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

NUCLEAR WASTE TECHNICAL REVIEW BOARD
EBS PANEL MEETING

SUBJECT: CHEMICAL AND MINERALOGICAL EFFECTS OF INTRODUCED MATERIALS IN THE POST EMPLACEMENT ENVIRONMENT

PRESENTER: DR. ANNEMARIE MEIKE

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PLEASANTON, CALIFORNIA
MARCH 10-11, 1994

U. S Department of Energy Office of Civilian Radioactive Waste Management
Nuclear Waste Technical Review Board Full Board Meeting

Subject: Chemical and Mineralogical Effects of Introduced Materials in the Post Emplacement Environment

Presenter: Dr. Annemarie Meike

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Pleasanton California
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Expected Gradients Caused by Introduced Materials

- pH
- Ionic composition
- Eh
- CO_2 partial pressure,
- Temperature
- Radiation
- Bacterial activity

i.e. The repository cannot be viewed as a homogeneous system

A wide variety of materials may be introduced as a result of construction and operation of a repository

- Insoluble metals (stainless steel): these include measurement devices and electrical accessories,
- Insoluble organic solids (neoprene, plastic): these include packing and rubber,
- Soluble inorganic solids (LiBr, LiCl, NaBr): tracers,
- Inorganic liquid (water with tracers),
- Miscible organic liquids (ethylene-glycol): these include antifreeze and fluorescein dye,
- Immiscible organic liquids (petroleum based oils): these include brake fluids, lubricants, oils, paints, grease and fuels, and
- Gases: H_2, N_2, O_2, CO, CO_2, C_2H_2

Degradation of materials will directly affect water quality

- Chemical Species
  - Organics
  - Alkali Metals
  - Halogen Elements
- pH/Eh
- Colloids
- Microbial Activity

Potential introduced materials are identified on the basis of

- Present and past draft repository designs
- Other mining operations
- Estimated and actual usage of materials during the construction of the ESF.

These materials include:

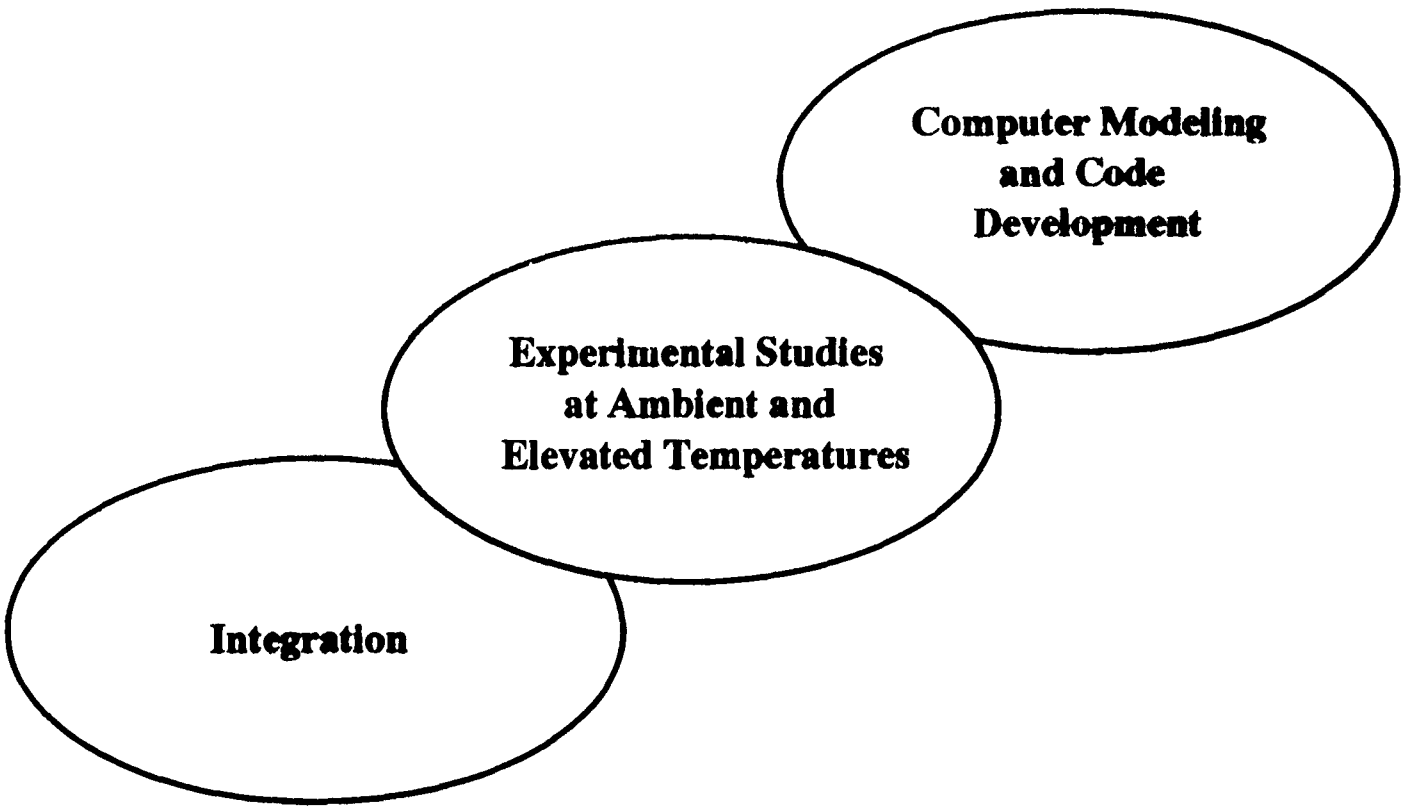
- Water
- Shotcrete
- Deisel Fuel
- Rock Bolts & emplacement materials
- Lubricants
- Miscellaneous materials, such as polystyrene and bentonite clay.

