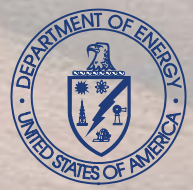
Thermal Testing Program: Drift Scale Test

Presentation to:
Nuclear Waste Technical Review Board (NWTRB)

Presentation by:
Deborah Barr
USBR/DOE

Beatty, Nevada
June 29-30, 1999



U.S. Department of Energy
Office of Civilian Radioactive Waste Management

Yucca Mountain Project

Content of Presentation

- Overview of Thermal Testing Program with Emphasis on Drift Scale Test (DST)
- DST Status
- DST Results
- Integration of Thermal Tests
- Applicability of DST Results

Thermal Testing Program

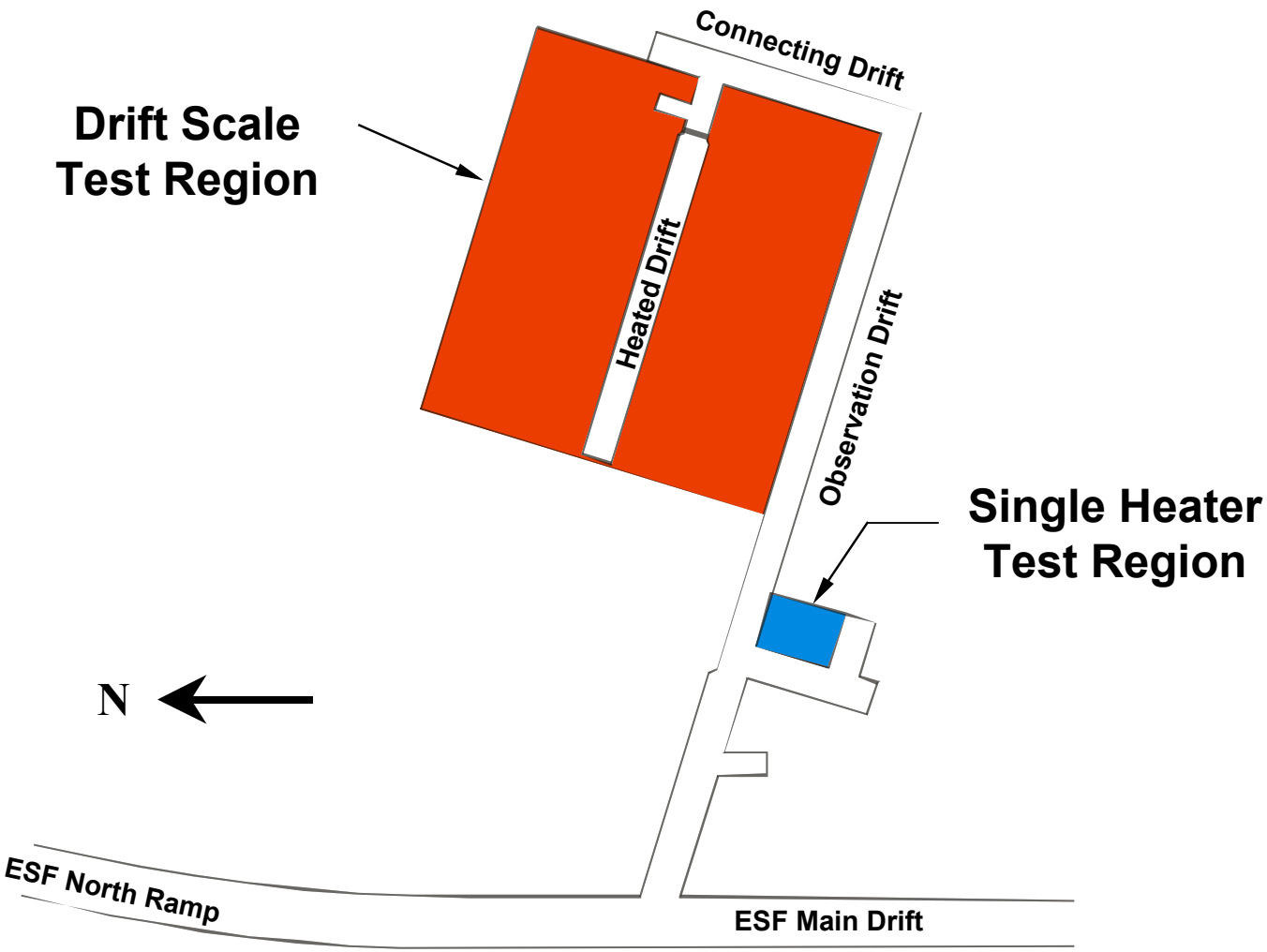
- **Single Heater Test**
- **Large Block Test**
- **Drift Scale Test**

Objective of Drift Scale Test

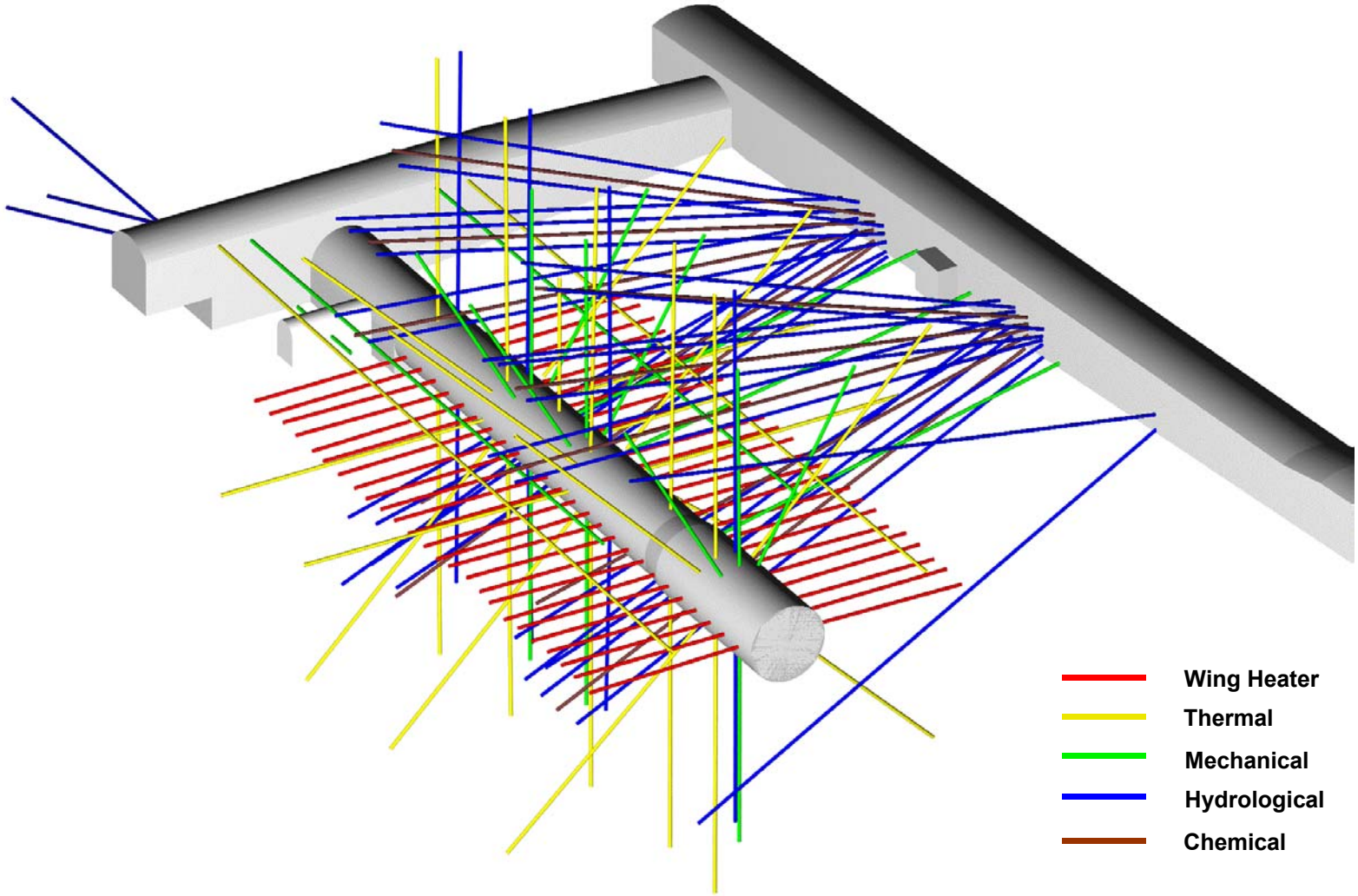
"Develop a more in-depth understanding of the coupled thermal, mechanical, hydrological and chemical processes anticipated in the local rock mass surrounding the potential repository"

