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

PRESENTATION TO
THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: PROTOTYPE FIELD TESTS OF THE NEAR FIELD ENVIRONMENT

PRESENTER: ABELARDO L. RAMIREZ

PRESENTER'S TITLE: GEOPHYSICIST
AND ORGANIZATION: LAWRENCE LIVERMORE NATIONAL LABORATORY
LIVERMORE, CALIFORNIA 94550

PRESENTER'S
TELEPHONE NUMBER: (415) 422-6909

JANUARY 18-19, 1990

Purpose is to evaluate the ability to characterize near field environment

- Evaluate technical feasibility of defining near field hydrothermal and geochemical environment during field testing

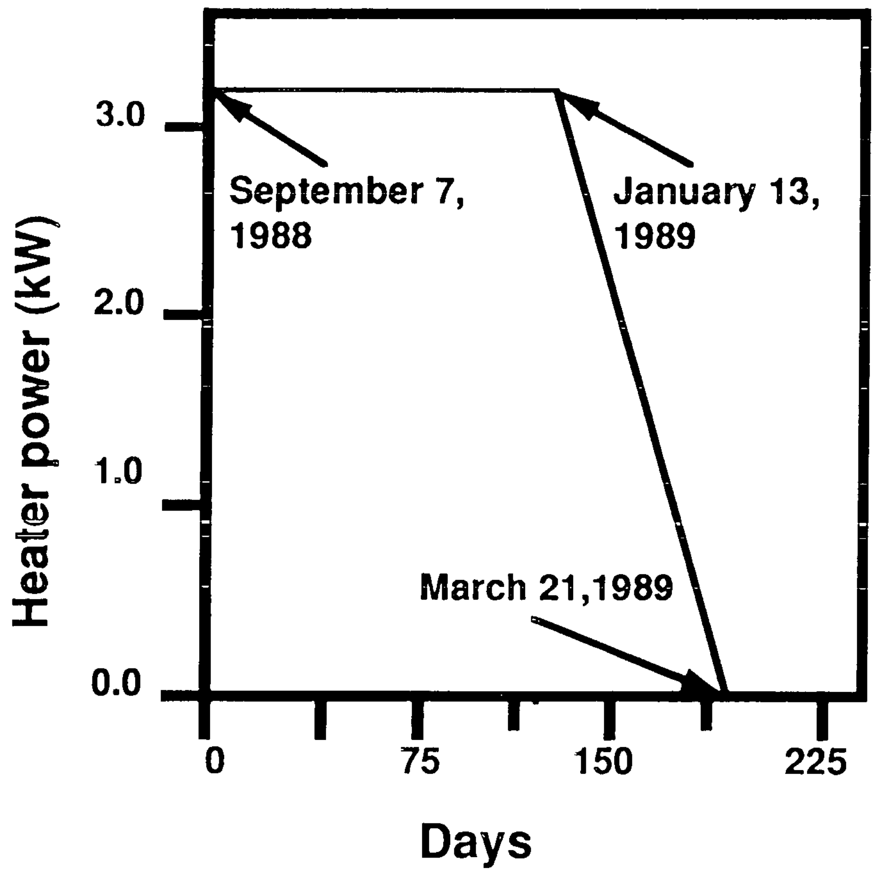
  -measurement technique performance

- Provide in situ data to improve understanding of conceptual models for near field environment

