YUCCA MOUNTAIN PROJECT

Studies

Analysis of Disturbed Events for TSPA-VA

Presented to
NWTRB
Panel on Performance Assessment: TSPA-VA
Albuquerque, New Mexico

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April 23-24, 1998

Outline

- Disturbed Events
- Disturbed Scenarios Analyzed for TSPA-VA

Disturbed Events

- Disturbances have a probability of occurrence less than 1
  - generally of low probability (10^{-7} – 10^{-8} per year)
  - initiator is an event (earthquake, volcano) or change in conditions (criticality)
- Disturbed scenarios do not include expected changes
  - e.g., climate

Disturbed Scenarios Analyzed for TSPA-VA

- Igneous intrusion
- Seismic activity
- Nuclear criticality
- Human intrusion

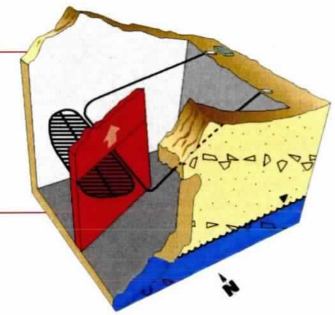
Igneous Intrusion

- Direct releases at surface from volcano
- Increased source term for groundwater transport from effects of intrusion
- Altered SZ transport from regional intrusion

TSPA-VA Analysis of Direct Volcanic Releases

- Emphasis placed on calculating the radionuclide source term
  - source term incorporates physical processes required to mobilize waste in eruptive stream
- Analysis of radionuclide dispersal uses CNWRA code (ASHPLUME)
- Performance measure is dose at receptor point 20 km S of repository

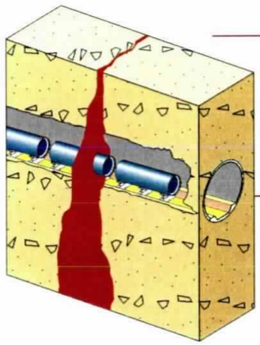
Igneous Activity Scenarios



Igneous intrusion occurs in YM Area?

No → *No performance assessment consequence. End Scenario.*

Yes ↓



Magmatic dike intrudes into repository?

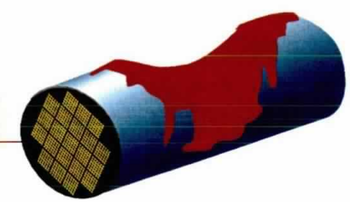
No → *No performance assessment consequence.*

Yes ↓

Dike intrusion directly contacts waste packages?

No → *No performance assessment consequence.*

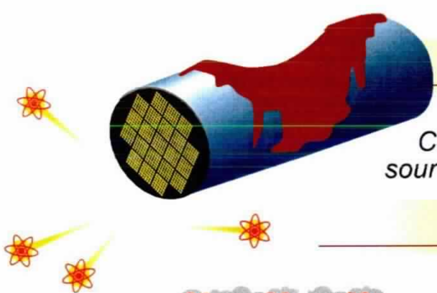
Yes ↓



Waste packages are breached?

No → *No performance assessment consequence.*

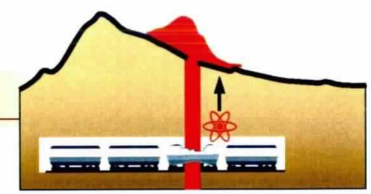
Yes ↓



Waste is removed from waste package?

No → *Contaminated basalt increases groundwater transport source term. Modeled in enhanced source term scenario.*

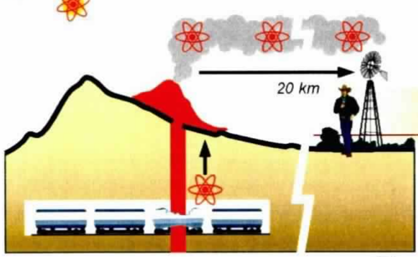
Yes ↓



Waste is entrained to surface in ascending ash?

No → *Performance assessment consequence modeled by enhanced source term scenario.*

Yes ↓



Waste is dispersed in ash plume?

No → *Performance assessment consequence not modeled.*

Yes ↓

Doses at receptor site used as performance assessment consequence.

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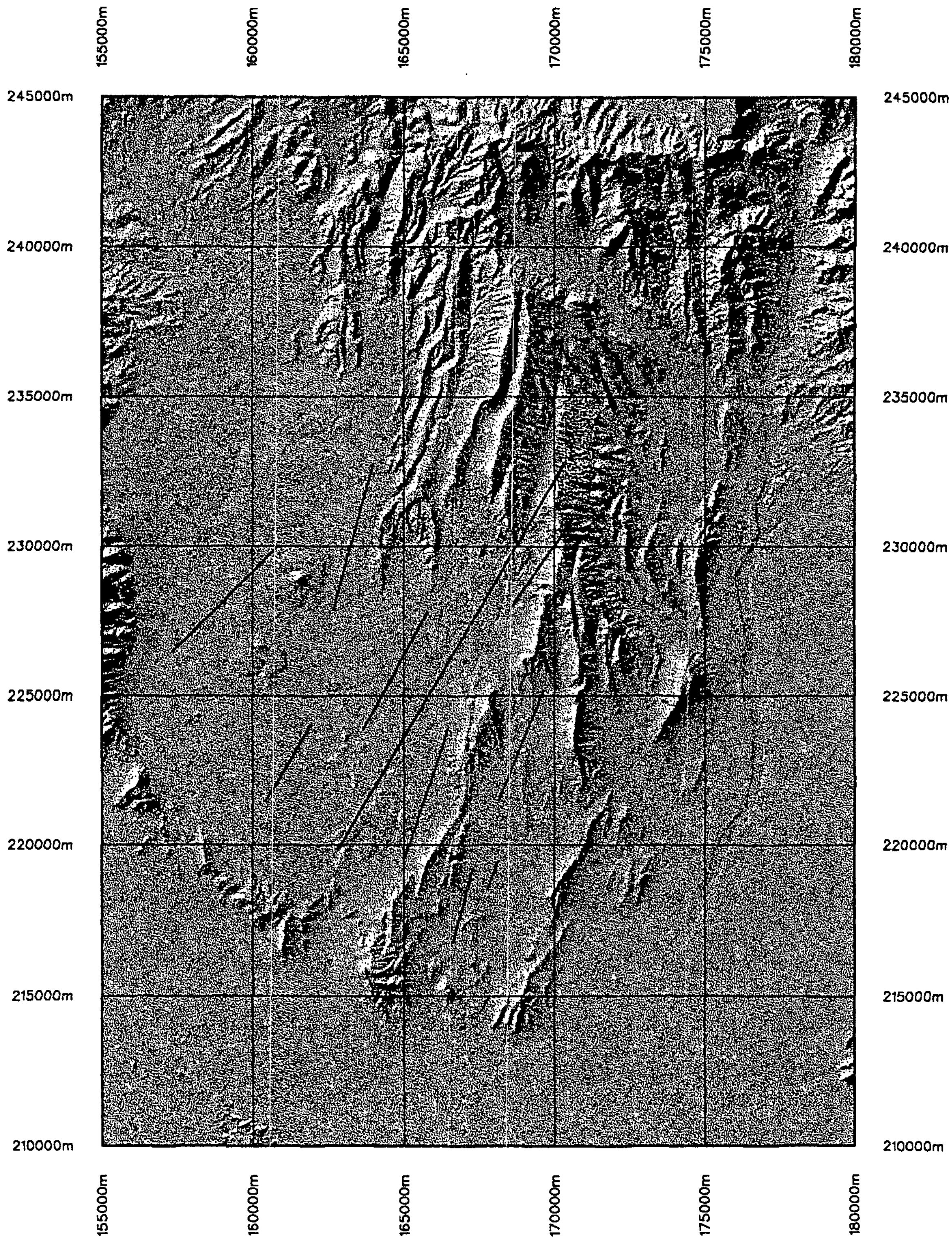
Source-Term analysis