- **Drift Scale Test Design Report, 1997**

Drift Scale Test: Alcove 5 Layout



3-D View of Drift Scale Test Boreholes

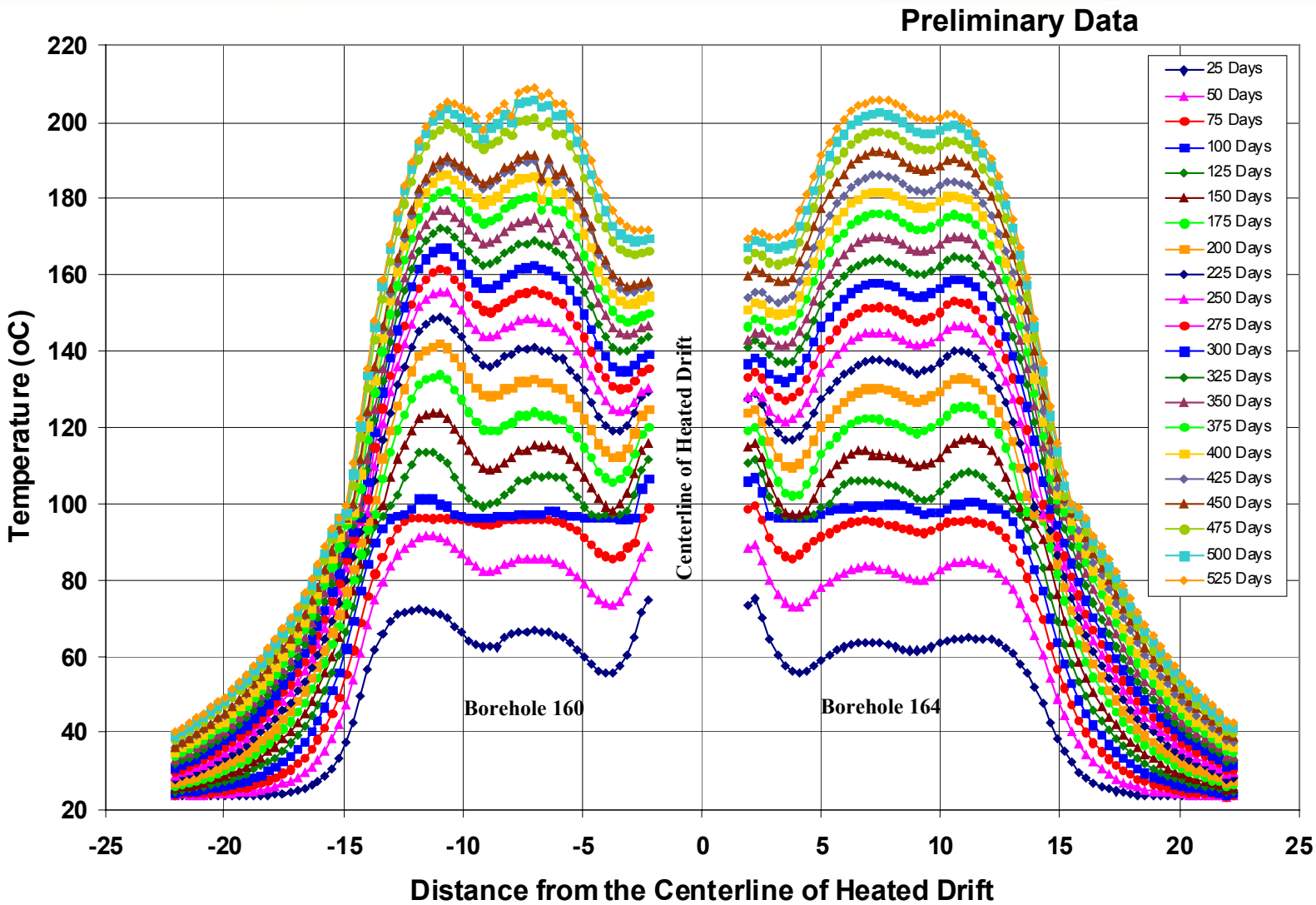


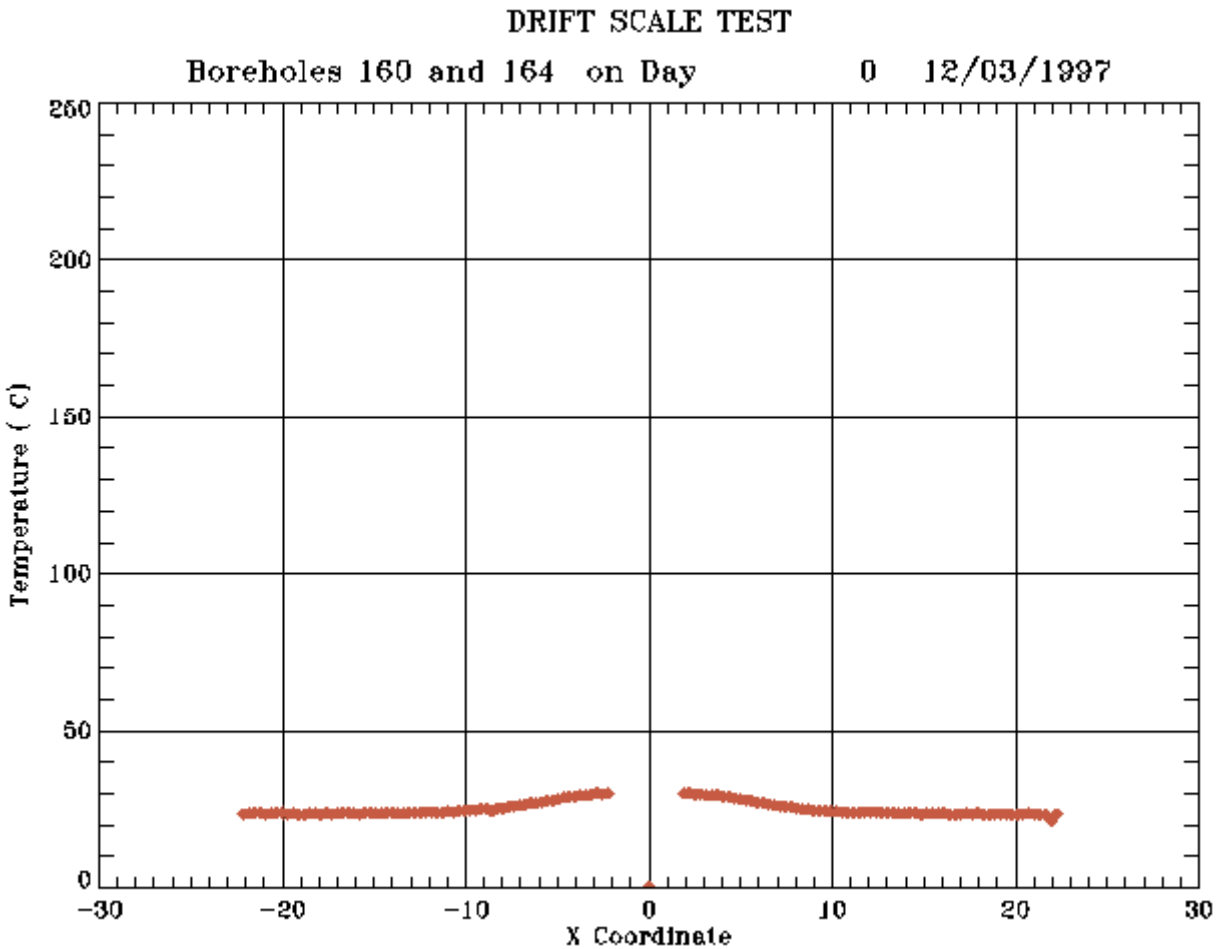
Drift Scale Test: Status

- **19 months of heating completed – 4 years planned**
