SKELETON TEXT
Date 11/30/93

TABLES FOR SECTION 3.1

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

9312020544 - Part 2

Table 3.1.1.1.4.2.1-1. List of Magnitude 5 and greater events within 320 km of the Yucca Mountain Site [INN 3.1.1.1.4.2.1-1]

Table 3.1.1.2.2.3-1. Stratigraphy, Age, and Magnetic Polarity of Tertiary Volcanic Rocks at Yucca Mountain[a]

K-Ar age (my) [b]	Magnetic Polarity[c]	Rock Unit[d]	Thickness (m)
10.2		Basalt dikes	
		* Timber Mountain Tuff	
		* Rainier Mesa Member	0-46
		Bedded tuff	0-61
		* Paintbrush Tuff	
12.5	R	* Tiva Canyon Member	69-148
		Bedded tuff	1-15
	R	* Yucca Mountain Member	0-29
		Bedded tuff	0-47
	R	* Pah Canyon Member	0-71
		Bedded tuff	0-9
13.1	N	* Topopah Spring Member	287-369
		Bedded tuff	1-17
13.4[e]		Tuffaceous beds of Calico Hills	27-289
		Bedded tuff	0-21
		* Crater Flat Tuff	
	N	* Prow Pass Member	80-193
		Bedded tuff	2-10
13.5	N	* Bullfrog Member	68-187
		Bedded tuff	6-22
	R	* Tram Member	190-369
		Bedded tuff	3-50
	N	Dacite lava and flow breccia	0-249
		Bedded tuff	0-14
	I	* Lithic Ridge Tuff	3-7
		Older volcanic rocks and volcanic-genic sedimentary rocks	345+

[a]Source: USGS (1984).
[b]my = million years.
[c]Magnectic polarity: N = normal; R = reversed; I = intermediate.
[d]Names and rankings of some units do not conform to USGS usage. Formally recongized names are preceded by *.
[e]Age determined on associated lava flow.

Table 3.1.1.2.4.2.2-1. List of Earthquakes Having Strong Motion Recordings Near Yucca Mountain

Location	Date	North Latitude	West Longitude	Depth (km)	Magnitude	Mechanism
Massachusetts Mtn	1971.8.5			4.3	4.3	strike-slip
Little Skull Mountain	1992.6.29	36.717	116.293	9.6	5.6	normal
Little Skull Mountain	1992.7.5				4.4	strike-slip
Little Skull Mountain	1993.5.9	36.729	116.300	9.5	3.2	
Southern Utah	1992.9.2				5.9	
Little Skull Mountain	1992.9.7				3.1	
Rock Valley	1993.5.15	36.717	116.124		3.6 4.0 2.8	
Rock Valley	1993.5.30	36.719	116.102	0	4.0	
Eureka Valley	1993.5.17 1993.6.3 1993.6.8	37.176 37.117 37.012	117.832 117.795 117.762	9.1 5.9 1.7	6.1 3.9 4.4	normal

Table 3.1.1.2.4.3.4-1. Reduction with Depth of Ground Motion Recorded on Rock

Station	Number of Events	Depth (meters)	Reduction in PGV[1]		Reduction in PGA[2]	
			Horizontal	Vertical	Horizontal	Vertical
Yucca Mountain (W29) whole waveform	11	83	0.85	0.9	0.55	0.50
Yucca Mountain (W29) S wave	3	83	0.73	0.77	0.55	0.56
Little Skull Mountain[1]	Aftershock	100	0.65	0.5	0.45	0.65
	SE Utah	100	0.65	1.0	0.22	0.43
Tomioka	15	100			0.54	
Iwaki	15	130			0.80	
Garner Valley[1]	Joshua Tree Eqk[3]	200	0.63		0.57	
Iwaki	15	200			0.86	
Tomioka	15	250			0.27	
Iwaki	15	330			0.67	
Yucca Mountain (W12/30,25,28) whole waveform	35	~360	0.5	0.75	0.45	0.42
Yucca Mountain (W12/30,25,28) S wave	9	~360	0.37	0.52	0.38	0.53

[1] Peak Ground Velocity or response spectral velocity at 5% damping at 1 Hz
[2] Peak Ground Acceleration
[3] similar reduction in Fourier amplitude spectra for 17 events

Table 3.1.1.2.4.4-1. Fault Parameters for Significant Seismic Sources at the Yucca Mountain Site [INN 3.1.1.2.4.4-1]

Table 3.1.1.2.7.1.1-1. Thermomechanical Stratigraphy

Description	Unit Name (designator)
Alluvium; colluvium; nonwelded, vitric ashflow tuff of the Tiva Canyon member of the Paintbrush tuff; any other geologic material that overlies the welded devitrified Tiva Canyon member.	Undifferentiated Overburden (UO)
Moderately to densely welded, devitrified ashflow tuff of the Tiva Canyon member of the Paintbrush tuff	Tiva Canyon welded unit (TCw)
Partially welded to nonwelded, vitric and occasionally devitrified tuffs of the lower Tiva Canyon and the Yucca Mountain, the Pah Canyon and the upper Topopah Spring member of the Paintbrush tuff	Upper Paintbrush non-welded Unit (PTn)
Moderately to densely welded, devitrified ashflows of the Topopah Spring member of the Paintbrush tuff that locally contain more than 10% by volume lithophysal cavities.	Topopah Spring welded unit, lithophysae-rich (TSw1)
Moderately to densely welded, devitrified ashflows of the Topopah Spring member of the Paintbrush tuff that locally contain less than 10% by volume lithophysal cavities.	Topopah Spring welded unit lithophysae-poor (TSw2)
Vitrophyre near the base of the Topopah Spring member of the Paintbrush tuff	Topopah Spring welded unit, vitrophyre (TSw3)
Nonwelded ashflows, bedded and reworked tuffs of the lower Topopah Spring member of the Paintbrush tuff	Topopah Spring non-welded unit (TSn)
Nonwelded tuffaceous beds of Calico Hills	Calico Hills non-welded unit (CHn1)
Basal bedded and reworked zones of the tuffaceous beds of Calico Hills	Lower Calico Hills non-welded unit (CHn2)
Upper partially welded to non-welded ashflows of the Prow Pass member of the Crater Flat tuff	Prow Pass non-welded unit (PPn)
Moderately welded, devitrified ashflows of the Prow Pass member of the Crater Flat tuff	Prow Pass welded unit (PPw)
Zeolitic nonwelded to partially welded ashflows and bedded, reworked portions of the lower Prow Pass member of the Crater Flat tuff	Prow Pass non-welded unit (lower) (PPn2)
Moderately to densely welded, devitrified ashflows of the Bullfrog member of the Crater Flat tuff	Bullfrog welded unit (BFw)
Zeolitic partially welded to non-welded ashflows of the lower Bullfrog member of the Crater Flat tuff	Bullfrog non-welded unit (BFn1)

Table 3.1.1.2.7.1.1-1. Thermomechanical Stratigraphy (Continued)

Description	Unit Name (designator)
Zeolitic basal bedded, reworked portion of the Bullfrog member of the Crater Flat tuff	Bullfrog non-welded unit (BFn2)
Zeolitic, partially welded ashflows of the upper portion of the Tram member of the Crater Flat tuff	Tram non-welded unit (TRn)
Moderately welded, devitrified ashflows of the Tram member of the Crater Flat tuff	Tram welded unit (TRw)

Table 3.1.1.2.7.3.1-1. Unconfined Compressive Test Results

Rock Unit	Source of Sample/ Hole Number	Unconfined Compressive Strength(MPa)*	Young's Modulus(GPa)*	Poisson's Ratio*
TCw	No Data	No Data	No Data	No Data
PTn	No Data	No Data	No Data	No Data
TSw1 (lithophysae-poor)	All Holes	142.9± 55.1(11)	19.0 ± 5.2 (3)	0.14 ± 0.0(2)
	USW G-2	171.7± 29.1(8)	NA**	NA**
	USW G-3	65.9 ± 2.9 (3)	19.0 ± 5.2 (3)	0.14 ± 0.0 (2)
TSw1 (litho-physae-rich)##	Busted Butte Outcrop	16.2 ± 5.0 (10)	15.5 ± 3.2 (10)	0.16 ± 0.03(10)
TSw2	All Holes	164.7± 64.0(45)	32.1 ± 3.5 (22)	0.23 ± 0.06(16)
	USW G-1	96.0± 36.6 (4)	29.9 ± 5.2 (4)	0.21 ± 0.05 (4)
	USW G-2	120.3 ± 44(10)	NA**	NA**
	USW G-3	184.9± 51.0(11)	32.4± 2.6 (11)	0.21± 0.03 (11)
	USW G-4	189.5± 63.0(20)	36.3 ± 3.2 (6)	0.27 ± 0.07 (6)
TSw3	USW G-4	68.4 ± 28.6 (4)	NA**	NA**
CHn1v	USW G-3	91.6±1.2 (2)	16.3±0.5(2)	0.18±0.005(2)
CHn1z	All Holes	22.9±8.0(27)	6.2±1.6 (17)	0.26±0.07(8)
	USW G-1	23.7 ± 6.1(18)	6.2 ±1.6 (17)	0.25± 0.07(8)
	USW G-2	31.6 ± 6.7 (4)	NA**	NA**
	USW G-4	12.9 ± 4.8 (5)	NA**	NA**
CHn2z	USW G-1	27.8 ± 14.7(4)	5.3 ± 3.4(4)	0.33 ± 0.05(4)

\# Data derived from unconfined compressive tests performed on artificially saturated samples. Testing artificially saturated samples results in underestimation of the compressive strength.

