SUBJECT:

Consequences of "Fast" Pathways for Yucca Mountain

Conceptual/Numerical Modeling of Fast-Path Flow for Groundwater Travel Time Studies

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Importance of Fast Paths to Yucca Mountain Site Evaluation

- Ground Water Travel Time
  - Paths less than 1000 years may indicate failure of subsystem requirements
- Total System Performance Assessment
  - Fast paths may result in high doses or releases at the accessible environment

Current Efforts to Investigate Fast Paths

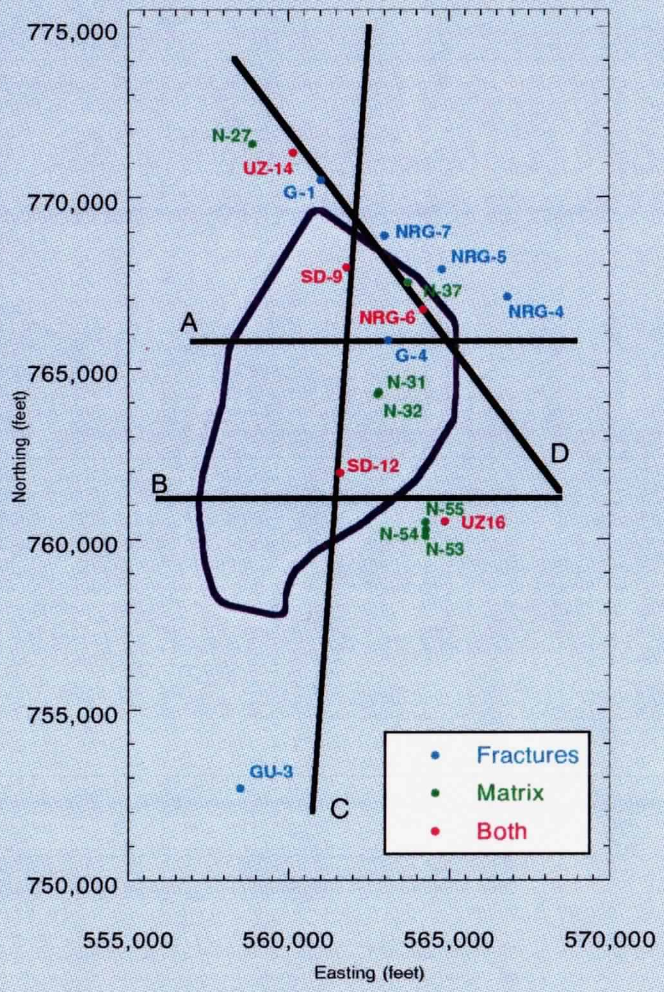
- "Phenomenological"
  - theoretical and experimental studies of flow channeling
- GWTT
  - Unsaturated Zone and Saturated Zone "water-particle" flow modeling
- TSPA (Hydrologic component)
  - geosphere represented as barriers
    - investigation of how fast paths impact efficacy of barriers
- Modeling efforts emphasize different
  - degrees of abstraction
  - scales

Update of Modeling for GWTT-95 Effort

- Geostatistical model domain
- Flow models
- Particle trackers
- Scenario screening
- Interactions with NRC staff

