

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

**NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING**

**SUBJECT: VOLCANISM STUDIES FOR THE
YUCCA MOUNTAIN PROJECT**

PRESENTER: DR. BRUCE CROWE

**PRESENTER'S TITLE
AND ORGANIZATION: PRINCIPAL INVESTIGATOR, VOLCANISM STUDIES
LOS ALAMOS NATIONAL LABORATORY
LAS VEGAS, NEVADA**

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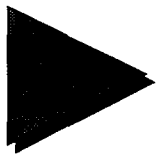
**ARLINGTON, VIRGINIA
OCTOBER 17-18, 1995**

Volcanism Studies for the YMP (are we done yet?)

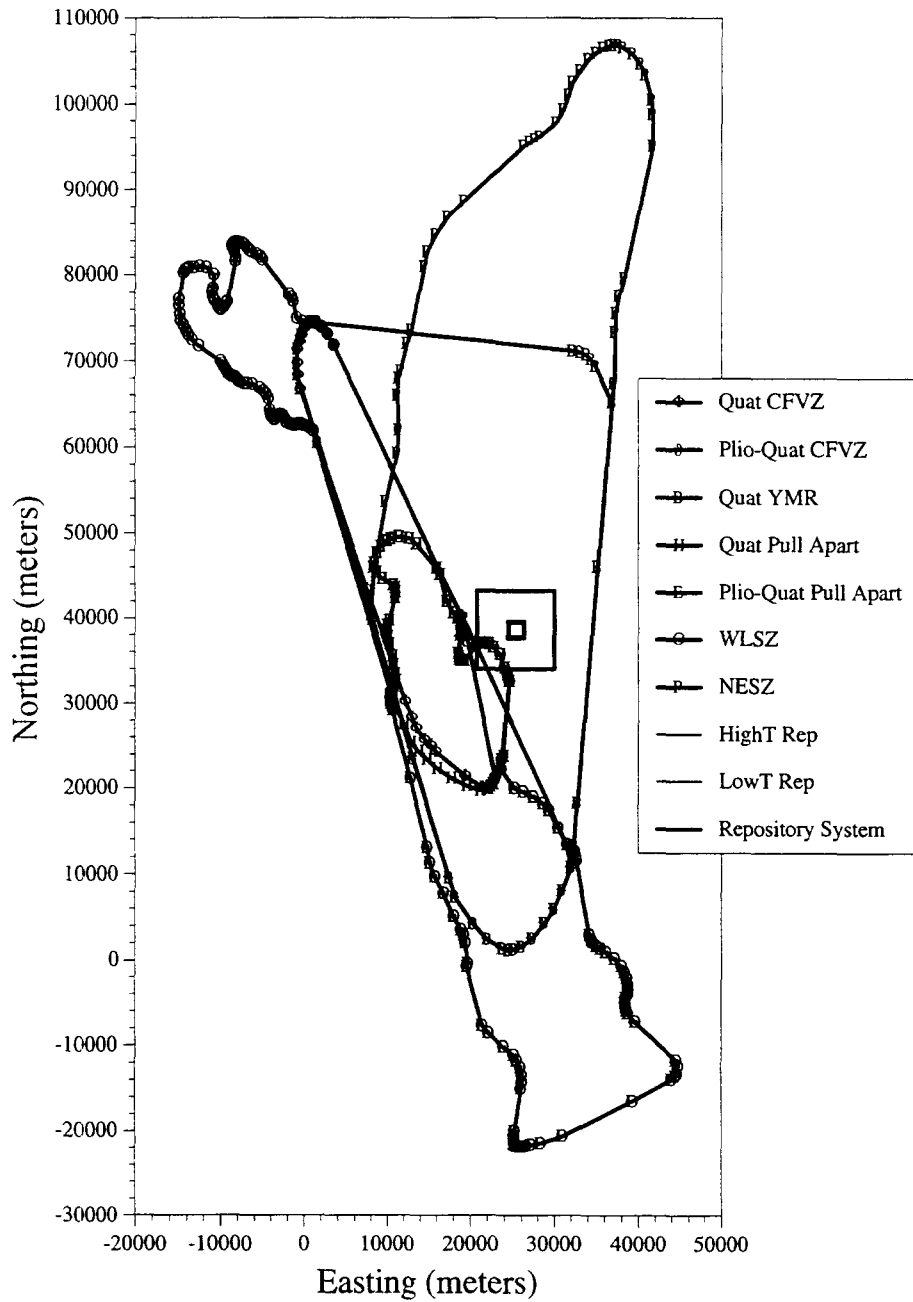
- **Simulation Modeling**
 - Disruption Ratio
 - Probability of Magmatic Disruption
 - » repository (Htemp/Ltemp repository)
 - » repository system
- **Volcanism Issue: PA Significance**
 - Data feeds from simulation modeling
 - Eruptive and Surface Effects
 - RIP using YMP base case
 - » Golder Associates
- **Dose/Risk Modeling: Volcanism**
 - Sandia Study: 1983
 - NAS Standards

