

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

NUCLEAR WASTE TECHNICAL REVIEW BOARD

**SUBJECT: HYDROLOGY AND CLIMATOLOGY
INTEGRATED STRATEGY - WRAPUP**

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Overview

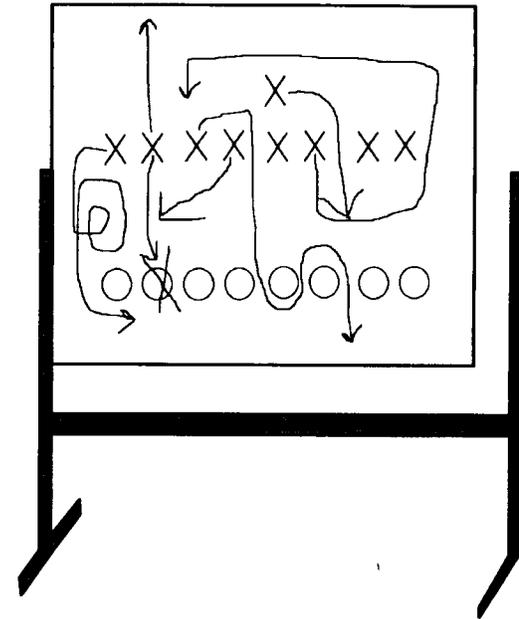
- **Address hydrology and climatology strategy for addressing waste isolation attribute on seepage**

Overall Objectives

- **Determine spatial and temporal variability, as well as magnitude, of infiltration and percolation flux**
- **Determine factors that influence infiltration and percolation**
- **Obtain adequate bounds on influencing factors**
- **Determine likely impacts on saturated zone flow and ultimately radionuclide transport**

Strategy

- **Use geologic framework as a basis**
- **Understand present-day hydrologic response to present-day climatic conditions**
- **Understand past hydrologic responses to past climatic conditions**
- **Building on climatic conditions “observed” to date, provide future climatic conditions that could effect repository performance**
- **Model hydrologic responses to future climatic conditions**



Scientific Studies

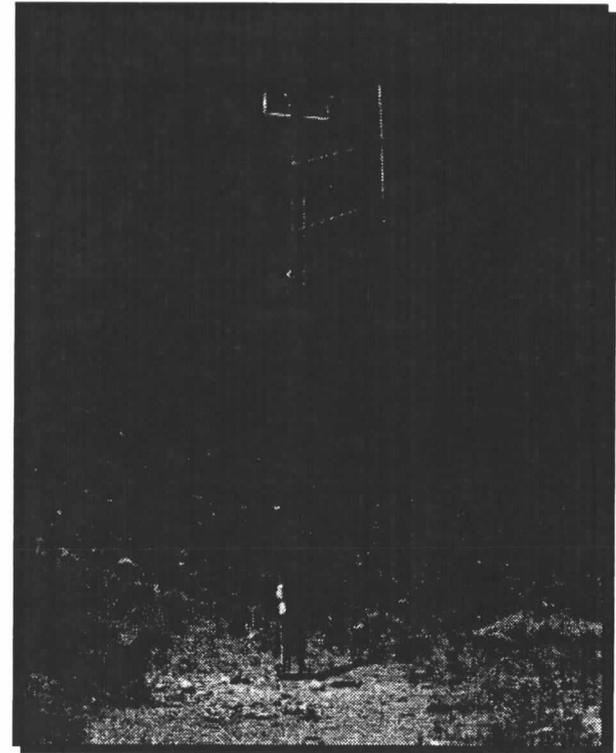
- **Use geologic framework as a basis**
 - “Geologic structure at Yucca Mountain” - Warren Day, Steve Beason
- **Present-day hydrologic response**
 - “Fracture pathways and flux through the UZ in the North Ramp area” - Edward Kwicklis
 - » Fracture flow occurs within and through the PTn
 - » Perched water reservoir in Drill Hole Wash Area - average magnitude of fracture flow is 0.001 to 0.29 mm/yr and matrix flow is 0.02 mm/yr
 - » Inferred heat-flux deficit at boreholes UZ4 and UZ5 implies deep percolation flux of 10 to 20 mm/yr in wash environ



Scientific Studies

(Continued)

- **Present-day climatic conditions**
 - **“Present day climate and infiltration” - Alan Flint**
 - » Infiltration is temporally and spatially variable
 - » Infiltration modeling can convert climate scenarios parameters into infiltration
- **Past climatic conditions**
 - **“Paleoclimate records: implications for future climate change” - Rick Forester**
 - » Changes in insolation during a 400ky climate cycle is main factor affecting future climate on multi-millennial time scale
 - » Climate during the next glacial cycle may be more equable than during the last two glacial cycles
 - » During the last glacial mean annual precip was about twice modern, mean annual temps about 5 to 10C lower

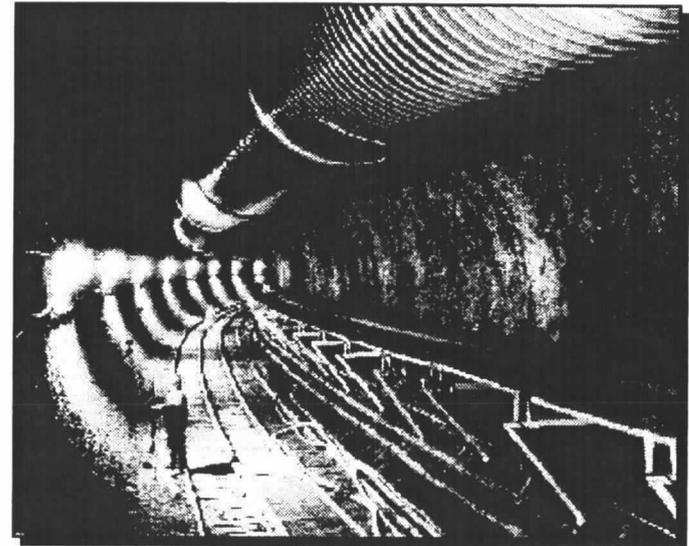


Scientific Studies

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- **Past hydrologic responses**

