

Using temperature to test
conceptual models of flow
and fault-zone recharge
near Yucca Mountain,
Nevada

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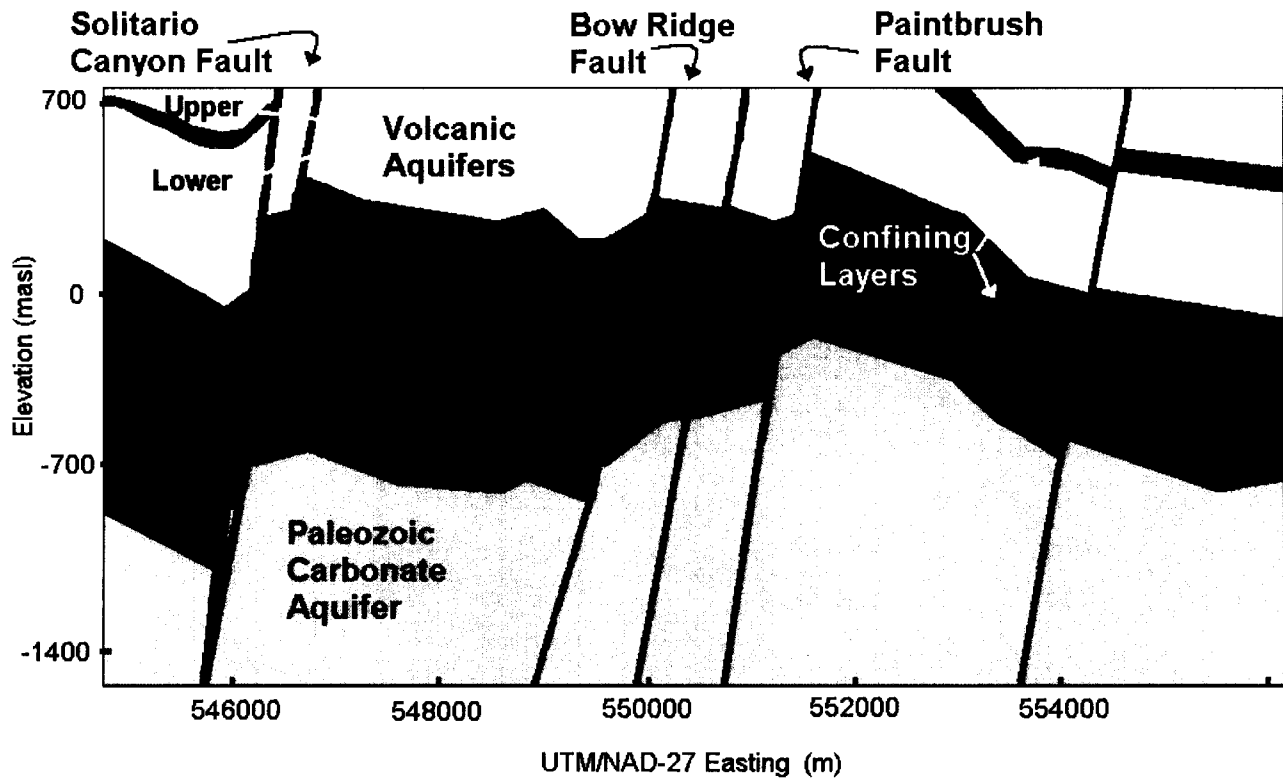
• Approach

- EarthVision geologic framework model:
 - used to interpret layer geometry and assign thermal and hydrologic properties to mass and energy transport model

- Mass and energy transport model:
 - 49 x 59 x 20 non-uniform but logically rectangular grid represents system geometry
 - Constant head/temperature side boundaries
 - No-flow, constant temperature top boundary
 - Both constant-temperature and constant heat-flux bottom at the boundary were evaluated
 - Mass transport calibrated to hydraulic heads observed in wells