Simulation Modeling: Disruption Ratio

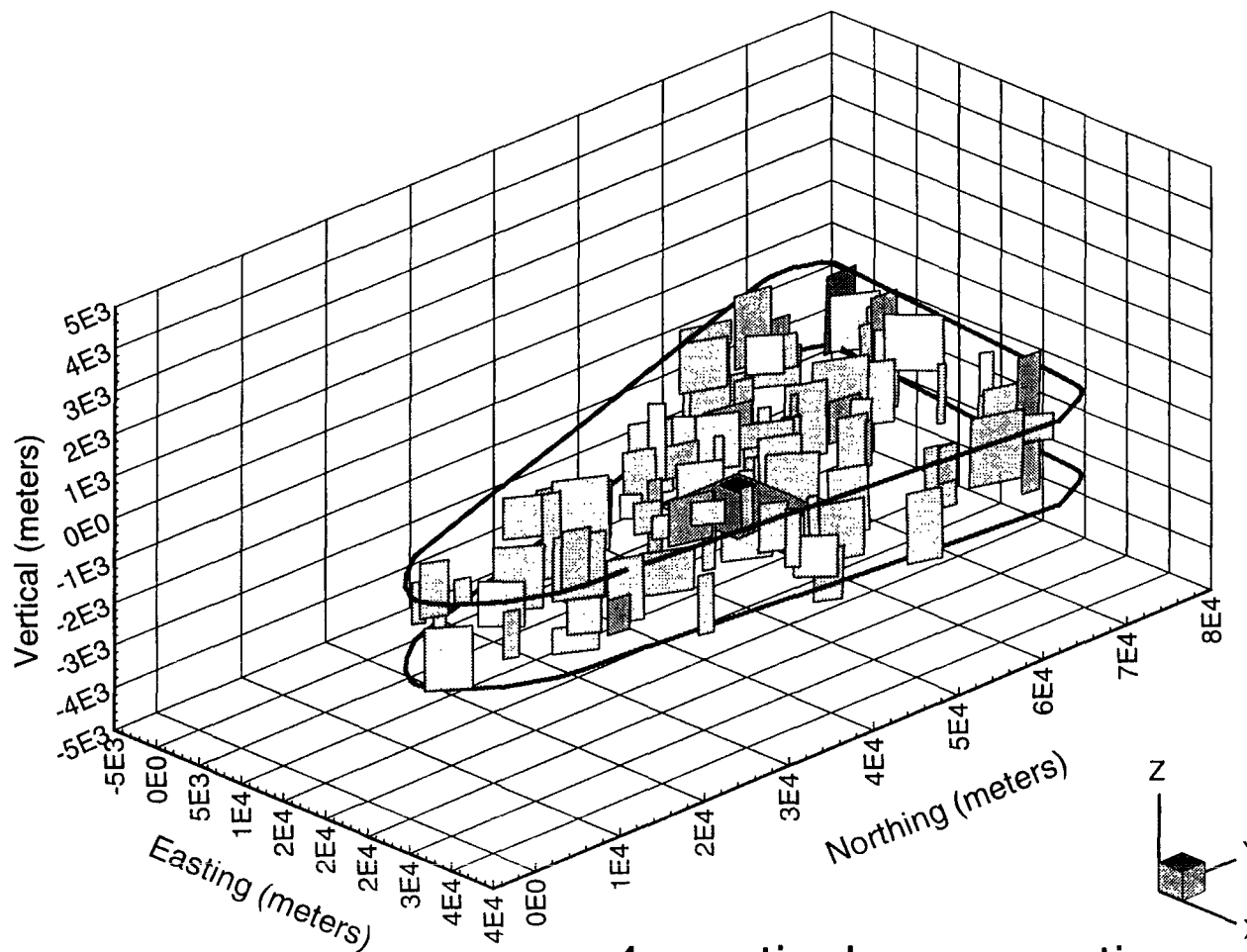
- **Extension of Dike Models of Sheridan (1992) and Wallmann et al. (1993)**
- **Spatial and Structural Models from *Volcanism Status Report***
 - **condensed to 7 spatial and structural models**
 - » **eliminated caldera and detachment models**
 - » **combined related models**
 - **2 volcanic cycles**
 - » **1.1 and 5.0 Ma**
- **Incorporated Subsurface Structure of Feeder systems**
 - **Simple, Complex feeder models**
 - **Dike Dimensions/Orientation: YM region**
- **FRACMAN used for simulation modeling**



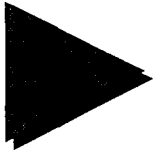
All Spatial and Structural Models



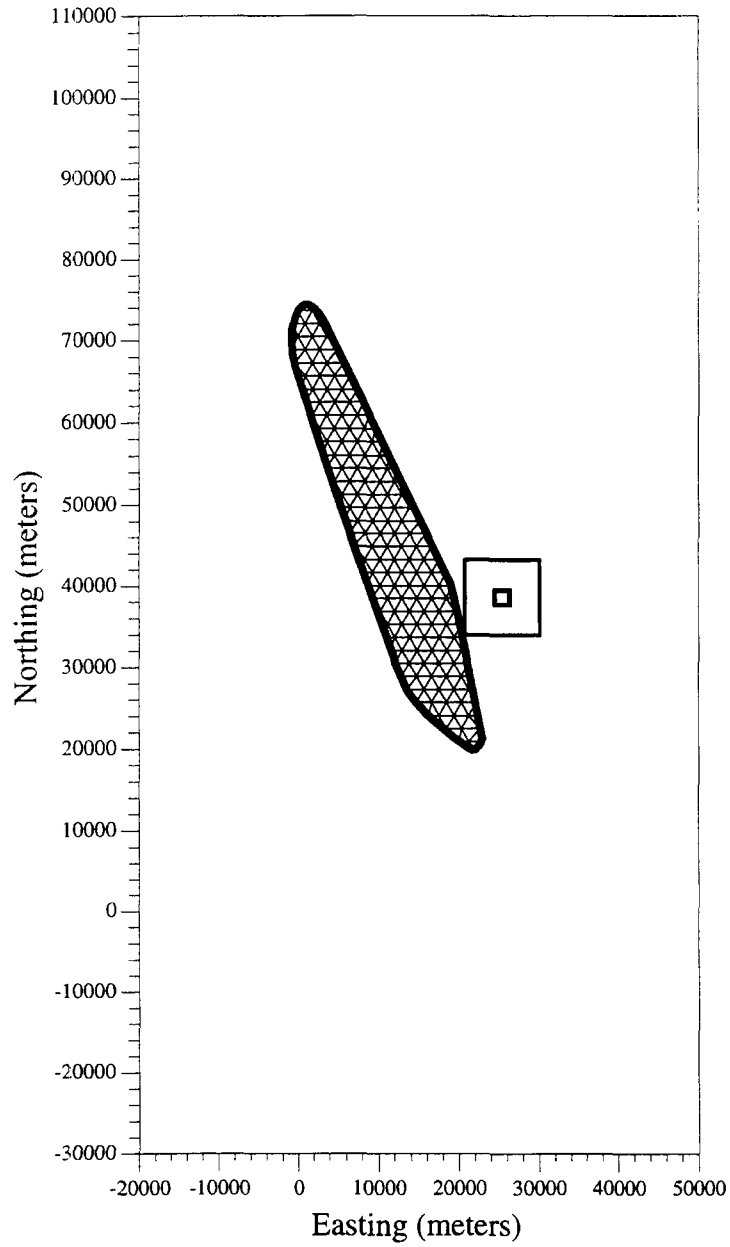
Disruption Simulation: Yucca Mountain Region