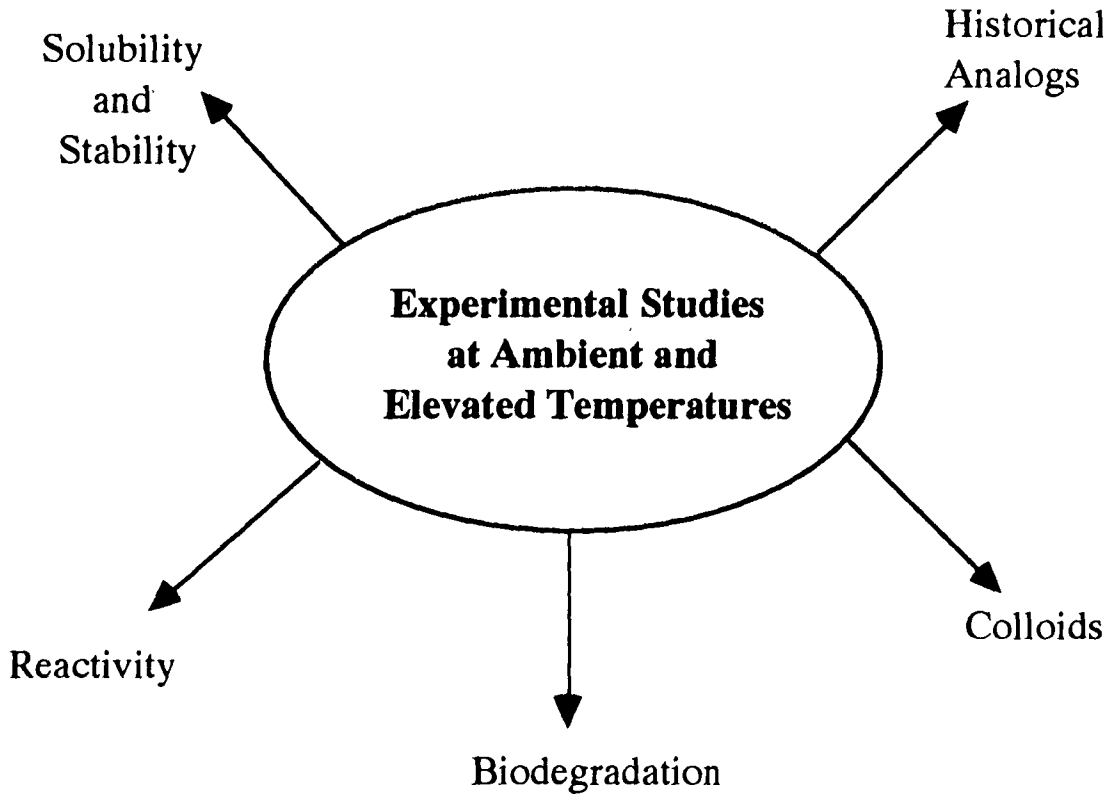
Some of these materials may be present in significant quantities.