* The format used in this table to report measured values of a parameter is Mean ± Standard Deviation (Number of tests)

** NA stands for "not available".

Data from Price et al. (1985), SAND84-0860

Table 3.1.1.2.7.3.2-1. Unconfined Compressive Test on Saturated Samples of Various Sizes of Topopah Spring Tuff from Outcrops at Busted Butte

Sample Dia. (mm)	Mean Comp. Strength (MPa)	Standard Deviation	Number of Tests
25.4	193.8	61.8	6
50.8	140.8	35.4	6
82.6	119.6	31.7	9
127.0	97.7	30.6	11
228.6	90.1	4.6	2

Table 3.1.1.2.7.3.2-2. Compressive Test Results of Saturated and Oven Dry Samples

Strain Rate	Moisture Content	Number of Tests	Compressive Strength± Std. Dev. (Percent) MPa	Young's Modulus± Std. Dev. (Percent) GPa
10^{-2}/second	Oven dry	3	180± 7.5 (4.2%)	27.7± 1.5 (5.4%)
10^{-2}/second	Saturated	3	125± 15 (12.1%)	24.2± 1.7 (7.0%)
10^{-4}/second	Oven dry	3	158± 2.8 (1.6%)	27.4± 1.2 (4.4%)
10^{-4}/second	Saturated	3	112± 10 (8.9%)	24.7± 0.7 (2.8%)
10^{-6}/second	Oven dry	3	137± 3.7 (2.8%)	28.4± 1.1 (3.9%)
10^{-6}/secon	Saturated	3	94.3± 14.6 (15.5%)	26.0± 0.7 (2.7%)

Table 3.1.1.2.7.3.2-3. Effects of Changes in Strain Rate on Rock Properties for Yucca Mountain Tuffs[a, b]

Unit	USW G-1 depth (m)	USW G-4 depth (m)	Strain rate (s^{-1})	Strength (mpa)	Axial strain to failure (%)	Young's modulus (GPa)	Poisson's ratio	Reference[c]
TSw2	372.5	--[d]	10^{-2}	157.2	0.48	29.2	0.31	P
TSw2	384.8	--	10^{-2}	149.7	0.49	36.6	--[d]	P
TSw2	372.5	--	10^{-4}	133.8	0.57	27.7	--	P
TSw2	373.0	--	10^{-4}	157.2	0.46	37.5	0.25	P
TSw2	371.3	--	10^{-6}	176.6	0.51	40.8	0.25	P
TSw2	373.0	--	10^{-6}	156.6	0.47	35.3	0.21	P
TSw2	390.0	--	10^{-6}	44.9	0.41	22.9	0.27	P
TSw2	--[d]	226.4	10^{-3}	319	0.95	37.4	0.29	N1
TSw2	--	226.4	10^{-3}	283	0.94	34.0	0.28	N1
TSw2	--	226.4	10^{-3}	280	0.89	38.4	0.25	N1
TSw2	--	226.4	10^{-5}	235	0.72	35.6	0.21	N1
TSw2	--	226.4	10^{-5}	256	0.83	36.8	0.21	N1
TSw2	--	226.4	10^{-5}	279	0.93	34.6	0.21	N1
TSw2	--	226.4	10^{-7}	243	0.69	37.5	0.20	N1
TSw2	--	226.4	10^{-7}	230	0.75	33.6	0.11	N1
TSw2	--	305.5	10^{-5}	179	0.56	33.6	0.32	N1
TSw2	--	305.5	10^{-5}	137	0.45	33.1	--[e]	N1
TSw2	--	305.5	10^{-7}	123	0.44	22.0	0.11	N1

Table 3.1.1.2.7.3.2-3. Effects of Changes in Strain Rate on Rock Properties for Yucca Mountain Tuffs[a, b] (Continued)

Unit	USW G-1 depth (m)	USW G-4 depth (m)	Strain rate (s^{-1})	Strength (mpa)	Axial strain to failure (%)	Young's modulus (GPa)	Poisson's ratio	Reference[c]
TSw2	--	305.5	10^{-7}	138	0.45	32.8	0.20	N1
TSw2[f]	--	--	10^{-5}	167	0.46	42.0	0.30	N2
TSw2[f]	--	--	10^{-5}	157	0.33	49.0	0.26	N2
TSw2[f]	--	--	10^{-7}	115	0.30	41.9	0.26	N2
TSw2[f]	--	--	10^{-7}	117	0.32	42.1	0.26	N2
CHnlz	508.4	--	10^{3}	24.7	0.61	5.41	0.33	PJ
CHnlz	508.4	--	10^{-3}	23.4	0.58	5.45	--[e]	PJ
CHnlz	508.4	--	10^{-5}	25.4	0.57	6.15	0.36	PJ
CHnlz	508.4	--	10^{-5}	16.7	0.43	4.92	0.18	PJ
CHnlz	508.4	--	10^{-7}	21.5	0.55	7.86	0.21	PJ
CHnlz	508.4	--	10^{-7}	19.9	0.51	7.03	0.22	PJ

[a]Data from unconfined, ambient temperature, constant-strain-rate tests on saturated samples allowed to drain during testing.
[b]Unit identifications, thickenesses and relation to formal stratigraphy are shown in Figure 3.1.1.2.7.1.1-1
[c]References: P = Price et al. (1982b); PJ = Price and Jones (1982); N1 = Nimick et al. (1985); N2 = Nimick and Schwartz (1987).
[d]The symbol "--" in this column indicates that the column is not relevant to the row in which the dashes appear
[e]Data not available
[f]Samples from drill hole USW G-2, 298.1 m depth 1

Table 3.1.1.2.7.3.3-1. Tensile Strength of Yucca Mountain Tuff

Rock Unit	Average Tensile Strength by Brazilian Method (MPa)	Standard Deviation (MPa)	Number of Tests	Average Porosity of samples (percent)
Topopah Spring Welded Unit	19.1	5.5	5	10.0
	18.8	3.0	5	10.0
	20.5	3.7	5	9.0
	25.9	2.4	5	10.0
	17.7	5.2	5	11.0
	7.6	0.1	3	25.0
	23.7	3.3	3	12.0
	11.4	2.8	4	9.0
Topopah Spring Vitrophyre	8.6	1.8	4	1.7
Calico Hills Unit	5.3	0.8	5	29.0
	5.9	0.9	5	26.0
	5.6	1.0	5	25.0
	5.8	0.8	5	20.0
	6.2	1.1	5	26.0
	5.4	0.4	5	26.0
	5.1	1.0	5	30.0
Bullfrog Unit	2.2	0.2	10	26.9
	2.4	0.2	5	26.1
Tram Unit	3.7	0.4	5	28.3
	12.2	3.0	4	16.1
	9.5	1.2	5	17.7

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.1.2.7.3.4-1. Summary of Coulomb Failure Criteria Parameters[a]

