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

NUCLEAR WASTE TECHNICAL REVIEW BOARD
PANEL ON STRUCTURAL GEOLOGY & GEOENGINEERING

SUBJECT: SUMMARY OF SEISMIC HAZARDS

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PRESENTER'S TITLE AND ORGANIZATION: SENIOR GEOLOGIST
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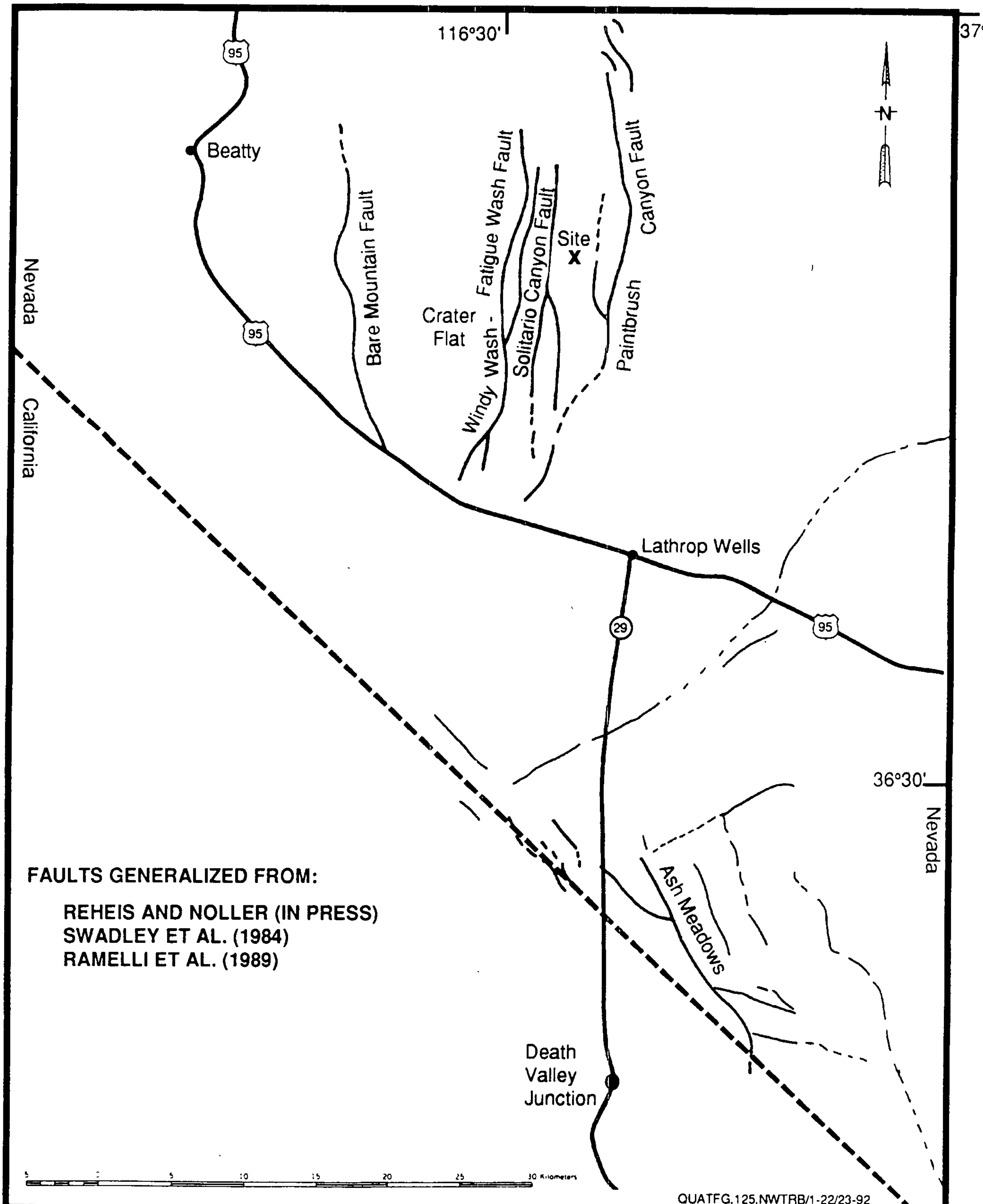
JANUARY 22-23, 1992

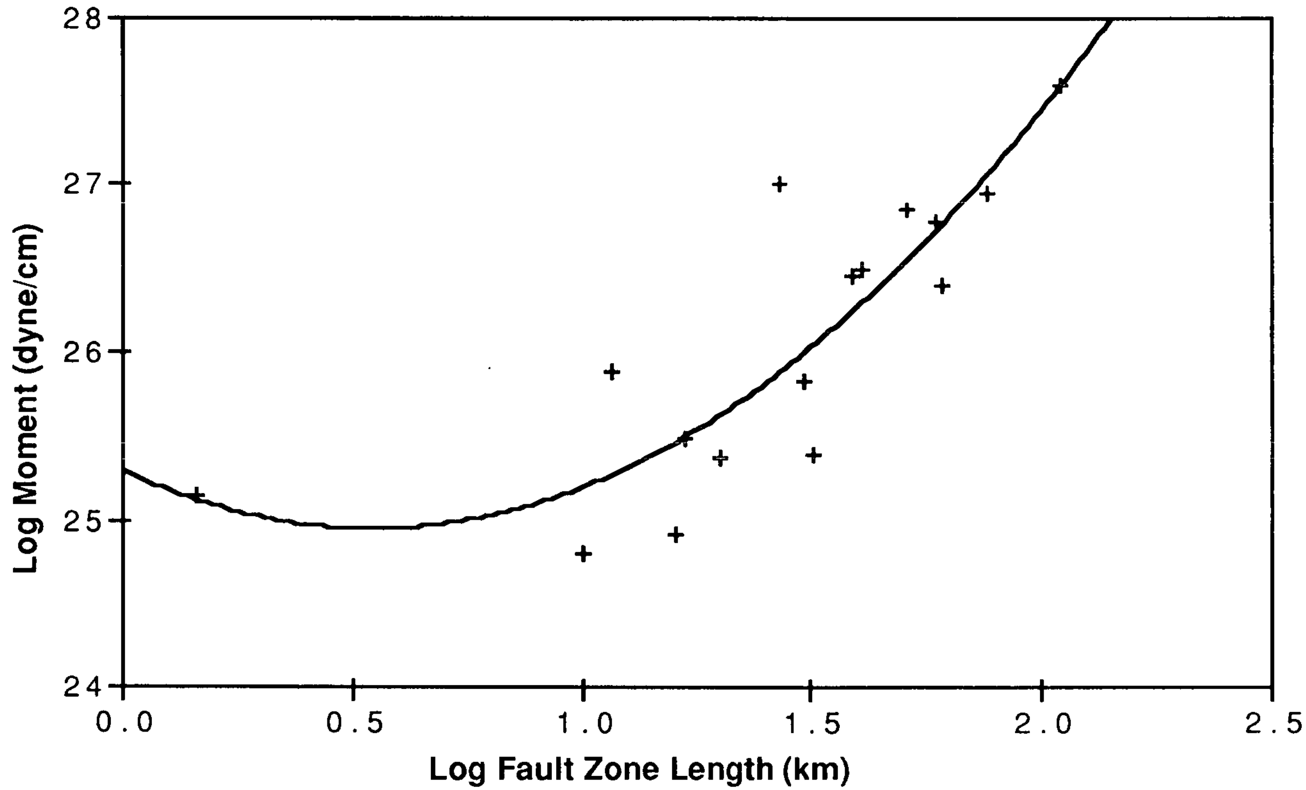
Preclosure Ground Motion

- Review currently available information
- Identify bounding conditions for use in assessing seismic vulnerabilities of preclosure facilities