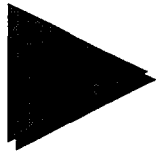


4x vertical exaggeration

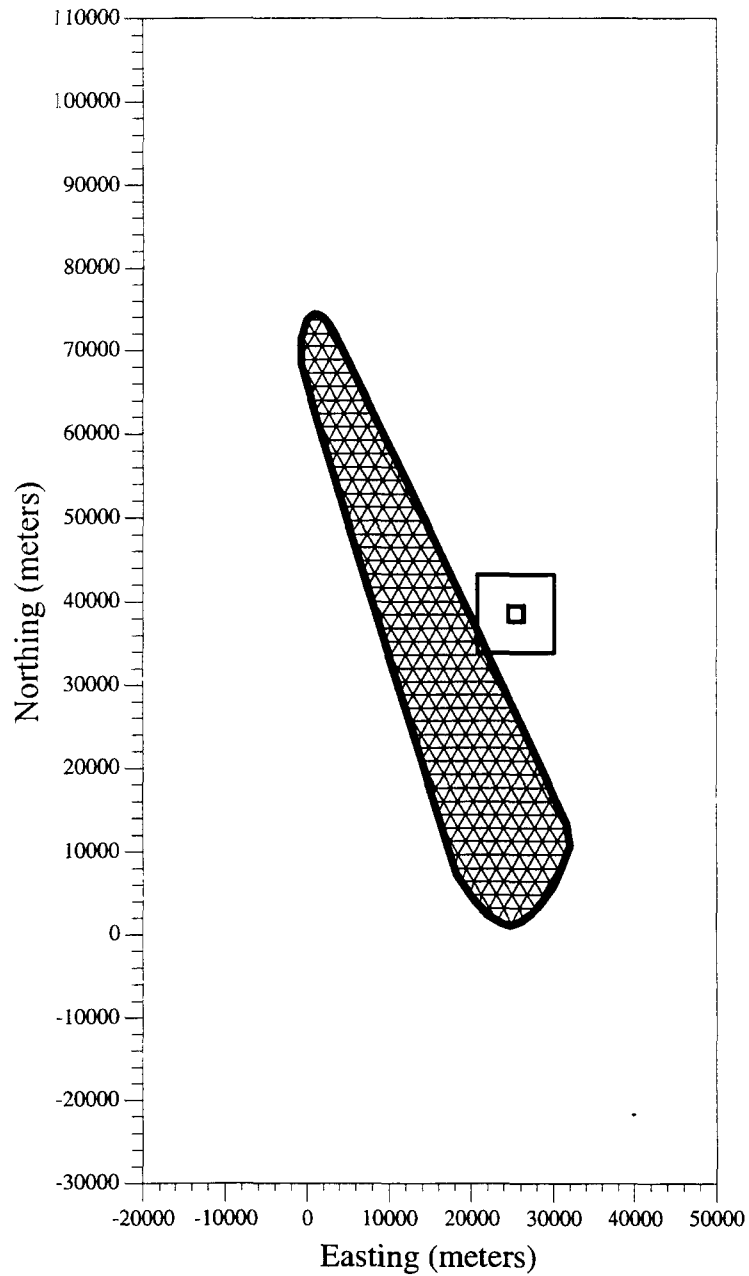


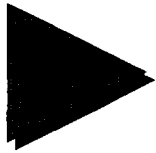
Quaternary CFVZ/YMR



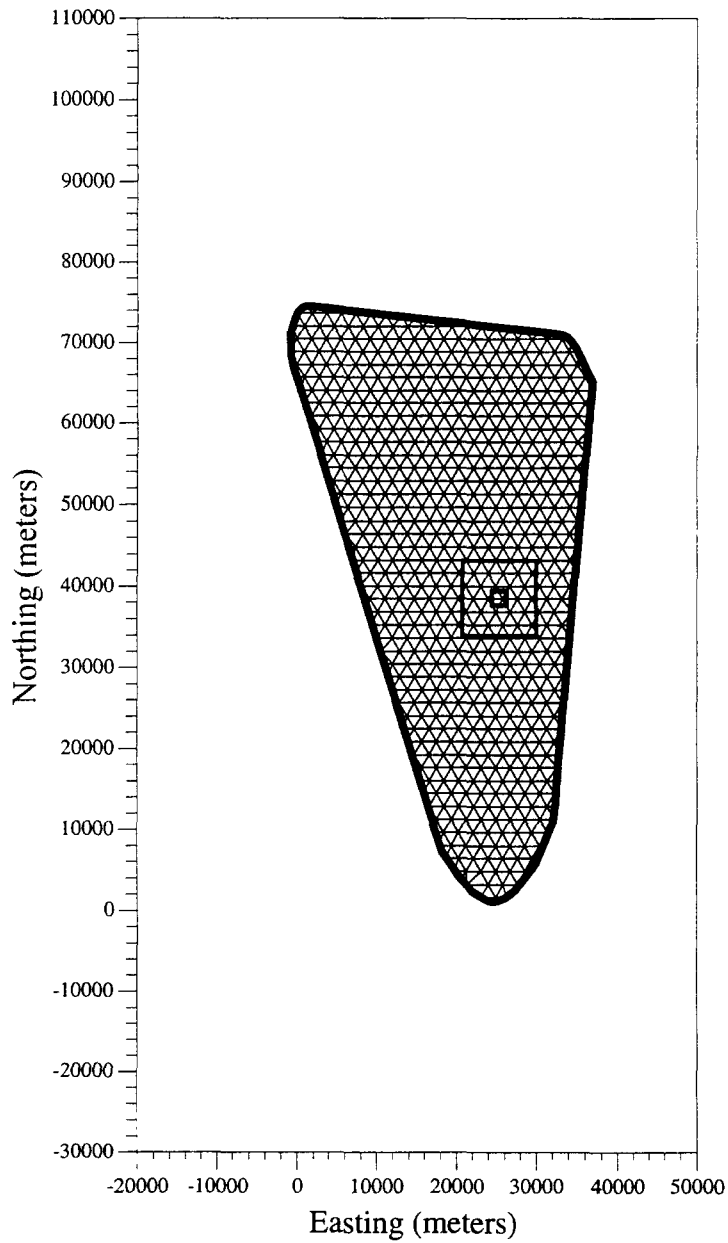


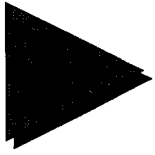