- **Drift wall temperature ~ 175 ^{o}C (Goal: 200 ^{o}C)**
- **100 ^{o}C Isotherm – Approx. 2 m deep around the heated drift and 6 m above and below horizontal planes of wing heaters**

Drift Scale Test Results

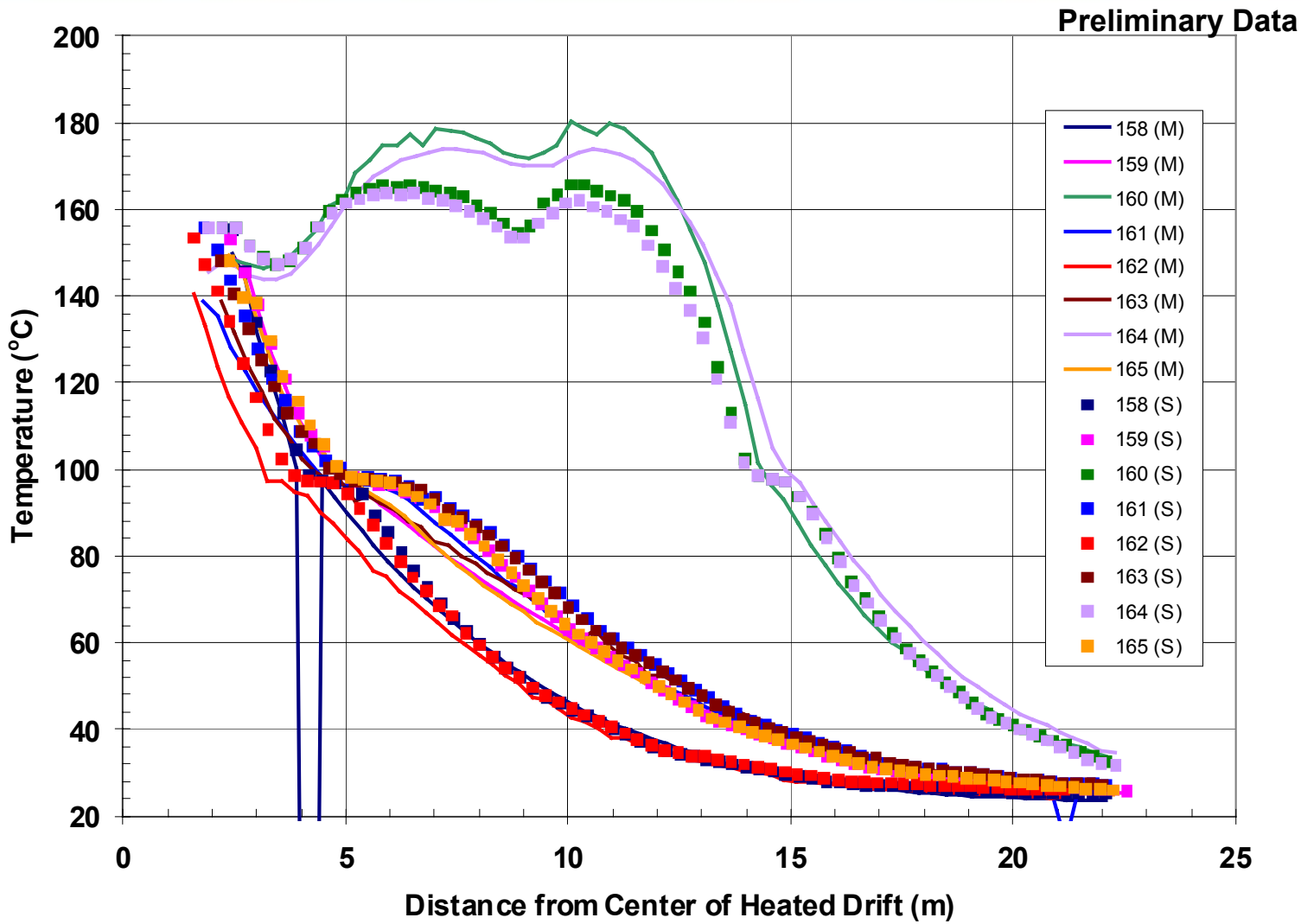
Representative Temperatures Parallel to the Wing Heaters

