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YUCCA MOUNTAIN PROJECT

Studies

Natural-System Models for Total System Performance Assessment-Site Recommendation

Presented to:
DOE/NRC Technical Exchange on
Total System Performance Assessment
San Antonio, Texas

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May 25-27, 1999

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Overview

- **This presentation focuses on changes from VA to SR in the natural-system models:**
  - **Climate and infiltration (UZFT PMR)**
  - **Unsaturated-zone flow and transport (UZFT PMR)**
  - **Seepage into emplacement drifts (UZFT PMR)**
  - **Thermal hydrology and coupled processes (NFE PMR)**
  - **Saturated-zone flow and transport (SZFT PMR)**
  - **Biosphere (Biosphere PMR)**

UZFT PMR

Relevant NRC Key Technical Issues

- Unsaturated and saturated flow under isothermal conditions
- Thermal effects on flow
- Repository design and thermal-mechanical effects
- Evolution of the near-field environment
- Total system performance assessment and integration
  - Radionuclide Transport

Drivers for Model Changes

- Quality assurance
- New repository design
- New regulations (proposed NRC 10 CFR Part 63; EPA 40 CFR Part 197 when it comes out)
- NRC IRSR acceptance criteria and comments on the VA
- Comments from PAPR, NWTRB, USGS
- New data for several models

Quality Assurance

- A large part of the current effort is bringing everything up to "Q" standards
  - All computer codes must be qualified
  - All data must be qualified (may need to qualify some older data via peer review or other method)
  - Strict process control for passing of information from one group to another
  - Strict requirements for planning and carrying out analyses
  - All documentation checked against source data and references to ensure traceability

Climate Change

USGS work

not sure what put into TSPA

- Updated climate model: "monsoon" state after about 600 years, "glacial transition (GT)" state after about 2000 years. (VA: change to "long-term average (LTA)" at a time sampled from 0 to 10,000 years.) We are concentrating on 10,000 years
- Uncertainty in climate "amplitude":
  - Monsoon climate is warmer and wetter than present. Lower bound is present-day Yucca Mountain; upper bound is like Nogales, AZ
  - Glacial-transition climate is cool and wet. Lower bound is like Beowave, NV; upper bound is like Spokane, WA. Similar to the LTA climate used in VA

Surface Infiltration

- Several model improvements, including runoff/run-on, temperature dependence, vegetation dependence, and snow pack. Geologic framework has also been updated
- Infiltration uncertainty being developed by varying input parameters over reasonable ranges in a stochastic analysis better than VA bounds VA was "semi-arbitrary"
- Preliminary results indicate lower mean net infiltration for wet climate than was used for VA (about 20 mm/yr for GT, as compared to about 40 mm/yr for LTA), but greater range

Unsaturated-Zone Flow

- Improved basis for fracture-matrix coupling ("active fracture" model) only a subset of fractures are actively flowing published in "water resources"
- Numerical mesh aligned with individual repository drifts
- Alternative conceptual models of flow through/around perched water being investigated

Seepage into Drifts

- New data from Exploratory Studies Facility (ESF) tests provide better basis for conceptual models and parameter ranges
- Several additional effects being investigated for possible inclusion:
  - Thermal effects
  - Effects of rockfall/drift collapse
  - Effects of THC/THM coupled processes
- Seepage uncertainty derived from input-parameter uncertainty, primarily fracture hydrologic properties (Same basic method as VA)

Thermal Hydrology

- **SR design changes that affect Thermal Hydrology (TH):**
  - **Lower thermal load**
  - **Waste-stream "blending"**
  - **Waste packages much closer together ("line load")**
  - **Drifts much farther apart**
  - **Preclosure ventilation**
  - **Drifts backfilled at closure**

peak temp. similar to VA

Thermal Hydrology
(Continued)

- Thermal effects on seepage and water & gas composition being included
- Thermal effects on far-field flow and transport being investigated for possible inclusion

Coupled Processes

- **The following are being investigated for possible inclusion:**
  - **THC processes**
  - **THM processes**
  - **Effects on temperature and relative humidity at waste package and drip shield**
  - **Effects on seepage into drifts**
  - **Effects on mountain-scale liquid and gas flow**

unlikely to be included ~ may be included as abstraction

doesn't think mineral caps are at likely

Unsaturated-Zone Transport

- Improved EBS/UZ transport coupling being developed to reduce artificial dilution
- Higher fracture porosities (10^{-2} vs. 10^{-4}), based on gaseous-tracer and seepage tests
- New data on flow and transport properties from Busted Butte test
- New colloid-transport process model being developed, in conjunction with Nevada Test Site (NTS) modeling (for both UZ and SZ transport)

