

**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

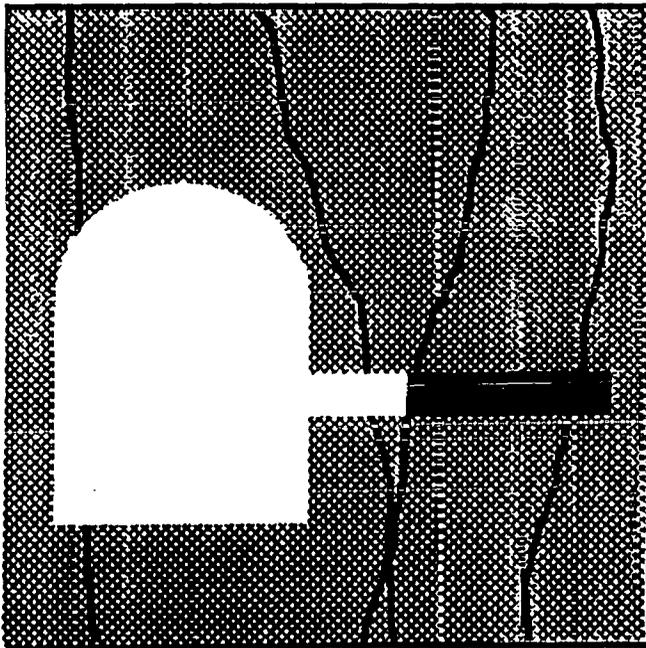
## ● EXCAVATION

- CURRENTLY PLANNING FURTHER WORK IN THIS AREA

## ● EMPLACEMENT OF MAN-MADE MATERIALS

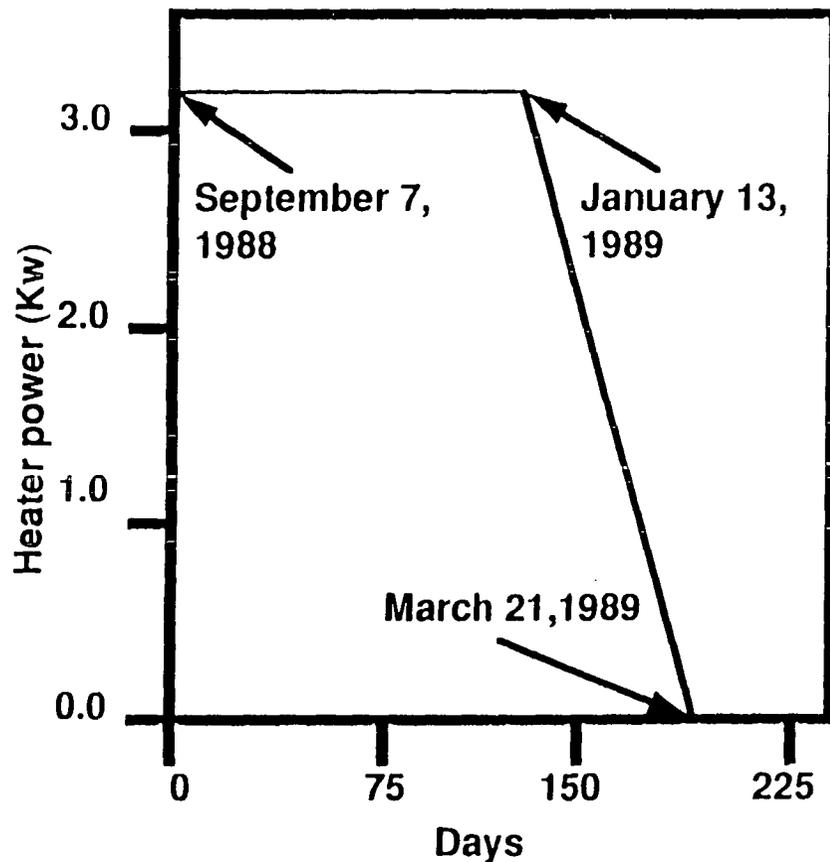
- HAVE INITIATED MODELING OF HIGH TEMPERATURE CONCRETE - WATER-ROCK INTERACTION; CURRENTLY PLANNING WORK TO EVALUATE MATERIALS

