

U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

**NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING**

SUBJECT: UPDATE ON SITE INVESTIGATIONS

PRESENTER: DENNIS R. WILLIAMS

**PRESENTER'S TITLE
AND ORGANIZATION: DEPUTY ASSISTANT MANAGER, SCIENTIFIC PROGRAMS
YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT OFFICE
LAS VEGAS, NEVADA**

TELEPHONE NUMBER: (702) 794-1417

**AUSTIN, TEXAS
APRIL 30 - MAY 1, 1996**

Site Investigations Update

- **ESF Testing**
 - **Thermal Testing Alcove Construction**
 - **In Situ Thermal Testing**
 - » **Predictive Calculations of Heater Tests**
 - **Moisture Monitoring**
- **Surface-Based Testing**
 - **G-2 Aquifer Test**
 - **Tracer Testing at C-Hole Complex**
 - **Ongoing Pneumatic Monitoring**
 - **SD-7 Instrumentation**

Site Investigations Update

(Continued)

- **Geology**
 - Detailed Geologic Mapping of Repository Area
 - South Ramp Geologic Predictions
 - Probabilistic Volcanic Hazard Assessment
 - Mineralogy/Petrology
- **Geochemistry**
 - Flow and Transport Modeling

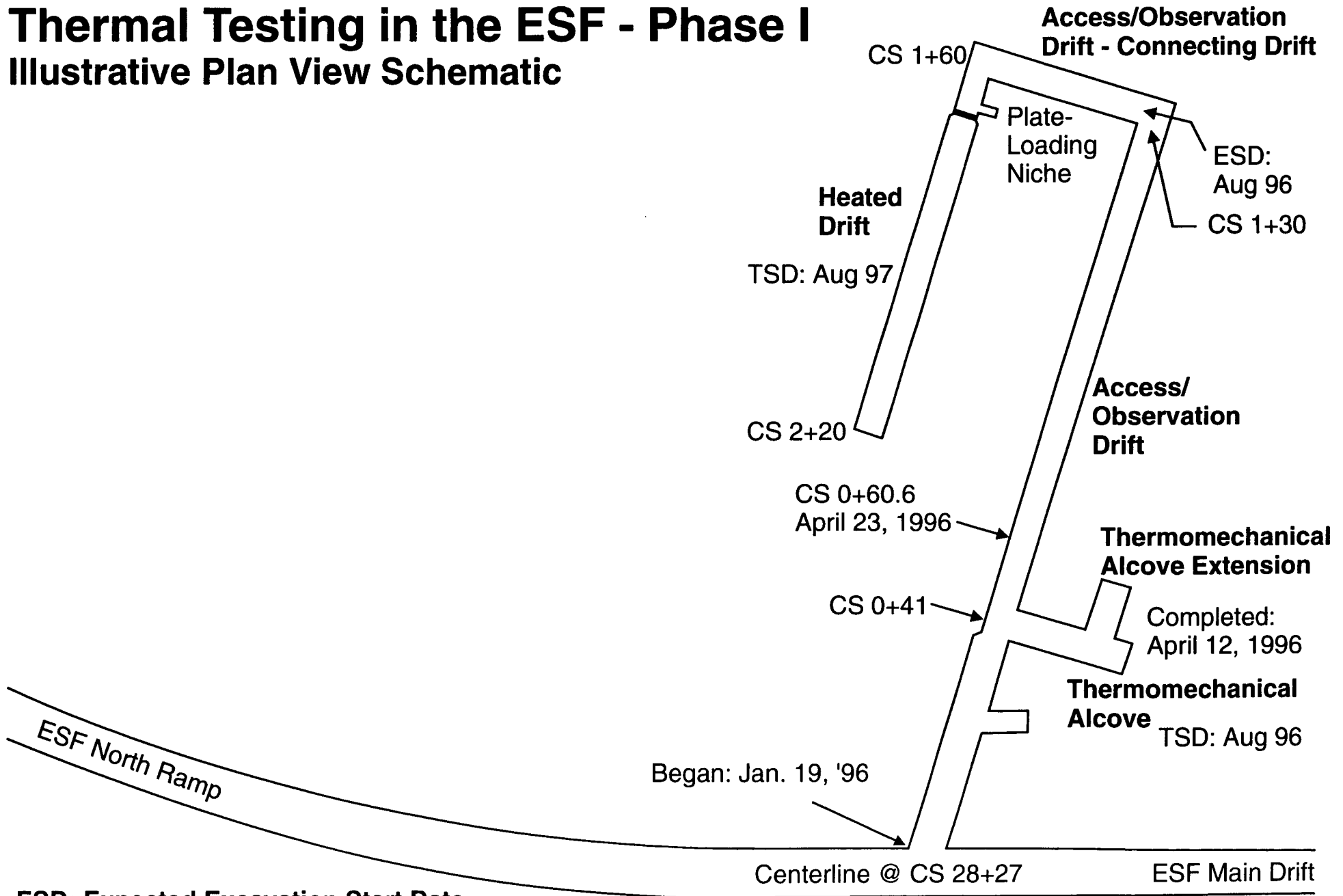
Site Investigations Update

(Continued)

- **Hydrology**
 - **Apparent Ages of Fracture Minerals**
 - **Isotope Tracers (^{36}Cl) and UZ Flow**
 - **Update on Conceptual Models**

