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

PRESENTATION TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: NEAR-FIELD ENVIRONMENT TESTING CONSIDERATIONS

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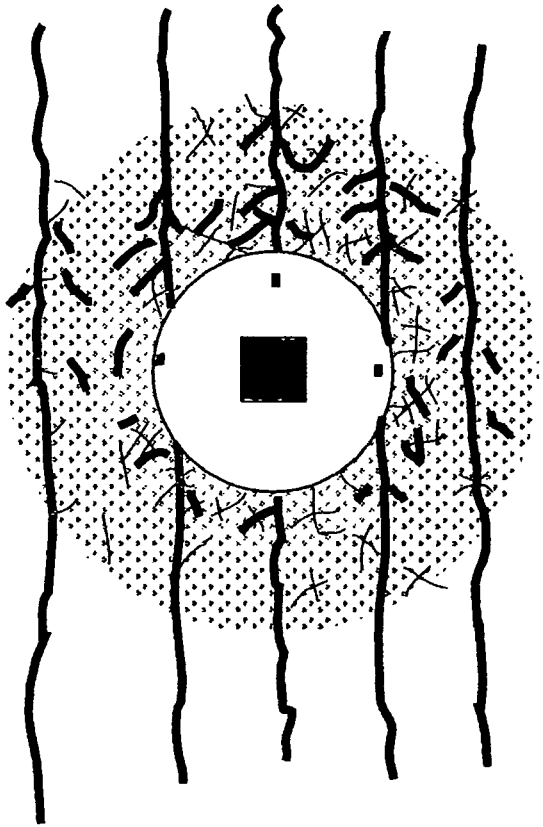
Scope

- An Engineered Barrier System includes waste package and the near-field environment
- The near-field environment is an integral part of a repository
- The main concern is the amount and quality of water in the environment
- This talk covers tests required to understand the moisture movement in the near-field environment

EBS Concepts — High and Low thermal loadings

HIGH



temperature

cracking

dehydration

rehydration

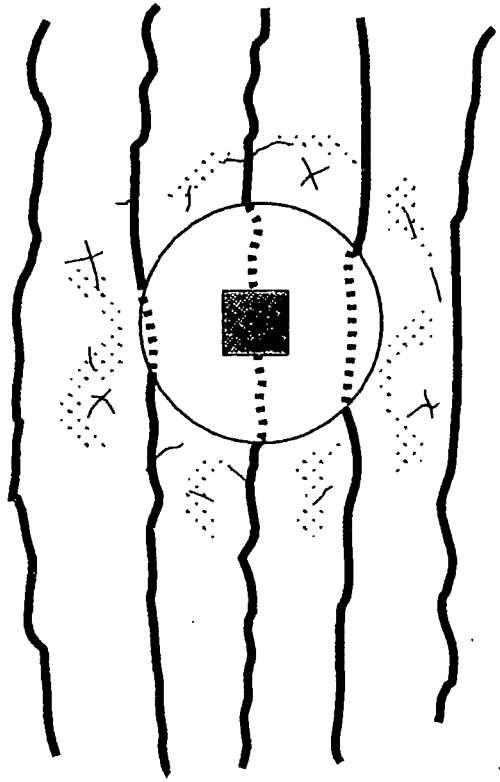
infiltration

geochemistry

flows

stability

LOW



Similar tests are required for both cases

Near-Field Environment Tests

Provide Input Data and Validation of Models

- Laboratory tests
- In situ tests

Laboratory Testing
To Study the Hydrologic Properties of Rocks

Will cover:

- Fracture healing
- Model validation experiments
- Matrix properties
- Hydrology and nuclide adsorption experiment

Fracture Healing Experiments

To Study Fracture Healing at Elevated Pressures and Temperatures

Experimental results so far suggest that fracture begins to "heal" when -

- Pressure = 5 MPa
- Temperature above 90° C (high and low)
- Flowing water or steam (high and low)