Quaternary Scarps Recognized by Remote Sensing Studies



Data for Basin and Range Earthquakes with Surface Rupture



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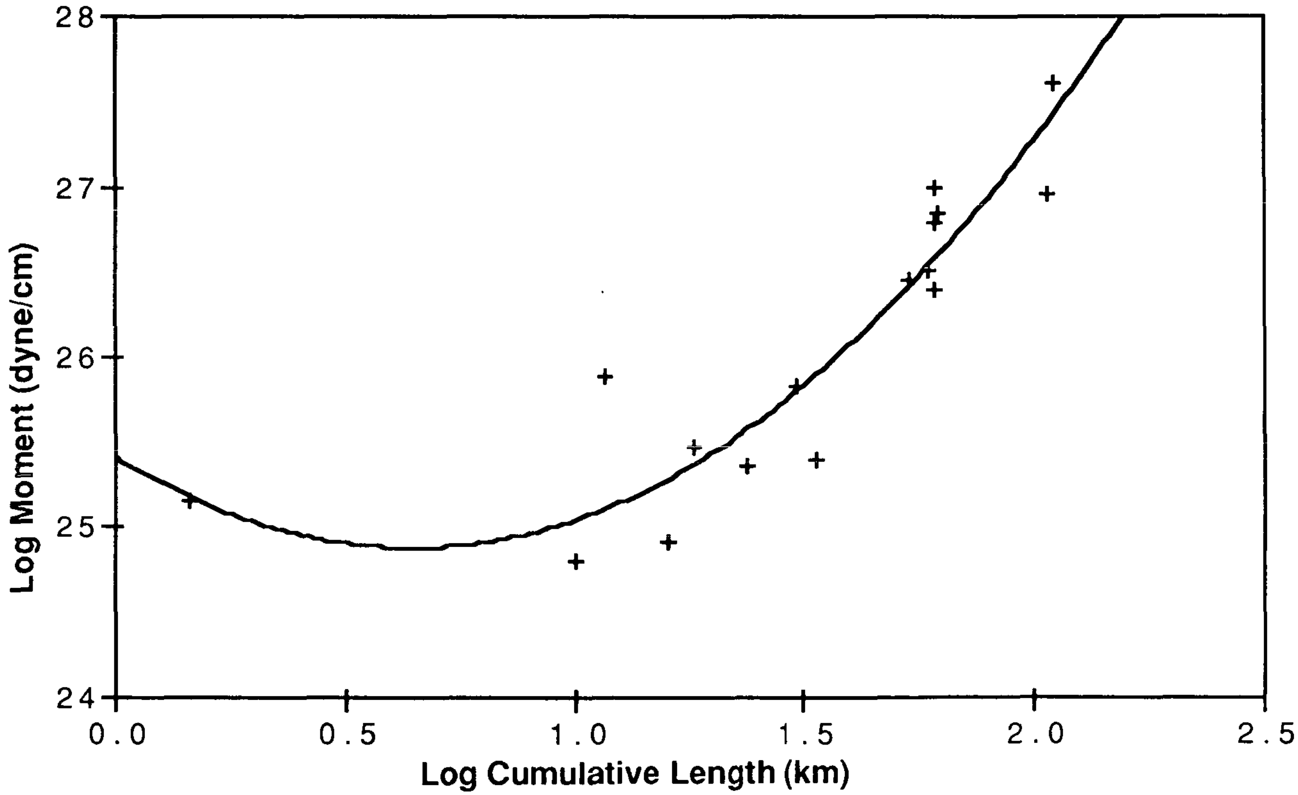

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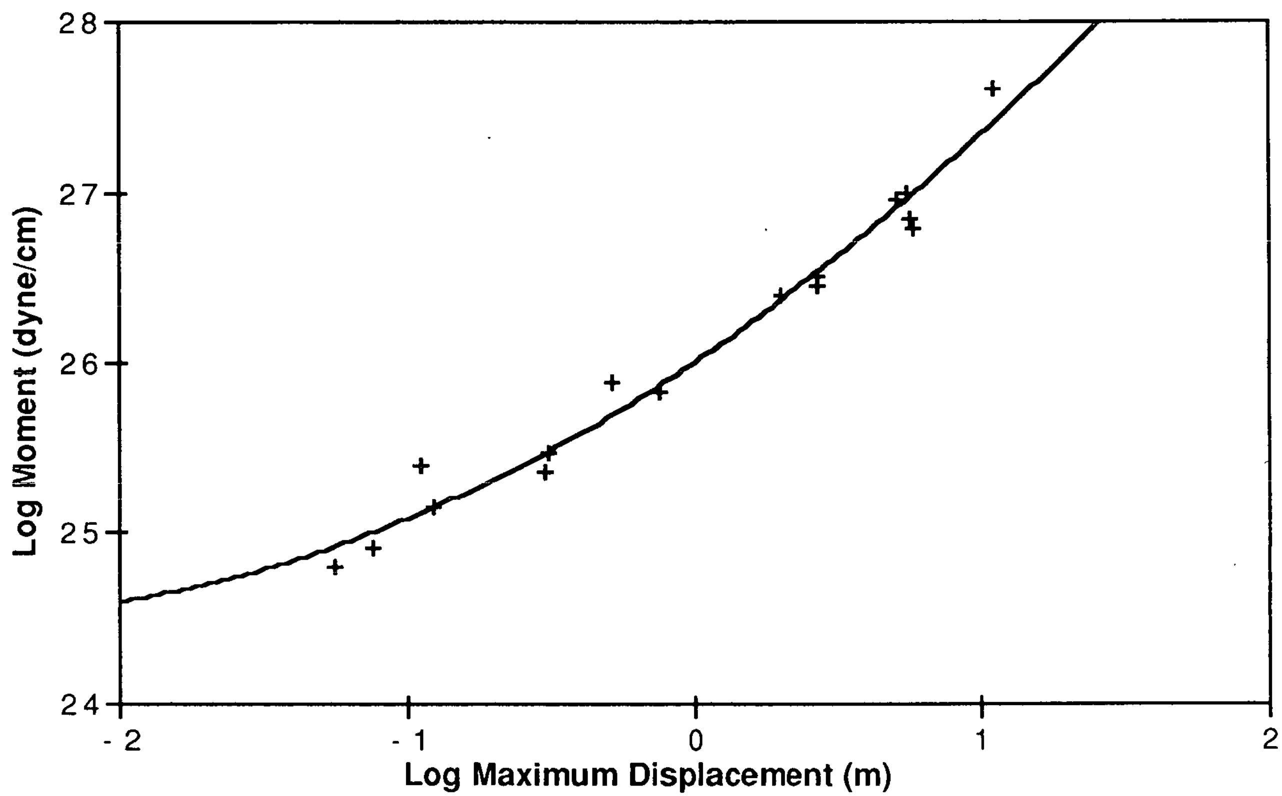

Scenario 1: Movement on Individual Faults

FAULT	RUPTURE LENGTH (km)	SLIP RATE (mm/yr)	SINGLE EVENT OFFSET (m)	ESTIMATED SEISMIC MOMENT (X 10**25 dyne-cm)	MOMENT MAGNITUDE	DIP	FOCAL DEPTH (km)
BARE MOUNTAIN	23 (Map length in Crater Flat only)	(0.07)	(0.44)	3.6 - 5.5	6.3 - 6.5	45-75E	10-15
		(0.07)	1.75 (Observed)	19.5	6.8		
PAINTBRUSH CANYON	49 (Caldera rim to Lathrop Wells cone, includes length of Bow Ridge fault)	0.005-0.009	(1.3-1.7)	20.3	6.8	45-75W	8-12
	31 (Apparent length of Quaternary ruptures, includes Bow Ridge fault)		(0.5-0.7)	6.6	6.5		
			1.5	16.2	6.8		
			0.27 (10K CSE)	2.7	6.3		
SOLITARIO CANYON	30 (Cumulative length)		(0.5-0.7)	6.1	6.5	45-75W	8-12
	23 (Length of fault zone)		(0.4)	5.5	6.5		
FATIGUE WASH-WINDY WASH	37 (Cumulative length)	0.008-0.01	(0.7)	9.9	6.6	45-75W	8-12
	23 (Length of fault zone)		(0.4)	5.5	6.5		
			1.5	16.2	6.8		
	6.3		0.3 (10K CSE)	3.0	6.3		

