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

# PRESENTATION TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

**SUBJECT:** OVERVIEW OF EFFECTS OF REPOSITORY DEVELOPMENT


**PRESENTER:** DR. WILLIAM E. GLASSLEY

**PRESENTER'S TITLE AND ORGANIZATION:** GEOCHEMIST,
LAWRENCE LIVERMORE NATIONAL LABORATORY
LIVERMORE, CALIFORNIA

**PRESENTER'S TELEPHONE NUMBER:** (415) 422-6499


DECEMBER 11-12, 1989

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# EFFECTS OF REPOSITORY DEVELOPMENT

- CONCERNED WITH PERFORMANCE OF WASTE PACKAGE AND GENERATION OF SOURCE TERM
- FOCUS IS ON POSTCLOSURE CONDITIONS
  - AT ELEVATED TEMPERATURES
  - AFTER COOLDOWN
- NEAR FIELD IS VIEWED IN TERMS OF PHYSICAL PROCESSES, NOT DISTANCE, AND IS SENSITIVE TO THERMAL (AND OTHER) PERTURBATIONS

# EFFECTS OF REPOSITORY DEVELOPMENT

(CONTINUED)

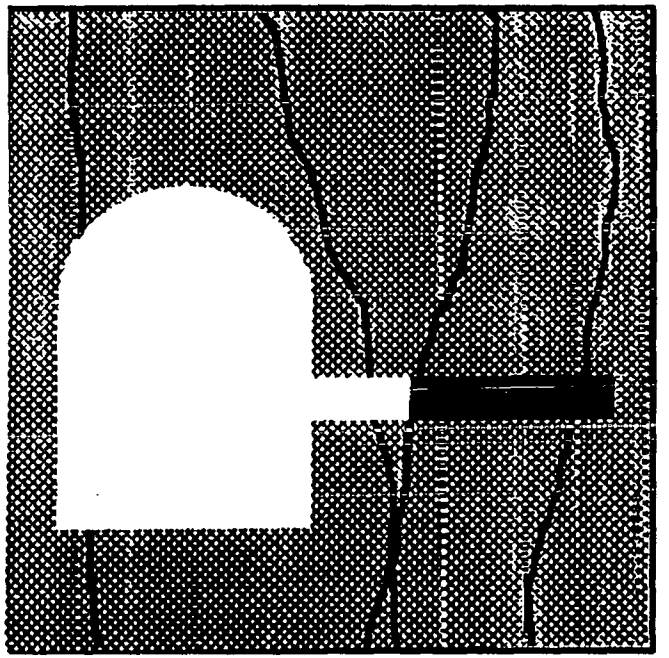
## EMPHASIS OF PRESENTATION

- PHYSICAL EFFECTS OF WASTE PACKAGE EMPLACEMENT ON THE ENVIRONMENT
- LABORATORY AND FIELD EVIDENCE FOR PHYSICAL AND CHEMICAL EFFECTS
- RADIONUCLIDE BEHAVIOR AT ELEVATED TEMPERATURE (SOURCE TERM)

