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

PRESENTATION TO
THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: WASTE PACKAGE ENVIRONMENT INTRODUCTION

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Focus of Presentations

- Near-field environment (not overall repository environment)
- Near-field defined by effects of processes not geometry
- Environment-container material interactions during 1,000 yr containment period.

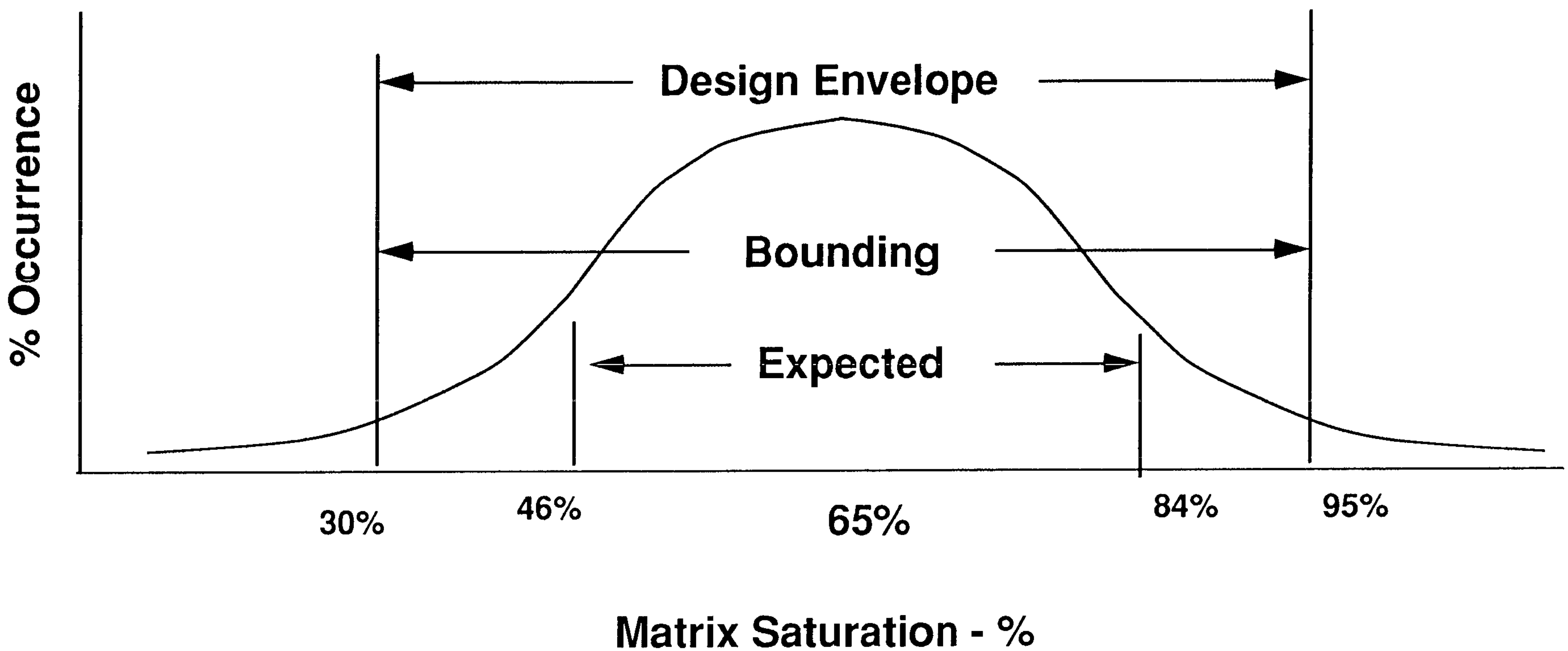
Issues of WP Environment-Container Interactions

- Amount/transport of Water/water vapor
- Composition of water/water vapor
- Mechanical loading on container
- Thermal conditions (heat transfer, temperatures)
- Radiation-chemical effects

WP Environment Terminology

Expected	The conditions that are judged most likely to occur during period of interest
Bounding	Conditions that are judged to be beyond expected values, but within possible ranges