- Develop Quality Assurance technical procedures

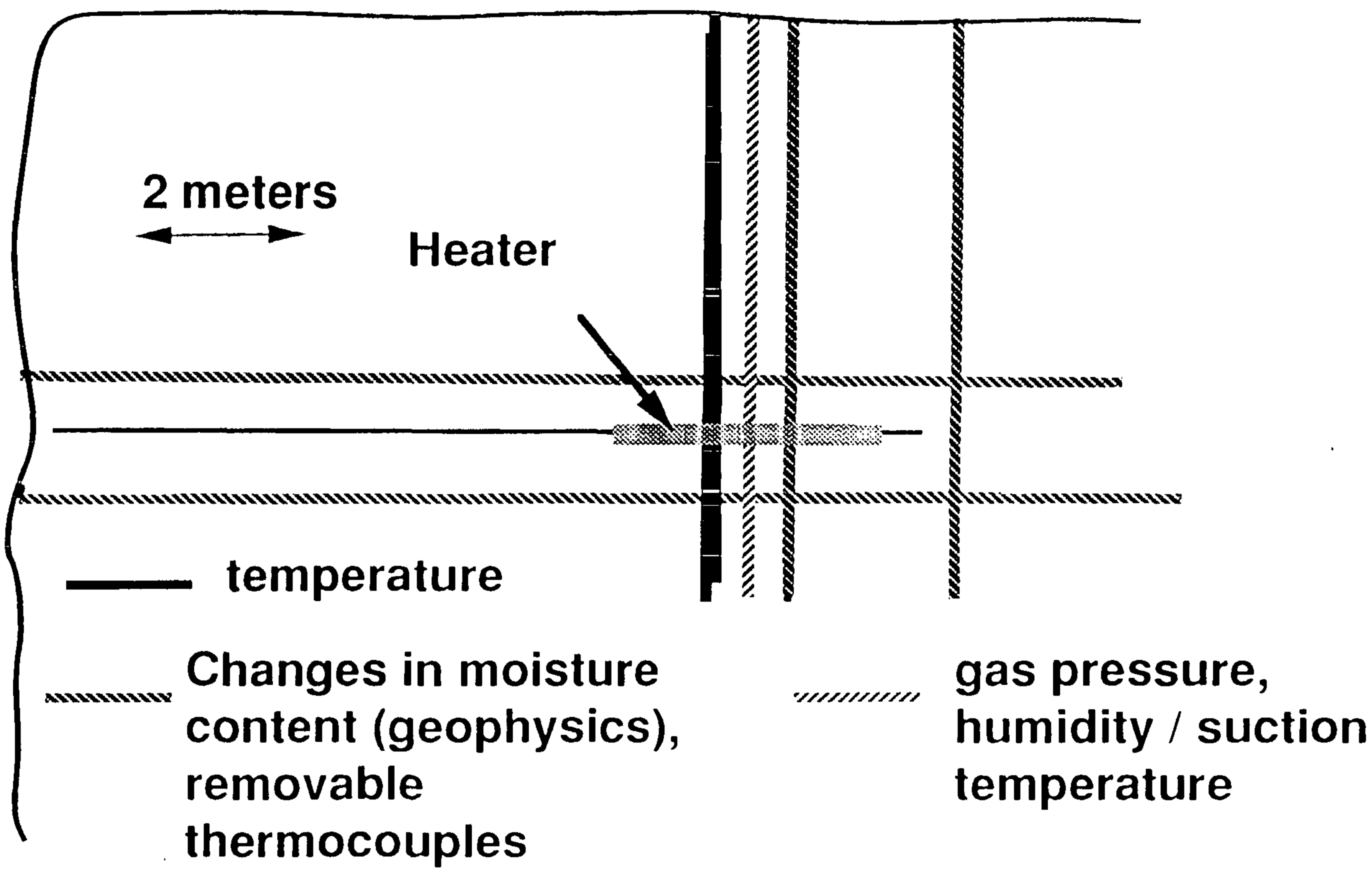
  -evaluate under realistic conditions

Rock was perturbed by a heating & cooling cycle



- Heat load approx. = 1.0-1.2 kW per meter of heater length
- Boiling region diameter of approx-1.4 meters
- Heater on for 195 days, 128 days heating, 68 days of power ramp-down
- Cooling highly accelerated (compared to a spent fuel waste package)

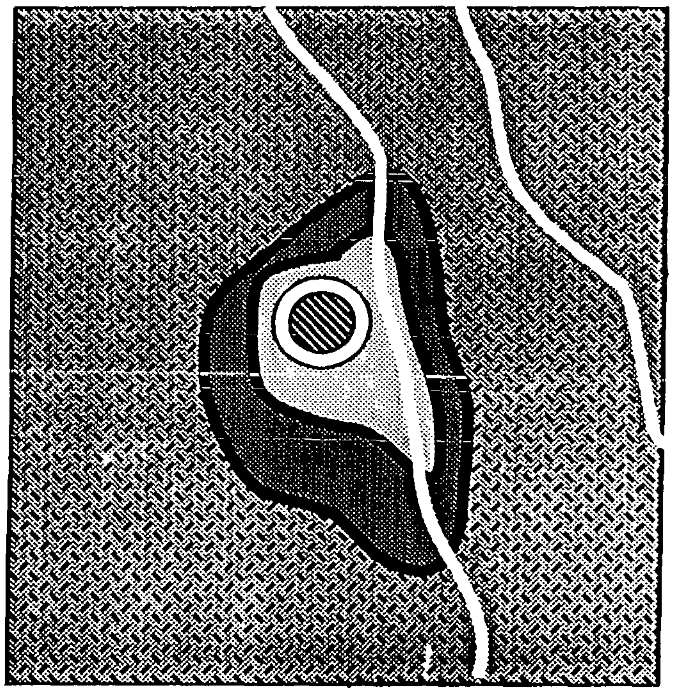
Plan view of test region



Various sensors monitored hydrothermal behavior of the rock

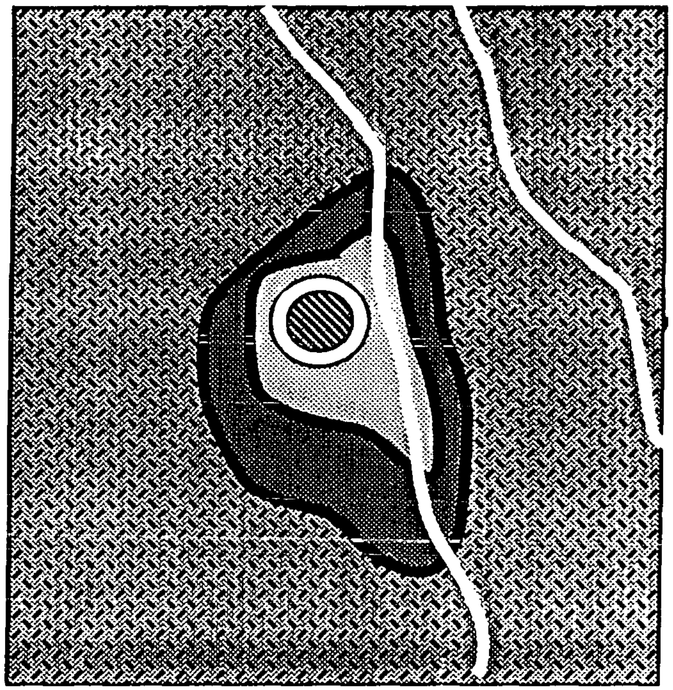
- Temperature -- thermocouples (approx. 120)
- Moisture content -- dielectric, neutron, and gamma density logging
- Steam pressure -- air pressure transducers
- Matrix pore pressure -- psychrometers, microwave resonant circuits, capacitance sensors
- Rock permeability -- air injection tests
- Moisture invading heater borehole -- condensation trap
- Fracture mapping -- core logging, borehole tv
- Atmospheric pressure -- barometer

Measurements confirmed elements of the conceptual model



- Dry region around heater, drying increases toward heater
- Saturation "halo" next to dry region and later dries as rock gets hotter
- Radius of dry region matched prediction of 0.6 - 0.7 m; total change is .16 g/cc
- Fractures have measurable effect on drying/ condensation front; re-wetting primarily along fractures
- Measured temperatures close to predictions; slight fracture effect where boiling occurrs