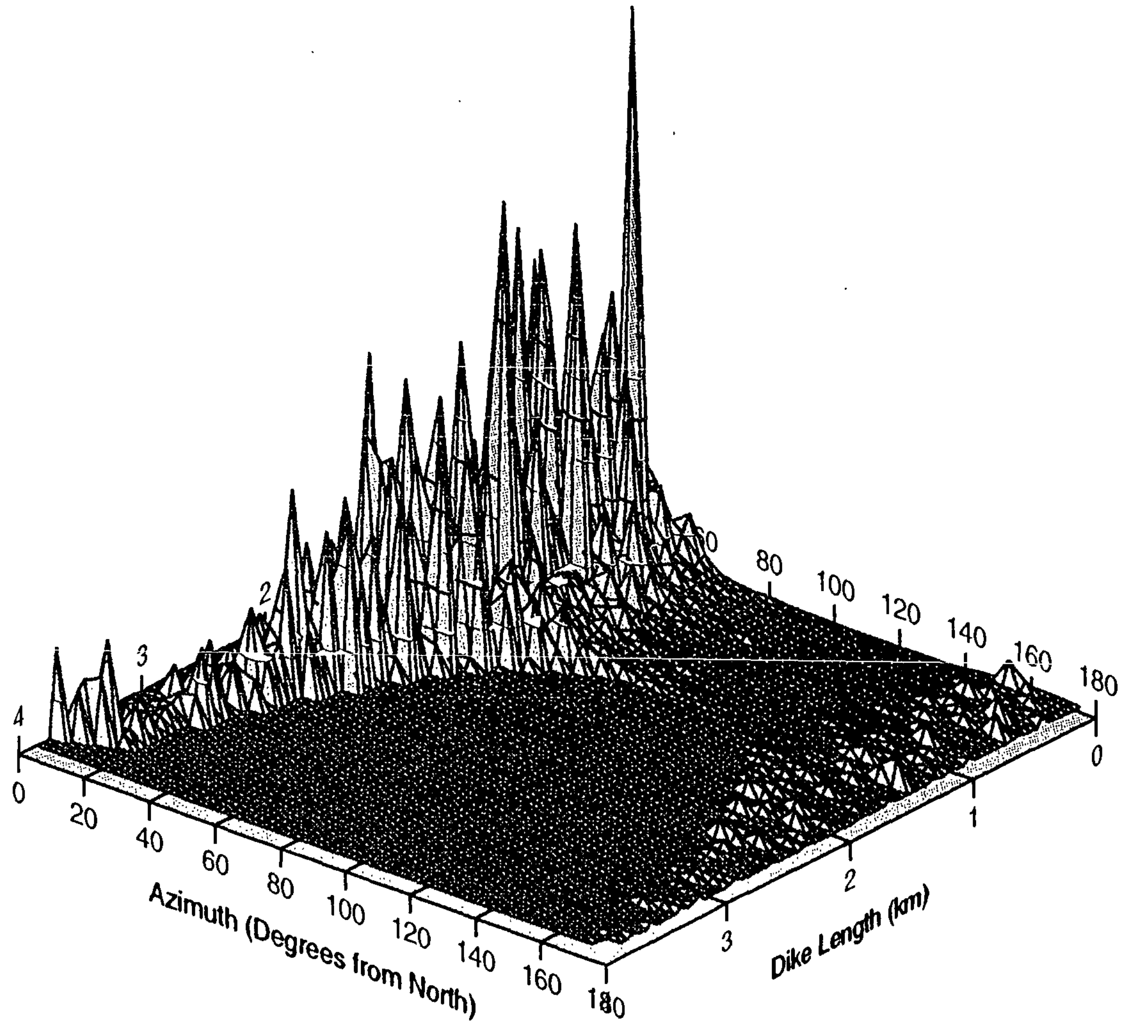
Intrusion Characteristics

- Intrusion locations from PVHA work
  - dike length and orientation
- Other intrusion plumbing parameters developed with inputs from YMP volcanic experts (Greg Valentine, Frank Perry, LANL)
  - dike width
  - number of vents in repository
  - fragmentation depth
  - eruption duration, volume, magma properties