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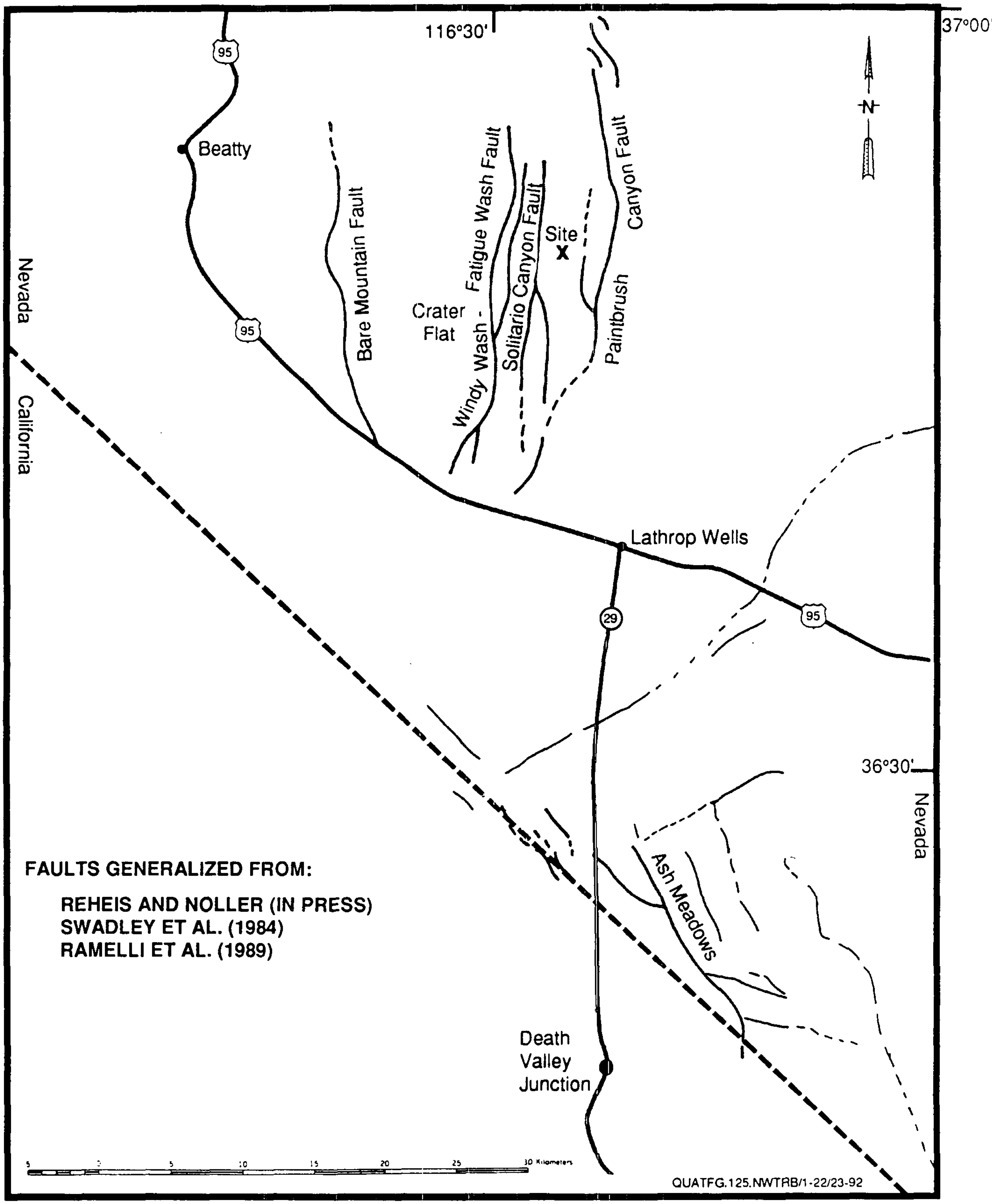
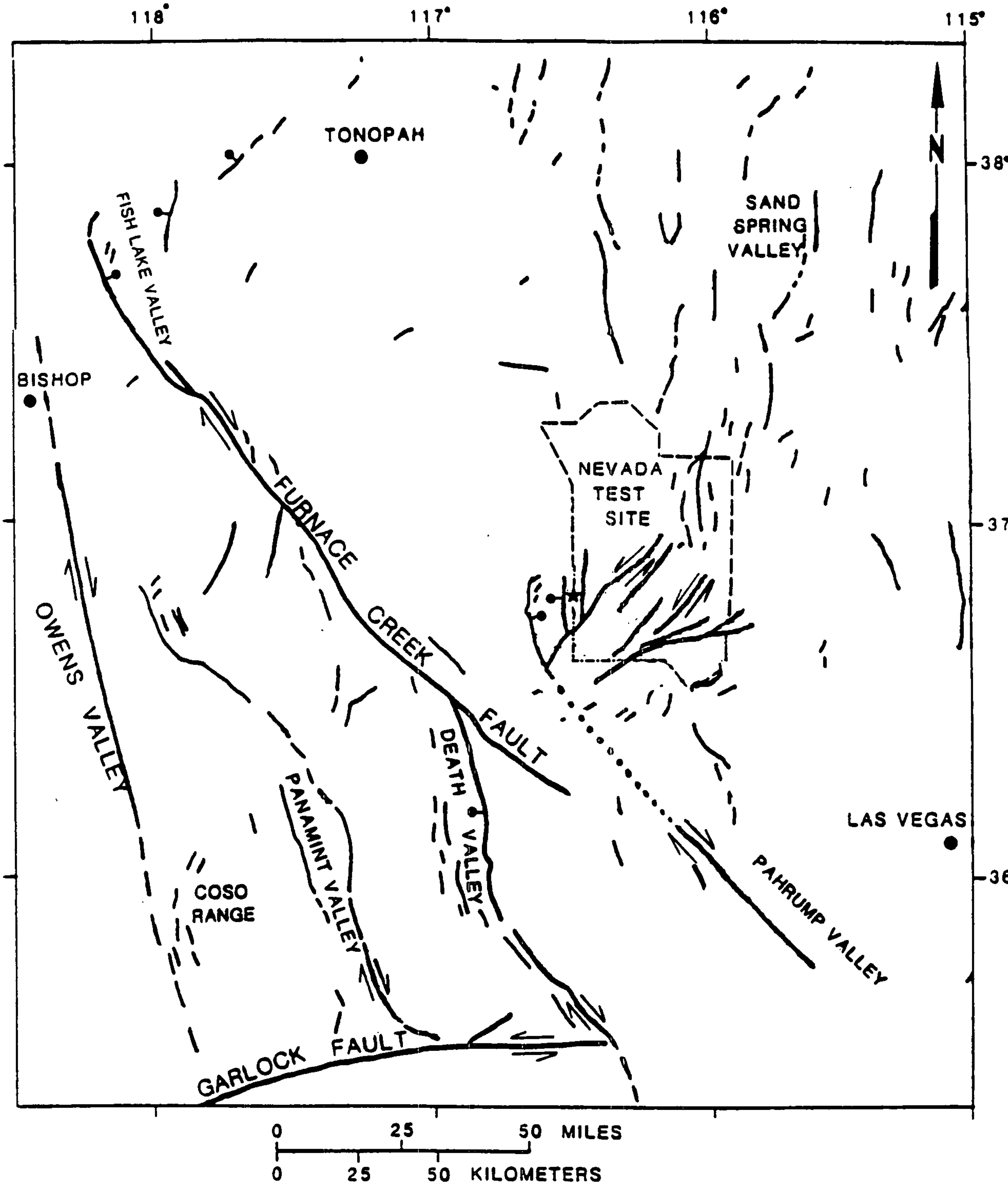


Scenario 2: Yucca Mountain Faults are Secondary Faults to the Bare Mountain Faults

FAULT	RUPTURE LENGTH (km)	SLIP RATE (mm/yr)	SINGLE EVENT OFFSET (m)	ESTIMATED SEISMIC MOMENT (X 10**25 dyne-cm)	MOMENT MAGNITUDE	DIP	FOCAL DEPTH (km)
BARE MOUNTAIN PLUS PARTIAL MOVEMENT ON PAINTBRUSH CANYON, WINDY WASH, AND SOLITARIO CANYON	23 10 10 10 53	(0.07)	(2.0)	25.1	6.9	45-75	10-15
	23 15 15 15 68		(3.5)	52.7	7.1		
			3.0	38.7	7.0		