Younger Postcaldera CFVZ



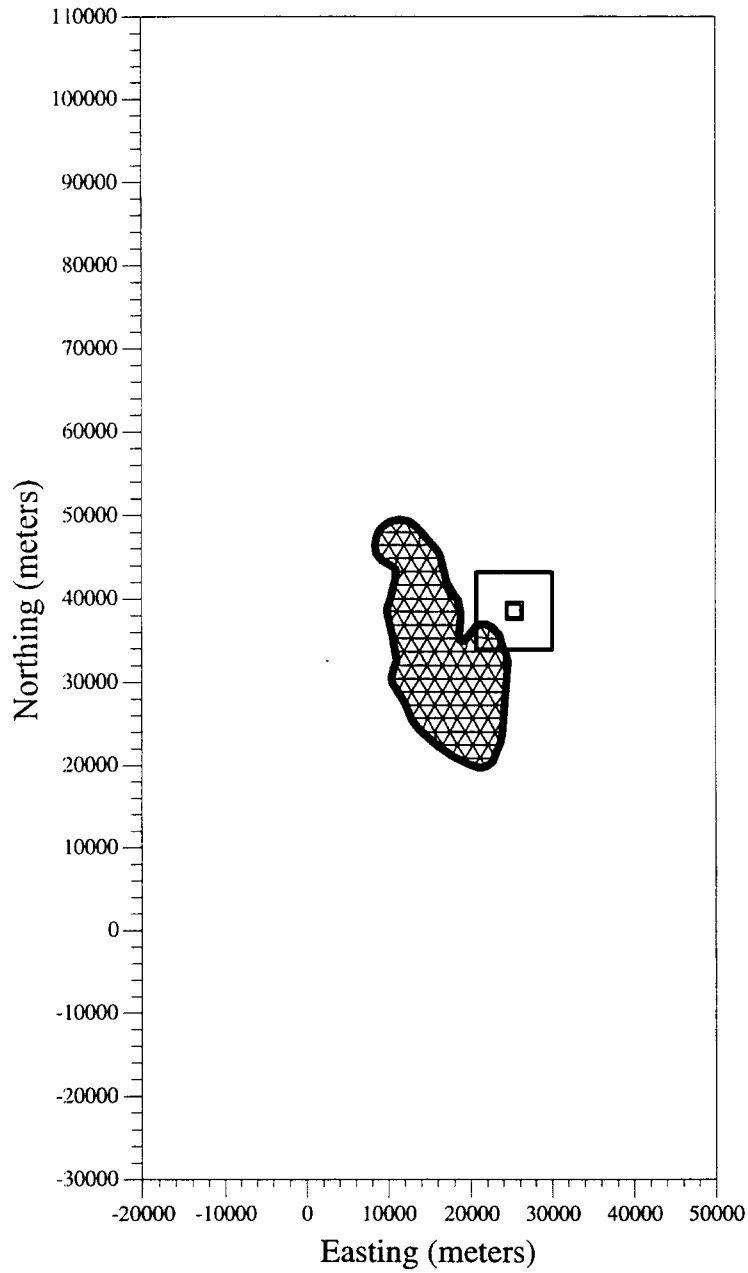


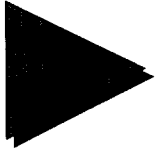
Younger Postcaldera YMR



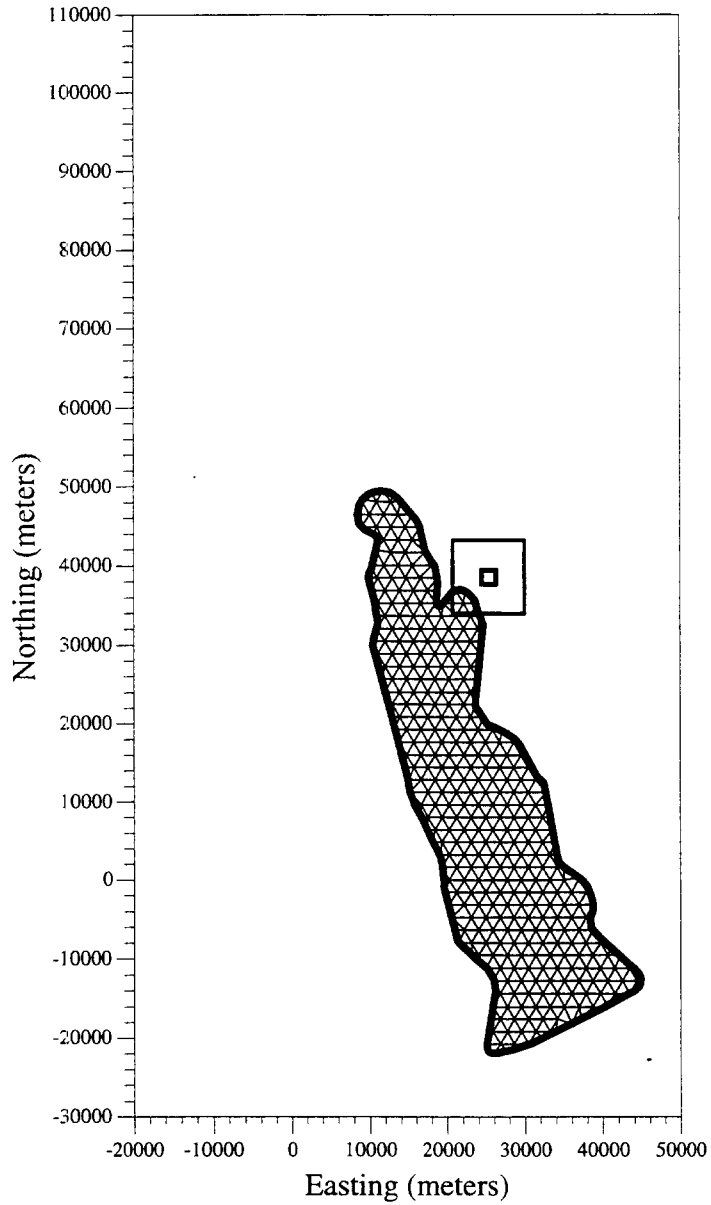


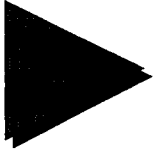
Quaternary Pull-Apart Basin



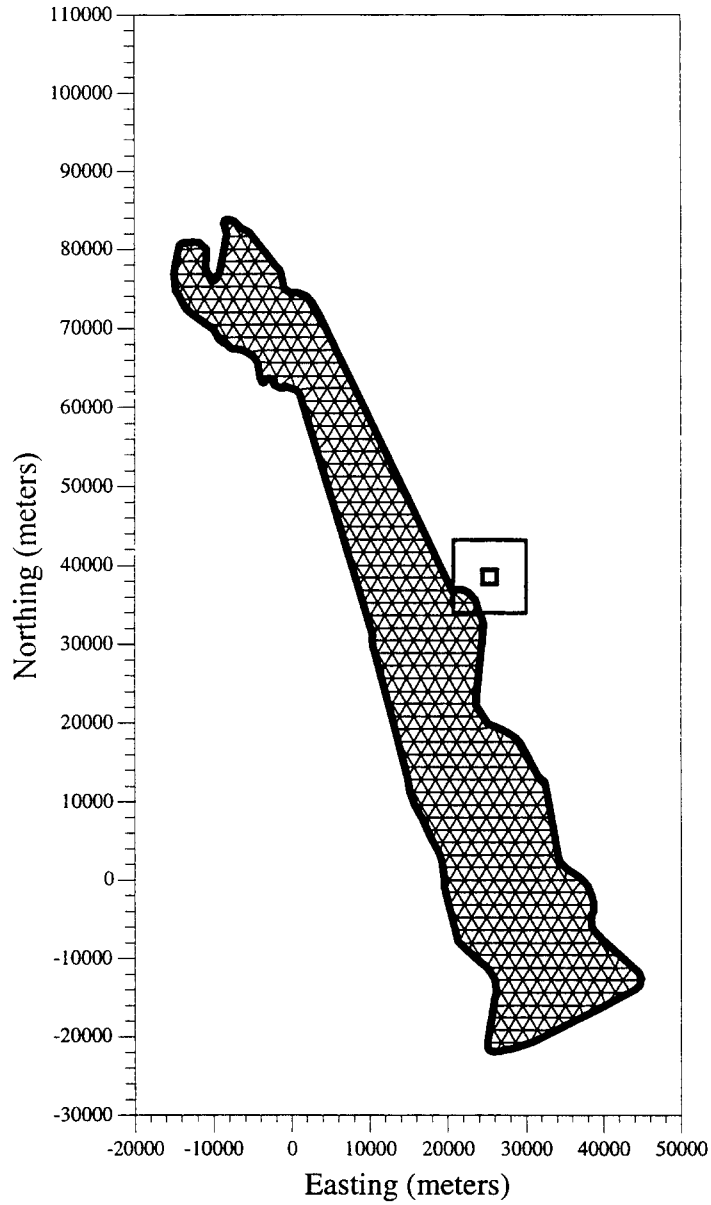