Model Domains

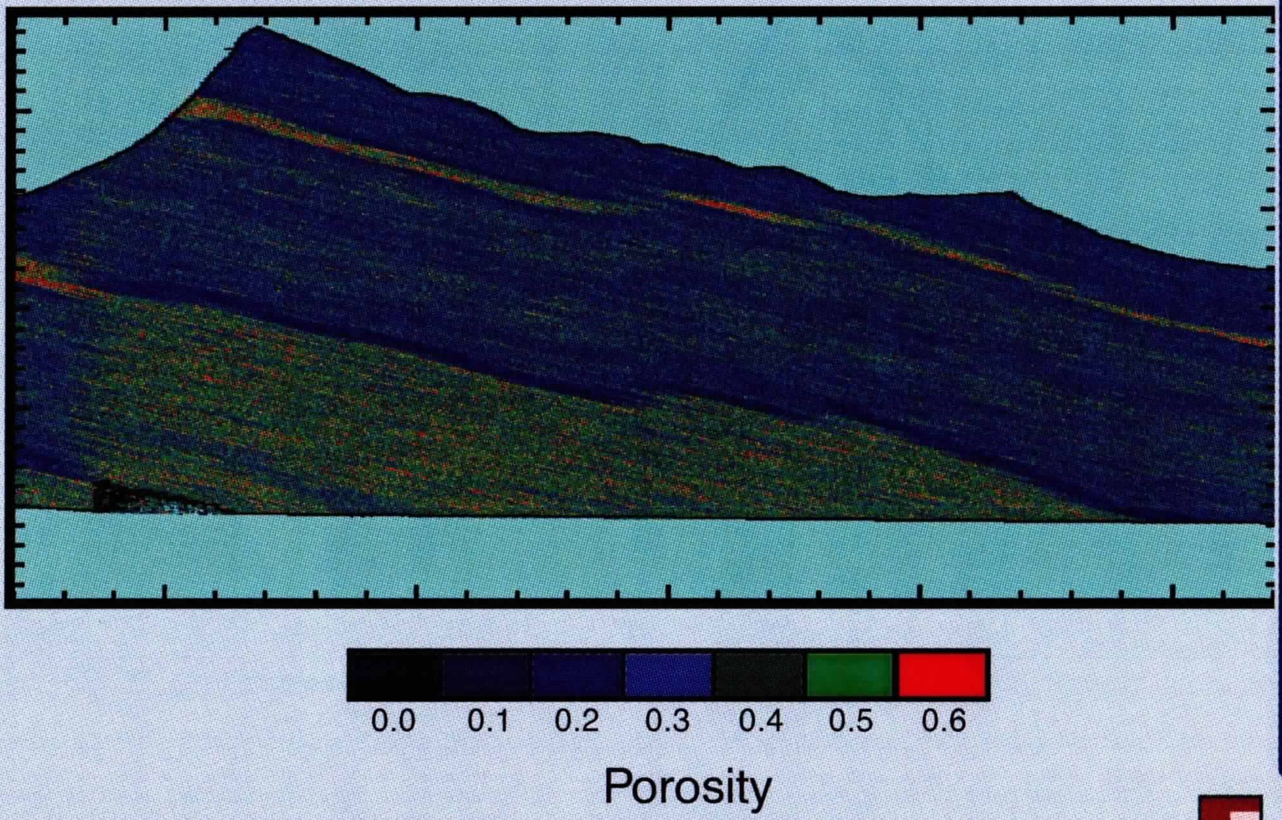
- 4 transects
  - 2 E–W extensions of GWTT-94
  - N–S near Ghost Dance Fault
  - Along Drill Hole Wash
- Drill holes near transects conditioned simulations
- Solitario Canyon and Ghost Dance Faults included



Modeling of Hydrologic Properties

(Matrix Porosity)

- Use porosity conditioning data where available
- Porosity simulated from geologic-framework model elsewhere
- K_{sat} calculated from porosity using co-regionalization technique



Features of GWTT-95 Geostatistical Modeling

- Materials properties simulated directly on transects
  - unit definitions based on lithologic properties (e.g., presence of lithophysae) and on mean porosity
  - more spatial anisotropy in correlations
- Fractures represented by randomly oriented (cooling) and vertical (tectonic)
  - hydraulic properties of faults modeled by density of vertical fractures
- Model combines deterministic geologic-framework model with geostatisitcal simulation of materials properties

Boundary Conditions

- Using steady-state spatial flux distribution map from USGS (Flint)
  - based on neutron-hole and surficial saturation data
  - includes geography of alluvial cover over units
- Will look at effects of transient boundary conditions as sensitivity study
  - short-term, local increases in infiltration
- Will review data and modeling from isotopic-dating studies as check on our models