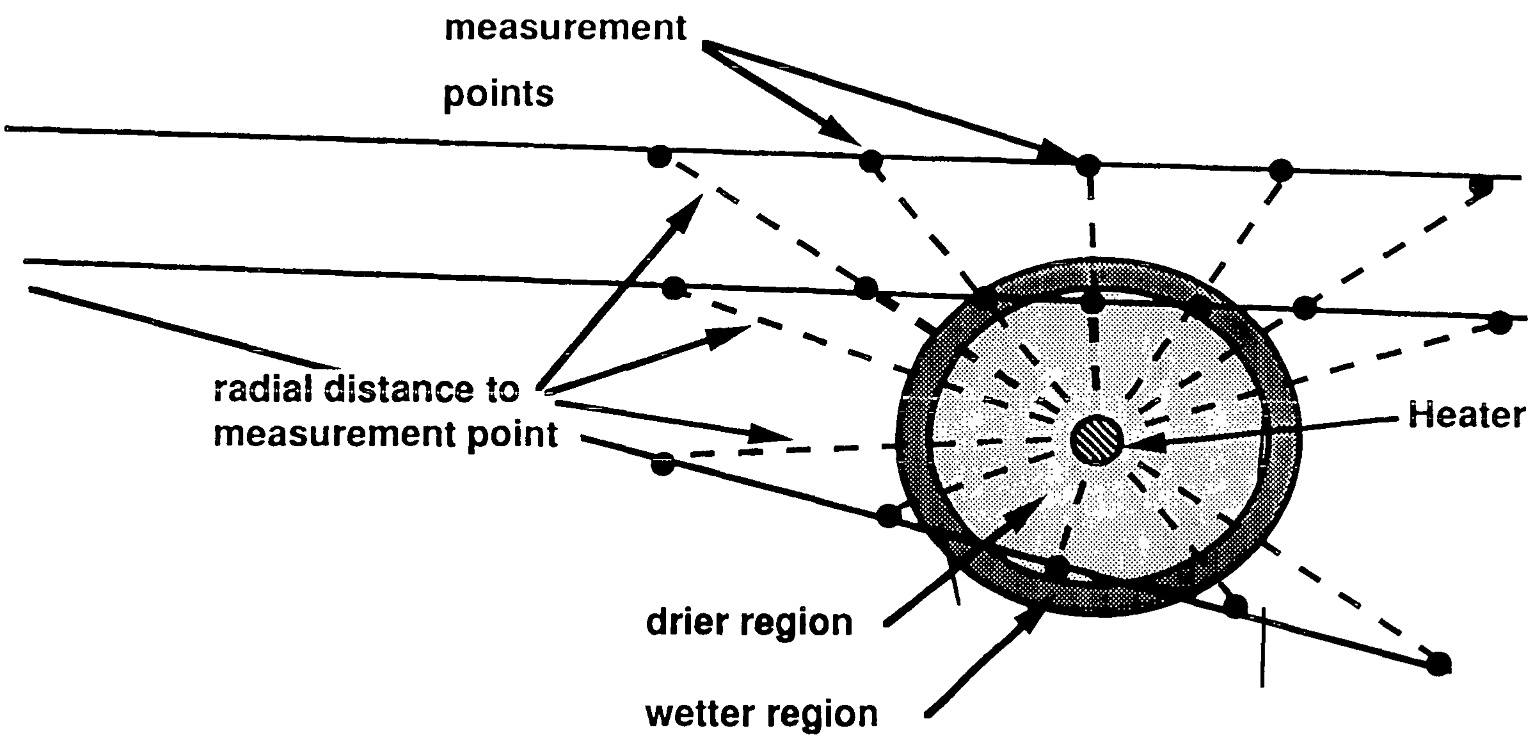
There were some surprises



- Below heater rock dried faster as temperatures increased
  - -gravity, fractures
- Above heater rock rewetted faster as temperatures decreased
  - -steeper moisture gradient, gravity
- Halo of increased saturation differs from predictions
  - due to high initial saturation? & to lack of wetting curves ?
- Slight increases in rock permeability

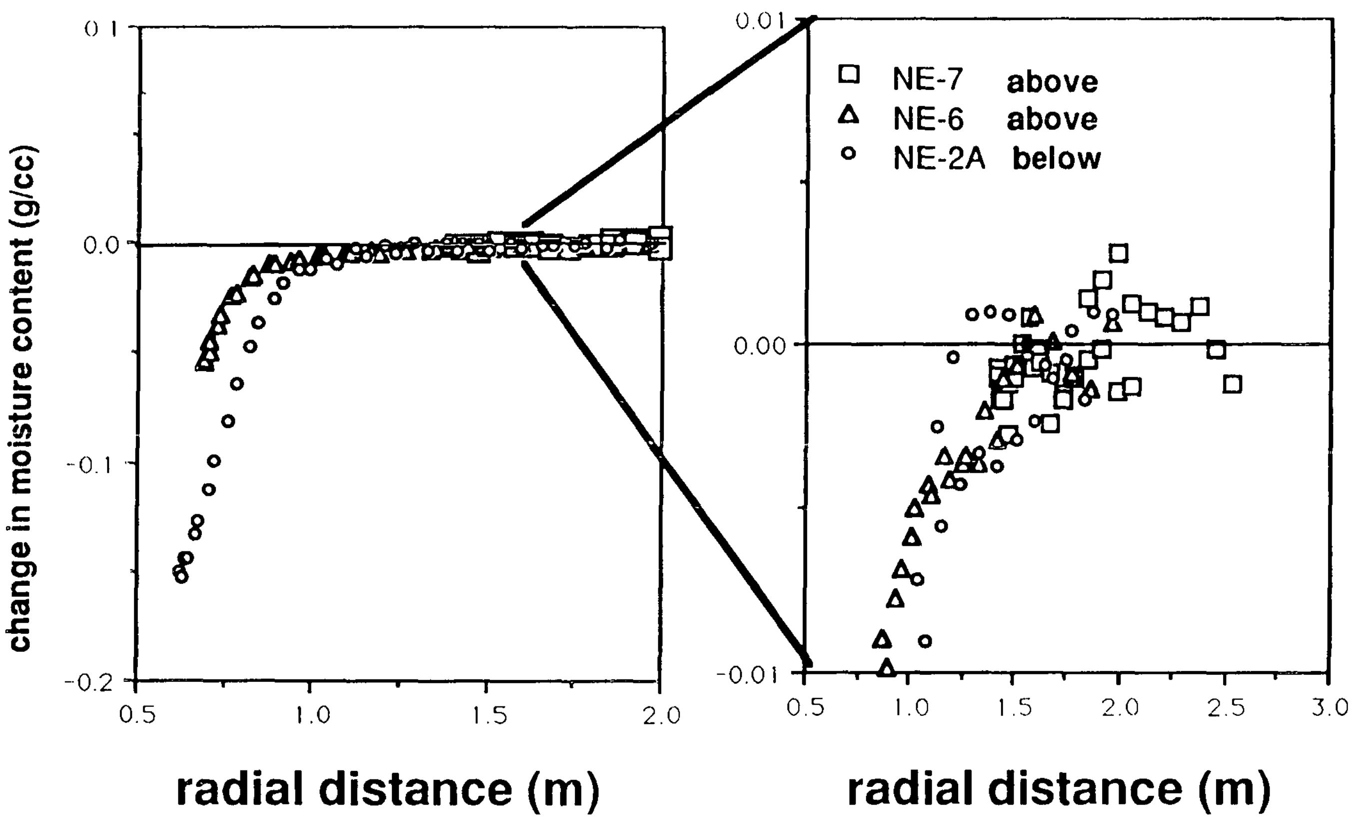
Several measurement problems: corrosion, inadequate calibration process, inconsistent results