# PHYSICAL EFFECTS OF WASTE PACKAGE EMPLACEMENT

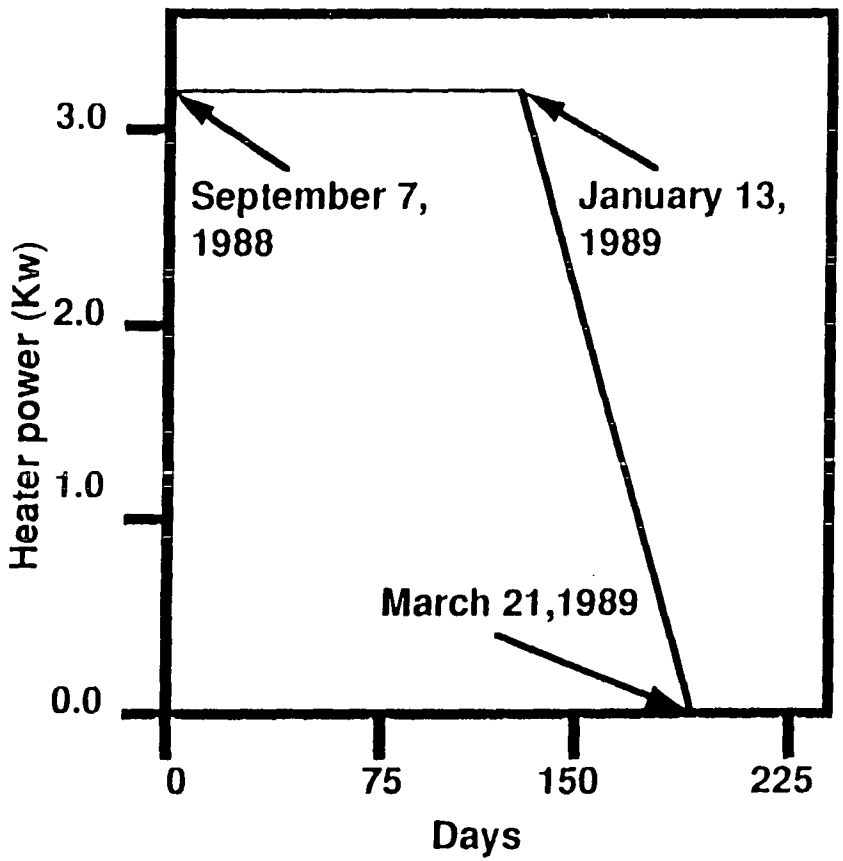
- **THERMAL**
  - MODELED TEMPERATURE BEHAVIOR
  - CONDUCTED PROTOTYPE HEATER TEST IN G–TUNNEL TO MONITOR ROCK DURING A HEATING AND COOLING CYCLE
- **RADIATION**
  - CONDUCTING THE STUDIES OF RADIOLYSIS PROCESSES IN MOIST ATMOSPHERES
- **EXCAVATION**
  - CURRENTLY PLANNING FURTHER WORK IN THIS AREA
- **EMPLACEMENT OF MAN–MADE MATERIALS**
  - HAVE INITIATED MODELING OF HIGH TEMPERATURE CONCRETE - WATER-ROCK INTERACTION; CURRENTLY PLANNING WORK TO EVALUATE MATERIALS

# PROTOTYPE HEATER TEST
# G-TUNNEL



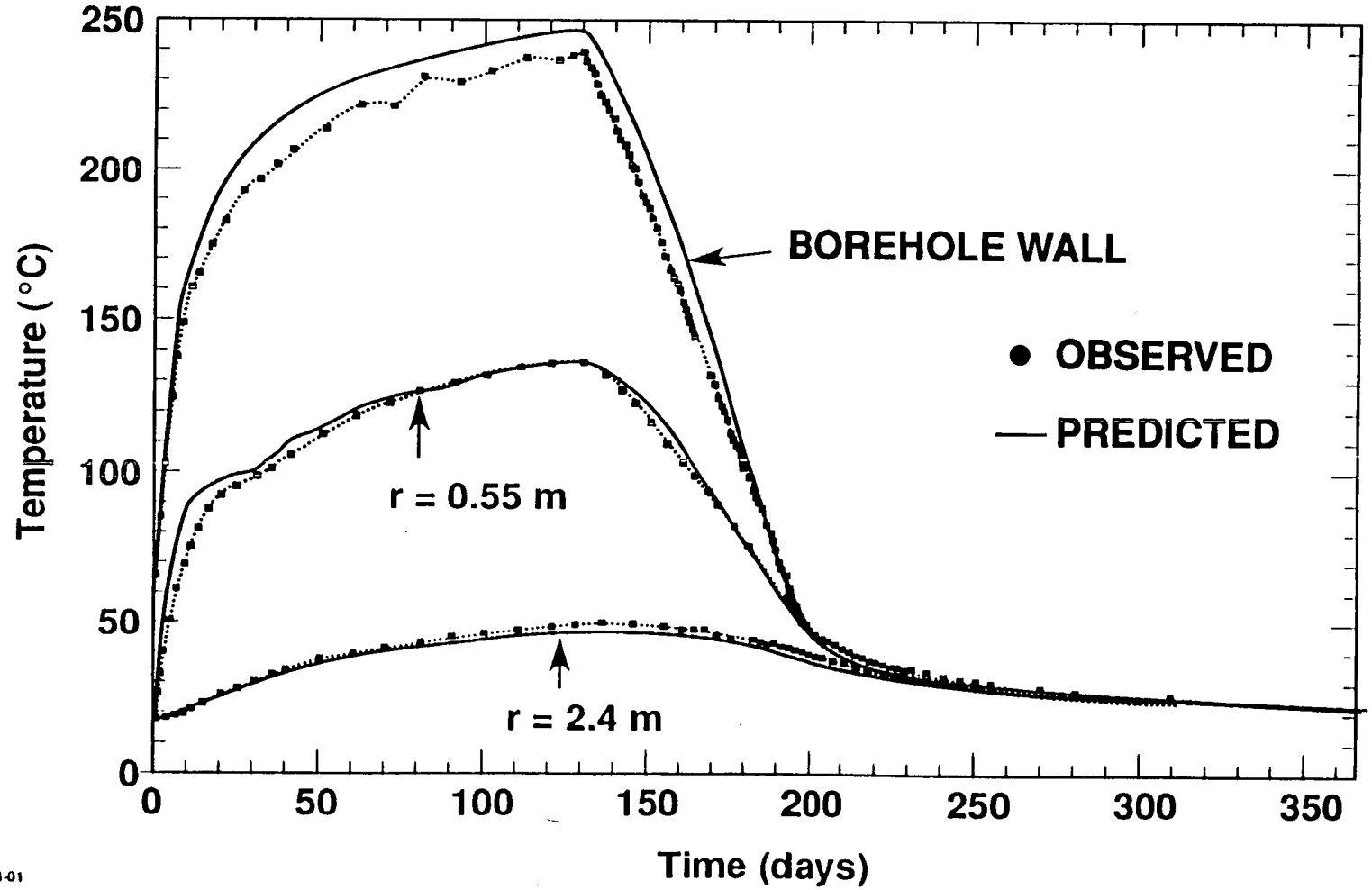
- TEST PERFORMED TO DETERMINE THERMAL RESPONSE AND MOVEMENT OF MOISTURE IN WP ENVIRONMENT
- SIMULATED HORIZONTAL EMPLACEMENT
- PREDICTED RESPONSE DEVELOPED USING TOUGH CODE

