss HLW program. As a result of this program, the estimated coal resources of Switzerland have increased 3 or 4 fold. Discovered a deep bedrock trough about 20 km wide. "Permeability decreases with depth . . . except where it doesn't." The gravity term was not constant in flow analyses. Used Graph

Theoretic Field Model (GFTM) and compared to Wang model (?). Field head measurements were found very sensitive to temp. Also used SWIFT.

Dan Reda, Sandia at NTS, presented the long term lab response of K tests on a core with one through-running fracture. Eighty percent of the flow was through the 1 micron fracture. Permeability of the rejoined core decreased over time to a final permeability of $1E-13$ m².

David Lee, Canada, reported borehole dilution technique to directly (?) measure flux into and out of a well. These results are much higher than very simple Darcy predictions. (Which is right?)

John Bredehoeft, USGS, described the importance of leakage through the Pierre Shale in South Dakota. The total through-flow of the Dakota sandstone aquifer is only 75 ft³/s. Most recharge and discharge is through the confining beds, not through outcrops. He could interpret the geochemistry of sulfate but found chloride impossible to work with.

Garth Van der Kamp, Canada, described how the excess head generated in a compacting bed underlying a tailings pile can function as a (temporary) hydraulic barrier; water will flow both downward and upward out of this aquitard. Compared mathematical model to actual field results from a pile in Canada.

Charlie Kreidler, ONWI, presented a regional model of Palo Duro. Lab K of evaporite was $1E-4$ md with overburden (this agrees with his model). The gravel wash acts as a drain for the system towards the Amarillo Uplift. This deep sink has generated hydrostatic heads higher in the shallow system. Using TRAVEL (Charbinau and Street 1976 2D) and FREESURF (Neumann and Witherspoon, cross-section) models, he estimated that 50 percent of the flow through the Wolfcamp comes from leakage, even with these low K's. The Mansfield and J. Friemel wells are not in geochemical equilibrium whereas the Zeck and Sawyer well are in equilibrium. The Chloride/Bromide ratio for most systems is 160-250; for systems with halite dissolution this ratio is 2400-3200. Zeck and Sawyer fall in the former range while Mansfield and Friemel look like dissolution. He presented cores showing massive re-crystallization about 1 m in width with bedded salt around it. If the salt cores are broken down into 1 ft sections, 10 percent of these sections contain fractures.

Bob Sterrett, ONWI, Paradox, reported test results from borehole GD-1. Observed a linear rise in pressure after shut-in, indicating non-standard behavior. Could be salt squeeze. All of pressure rise in test zone 3 due to salt creep. Creep is still occurring 2 years after the borehole installation. This probably implies that the borehole is deforming.

Phil Smith, Texas, used SAS package and performed statistical analysis of DST data for Palo Duro. Reported an "extremely normal log K distribution." The distribution is not as normal when broken into regions. Could determine not statistical difference between regions or lithologies. (?) Median d of 0.5 md.

Don Diego Gonzalez, ex-Sandia, WIPP, identified several anomalies with detailed investigation. He does not think that the aquifers overlying the repository are adequately understood. Effective porosity range from 0.0001 to 0.1. He observed a halite dissolution zone in the aquifers. Proposed future work: sorbing tracer tests and large scale (4 to 5 miles!) pumping tests.

Ed Weeks, USGS, described unsaturated vapor transport in sediments Carbon 14 is attenuated with depth, does not move as fast as predicted. Carbon dioxide movement was predicted well. He is running a vapor tracer test at Barnwell.

Marty Levin, South Africa, described the investigation of an arid site for LLW disposal. No apparent surface drainage on large scale. Water table is 50m deep; free water movement in only upper 4m; almost no percolation.

W.N. Herkelrath, NNWSI, reported 10 to 20 percent adsorbed water in equilibrium with vapor phase in tuff. He reported that thermodynamics are very important at low moisture contents. The surface areas derived from water experiments is about 3 times as high as areas determined from nitrogen experiments. Could not get experimental reproduction with shale; could with tuff.

Shlomo Neuman, Arizona, described a moderate size insitu pump test at Oracle, Arizona. He could not find a relationship between fracture density and log hydraulic conductivity. It may not be very important to measure density in terms of flow and transport. On this scale, the system seems to be behaving as an equivalent porous media for flow. The geometric mean conductivity from straddle packer tests was close to the results from a crosshole test. Discussed kriging and importance of conditional simulation.

Peter Clifton, BWIP, reported results of groundwater travel time calculations from Monte-Carlo simulations with variable transmissivity, and constant effective thickness and boundary heads. Median travel time was 21,500 years, with range from 1000 to one million years.