Saturated Zone Flow and Transport

- New 3-D process model being developed; dual-porosity formulation, utilizing available data on flowing-interval spacing. Horizontal permeability anisotropy may be included
- New data from Nye County wells
- Improved UZ/SZ transport coupling being developed to reduce artificial dilution
- Particle-tracking method used to reduce numerical dispersion
- Uncertainty in SZ flow based on SZ expert elicitation

Saturated Zone Flow and Transport

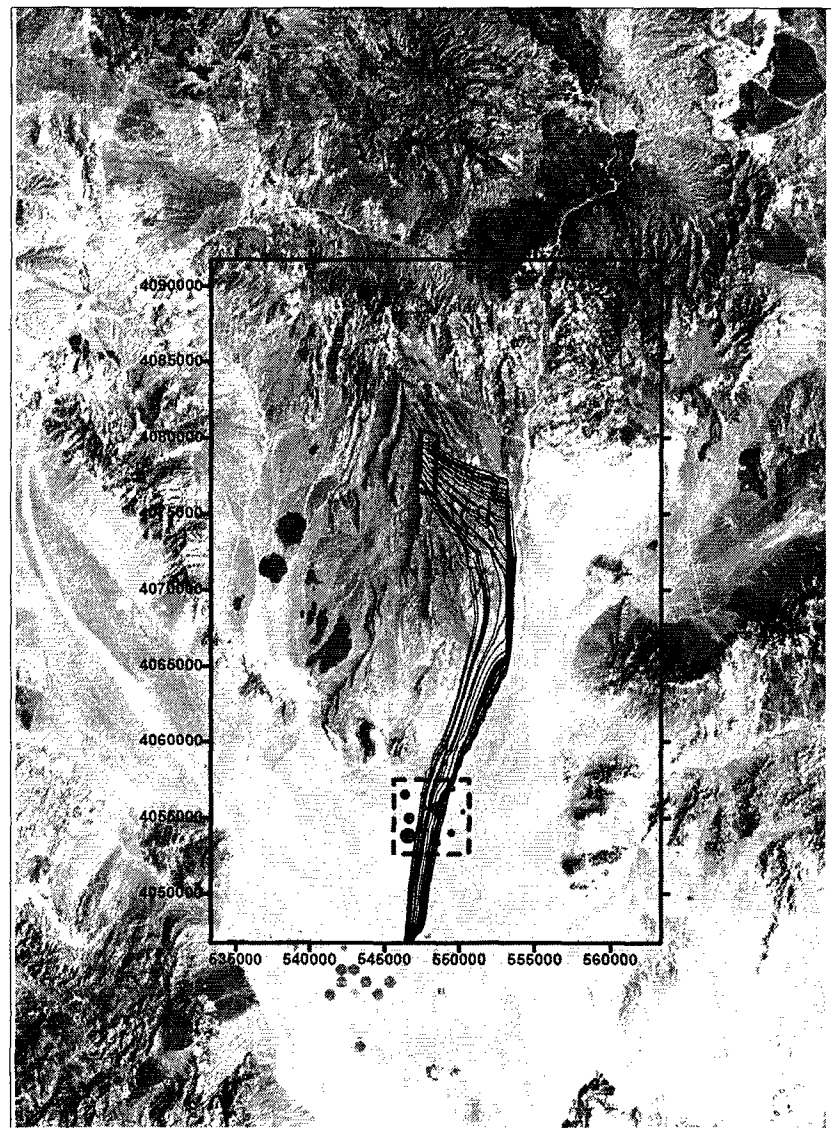
(Continued)

- Two methods of calculating radionuclide concentration are being pursued:
  - Divide radionuclide flux from entire plume into water-usage rate for small farming community (suggested by NRC in proposed 10 CFR Part 63)
  - Take maximum radionuclide concentration in plume at given distance (might be needed for EPA groundwater-protection standard and/or Reasonably Maximally Exposed Individual)
- We are assuming that the compliance point is 20-km downstream from the repository

Saturated Zone Flow and Transport

(Continued)

- First method of calculating radionuclide concentration assumes capture and blending of all radionuclide mass in a hypothetical community water supply
- Second method assumes a small individual well at the location of maximum concentration



Biosphere

- Dose receptor: average member of the critical group within farming community of about 100 people (from proposed 10 CFR Part 63)
  - Critical group being defined from survey data
  - Water usage defined by farming-community needs
- Improved handling of radionuclide buildup/removal in soil based on PRA comment
- Including uncertainty in water usage and crop distribution/irrigation, as well as receptor parameters (e.g., consumption rates) and biosphere transfer coefficients

Summary

- Important drivers for changes from VA to SR:
  - Quality assurance
  - New repository design
  - New regulations (proposed 10 CFR 63; 40 CFR 197 when out)
- New data for several models (notably seepage tests, Busted Butte, Nye County wells)
- New models for SZ and colloids
- Progress in coupled processes
- Several other improvements, including improved EBS/UZ and UZ/SZ transport coupling