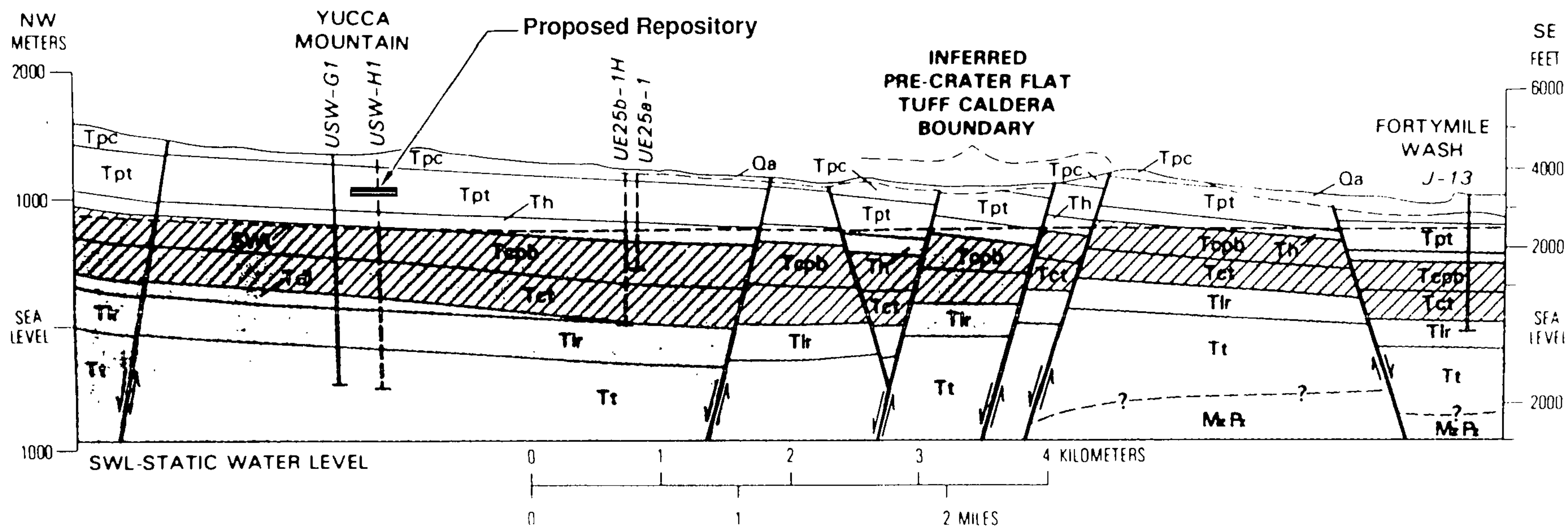
Yucca Mountain Matrix Saturation conditions as Currently Understood



Expected Yucca Mountain Conditions (unchanged or ambient)

- Hydrologic Conditions
  - Unsaturated S ≈ 65%
  - moist (100% humidity) air in remaining voids
  - Matrix suction potential high
  - Fracture flow not expected
- Water Chemistry
  - bicarbonate water
  - vadose water chemistry unknown but expect to be in equilibrium with Topopah Springs Tuff
  - J-13 well water representative of water in saturated zone, but is not in equilibrium w/Tpt
- Mechanical Loading
  - No lithostatic or hydrostatic loads
  - No point loads
- Thermal
  - Conductive, radiative, and convective-latent heat transfer

Cross Section of Yucca Mountain Hydrology



Bounding Yucca Mountain Conditions

- Liquid water in borehole (5ℓ /yr/borehole) for up to 5% of WPs

  Requires either 1) much higher than expected flux

  2) high infiltration pulse

- Chemistry more concentrated than expected
- Loading
  - Small block failures--1000 to 3000 KG
  - Point loading
  - Sloughing provides bridge for lithostatic loads
- Thermal
  - More liquid water present--greater vapor influence
  - local geologic variations

Waste Package Environment

- Emplacement environment

    Not ambient--perturbed by construction etc.