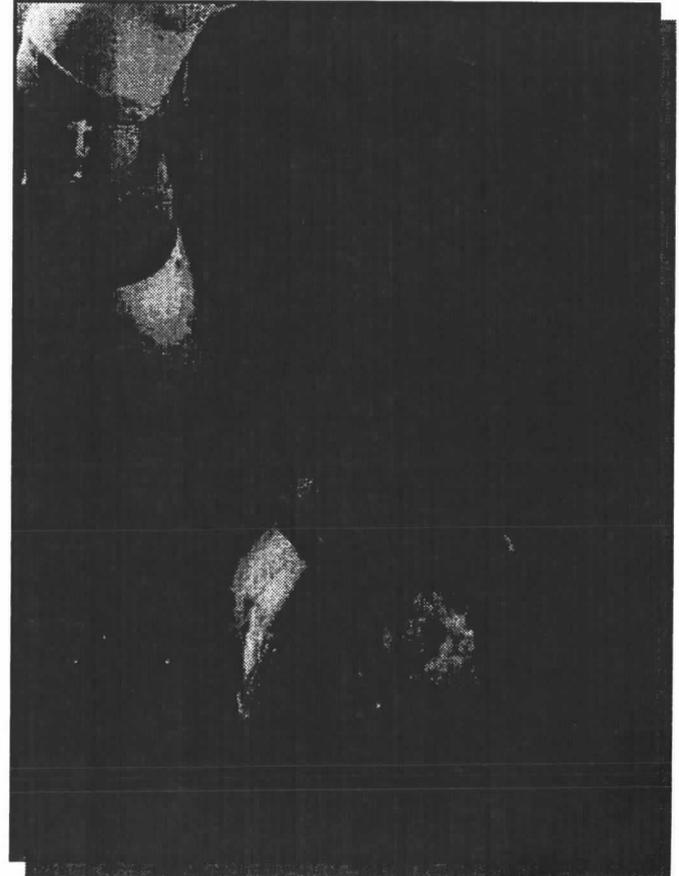
- **“Paleohydrology - age control from U-series and ^{14}C dating of calcite and opal in the ESF” - Zell Peterman, James Paces**
 - » Isotopic dating of calcite and opal suggests slow percolation through the rock mass away from fault paths
 - » Ages and thicknesses of deposits indicate very slow depositional rates on the order of micrometers per thousands of years
 - » Style of flow is suggested by mineral textures - low volume water films moving down fracture surfaces and into cavities



Scientific Studies

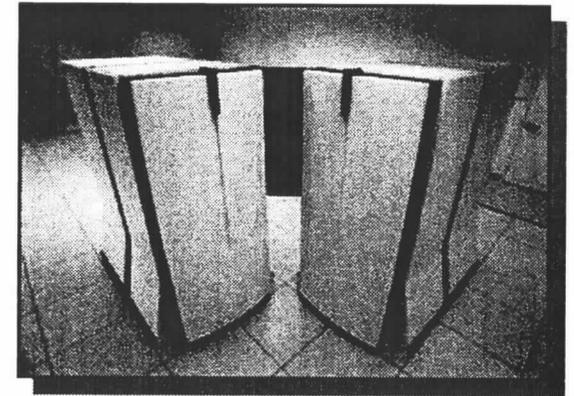
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- **Past and present hydrologic response**
 - **“Hydrologic flow paths and rates inferred from the distribution of ^{36}Cl in the ESF” - June Fabryka-Martin, Andrew Wolfsburg**
 - » Penetration of recent water into TSw unit is indicated by bomb-pulse ^{36}Cl in ESF fractures. However, bomb-pulse signals by themselves do not indicate magnitude of fluxes
 - » Bimodal distribution of $^{36}\text{Cl}/\text{Cl}$ ratios demonstrates the existence of isolated fast paths from the surface to the ESF
 - » Modeling studies indicate elevated $^{36}\text{Cl}/\text{Cl}$ ratios are consistent with rapid transport in fractures



Modeling Efforts

- **Provide future climatic conditions**
 - **“Future climate modeling” - Starley Thompson**
 - » The system for modeling future climates has been tested for present and past cases
 - » The first future climate analysis, a CO₂ “global warming” case, will be completed in FY96
 - » Numerical output from the future climate effort will flow to both hydrology and performance assessment
- **Model hydrologic responses**
 - **“TSPA insights into impacts of climate and ³⁶Cl” - Michael Wilson**
 - » PA analyses must evaluate all alternative conceptual models of flow, transport, and climate that are consistent with observations. The use of a single “best” model is not appropriate.



Summary

- **Paleoclimate study determines climatic conditions**
- **Isotopic studies identify the mountain's hydrologic response to those climatic conditions**
- **Present-day climate/infiltration studies identify effects of temporal and spatial variability of climate conditions on hydrology**
- **Future climate models provide climate scenarios that could affect future hydrology**
- **TSPA examines impacts of future hydrology on waste containment and isolation**