Model Validation Experiments

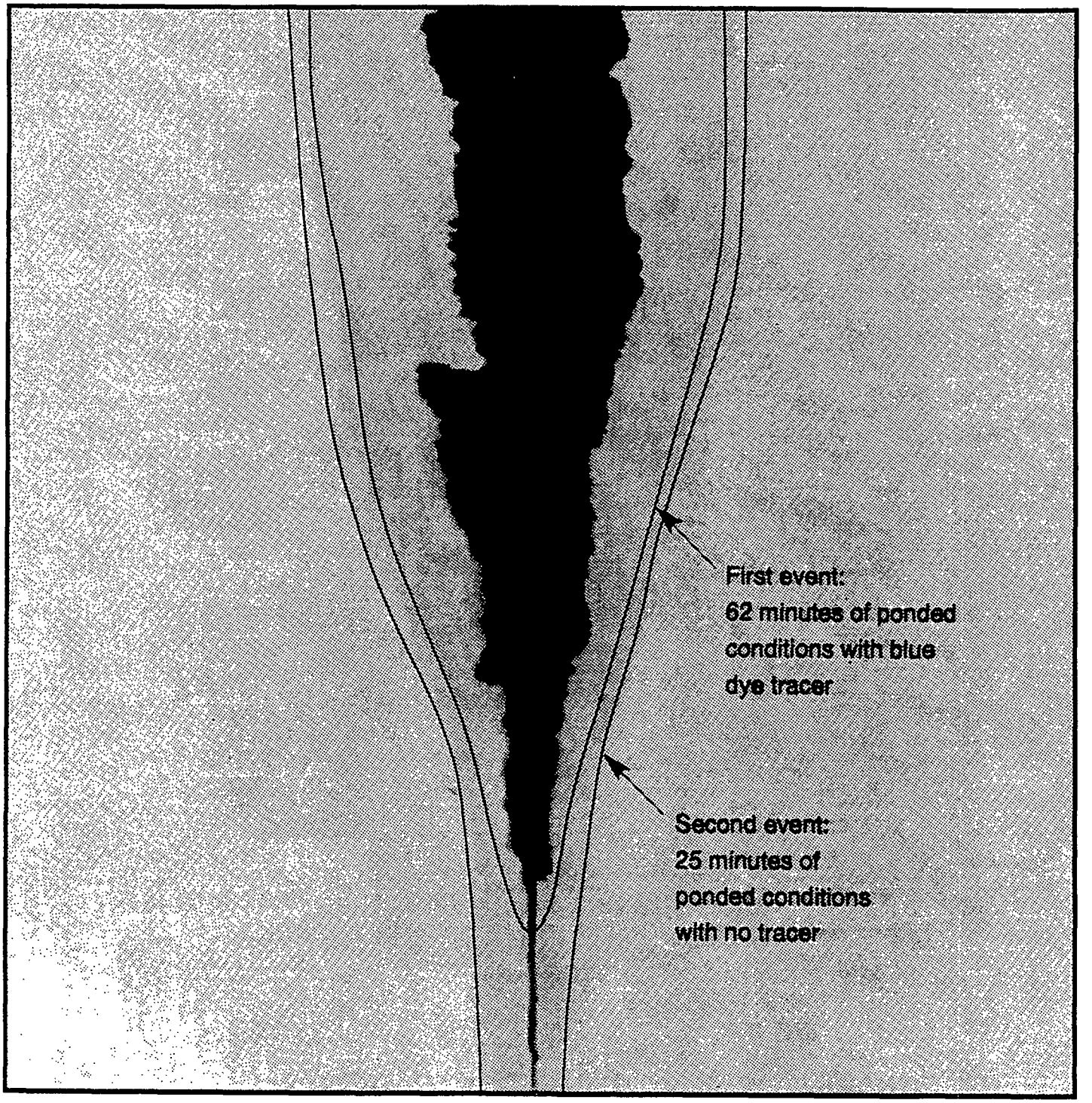
Effect of Temperature on the Flow of Water and Vapor

- Imbibition and drying (high and low)
- Condensation along fractures (high)
- Fracture flow vs. matrix flow (high and low)
- Laboratory heated block experiments (high and low)

Impedance images of a rock sample indicate that rehydration is not a reverse process of dehydration

Prototype Experiment of Fracture-Matrix Flow

First episodic event: wetting front after 62 minutes of ponded conditions using blue dye tracer