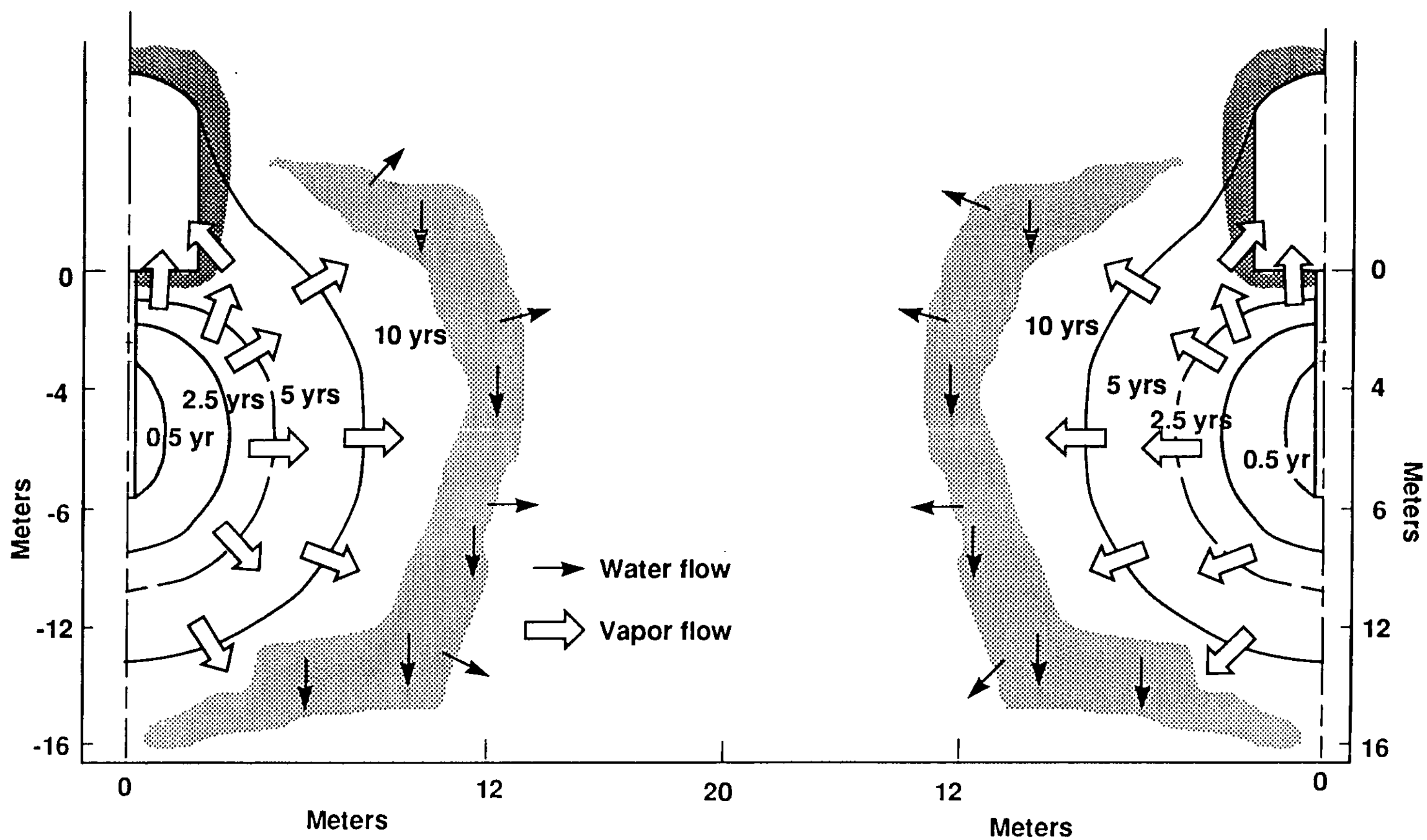
- WP environment emplacement perturbations will be changing with time

    -thermal, radiation, and chemical reactions are all f(t)

- Understanding ambient conditions is necessary to evaluate perturbed conditions

- A table or matrix containing singleWP environment parameter values is not possible. Rather the "table" will consist of functional relationships (e.g., saturation and temperatures as functions of time)