Data from several boreholes are combined to form radial profiles



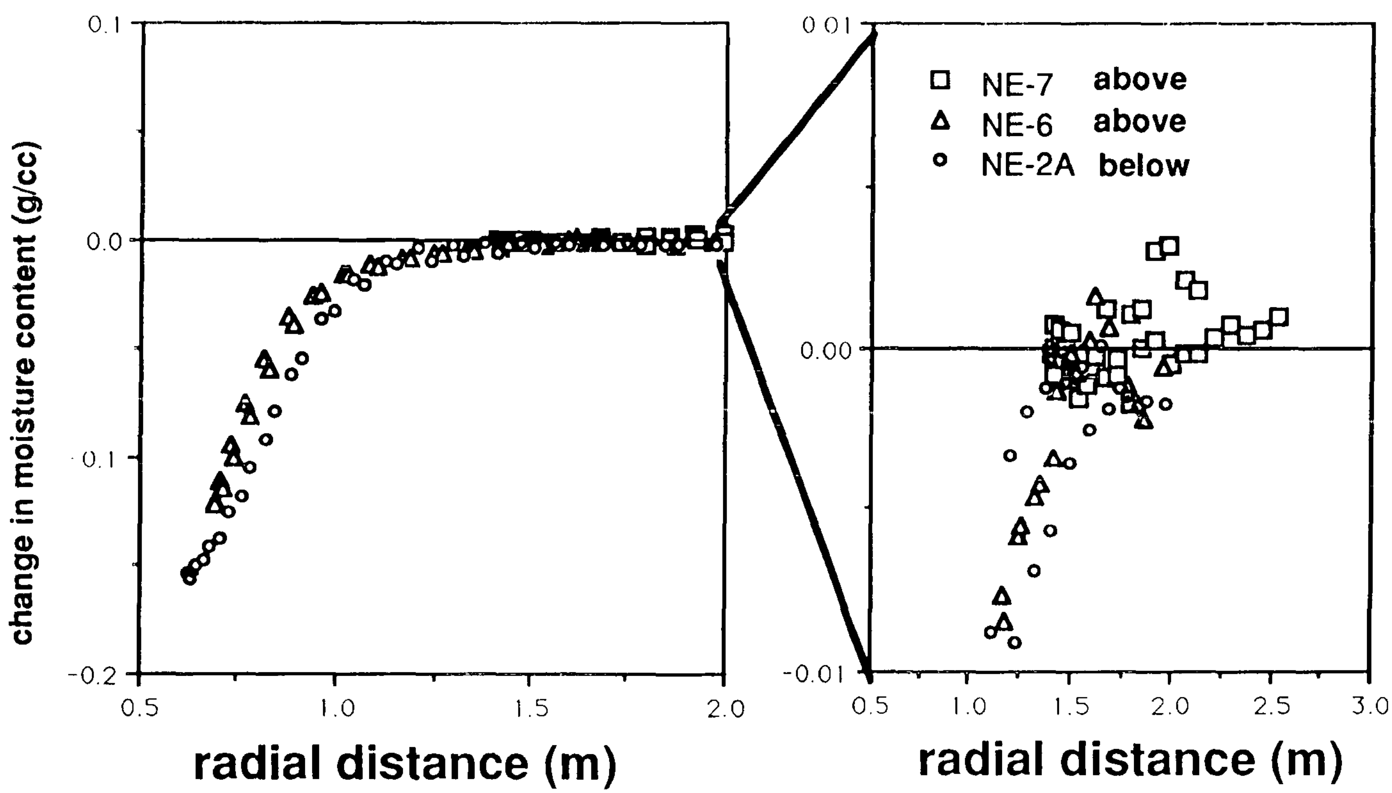
Drying front advanced faster below heater than above