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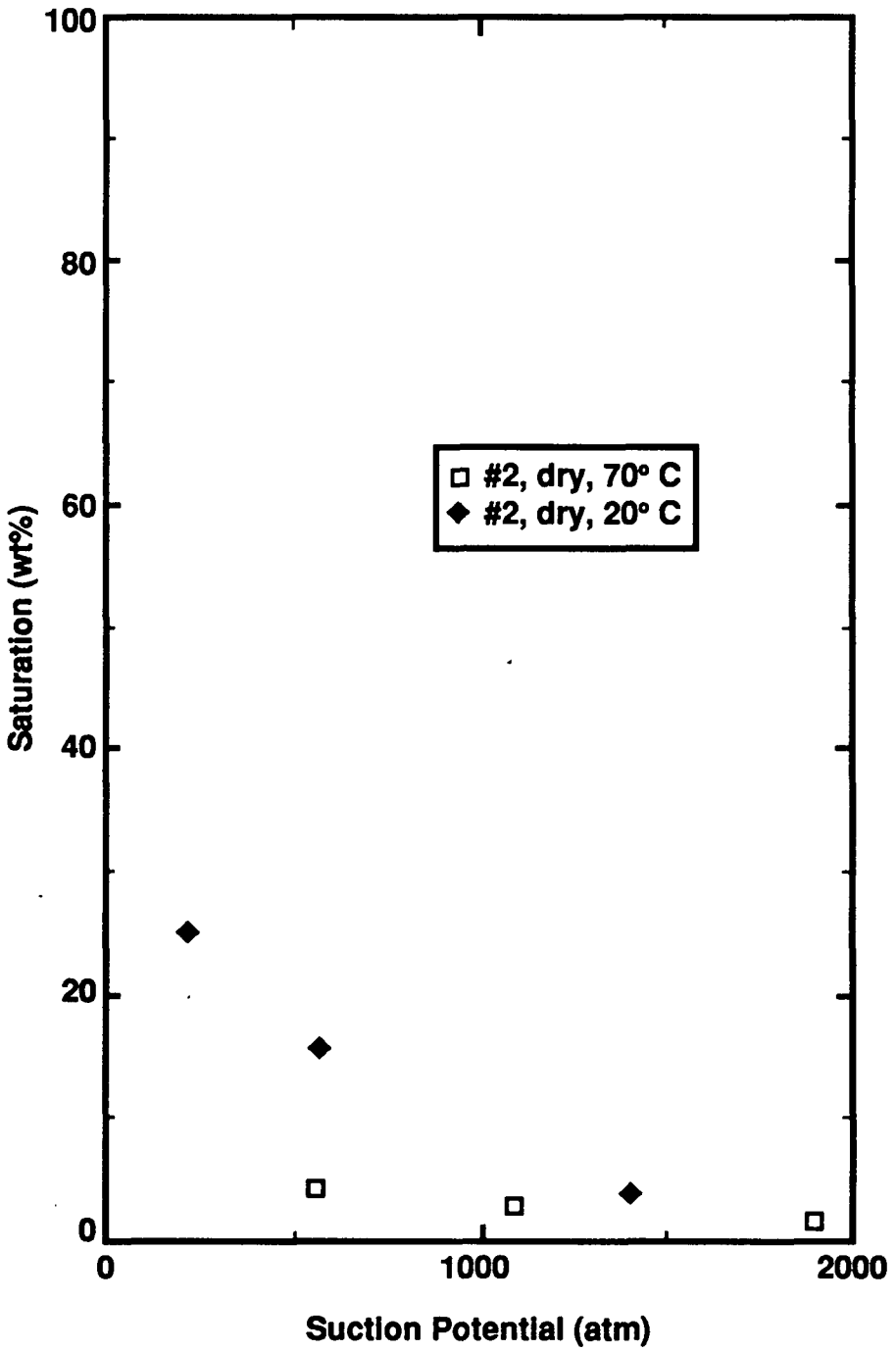
Matrix Properties

Effect of Temperature on Intact Sample

Measure:

- Suction potential (T to 160° C) (high and low)
- Thermal cracking (more at high)
- Permeability (high and low)
- Klinkenberg coefficients (high and low)