Changing Environment with time
Boiling Point Isotherms for 8 YOC Spent Fuel



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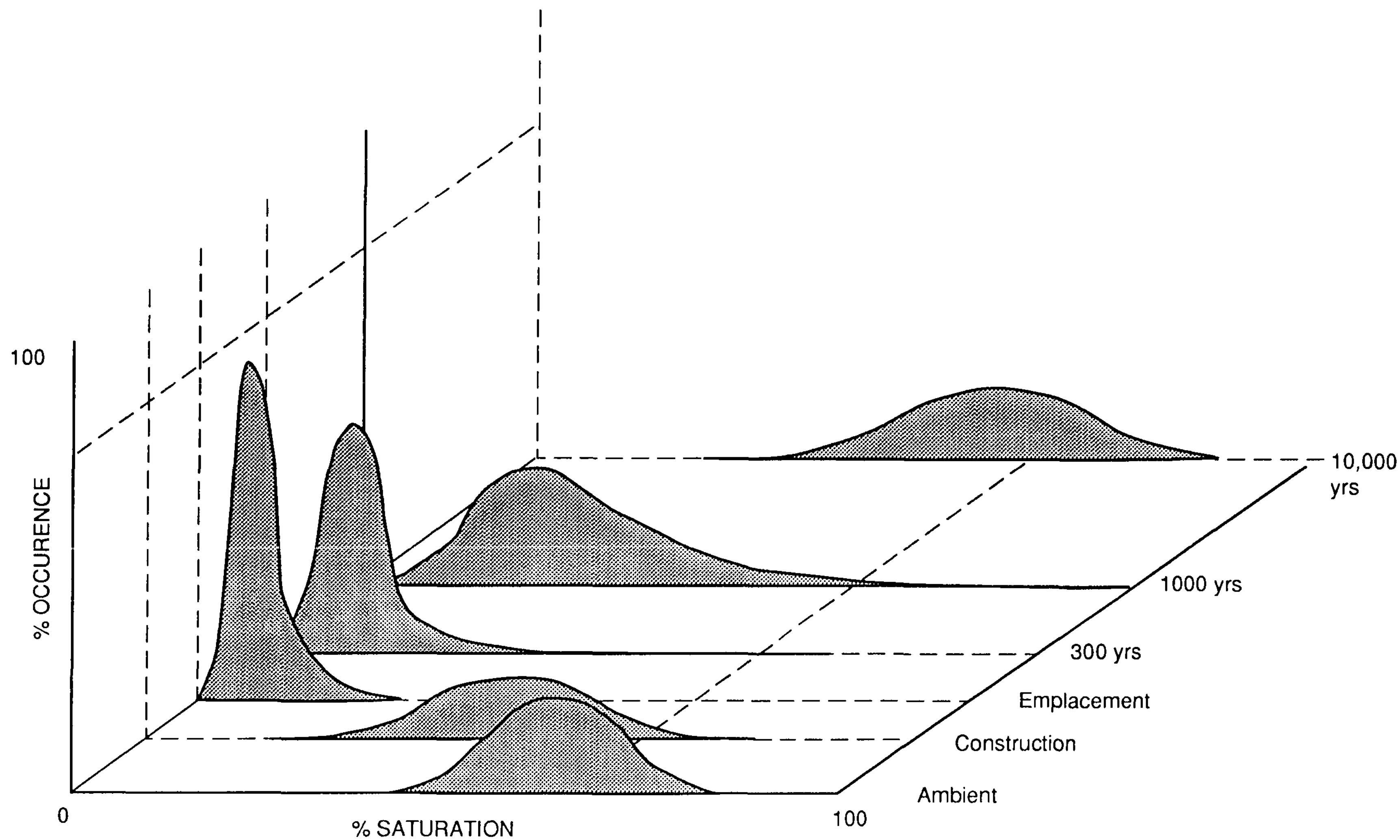
Saturation of Rock around SF Boreholes
an example of changing environment with time



