YUCCA MOUNTAIN PROJECT

Studies

Saturated Zone Flow and Transport Expert Elicitation: Process and Summary of Results

Presented to:
Nuclear Waste Technical Review Board

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Saturated Zone Flow and Transport Expert Elicitation Project (SZEE)

Objectives

- To quantify uncertainties in key aspects of saturated zone flow and transport
- Panel of experts provides perspective and experience
- Provides a "snapshot" of uncertainties given available data
- Part of series of expert elicitations being conducted for TSPA-VA

Saturated Zone Flow and Transport Expert Elicitation (SZEE): Process

Steps followed

- Expert Selection
- Data Workshop #1: Issues and Available Data
- Workshop #2: Alternative Models and Interpretations
- Field trip to Yucca Mountain: recharge and discharge areas
- Elicitation Training
- Workshop #3: Preliminary Expert Interpretations
- Elicitation Interviews
- Feedback
- Documentation

Members of the SZEE Expert Panel

Allan Freeze	R. Allan Freeze Engineering, Inc.
Lynn Gelhar	Massachusetts Institute of Technology
Donald Langmuir	Colorado School of Mines, Emeritus
Shlomo Neuman	University of Arizona
Chin-Fu Tsang	Lawrence Berkeley National Laboratory

Summary of Key Assessments (SZEE)

Conceptualization of SZ Groundwater Flow

- Flow direction to southeast; south
- Flow primarily in lower volcanic aquifer and alluvium, not in carbonates
- Highly permeable flow regime; channelized in preferential flow paths
- Highly interconnected system of faults and fracture systems

Large Hydraulic Gradient

- Two viable alternative explanations
- 1) Water table slope within saturated flow system
- 2) Perched water system (slightly preferred)
- Transient change is very unlikely

Summary of Key Assessments (SZEE)
(continued)

Flux at Top SZ Beneath Yucca Mountain

- Expressed as specific discharge q = Ki
- K assessed for four hydrogeologic units: lower volcanic aquifer, volcanic aquitard, carbonate aquifer, and alluvium
- Assessed for scales of 1.5x1.5x0.1 km
- C-wells data very important
- q ~ 0.1 - 1 m/yr (range 0.0001 to 10)