Thermal Testing in the ESF - Phase I

Illustrative Plan View Schematic



ESD: Expected Excavation Start Date
TSD: Expected Testing Start Date

In Situ Thermal Testing

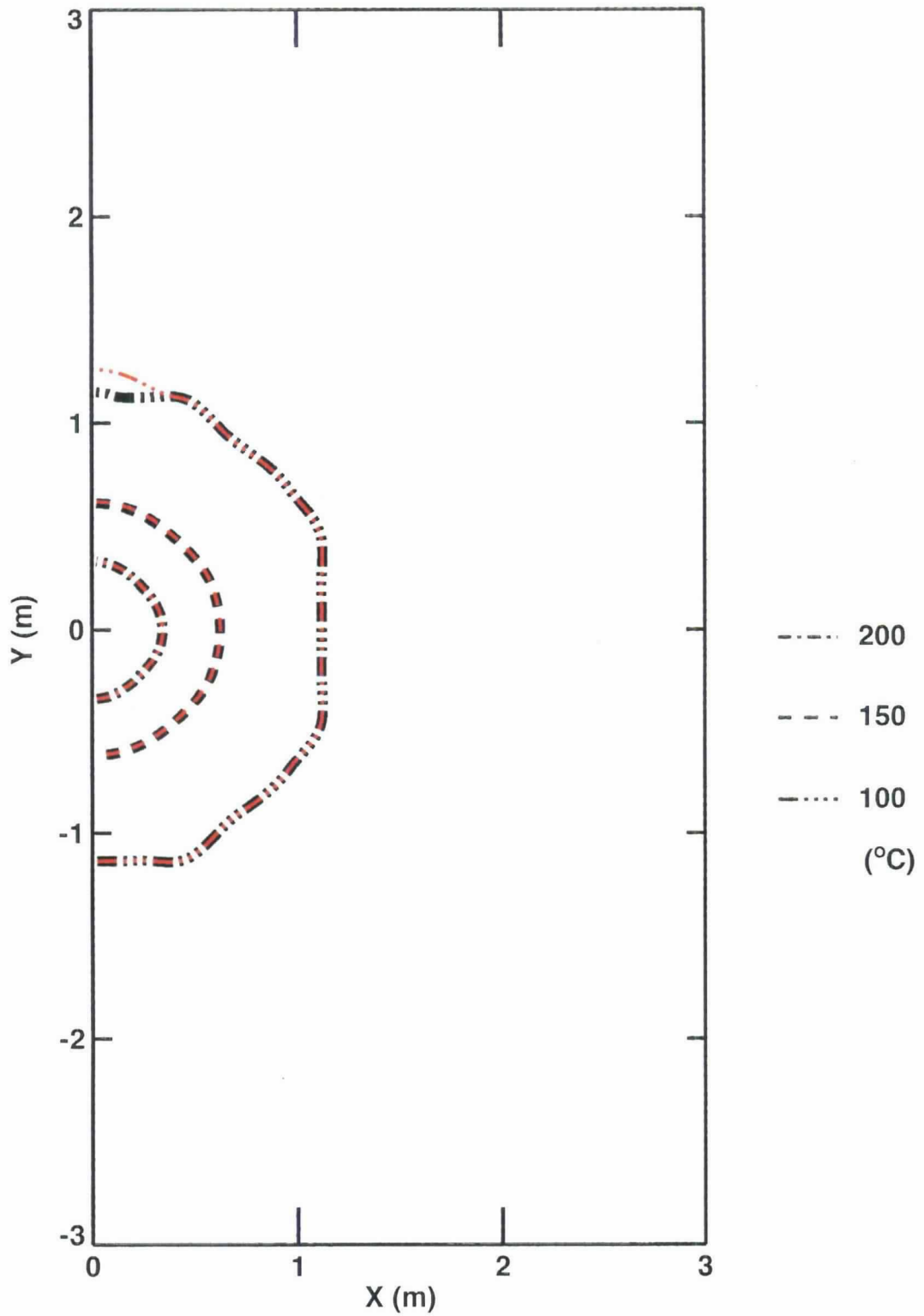
- **Temperature profiles and moisture distribution predictions for single heater test and drift-scale heater test**

In Situ Thermal Testing

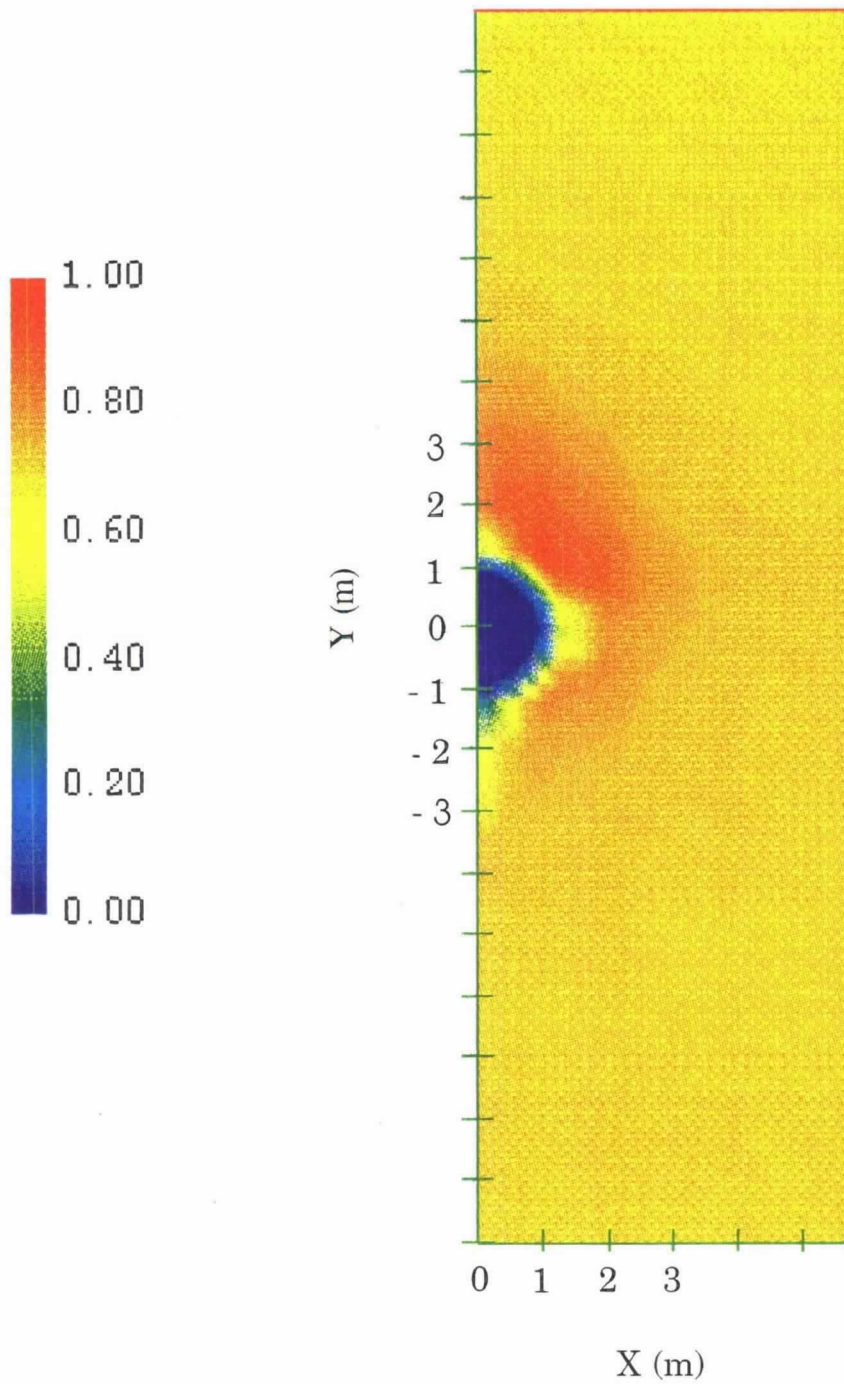
(Continued)

- **Thermomechanical Heater Test**
 - **Results from thermomechanical heater test simulations (Nick Francis - SNL)**

PRELIMINARY
4/24/96



Temperature Distribution at 1 Year as Viewed From the
Thermal-Mechanical Alcove Looking East
Black Lines - 1 Darcy Case
Red Lines - 10 Darcy Case



Liquid Saturation Distribution at 1 year Viewed from the Thermal-Mechanical Alcove Looking East - 10 Darcy Case