Full power phase, 70 days after start of heating

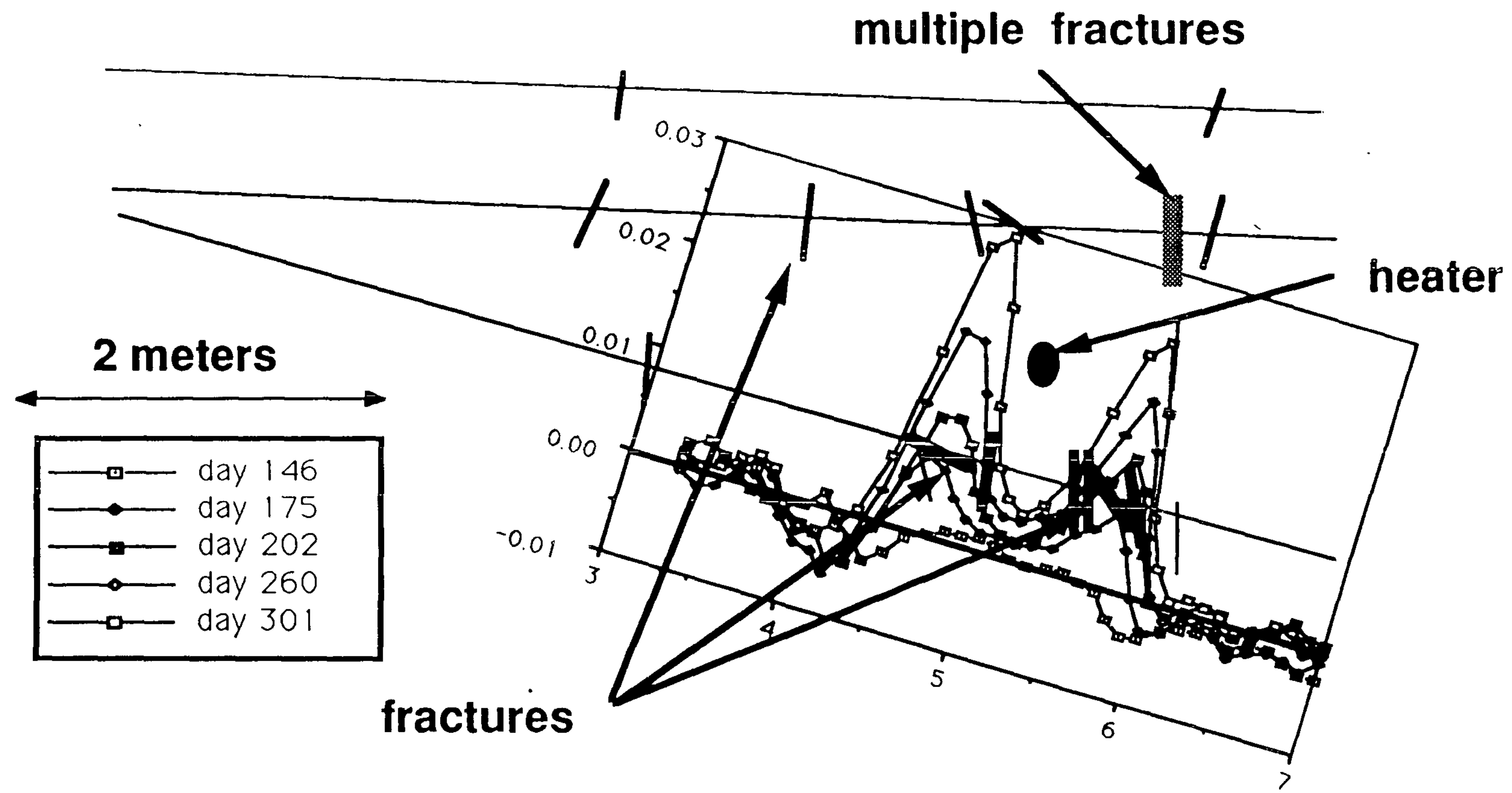


Rock above the heater re-wetted faster than below

Heater off, 301 days from start of heating

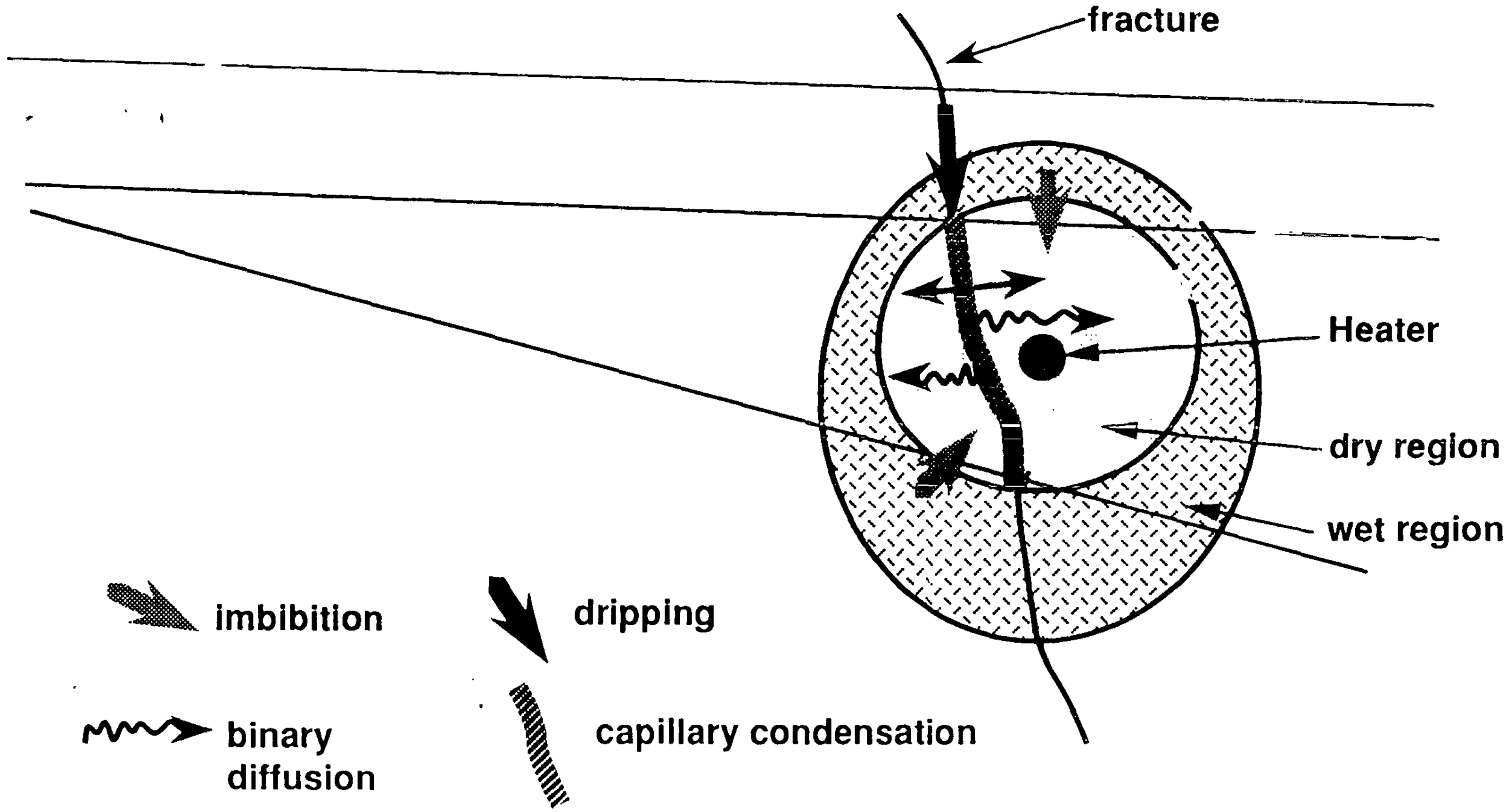


Fractures increase the rate of re-wetting