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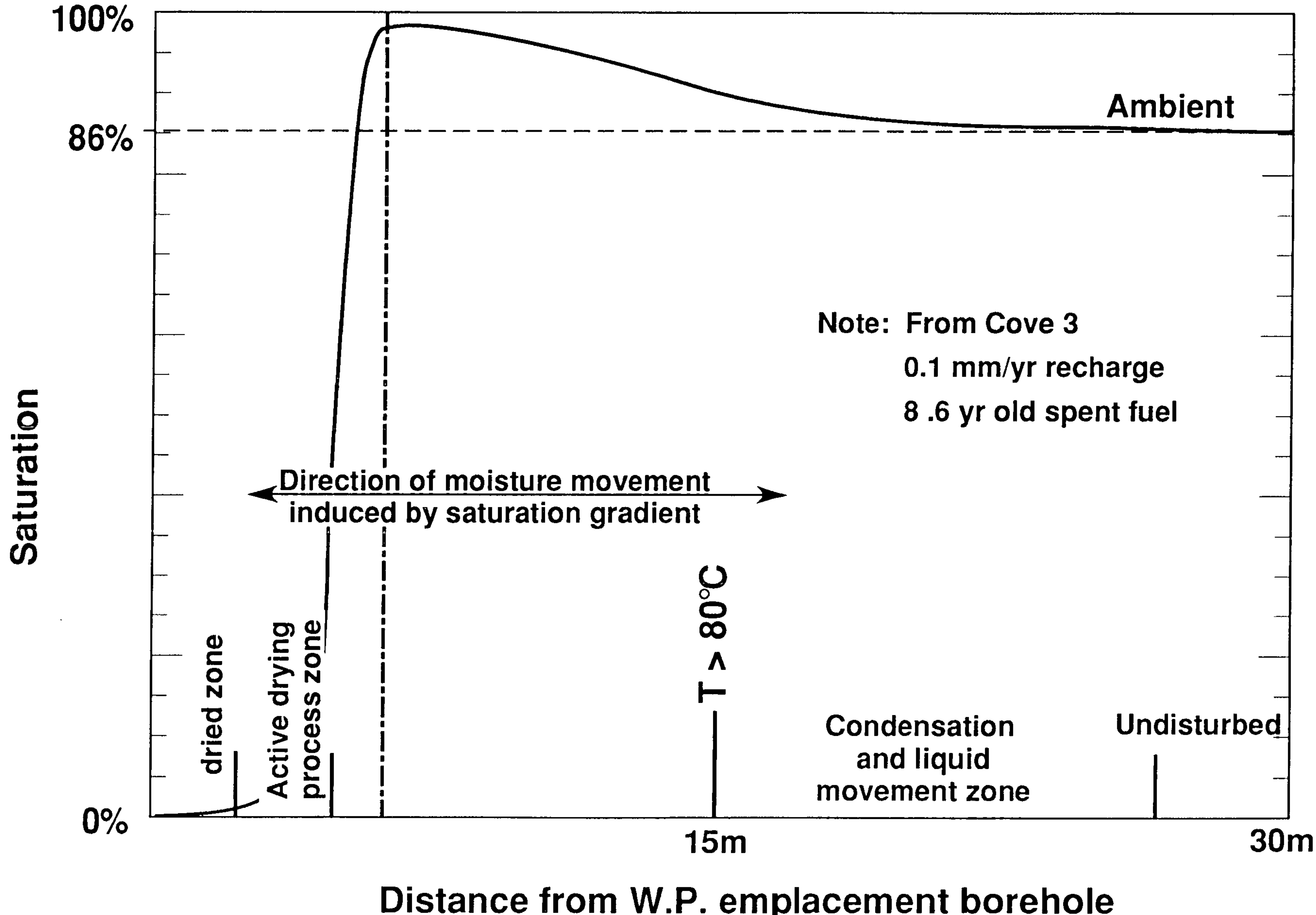
Post-emplacement Saturation Conditions around borehole of typical Spent Fuel Canister