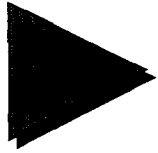
Younger Postcaldera PAB



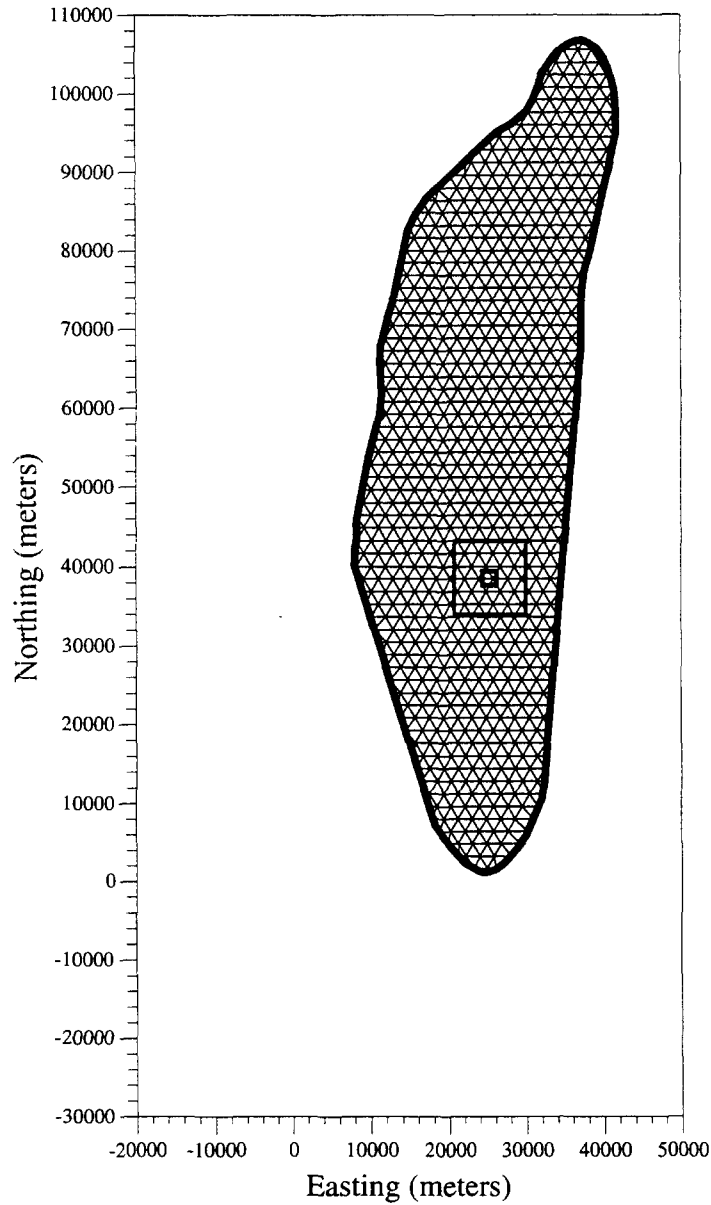


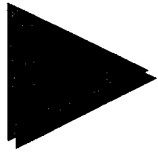
Walker Lane Structural Zone





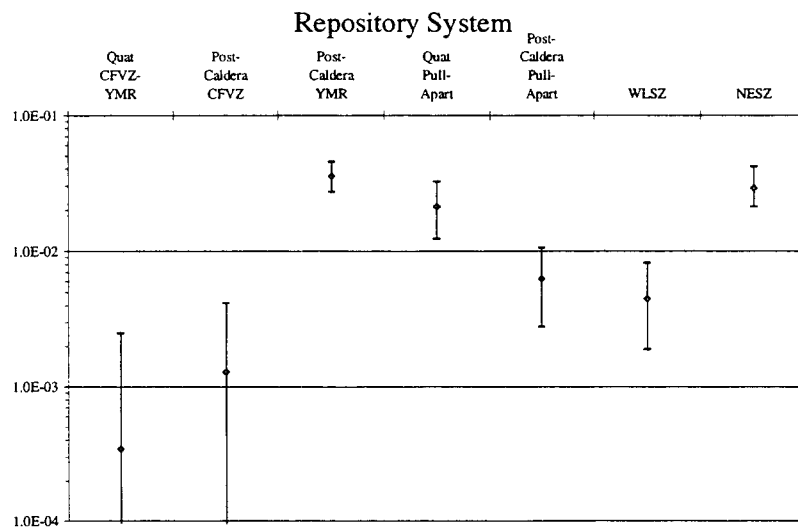
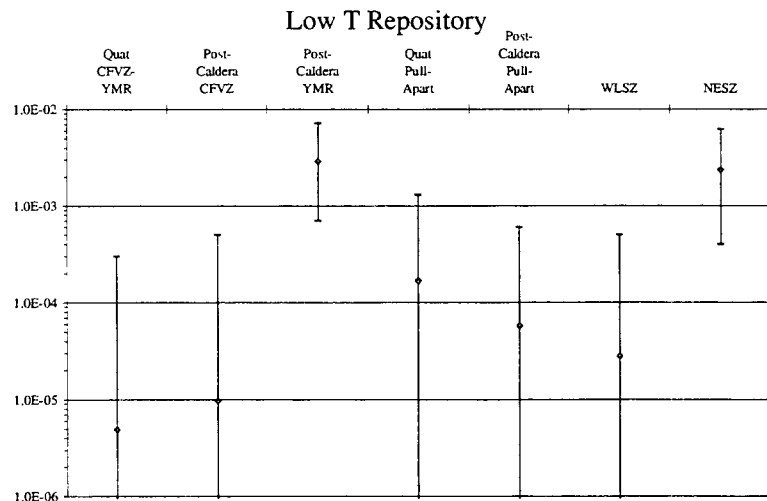