Note: Map grid is based on Nevada (Central) State Plane Coordinate System

Joint Probability Distribution Function for Instrusion Length and Orientation

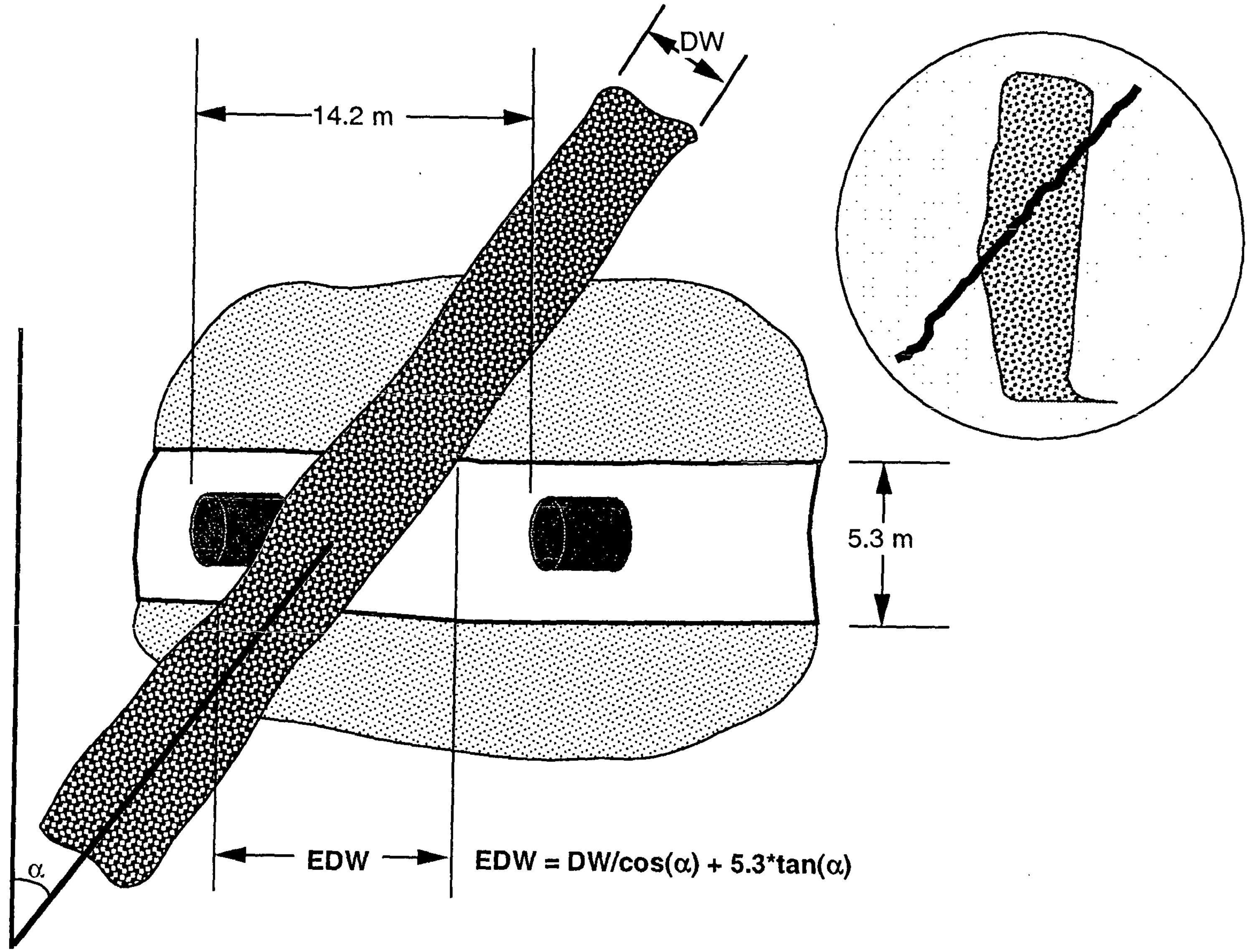


Source Term (Continued)

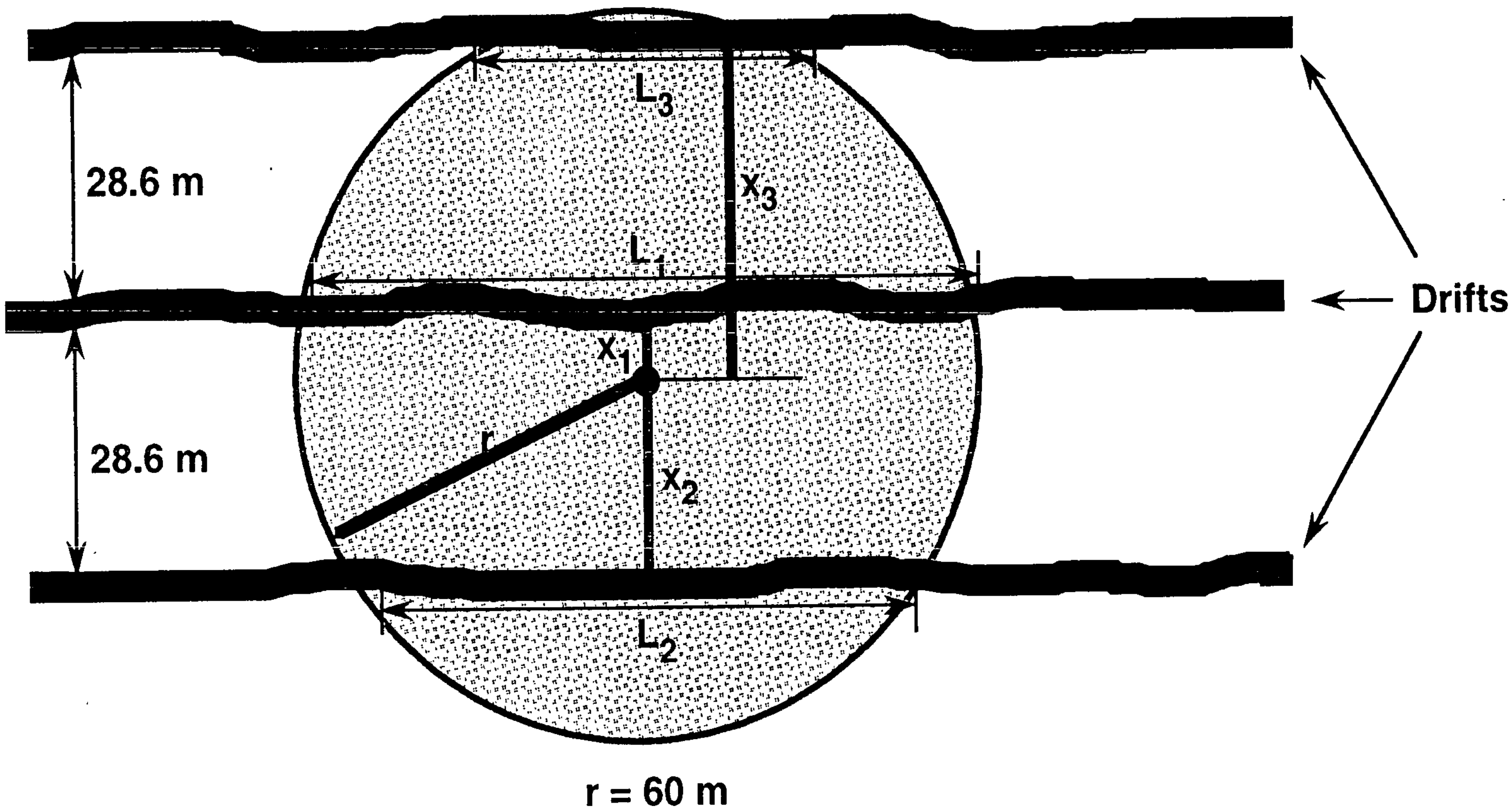
Interaction of Intrusion and Waste Packages