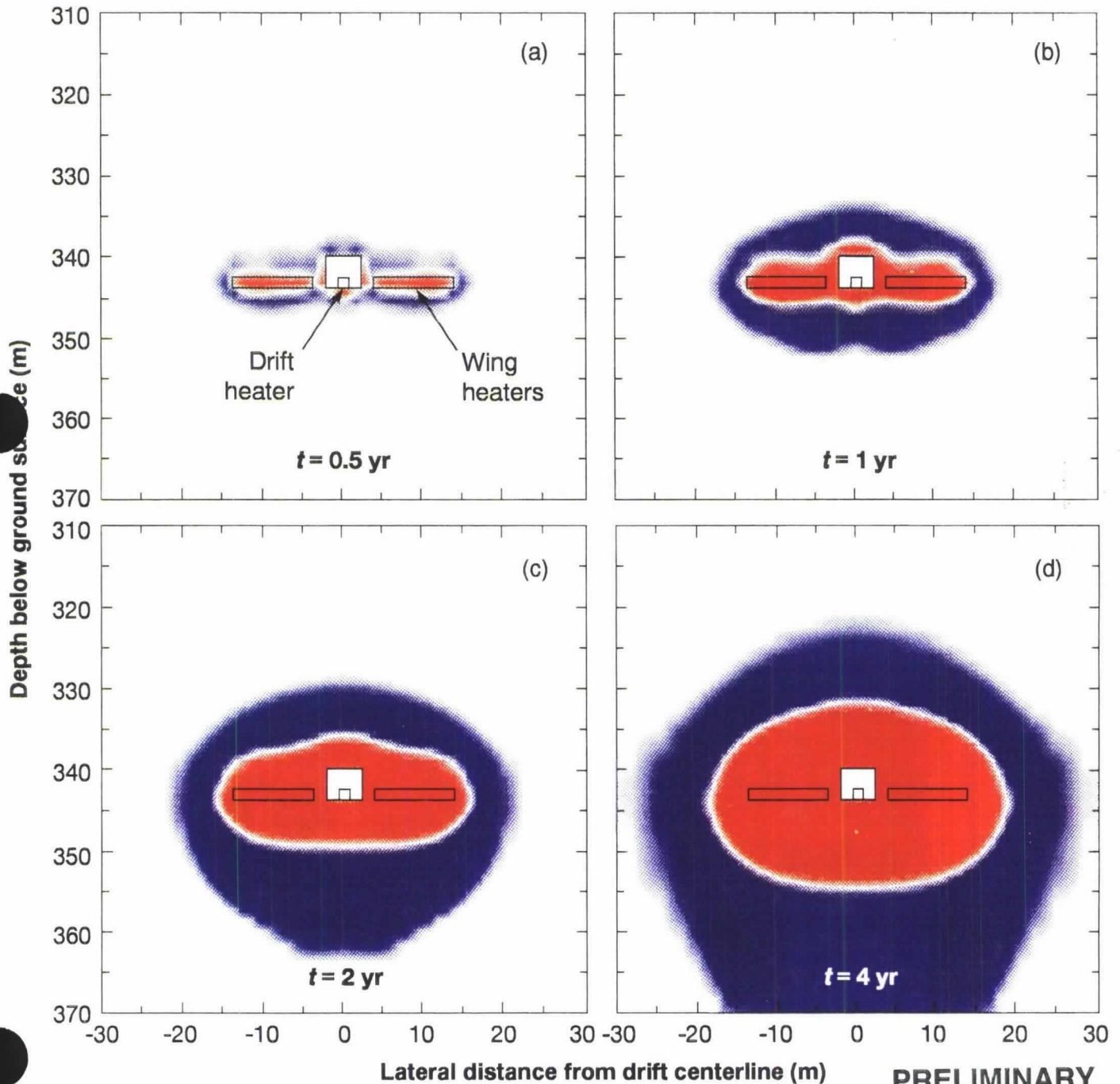
In Situ Thermal Testing

(Continued)

- **Drift-Scale Heater Test**
 - **Results from drift-scale heater test simulations (Tom Buscheck - LLNL)**

Dimensionless liquid saturation distribution transverse to the ESF drift-scale thermal test

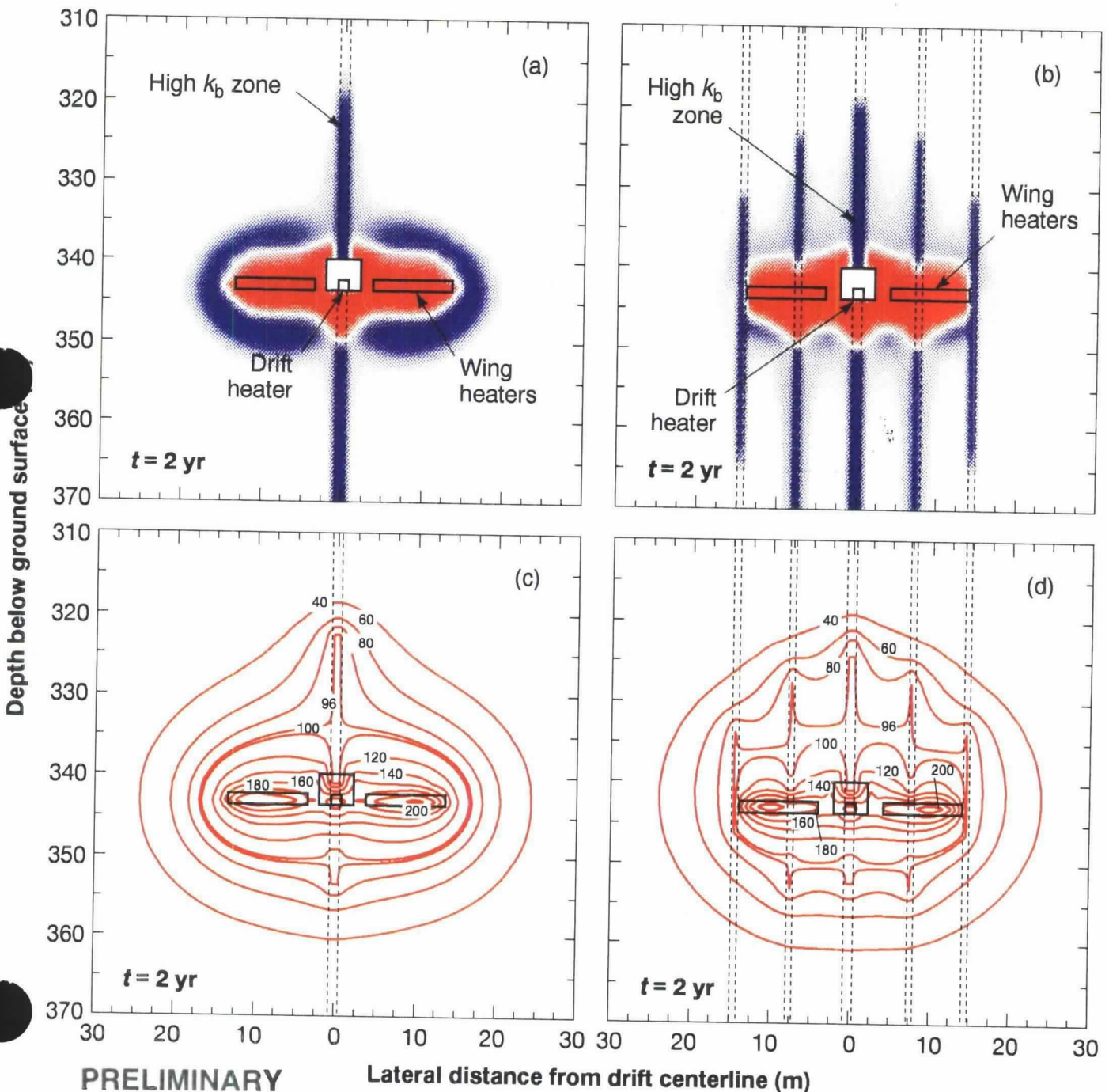
The red area corresponds to a region that is drier than ambient (dry-out zone); the blue areas correspond to regions that are wetter than ambient (condensation zones)



PRELIMINARY
4/24/96

Dimensionless liquid saturation and temperature distribution transverse to the ESF drift-scale thermal test resulting from heterogeneous property distributions