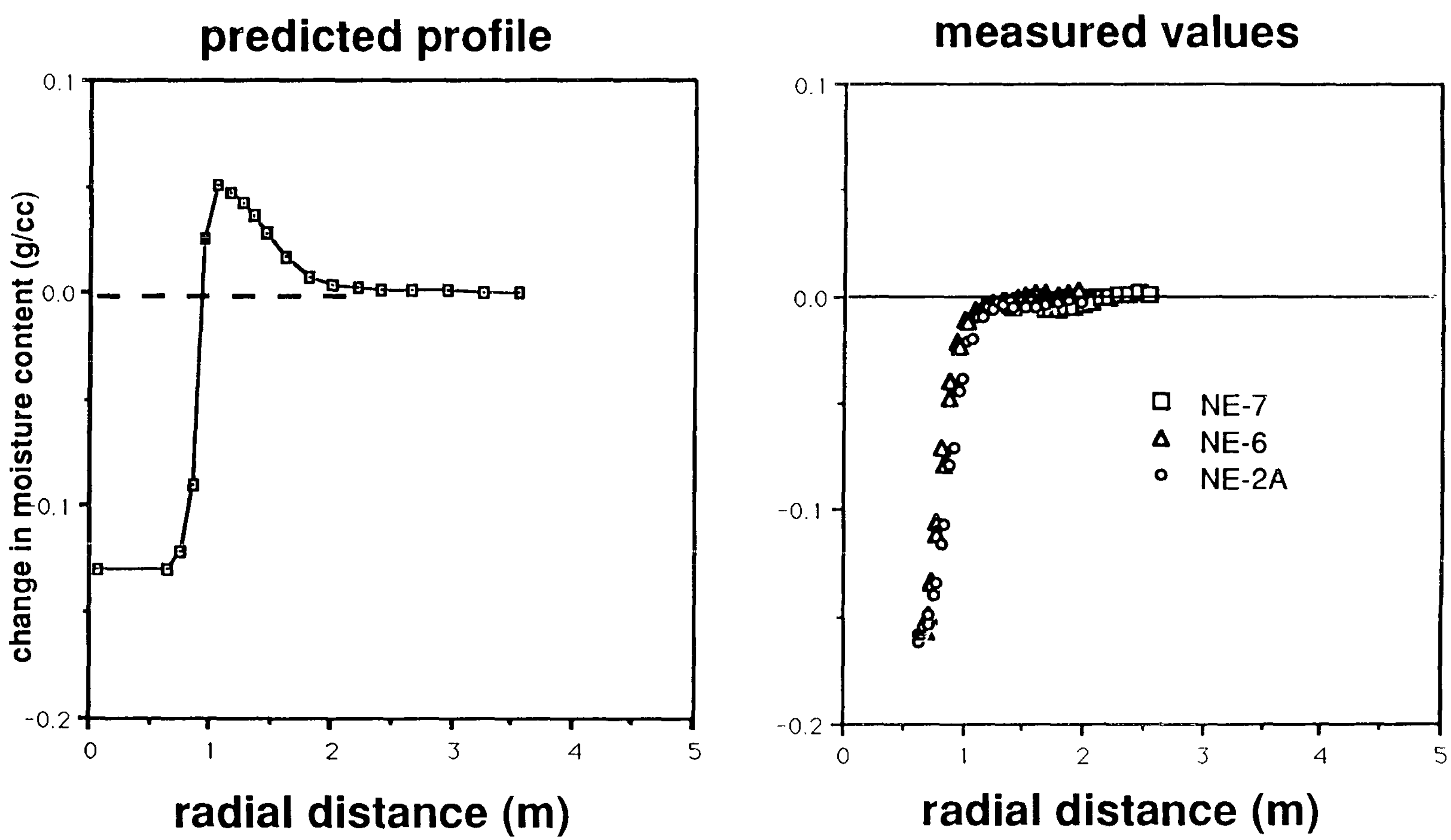


Borehole NE-2A, ramp-down phase, changes relative to last day of heating

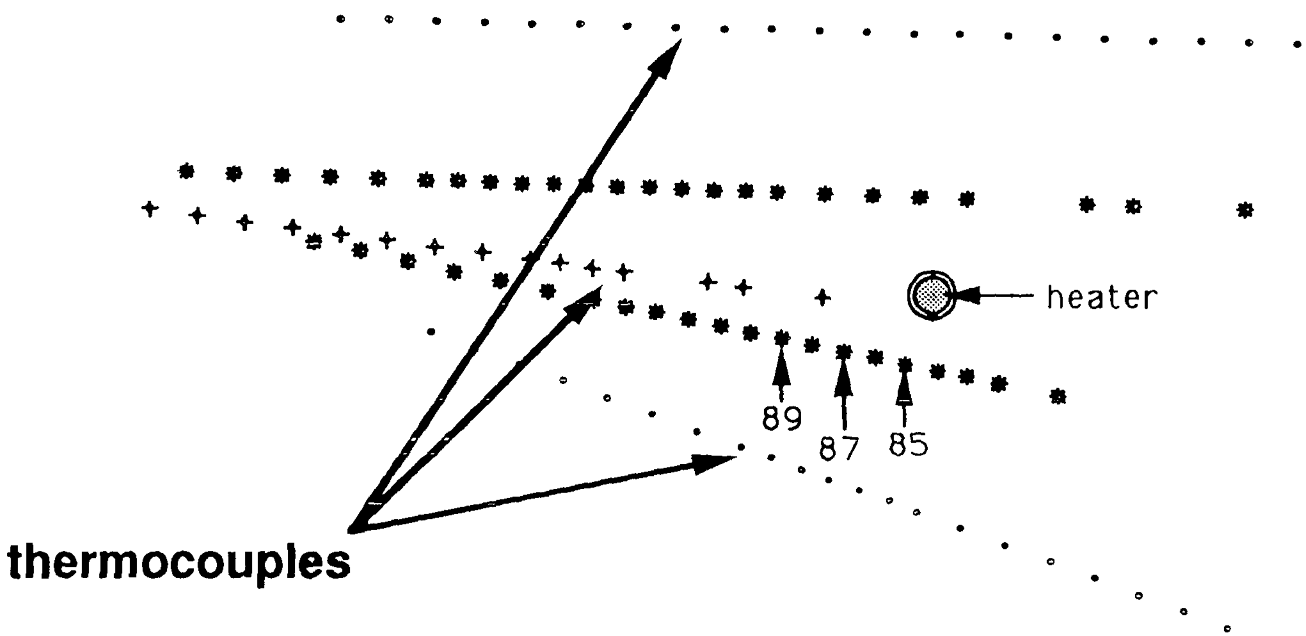
Capillary condensation, dripping and imbibition served as re-wetting mechanisms