Map Showing Major Quaternary Faults in the Region Surrounding the Site



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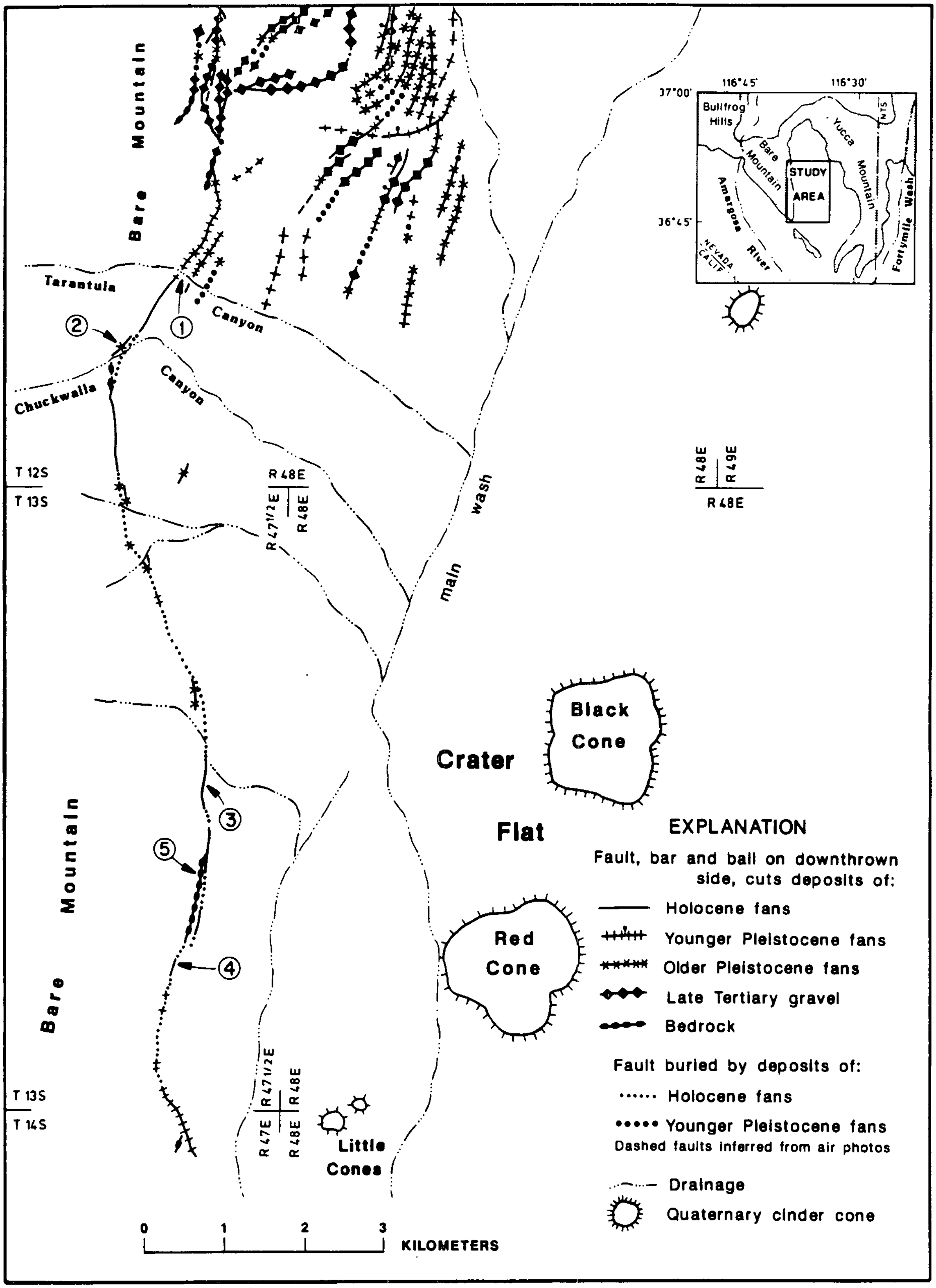
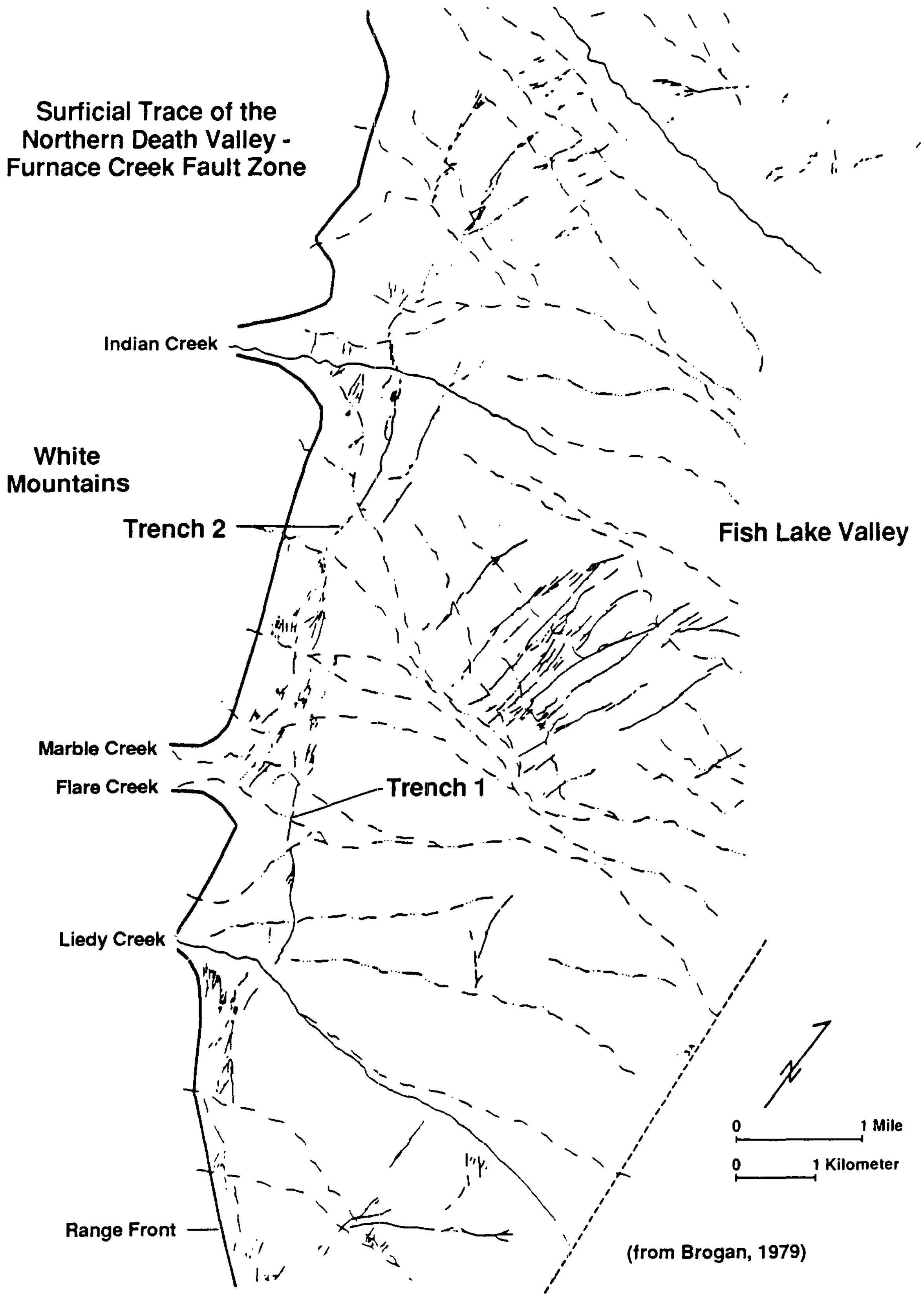
A. Map of Bare Mountain Fault. Reheis (1986)