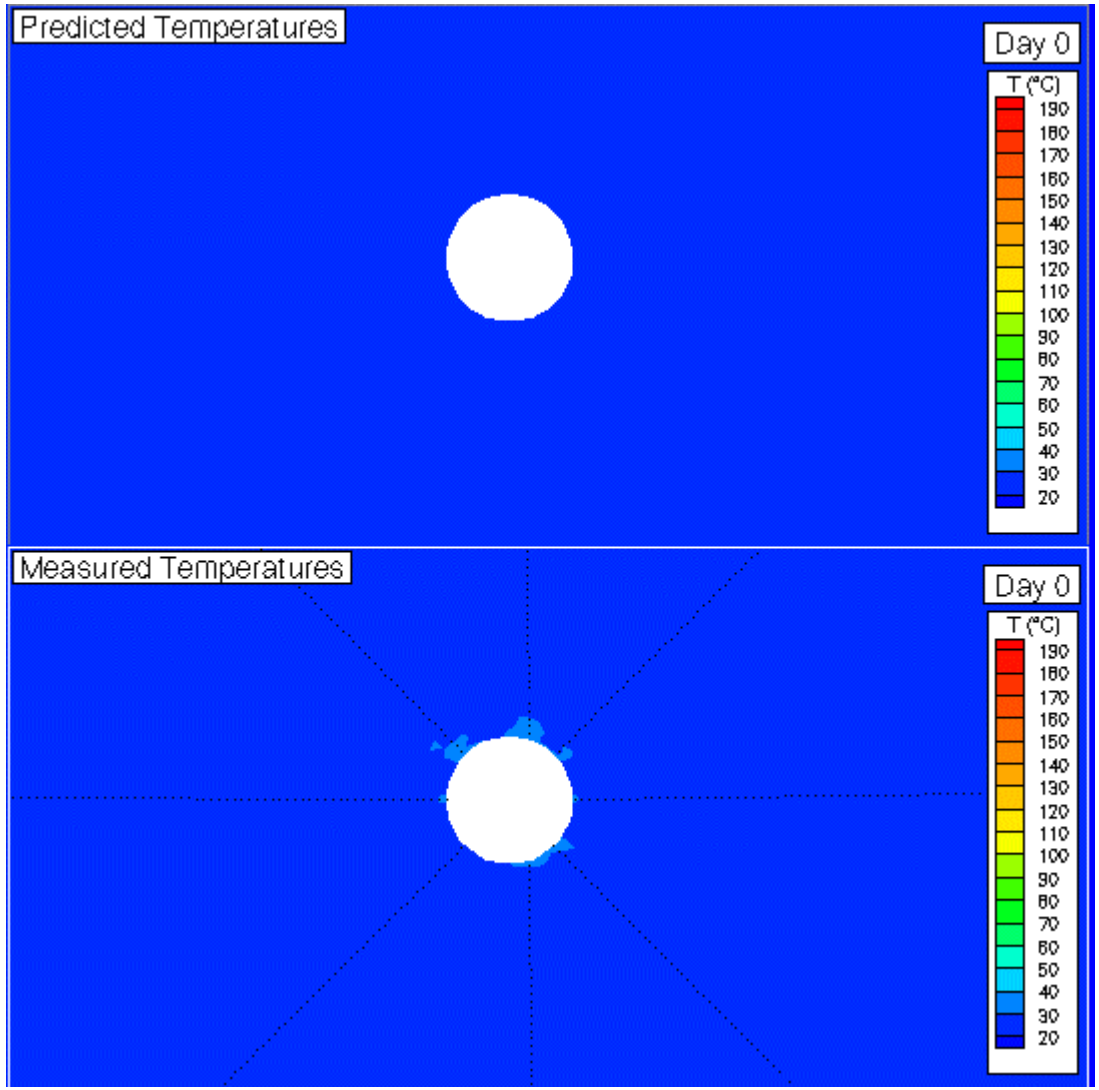



DRIFT SCALE TEST
Boreholes 160 and 164 on Day 0 12/03/1997
Temperature (C)
250
200
150
100
50
0
-30
-20
-10
0
10
20
30
X Coordinate

Drift Scale Test Results

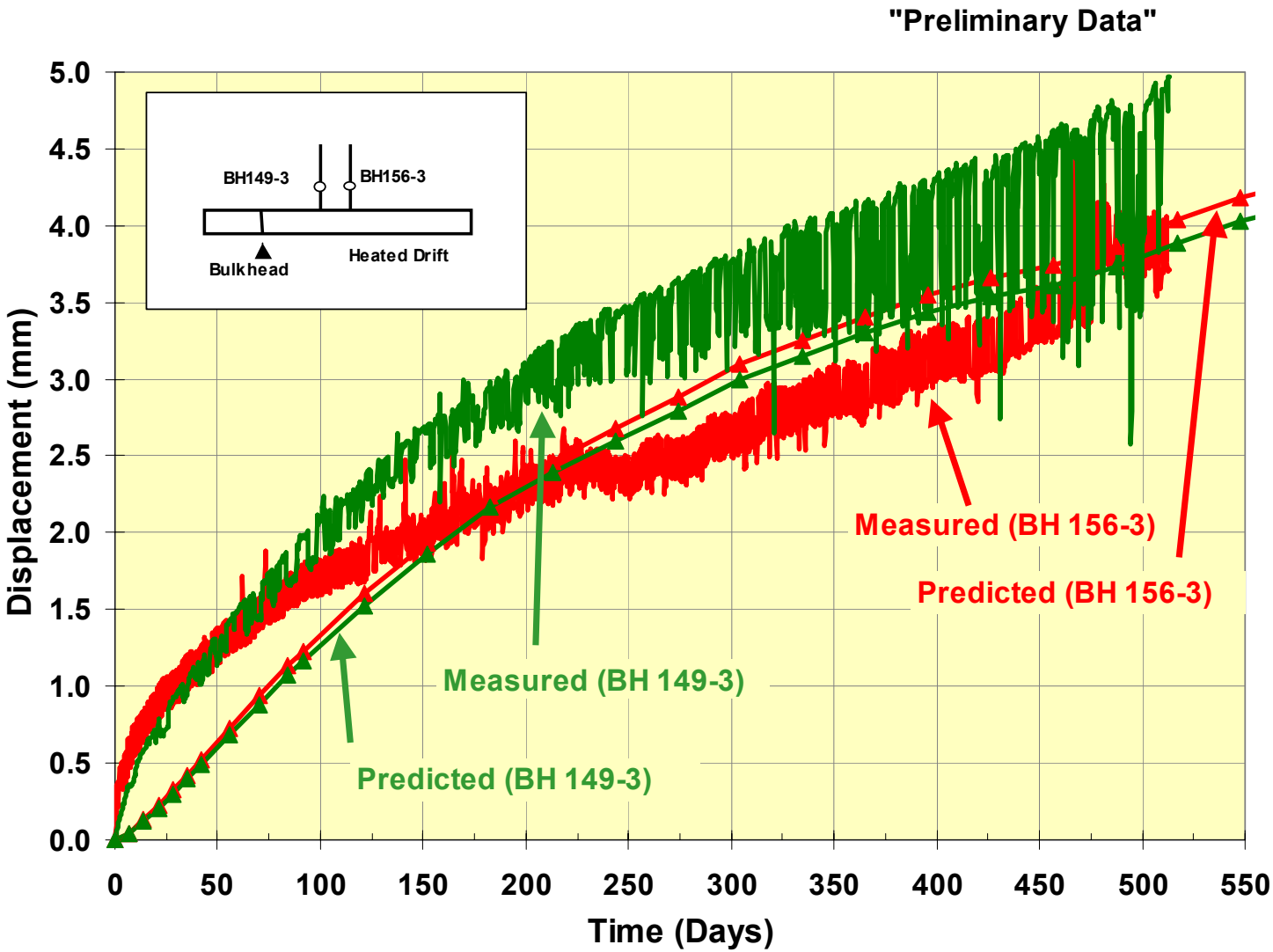
Measured (M) and Simulated (S) Temperatures at Mid-length of the Heated Drift after 1 Year of Heating