Options for Usage of Materials in a Repository

- No Limitations (Default)
- Restricted Usage
- Removal
- Substitute Materials

Activities Intended to Address Concerns Related to Materials Introduced into a Radioactive Waste Repository




Solubility and Stability
Historical Analogs
Experimental Studies at Ambient and Elevated Temperatures
Reactivity
Biodegradation
Colloids

Present Experimental Program:

- Diesel Fuel Stability at Elevated Temperatures
  (Experimental Study)

  Initiated FY 92

- Cementitious Materials at Elevated Temperatures
  Non-microbial Degradation
  Biodegradation
  (Historical Analog and Field Experiment)

  Initiated FY 93

- Long Term Chemical/Microbial Consequences of
  Diesel Exhaust Deposits
  (Field Experiment)

  Planned for FY 94

Goal of Colloid Studies within the Man-made materials Task

Identify introduced material sources and their significance with respect to:

- Colloid formation
- Adsorptive capacity modification
- Natural colloid enhancement

OBJECTIVE: Provide information for the development of policies with regard to introduced materials:

- Removal
- Minimized usage
- Special measures during emplacement and use

Possible colloids derived from introduced materials

COMPOSITION:

- Oxy(hydr)oxides
- Clays
- Organic particles
- Polysilicates

SIZE:

- Very small (< 10 nm), eg. hydrated metal ions, small organic particles, polyhydroxo-complexes, polysilicates, fulvic acids...
- Medium sized (10 -100 nm), eg. clays, metal-hydroxides
- Large (> 1μm), eg. inorganic and organic particles

Influences on formation, transport and stability

COLLOID CHARACTERISTICS:

- Physical size
- Bulk charge
- Density
- Chemical reactivity
- Chemical structure
- Sorption potential

ENVIRONMENTAL CHARACTERISTICS:

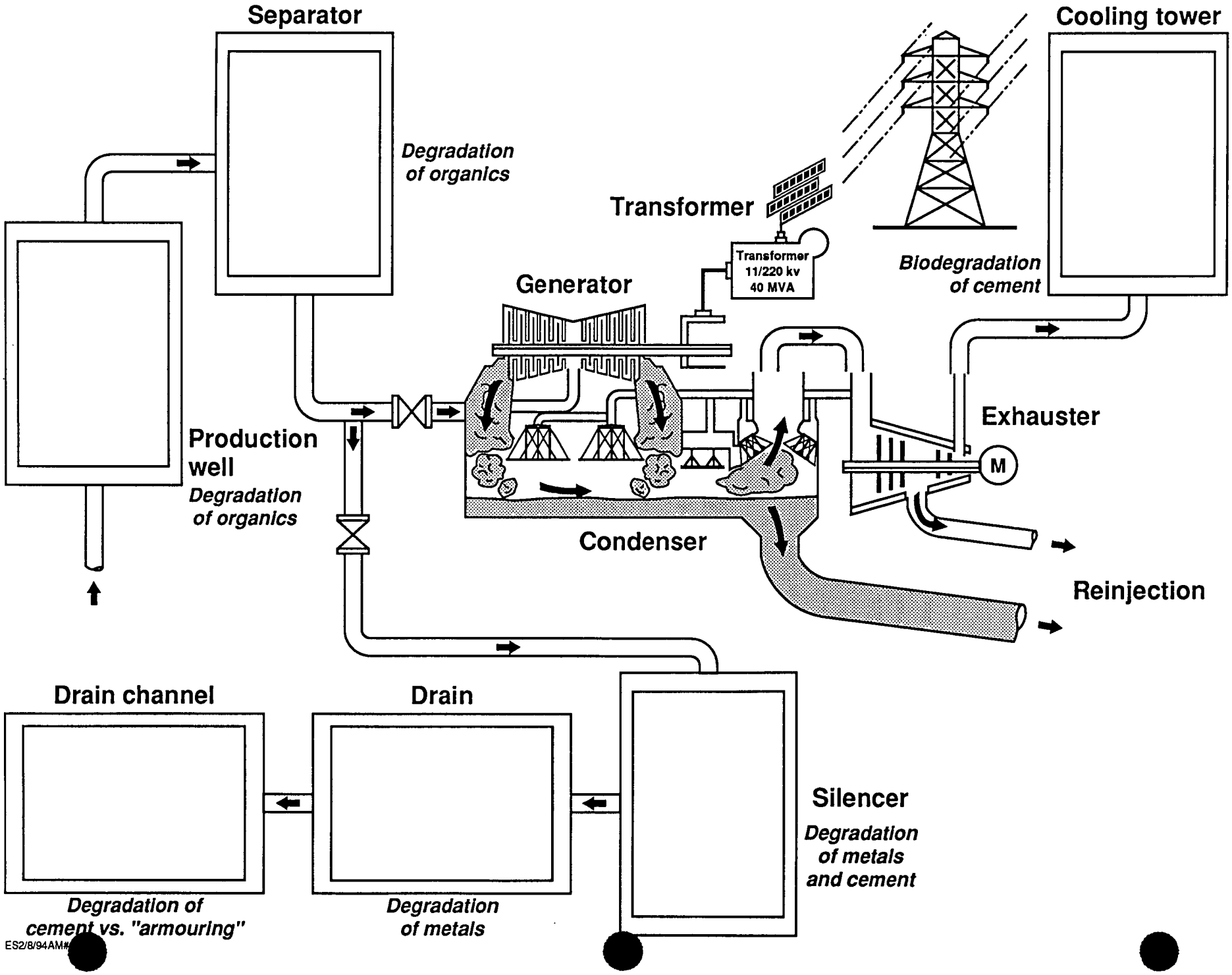
- pH (cement)
- Redox potential (cement, metal)
- Ionic strength
- Competing ions
- Organic matter (peanut butter and jelly sandwiches)
- Temperature
- Microbial activity
- Radiolysis