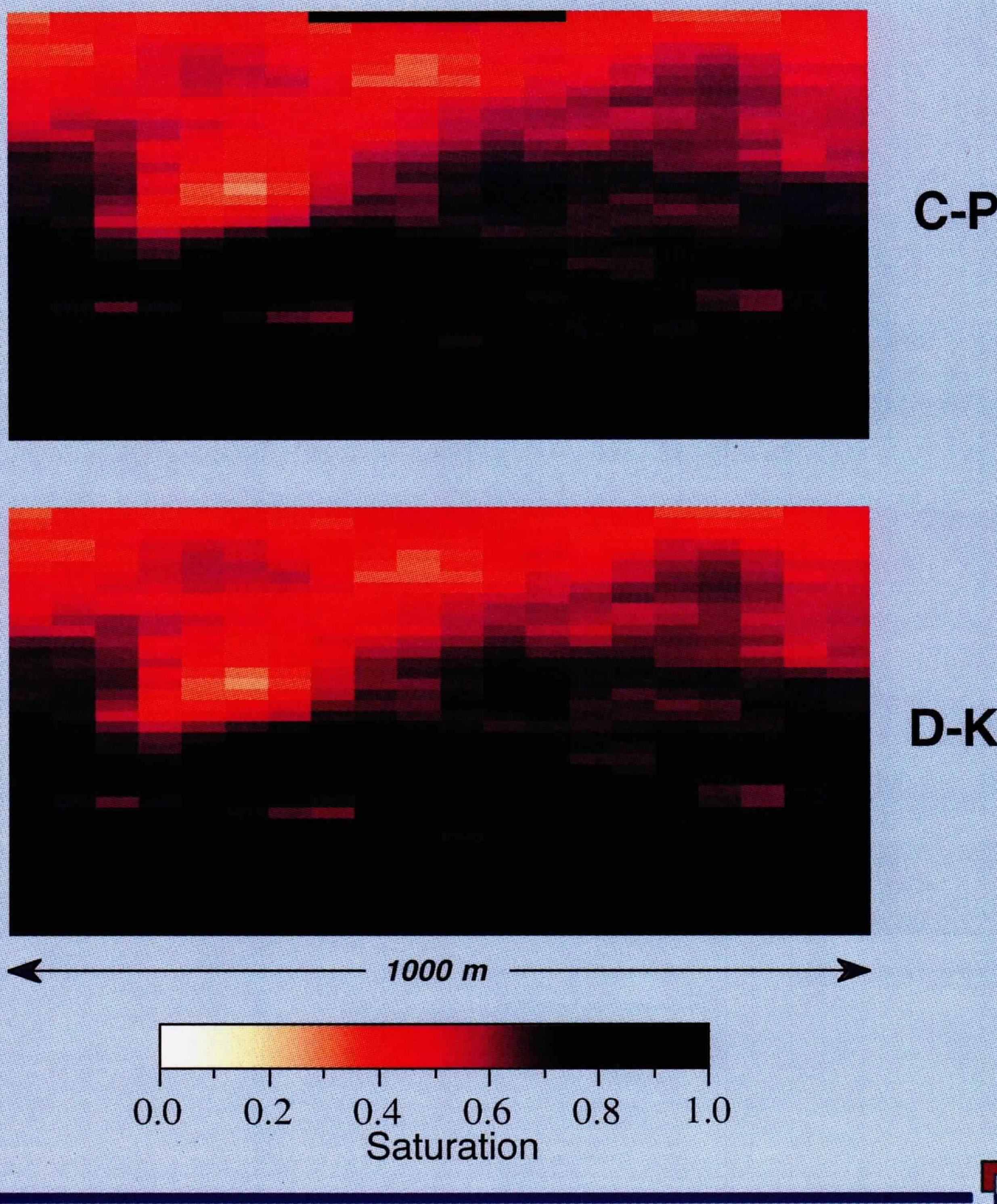
UZ Flow Models used for GWTT-95

- TOUGH2, FEHMN, and DUAL have been compared in benchmark tests
  - 1-D (composite-porosity) comparison to semi-analytical solution
  - 2-D layered, homogeneous, uniform infiltration using dual-permeability (D-K) model
  - 2-D tilted layers, homogeneous, uniform infiltration
  - 2-D heterogeneous, steady and transient infiltration
  - Comparison with UZ-16 saturation data
- Dual-permeability was able to model fracture flow with less than saturated matrix conditions

Comparison of C-P and D-K Modeling in UZ

(1-hr ponding, top middle element)