The red area corresponds to a region that is drier than ambient (dry-out zone); the blue areas correspond to regions that are wetter than ambient (condensation zones); temperature contours are shown in (c) and (d)



PRELIMINARY
4/24/96

Lateral distance from drift centerline (m)

ESF Moisture Study

- **Objectives**
 - **Determine amount of moisture removed by ventilation & muck as TBM advances**
 - **Determine rate of moisture removal from rock**
 - **Provide data for testing thermohydrologic coupled process models**
 - **Report due September 1, 1996**

Preliminary Results from ESF Moisture Study

- **From scoping studies, fall 1995:**
 - **Ventilation air relative humidity increases from the portal to the TBM**
 - **Water removed in ventilation air averages more than 100 liters per year per square meter of tunnel area (flux 100 mm/yr)**
- **Humidity measurements and infrared images indicate increase in relative humidity on the weekends and toward the TBM (Joe Wang - LBNL)**

Preliminary Results from ESF Moisture Study

(Continued)

- **Measurements in Alcove 3 (which was bulkheaded) by USGS (Alan Flint)**
 - **Flux out of rock depends on rock properties**
 - » **About 1.0 mm/day from columnar unit (Crystal-Poor Member of Tiva Canyon Tuff)**
 - » **About 0.25 mm/day from vitric unit (Vitric Zone of Tiva Canyon Tuff)**

G-2 Aquifer Test

- **Purpose is to characterize large hydraulic gradient north of site**
- **Pumping currently in progress (scheduled to end 4-26-96) to be followed by two months of recovery to test if water-bearing zone is a perched water body**

C-Hole Complex Testing

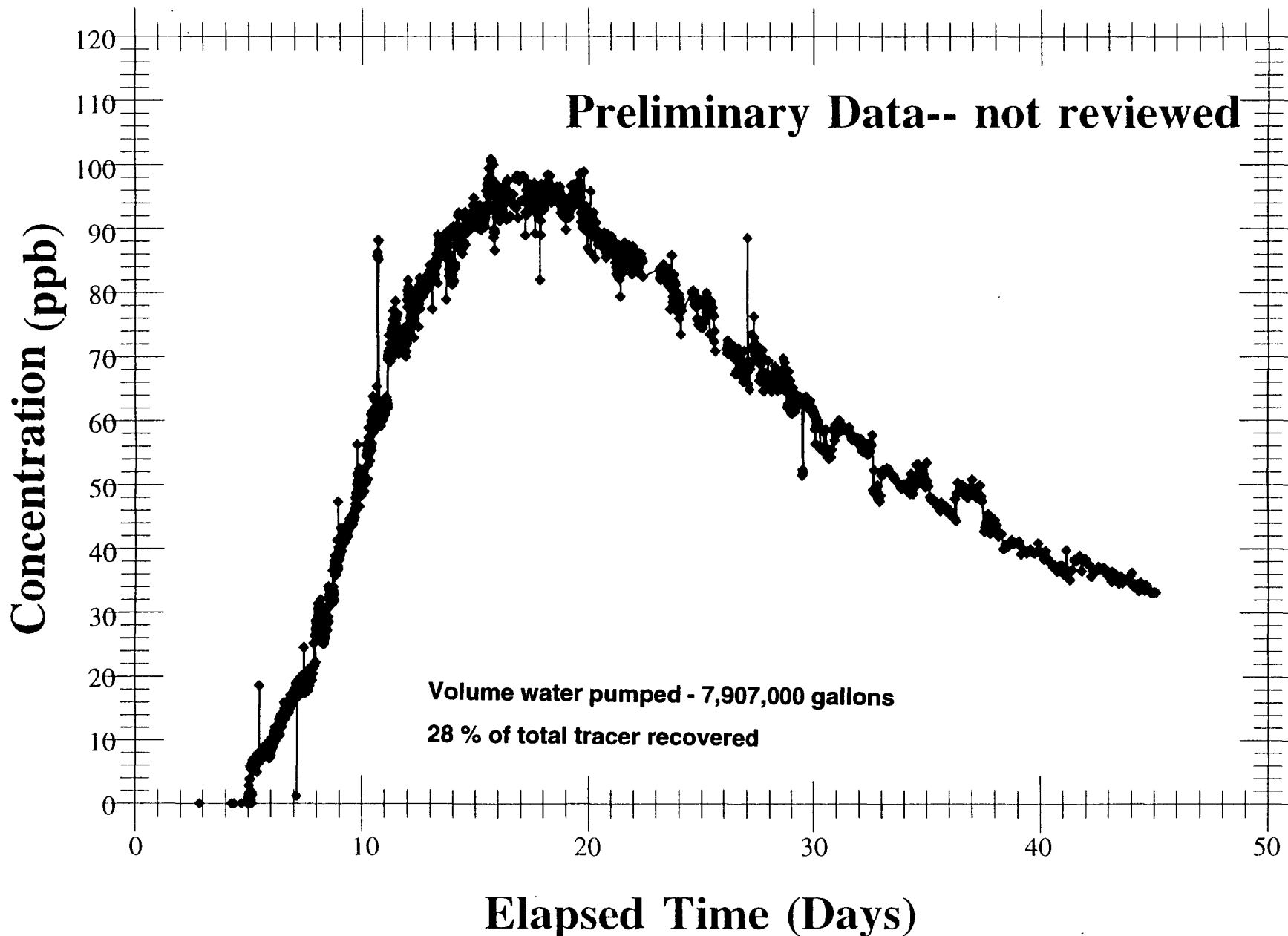
- **Purpose is to conduct hydraulic, conservative tracer, and reactive tracer tests in the saturated zone at the site**
- **Have completed two hydraulic tests and a conservative tracer test during the past year**
- **Next set of hydraulic, conservative, and reactive tracer tests to start 5-1-96**

C-Hole Complex Testing

(Continued)

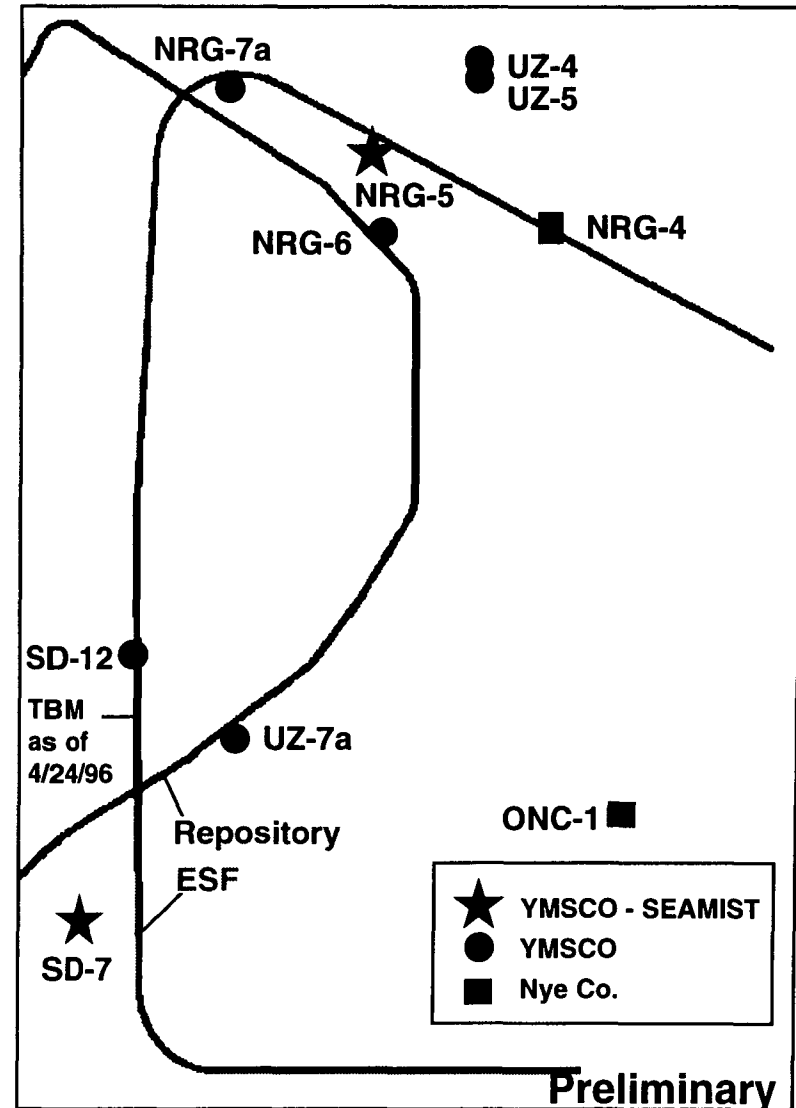
- Breakthrough curve for conservative tracer test (USGS)**