# PROTOTYPE HEATER TEST G-TUNNEL



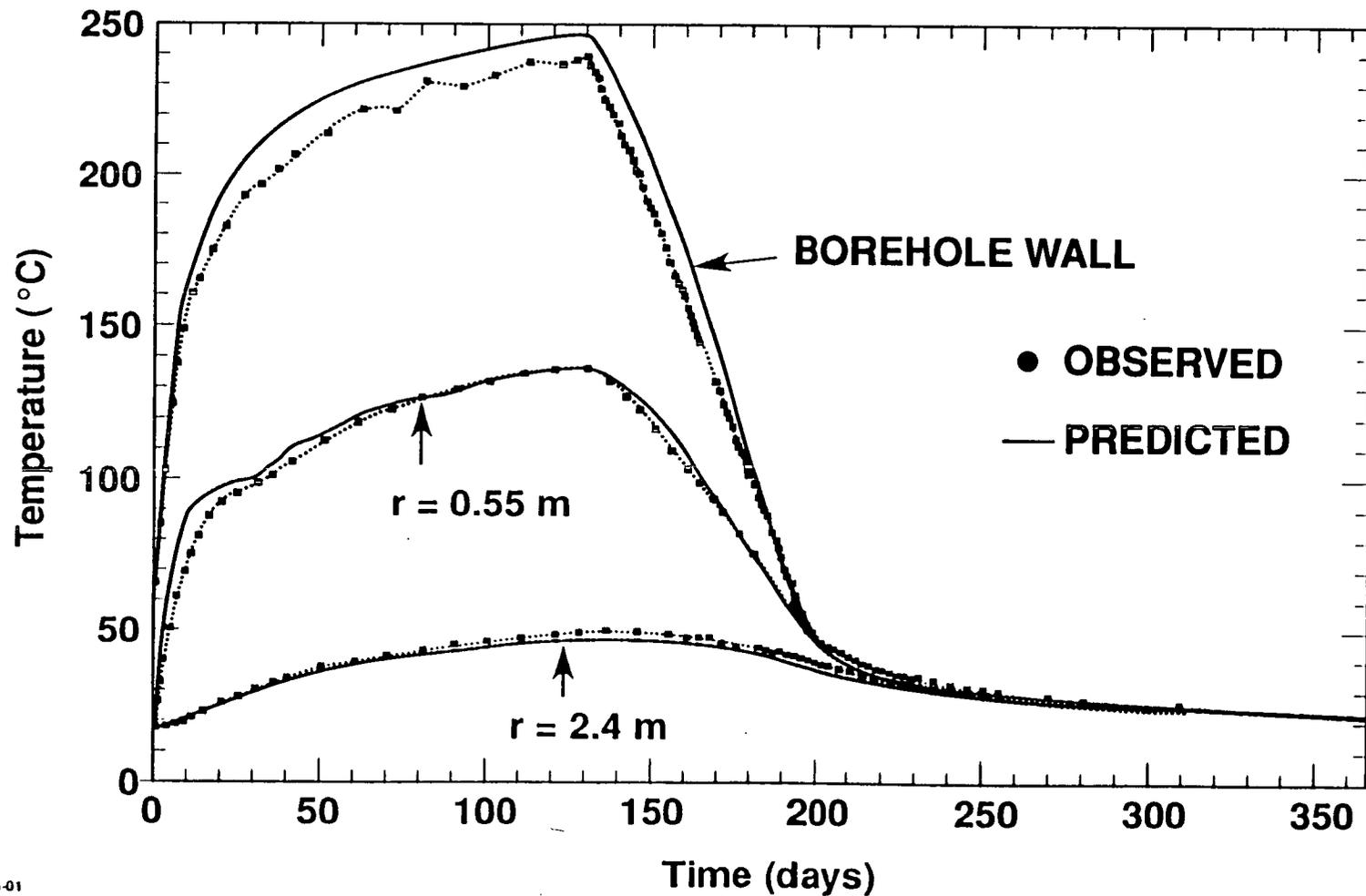
- TEST PERFORMED TO DETERMINE THERMAL RESPONSE AND MOVEMENT OF MOISTURE IN WP ENVIRONMENT
- SIMULATED HORIZONTAL EMPLACEMENT
- PREDICTED RESPONSE DEVELOPED USING TOUGH CODE