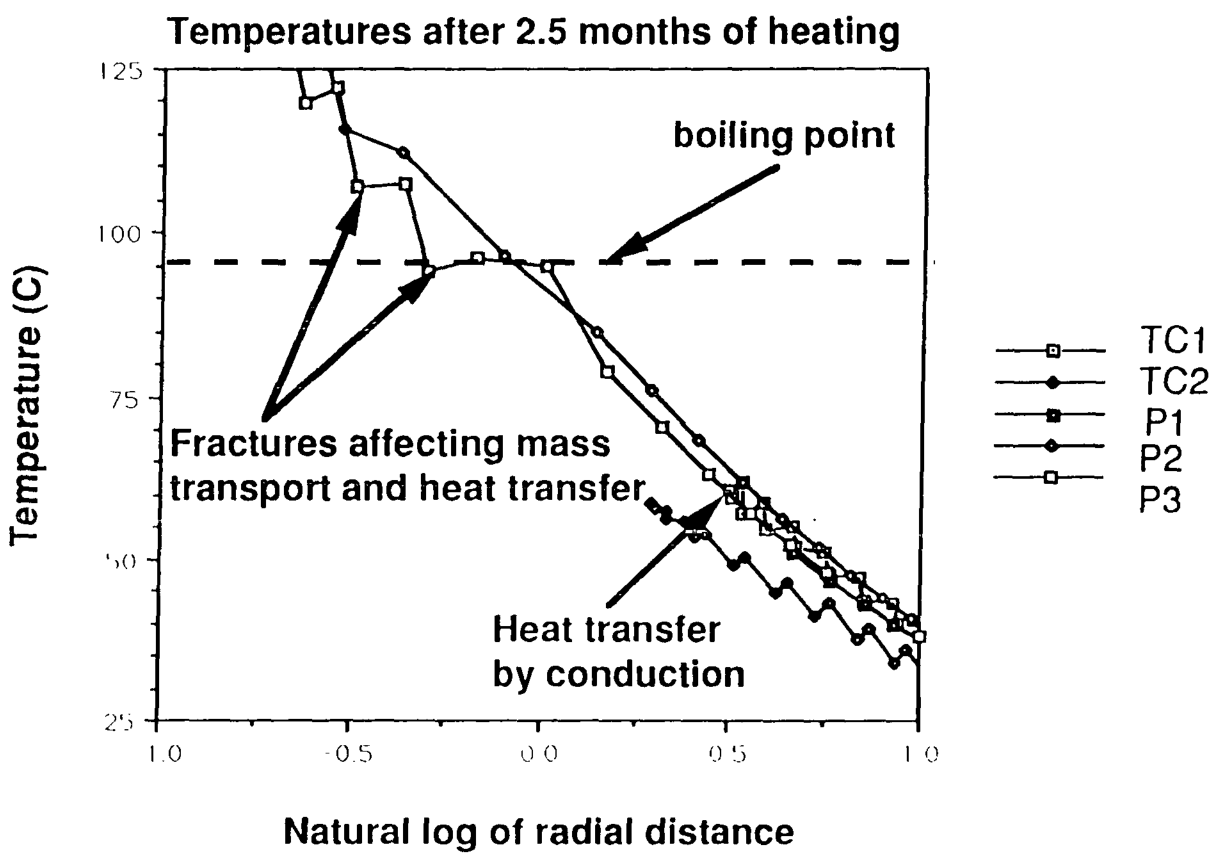
Predicted and measured radial profiles are different



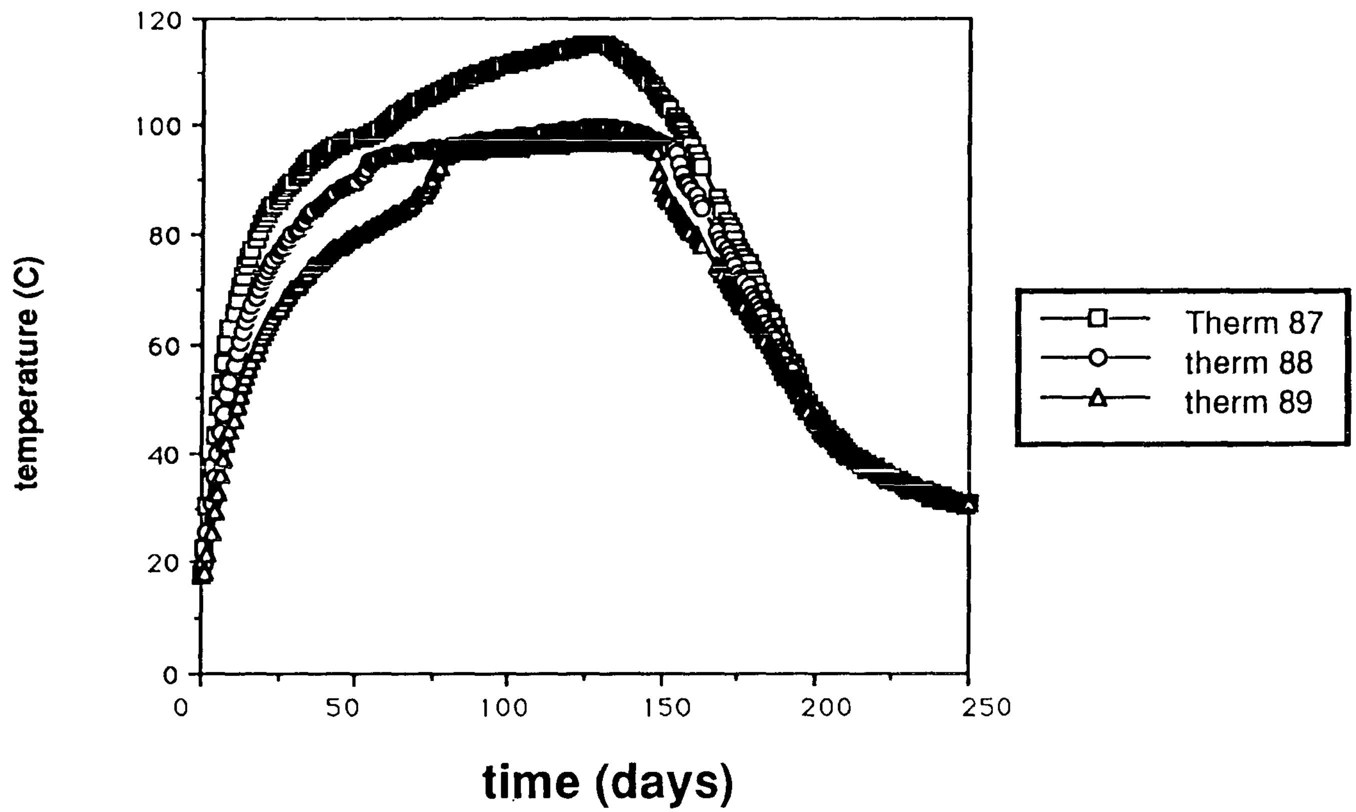
Side view showing thermocouple locations