Tracer Test at Cwells 02/13/96 NaI (10,000 ppm) Injectate



Pneumatic Testing/Monitoring

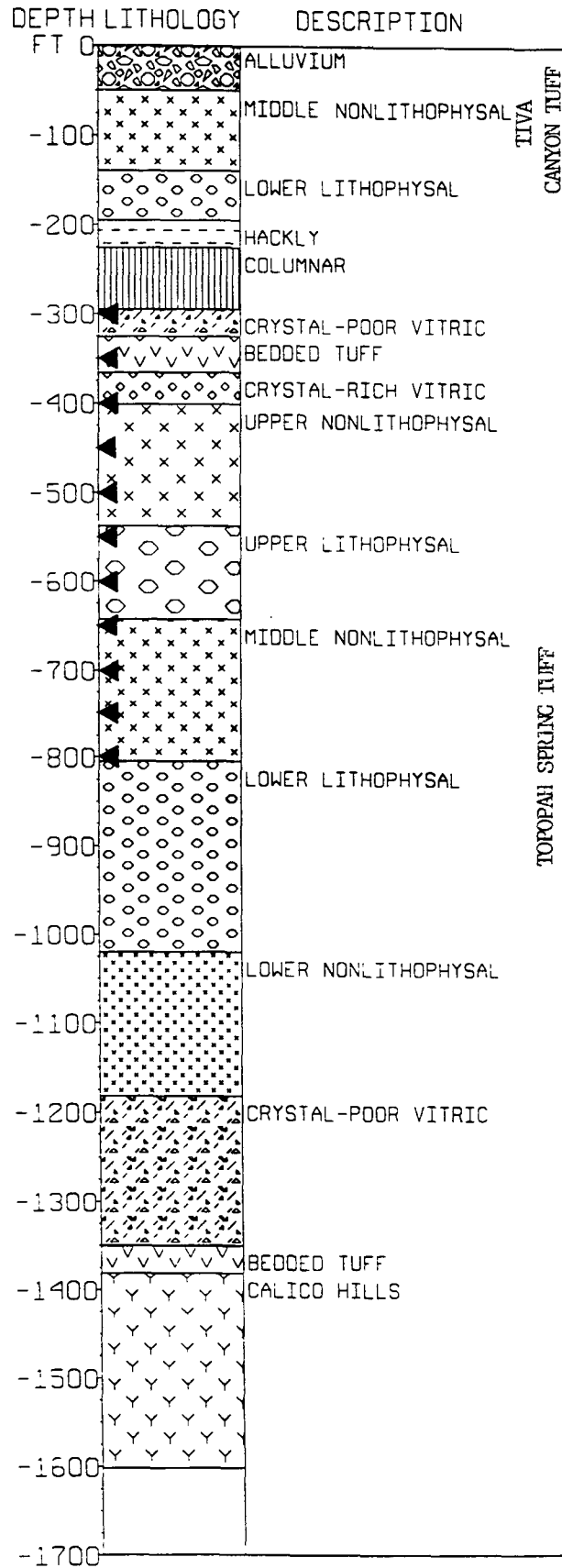
- DOE currently monitoring eight boreholes
- Nye County monitoring an additional two boreholes
- Response at depth to barometric pressure fluctuations recorded
- Pneumatic response to ESF penetrating PTn recorded
- Pressure response calculations made with UZ gas flow model



SD-7 Instrumentation

- **Purpose is to install temporary instrumentation to monitor pneumatic pressure response prior to and during TBM advance past borehole**

USW SD-7



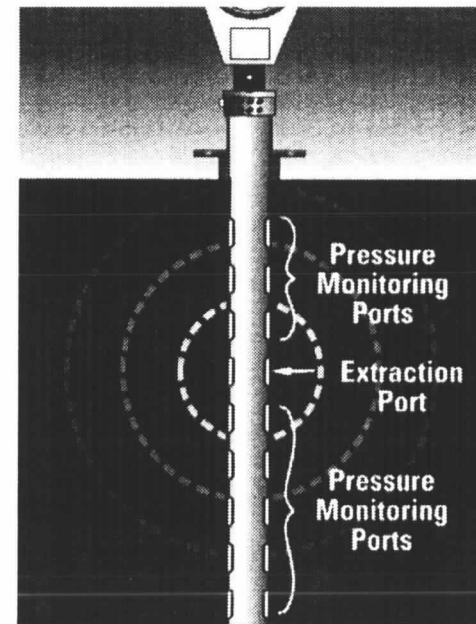
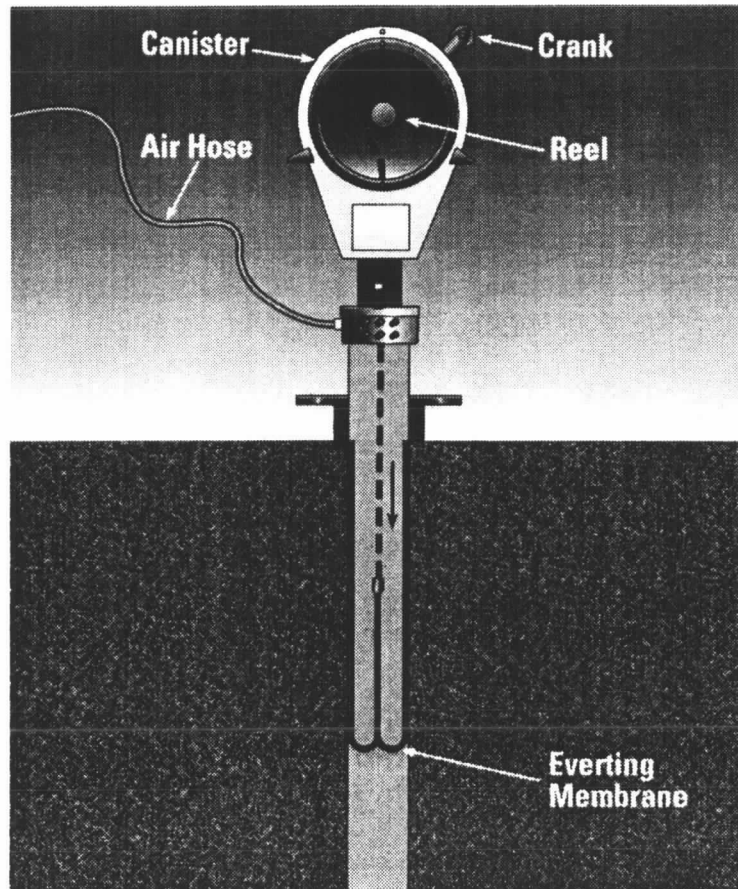
TIVA
CANYON TUFF