# ROCK WAS PERTURBED BY A HEATING AND COOLING CYCLE




- HEAT LOAD APPROX. = 1.0-1.2 Kw/METER OF HEATER
- BOILING REGION DIAMETER LESS THAN APPROX. 1.4 METERS
- HEATER ON FOR 195 DAYS, 128 DAYS HEATING, 68 DAYS RAMP-DOWN
- COOLING HIGHLY ACCELERATED (COMPARED TO A SPENT FUEL WASTE PACKAGE)

# OBSERVED AND PREDICTED TEMPERATURE

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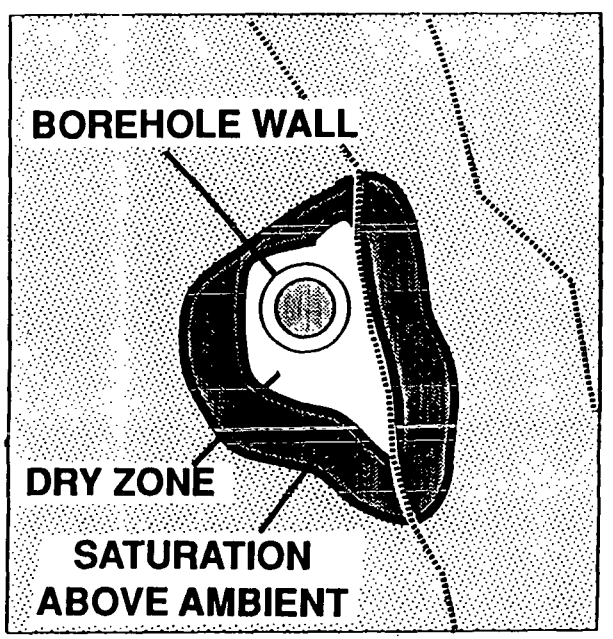
# MEASUREMENTS CONFIRMED ELEMENTS OF THE CONCEPTUAL MODEL




- DRY ZONE AROUND THE HEATER, DEGREE OF DRYING INCREASES TOWARDS HEATER
- SATURATION "HALO" NEXT TO DRY REGION FORMS AND LATER DRIES AS ROCK GETS HOTTER
- FRACTURES HAVE MEASURABLE EFFECT ON DRYING/CONDENSATION FRONT
- ROCK RE-WETS SLOWLY AS POWER DECREASES PRIMARILY ALONG FRACTURES
- RADIUS OF DRY REGION MATCHED PREDICTION OF 0.6 - 0.7m; TOTAL CHANGE IS .16 g/cc