- For direct releases, intrusion must directly contact waste packages
  - near misses are for the enhanced source term scenario
- Interaction can be between either liquid magma or "ash"

Intersection of Dike and Drifts



Intersection of Eruptive Conduit with Drifts

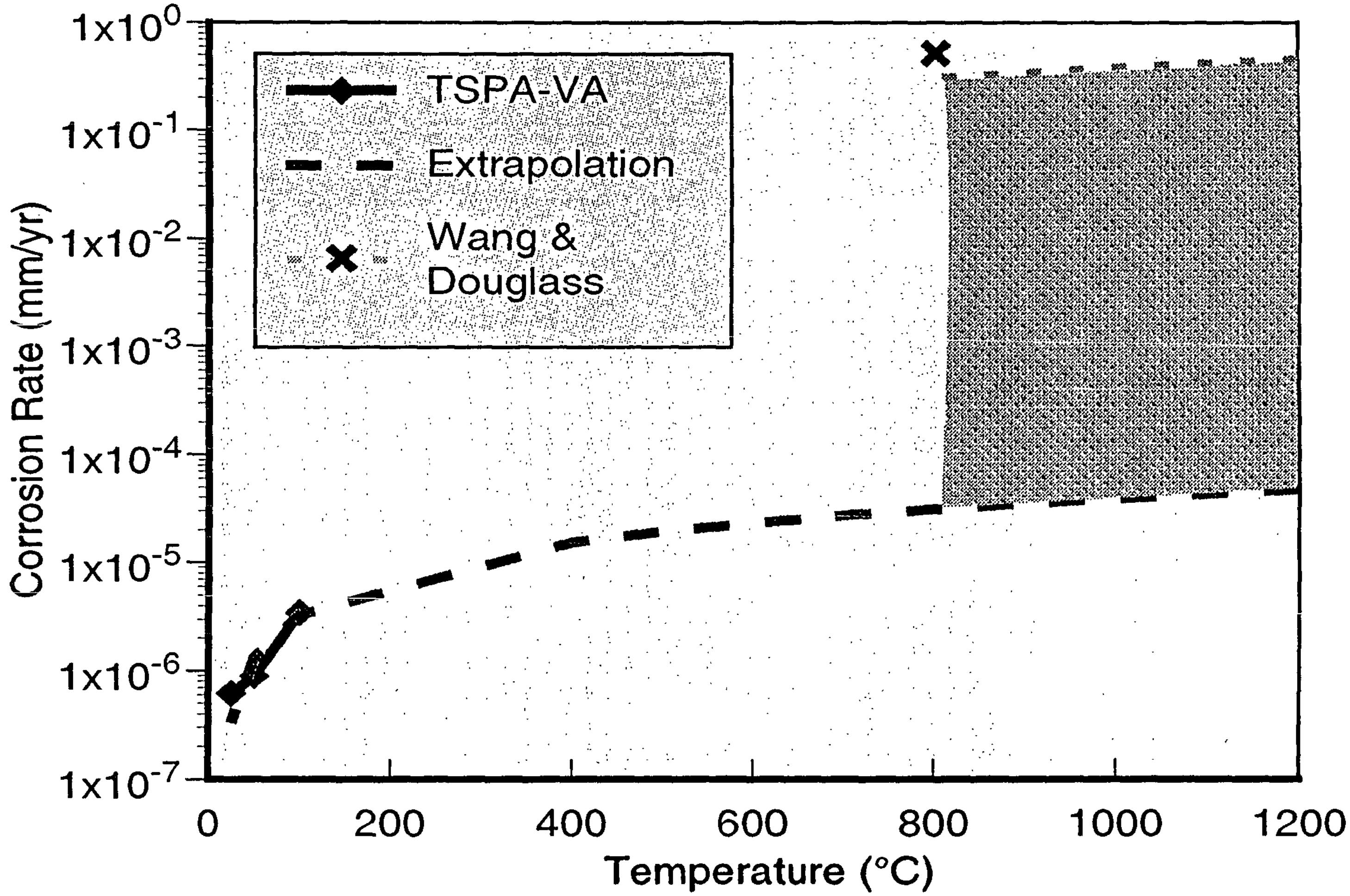


Source Term (Continued)

