TSPA Insights Into Impacts of Climate and Chlorine-36

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Performance-assessment interface with infiltration, isotope, and climate studies

- Based on TSPA results to date, these studies are very important.
  - Repository performance is very sensitive to percolation flux in the unsaturated zone (and therefore to infiltration).
  - Repository performance is very sensitive to seepage into drifts, which is related to division of flow between matrix and fractures (which isotope studies provide information about).
  - Repository performance is sensitive to climate changes.
- PA analysts have provided specific feedback on priorities of PA information needs from study plans and modeling studies.

Performance-assessment interface with infiltration, isotope, and climate studies (cont.)

- PA analysts are currently conducting sensitivity studies to determine how new data (especially ^{36}Cl) might affect past TSPA predictions.
- Some data are used directly in PA models (e.g., infiltration), but some are used more indirectly for model validation or to constrain ranges for model parameters (e.g., calcite ages).
- Joint performance-assessment/site-characterization working groups to be formed in FY97 will be critical in establishing a defensible transition from detailed site data and models to "abstracted" TSPA models.

Outline of presentation

- Importance of ESF and isotope observations
- Importance of climate effects

Important recent findings

- Isotopic data (^{36}Cl, ^{3}H, ^{14}C, calcite/opal ages) are providing evidence of flow in isolated "fast paths."
- High levels of ^{36}Cl have been found, indicating places where there might have been seeps some time in the last 40 years.
- However, the ESF tunnel is basically dry; no seeps have yet been found (though they could be obscured by ventilation).
- These observations are important because they provide constraints on flow, transport, and climate models.