# ROCK WAS PERTURBED BY A HEATING AND COOLING CYCLE

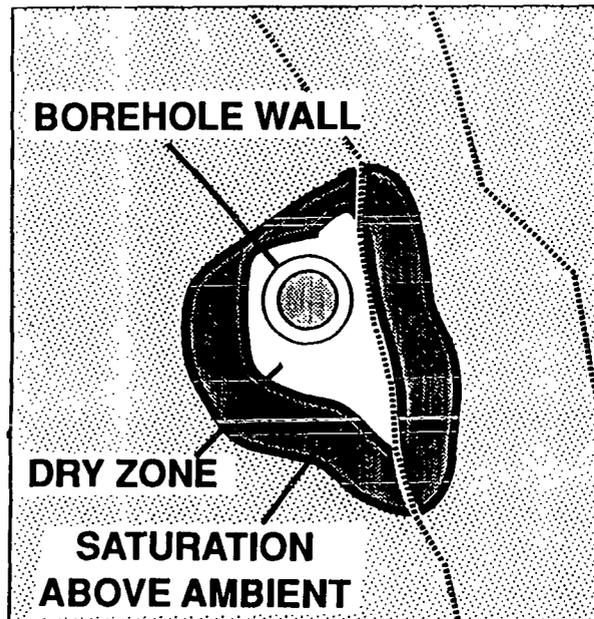


- HEAT LOAD APPROX. = 1.0-1.2 Kw/METER OF HEATER
- BOILING REGION DIAMETER LESS THAN APPROX. 1.4 METERS
- HEATER ON FOR 195 DAYS, 128 DAYS HEATING, 68 DAYS RAMP-DOWN
- COOLING HIGHLY ACCELERATED (COMPARED TO A SPENT FUEL WASTE PACKAGE)