# PHYSICAL EFFECTS OF WASTE PACKAGE EMPLACEMENT

## RADIATION

- RADIOLYSIS IN MOIST AIR STUDIED AT ELEVATED TEMPERATURE
- EFFECTS ON METALS ARE BEING EVALUATED
- CHEMICAL INTERACTION WITH TUFF TO BE EXAMINED

# PHYSICAL EFFECTS OF WASTE PACKAGE EMPLACEMENT

(CONTINUED)

## EXCAVATION

- STRESS IN THE ROCK WILL CHANGE DUE TO EXCAVATION OF SHAFTS AND BOREHOLES AND INCREASED TEMPERATURE

- LABORATORY, MODELING, AND FIELD STUDIES WILL FOCUS ON:

  - EFFECT OF STRESS, TEMPERATURE, AND MOISTURE ON MECHANICAL PROPERTIES
  - LONG–TERM "CREEP" BEHAVIOR OF ROCK
  - SUBCRITICAL CRACK GROWTH
  - SPALLING OF BOREHOLE
  - BLOCK STABILITY

# PHYSICAL EFFECTS OF WASTE PACKAGE EMPLACEMENT

(CONTINUED)

## EMPLACEMENT OF MAN-MADE MATERIALS

- ADDITION OF PAINTS, CONCRETE, RUBBER, GREASE, ETC. MAY HAVE CHEMICAL CONSEQUENCES THAT MODIFY WATER CHEMISTRY
- LABORATORY, MODELING, AND FIELD STUDIES WILL FOCUS ON
  - IDENTIFYING MATERIALS THAT HAVE POTENTIALLY ADVERSE CHEMICAL CHARACTERISTICS OVER TIME AND TEMPERATURE OF CONCERN
  - OBTAIN THERMODYNAMIC AND KINETICS PROPERTIES FOR MATERIALS OF CONCERN
  - CONDUCT EXPERIMENTS TO EVALUATE CONSEQUENCES OF COUPLED PROCESSES (e.g., EPOXY-CONCRETE-METAL-ROCK)
  - MODEL LONG-TERM BEHAVIOR