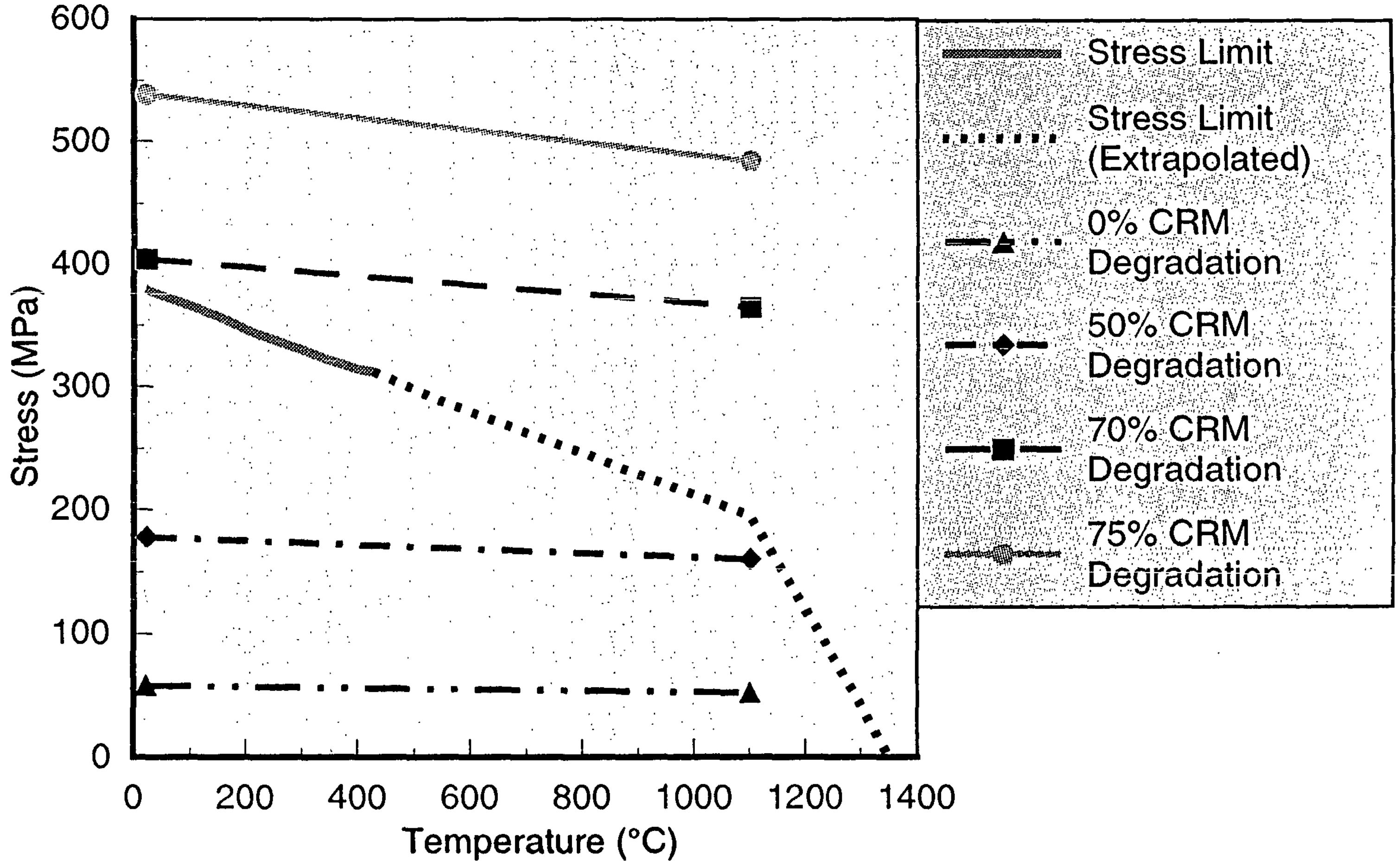
Waste-Package Breach

- Magmatic intrusion is extremely hostile environment
  - Temperature: 1000°C – 1200°C
  - Corrosive gasses present (SO_2, H_2O, CO_2, HF)
- CAM on waste package does not survive
- CRM (C-22) is quite resistant to this environment
  - eruption duration (5 days – 40 days) is insufficient to corrode full-thickness CRM
  - Waste package is breached if it has previously corroded to ~50% thickness
- CRM failure mode is corrosion and high-temperature deformation

CRM Corrosion Rate



CRM Deformation



Source Term (Continued)

Waste-Particle Ejection and Entrainment

- Waste particles have density of ~11 g/cm^3
  - ash density is 0.8 – 2.65 g/cm^3
- Impinging ash requires sufficient momentum (mass and velocity) to remove and carry waste
  - relative sizes of ash and waste – 1:1 or 2:1
- Heavy waste particles can settle in ascending ash and not reach surface

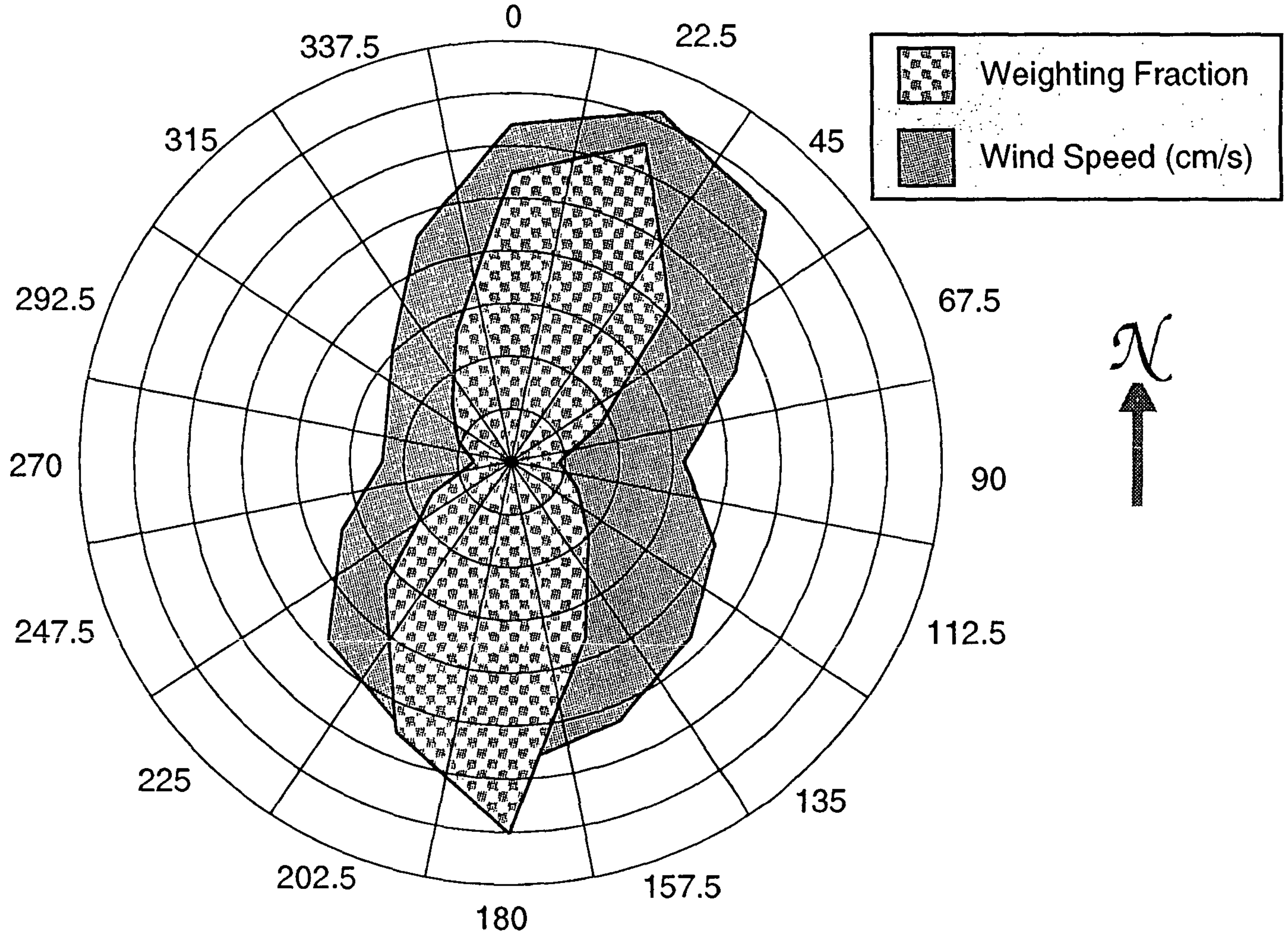
Results of Source-Term Modeling

- Of 300 realizations, 17 produced radionuclides at surface for input to ASHPLUME (5.7%)
  - some realizations were eliminated by dikes not intersecting repository, or no vents occurring inside repository
  - almost all realizations where liquid magma interacted with waste were eliminated
    - insufficient ascent velocity
  - waste package was breached only if time of occurrence of event was later than about 400,000 years, which eliminated a few realizations
    - range of times for 50% CRM reduction is 400,000 – 1,000,000 years
  - many realizations were eliminated because ash particle sizes were too small to eject waste