Saturation vs Suction Potential of Topopah Spring Tuff, Drying, at 20 and 70° C



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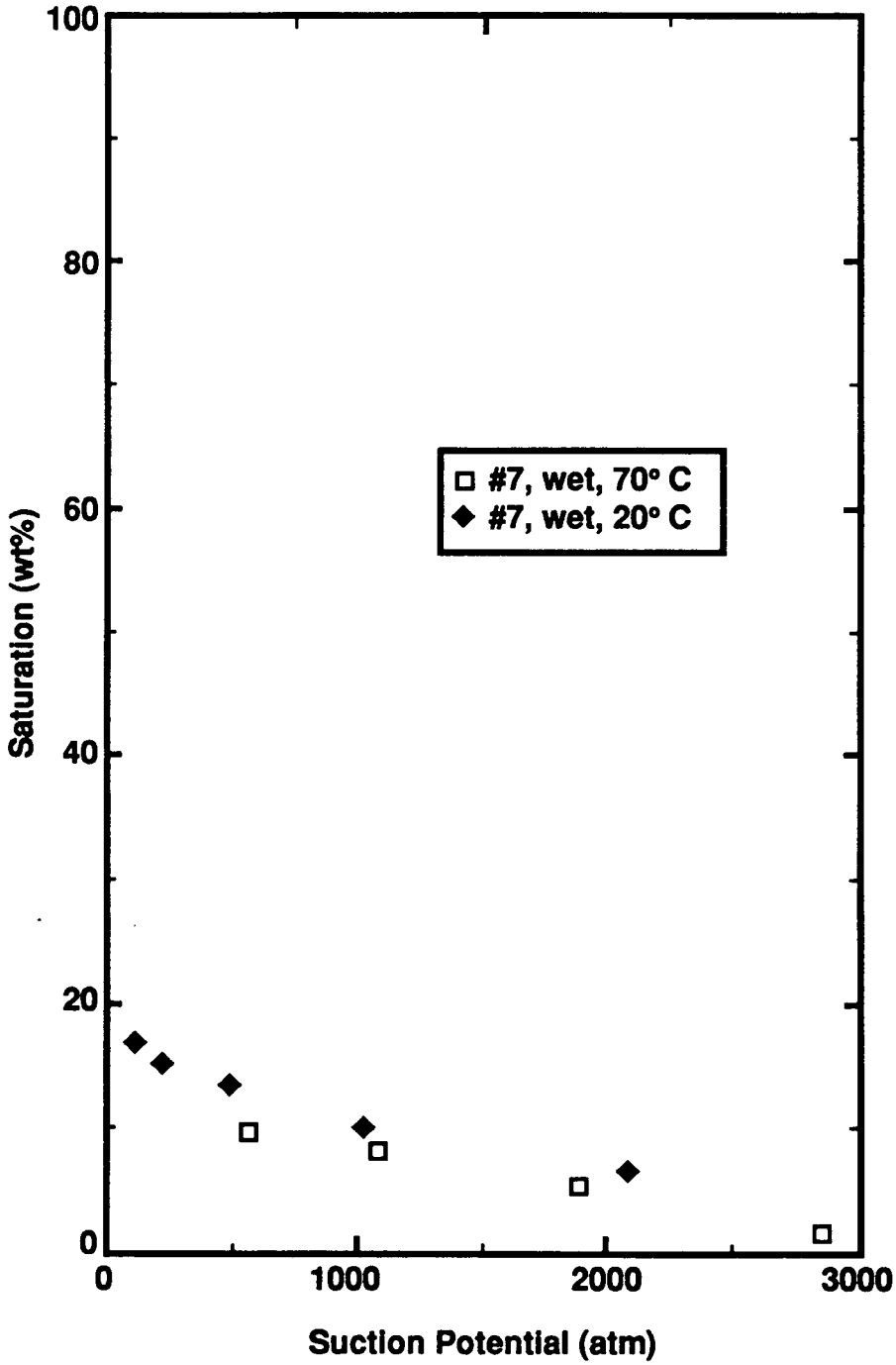
Saturation vs Suction Potential of Topopah Spring Tuff, Wetting, at 20 and 70° C