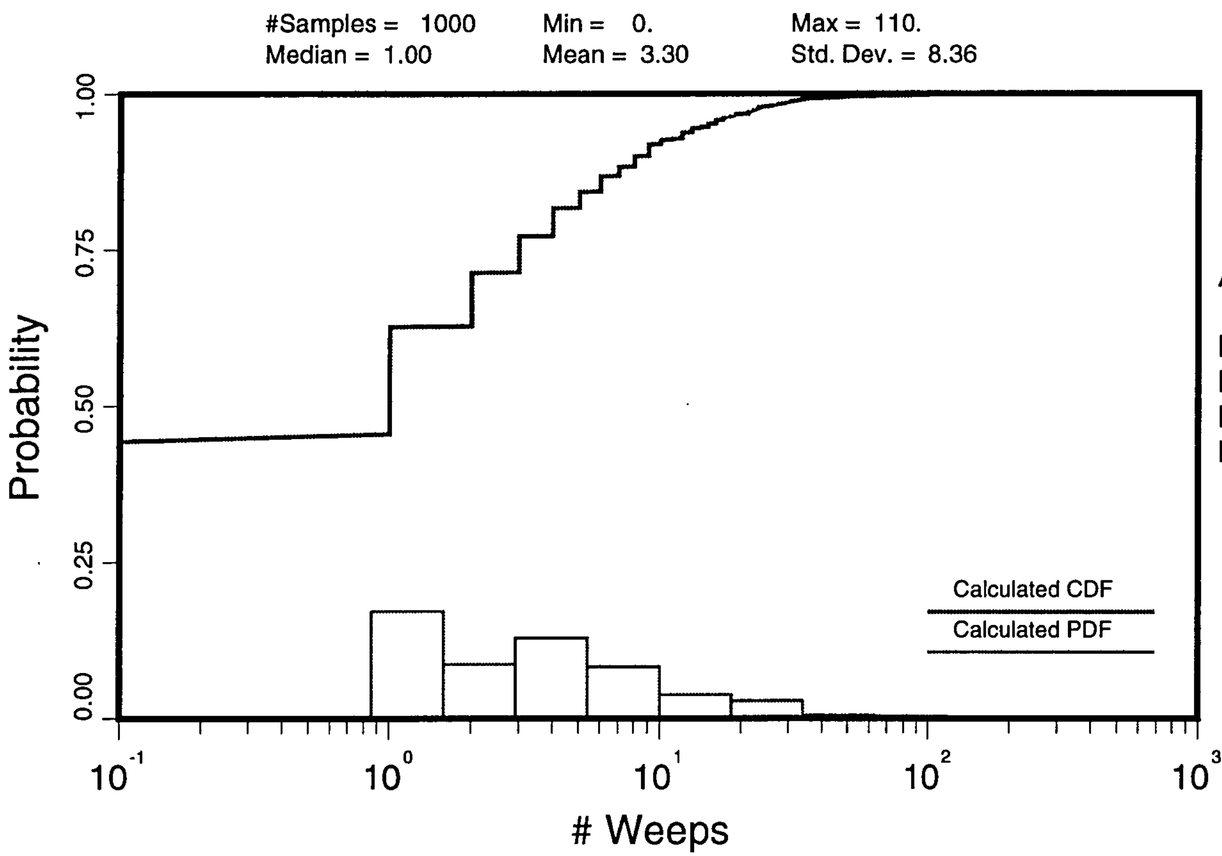
Conceptual models of flow and transport

- A composite-porosity (equivalent-continuum) model requires a very high flux to show movement of a tracer from the surface to the ESF level within 40 years.
- A dual-permeability model with steady-state flow and standard matrix-fracture coupling can have sufficient tracer movement for some ranges of hydrologic parameters and infiltration.
- A dual-permeability or discrete-fracture model with reduced matrix-fracture coupling or with episodic infiltration can have even faster transport of a tracer. (The weeps model is a simplified version of such a model.)

Implications of recent findings