Gene Simpson, Arizona, described details of Oracle field tests. Doesn't feel that fracture systems with $K 10^{-11}$ cm/sec can be studied with converging tracer tests (too slow and borehole dewaterers); should use diverging tests with overpressure applied.

Graham, BWIP, described the effects of drilling fluid on well geochemistry. Even after recovery of 200 times the volume lost during drilling, carbon 14 values are still different than ambient. Most constituents are within 5 percent of original values after 5 fluid loss volumes removed. The "box dilution" model does not accurately predict recovery of well geochemistry.

Shlomo Newman (University of Arizona) questioned if we actually need to be able to characterize flow. While on the other hand, Paul Witherspoon (University of California, Berkeley) stressed the unique advantages of underground laboratories and suggested that adequate characterization would not be possible within the existing schedule deadlines.

17th INTERNATIONAL CONGRESS
INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS
JANUARY 7-12, 1985
TUCSON, ARIZONA, USA

REVISED PROGRAM SUMMARY

SESSION 1A: HYDRAULIC STUDIES IN IGNEOUS AND METAMORPHIC ROCKS

Monday Morning: 7 January 1985

Chaired By: D. A. Stephenson (Dames & Moore, Phoenix, AZ)

- 10:20 - 10:50: J. E. Gale (Canada)
HYDRAULIC PROPERTIES OF FRACTURES
- 10:50 - 11:05: A. F. Moench, P. A. Hsieh (USA)
ANALYSIS OF SLUG TEST DATA IN A WELL WITH FINITE THICKNESS SKIN
- 11:05 - 11:20: F. A. Spane Jr., P. D. Thorne (USA)
EFFECTS OF DRILLING FLUID INVASION ON HYDRAULIC CHARACTERISTICS
OF LOW PERMEABILITY BASALT HORIZONS - A FIELD EVALUATION
- 11:20 - 11:35: B. Ross (USA)
THEORY OF THE OSCILLATING SLUG TEST IN DEEP WELLS
- 11:35 - 11:50: L. S. Leonhart, A. H. Lu, S. M. Baker (USA)
STRATEGY AND SEQUENCING OF HYDROLOGIC CHARACTERIZATION OF THE
COLUMBIA RIVER BASALTS
- 11:50 - 12:00: Discussion

SESSION 1B: HYDRAULIC STUDIES IN IGNEOUS AND METAMORPHIC ROCKS (Continued)

Monday Afternoon: 7 January 1985

Chaired by: P. A. Hsieh (U.S. Geological Survey)

- 1:30 - 2:00: G. E. Grisak, J. F. Pickens, J. D. Avis (Canada)
PRINCIPLES OF HYDROGEOLOGIC INVESTIGATIONS AT DEPTH IN CRYSTALLINE ROCK
- 2:00 - 2:15: K. G. Raven, J. A. Smedley, R. A. Swezey, K. S. Novakowski (Canada)
FIELD INVESTIGATIONS OF GROUNDWATER FLOW IN A 100 METRE-SIZE BLOCK
OF FRACTURED GRANITIC GNEISS
- 2:15 - 2:30: D. C. Reda, G. R. Hadley (USA)
SATURATED PERMEABILITY MEASUREMENTS ON PUMICE AND WELDED-TUFFACEOUS
MATERIALS
- 2:30 - 2:45: A. Makurat (Norway)
THE EFFECT OF SHEAR DISPLACEMENT ON THE PERMEABILITY OF NATURAL
ROUGH JOINTS
- 2:45 - 3:00: D. R. Lee (Canada)
SEMI-QUANTITATIVE MEASUREMENT OF WATER FLOW THROUGH FRACTURED
CRYSTALLINE ROCK USING THE BOREHOLE-DILUTION TECHNIQUE
- 3:00 - 3:10: Discussion

SESSION 2A: HYDRAULIC STUDIES IN SEDIMENTARY ROCK

Monday Afternoon: 7 January 1985

Chaired By: P. G. Smith (Stone & Webster, Boston, MA)