TOPOPAH SPRING TUFF

◀ BOREHOLE LINER MONITORING PORT

Preliminary
4/24/96

SD-7 Instrumentation



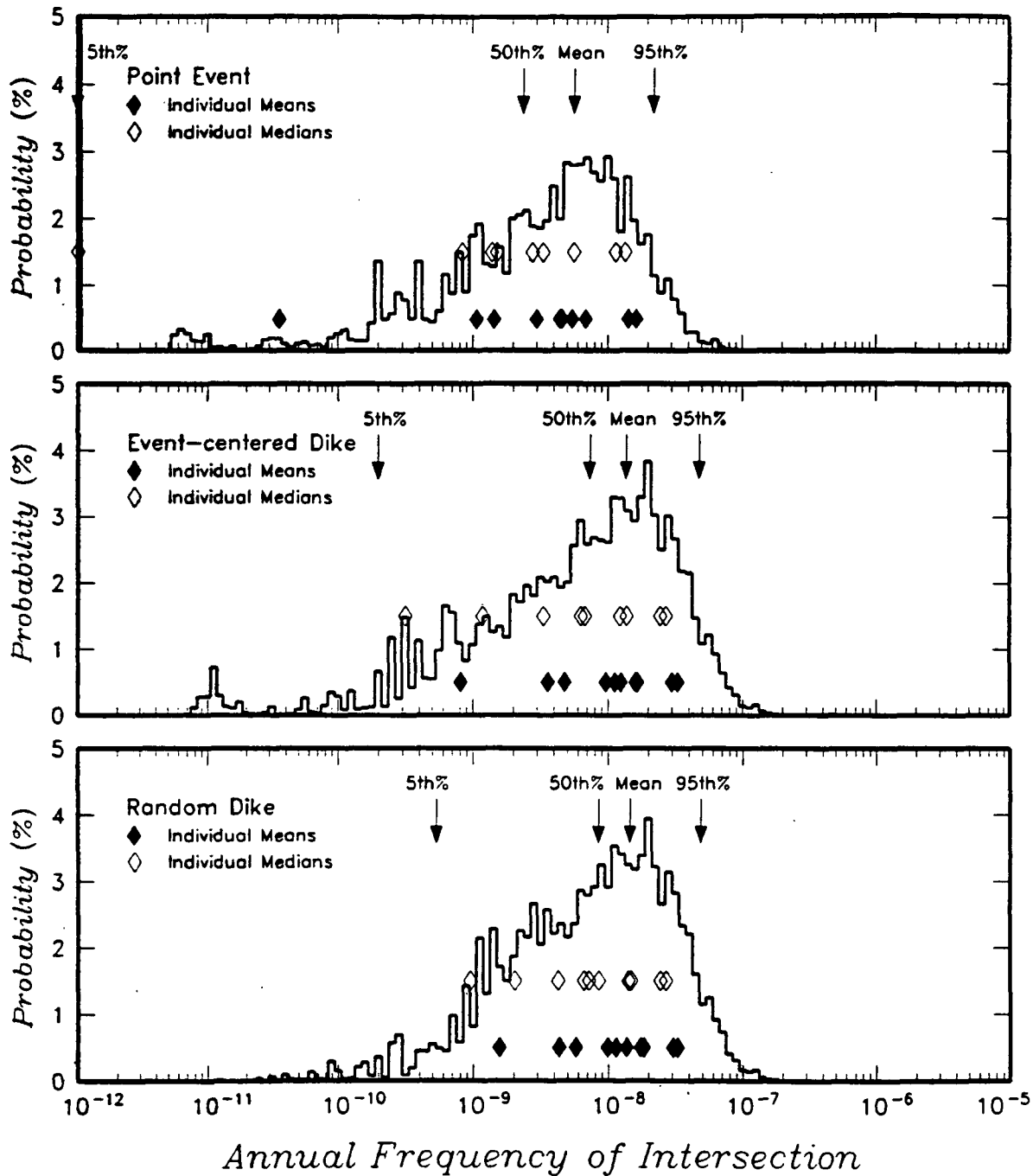
Geologic Mapping

- **Central Block geologic field mapping completed**
 - **Result will be a much more precise map in terms of locations and interpretations of geologic structures**
- **South Ramp predictive geology cross-section submitted to ESF design**
 - **Ground will probably be difficult and several faults and breccia zones will probably be encountered**
 - **No major structures in the area of the South Portal**

Probabilistic Volcanic Hazard Assessment

- **Final report delivered to M&O and being reviewed prior to submittal to DOE**
- **Mean aggregate probability is 1.5×10^{-8}**
 - **Value very similar to estimates made by Project scientists**

Aggregate Distributions for Frequency of Intersecting the Yucca Mountain Repository Footprint



Mineralogy/Petrology

- **Completed report, *Mineralogy-Petrology Contribution to the Near-Field Environment Report***
 - **Significant contribution to the NFER, due at the end of the FY**
 - **Contains compilation of mineral kinetic and thermodynamic data and discussion of alteration history and past mass transport**

Geochemistry

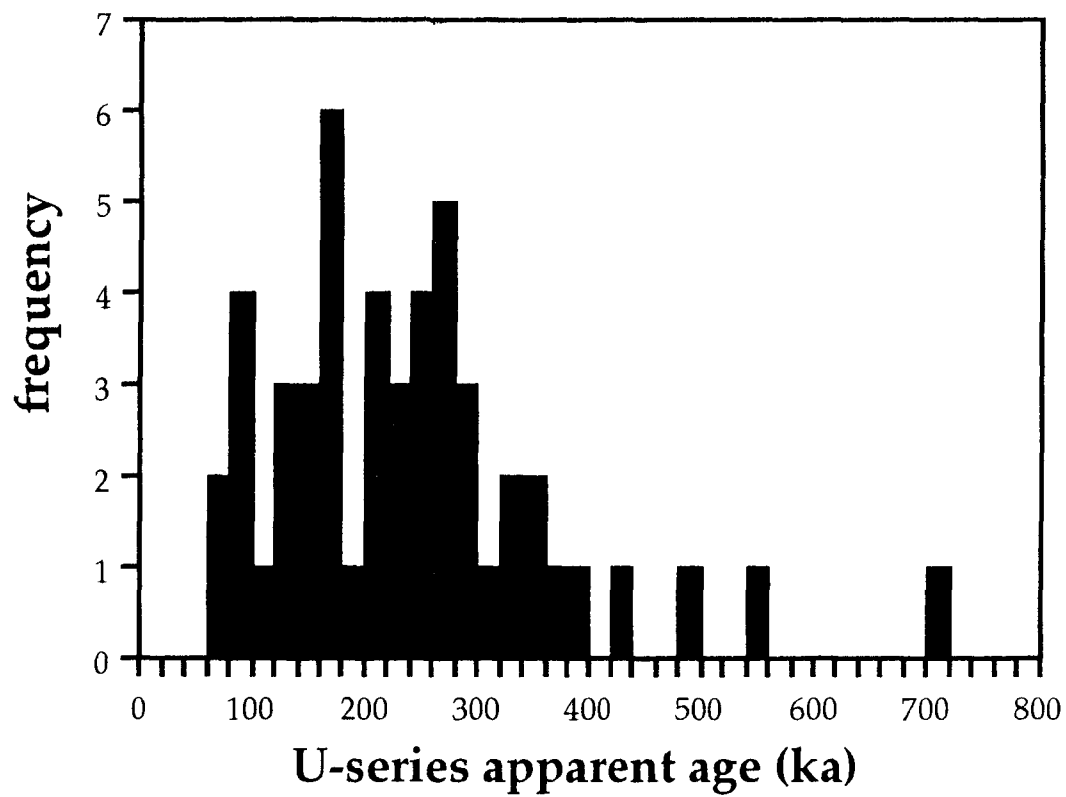
- **Refinement of the UZ Flow and Transport model continues**
 - **Added thermal effects to model**
 - **First simulations of the effect of heat on Np transport**
 - **FEHM code reviewed and commented upon by AECL**
- **Progress on development of first SZ Flow and Transport Model this FY**
 - **Completed grid construction with GEOMESH**