Thermal mechanical unit[b]	Depth (m) USW G4	Depth (m) USW G1	Depth (m) UE-25a#1q	Effective pressure (MPA)	Temp. (° C)	Strain rate (S^{-1})	Saturation (S,R)[c]	Drained Condition (Y,N)[d]	Cohesion (MPa)	Angle of internal friction (°)	Correlation coefficient
TCw	--[e]	--	26.7	0,10,20	23	10^{-4}	R	N	28.1	68.0	0.89
TSw2	--	--	381.0	0,10,20	23	10^{-4}	R	N	17.5	66.7	0.999
TS[c]	--	--	--	10,20,30,50	23	10^{-4}	S	N	92.0	29.1	0.47
TS[c]	--	--	--	10,20,30,40	23	10^{-6}	S	N	48.9	45.6	0.70
TSw2	209.3	--	--	0,5,10	23	10^{-5}	S	Y	37.1	51.8	0.31
TSw2	294.2	--	--	0,10	23	10^{-5}	S	Y	47.4	27.2	0.16
CHnlz	426.9	--	--	0,5,10	23	10^{-5}	S	Y	6.6	15.9	0.45
CHnlz	--	453.4	--	0,10,20	23	10^{-5}	S	Y	10.2	11.1	0.04
CHnlz	--	453.4	--	0,10,20	23	10^{-5}	S	N	10.6	7.8	0.62
CHnlz	--	507.6	--	0,10	23	10^{-5}	R	N	10.2	32.2	0.96
CHnlz	--	507.6	--	0,10,20	23	10^{-5}	S	N	13.2	6.8	0.55
CHnlz	--	508.4	--	0,10	23	10^{-5}	S	N	9.7	4.8	0.21
BFw	--	759	--	5,12.5,20.7	200	10^{-4}	S	Y	23.6	19.6	0.93
BFw	--	759	--	5,10,20.7	200	10^{-4}	R	Y	16.5	37.7	0.89
BF	--	--	--	10,30,40,50	23	10^{-4}	S	N	22.7	42.1	0.93
BF	--	--	--	10,20,30,40, 50	23	10^{-6}	S	N	15.2	44.3	0.98

[a]Olsson and Jones (1980); Olsson (1982); Price and Jones (1982); Price (1983); Morrow and Byerlee (1984); Nimick et al, (1985).
[b]Unit identifications, thicknesses, and relation to the formal stratigraphy are shown in Figure 3.1.1.2.7.2.1-1.
[c] Saturation: R - room dried (unknown degree of saturation) and S -= fully saturated
[d]Drained condition: N = undrained and Y = drained
[e]Data not available

Table 3.1.1.2.7.5-1. Fracture Orientations as Estimated from Oriented Core and Borehole Television Surveys

Geologic Member	USW GU-3		USW G-4	
	Strike	Dip	Strike	Dip
Tiva Canyon Member	N-N30°W	85°-90°SW/NE	N-N22°E	65°-90°NW
	N50°W	12°NE	---	---
	N18°W-36°E	*NM*	E-W	70°-90°N/S
	---	---	N50°W	70°-90°NE/SW
Topopah Spring Member	N10°W	75°-90°NE/SW	N°12W	80°-90°NE/SW
	N25°E	10°SE	---	---
	N45°E	80°-90°SE/NW	N-N40°E	NM

NM = Not measured by borehole television system.
--- = No corresponding joint was observed.

Table 3.1.1.2.7.5-2. Thickness, Numbers of Fractures, and Linear Fracture, and Linear Fracture Frequencies in Tuff Units

Thermomechanical Units		USW G-1	USW G-4	USW GU-3	UE-25a#1
TCw	Interval (m)	NA	9.1-36.0	12.2-104.5	9.1-59.4
	Thickness (m)	NA	26.8	92.4	50.3
	Fractures	NA	207	349	138
	Frequency (m^{-1})	NA	7.7	3.8	2.7
PTn	Interval (m)	18.3-85.3	36.0-74.1	104.5-131.1	59.4-84.4
	Thickness (m)	67.1	38.0	26.5	25
	Fractures	NA	38	41	10
	Frequency (m^{-1})	NA	1.0	1.5	0.4
TSw1	Interval (m)	85.3-217.9	74.1-204.2	131.1-210.3	84.4-189.0
	Thickness (m)	189.9	130.1	79.2	104.5
	Fractures	790	561	105	46
	Frequency (m^{-1})	4.2	4.3	1.3	0.4
TSw2	Interval (m)	217.9-392.3	204.2-394.1	210.3-361.8	189.0-384.7
	Thickness (m)	174.3	189.9	151.5	195.7
	Fractures	152	790	860	339
	Frequency (m^{-1})	0.9	4.2	5.7	1.7
TSw3	Interval (m)	392.3-409.0	394.1-410.0	361.8-386.8	384.7-401.4
	Thickness (m)	16.8	15.8	25	16.8
	Fractures	42	53	43	33
	Frequency (m^{-1})	2.5	3.4	1.7	2.0
CHn1	Interval (m)	409.0-529.1	410.0-519.7	386.8-459.3	401.4-545.3
	Thickness (m)	120.1	109.7	72.5	143.9
	Fractures	12	25	35	28
	Frequency (m^{-1})	0.1	0.2	0.5	0.2

NA = Data not available.

Table 3.1.2.1.1-1. Approximate Areas of the Eight Hydrographic Areas in the Hydrographic Study Area

Area Number on Figure 3.1.2.1.1-1	Hydrographic Area	State[a, b]	Approximate Area (mi^2)	Approximate Area (km^2)
1	Death Valley and Lower Amargosa	NV CA	344 5,019	891 13,000
2	Amargosa Desert and Upper Amargosa Area	NV CA	896 1,122	2,321 2,906
3	Crater Flat	NV	182	471
4	Fortymile Canyon, Jackass Flats	NV	279	723
5	Fortymile Canyon, Buckboard Mesa	NV	240	622
6	Mercury Valley	NV	110	285
7	Oasis Valley	NV	460	1,191
8	Rock Valley	NV	82	212

[a]Data for Nevada from Rush (pg. 27, 1968)
[b]Data for California from U.S. Geological Survey (1978)

Table 3.1.2.1.1-2. Summary of Peak Streamflow Data for Selected Crest-Stage Sites in Hydrographic Study Area and Adjacent Areas[a]

Site Number	Station Number	Station Name	Drainage Area (mi^2)	Drainage Area (km^2)	Period of Record	Peak Discharge (m^3/s)	Date of Peak Discharge	Discharge per unit area $(m^3/s)/km^2$
1	10247860	Penoyer Valley tributary near Tempiute, Nevada	1.48	3.83	1964-80	3.68	1968	0.96
2	10248490	Indian Springs Valley tributary near Indian Springs, Nevada	29.0	75.1	1964-80	14.1	1972	0.19
3	10251270	Amargosa River Tributary near Mercury, Nevada	110.0	284.9	1963-80	97.1	1968	0.34
4	10251271	Amargosa River tributary No. 1 near Johnnie, Nevada	2.21	5.72	1967-80	9.9	1970	1.73
5	10251272	Amargosa River tributary No. 2 near Johnnie, Nevada	2.49	6.45	1968-80	3.54	1968	0.55
6	10251220	Amargosa River near Beatty, Nevada	470.0	1217.0	1964-79	453.0	1969	0.37

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.2.1.1-2. Summary of Peak Streamflow Data for Selected Crest-Stage Sites in Hydrographic Study Area and Adjacent Areas[a] (Continued)

Site Number	Station Number	Station Name	Drainage Area (mi^2)	Drainage Area (km^2)	Period of Record	Peak Discharge (m^3/s)	Date of Peak Discharge	Discharge per unit area $(m^3/s)/km^2$
7	10249050	Sarcobatus Flat tributary near Springdale, Nevada	37.1	96.1	1961-80	1.78	1980	0.02
8	10249850	Palmetto Wash tributary near Lida, Nevada	4.73	12.25	1967-80	5.46	1969	0.45
9	10248970	Stonewall Flat tributary near Goldfield, Nevada	0.53	1.37	1964-79	4.25	1969	3.10
10	10249680	Big Smoky Valley tributary near Blair Junction, Nevada	11.4	29.5	1961-79	4.81	1976	0.16
11	10249135	San Antonio Wash tributary near Tonopah, Nevada	3.42	8.86	1965-80	18.7	1972	2.10
12	10249180	Salsbury Wash, Tonopah, Nevada	56.0	145.0	1962-80	9.62	1969	0.07

[a] Source: Squires and Young, (pg. 15, 1984) and Waddell et al. (pp. 8-13, 1984).