North-East Structural Zone



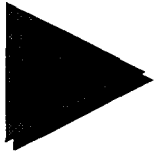


Disruption Ratio Summary: E2

bar = min to max
triangle = expected value



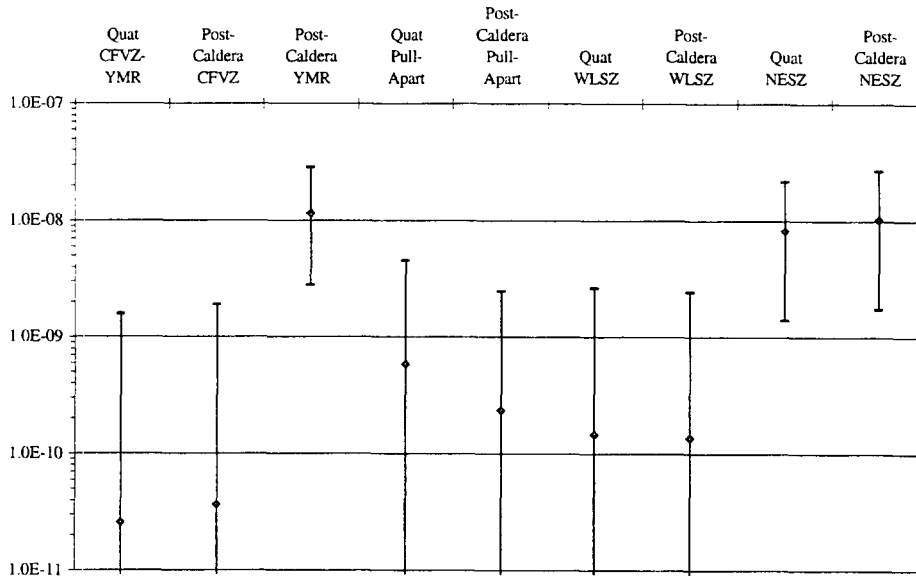
Probability Magmatic Disruption Summary: *E1* given *E2*