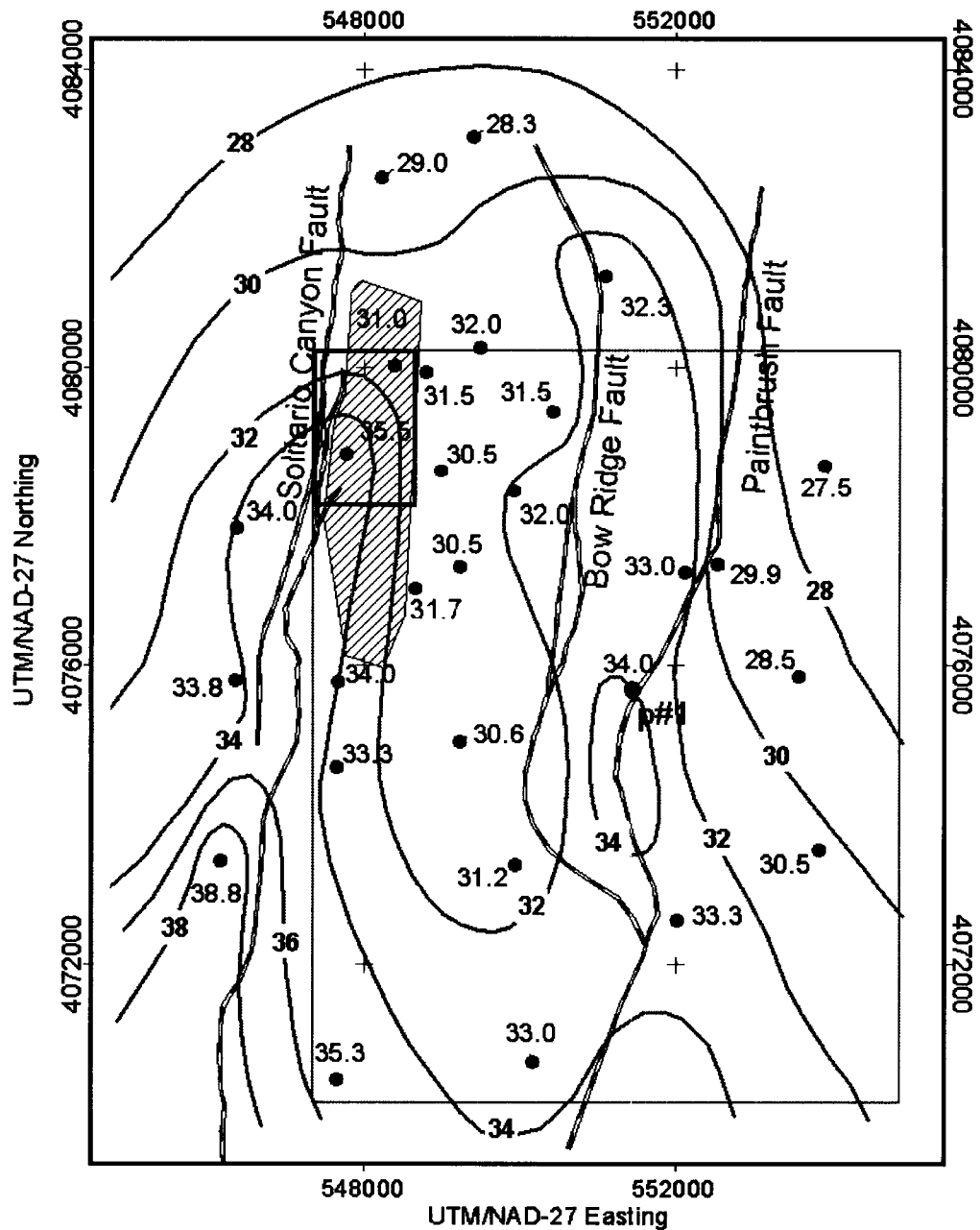
- Evaluate factors that affect modeled temperature distribution:
 - Case with heat conduction only (no mass flow)
 - Case with heat conduction and groundwater advection but no fault zone recharge
 - Evaluate effects of bottom boundary (constant temperature vs. constant heat flux)
 - Evaluate effects of varying fault-zone recharge on water table temperature

Yucca Mountain Groundwater Flow System



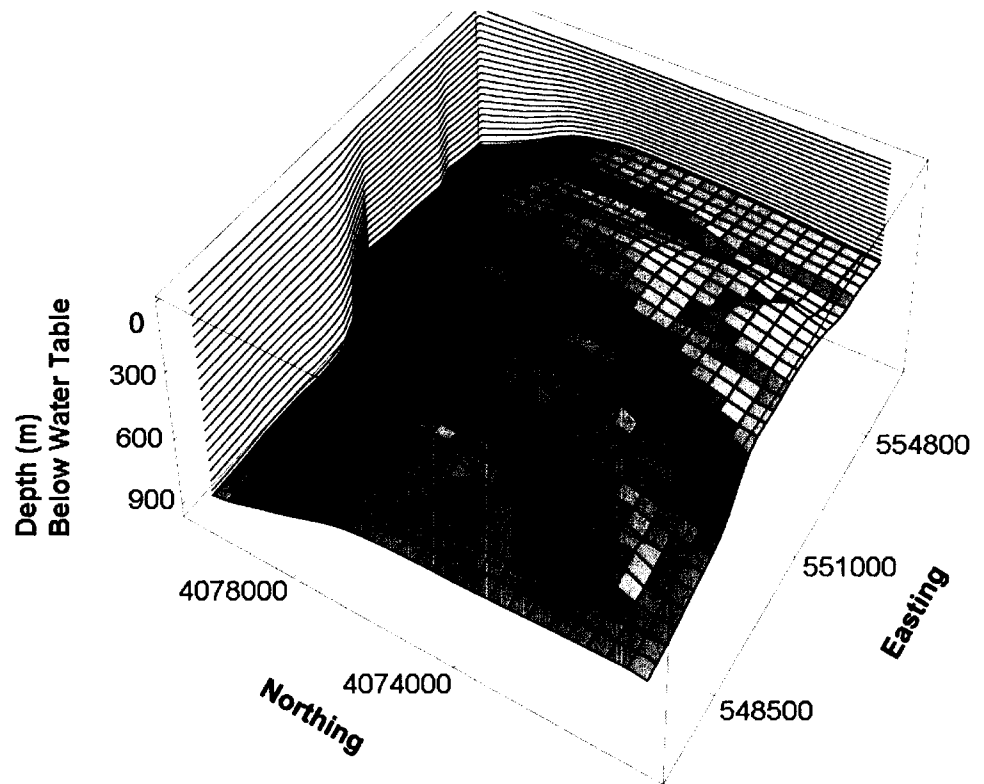
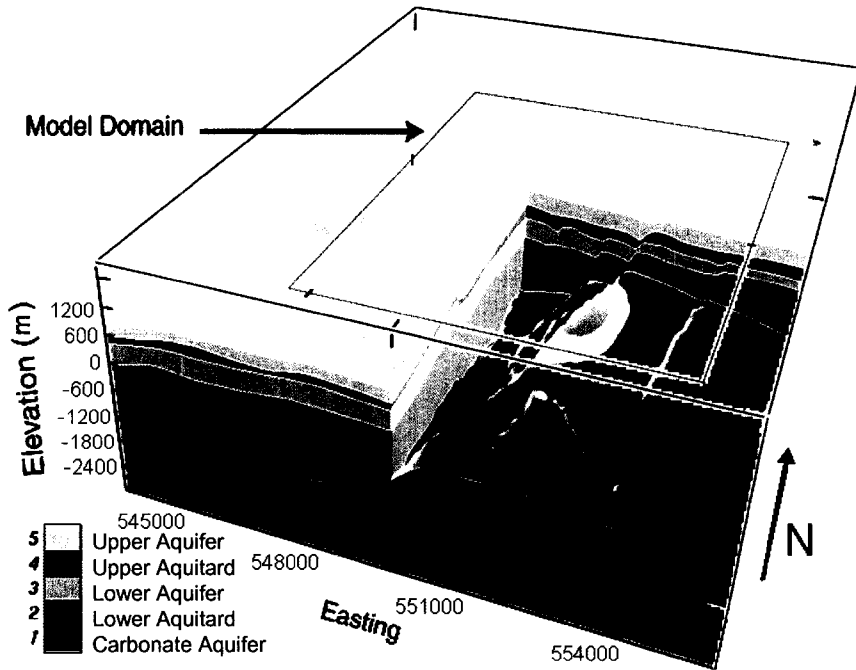
East-West Cross Section from the EarthVision Hydrogeologic Framework Model