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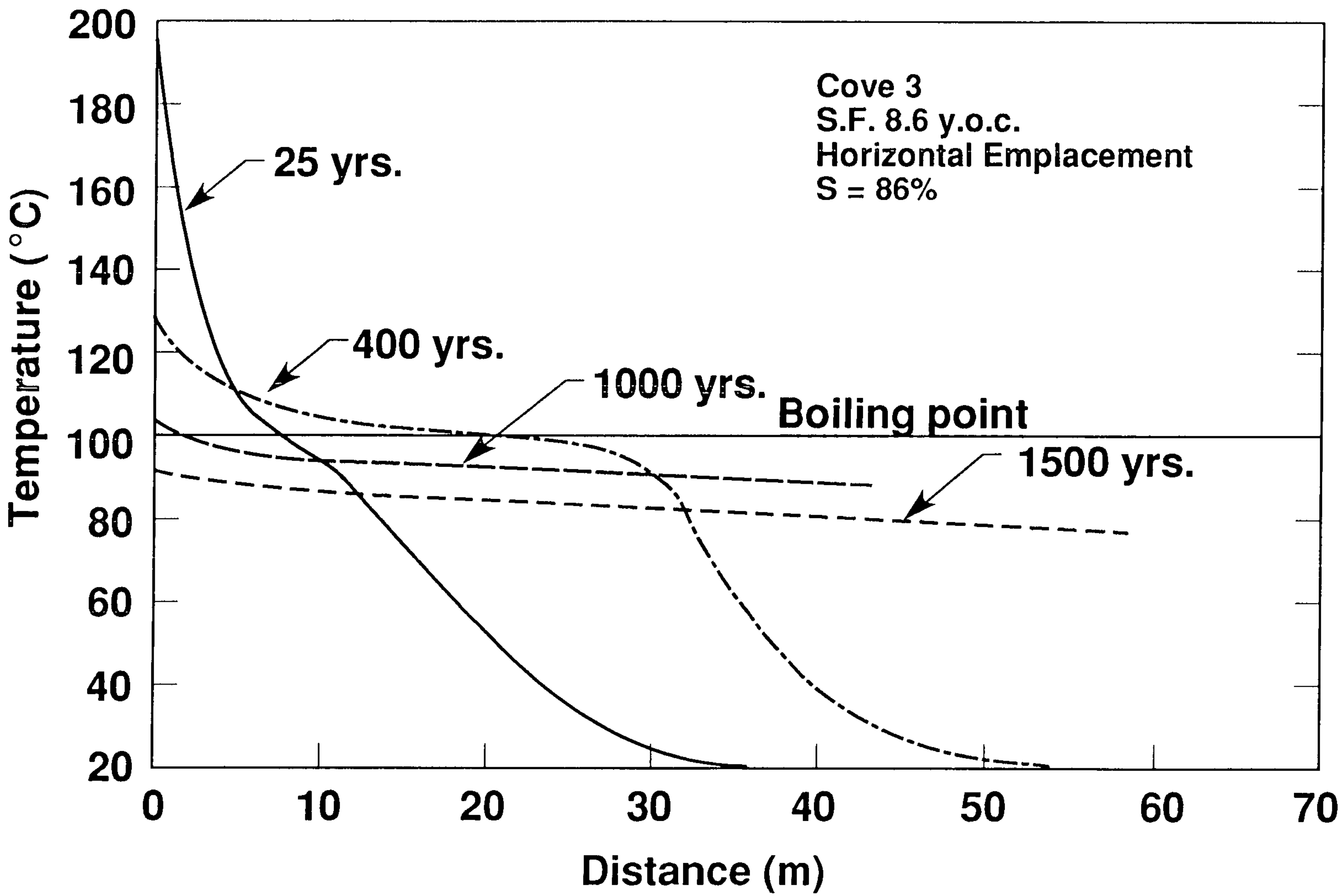
TEMPERATURE PROFILE



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Testing Plans to address Scale Dependency

e.g. high Temp etc.

- Short Duration Tests (1-2 yrs, often overdriven)
  e.g. G-Tunnel, Lab Tests, Exploratory Shaft Test #1

  Identify Physical Processes
  Provide Parameter Values
  Test Models over limited conditions
  Limited Model Validation

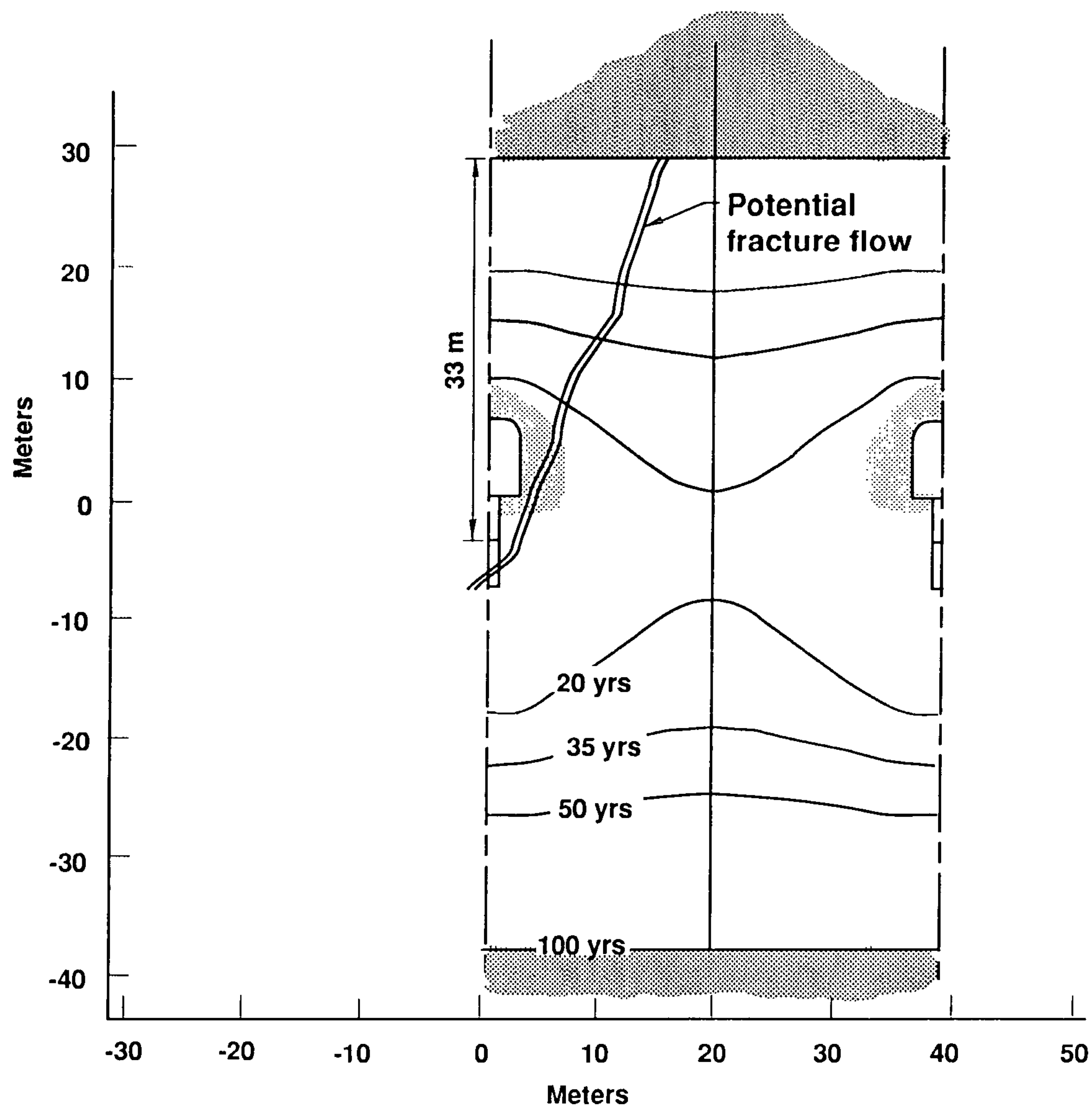
- Longer Duration Tests (3-5 yrs, partially overdriven)
  e.g., Exploratory Shaft Tests #2, and #3