Hydrology

- **Apparent Ages of Fracture Minerals**
- **Isotope Tracers (^{36}Cl) and UZ Flow**
- **Update on Conceptual Models**

Apparent Ages of Fracture Minerals

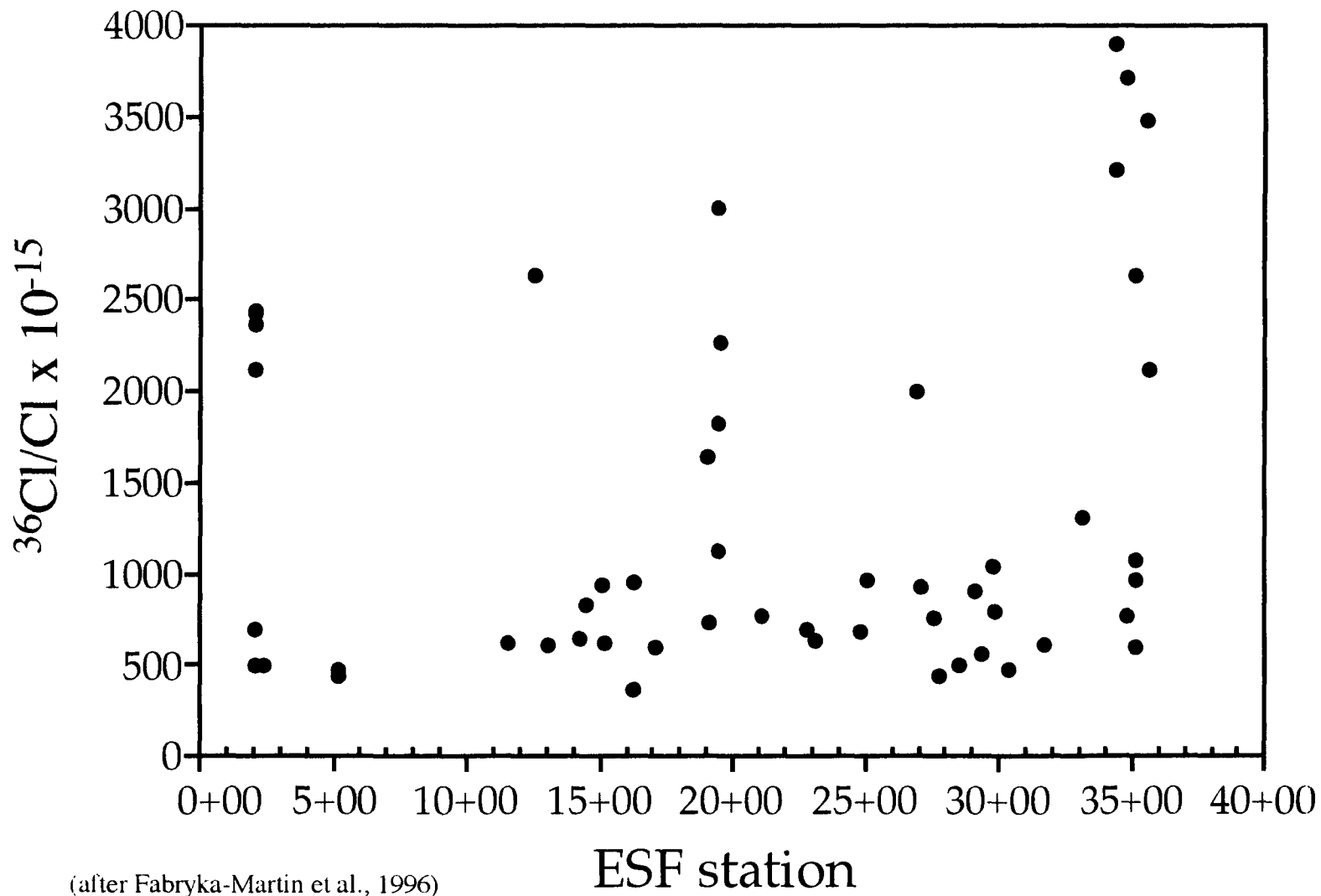
- **Purpose is to constrain further the timing of percolation into the repository horizon**
- **Continuing to collect data from ESF**
 - **Results to date (Paces et al. - USGS)**



(data from Paces et al., 1996)

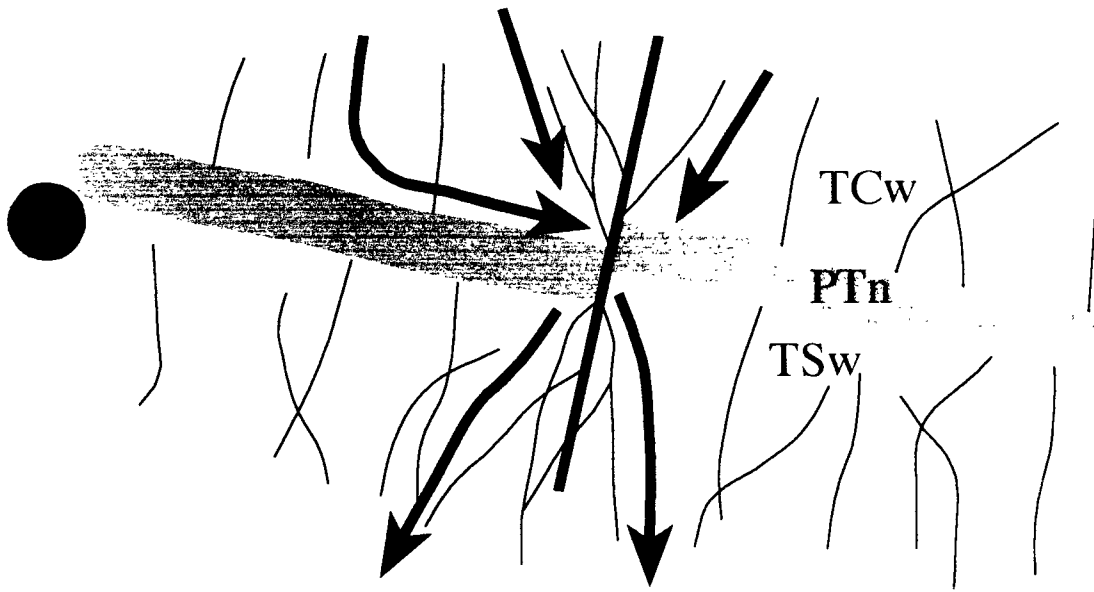
Isotope Tracers (^{36}Cl) and UZ Flow

- **Purpose is to constrain further the residence time of UZ water as a function of depth and structural features**
- **Continuing to collect data from the ESF**
 - **Results to date (Fabryka-Martin et al. - LANL)**