Temperature Distribution at Water Table



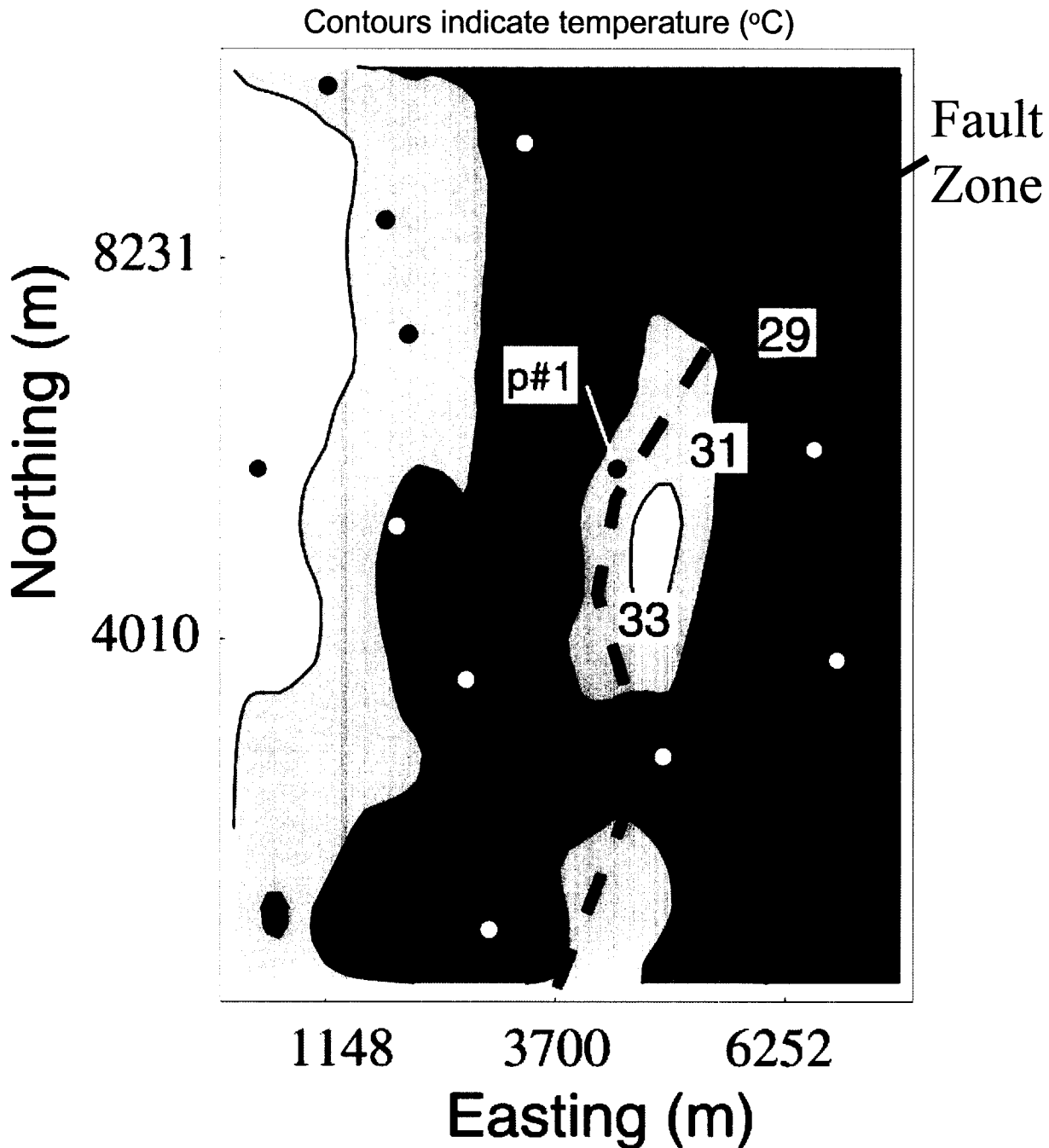
- | | |
|---|---|
|  Model Boundary |  Temperature Measurements |
|  Proposed Repository Area |  Major Faults |
|  Reduced Permeability Zone |  Temperature Contours (°C) |