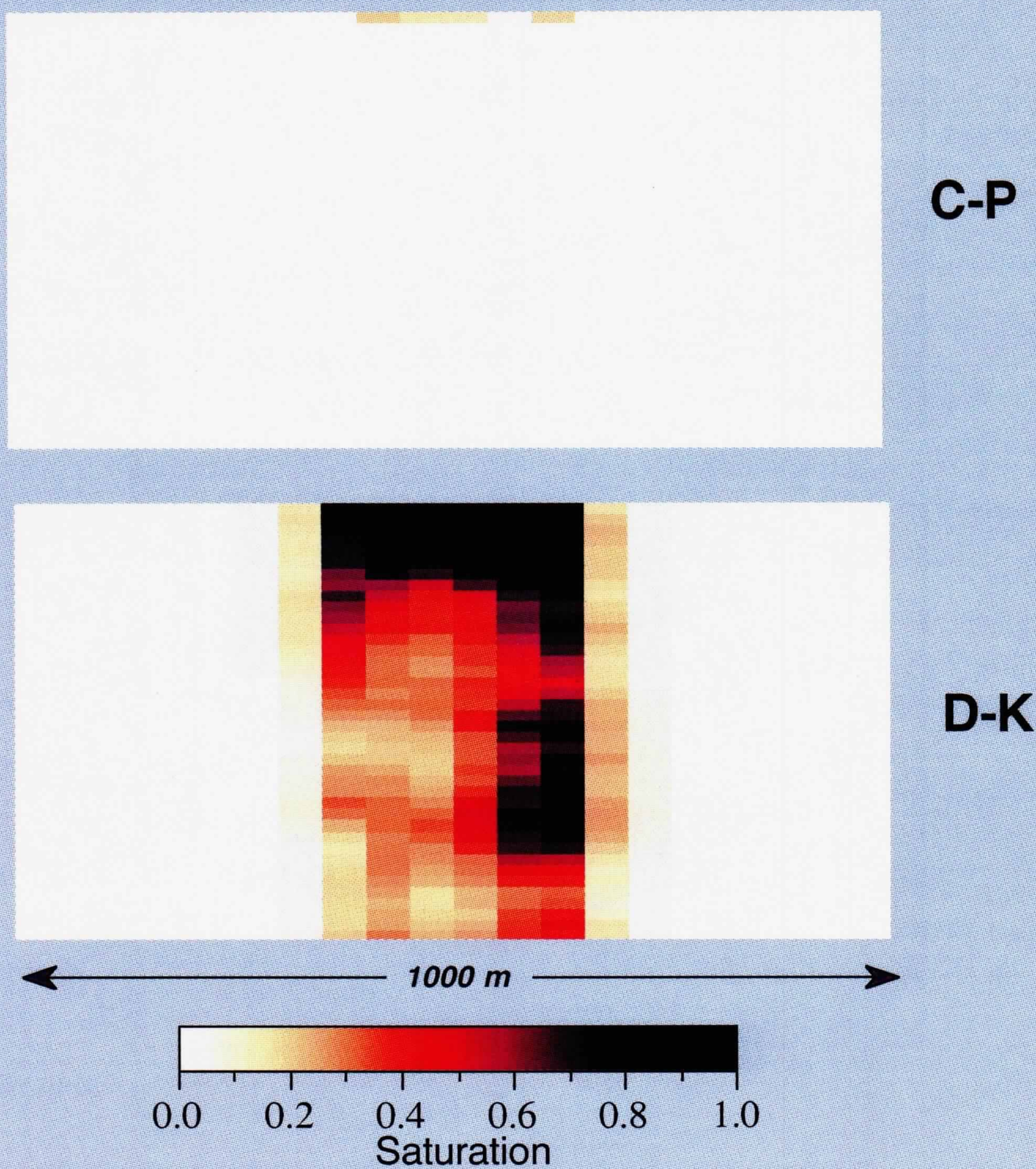
Matrix Saturations



Comparison of C-P and D-K Modeling in UZ

(Continued)

Fracture Saturations



Development of SZ GWTT Model

- Model domain enhanced from TSPA-93
  - reinterpretation of geologic contacts between units below water table
  - inclusion of fault offsets in units
- Flow field calculated using STAFF-3D, but not yet calibrated to well data
  - based on equivalent porous medium model (assumes ability to readily exchange between fractures and matrix)
- Problem is also being run using FEHM

Particle Tracker

- UZ particle tracker based on D-K conceptual model
  - particles tracked in both fracture and matrix continua
  - exchange of particles between fracture and matrix under development
- SZ particle tracker based on code developed for STAFF-3D
  - particles transported at average equivalent-porous-medium flux
- Linking UZ and SZ distributions remains to be done
  - linkage must include both spatial and temporal factors

Scenario Selection

- Selection of post-emplacement fast-path scenarios consistent with potential pre-emplacement paths
- Groundwater flow is assumed to be controlled by
  - thermal Features, Events, and Processes (condensation zone, heat pipe)
  - geochemical FEPs (alteration of TSbv, silica deposition in tuff aquifer)
- Assumptions of which FEPs apply and to what degree they apply depend on thermal history
  - thermal loading
  - time of calculation

Interactions with NRC staff

- Evaluation of fastest paths
  - Alternative approaches proposed by DOE and NRC staff
  - Reviewed with NRC staff and Advisory Committee on Nuclear Waste
- Evaluation of post-waste-emplacement and pre-waste- emplacement GWTTs
  - Suggested by NRC Staff as a method to avoid calculating a disturbed zone
- Evaluation of appropriate times in repository history for making GWTT calculation