SVSHTG5P.125.NWTRB/1-22/23-92

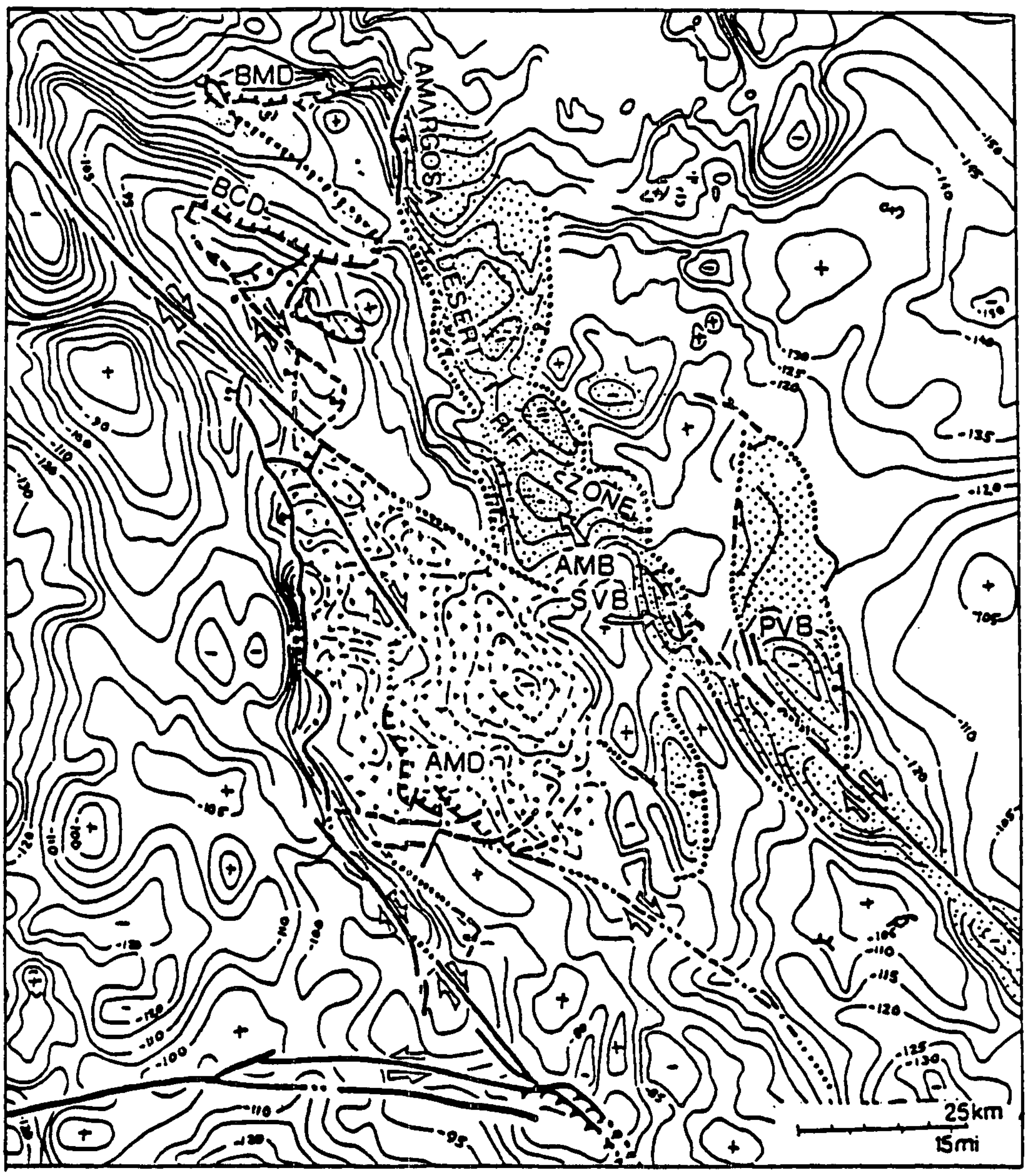


B. Map of Furnace Creek Fault in Fish Lake Valley. Sawyer



Bouger Gravity Map

Wright (1989) with an Overprint of Neogene Faults



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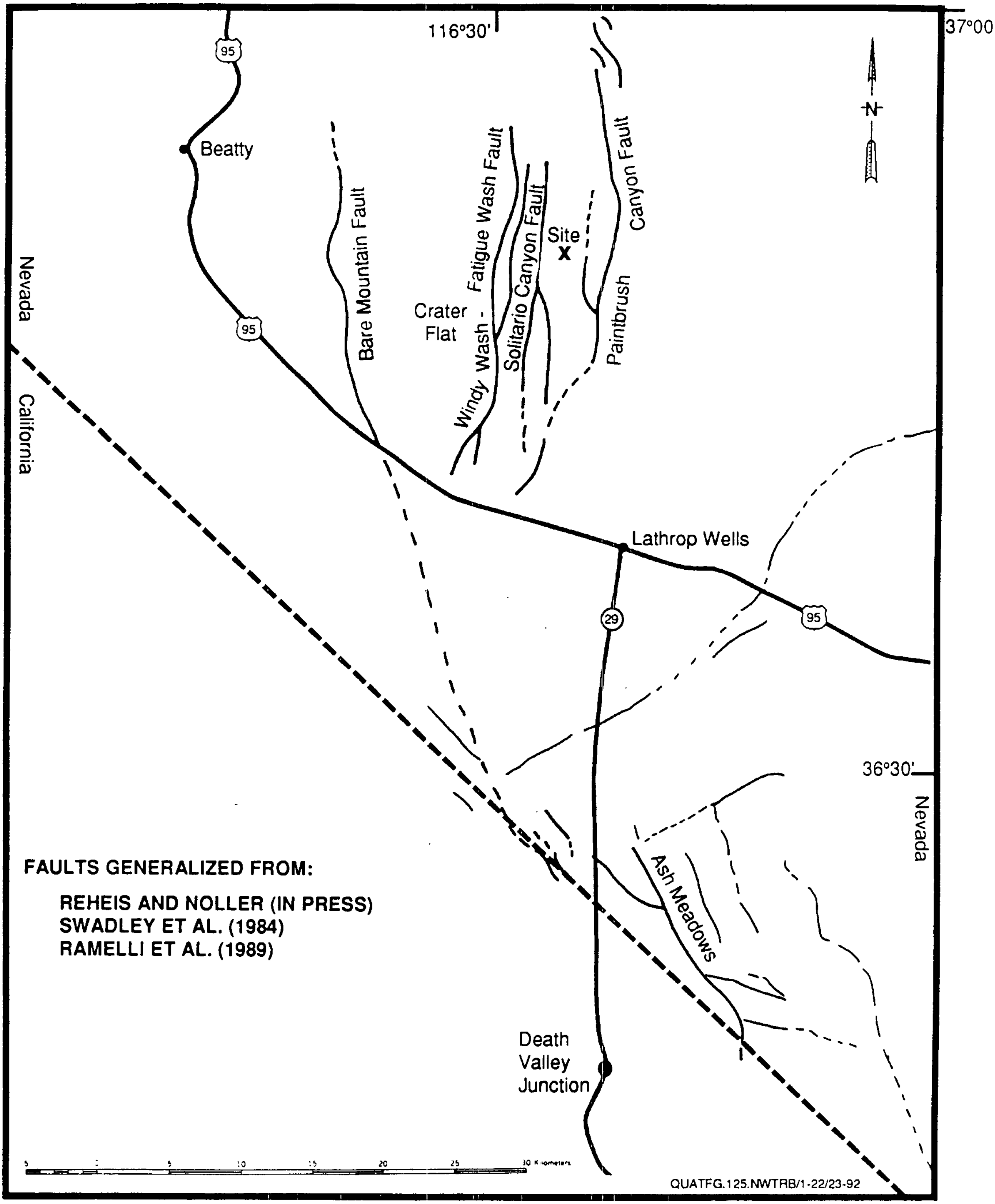
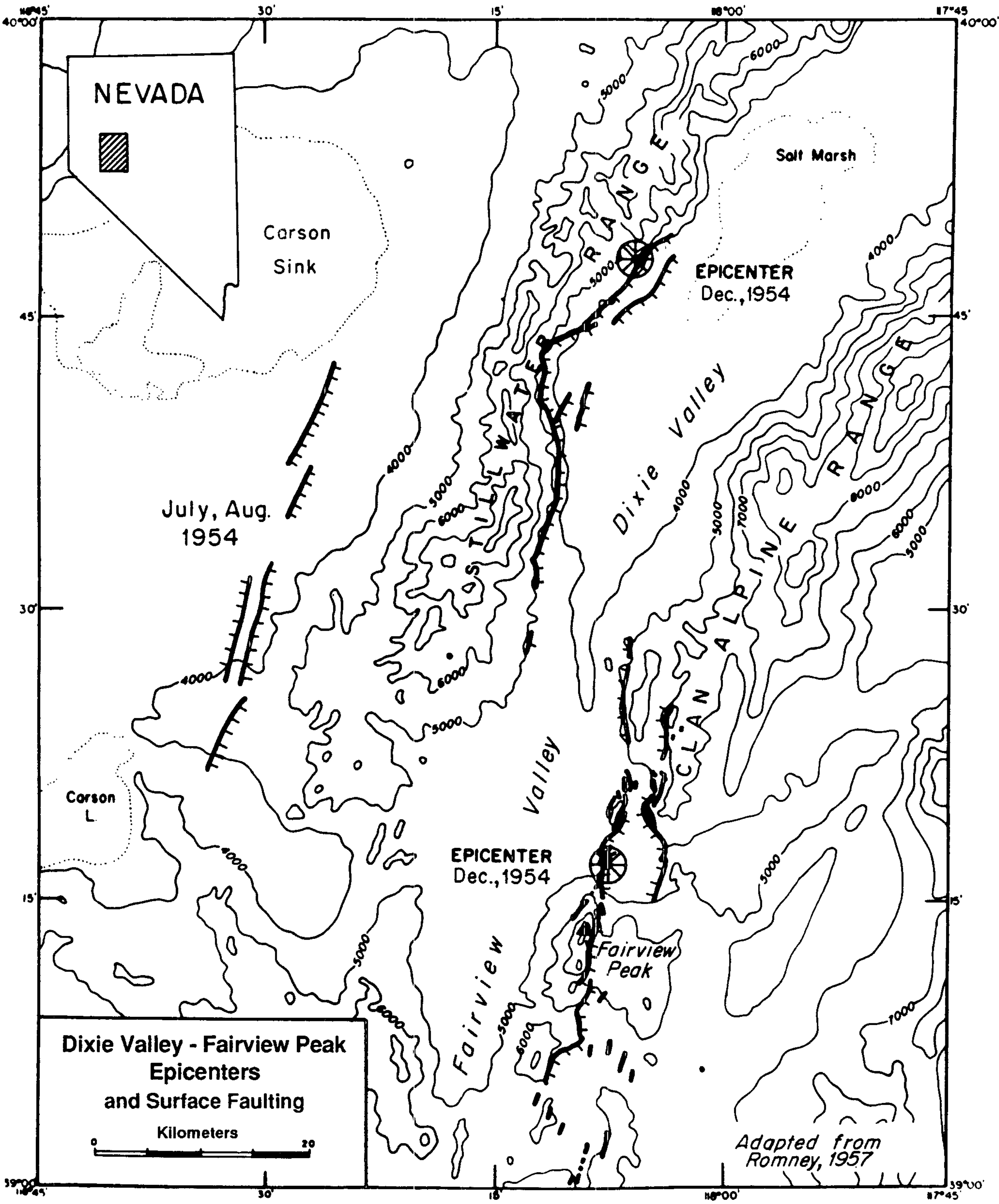
Quaternary Scarps Recognized by Remote Sensing Studies



Scenario 3: The Bare Mountain Fault is Part of a Strike-Slip System

FAULT	RUPTURE LENGTH (km)	SLIP RATE (mm/yr)	SINGLE EVENT OFFSET (m)	ESTIMATED SEISMIC MOMENT (X 10**25 dyne-cm)	MOMENT MAGNITUDE	DIP	FOCAL DEPTH (km)
BARE MOUNTAIN FAULT EXTENDS TO ASH MEADOWS	73	(0.07)	(4.1)	65.8	7.2	45E-90	10-15

Faulting Pattern of the 1954 Dixie Valley - Fairview Peak Earthquake Sequence
(Thompson, 1985)