3-D Mass and Energy Transport Model

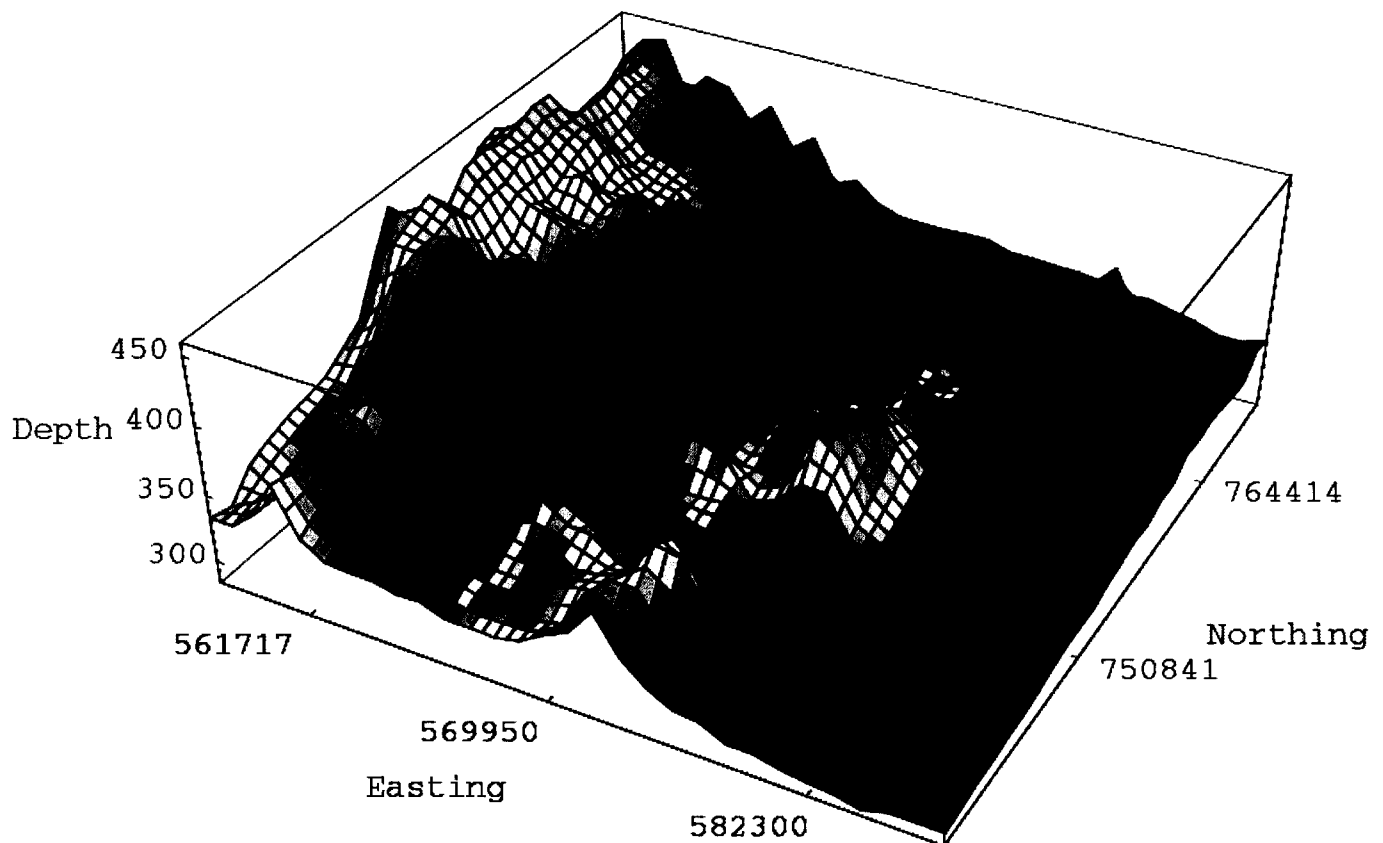


Modeled Temperature Distribution

Heat conduction only model (no mass flow):
Constant temperature (55°C) at lower boundary