Table 3.1.2.1.1-3. Springs, Seeps, and Phreatophyte Areas in the Hydrogeologic Study Area

Latitude/Longitude	Township, range & spring location #	Name[a]	Aquifer[b]	Discharge (gpm)	Use	Reference[c]	Comments
		Alkali Flat-Furnace Creek Ranch Subbasin (California)					
36 26 40/116 49 50	27N/01E-23R1	Travertine		305	ND	T&R, 71 P&K, 64	
36 26 30/116 49 40	27N/01E-26A2	Travertine		220	Irrigation	T&R, 71 P&K, 64	
36 26 30/116 49 50	27N/01E-26AS5	Travertine		ND[d]	Irrigation	T&R, 71 P&K, 64	
36 26 30/116 49 50	27N/01E-26A6	Travertine		270	Irrigation	T&R, 71 P&K, 64	
36 26 30/116 49 50	27N/01E-26A7	Travertine		ND	Irrigation	T&R, 71 P&K, 64	
36 26 30/116 49 40	27N/01E-26A1	Travertine		103	Irrigation	T&R, 71 P&K, 64	
36 26 30/116 49 40	27N/01E-25D2	Travertine		ND	Irrigation	T&R, 71 P&K, 64	Seep
36 26 30/116 49 40	27N/01E-25D1	Travertine		ND	Irrigation	T&R, 71 P&K, 64	
36 26 30/116 49 50	27N-01E-26A3	Travertine		0.4	Irrigation	T&R, 71 P&K, 64	
36 26 30/116 49 50	27N/01E-26A4	Travertine		4	Irrigation	T&R, 71 P&K, 64	
36 30 30/116 49 10	28N/01E-36K1	Nevares		ND	Domestic Public Supp.	M, 77 P&K, 64	Seep
36 30 30/116 49 40	28N/01E-36M2	Nevares		ND	Domestic Public Supp.	M, 77 P&K, 64	
36 30 30/116 49 40	28N/01E-36M1	Nevares		31	Domestic Public Supp.	M, 77 P&K, 64	

Table 3.1.2.1.1-3. Springs, Seeps, and Phreatophyte Areas in the Hydrogeologic Study Area (Continued)

Latitude/Longitude	Township, range & spring location #	Name[a]	Aquifer[b]	Discharge (gpm)	Use	Reference[c]	Comments
36 30 40/116 49 10	28N/01E-36G2	Nevares		22	Domestic Public Supp.	M, 77 P&K, 64	
ND/ND	28N/01E-36FS1			40	ND	M, 77 p.59	
36 30 40/116 49 10	28N/01E-36GS1	Nevares		269	Domestic Public Supp.	M, 77 P&K, 64	
36 29 40/116 51 20	27N/01E-03P1	Salt		4	Unused	P&K, 64	
36 29 40/116 51 20	27N/01E-03K1	Salt		ND	NA[e]	P&K, 64	
36 27 10/116 51 00	27N/01E-22H1	Furnace Creek Inn Tunnel		148	Irrigation	P&K, 64	
36 26 30/116 49 40	27N/01E-26B1	South Travertine (Sump in Furnace Creek Wash)		566	Irrigation	M, 77 P&K, 64	
36 26 30/116 49 40	27N/01E-26B2	Buried tile in Furnace Creek Wash		200	Irrigation	P&K, 64	
36 26 40/116 49 50	27N/01E-23B1	Texas Spring (Tunnel)		224	Irrigation and Public Supply	P&K, 64	
	27N/01E-14N1			NA	NA	P&K, 64	Phreatophyte
	27N/01E-14P1			NA	NA	P&K, 64	Phreatophyte
	27N/01E-14Q1			NA	NA	P&K, 64	Phreatophyte
	27N/01E-23B2			NA	NA	P&K, 64	Phreatophyte
	27N/01E-23B3			NA	NA	P&K, 64	Phreatophyte
	27N/01E-23B4			NA	NA	P&K, 64	Phreatophyte
36 27 10/116 50 20	27N/01E-23F1			4	ND	P&K, 64	Phreatophyte

Table 3.1.2.1.1-3. Springs, Seeps, and Phreatophyte Areas in the Hydrogeologic Study Area (Continued)

Latitude/Longitude	Township, range & spring location #	Name[a]	Aquifer[b]	Discharge (gpm)	Use	Reference[c]	Comments
	27N/01E-23G1			NA	NA	P&K, 64	Phreatophyte
	27N/01E-23G2			NA	NA	P&K, 64	Phreatophyte
	27N/01E-23J1			NA	NA	P&K, 64	Phreatophyte
	27N/01E-23J2			NA	NA	P&K, 64	Phreatophyte
36 27 00/116 50 10	27N/01E-23K1			NA	NA	P&K, 64	Seep
36 27 00/116 50 10	27N/01E-23K2			4	ND	P&K, 64	
36 27 00/116 50 20	27N/01E-23L1			NA	NA	P&K, 64	Seep
36 27 00/116 50 20	27N/01E-23L2			NA	NA	P&K, 64	Phreatophyte
36 27 00/116 50 20	27N/01E-23L3			NA	NA	P&K, 64	Seep
36 26 40/116 50 10	27N/01E-23Q1			NA	NA	P&K, 64	Seep
36 26 40/116 50 10	27N/01E-23Q2			NA	NA	P&K, 64	Seep
36 26 40/116 50 10	27N/01E-23Q3			4	ND	P&K, 64	
36 26 40/116 50 10	27N/01E-23Q4			NA	NA	P&K, 64	Seep
36 26 40/116 50 10	27N/01E-23Q5			NA	NA	P&K, 64	Seep
36 26 40/116 50 10	27N/01E-23Q6			NA	NA	P&K, 64	Seep
36 26 40/116 49 50	27N/01E-23R2			NA	NA	P&K, 64	Phreatophyte
36 26 40/116 49 50	27N/01E-23R3			NA	NA	P&K, 64	Phreatophyte
36 26 40/116 49 40	27N/01E-24N1			NA	NA	P&K, 64	Seep
36 26 30/116 50 10	27N/01E-26B4			NA	NA	P&K, 64	Seep
36 26 30/116 50 10	27N/01E-26B5			NA	NA	P&K, 64	Seep

Table 3.1.2.1.1-3. Springs, Seeps, and Phreatophyte Areas in the Hydrogeologic Study Area (Continued)

Latitude/Longitude	Township, range & spring location #	Name[a]	Aquifer[b]	Discharge (gpm)	Use	Reference[c]	Comments
36 30 00/116 51 00	27N/01E-3A1	Cow		18	Unused	P&K, 64	
	27N/01E-3B1			NA	NA	P&K, 64	Phreatophyte
	27N/01E-34M1			NA	NA	P&K, 64	Phreatophyte
36 30 10/116 51 50	28N/01E-34N1			NA	NA	P&K, 64	Seep
36 30 10/116 51 50	28N/01E-34N2			NA	NA	P&K, 64	Phreatophyte
	28N/01E-34P1			NA	NA	P&K, 64	Phreatophyte
	28N/01E-35E1			NA	NA	P&K, 64	Phreatophyte
	28N/01E-35G1			NA	NA	P&K, 64	Phreatophyte
36 30 30/116 50 20	28n/01E-35k1			NA	Unused	P&K, 64	Seep
	28N/01E-35n1			4	NA	P&K, 64	
	25N/02E-13GS1	Lemonade	Volcanic Rock	<1	ND	USGS Map Death Valley M, 77	
	26N/02E-13FS1	Navel	Fanglomerate	ND	ND	USGS Map Death Valley M, 77	
36°39'/ 116°51'	29N/01E-15			ND	ND	USGS Map Death Valley M, 77	
36°37' /116°48'	29N/02E-30			ND	ND	USGS Map Death Valley M, 77	
			Alkali Flat-Furnace Creek Ranch Subbasin (Nevada)				
36 25 40/116 24 50	17S/49E-35d1	Ash Tree	ND	9	ND	T&R, 71 W&T, 75	
36 48 07/116 05 13	ND	Cane	Tertiary igneous	2	Unused	T&R, 71 W&T, 75	Perched

Table 3.1.2.1.1-3. Springs, Seeps, and Phreatophyte Areas in the Hydrogeologic Study Area (Continued)