GRADIENTS in environmental chacteristics (space, time)

New Zealand Field experiment/ Analog study

This is a collaborative study being conducted by the Man-made Materials and Geochemistry Tasks

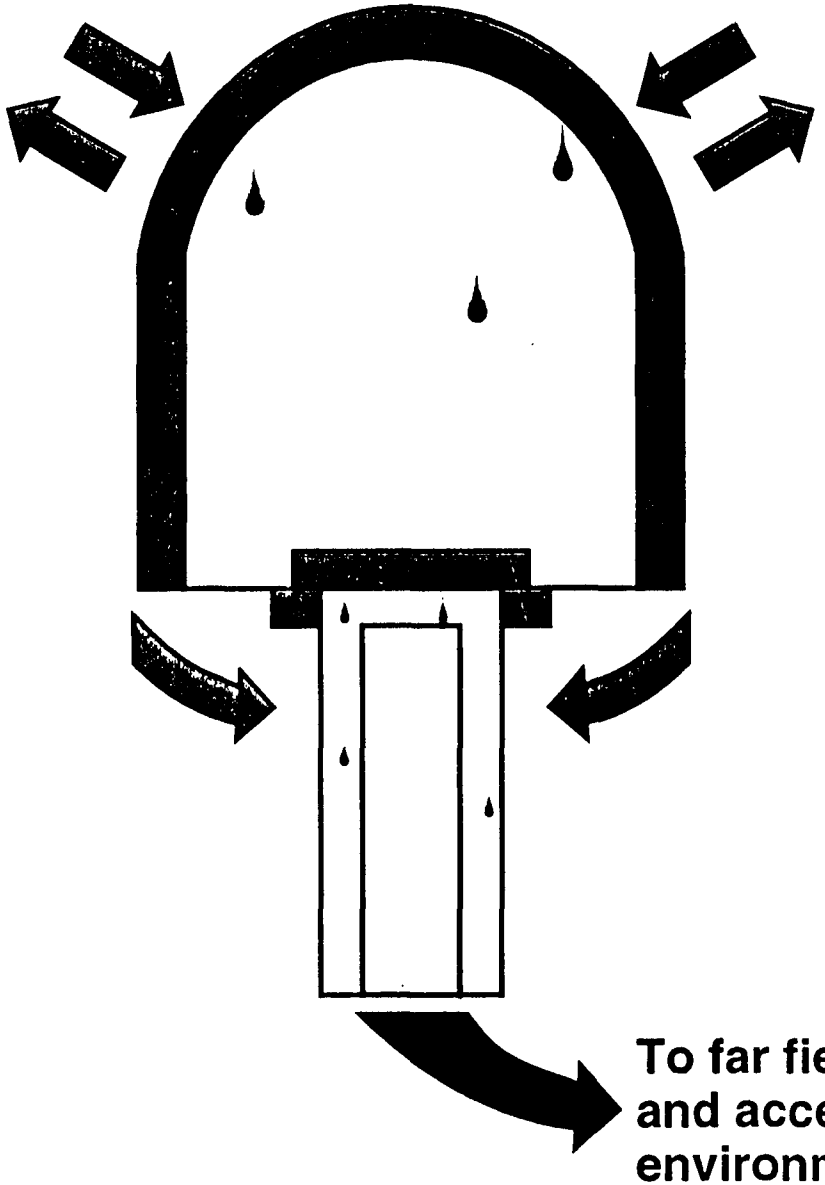
Goal: Obtain Long-term chemical data and validate chemical simulation computer codes that will eventually be used for prediction of water chemistries.