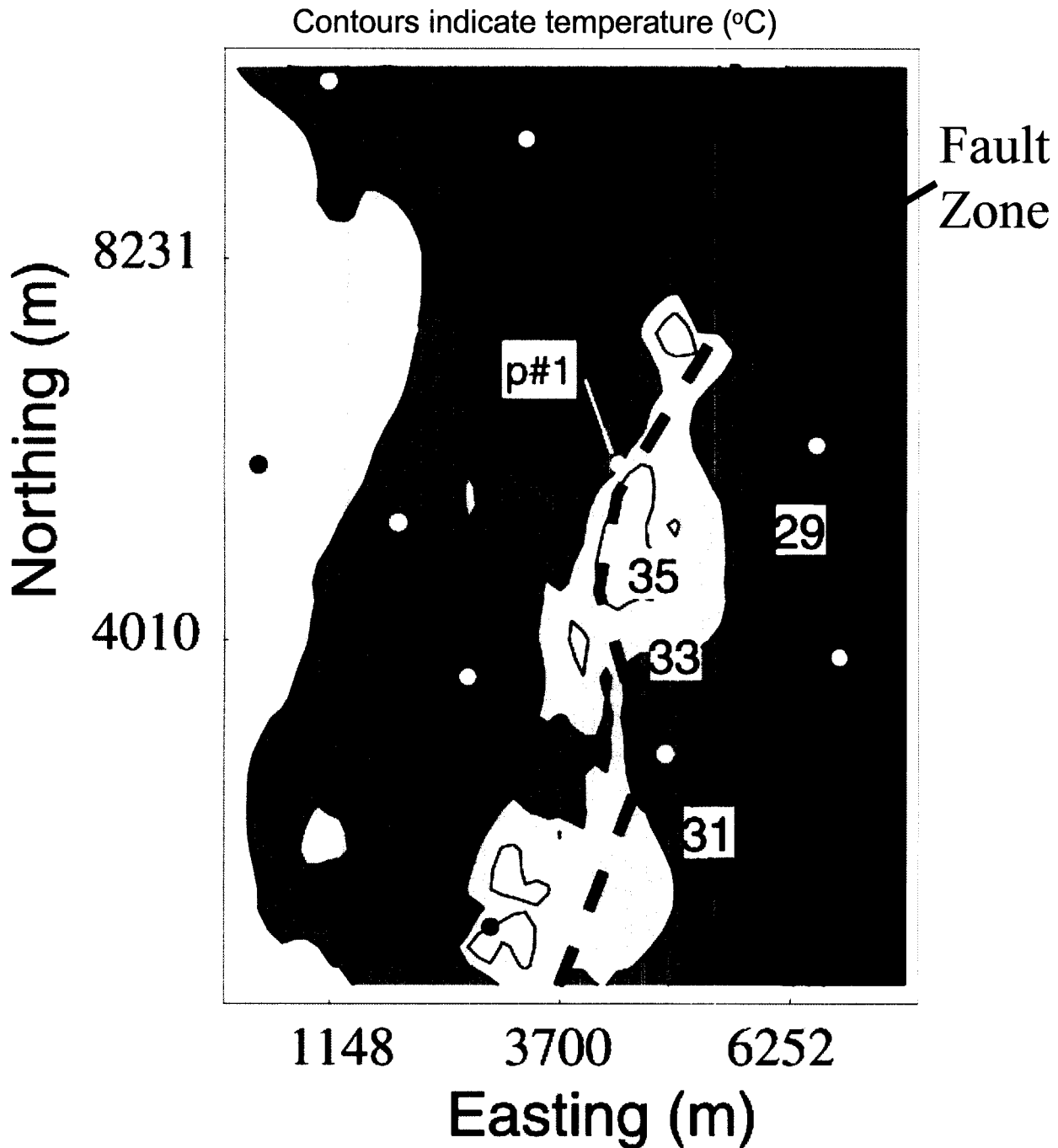
Effect of Topography on Calculated Water Table Temperature