ASHPLUME Analyses

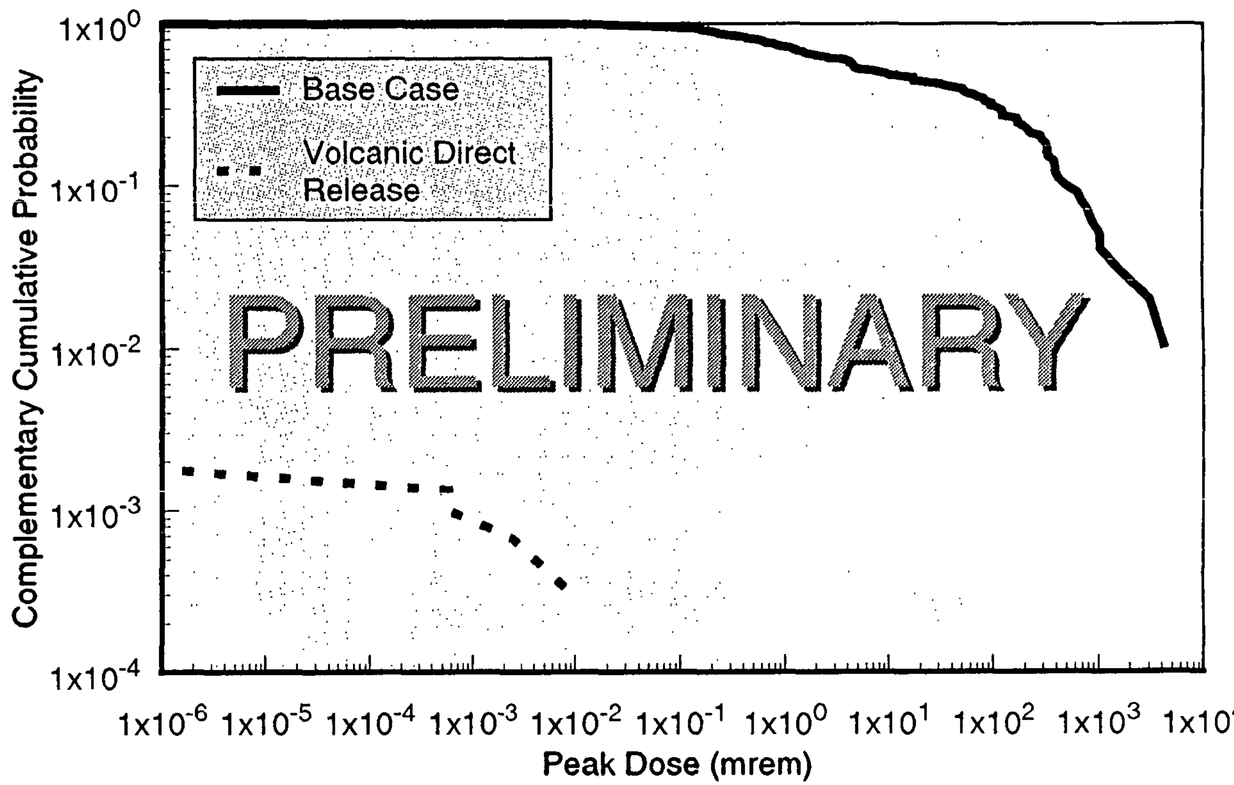
- Code was run in “deterministic” mode using stochastically developed source term
- Wind direction and speed was stochastically selected for the 17 runs
  - 9 of the 17 runs had wind blowing northerly, away from main dose receptor point

Wind Rose


0
22.5
45
67.5
90
112.5
135
157.5
180
202.5
225
247.5
270
292.5
315
337.5
Weighting Fraction
Wind Speed (cm/s)
N

Dose Calculations

- Time of occurrence used to calculate radionuclide inventory
- BDCFs for 39 radionuclides applied to ASHPLUME surficial concentration at receptor point (20 km south of vent)

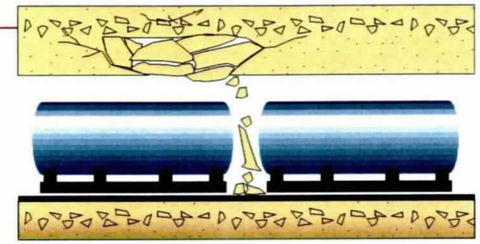


Seismic Activity

- Primary disruption is expected to be from rockfall
- Water-table rise, seismic pumping, refocusing of UZ flow are short-term or low-impact events
- Rockfall can occur from thermo-mechanical or seismic effects
  - seismic is lower probability than thermo-mechanical

Rockfall Scenario

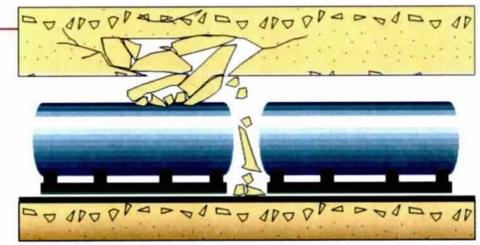
Seismic events or thermo-mechanical effects cause rocks to fall from drift ceiling.



No → STOP — *No performance assessment consequence. End Scenario.*

Yes ↓

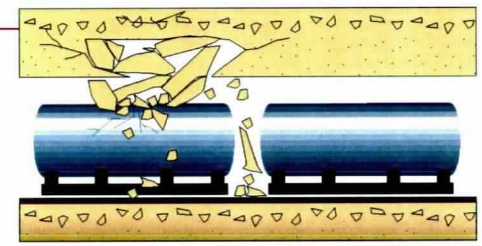
Falling rocks strike waste packages.



No → STOP — *No performance assessment consequence. .*

Yes ↓

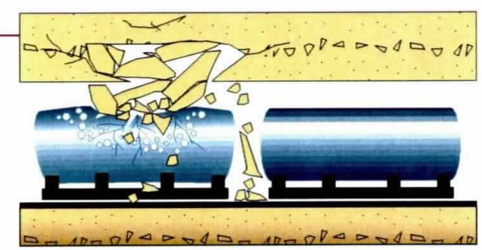
Rock ruptures waste package.



No → **Rock damages waste package wall.**

- No → *Performance assessment consequence not modeled here.*
- Yes ↓

Waste package corrosion increases at site of damage.