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Hydrology and Adsorption

Integrated Study of Flow and Nuclide Adsorption

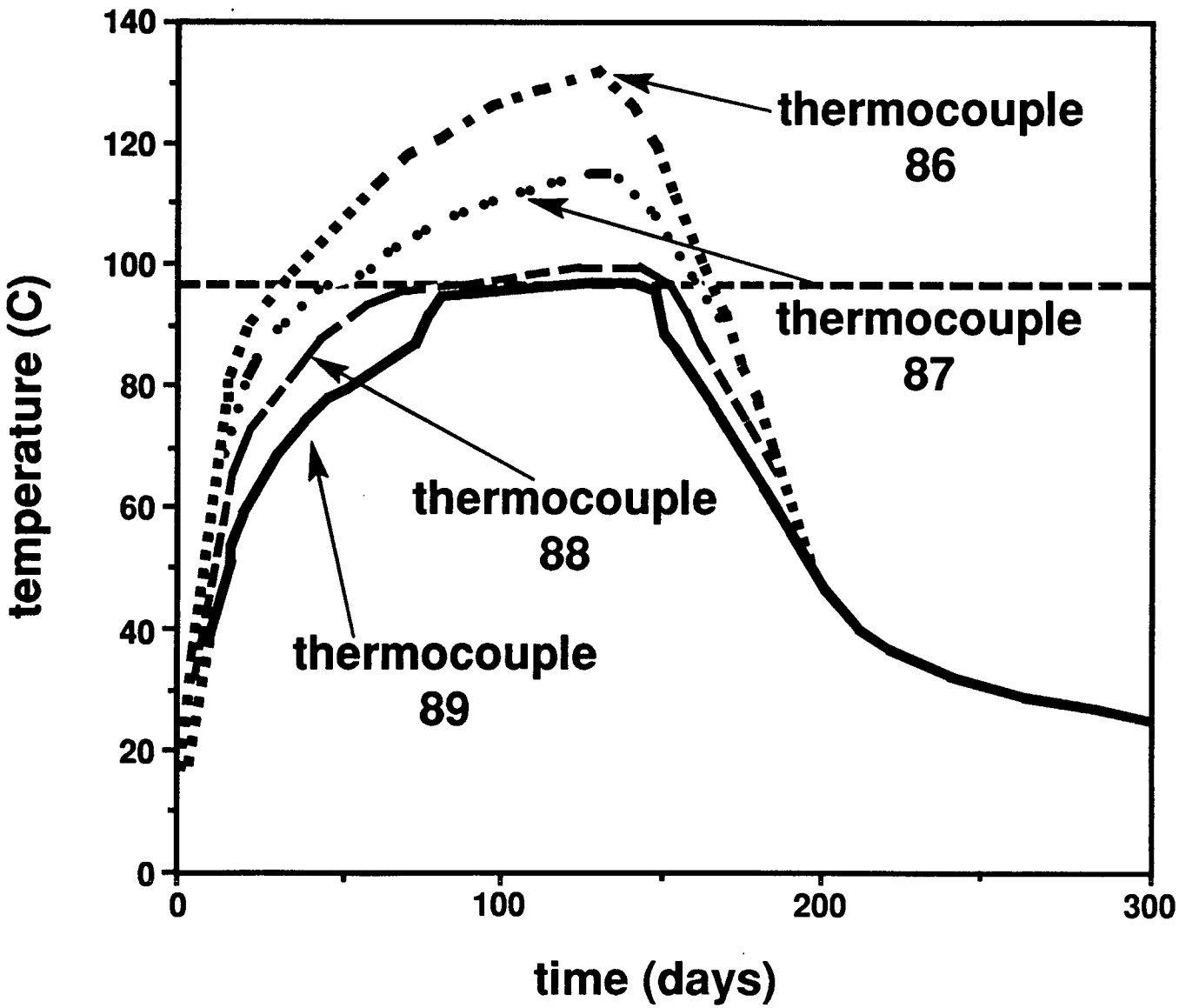
- Temperatures to 150° C
- Various confining pressures and pore pressures
- Both high and low thermal loadings

In Situ Tests

Extension of Laboratory and Validation of Model Studies

- Study hydrologic, geochemical, and geomechanical responses of rock mass to thermal loading
- Various power outputs of heater
- Overdrive the rock mass
- Test model at greater range of conditions
- For both high and low thermal loadings