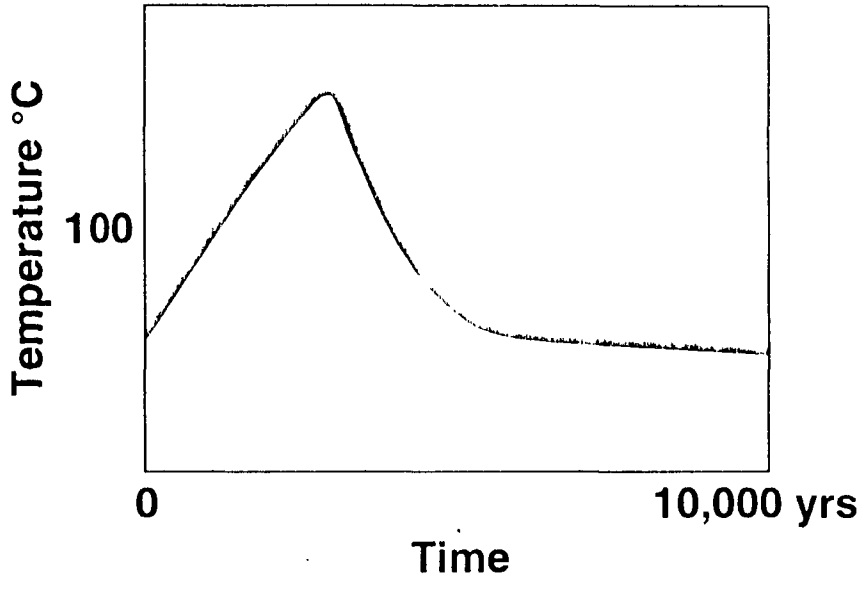

Separator
Degradation of organics
Cooling tower
Transformer
Transformer 11/220 kv 40 MVA
Biodegradation of cement
Generator
Exhauster
M
Production well
Degradation of organics
Condenser
Reinjection
Drain channel
Drain
Silencer
Degradation of metals and cement
Degradation of cement vs. "armouring"
Degradation of metals
ES2/8/94AM#

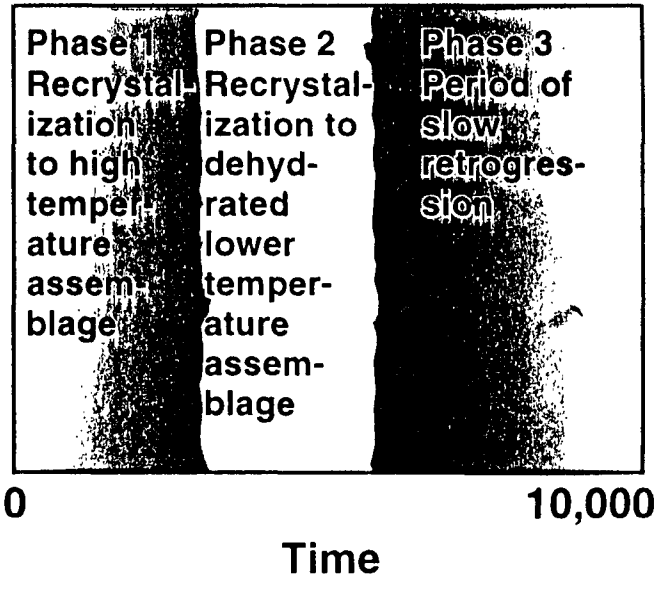
New Zealand Field experiment/ Analog study

Cement: What are the significant mechanisms and parameters that control the pH of water in contact with cement over long periods of time?