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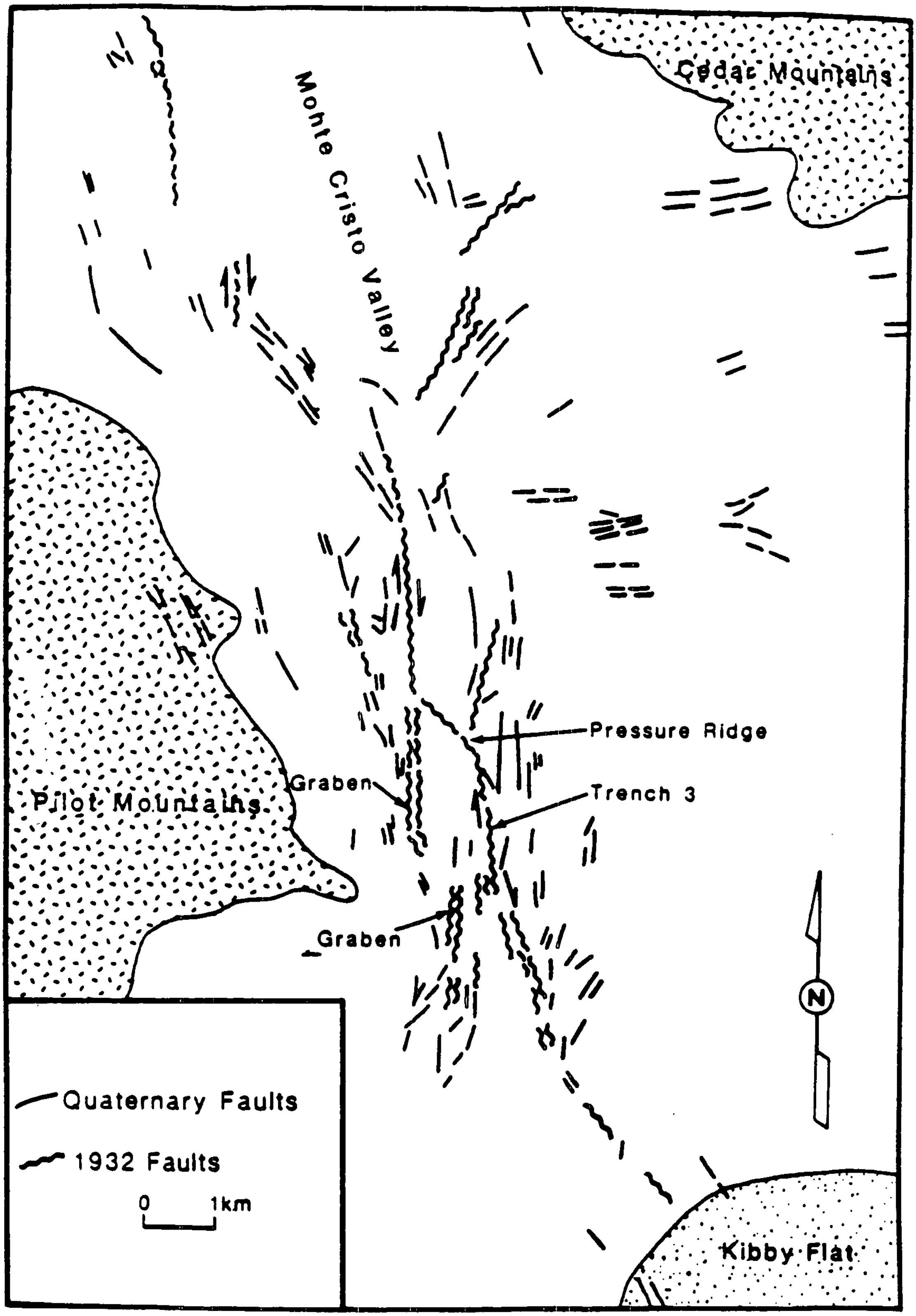
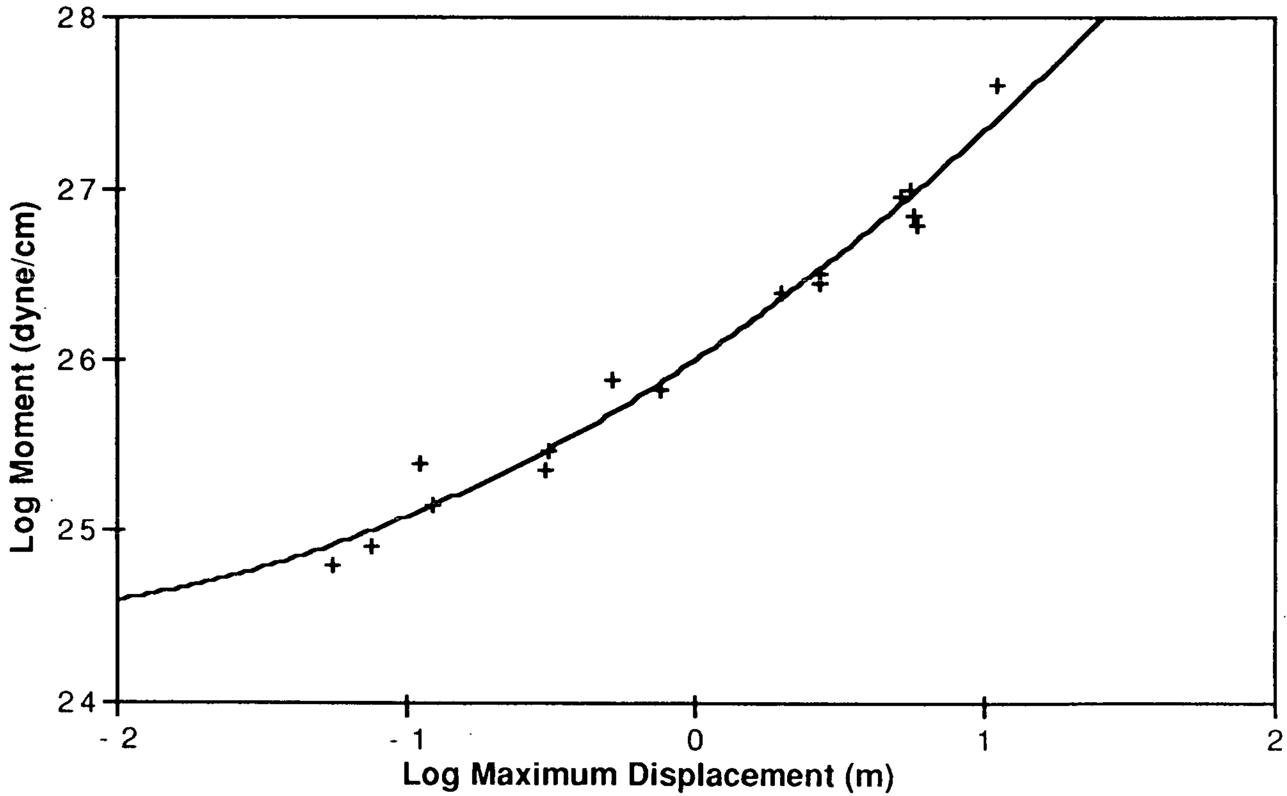
Quaternary and 1932 Faulting in Monte Cristo Valley. Bell (1988)



Data for Basin and Range Earthquakes with Surface Rupture



Preclosure Ground Motion Conclusions

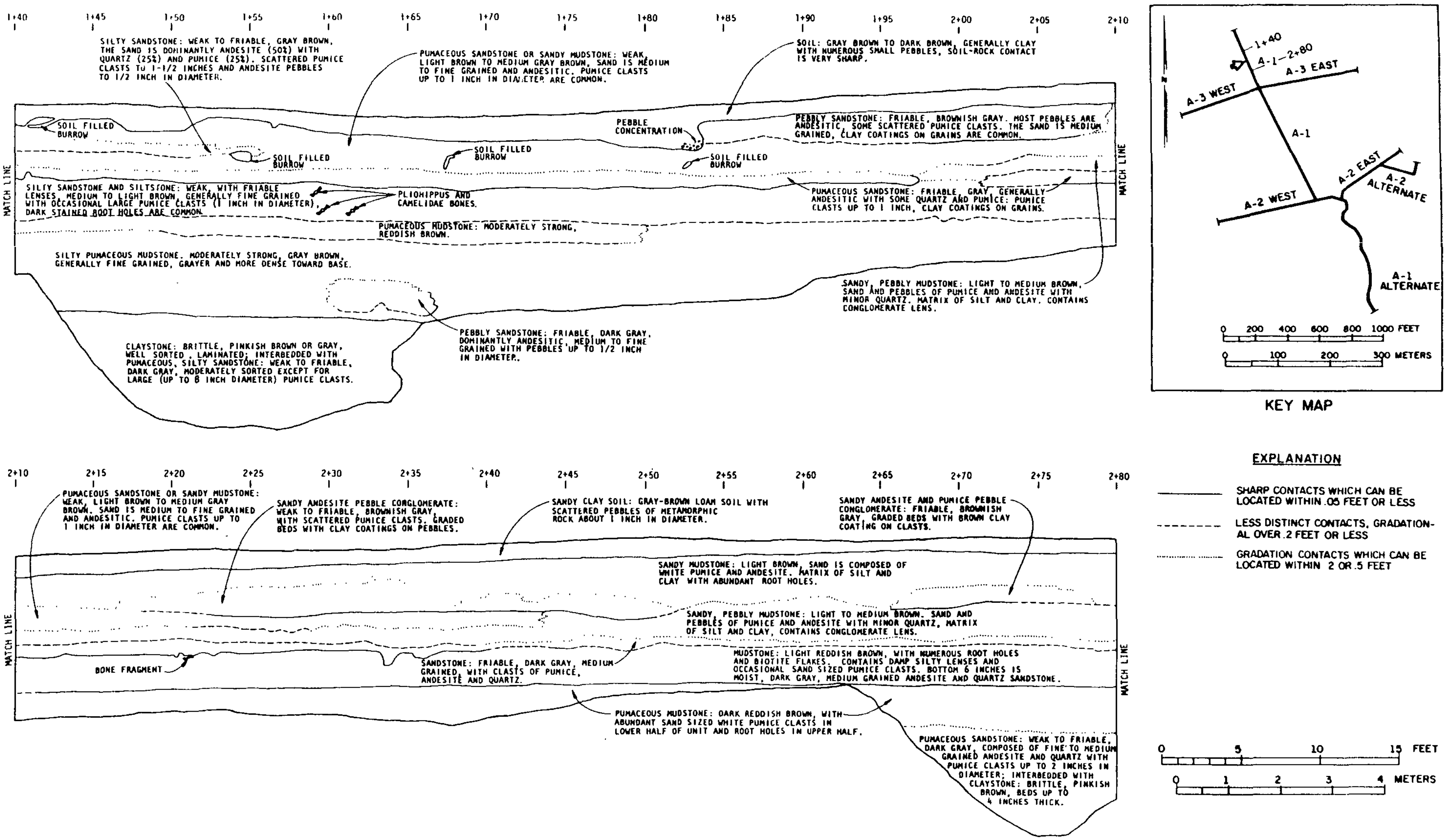
- Bounding events affecting the site appear to range from moment magnitudes of 7 to 7 1/4
- Site facilities would be in the near field of these events
- Estimates of the exceedance probabilities for these bounding events range from about 1.5×10^{-5} to 4×10^{-6}
- Events may occur as a series of earthquakes on different faults with the same intervals between events ranging from minutes to months