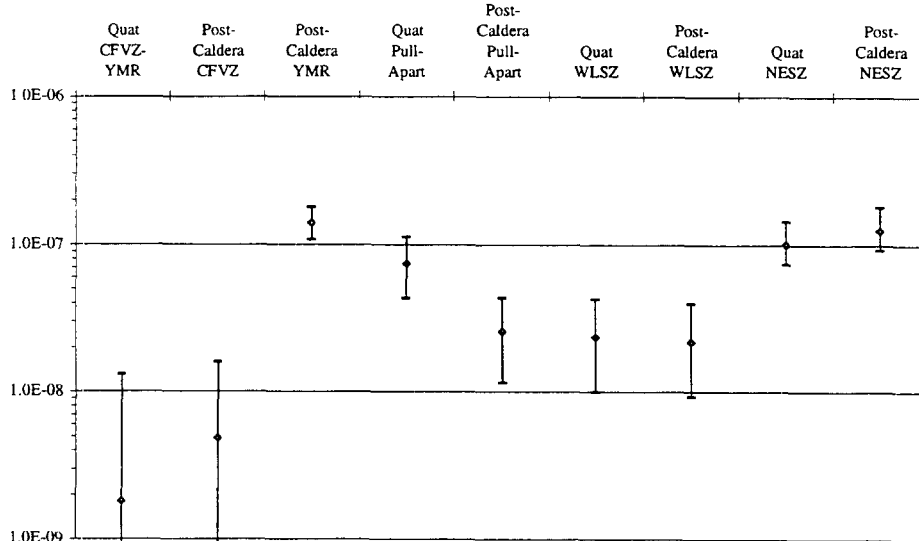
bar = min/max

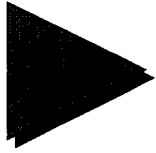
triangle = expected value

Low T Repository



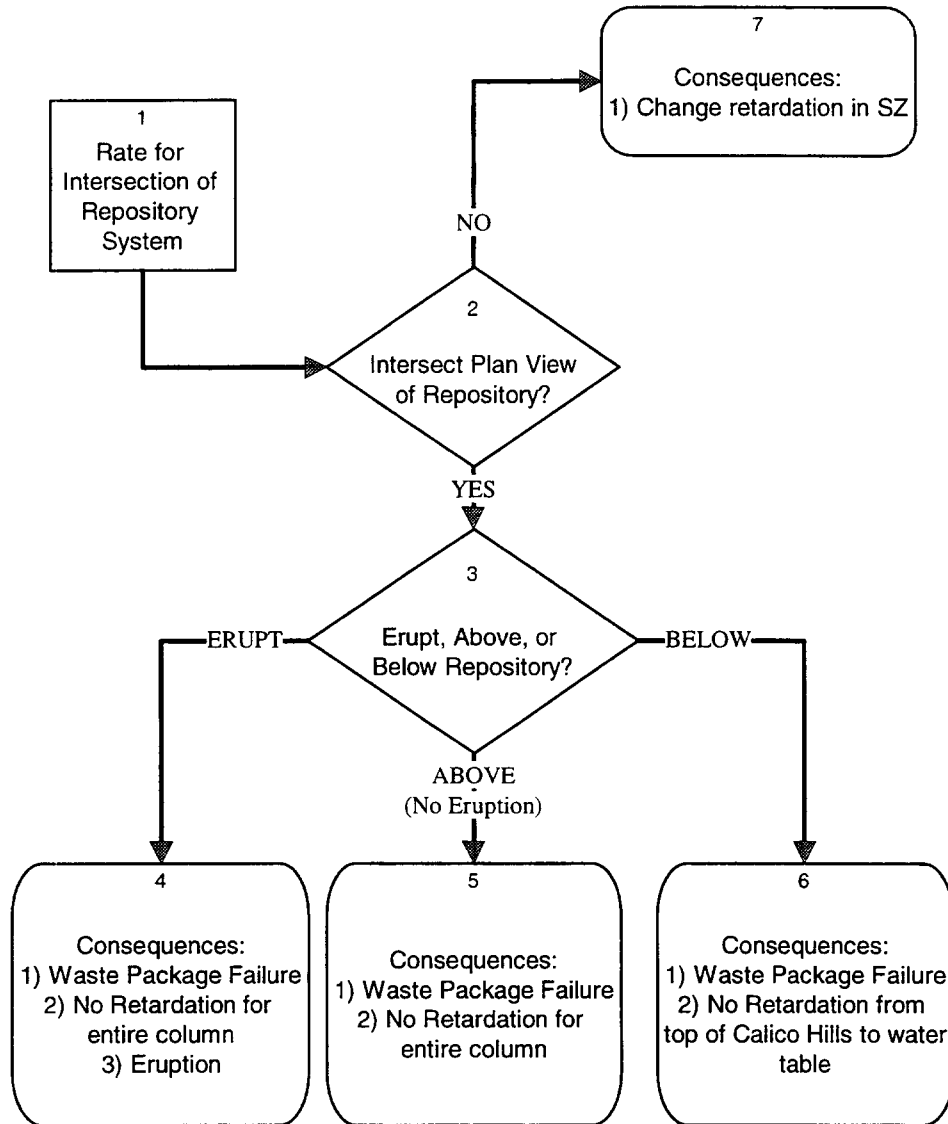
Repository System





RIP Volcanic Disruptive Events

Module: Logic



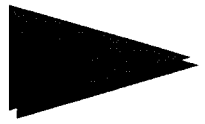


RIP Volcanic Disruptive Events Module: Functions/Parameters I

- **E1 -- recurrence rate (events yr⁻¹)**
 - Distribution for disruption zone
- **E2 -- disruption probability**
 - Derived from simulations
 - Distribution for disruption zone
- **Derived from E2 simulations**
 - Dike length in repository (DL)
 - Ratio of repository to total dike length (DR)
 - Probability of Magmatic Disruption
- **Eruption Criteria**
 - DL > 500 m
 - DR > 0.25



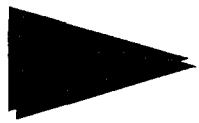
**Golder
Associates**



RIP Volcanic Disruptive Events Module: Functions/Parameters II

- **Number of waste packages disrupted/corroded**
 - ratio of dike to repository area
- **Volume erupted**
 - ratio of waste to repository volume (waste uniformly distributed)
 - dike length
 - lithic volume per m of dike
 - data from Valentine et al. (in press)
 - **Truncated Normal Distribution**
 - Mean = 8.5×10^{-6}
 - StdDev = 2.8×10^{-5}
 - Lower Bound = 1.0×10^{-7}



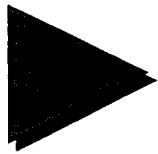


RIP Volcanic Disruptive Events Module: Functions/Parameters III

- **Retardation Effects**
 - Unsaturated Zone
 - **No retardation effects in matrix for affected rocks**
 - Saturated Zone
 - **1 - 10% reduction in retardation**
- **No recurring events (one event per realization)**