- 3:30 - 4:00: J. D. Bredehoeft, C. E. Neuzil, P. C. D. Milly (USA)
REGIONAL FLOW IN THE DAKOTA AQUIFER: A STUDY OF THE ROLE OF
CONFINING LAYERS
- 4:00 - 4:15: J. H. Black, D. C. Holmes, J. Alexander, M. A. Brightman (UK)
THE ROLE OF LOW-PERMEABILITY ROCKS IN REGIONAL FLOW SYSTEMS:
THE HARWELL AREA STUDY
- 4:15 - 4:30: G. Van der Kamp, H. Maathuis (Canada)
EXCESS HYDRAULIC HEAD IN AQUITARDS UNDER SOLID WASTE EMBLACEMENTS
- 4:30 - 4:45: A. Barari, L. Hedges (USA)
MOVEMENT OF WATER IN GLACIAL TILL
- 4:45 - 5:00: E. D. Smith, N. D. Vaughan (USA)
EXPERIENCE WITH AQUIFER TESTING AND ANALYSIS IN FRACTURED LOW
PERMEABILITY SEDIMENTARY ROCKS EXHIBITING NONRADIAL PUMPING RESPONSE
- 5:00 - 5:10: Discussion

SESSION 2B: HYDRAULIC STUDIES IN SEDIMENTARY ROCK (Continued)

Tuesday Morning: 8 January 1985

Chaired by: Jack Robertson (Weston Designers & Consultants, Rockville, MD)

- 8:00 - 8:30: C. W. Kreitler (USA)
HYDROLOGIC CHARACTERIZATION OF AN EVAPORITE AQUITARD
- 8:30 - 8:45: R. J. Sterrett, R. A. Nelson (USA)
IMPACT OF BOREHOLE DEFORMATION ON HYDROGEOLOGIC TESTING IN SALT
- 8:45 - 9:00: P. G. Smith, G. W. Page, J. K. Downing (USA)
REGIONAL LITHOPERMEABILITY DETERMINATIONS FOR THE PERMIAN BASIN AREA
OF TEXAS AND NEW MEXICO
- 9:00 - 9:15: L. W. Picking, D. E. Wilton (USA)
TESTING THE HYDRAULIC CHARACTERISTICS OF LOW PERMEABILITY CARBONATES,
PALO DURO BASIN, TEXAS
- 9:15 - 9:30: H. Speelman, J. N. Breunese (The Netherlands)
DETERMINATION OF POROSITY AND PERMEABILITY OF LOW-PERMEABLE
UNCONSOLIDATED MARINE TERTIARY DEPOSITS IN THE NETHERLANDS
- 9:30 - 9:45: D. D. Gonzalez (USA)
HYDRAULIC STUDIES IN LOW PERMEABILITY EVAPORITE DEPOSITS, SOUTHEASTERN
NEW MEXICO (SENM)

SESSION 3: FLOW AND MASS TRANSPORT IN UNSATURATED ZONE

Tuesday Morning: 8 January 1985

Chaired By: D. D. Evans (University of Arizona)

- 10:20 - 10:50: E. P. Weeks (USA)
METHODS FOR ESTIMATING GASEOUS DIFFUSION PARAMETERS IN THE UNSATURATED ZONE
- 10:50 - 11:05: M. Sophocleous, C. A. Perry, N. Shaukat (USA)
UNSATURATED FLOW AND GROUND-WATER-RECHARGE DYNAMICS IN SHALLOW AQUIFERS: A FIELD-EXPERIMENTAL APPROACH
- 11:05 - 11:20: M. Levin, B.Th. Verhagen (South Africa)
SOIL MOISTURE STUDIES IN THE UNSATURATED ZONE AT THE SOUTH AFRICAN NUCLEAR WASTE REPOSITORY FACILITY
- 11:20 - 11:35: W. N. Herkelrath, C. F. O'Neal II (USA)
WATER VAPOR ADSORPTION IN LOW-PERMEABILITY ROCKS
- 11:35 - 11:50: R. T. Green, D. D. Evans (USA)
RADIONUCLIDE TRANSPORT AS VAPOR IN UNSATURATED FRACTURED ROCK
- 11:50 - 12:00: Discussion

SESSION 4A: FLOW AND MASS TRANSPORT IN SATURATED ZONE

Tuesday Afternoon: 8 January 1985

Chaired By: K. G. Raven (NHRI Environment Canada)

- 1:30 - 2:00: G. de Marsily (France)
FLOW AND TRANSPORT IN FRACTURED ROCKS: CONNECTIVITY AND SCALE EFFECT
- 2:00 - 2:15: C. J. Duffy, S. Sangani (USA)
THE IMPACT OF LOW PERMEABLE MARINE STRATA ON GROUNDWATER AND STREAM SALINITY IN THE UPPER COLORADO RIVER BASIN
- 2:15 - 2:30: G. R. Walter (USA)
NONADVECTIVE TRANSPORT PROCESSES IN ROCKS OF VERY LOW PERMEABILITY
- 2:30 - 2:45: C. C. Davison, V. Guvanasekera (Canada)
HYDROGEOLOGICAL CHARACTERIZATION, MODELLING AND MONITORING OF THE SITE OF CANADA'S UNDERGROUND RESEARCH LABORATORY
- 2:45 - 3:00: S. P. Neuman, E. S. Simpson, P. A. Hsieh, J. W. Jones, C. L. Winter (USA)
STATISTICAL ANALYSIS OF HYDRAULIC TEST DATA FROM FRACTURED CRYSTALLINE ROCK NEAR ORACLE, ARIZONA
- 3:00 - 3:10: Discussion
- 3:10 - 5:10: POSTER SESSION: Poster Session shall take place in room adjacent to meeting room.