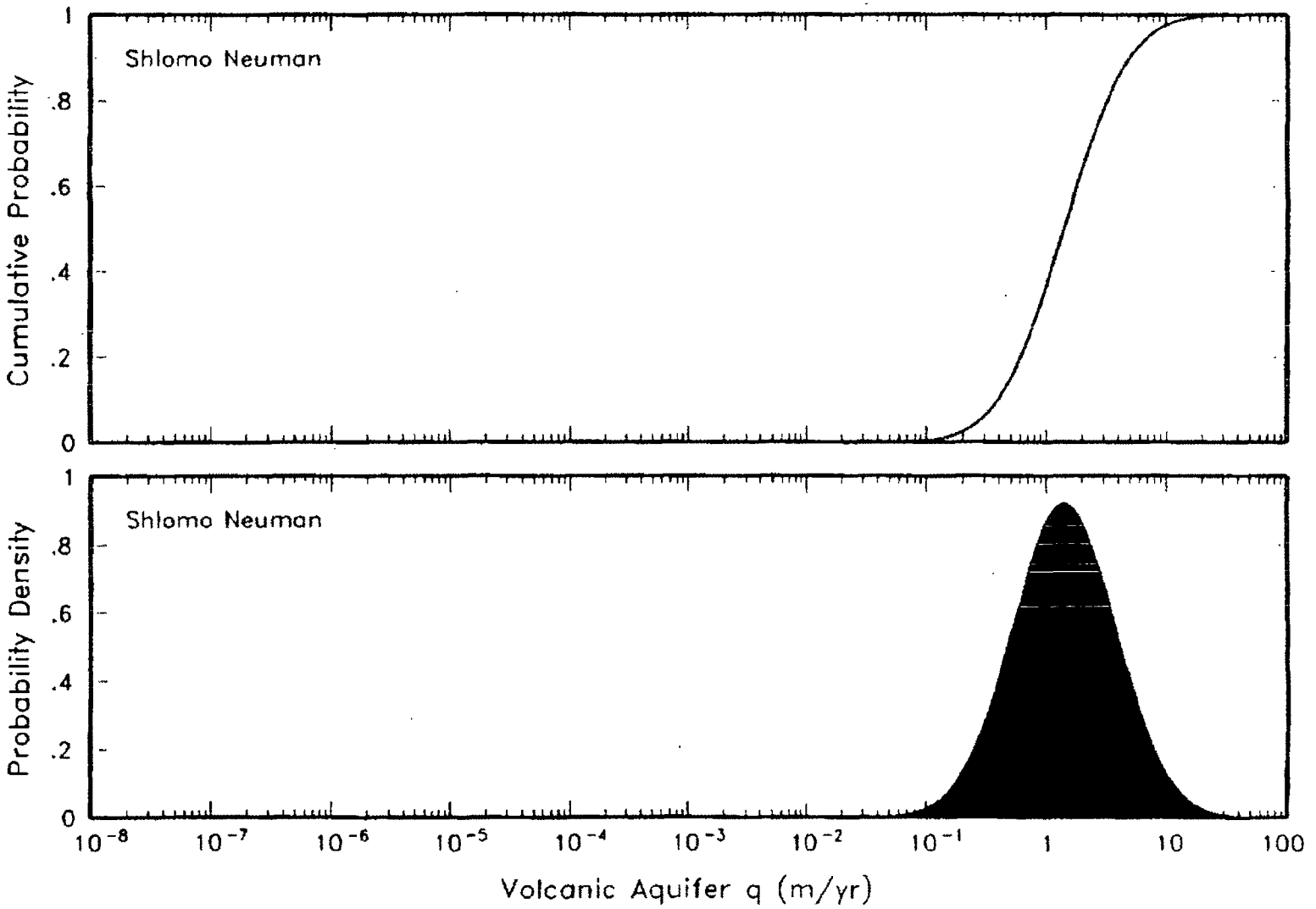
Velocities and Porosities

- Average linear velocities ~m/yr (0.3-30)
- Effective/kinematic porosities 0.1-1% (0.001-10%)