Preclosure Surface Fault Rupture

- For surface facilities, the primary strategy is to avoid areas of known hazard
- Current designs for subsurface facilities indicate that some structures will cross faults with a potential for movement (e.g., the Bow Ridge Fault)

Example of Trenching Investigations for Faulting Hazards

Example of Trenching Investigations for Faulting Hazards



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Preclosure Surface Fault Rupture Conclusions

- Site characterization trenching studies can provide confidence that faulting is not present at a facility location

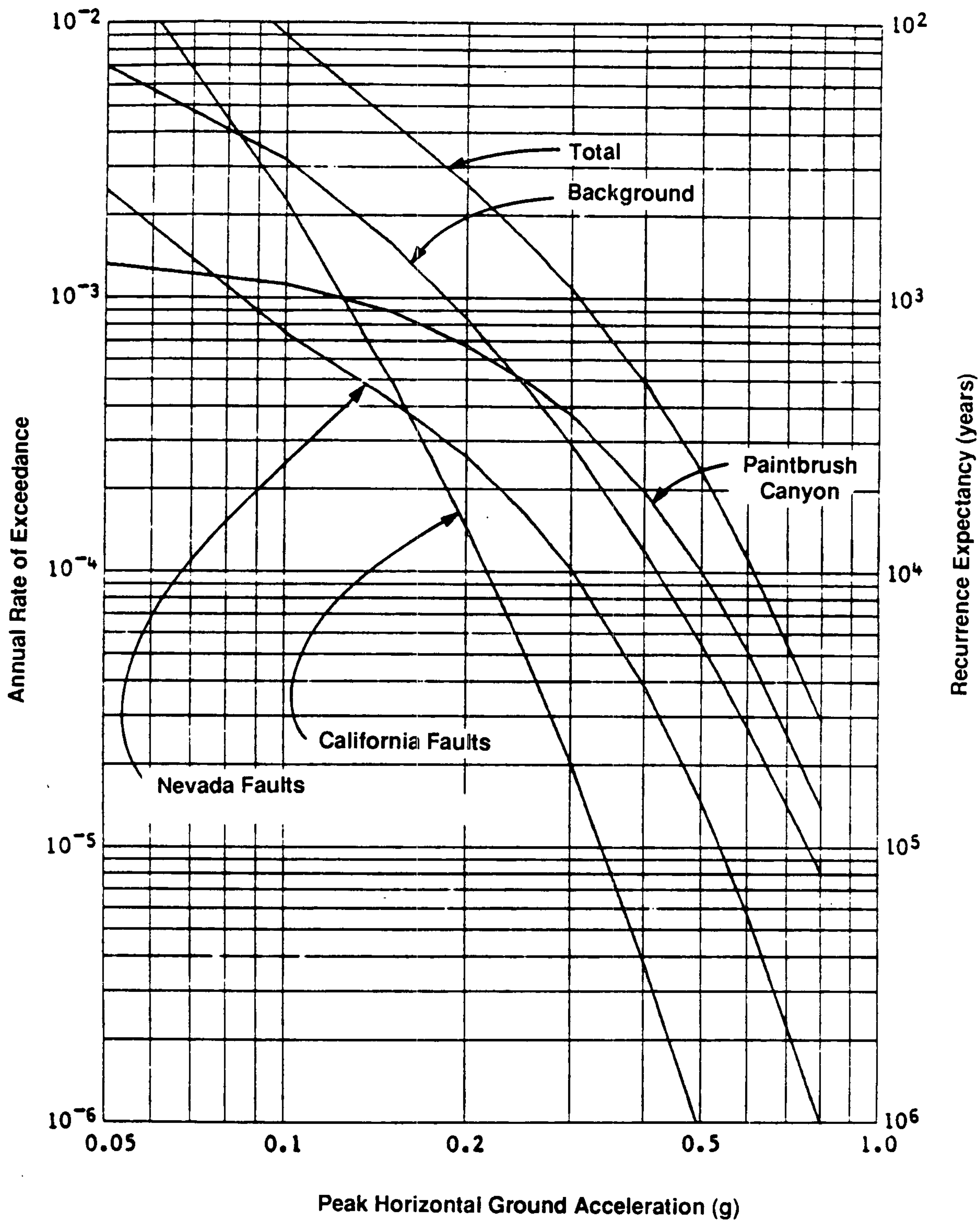
- The degree of confidence provided by trenching studies is related to the nature the materials encountered beneath the site. Current estimates are that significant faulting with annual probabilities of occurrence in the 1 x 10^{-5} to 1 x 10^{-6} range can be detected

Postclosure Ground Motion

- Concern with respect to the seismic vulnerability of facilities is primarily with the performance of the Engineered Barrier System

- Factors to be considered are:
  - Long duration of performance period (300-1,000 and 10,000 yrs)
  - Presumed absence of repairs or monitoring after event occurs

Composition of PGA Exceedance Rates. URS/Blume (1986)



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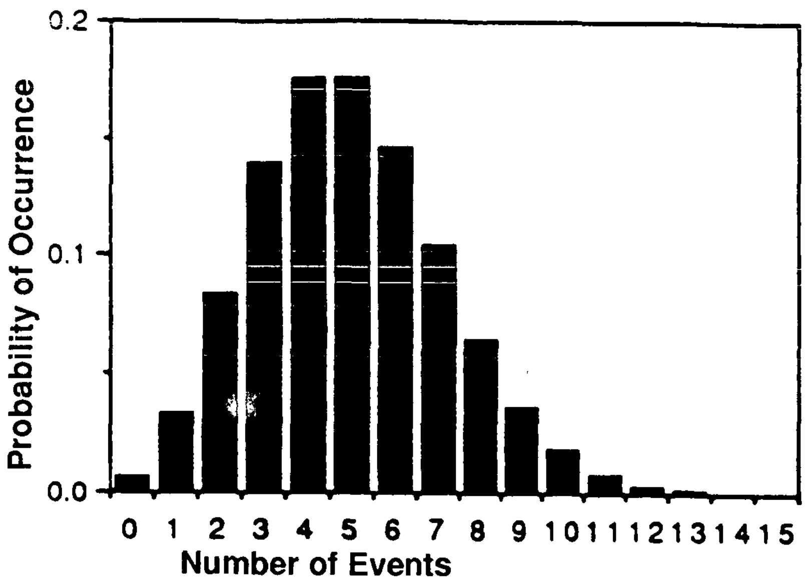
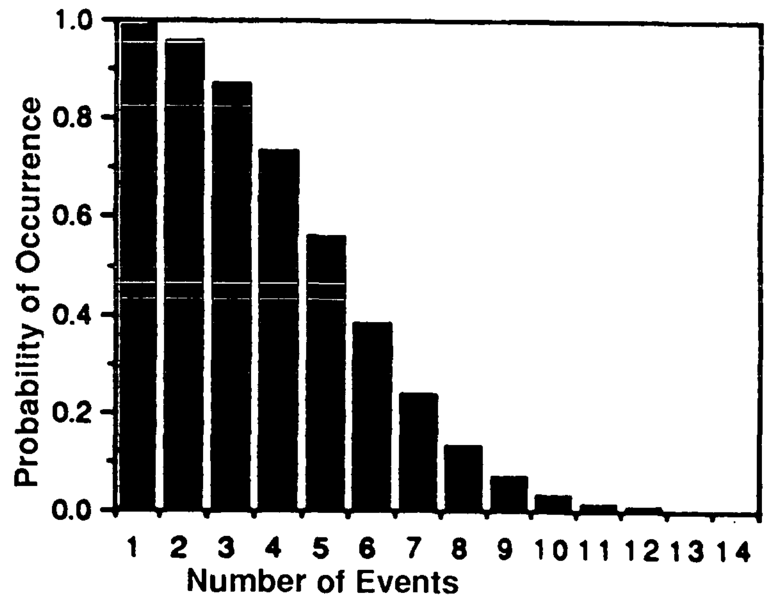
Probability of a Specific Number of Episodes of Site Accelerations > 0.4 g in a 10,000 Year Period