Predicted Temperatures
Day 0
T (°C)
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
Measured Temperatures
Day 0
T (°C)
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20

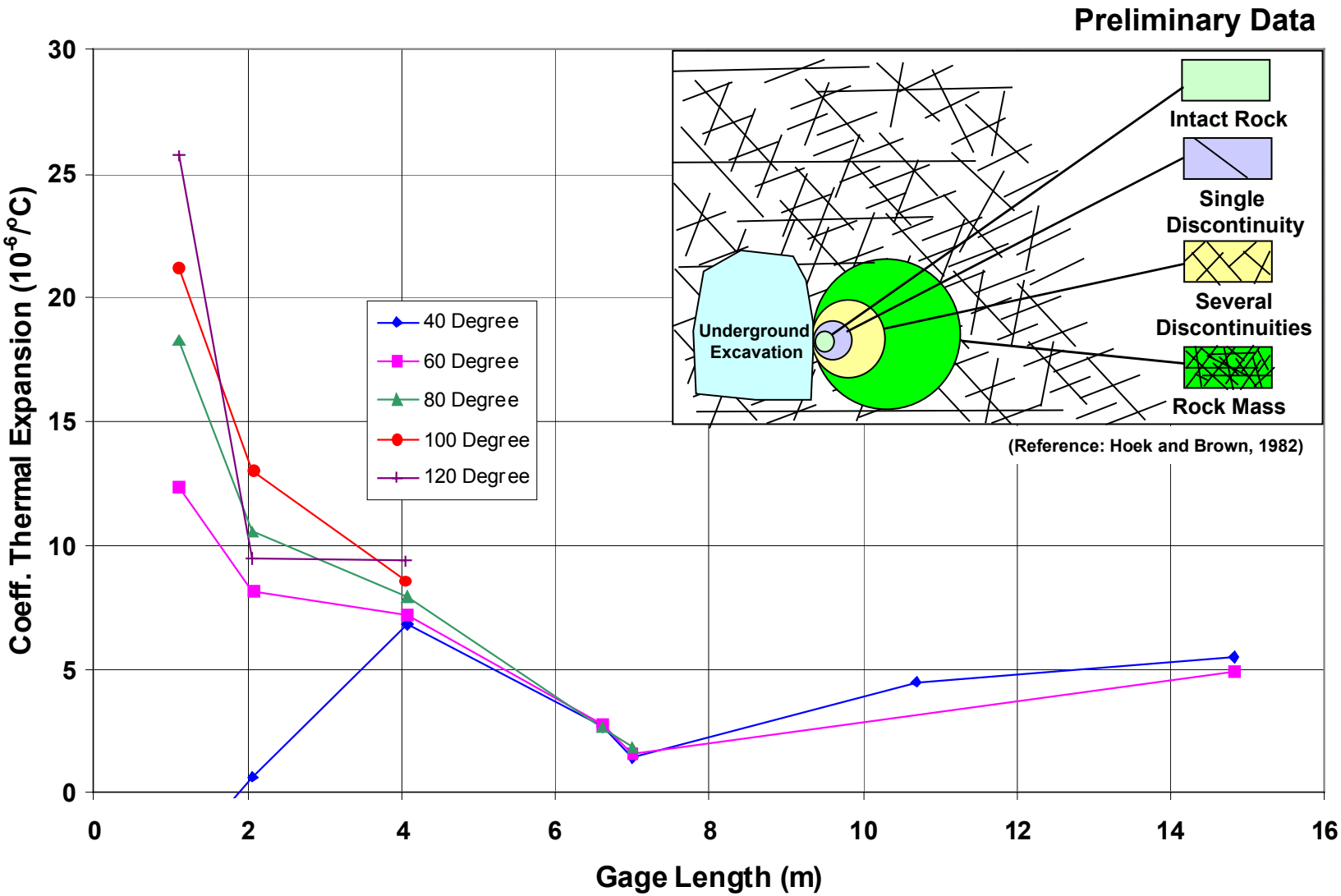
Drift Scale Test Results

Comparison of Measured and Simulated Deformation



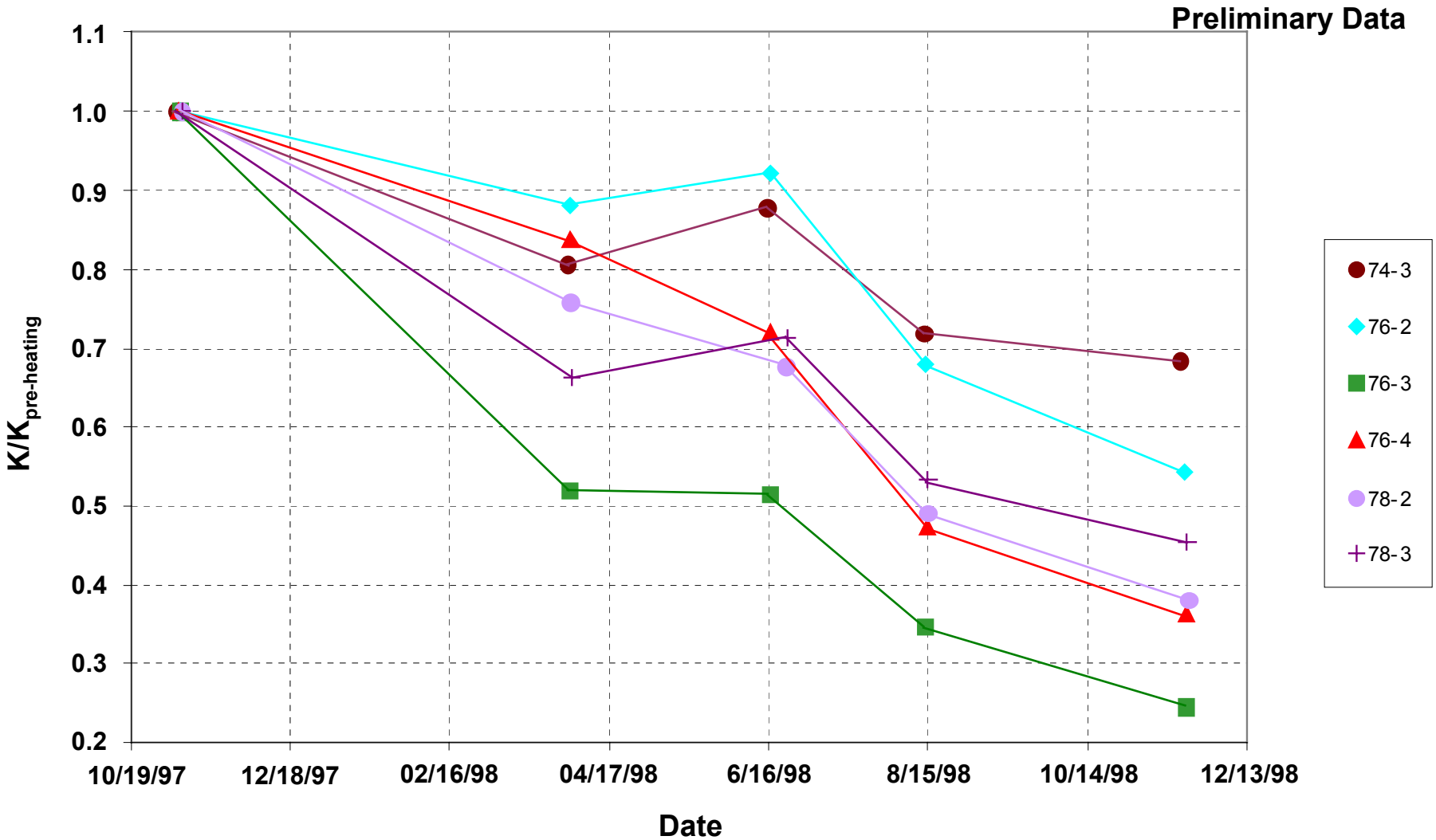
Drift Scale Test Results

Thermal Expansion vs. Gage Length

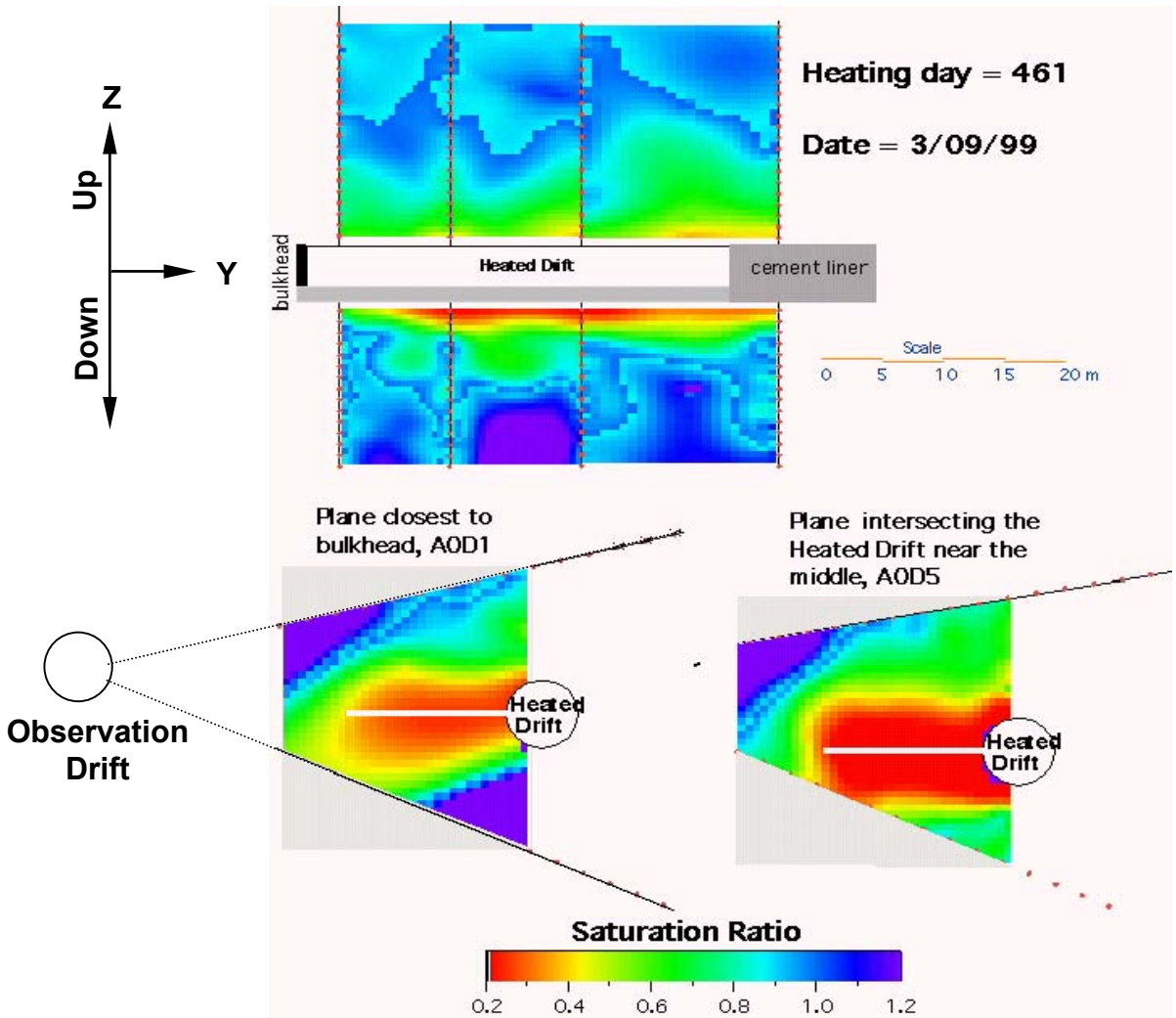


Drift Scale Test Results

Air-Permeability Reduction Due to Increased Fracture Saturation



Drift Scale Test Results
Electrical Resistivity Tomography

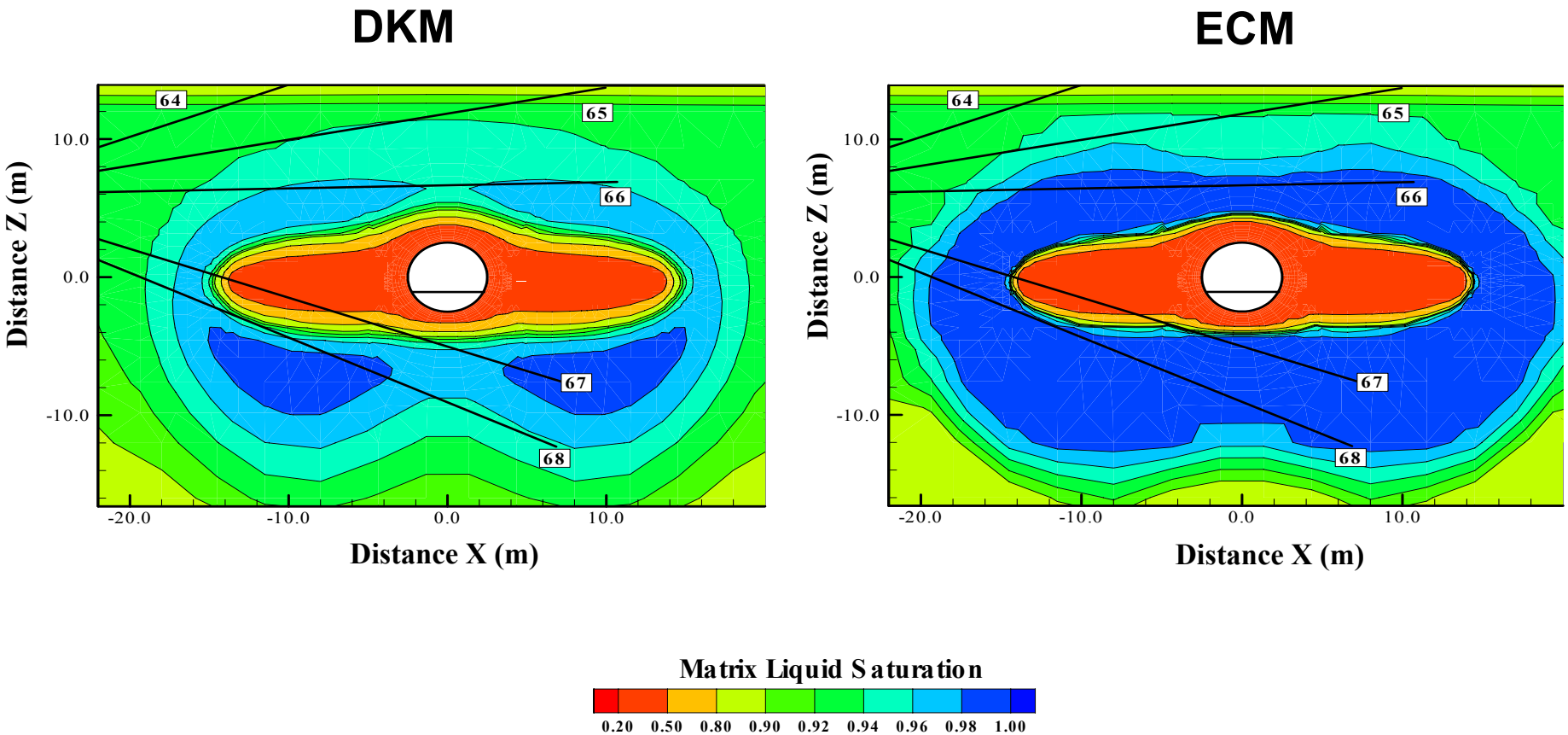


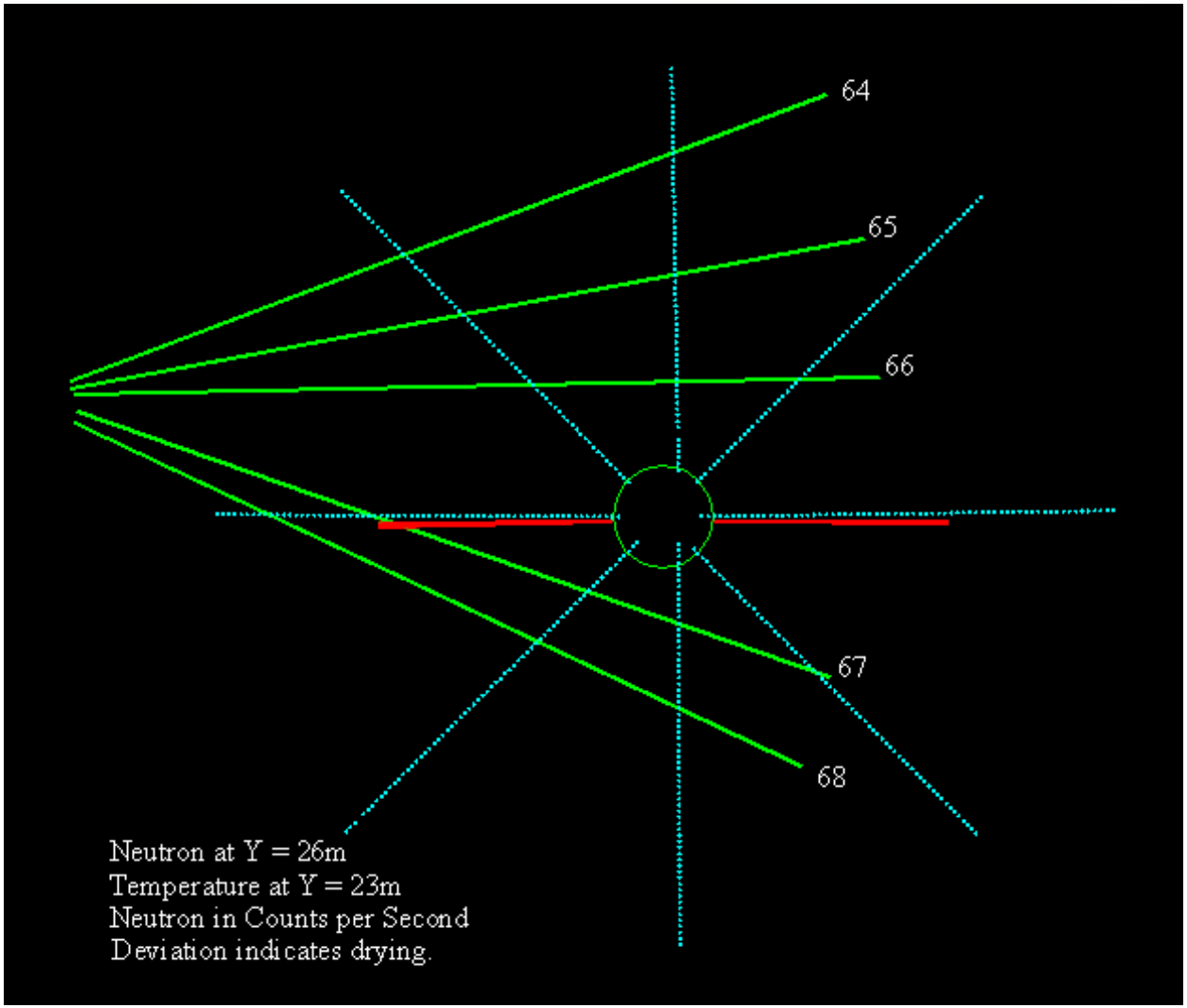
Preliminary Data

Drift Scale Test Results

Simulated Matrix Liquid Saturation After 12 Months of Heating

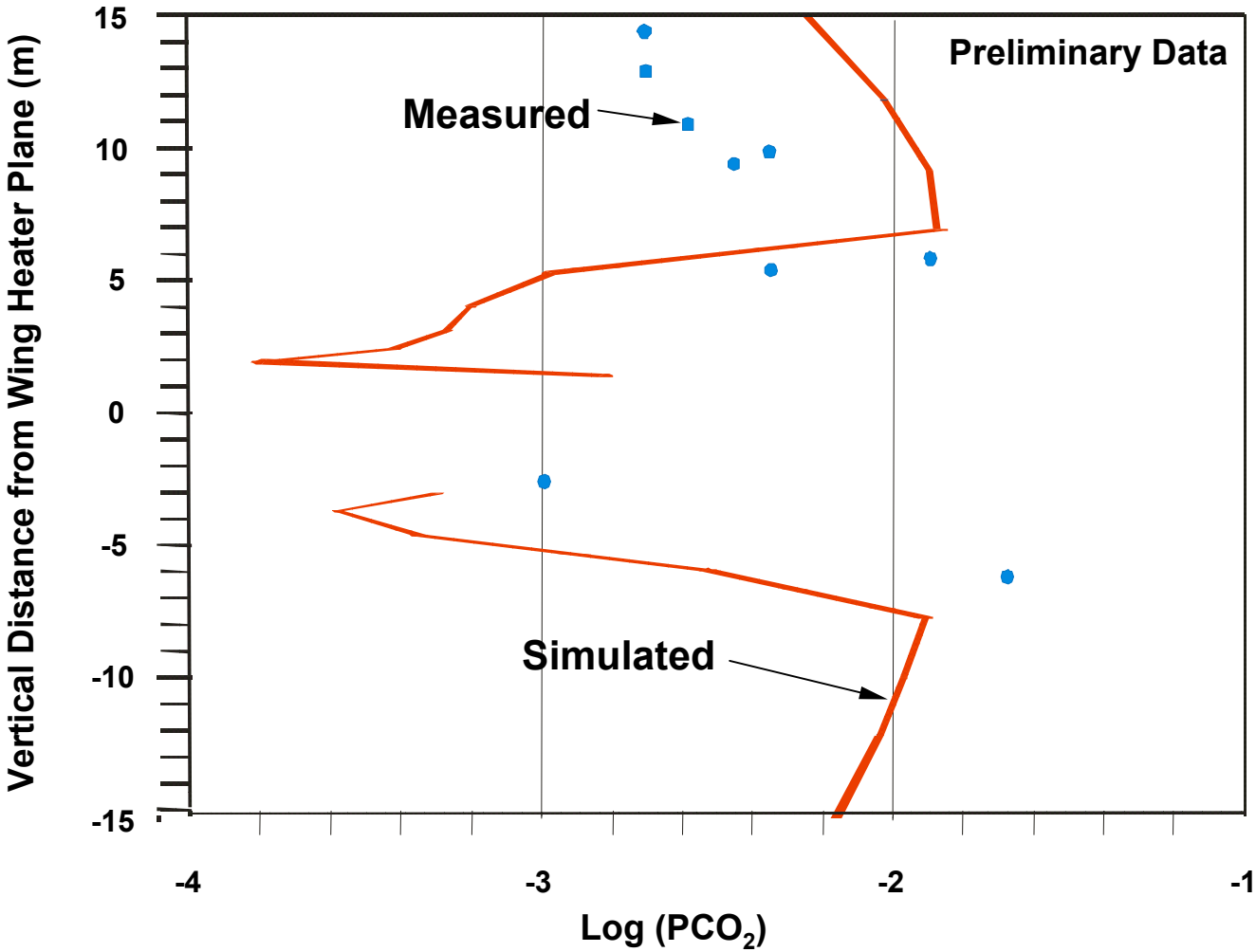
Preliminary Data




64
65
66
67
68