Some Locations Remained At Boiling Temperature



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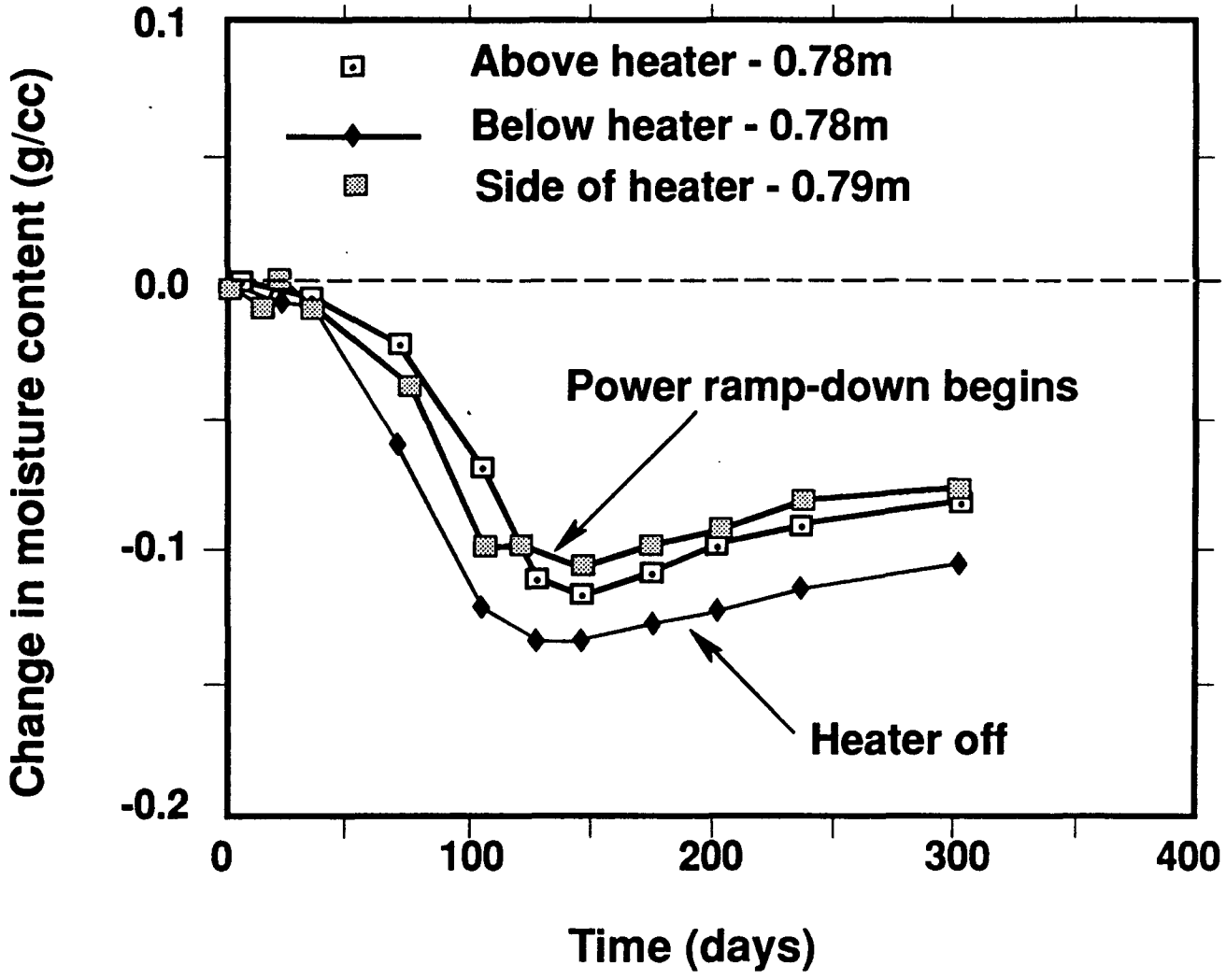

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In Situ Tests

Measurements and Samplings

- **Measurements:**

  - Temperature field, f(x,t)
  - Moisture content, f(T,x,t)
  - Gas pressure, f(T,x,t)
  - Borehole stability, f(T,t)
  - Air permeability (effect of heating)
  - Infiltration study