- No → *Performance assessment consequence modeled in base case.*
- Yes ↓

Yes ↓

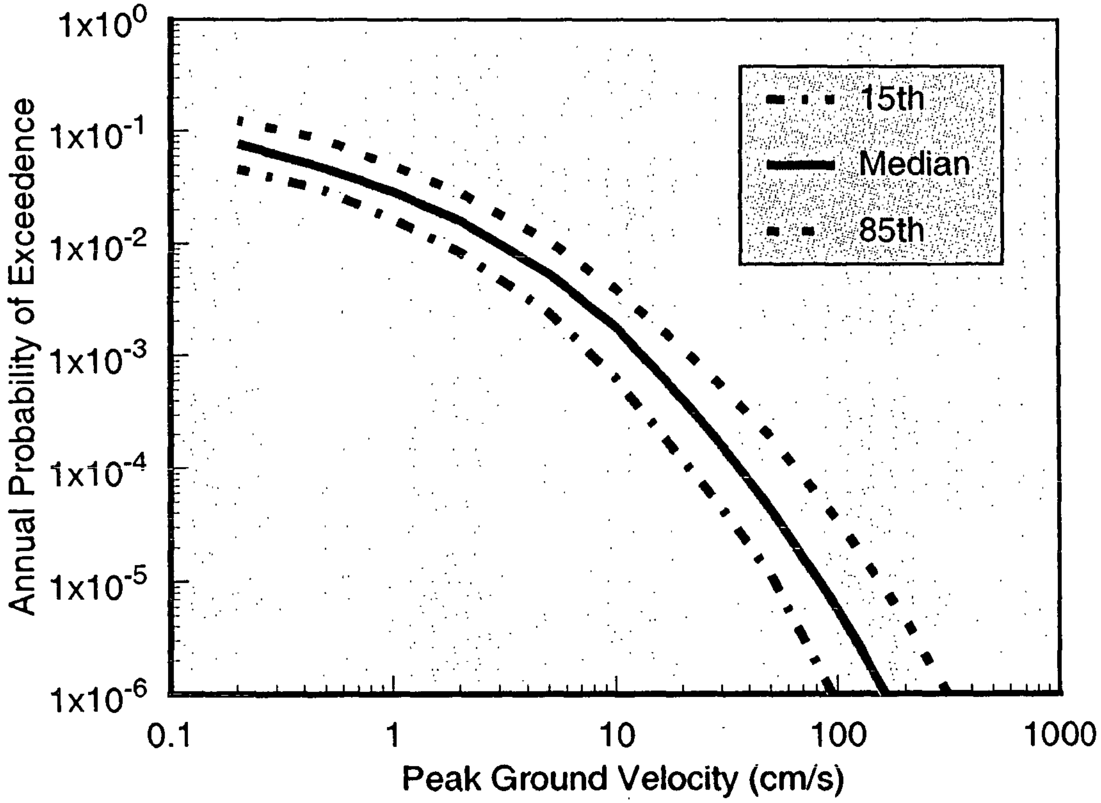
Waste is more accessible to groundwater.
Enhanced source term for groundwater radionuclide transport.
Performance Assessment consequence is measured by dose at receptor site.

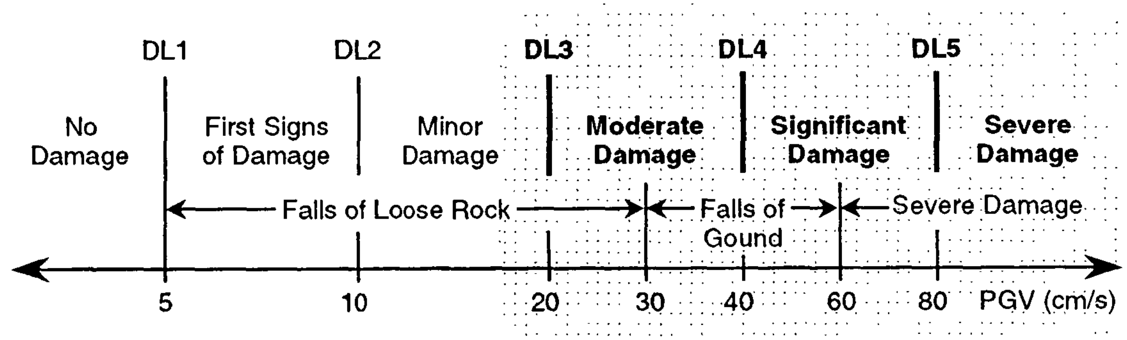
snl/trw abq 04.eps

Rockfall Analysis

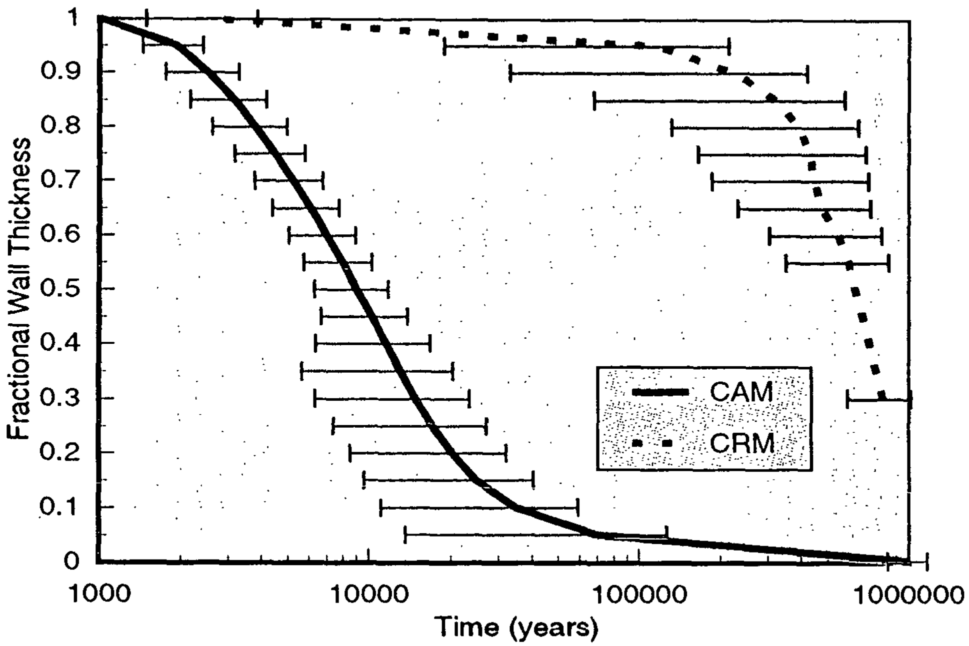
- Initiated by seismic event
  - Peak ground velocity determines extent of rockfall
    - more competent rock requires greater seismic disruption
- Damage caused by rockfall on waste package depends on impact
  - minimum rock mass that can breach or dent waste package
  - waste-package corrosion reduces mass of critical rock
- Distribution of potential rock sizes determines if one is available to do damage