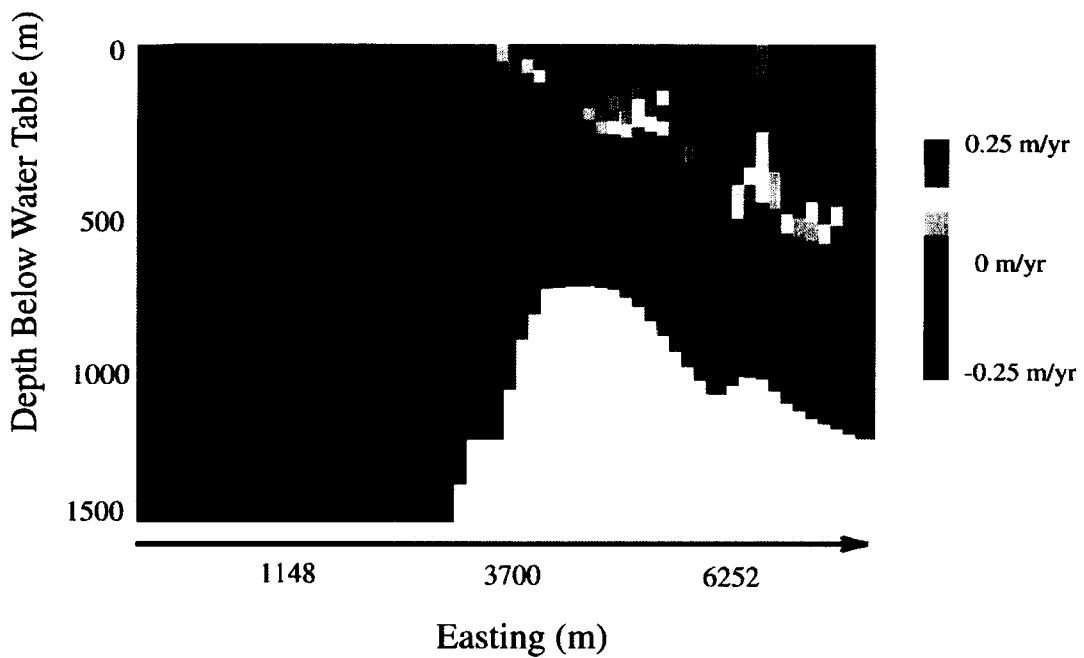
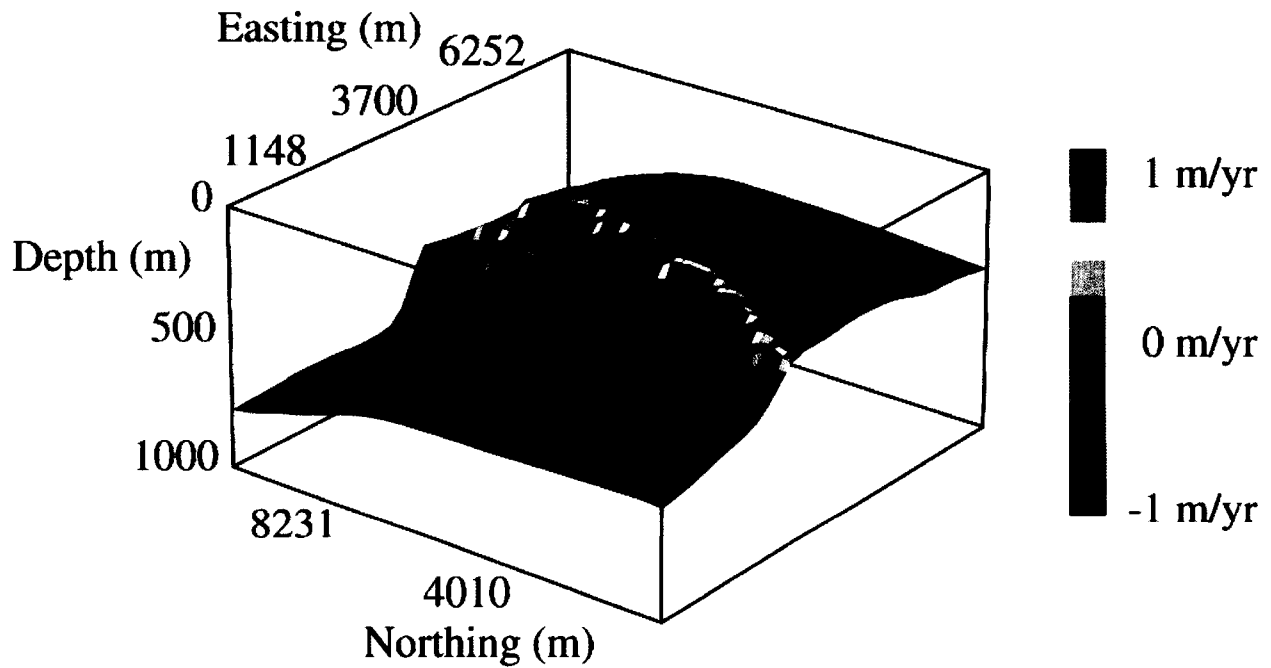
Warm colors = Higher Temperature
(range = 28-36 degrees Celsius)

Modeled Temperature Distribution

Conduction and groundwater advection:
constant temperature (55°C) at lower boundary