# OBSERVED AND PREDICTED TEMPERATURE



# 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**

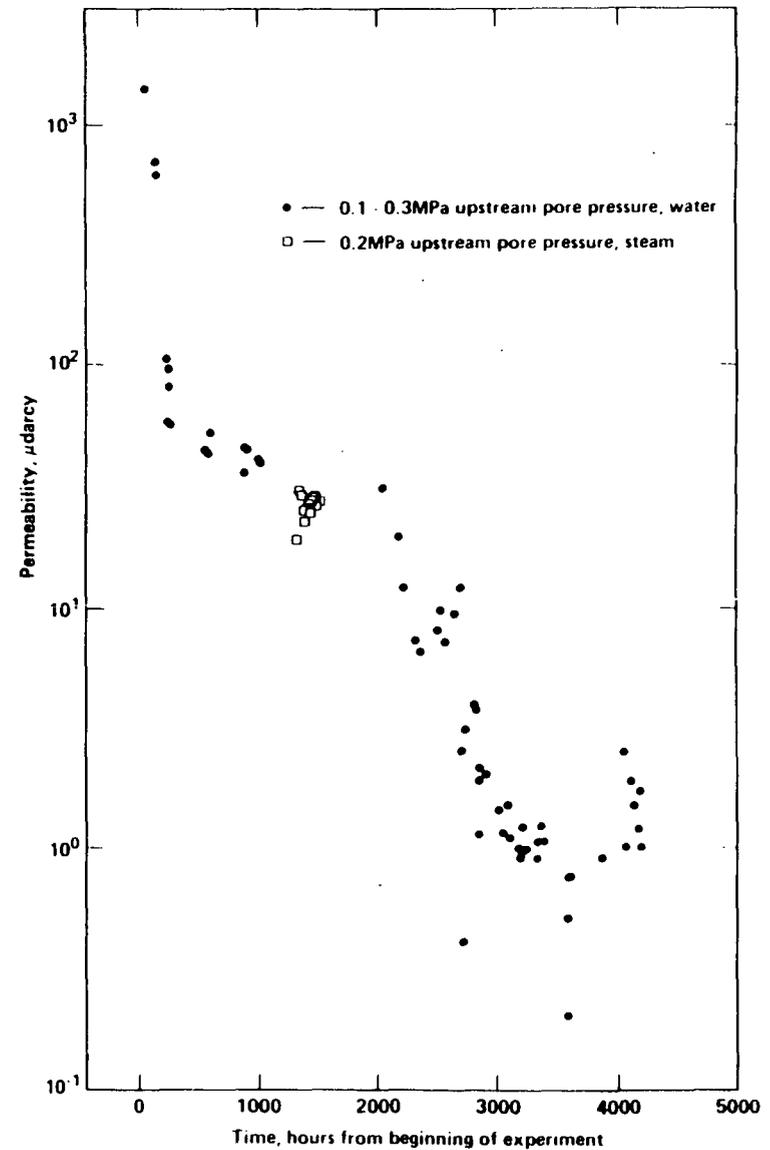
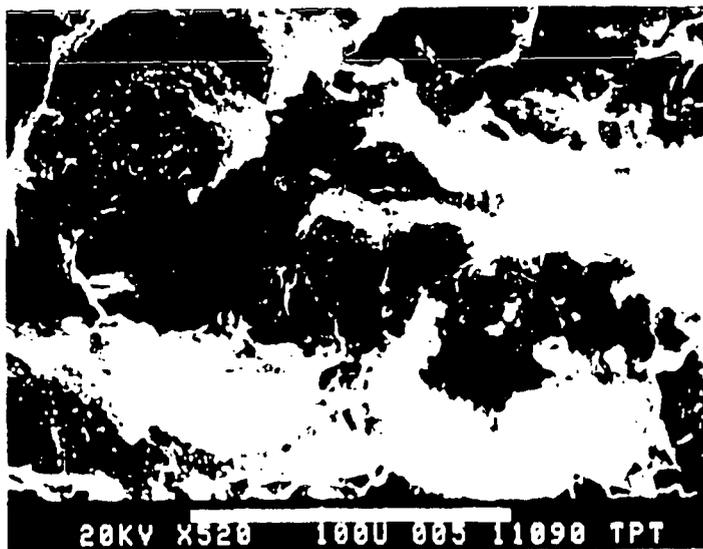
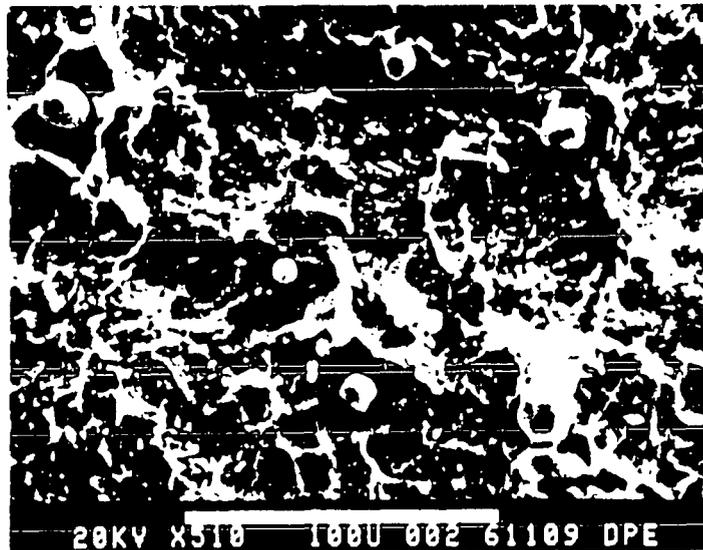
## **● GEOCHEMICAL**