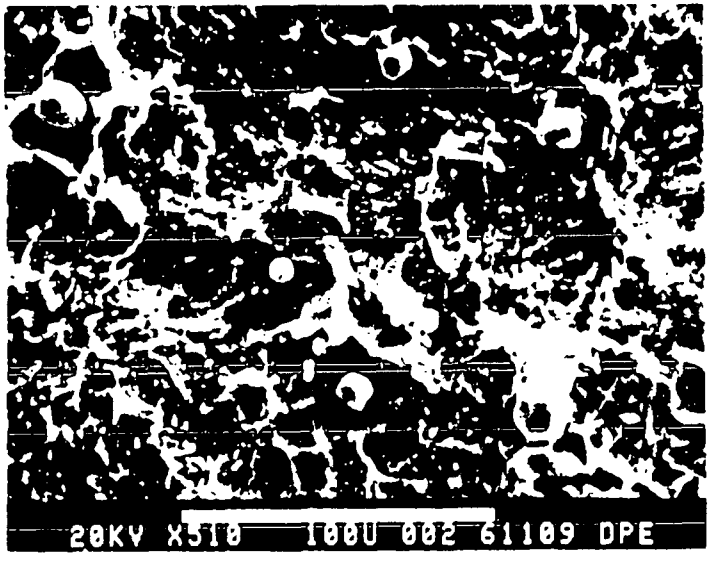
# LABORATORY AND FIELD EVIDENCE

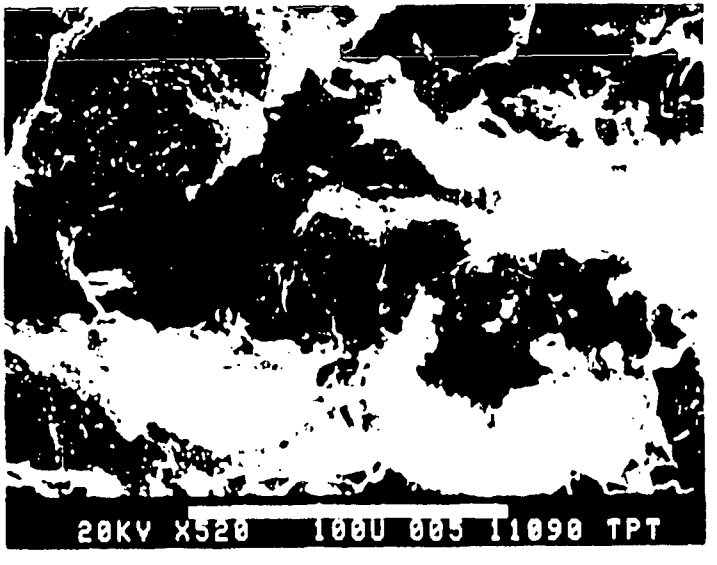
- **THERMOHYDROLOGICAL**
  - FIELD TESTS (PREVIOUSLY DISCUSSED)
  - LABORATORY TESTS
- **GEOCHEMICAL**
  - WATER–ROCK INTERACTION
  - WASTE FORM DISSOLUTION AND SOURCE TERM FOR FAR-FIELD STUDIES
  - THERMODYNAMIC AND KINETIC DATA FOR GEOCHEMICAL MODELS

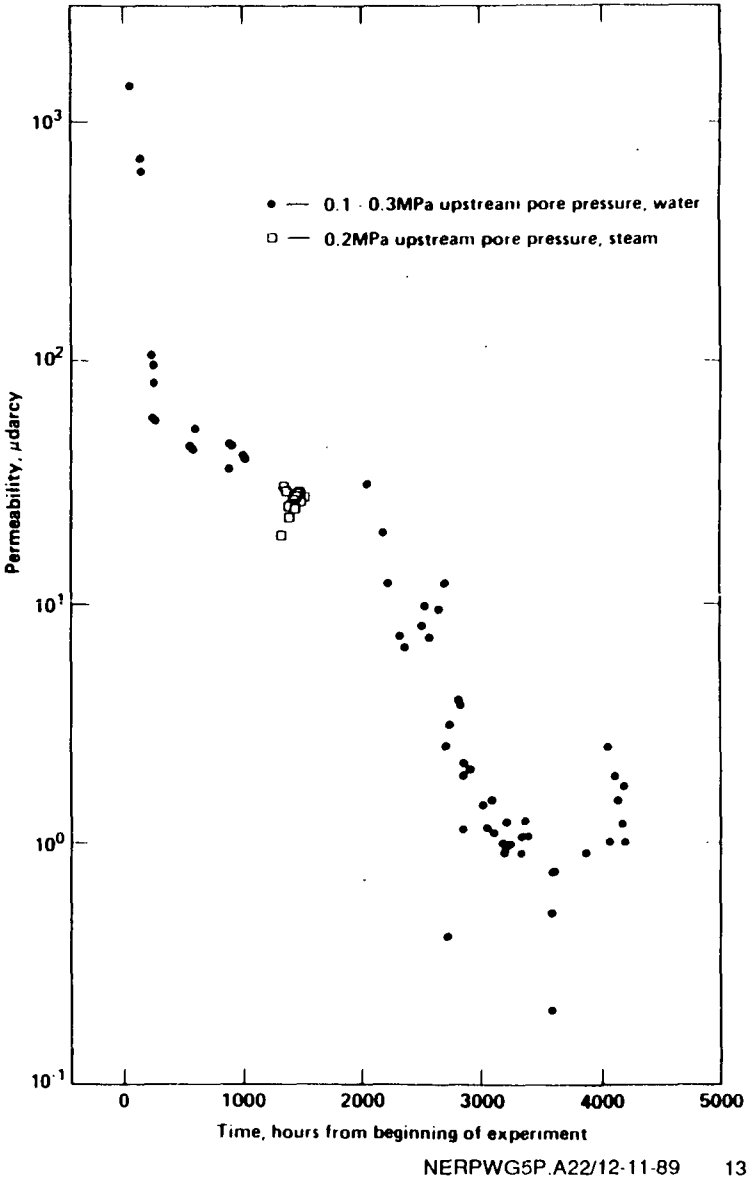
# LABORATORY STUDIES - THERMOHYDROLOGICAL RESULTS

- LABORATORY RESULTS SHOW WETTING AND DRYING OF A FRACTURE ARE NOT REVERSIBLE PROCESSES
- ASPERITIES CHANGE FORM
- MINERALS DISSOLVED AND PRECIPITATED