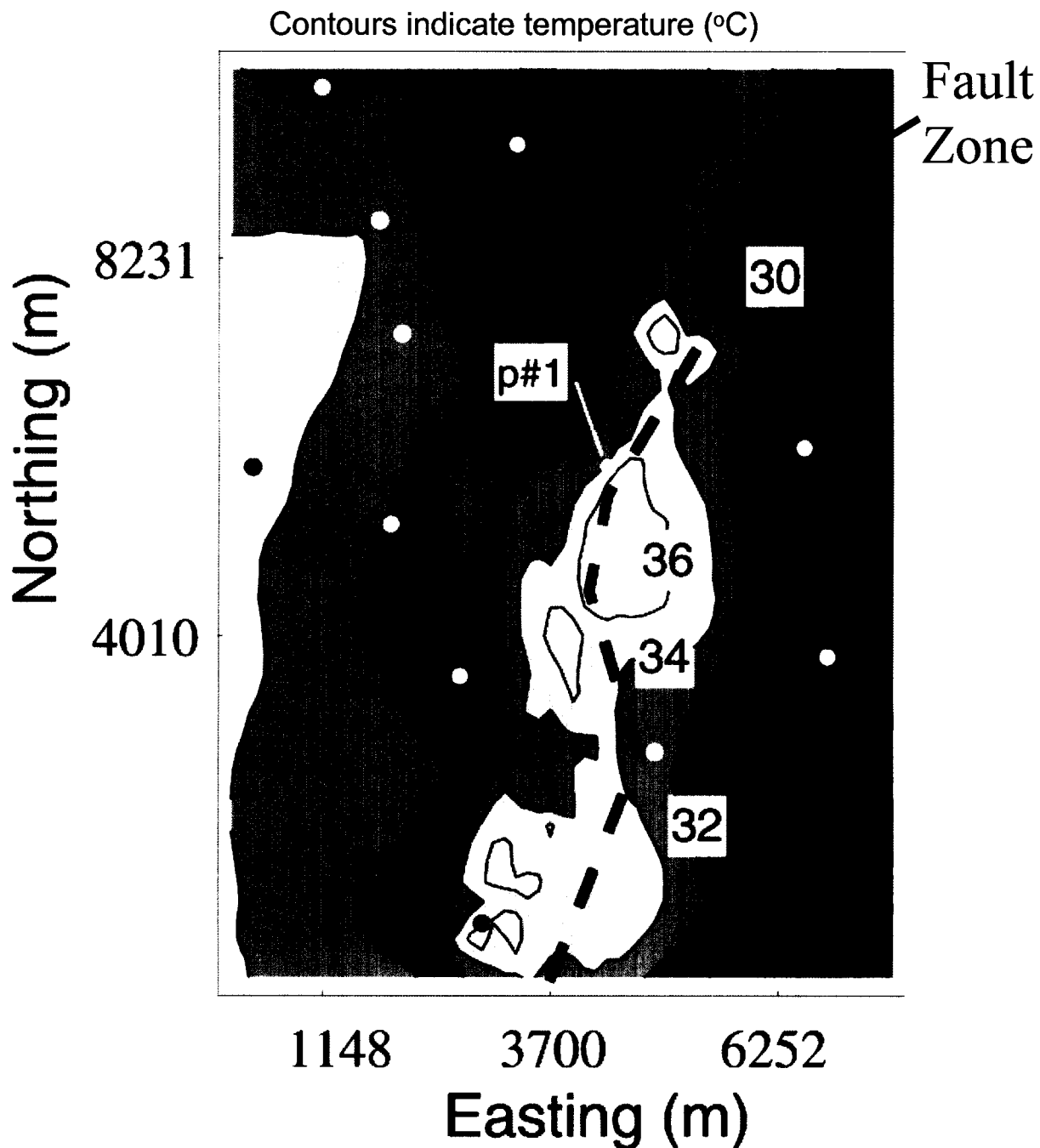
Effect of System Geometry on Vertical Flow Velocity



Cool colors = upward flow

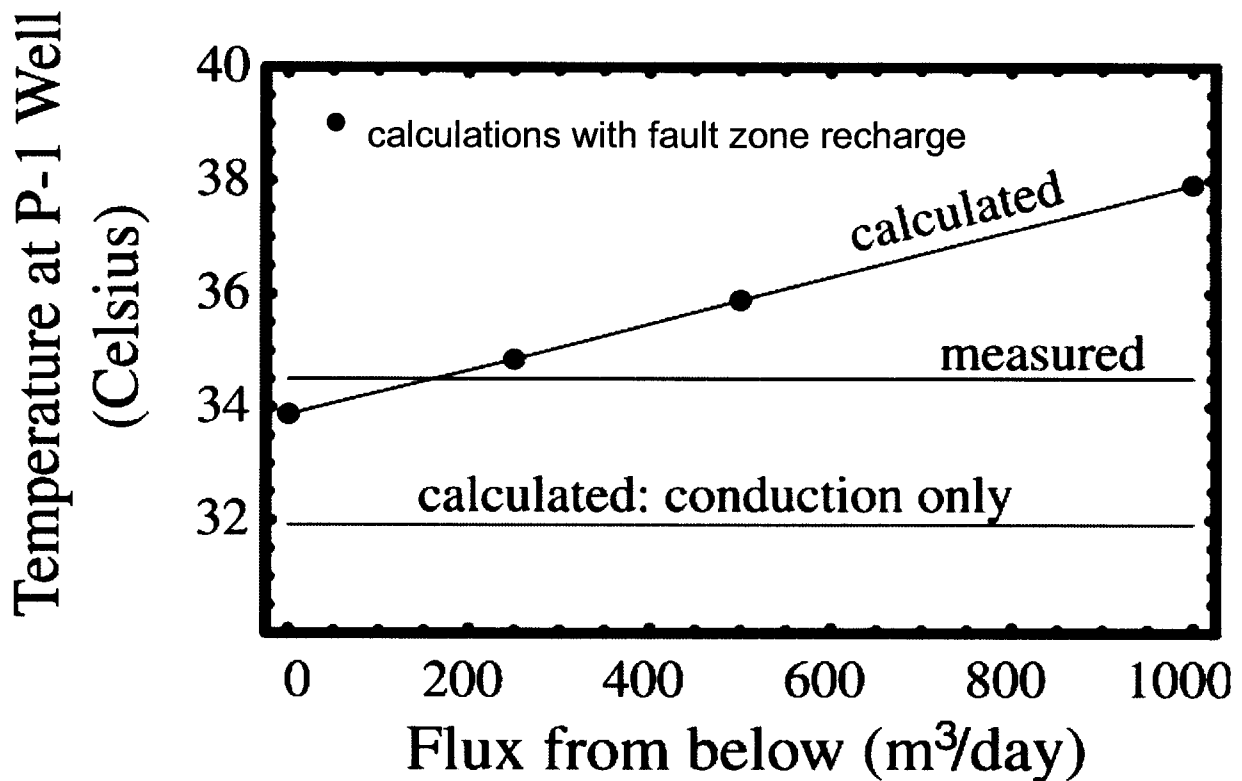
Modeled Temperature Distribution

Conduction and groundwater advection: Specified heat flux (30 mW/m²) at lower boundary