SESSION 4B: FLOW AND MASS TRANSPORT IN SATURATED ZONE (Continued)

Wednesday Morning: 9 January 1985

Chaired By: F. L. Doyle (U.S. Department of Interior)

- 8:00 - 8:30: I. Neretnieks (Sweden)
TRANSPORT IN FRACTURED ROCKS
- 8:30 - 8:45: K. Cartwright (USA)
EFFECTIVE TRANSPORT POROSITY (EFFECTIVE PORE VOLUME) OF SOME
FINE-GRAINED SEDIMENTS
- 8:45 - 9:00: P. M. Clifton, B. Sagar, R. G. Baca (USA)
STOCHASTIC GROUNDWATER TRAVELTIME MODELING USING A MONTE CARLO
TECHNIQUE
- 9:00 - 9:15: J. J. Cullen, K. J. Stetzenbach, E. S. Simpson (USA)
FIELD STUDIES OF SOLUTE TRANSPORT IN FRACTURED CRYSTALLINE ROCKS
NEAR ORACLE, ARIZONA
- 9:15 - 9:30: K. S. Novakowski (Canada), G. V. Evans (UK), K. G. Raven (Canada)
FIELD EXPERIMENTS INVESTIGATING RADIONUCLIDE MIGRATION IN
PLUTONIC ROCK
- 9:30 - 9:40: Discussion

SESSION 5A: HYDROGEOCHEMISTRY AND ENVIRONMENTAL ISOTOPES

Wednesday Morning: 9 January 1985

Chaired By: Austin Long (University of Arizona)

- 10:20 - 10:50: W. Back (USA)
GEOCHEMICAL SIGNIFICANCE OF AQUITARDS
- 10:50 - 11:05: H. R. Henry, G. P. Whittle, T. A. Carlton, R. J. Graves (USA)
EFFECTS OF HAZARDOUS WASTE CHEMICALS ON THE PERMEABILITY OF ROCK AND
CLAY CONTAMINANT CONTAINMENT MEDIA AS RELATED TO THE TRANSPORT
OF POLLUTANTS TO GROUNDWATER
- 11:05 - 11:20: D. L. Graham, R. W. Bryce, D. J. Halko (USA)
A FIELD TEST TO ASSESS THE EFFECTS OF DRILLING FLUIDS ON
GROUNDWATER CHEMISTRY COLLECTED FROM COLUMBIA RIVER BASALTS
- 11:20 - 11:35: W. J. Stone (USA)
RECHARGE THROUGH CALCRETE
- 11:35 - 11:50: K. R. Bradbury, D. E. Connell, R. G. Hennings (USA), D. S. Desaulniers
(Canada)
GROUNDWATER MOVEMENT THROUGH CLAYEY TILL, NORTHWESTERN WISCONSIN, USA
- 11:50 - 12:00: Discussion

SESSION 5B: HYDROGEOCHEMISTRY AND ENVIRONMENTAL ISOTOPES (Continued)

Wednesday Afternoon: 9 January 1985

Chaired By: Austin Long (University of Arizona)

- 1:30 - 2:00: P. Fritz (Canada)
THE USE OF ENVIRONMENTAL ISOTOPES IN REPOSITORY STUDIES
- 2:00 - 2:15: S. Gifford, H. Bentley (USA)
CHLORINE ISOTOPES AS ENVIRONMENTAL TRACERS IN COLUMBIA RIVER
BASALT GROUNDWATERS
- 2:15 - 2:30: J. W. Hess, R. L. Jacobson (USA)
ROLE OF ENVIRONMENTAL ISOTOPES AND GEOCHEMISTRY IN STUDYING ROCKS
OF LOW PERMEABILITY - WITH APPLICATIONS TO SEMI-ARID AREAS
- 2:30 - 2:40: Discussion