Latitude/Longitude	Township, range & spring location #	Name[a]	Aquifer[b]	Discharge (gpm)	Use	Reference[c]	Comments
36 53 00/115 45 00	12S/47E-20bb1		ND	ND	Irrigation	T&R, 71	
36 53 10/116 45 00	12S/47E-20bbb		ND	100	Irrigation	T&R, 71	
36 56 21/116 16 14	ND	Topopah	Tertiary igneous	0.1	Unused	T&R, 71	Perched
37 02 36/116 12 26	ND	Tippipah	Tertiary igneous	8	Unused	T&R, 71	Perched
37 11 22/116 11 43	ND	Rainier	Tertiary igneous	0.1	Unused	T&R, 71	
37 26 30/116 06 00	06S/52E-10ad	Indian	Tertiary-Quaternary alluvium	2	Unused	T&R, 71	
37 30 40/116 05 20	05S/52E-14db	Cliff	Tertiary igneous	0.4	Unused	T&R, 71	
37 37 00/116 20 00	04S/50E-01dd		Tertiary igneous	0.1	Unused	T&R, 71	
36 45 30/115 15	ND	Pavits	Tertiary igneous	ND	ND	T&R, 71	Perched
36 18 50/116 18 40	19S/50E-02	Grapevine	ND	ND	ND	T&R, 71 W&T,75	
36 52 50/116 39 40	12S/48E-30	Specie	ND	ND	ND	USGS Map Death Valley	
			Oasis Valley Subbasin				
36 55 10/116 44 40	12S/47E-05cda	Beatty	Tertiary volcanic	100	Public Use	T&R, 71 W, 79	Not used
36 56 30/116 43 40	11S/47E-33bac		ND	25	Domestic	T&R, 71	

Table 3.1.2.1.1-3. Springs, Seeps, and Phreatophyte Areas in the Hydrogeologic Study Area (Continued)

Latitude/Longitude	Township, range & spring location #	Name[a]	Aquifer[b]	Discharge (gpm)	Use	Reference[c]	Comments
36 56 40/116 47 40	11S/46E-26dcc	Lower Indian	Tertiary igneous	8	Stock	T&R, 71 M&E, 62	Perched
36 57 00/116 47 50	11S/46E-26ca-1	Middle Indian	Tertiary igneous	ND	Municipal	T&R, 71 M&E, 62	Perched
36 57 10/116 48 20	11S/46E-26cbb-1	Upper Indian	Tertiary igneous	5	Municipal	T&R, 71 M&E, 62	Perched
36 57 00/116 43 00	11S/47E-28dac-1		Tertiary-Quaternary alluvium	35	Irrigation	T&R, 71	
36 57 30/116 43 10	11S/47E-28aa-2	Ute	Quaternary alluvium	25	Irrigation	T&R, 71 W, 79	
36 57 50/116 43 20	11S/47E-21dbb-2		Tertiary-Quaternary alluvium	37	Domestic	T&R, 71	
36 58 20/116 43 10	11S/47E-21aba-2	(Hicks?) (Bailey?)	Tertiary alluvium	ND	Public	T&R, 71	
36 58 30/116 43 20	11S/47E-16dcd-2	Burro Hot	Tertiary igneous	5	Public	T&R, 71 M&E, 62	
36 58 30/116 43 20	11S/47E-16dcd-1	Burro Hot	Tertiary igneous	ND	Domestic	T&R, 71	
36 59 10/116 45 30	11S/47E-18acb	Crystal	Tertiary igneous	2	Domestic	T&R, 71 M&E, 62	
36 59 30/116 42 50	11S/47E-10ccb		Tertiary-Quaternary alluvium	ND	Stock	T&R, 71	
36 59 30/116 42 50	11S/47E-10ccb		Tertiary igneous	ND	Domestic	T&R, 71	

Table 3.1.2.1.1-3. Springs, Seeps, and Phreatophyte Areas in the Hydrogeologic Study Area (Continued)

Latitude/Longitude	Township, range & spring location #	Name[a]	Aquifer[b]	Discharge (gpm)	Use	Reference[c]	Comments
36 59 40/116 42 30	11S/47E-10bdd		Tertiary igneous	49	Irrigation	T&R, 71	
37 00 00/116 42 20	11S/47E-10ab-1	Goss	Tertiary igneous	50	Irrigation	T&R, 71	
37 00 20/116 42 30	11S/47E-03cdb-1		Tertiary igneous	40	Irrigation	T&R, 71	
37 00 30/116 42 30	11S/47E-04cad		Tertiary-Quaternary alluvium	10	Irrigation	T&R, 71	
37 00 50/116 43 50	11S/47E-04bb-1		ND	7	Domestic	T&R, 71	
37 01 40/117 43 20	10S/47E-33abc		Tertiary igneous	255	Irrigation	T&R, 71	
37 01 50/116 45 10	10S/47E-31aab-1		Tertiary-Quaternary alluvium	11	Irrigation	T&R, 71	
37 02 00/116 45 20	10S/47E-30d-1		ND	25	Domestic	T&R, 71	
37 04 30/116 41 30	10S/47E-14bab		Tertiary-Quaternary alluvium	100	Irrigation	T&R, 71	
37 37 10/116 43 40	04S/47E-04ca	Antelope	Tertiary alluvium	0.4	Unused	T&R, 71	
36 59 40/116 51 20	11S/46E-08bdc	Mud	Tertiary-Quaternary alluvium	ND	Stock	T&R, 71	
	12S/47E-20bb1		ND	ND	Irrigation domestic	M&E, 62	

Table 3.1.2.1.1-3. Springs, Seeps, and Phreatophyte Areas in the Hydrogeologic Study Area (Continued)

Latitude/Longitude	Township, range & spring location #	Name[a]	Aquifer[b]	Discharge (gpm)	Use	Reference[c]	Comments
	11S/47E-7dcl		ND	ND	ND	M&E, 62	
	10S/47E-30dl		ND	25	Domestic, stock	M&E, 62	
	10S/47E-32dda		Quaternary	225	ND	W, 79	
			Ash Meadows Subbasin				
36 26 00/116 18 30	17S/50E-35al		Lower carbonate aquifer	140	ND	T&R, 71 W&T, 75	Ash Meadows
36 26 10/116 18 50	17S/50E-35b1		Lower carbonate aquifer	17	ND	T&R, 71 W&T, 75	Ash Meadows
36 27 50/116 19 00	17S/50E-23b1	(Five Springs area?)	Lower carbonate aquifer	193	ND	T&R, 71 W&T, 75 D&L, 76	Ash Meadows
36 28 00/116 19 30	17S/50E-22a1	Longstreet	Lower carbonate aquifer	1,042	ND	T&R, 71 W&T, 75	Ash Meadows
36 28 50/116 19 30	17S/50E-15a1	Rogers	Lower carbonate aquifer	736	ND	T&R, 71 W&T, 75	Ash Meadows
36 29 20/116 20 10	17S/50E-10cl	Bell(Soda)	Lower carbonate aquifer	79	ND	T&R, 71 W&T, 75	Ash Meadows
36 29 20/116 20 30	17S/50E-09a1	Fairbanks	Lower carbonate aquifer	1,715	ND	T&R, 71 W&T, 75	Ash Meadows

Table 3.1.2.1.1-3. Springs, Seeps, and Phreatophyte Areas in the Hydrogeologic Study Area (Continued)

Latitude/Longitude	Township, range & spring location #	Name[a]	Aquifer[b]	Discharge (gpm)	Use	Reference[c]	Comments
	17S/50E-22ac	McGillivary	Lower carbonate aquifer	See comments	ND	D&L, 76	Ash Meadows flow reported in 1986 at 155 gpm; no flow in 1971, water level 5 ft. below outlet
	17S/50E-35acc	Scruggs	Lower carbonate aquifer	60	ND	D&L, 76	Ash Meadows
	17S/50E-35d1	School	Lower carbonate aquifer	6	ND	D&L, 76	Ash Meadows
	18S/50E-01ca	Collins	Lower carbonate aquifer	10	ND	D&L, 76	Ash Meadows
	18S/50E-12dc	Sink	Lower carbonate aquifer	See comments	ND	D&L, 76	Ash Meadows flow observed at 25 gpm in 1966, no flow observed in 1971
ND/ND	17S/50E-21ac	Cold	Lower carbonate aquifer	73	ND	D&L, 76	Ash Meadows
36 25 10/116 19 20	18S/50E-03a	Crystal Pool	Lower carbonate aquifer	2,820	ND	W&T, 75 T&R, 71	Ash Meadows
36 24 50/115 44 20	18S/55E-01d	Cold Creek	Tertiary-Quaternary alluvium	690	Domestic	T&R, 71	

Table 3.1.2.1.1-3. Springs, Seeps, and Phreatophyte Areas in the Hydrogeologic Study Area (Continued)