Cements in a repository







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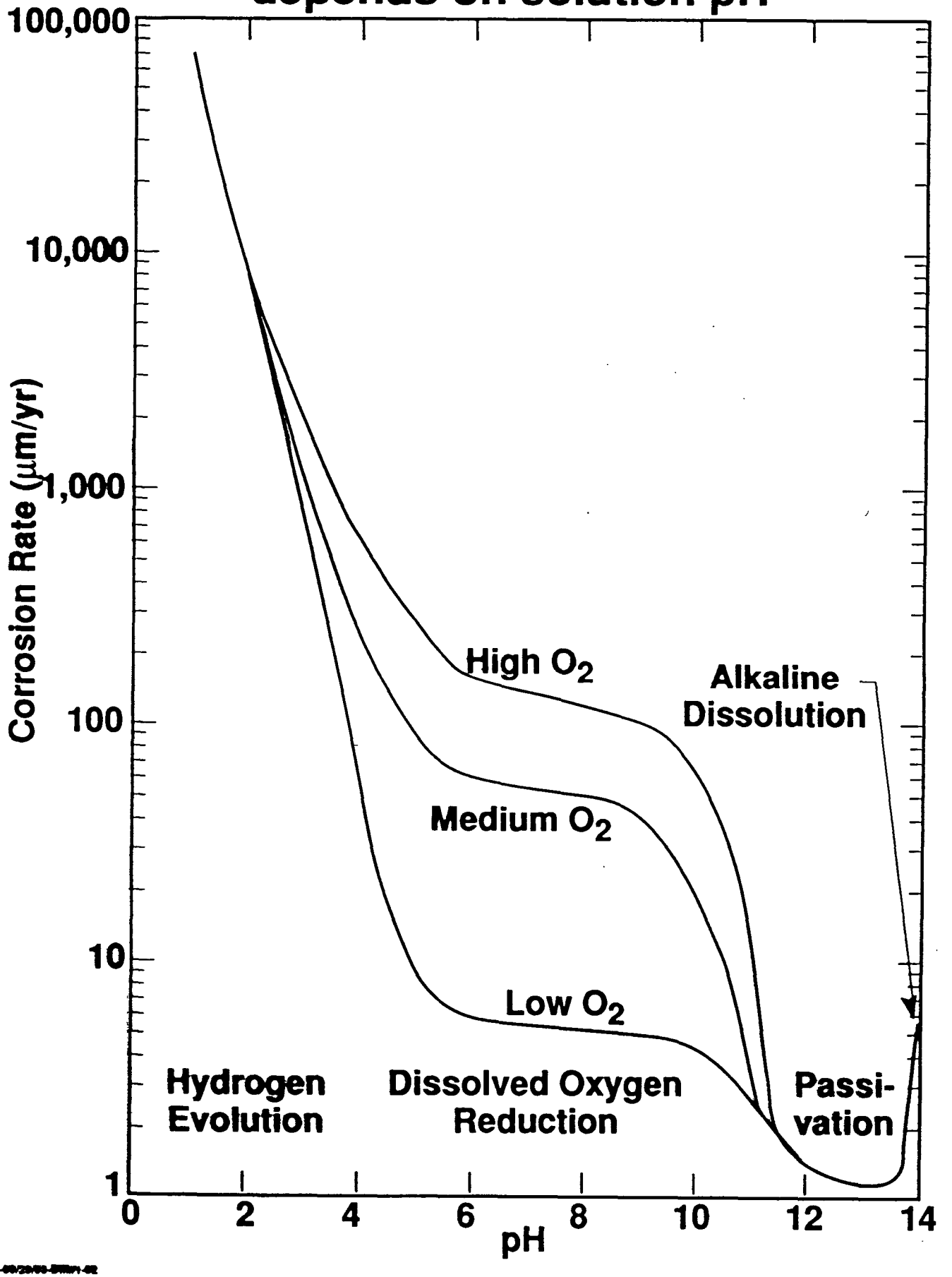
Corrosion rate of carbon steel depends on solution pH



Summary

Are these issues significant?

1) Quantities of materials that may be used and their potential proximity of some materials to the waste packages indicates that their potential for modifying water chemistry should not be overlooked.

2) The potential exists for the modified water chemistry to have either positive or negative effects with respect to repository design. This potential must be determined for each material category.

3) The Man-made materials task can support design efforts with this information.