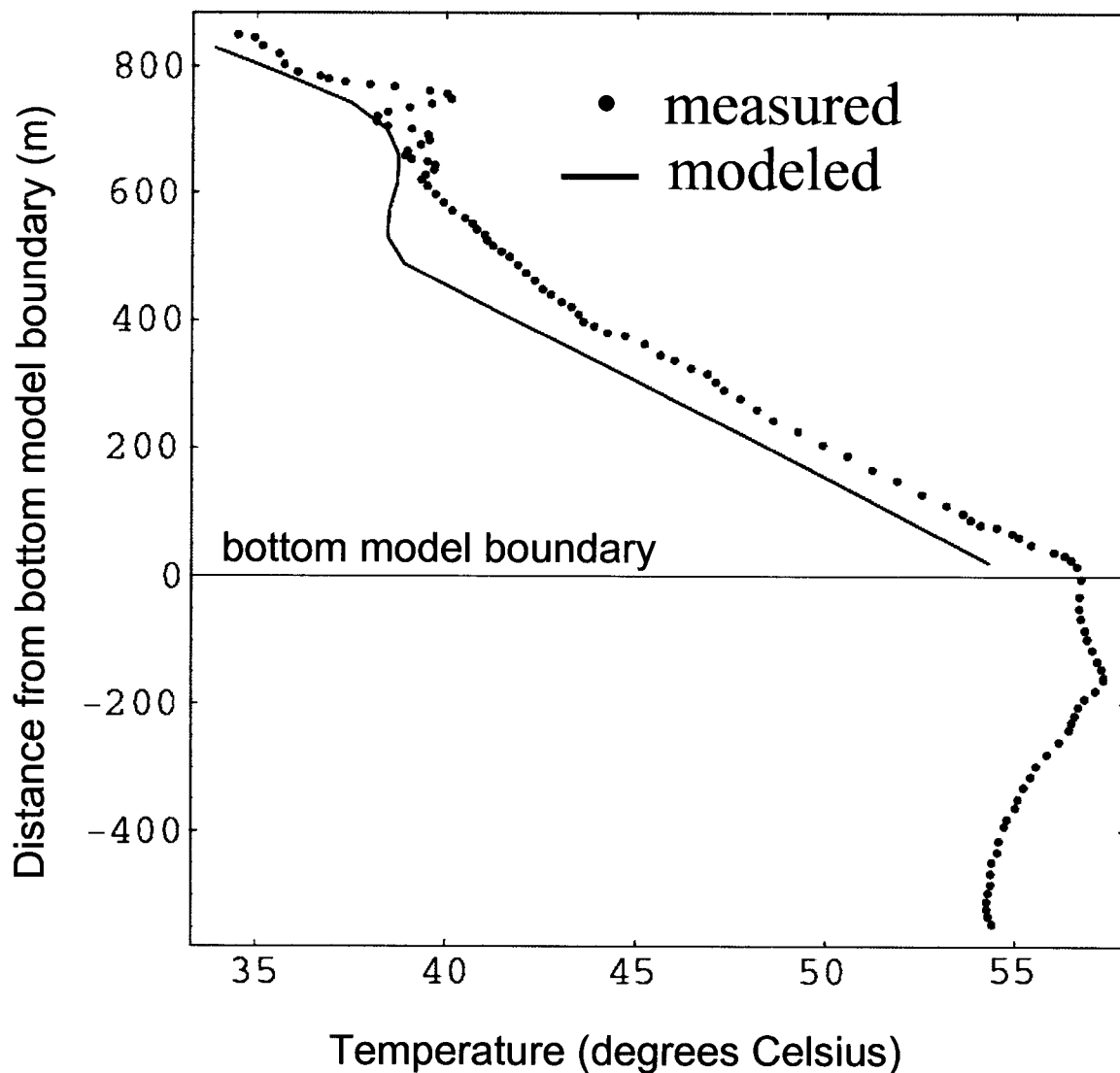
Effects of Fault Zone Recharge on Water Table Temperature

Modeled water table temperature at well UE-25p#1 location



Modeled vs. Observed Temperature Profiles in Well UE-25p#1

Case with conduction + groundwater
advection, no fault-zone recharge, and
constant temperature lower boundary





- **Conclusions**

- Observed elevated groundwater temperatures aligned with fault zones East of Yucca Mountain can be explained without significant fault-zone recharge
- Meaningful interpretation of groundwater temperature patterns requires consideration of unsaturated zone thickness, aquifer system geometry, and 3-dimensional flow patterns
- Temperature data can provide valuable additional constraints for flow model calibration