- WATER-ROCK INTERACTION**
- WASTE FORM DISSOLUTION AND SOURCE TERM FOR FAR-FIELD STUDIES**
- THERMODYNAMIC AND KINETIC DATA FOR GEOCHEMICAL MODELS**

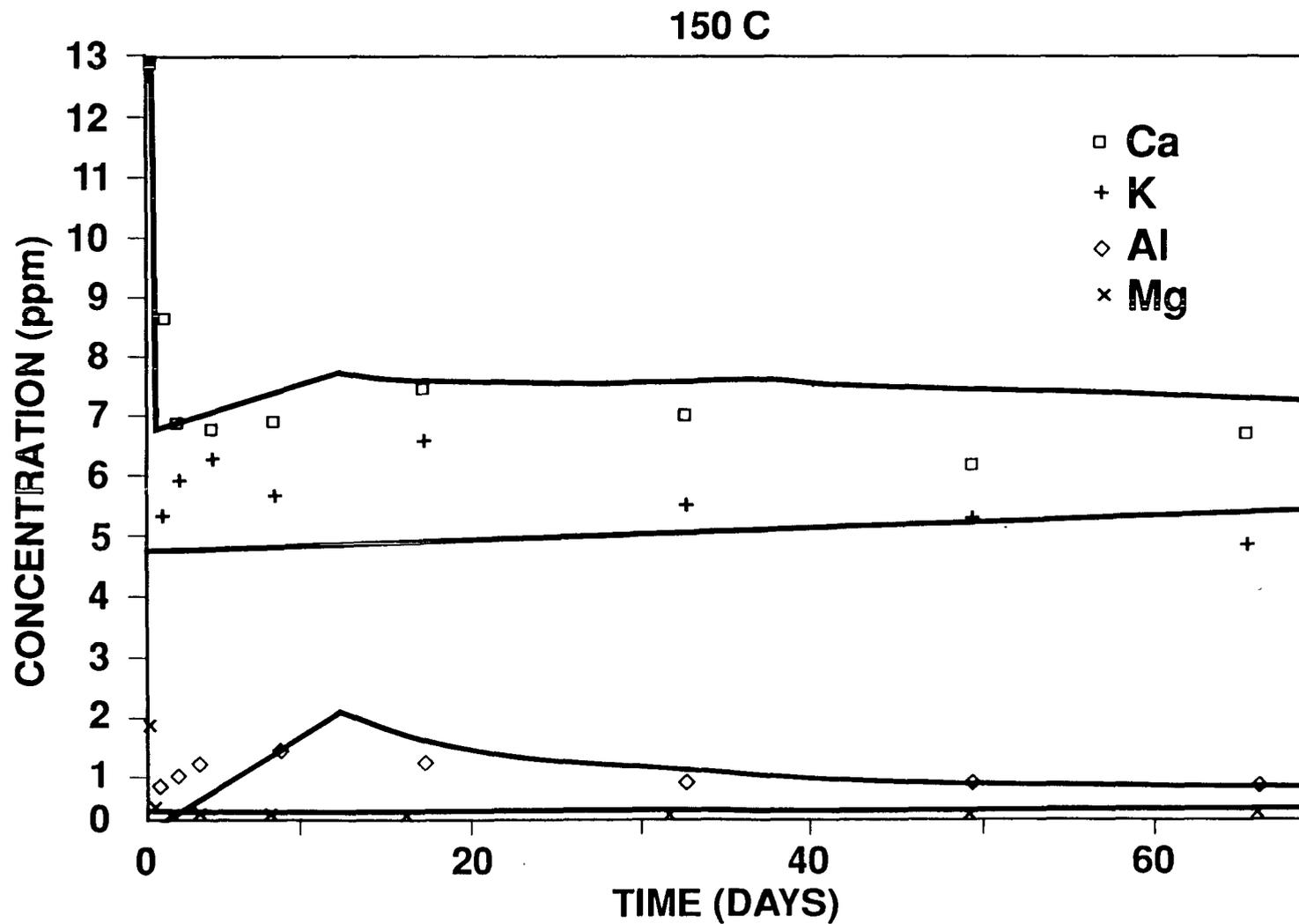
# **LABORATORY STUDIES - THERMOHYDROLOGICAL RESULTS**