SESSION 6A: NUMERICAL AND ANALYTICAL MODELS OF MASS TRANSPORT

Wednesday Afternoon: 9 January 1985

Chaired By: John Wilson (New Mexico Inst. of Mining & Tech., Socorro, NM)

- 3:00 - 3:30: C. F. Tsang (USA)
MASS TRANSPORT IN LOW PERMEABILITY ROCKS UNDER THE INFLUENCE OF
COUPLED THERMOMECHANICAL AND HYDROCHEMICAL EFFECTS - AN OVERVIEW
- 3:30 - 3:45: W. S. Dershowitz, B. M. Gordon, J. C. Kafritsas (USA)
A NEW THREE DIMENSIONAL MODEL FOR FLOW IN FRACTURED ROCK
- 3:45 - 4:00: J. C. S. Long, H. K. Endo, K. Karasaki, L. Pyrak, P. Maclean,
P. A. Witherspoon (USA)
HYDROLOGIC BEHAVIOR OF FRACTURE NETWORKS
- 4:00 - 4:15: A. M. Shapiro (USA), J. Bear (Israel)
EVALUATING THE HYDRAULIC CONDUCTIVITY OF FRACTURED ROCK FROM
INFORMATION ON FRACTURE GEOMETRY
- 4:15 - 4:30: C. F. Tsang, J. Noorishad, P. A. Witherspoon (USA)
THE EFFECT OF DEFORMABILITY ON FLUID FLOW THROUGH A FRACTURED-
POROUS MEDIUM
- 4:30 - 4:45: K. Pruess, Y. W. Tsang, J. S. Y. Wang (USA)
MODELING OF STRONGLY HEAT-DRIVEN FLOW IN PARTIALLY SATURATED
FRACTURED POROUS MEDIA
- 4:45 - 5:00: Discussion

SESSION 6B: NUMERICAL AND ANALYTICAL MODELS OF MASS TRANSPORT (Continued)

Thursday Morning: 10 January 1985

Chaired By: P. A. Witherspoon (University of California, Berkeley)

- 8:00 - 8:30: L. W. Gelhar (USA)
STOCHASTIC ANALYSIS OF TRANSPORT PROCESSES IN HETEROGENEOUS ROCKS
- 8:30 - 8:45: B. Sagar, P. M. Clifton (USA)
STOCHASTIC GROUNDWATER FLOW MODELING USING THE SECOND-ORDER METHOD
- 8:45 - 9:00: L. Kiraly, I. F. Kimmeyer, P. Perrochet (Switzerland), R. W. Andrews (USA)
REGIONAL GROUND-WATER FLOW IN THE CRYSTALLINE ROCKS AND OVERLYING
SEDIMENTARY SEQUENCE OF NORTHERN SWITZERLAND
- 9:00 - 9:15: M. Th. van Genuchten (USA)
A GENERAL APPROACH FOR MODELING SOLUTE TRANSPORT IN STRUCTURED SOILS
- 9:15 - 9:30: H. K. Endo, P. A. Witherspoon (USA)
MECHANICAL TRANSPORT AND POROUS MEDIA EQUIVALENCE IN ANISOTROPIC
FRACTURE NETWORKS
- 9:30 - 9:45: F. W. Schwartz, L. Smith (Canada)
A NEW CONTINUUM APPROACH FOR MODELING DISPERSION IN FRACTURED MEDIA

SESSION 7: REGIONAL STUDIES

Thursday Morning: 10 January 1985

Chaired By: Jozsef Toth (University of Alberta, Canada)

- 10:20 - 10:50: M. R. Llamas (Spain)
HYDROGEOLOGY OF ROCKS OF LOW PERMEABILITY: REGIONAL STUDIES
- 10:50 - 11:05: E. Custodio (Spain)
LOW PERMEABILITY VOLCANICS IN THE CANARY ISLANDS (SPAIN)
- 11:05 - 11:20: P. Glasbergen (The Netherlands)
FLOW, ORIGIN, AND AGE OF GROUNDWATER IN SOME DEEP-LYING POORLY
PERMEABLE AQUIFERS IN THE NETHERLANDS: IMPLICATIONS FOR
GEOLOGICAL WASTE DISPOSAL
- 11:20 - 11:35: J. Alexander (UK)
REGIONAL GROUNDWATER SAMPLING FOR THE ASSESSMENT OF FLUID MOVEMENT
- 11:35 - 11:50: E. S. Bair, T. P. O'Donnell (USA)
HYDRODYNAMICS OF AQUIFERS AND AQUITARDS AT PROPOSED HIGH-LEVEL
NUCLEAR-WASTE REPOSITORY SITES, PALO DURO BASIN, TEXAS, USA