- The rapidity of transport of ^{36}Cl from surface to ESF seems to favor a weeps-type flow model (fracture flow with limited matrix interaction).
- Dryness in the ESF is a favorable indication for repository performance: either there is very little water flow at repository depth or most of the water does not enter tunnels (and therefore wouldn't contact waste).
- PA analysts are considering multiple conceptual models and testing their performance predictions. Results so far indicate that the number of waste containers subjected to seepage flow is extremely important to performance.
- An important question is whether the observed dryness carries over to wetter climatic conditions.

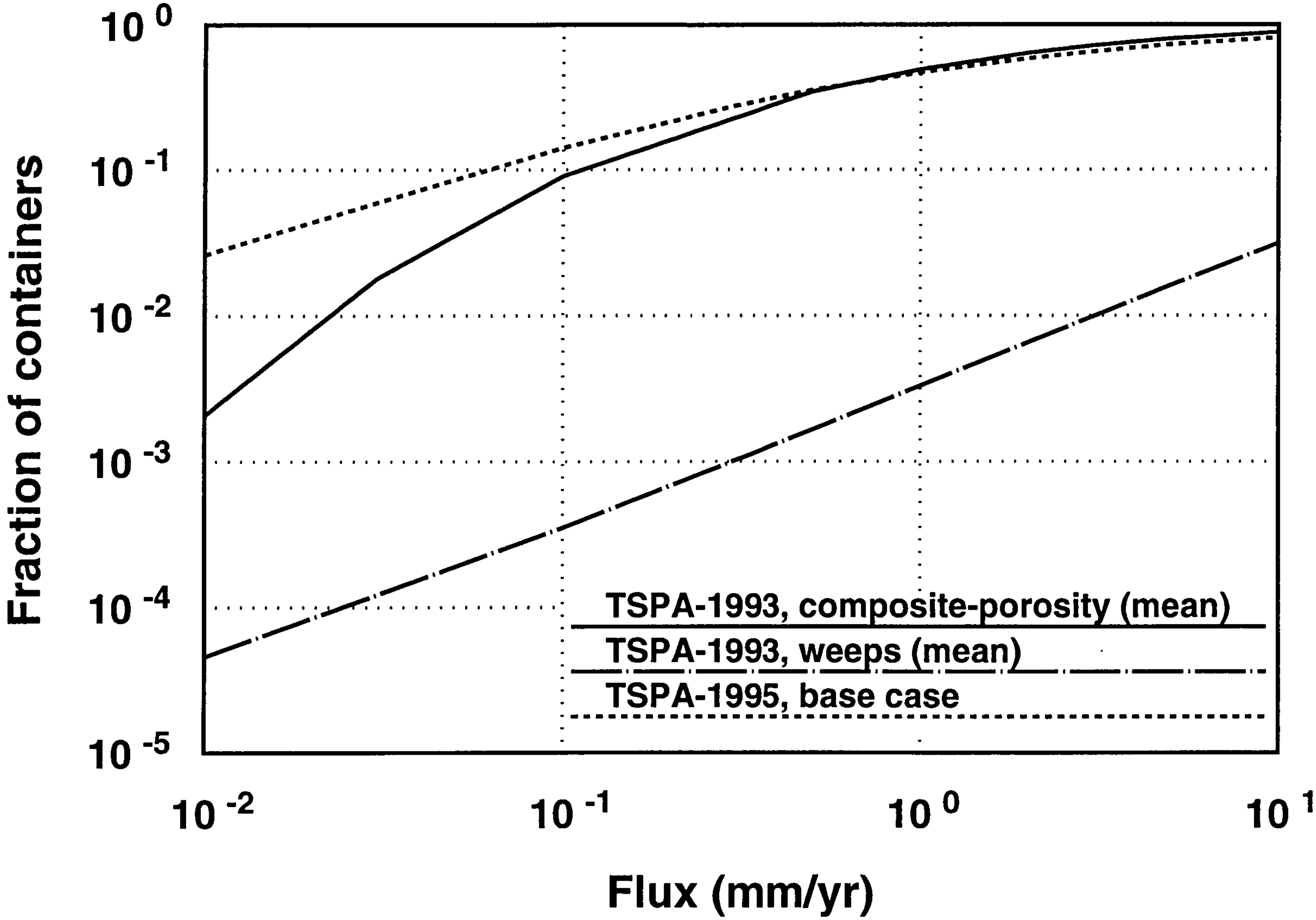
Estimated Weeps in the ESF Main Tunnel (presented at 1994 HLRWM conference)