Latitude/Longitude	Township, range & spring location #	Name[a]	Aquifer[b]	Discharge (gpm)	Use	Reference[c]	Comments
36 25 00/115 45 50	18S/55E-02a	Willow	Tertiary-Quaternary alluvium	340	ND	T&R, 71	
36 26 40/115 55 40	17S/54E-29d	Big Timber	Cambrian sedimentary	ND	ND	T&R, 71	
36 18 30/115 41 10	19S/56E-10c	Three	Cambrian limestone	21	ND	T&R, 71	Spring Mountains
36 19 10/115 40 40	19S/56E-03c	Scout Canyon	Ordovician limestone	11	ND	T&R, 71	Spirng Mountains
31 21 30/116 16 20	18S/51E-30d	Last Chance	Lower carbonate aquifer	1	ND	T&R, 71 W&T, 75	Ash Meadows
36 21 50/116 15 40	18S/51E-29b		Lower carbonate aquifer	1	ND	T&R, 71 W&T, 75	Ash Meadows
36 21 50/116 16 10	18S/51E-30a1	Bole	Lower carbonate aquifer	12	ND	T&R, 71 W&T, 75	Ash Meadows
36 22 30/116 16 20	18S/51E-19a1	Big (Deep) (Ash Meadows)	Lower carbonate aquifer	1,036	ND	T&R, 71 W&T, 75	Ash Meadows
36 23 20/116 16 40	18S/51E-18b1	Jack Rabbit	Lower carbonate aquifer	587	ND	T&R, 71 W&T, 75	Ash Meadows
36 24 00/116 18 00	18S/50E-12c1		Lower carbonate aquifer	11	ND	T&R, 71 W&T, 75	Ash Meadows

Table 3.1.2.1.1-3. Springs, Seeps, and Phreatophyte Areas in the Hydrogeologic Study Area (Continued)

Latitude/Longitude	Township, range & spring location #	Name[a]	Aquifer[b]	Discharge (gpm)	Use	Reference[c]	Comments
36 24 00/116 18 10	18S/50E-11d3	Davis Ranch (Bradford)	Lower carbonate aquifer	30	ND	T&R, 71 W&T, 75	Ash Meadows
36 24 10/116 18 10	18S/50E-11d2	Davis Ranch (Bradford)	Lower carbonate aquifer	5	ND	T&R, 71 W&T, 75	Ash Meadows
36 24 00/116 18 10	18S/50E-11d1	Davis Ranch (Bradford)	Lower carbonate aquifer	397	ND	T&R, 71 W&T, 75	Ash Meadows
36 24 10/116 16 10	18S/51E-07d1	King Pool (Point of Rock)	Lower carbonate aquifer	1,078	ND	T&R, 71 W&T, 75	Ash Meadows
36 24 10/116 16 10	18S/51E-07d4	(Point of Rock)	Lower carbonate aquifer	19	ND	T&R, 71 W&T, 75	Ash Meadows
36 24 10/116 16 10	18S/51E-07d3	Indian Rock (Point of Rock)	Lower carbonate aquifer	379	ND	T&R, 71 W&T, 75	Ash Meadows
36 24 10/116 16 10	18S/51E-07d2	Indian Rock (Point of Rock)	Lower carbonate aquifer	22	ND	T&R, 71 W&T, 75	Ash Meadows
36 24 10/116 16 20	18S/51E-07d5	(Point of Rock)	Lower carbonate aquifer	2	ND	T&R, 71 W&T, 75	Ash Meadows
36 25 30/116 17 30	17S/50E-36d1	Devil's Hole	Lower carbonate aquifer	See Comments	ND	T&R, 71 W&T, 75 D&L, 76	Ash Meadows No discharge as flow, Cyprinodon diabolis habitat

Table 3.1.2.1.1-3. Springs, Seeps, and Phreatophyte Areas in the Hydrogeologic Study Area (Continued)

Latitude/Longitude	Township, range & spring location #	Name[a]	Aquifer[b]	Discharge (gpm)	Use	Reference[c]	Comments
36 33 40/115 39 50	16S/56E-16b1	Indian	Tertiary-Quaternary alluvium	430	Domestic	T&R, 71	
36 34 30/115 43 40	16S/55E-11a	Cactus	Tertiary-Quaternary alluvium	0.5	Domestic	T&R, 71	
36 59 10/116 45 30	11S/57E	Quartz	ND	ND	ND	T&R, 71	
37 10 09/116 10 07	ND	Captain Jack	Tertiary igneous	0.2	Unused	T&R, 71	Perched
37 12 13/116 07 54	ND	Whiterock	Tertiary igneous	1.0	Unused	T&R, 71	Perched
37 14 23/116 02 30	ND	Tubb	Tertiary igneous	ND	Unused	T&R, 71	Perched
37 14 41/116 04 24	ND	Oak	Tertiary igneous	0.1	Unused	T&R, 71	Perched
37 31 40/115 56 00	05S/54E-08bc	White Blotch	Tertiary igneous	0.2	Unused	T&R, 71	
36 27 50/115 57 40	17S/53E-24a	Gold	Cambrian sedimentary	ND	ND	T&R, 71	
36 29 10/115 58 20	17S/53E-12c	Rock	Cambrian sedimentary	ND	ND	T&R, 71	
36 29 10/115 59 00	17S/53E-11d	Jaybird	Cambrian sedimentary	ND	ND	T&R, 71	
36 38 00/115 12 30	ND	Wiregrass	Ordovician dolomite	0.5	ND	T&R, 71	
36 38 50/115 13 50	ND	Pine	Ordovician dolomite	ND	ND	T&R, 71	

Table 3.1.2.1.1-3. Springs, Seeps, and Phreatophyte Areas in the Hydrogeologic Study Area (Continued)

Latitude/Longitude	Township, range & spring location #	Name[a]	Aquifer[b]	Discharge (gpm)	Use	Reference[c]	Comments
36 39 30/115 13 10	ND	Canyon	Ordovician dolomite	ND	ND	T&R, 71	
36 40 50/115 10 40	ND	Sawmill	Ordovician dolomite	ND	ND	T&R, 71	
36 41 30/115 12 30	ND	Basin	Ordovician dolomite	ND	ND	T&R, 71	
36 42 20/115 00 50	ND	Perkins	Ordovician dolomite	ND	ND	T&R, 71	
36 42 30/115 11 00	ND	Yellow Jacket	Ordovician dolomite	ND	ND	T&R, 71	
36 42 30/115 14 20	ND	Whiterock	Ordovician dolomite	ND	ND	T&R, 71	
36 42 50/115 10 50	ND	Shalecut	Ordovician dolomite	ND	ND	T&R, 71	
36 43 00/115 10 50	ND	Bootleg	Ordovician dolomite	ND	ND	T&R, 71	

[a] Blank means the area is not named.
[b] When the discharging aquifer could be determined, it is listed; otherwise only the lithology is shown. The main source of the ground water discharging in the Furnace Creek Ranch area is believed to be the lower carbonate aquifer (Waddell et. al., page, 1984).
[c] P&K, 64 = Pistrang and Kunkel, 1964; M&E, 62 = Malmberg and Eakin, 1962; T&R, 71 = Thordarson and Robinson, 1971; W&T, 75 = Winograd and Thordarson, 1975; D&L, 76 = Dudley and Larson, 1976; M, 77 = Miller, 1977; W, 79 = White, 1979; W et al., 84 = Waddell et al., 1984; S&M, 64 = Schoff and Moore, 1964.
[d] ND = No data.
[e] NA = Not applicable.

Table 3.1.2.1.2-1. Proposed and Existing Surface-Water Monitoring Sites

Site Number (Numbers in parentheses are former station designation numbers)	Status	Location	Nevada State Coordinates	Planned Configuration	Purpose
10251220 (SR1)	Existing crest stage site (Note all existing crest stage sites have rain gages) (Note all existing crest stage sites are scheduled to become full sites eventually)	Amargosa River near Beatty	N771,046 E472,861	Recording stage Crest stage Rain gauge	Monitor peak flow of runoff for the Amargosa River north of Beatty airport. Site has long-term record. Collect supplementary precipitation data.
10251248 (SR2)	Existing full site, stilling well (Note all existing full sites have recording stage gages, crest stage gages, and rain gages)	Unnamed tributary to Stockade Wash near Rattlesnake Ridge	N886,362 E617,007	Recording stage Crest stage Rain gauge	Monitor total runoff in a selected drainage of the Upper-Fortymile Wash watershed. Collect supplementary precipitation data. Sediment collection station.
10251250 (SR3)	Existing full site	Fortymile Wash at the Narrows	N777,832 E583,671	Recording stage Crest stage Rain gauge	Monitor total runoff above main tributary (Yucca Wash) to determine losses and gains of flow. Collect supplementary precipitation data.
10251252(SR4)	Existing crest stage site	Yucca Wash at mouth	N770,338 E579,875	Recording stage Crest stage Rain gauge	Monitor peak flow of runoff from large drainage contribution to Fortymile wash. Collect supplementary precipitation data.