  Partially characterize physical processes that are sensitive to overdriving (i.e., overdrive heat slower rate cooling #2, slow heating with overdrive cooling #3)
  Test models over more extended conditions
  Additional model validation
  Address geochemical and geomechanical

- Performance Confirmation Tests (representative rate tests)

  Exploratory Shaft Test #2--long term cooldown--validate cooldown portions of models
  Actual Waste Package Monitoring--validate heating portions of models

POTENTIAL FRACTURE FLOW PATH INTO WP EMPLACEMENT BOREHOLES



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Hydrologic Interactions
T. Buscheck/ J. Nitao

- **Amount/transport of Water/water vapor**
- **Thermal conditions (heat transfer, temperatures)**

Composition of water/water vapor

Mechanical loading on container

Radiation-chemical effects

- **Theory describing interaction of flow in fractures and matrix blocks--conditions under which fracture flow is possible which would allow water contact with WPs**
- **Matrix dominated flow--role of fractures (hinder or assist) in matrix flow in rock**

Geochemical Interactions
B. Glassley

Amount/transport of Water/water vapor

Thermal conditions (heat transfer, temperatures)

► **Composition of water/water vapor**

Mechanical loading on container

Radiation-chemical effects

- **Rock water interactions, etc.**

Mechanical Attributes of the WP Environment

S. Blair

Amount/transport of Water/water vapor

Thermal conditions (heat transfer, temperatures)

Composition of water/water vapor

► **Mechanical loading on container**

Radiation-chemical effects

- **Hydrology impacts (Impact on air-gap)**
- **Geochemistry impacts--Surface Area**
- **Loading conditions**
  - **block failures**
  - **creep**

G-Tunnel Prototype Test

A. Ramirez

Field Scale Test of Hydrothermal Models, measurement techniques and procedures

Horizontal Orientation

Limited vertical extent of welded tuff

Limited resources prevented complete suite of testing that the reference orientation deserved--planned vertical for later more complete tests

- Understanding of physical processes
- Comparison of numerical and analytical codes and models for "generic" tuff
- Instrumentation/Measurement Technique Evaluation

Interaction of Radiation with the WP Environment

R. Van Konynenburg

Amount/transport of Water/water vapor

Thermal conditions (heat transfer, temperatures)

Composition of water/water vapor

Mechanical loading on container

➤ **Radiation-chemical effects**

- **Effects on Environment**
- **Interaction of radiation-chemical products with container materials**