Assumptions

Main-tunnel area:	24,000 m^2
Mean flux:	0.5 mm/yr
Mean flow aperture:	180 μm
Mean episodicity:	0.2

Containers contacted by seeps Three different TSPA models (ambient conditions)



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- Importance of climate effects

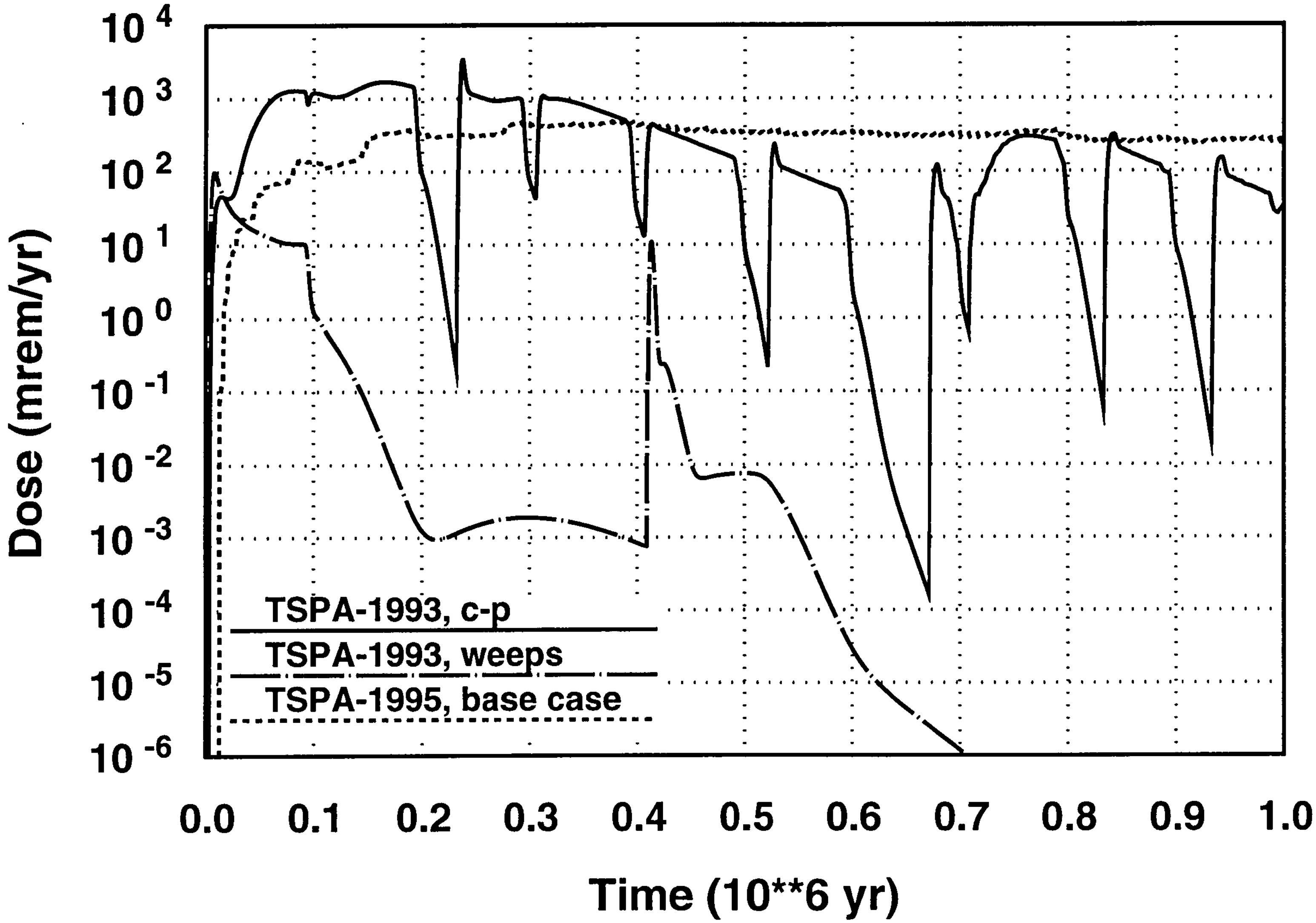
Climate-change timing

- For a "short" performance period (e.g., 10,000 years), the probability of a change to wetter climatic conditions is important.
- For a long performance period (e.g., 1,000,000 years), many climate cycles are certain to take place.
- A change to wetter climatic conditions during the thermal period could be particularly important because the extra influx could change predictions of dryout time, relative humidity, etc.

Climate-change effects on repository performance

- Climate-change effects that might be important include
  - Changes in unsaturated-zone percolation flux
  - Redistribution of seeps to different locations
  - Changes in episodicity of flow (the fraction of time that seeps flow)
  - Changes in water-table elevation
  - Changes in saturated-zone flow (e.g., changes in the amount of dilution and creation of new springs)
  - Changes in the biosphere

Example dose curves with different climate assumptions



Preliminary evaluation of climate effects

- TSPA-1995 found the climatic increase in UZ flux to be important to performance, both for cumulative release and for peak dose; TSPA-1993 found the timing of climate change to be important for 10,000-year releases.
- TSPA-1993 found weep stability to be important for the weeps model (that is, are weeps stable over time, or do flow paths change occasionally, perhaps triggered by climate change?).
- Climate-induced changes in SZ flow and biosphere have not yet been included in TSPA models.

Climate impacts are contingent on flow model

- For a composite-porosity-type model, by far the most important UZ climate effect is the change in percolation flux.
- For a weeps-type model, percolation flux is important, but other parameters affecting the weeps are important as well, including episodicity of flow and the distributions of weep sizes and locations.

Conclusions

- PA analyses evaluate alternative conceptual models of flow, transport, and climate that are consistent with observations. The use of a single "best" model is not appropriate.
- ESF observations, ^{36}Cl, and other isotopic data provide important constraints on the models.
- Percolation flux (including its spatial and temporal variation) is important to repository performance.
- The number of waste containers contacted by flowing water is probably more important than the speed of flow.
- Climate change is potentially important to performance, both in the near term (thousands of years) and the long term (hundreds of thousands of years).