Cumulative Probability of N and Greater Episodes of Site Accelerations > 0.4 g in a 10,000 Year Period



Postclosure Ground Motion Conclusions

- Engineered Barrier System design evaluations should consider the occurrence of multiple events of strong motion during the performance period rather than a single design event

- Probabilistic evaluations are best suited for evaluating the possibility of multiple events from multiple sources over long performance periods

Postclosure Fault Rupture

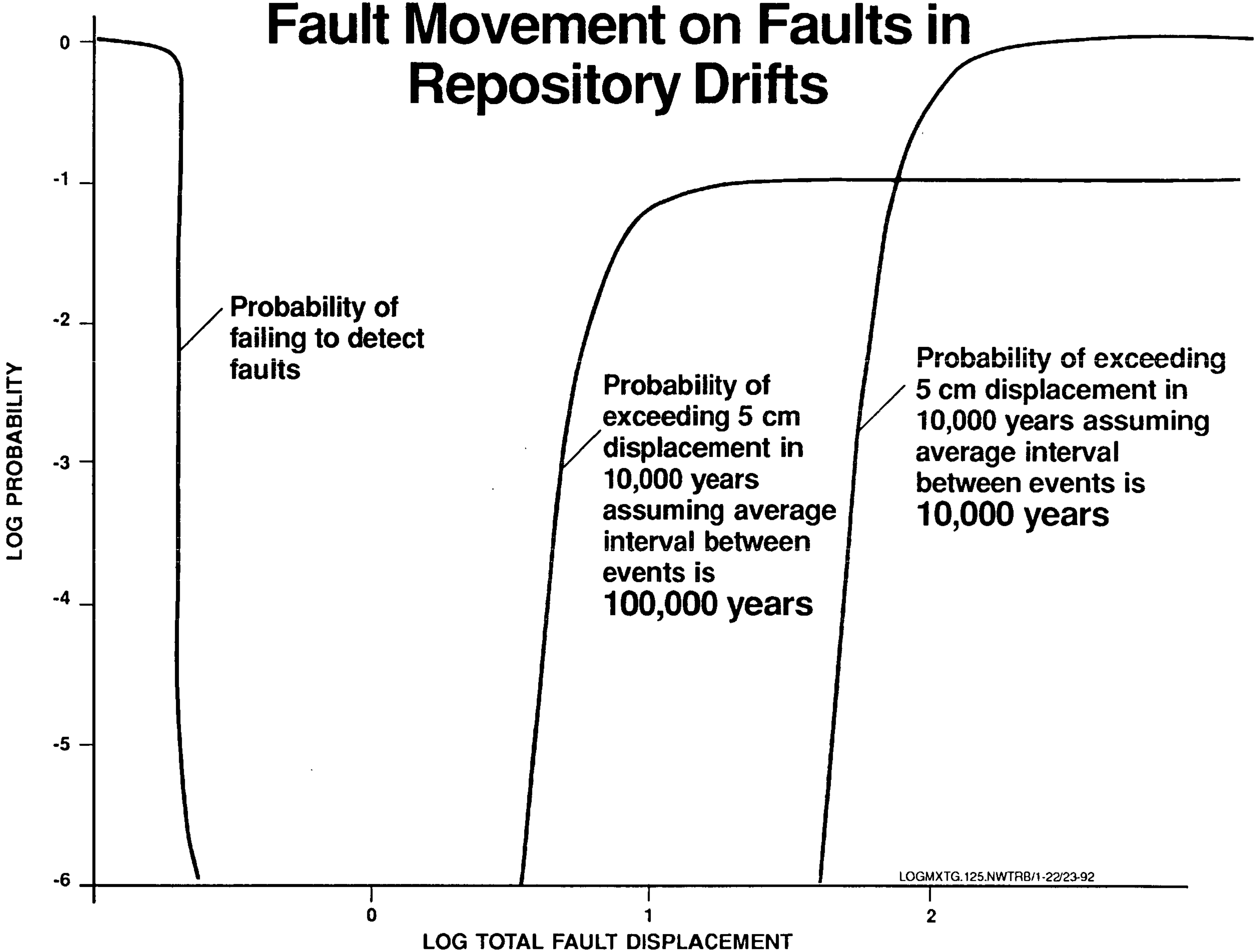
- Concern with respect to the seismic vulnerability of facilities is primarily with the performance of the Engineered Barrier System

- Basic strategy is to avoid placing waste packages in locations where faulting could occur

- Major concern is ability to detect potentially significant faults during the process of selecting waste emplacement locations

- Any methods of evaluating locations must recognize limitations on available data (i.e., the data that will be available in an emplacement drift)

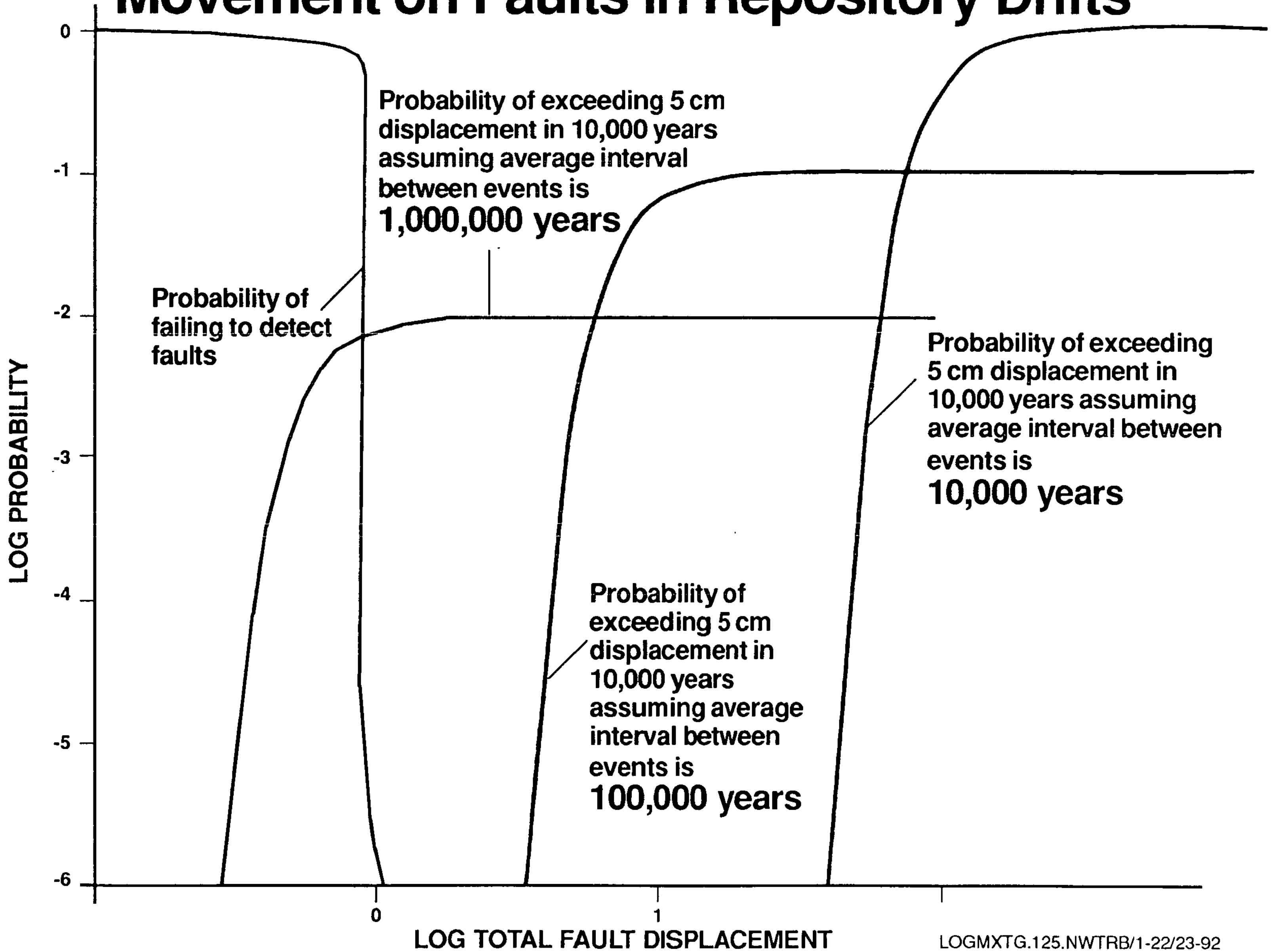
Hypothetical Probability of Postclosure Fault Movement on Faults in Repository Drifts



Assumptions

- The slip history on smaller faults is proportional to the slip history on the larger faults in the area
- The smaller faults in the area are secondary faults to the major faults and move in concert with them
- However, a particular fault may not move every time there is an event on the major faults
- When movement occurs, the possibility of exceeding a given displacement threshold can be estimated by assuming displacement is distributed about a mean value based on the average slip rate and average interval between events

Hypothetical Probability of Postclosure Fault Movement on Faults in Repository Drifts



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Postclosure Fault Rupture Conclusions

- Preliminary evaluations would indicate that significant faults can be detected and avoided with a high degree of confidence in the emplacement drifts