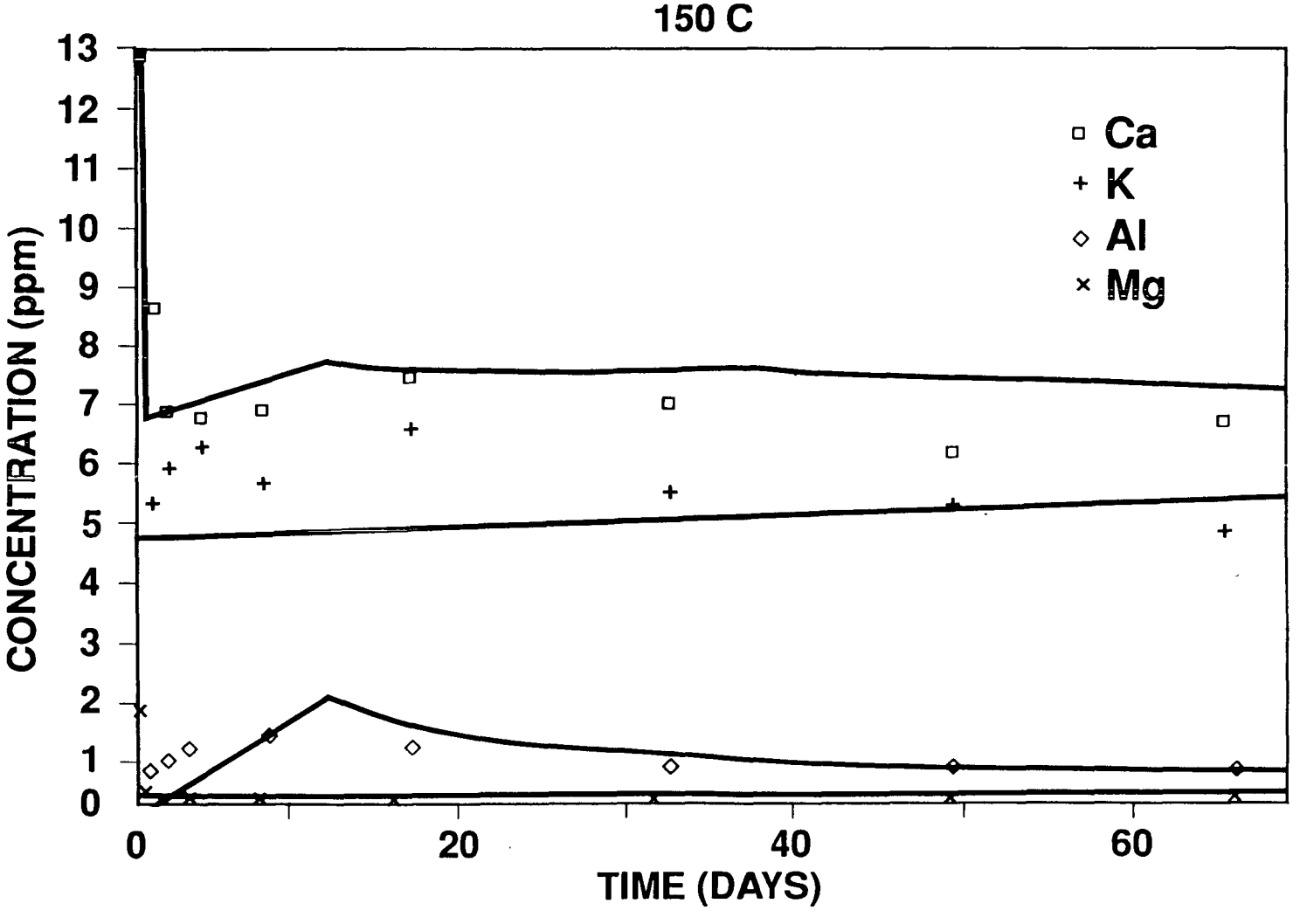
# NATURAL FRACTURE IN TOPOPAH SPRING TUFF HEALS ABOVE 90°C



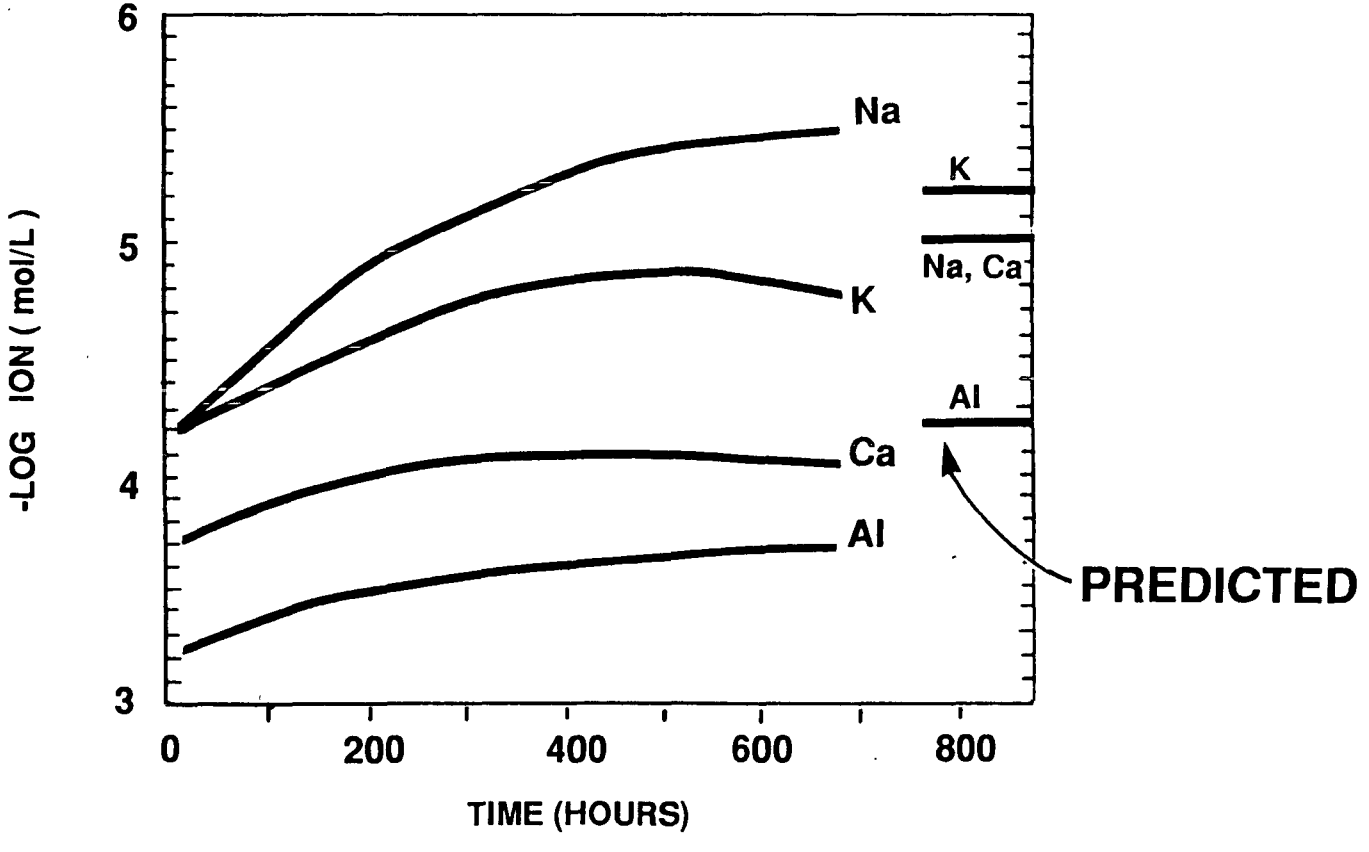
# LABORATORY - WATER-ROCK INTERACTION



# KINETIC STUDIES OF MINERAL DISSOLUTION

## ZEOLITE DISSOLUTION IS IMPORTANT FOR DETERMINATION OF FLUID CHEMISTRY IN WASTE PACKAGE ENVIRONMENT

## MEASURED VS. PREDICTED VALUES ARE SHOWN FOR HEULANDITE



# SUMMARY

- MODELING ACTIVITIES SUCCESSFULLY DESCRIBE THE HYDROLOGICAL, CHEMICAL, AND GEOCHEMICAL BEHAVIOR OF A RANGE OF LABORATORY AND FIELD SYSTEMS

- CONFLICTS BETWEEN MODEL PREDICTIONS, AND LABORATORY AND FIELD STUDIES IDENTIFY IMPORTANT DATA NEEDS AND MODEL SHORTCOMINGS

- FUTURE WORK WILL CONCENTRATE ON THESE AREAS, AND ON MODEL VALIDATION