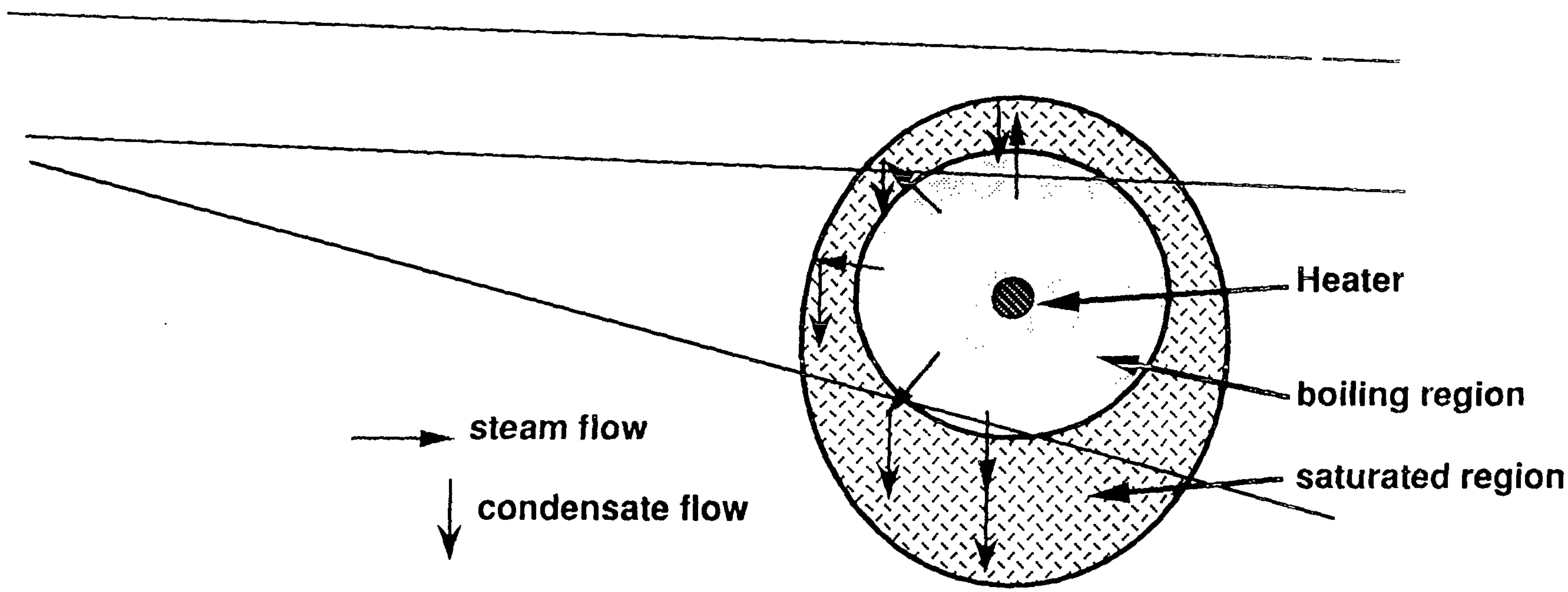
Heat transfer by conduction and by mass transport



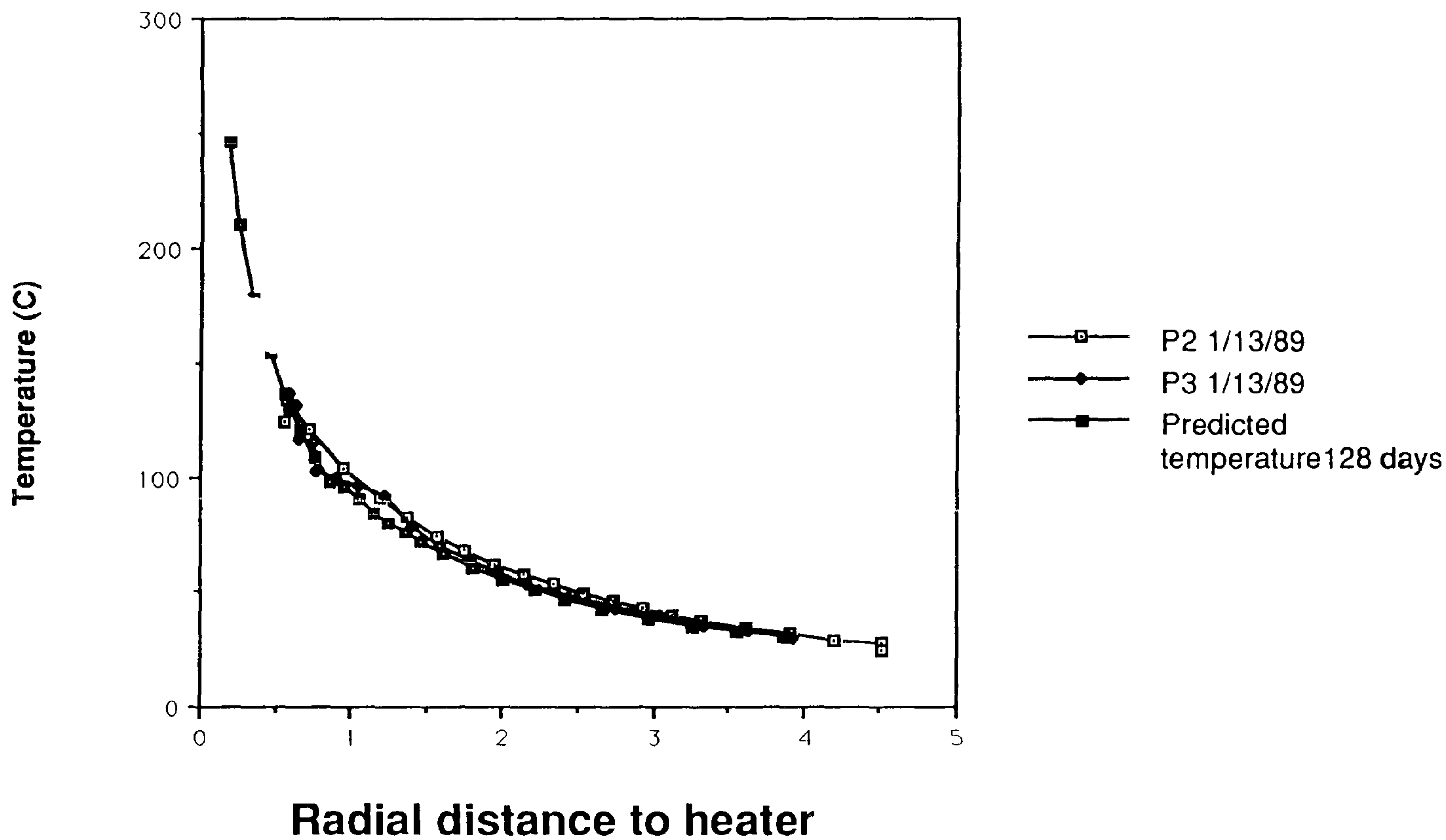
Some regions remained at boiling point for a long time



Liquid may be shed from top to sides and bottom of boiling region



Predicted and measured temperatures are very close



Heating changed air permeability near heater