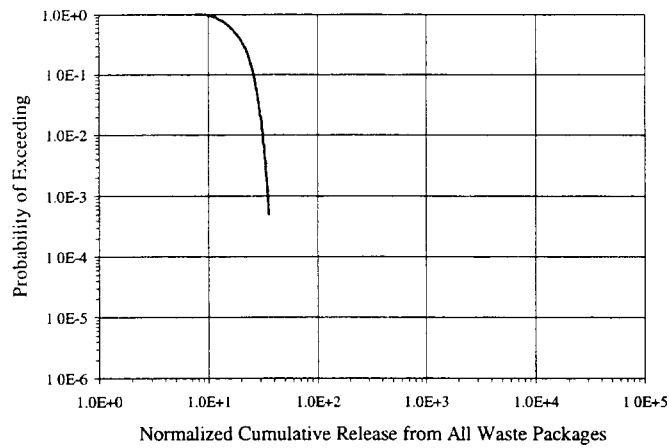


**Golder
Associates**

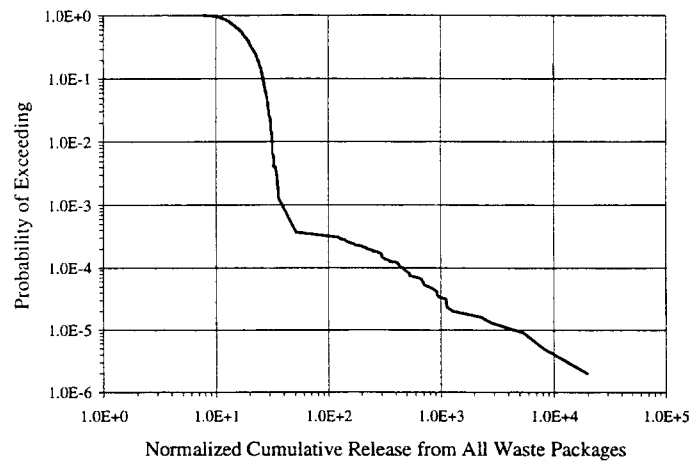


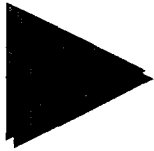
RIP Results: 10,000 yr Waste Package Release

Base Case - No Volcanic Events



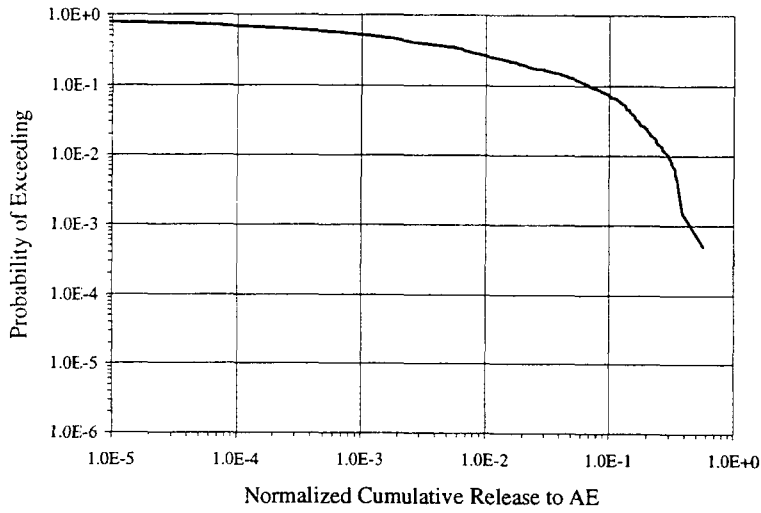
Post-Caldera Cycle Northeast Structural Zone



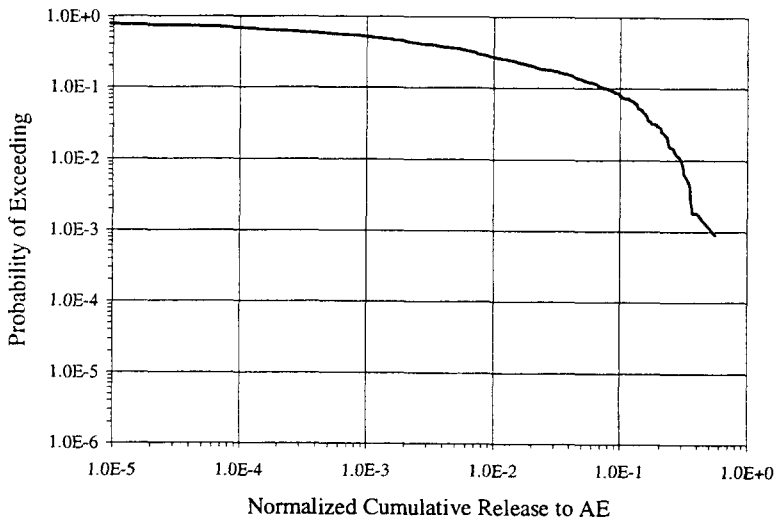


RIP Results: 10,000 yr Release to AE

Base Case - No Volcanic Events



Post-Caldera Cycle Northeast Strutral Zone



Radiological Consequences Sandia Report 1982

- **Dose Calculations Included**
 - inhalation and immersion (eruption)
 - surface exposure, resuspended particles and food chain
 - current population/conditions-patterns
- **Airborne Particles**
 - maximum dose: 14 mrem/year
- **Non-Airborne**
 - worst case: 4 rem/year
 - occupying scoria cone/fall sheet
- **NAS Implications**
 - volcanism: expected event
 - 3 to 4 x 10⁻⁶ yr.⁻¹
 - disruption ratio: standoff
 - 3/1000 effect

NAS Considerations (cont)

- **disruption models conservative**
 - dike lengths
- **longer intervals: > 10⁵ yr.**
 - waning volcanism
 - southwest drift
- **lithic fragments as analogs**
 - not physically reasonable
 - waste package not transported
- **depositional mode important in an eruption**
 - lava flows
 - scoria cones
 - scoria-fall sheet
 - airborne-component
- **Past Studies Difficult to Apply**
 - but some high doses: individuals

Conclusions

- **Choice of spatial or structural source region: important effect on disruptive ratio**
- **Probability of Magmatic Disruption: low**
 - Most likely event rate * maximum disruptive probability < 3.0×10^{-8} for Low T repository
 - even lower for short dike lengths (expected value: 10^{-9} to 10^{-10} events yr⁻¹)
- **Volcanism: low probability event and consequences are limited (lower priority)**
 - sensitivity to dike lengths, dike complexity
 - should be bounded in parameter ranges used in simulation modeling
 - eruption effects sensitive to physical model of waste incorporation
 - high individual doses possible but based on conservative model assumptions
- **Secondary effects (corrosion, reduction of retardation) are more important than eruption**
- **Volcanism not a high priority issue**