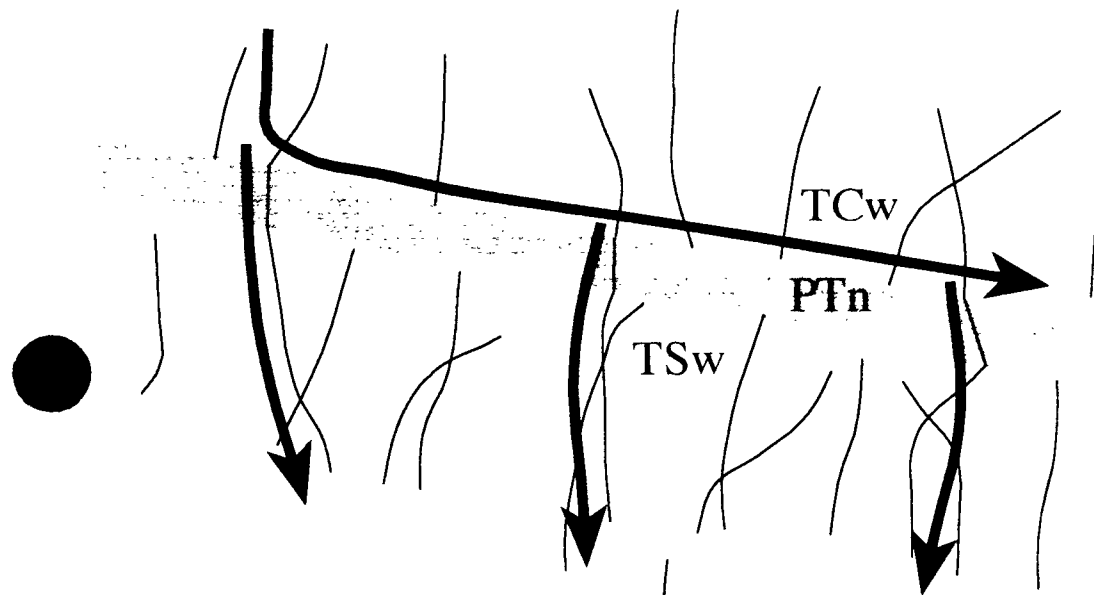


Conceptual Models

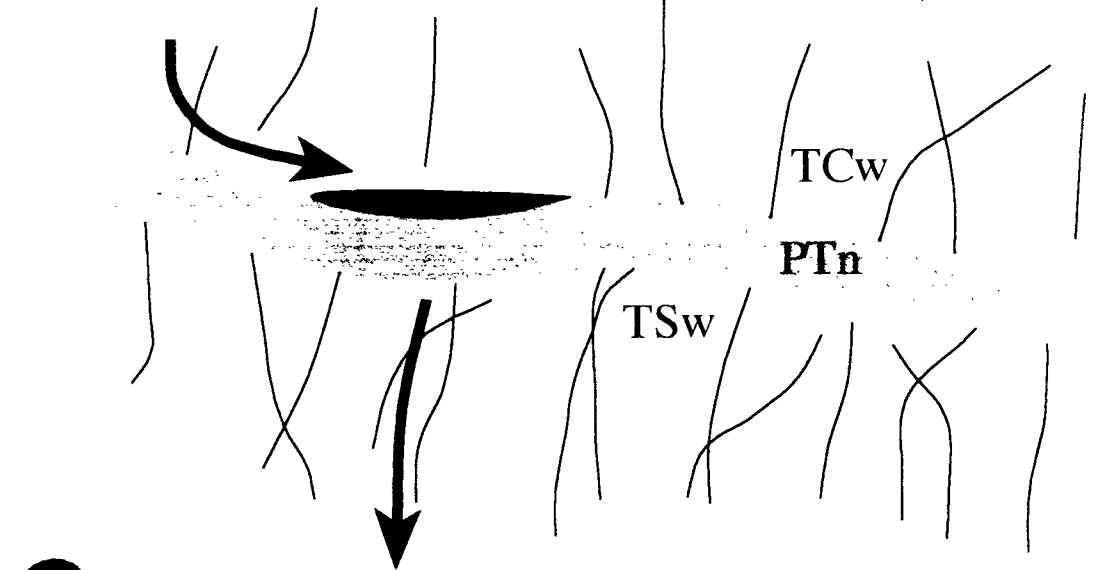
- **A fraction of ^{36}Cl in some ESF samples appears to be bomb pulse**
- **Three possible conceptual models developed to interpret how bomb pulse ^{36}Cl may enter the repository horizon rocks**
- **the models address specifically how modern water may pass through the PTn**
- **once through the PTn, the water follows fracture/fault systems**



Model A



Model B



Model C

Conceptual Models

(Continued)

- **Model A - following the Montazer & Wilson concept**
 - **Water travels down fault zone, or is laterally diverted at the top of the PTn until a fault zone is encountered**
 - **Water travels down fault zone through PTn to the TSw**
 - **Water then travels down nearest available fracture/fault system (optimum path for gravity flow) to the repository horizon**

Conceptual Models

(Continued)

- **Model B - variant of Model A**
 - **Water is laterally diverted at the top of the PTn until a throughgoing fracture/joint system is encountered**
 - **Water travels down fracture/joint system through PTn to the TSw**
 - **Water then travels down nearest available fracture/fault system (optimum path for gravity flow) to the repository horizon**

Conceptual Models

(Continued)

- **Model C**
 - **Water flow is impeded at the PTn and diverted laterally into “lows” in the PTn to form perched water bodies**
 - **Water then travels through the PTn by matrix flow to the TSw**
 - **Water then travels down nearest available fracture/fault system (optimum path for gravity flow) to the repository horizon**

^{36}Cl Strategy

- **Continue systematic and feature-based sampling in ESF to test conceptual models**
- **Use other isotope tracers to corroborate observations from ^{36}Cl (e.g., ^3H ?)**
- **Constrain the amount of bomb pulse ^{36}Cl required to produce the observed ratios**
- **Test possible conceptual models with UZ flow models**

Conclusions

- **Thermal Testing Alcove construction continues to progress**
- **Predictions being made and finalized prior to initiation of Thermal Testing**
- **G-2 and C-Hole testing continues**
- **Geologic mapping being finalized**
 - **Very useful for location of structural features pertinent to ^{36}Cl data**
- **South Ramp geologic predictions made and being used by ESF design**

Conclusions

(continued)

- **Probabilistic Volcanic Hazard Assessment completed and in form needed by Performance Assessment**
- **Dating of fracture minerals continues**
- **^{36}Cl studies continue**
 - **Revised our conceptual models and testing strategy**