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.2.1.2-1. Proposed and Existing Surface-Water Monitoring Sites (Continued)

Site Number (Numbers in parentheses are former station designation numbers)	Status	Location	Nevada State Coordinates	Planned Configuration	Purpose
(SR5)	Proposed full site	Sever Wash above confluence with Fortymile Wash	N753,750 E578,702	Recording stage Crest stage Rain gauge	Monitor peak flow of runoff from large drainage contribution to Fortymile Wash. Collect supplementary precipitation data.
10251255(SRI)	Existing full site	Fortymile Wash near Well J-13	N748,489 E577,904	Recording stage Crest stage Rain gauge	Monitor total runoff below major tributaries (Sever and Yucca Washes) to determine losses and gains of flow. Collect supplementary precipitation data.
10251256(SRI)	Existing crest stage site	Dune Wash near mouth	N743,718 E578,841	Recording stage Crest stage Rain gauge	Monitor peak flow of runoff from large drainage contributing to Fortymile Wash.
10251258(SRI)	Existing full site	Fortymile Wash near Amargosa Valley	N699,720 E566,798	Recording stage Crest stage Rain gauge	Monitor total runoff entering Amargosa Valley via Fortymile Wash. Collect supplementary precipitation data.
10251260(SR9)	Existing crest stage site, scheduled to soon be a full site	Tonopah Wash below Little Skull Mountain	N734,809 E600,560	Recording stage Crest stage Rain gauge	Monitor peak flow of runoff for major wash drainage Calico Hills and Jackass Flats. Collect supplementary precipitation data.

Table 3.1.2.1.2-1. Proposed and Existing Surface-Water Monitoring Sites (Continued)

Site Number (Numbers in parentheses are former station designation numbers)	Status	Location	Nevada State Coordinates	Planned Configuration	Purpose
10251265(SR10)	Existing crest stage site	Cane Spring Wash Tributary	N749,285 E667,273	Recording stage Crest stage Rain gauge	Monitor peak flow of runoff for a selected drainage located peripheral to Yucca Mountain. Collect supplementary precipitation data.
10251270(SR11)	Existing crest stage site	Amargosa River Tributary near Mercury	N659,683 E666,419	Recording stage Crest stage Rain gauge	Monitor peak flow of runoff for a selected drainage located peripheral to Yucca Mountain. Site has long-term record. Collect supplementary precipitation data.
10251271(SR12)	Existing crest stage site	Amargosa River tributary #1 near Johnnie	N622,862 E664,349	Recording stage Crest stage Rain gauge	Monitor peak flow of runoff for a selected drainage located peripheral to Yucca Mountain. Site has long-term record. Collect supplementary precipitation data.
10251272(SR13)	Existing crest stage site	Amargosa River tributary #2 near Johnnie	N614,123 E674,205	Recording stage Crest stage Rain gauge	Monitor peak flow of runoff for a selected drainage located peripheral to Yucca Mountain. Site has long-term record. Collect supplementary precipitation data.

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.2.1.2-1. Proposed and Existing Surface-Water Monitoring Sites (Continued)

Site Number (Numbers in parentheses are former station designation numbers)	Status	Location	Nevada State Coordinates	Planned Configuration	Purpose
10248490(SR14)	Existing crest stage site	Indian Springs Valley tributary near Indian Springs	N662,332 E751,244	Recording stage Crest stage Rain gauge	Monitor peak flow of runoff for a selected drainage located peripheral to Yucca Mountain. Site has long-term record. Collect supplementary precipitation data.
10251215(SR15)	Existing full site, stilling well	Beatty Wash above confluence with Amargosa River	N434,422 E484,707	Recording stage Crest stage Rain gauge	Monitor total runoff from large drainage just north of Yucca Mountain contributing to Amargosa River. Collect supplementary precipitation data.
10251218(SR16)	Existing full site, stilling well	Amargosa River below Beatty	N774,886 E475,221	Recording stage Crest stage Rain gauge	Monitor total runoff at location where flow enters the Amargosa Valley. Collect supplementary precipitation data.
(SR17)	Proposed full site	Crater Flats Wash above Highway 95	N716,348 E535,414	Recording stage Crest stage Rain gauge	Monitor total runoff from large drainage west of Yucca Mountain at location where flow enters Amargosa Valley. Collect supplementary precipitation data.

Table 3.1.2.1.2-1. Proposed and Existing Surface-Water Monitoring Sites (Continued)

Site Number (Numbers in parentheses are former station designation numbers)	Status	Location	Nevada State Coordinates	Planned Configuration	Purpose
(SR18)	Recently put in full site, no number yet	Amargosa River near State line	N595,782 E571,786	Recording stage Crest stage Rain gauge	Monitor total runoff above confluence with springflow associated with Ash Meadows. Collect supplementary precipitation data.
(SR19)	Recently put in full site, No number yet	Amargosa River near Eagle Mountain	N526,462 E588,107	Recording stage Crest stage Rain gauge	Monitor total streamflow below confluence with springflow associated with Ash Meadows. Collect supplementary precipitation data.
10251300(SR20)	Existing full site	Amargosa River at Tecopa	N400,129 E629,655	Recording stage Crest stage Rain gauge	Monitor total streamflow at location with previous long-term record. Collect supplementary precipitation data.
(PR1)	Precipitation site, No number yet, Rain gage in place, tipping bucket proposed	Exile Hille-central top of ridge	N765,152 E569,405	Rain gauge	Collect supplementary precipitation data near site of proposed surface facilities.

Table 3.1.2.1.2-1. Proposed and Existing Surface-Water Monitoring Sites (Continued)

Site Number (Numbers in parentheses are former station designation numbers)	Status	Location	Nevada State Coordinates	Planned Configuration	Purpose
(PR2)	Precipitation site, No number yet, Rain gauge in place, tipping bucket proposed	North Fork Coyote Wash above proposed Exploratory Studies Facility site	N766,149 E563,064	Rain gage	Collect supplementary precipitation data near site of proposed Exploratory Studies Facility.
(PR3)	Precipitation site, No number yet, Rain gauge in place, tipping bucket proposed	Skull Mountain Pass at Jackass Flats road	N723,793 E627,134	Rain gauge	Collect supplementary precipitation data at site peripheral to Yucca Mountain.
(PR4)	Precipitation site, No number yet, Rain gage in place, tipping bucket proposed	Rock Valley at Jackass Flats road	N704,499 E651,738	Rain gauge	Collect supplementary precipitation data at site peripheral to Yucca Mountain.
10251262(PR5)	Precipitation site, Rain gauge in place, tipping bucket proposed	Rock Valley at Highway 95	N683,353 E604,820	Rain gauge	Collect supplementary precipitation data at site peripheral to Yucca Mountain.

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.2.1.2-1. Proposed and Existing Surface-Water Monitoring Sites (Continued)

Site Number (Numbers in parentheses are former station designation numbers)	Status	Location	Nevada State Coordinates	Planned Configuration	Purpose
(PR6)	Precipitation site, No number yet, Rain gauge in place, tipping bucket proposed	Stockade Pass above Area 12	N878,661 E635,657	Rain gauge	Collect supplementary precipitation data at site peripheral to Yucca Mountain.
(SF1)	Proposed full site	Pah Canyon Wash near confluence with Fortymile Wash	N798,672 E586,288	Recording stage Crest stage Rain gauge	Monitor total runoff from small drainage east of Fortymile Wash. Collect supplementary precipitation data.
(SF2)	Proposed full site	Fortymile Wash West of Shoshone Mountain	N825,821 E600,233	Recording stage Crest stage Rain gauge	Monitor total runoff above tributary (Pah Canyon Wash) to determine losses and gains of flow. Collect supplementary precipitation data.
10251249(SF3)	Existing full site	Stockade Wash above confluence with Fortymile Wash	N846,134 E596,432	Recording stage Crest stage Rain gauge	Monitor total runoff from large drainage entering Upper Fortymile Wash. Collect supplementary precipitation data.
10251243(SF4)	Existing full site with tipping bucket rain gage	East Cat Canyon Wash near confluence with Fortymile Wash	N843,995 E591,739	Recording stage Crest stage Rain gauge	Monitor total runoff from large drainage entering Upper Fortymile Wash. Collect supplementary precipitation data.