- **Samples:**

  - Rock samples
  - Water and gas samples

All are needed for high and low thermal loadings

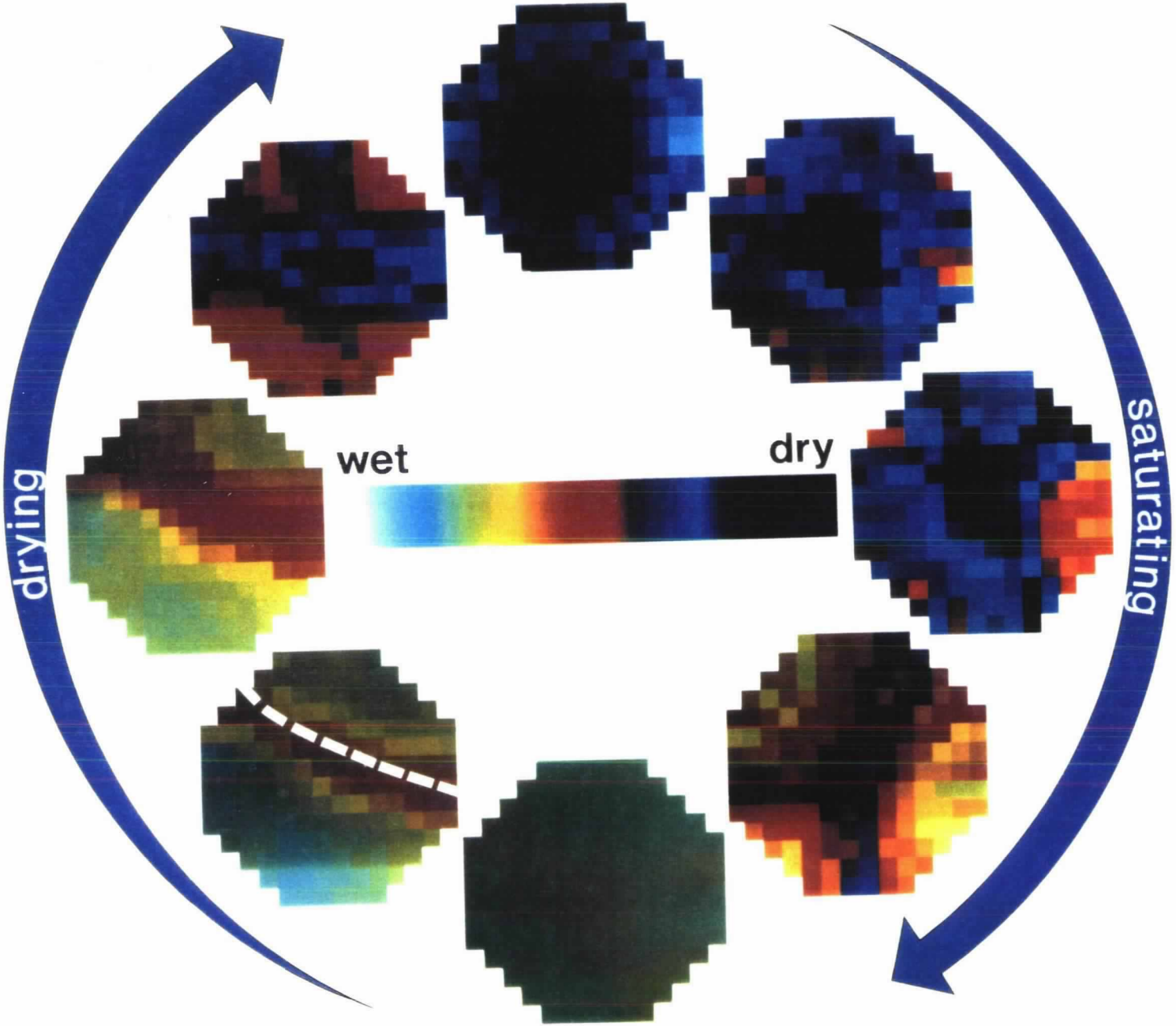
In Situ Tests

Methods and Instruments

- Thermocouple (high and low)
- Neutron and density logs (high and low)
- HFEM (high and low)
- Microwave resonator (high and low)
- Thermocouple psychrometer (low)
- Geotechnical instruments (better at low)

Conclusions

- Both high and low thermal loadings require similar tests
- Technologies exist for both cases
- A few instruments are more reliable for low case
- Some parameters are more detectable in high case


drying
saturating
wet
dry