- **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



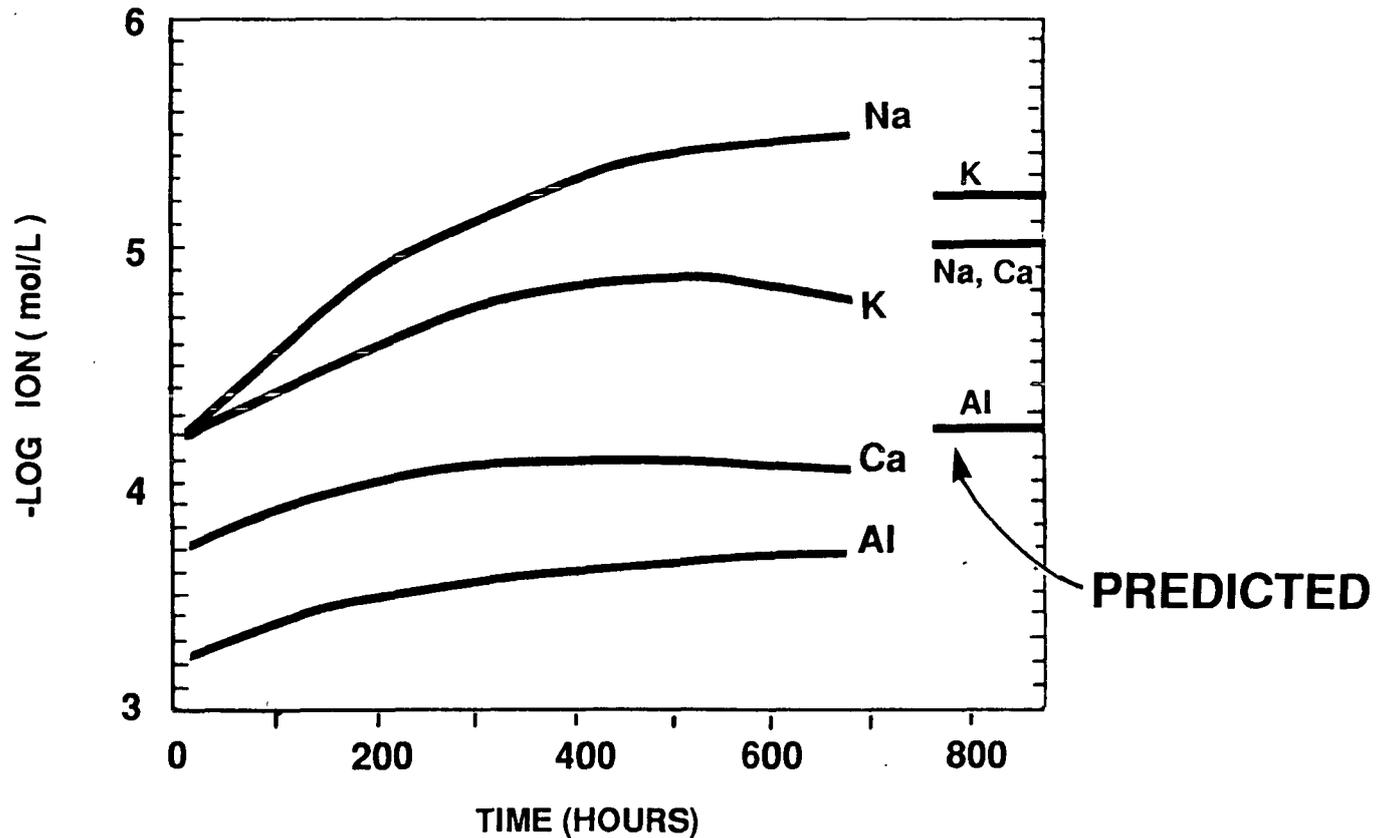
# LABORATORY - WATER-ROCK INTERACTION



# 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**