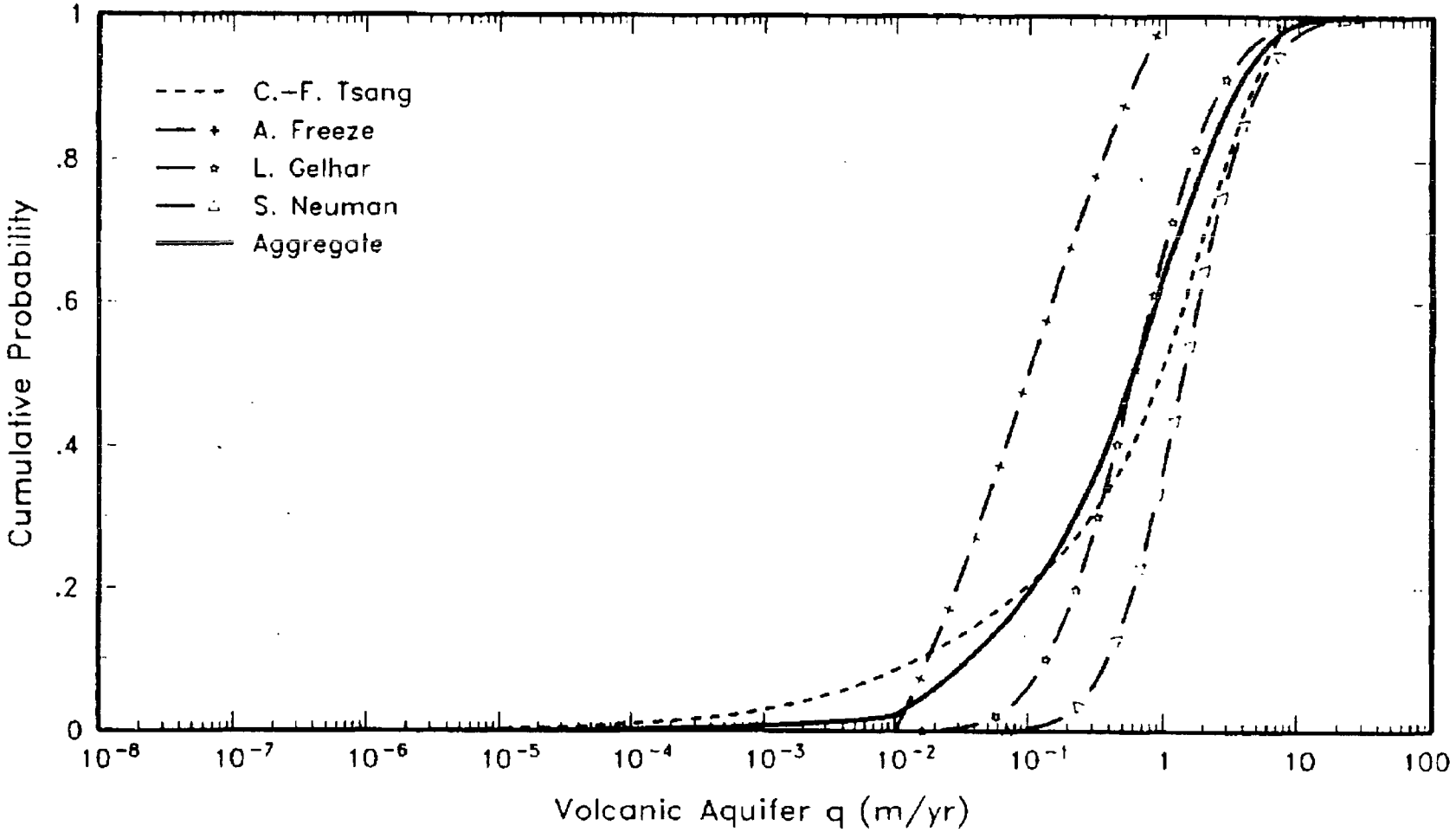
Influence of Climate Change

- Future water-table changes best assessed from glacial record
- 80-120m judged reasonable
- Application of regional hydrologic model
- Could have more transients, changes in flow direction during wetter glacial periods

Distribution for volcanic aquifer specific discharge assessed by Shlomo Neuman



Individual and aggregate cumulative distributions for volcanic aquifer specific discharge



Summary of Key Assessments (SZEE)

(continued)