Peak Ground Velocity and Damage Levels

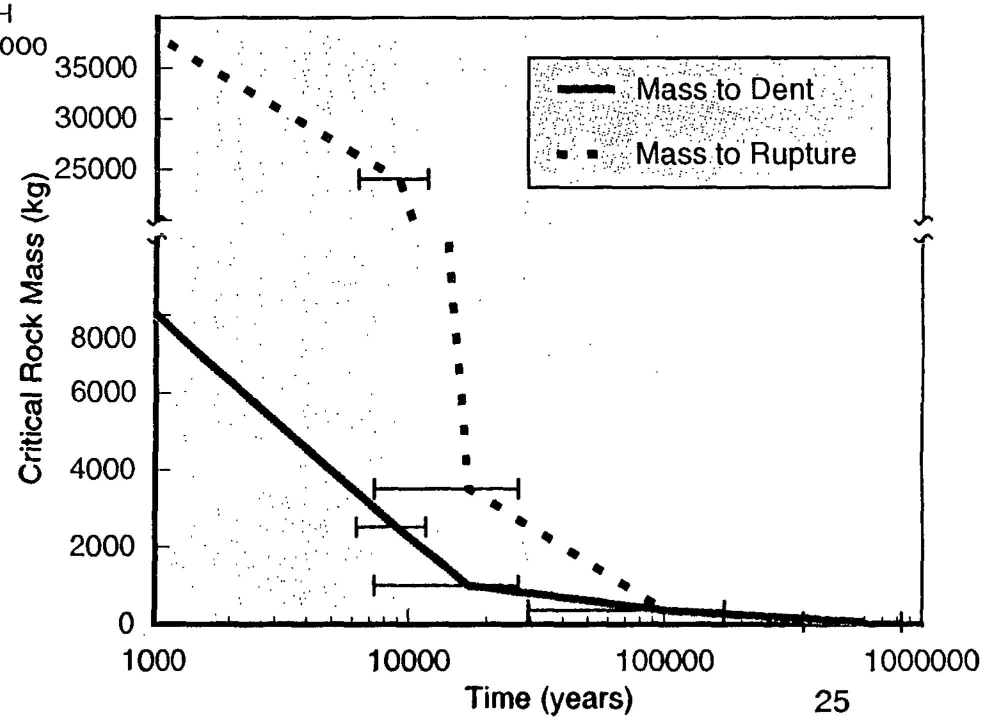




Critical Rock Masses and WP Corrosion

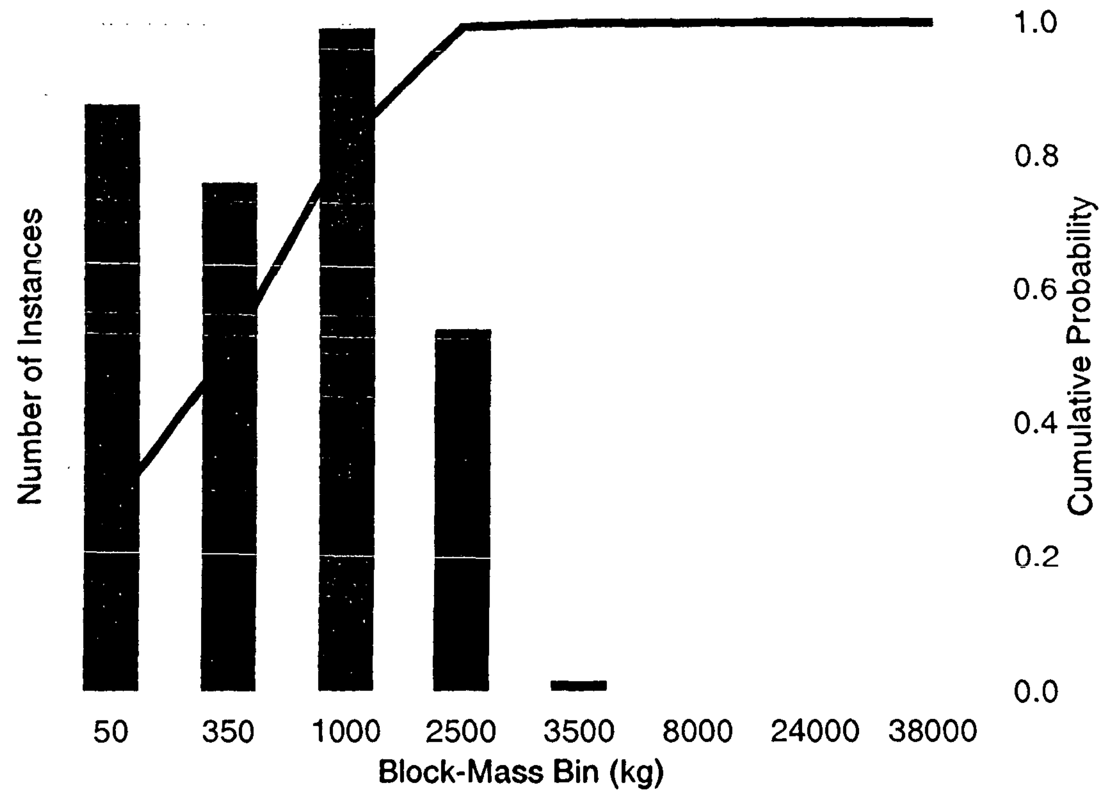


CRM corrosion rate for dripping conditions



Block-Size Distribution

- Derived from ESF joint-frequency study



Description of Rockfall Analysis

- Time of occurrence -> PGV -> rockfall characteristics
  - the greater PGV, the larger rocks that fall
- Time of occurrence -> extent of waste package degradation
  - determines minimum size rock that can damage waste package
- Sampling from rock-size distribution determines if rock does damage
  - if no breach, size of rock determines acceleration of localized corrosion
- WAPDEG calculations provide source term to RIP

Preliminary Results of Rockfall Modeling

- Rockfall analyses stratified by hazard level
- No rockfall failures in less than 10,000 years
  - predicted PGV is small
  - waste-package walls are thick
- Overall, ~12% of rockfall events cause failure in 1,000,000 years

Hazard Level	Average Time of Occurrence (years)	Average PGV (cm/s)	Fraction of Packages Breached*	Fraction of Packages Damaged
> E-3	560	9.9	0.0	0.0
E-3 – E-4	5500	28.0	0.0	0.001
E-4 – E-5	57600	67.4	0.167	0.013
E-5 – E-6	533800	135.7	0.310	0.013

* Includes the probability that falling rock hits a package, and doesn't fall between packages