Neutron at Y = 26m
Temperature at Y = 23m
Neutron in Counts per Second
Deviation indicates drying.

Drift Scale Test Results

Partial Pressure of CO_2 In Fractures



Observations From Thermal Testing

- **Condensated rock moisture, mobilized by heating, drains by gravity via fractures to below the heated region rather than remaining perched above it**
- **Air-permeability in the rock mass beyond the dry-out zone decreases as mobilized water fills fractures**
- **Understanding of thermal-mechanical rock mass properties is being refined**

Observations From Thermal Testing

(continued)

- **The dual-permeability model [DKM] simulates the movement of moisture better than the equivalent continuum model [ECM]**
- **DKM and ECM behave similarly for simulating thermal behavior**
- **DKM will accommodate simulation of THC behavior better than ECM**
- **Rock porewater exsolves CO_2 upon heating based on measurements of increased CO_2 concentrations in gas samples which, upon dissolution into mobilized water, results in a pH much lower than ambient porewater**

Integration of DST with SHT and LBT

- **Experience in the Single Heater Test (SHT) was instrumental in the design and refinement of several DST measuring systems**
- **Collection and analyses of water samples from the SHT revealed the importance of CO_2 in the assessment of thermally-driven processes and the design of water and gas sampling systems in the DST**
- **Observation of thermally-driven moisture below the heated region in the SHT and Large Block Test (LBT) has been corroborated by the DST**

Applicability of DST Results to Design

- The understanding of thermally-driven coupled processes can be applied to a range of different repository configurations, components, and heating scenarios
- The range of the TMHC processes considered encompasses anticipated behavior in most repository designs
- Thus, DST results can be used to evaluate conditions expected in other design scenarios

Applicability of DST Results To *Tptpll*

- **The DST provides a broad foundation for understanding how coupled TMHC processes are influenced by characteristic rock properties such as thermal conductivity, thermal expansion, permeability, porosity, saturation, and mineralogy**
- **Developed process models will be used to predict behavior in the planned ECRB thermal test**
- **Process models will be validated and refined with the test results from the planned ECRB thermal test**
- **An objective of the thermal test program is to develop robust process models that can be used with greater confidence in a variety of conditions**