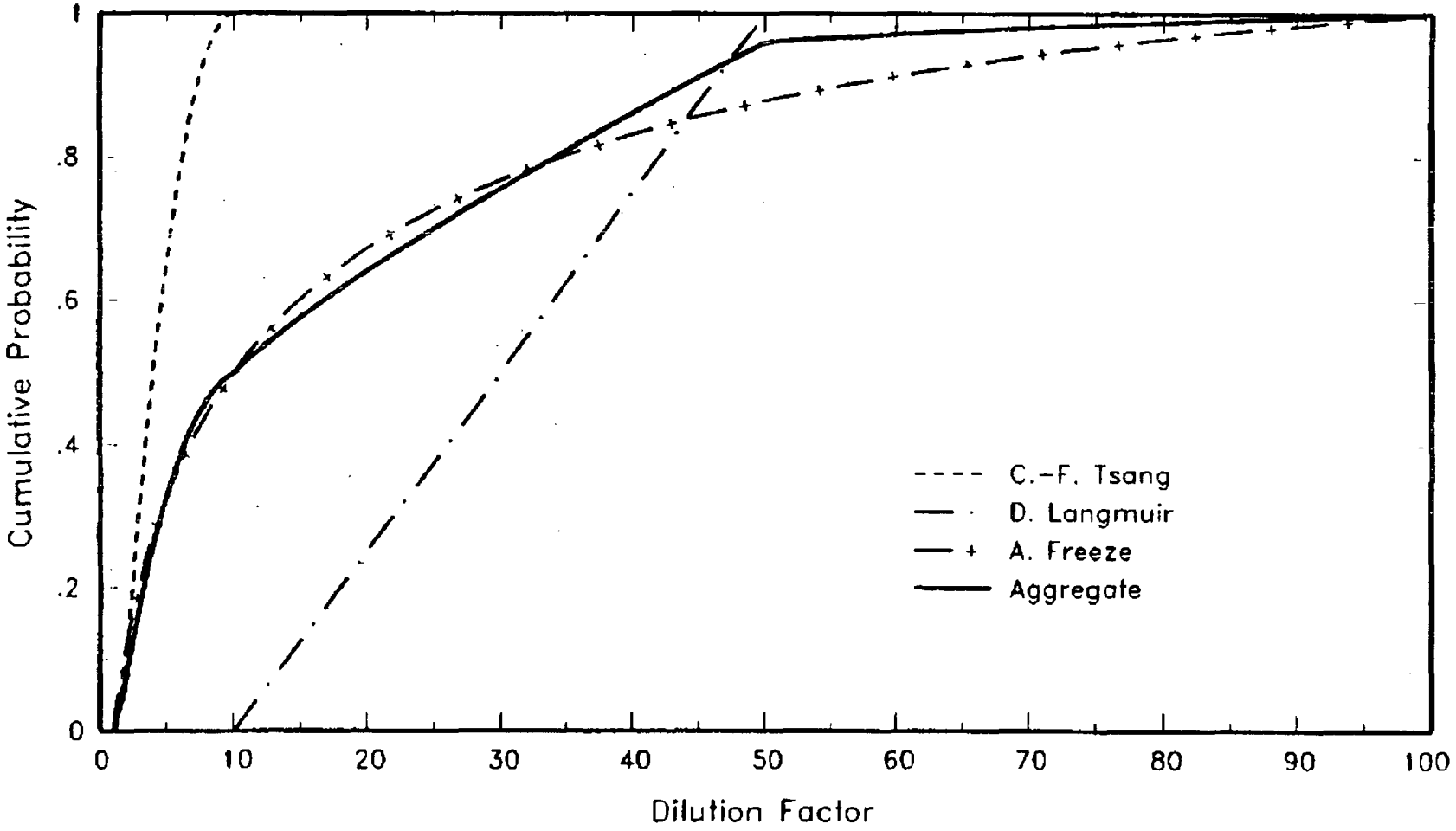
Conceptual Models of Saturated Zone Transport

- Advective transport, particularly along preferential flow paths
- Flow tubes within volcanic aquifer and alluvium; little travel in carbonates
- Dilution mechanisms: molecular diffusion and advective dispersion
- Few mechanisms that lead to substantial mixing
- Vertical width of plume few tens of meters
- Relatively small amounts of lateral and vertical dispersion

Dilution Factor/Dispersivity

- Regional distances of 5 to 30 km
- Dilution factor (12; 2 to 100)
- Longitudinal and transverse dispersivity
- Does not include dilution in extraction well

Individual and aggregate cumulative distributions for dilution factor



Summary of Key Assessments (SZEE)
(continued)

Effective Fracture Density

- Average spacing of significant fractures that carry the flow
- Range from 10 to 100m

Hydrochemical Transport Parameters

- Sorption is not only control on max. concentrations; solubility and redox reactions may also be important
- Residence time in matrix is important; evidence for matrix diffusion at C-wells is not clear
- Laboratory sorption data; how representative of field conditions
- Effective Kd values, accounting for conditions and reactions along flow paths

Summary of Key Assessments (SZEE)
(continued)

Thermohydrology

- Possible effects from repository heating: changes in viscosity, precipitation, dissolution, reduction in vertical plume width
- Different opinions about importance to SZ flow and transport

Colloids

- Plutonium is key actinide of concern
- Fate of colloids assessed by Dr. Langmuir; NTS results "not an analogue for Yucca Mountain"

Summary of Key Assessments (SZEE)
(continued)

Water-Table Changes from Disruptive Events

- Changes from earthquakes not significant nor long-lived

Anisotrophy

- Horizontal: vertical anisotrophy range 3:1 to 100:1 due to layering
- Horizontal anisotrophy suggested from C-wells
- Flow in faults and fractures

Recommendations for Reducing Uncertainty

- Large scale multi-hole hydraulic and tracer tests
- Interference tests at C-wells complex for fault zone properties, etc.
- Strengthen and calibrate site-scale and regional groundwater flow models and couple the two
- Gather, interpret, and model groundwater chemical data