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.2.1.2-1. Proposed and Existing Surface-Water Monitoring Sites (Continued)

Site Number (Numbers in parentheses are former station designation numbers)	Status	Location	Nevada State Coordinates	Planned Configuration	Purpose
(SF5)	Proposed full site in 1994	Stockade Wash near Buckboard Mesa Road	N866,613 E609,884	Recording stage Crest stage Rain gauge	Monitor total runoff at a selected location within a large drainage to determine losses and gains of flow. Collect supplementary precipitation data.
(SF6)	Proposed full site	Fortymile Wash west of Scrugham Peak	N862,658 E676,775	Recording stage Crest stage Rain gauge	Monitor total runoff above major tributaries to determine losses and gains of flow. Collect supplementary precipitation data.
(SY1)	Proposed full site with flume	Upper reach of Wren Wash	N768,119 E560,662	Recording stage Crest stage Rain gauge Flume	Monitor total runoff to characterize flow in small drainage located above proposed site facilities. Collect supplementary precipitation data.
(SY2)	Proposed full site with flume	Unnamed wash near northern tip of Fran Ridge	N761,770 E576,158	Recording stage Crest stage Rain gauge Flume	Monitor total runoff from drainage located south of the proposed surface facilities and contributing to Sever Wash. Collect supplementary precipitation data.

Table 3.1.2.1.2-1. Proposed and Existing Surface-Water Monitoring Sites (Continued)

Site Number (Numbers in parentheses are former station designation numbers)	Status	Location	Nevada State Coordinates	Planned Configuration	Purpose
(SY3)	Proposed full site with flume	Sever Wash near South tip of Alice Ridge	N762,164 E575,829	Recording stage Crest stage Rain gauge Flume	Monitor total runoff from drainage containing proposed surface facilities. Collect supplementary precipitation data.
(SY4)	Proposed full site with flume	Unnamed wash west of Fran Ridge along tracer of Paintbrush Canyon Fault	N759,239 E573,074	Recording stage Crest stage Rain gauge Flume	Monitor total runoff in upper part of tributary to Sever Wash to determine losses or gains to flow. Collect supplementary precipitation data.
10251254(SY5)	Existing crest-stage recorder, proposed full site, flume	Drill Hole Wash below confluence of Split Wash and WT2 Canyon	N760,921 E570,515	Recording stage Crest stage Rain gauge Flume	Monitor total runoff for drainage located south of proposed surface facilities to determine losses and gains of flow. Collect supplementary precipitation data.
(SY6)	Proposed full site with flume	Unnamed tributary near upper confluence of drainage between antler Ridge and Whale Back Ridge	N762,554 E562,718	Recording stage Crest stage Rain gauge Flume	Monitor total runoff for small drainage located within the repository block. Collect supplementary precipitation data.

Table 3.1.2.1.2-1. Proposed and Existing Surface-Water Monitoring Sites (Continued)

Site Number (Numbers in parentheses are former station designation numbers)	Status	Location	Nevada State Coordinates	Planned Configuration	Purpose
(SY7)	Proposed full site with flume	Unnamed tributary near lower portion of Antler Ridge and Whaleback Ridge drainage	N760,824 E564,885	Recording stage Crest stage Rain gage Flume	Monitor total runoff in drainage to determine losses and gains of flows. Collect supplementary precipitation data.
(SY8)	Existing full site, flume proposed, no number yet	Upper split Wash	N764,170 E562,857	Recording stage Crest stage Rain gage Flume	Monitor total runoff in small drainage located south of proposed underground facilities. Collect supplementary precipitation data.
(SY9)	Proposed full site	Split Wash between Antler Ridge and Live Yucca Ridge	N761,991 E566,136	Recording stage Crest stage Rain gauge Flume	Monitor total runoff in drainage located south of proposed underground facilities to determine losses or gains of flow. Collect supplementary precipitation data.
(SY10)	Proposed full site with flume	Unnamed tributary near upper portion of small drainage just north of Peak Yucca Mountain Ridge	N767,076 E562,010	Recording stage Crest stage Rain gauge Flume	Monitor total runoff in small drainage located north of proposed underground facilities. Collect supplementary precipitation data.

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.2.1.2-1. Proposed and Existing Surface-Water Monitoring Sites (Continued)

Site Number (Numbers in parentheses are former station designation numbers)	Status	Location	Nevada State Coordinates	Planned Configuration	Purpose
(SY11)	Proposed full site with flume	Unnamed tributary near lower portion of small drainage just north of Dead Yucca Ridge	N767,080 E563,064	Recording stage Crest stage Rain gauge Flume	Monitor total runoff in drainage located north of proposed underground utilities to determine losses or gains of flow. Collect supplementary precipitation data.
(SY12)	Proposed full site with flume	Upper Drill Hole Wash	N772,220 E559,762	Recording stage Crest stage Rain gauge Flume	Monitor total runoff in small drainage located northwest of proposed underground facilities. Collect supplementary precipitation data.
(SY13)	Proposed full site with flume	Teacup Wash above confluence with Drill Hole Wash	N772,984 E561,341	Recording stage Crest stage Rain gauge Flume	Monitor total runoff in drainage contributing to Drill Hole Wash. Collect supplementary precipitation data.
(SY14)	Proposed full site with flume	Upper Pagany Wash	N773,295 E563,018	Recording stage Crest stage Rain gauge Flume	Monitor total runoff of small drainage in the upper reach of Pagany Wash. Collect supplementary precipitation data.

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.2.1.2-1. Proposed and Existing Surface-Water Monitoring Sites (Continued)

Site Number (Numbers in parentheses are former station designation numbers)	Status	Location	Nevada State Coordinates	Planned Configuration	Purpose
102512533(SY15)	Existing full site and tipping bucket rain gauge, flume proposed	Pagany Wash near Well UZ-4	N768,379 E567,386	Recording stage Crest stage Rain gauge Flume	Monitor total runoff at location above proposed surface facilities to determine losses and gains of flow. Collect supplementary precipitation data.
(SY16)	Proposed full site with flume	Pagany Wash near northern tip of Exile Hill	N767,791 E570,101	Recording stage Crest stage Rain gauge Flume	Monitor total runoff of location adjacent to proposed surface facilities to determine losses or gains of flow. Collect supplementary precipitation data.
(SY17)	Proposed full site with flume	Upper Solitario Canyon	N766,974 E557,324	Recording stage Crest stage Rain gauge Flume	Monitor total runoff for drainage located west of Yucca Crest and proposed underground facilities. Collect supplementary precipitation data.
(SY18)	Proposed full site with flume	Middle Solitario Canyon	N761,751 E556,001	Recording stage Crest stage Rain gauge Flume	Monitor total runoff at location west of Yucca Crest to determine losses or gains of flow. Collect supplementary precipitation data.

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.2.1.2-1. Proposed and Existing Surface-Water Monitoring Sites (Continued)

Site Number (Numbers in parentheses are former station designation numbers)	Status	Location	Nevada State Coordinates	Planned Configuration	Purpose
(SY19)	Proposed full site with flume	Lower Solitario Canyon	N755,946 E554,574	Recording stage Crest stage Rain gauge Flume	Monitor total runoff at mouth of Solitario Canyon west of Yucca Ridge to determine losses or gains of flow. Collect supplementary precipitation data.
(SY20)	Proposed full site with flume	North Branch of Ghost Dance Wash	N755,991 E562,765	Recording stage Crest stage Rain gauge Flume	Monitor total runoff in small drainage contributing to Dune Wash. Collect supplementary precipitation data.
(SY21)	Proposed full site with flume	South Branch of Ghost Dance Wash	N756,186 E563,144	Recording stage Crest stage Rain gauge Flume	Monitor total runoff in small drainage contributing to Dune Wash. Collect supplementary precipitation data.
(SY22)	Proposed full site with flume	Dune Wash west of Boundary Ridge	N751,846 E565,166	Recording stage Crest stage Rain gauge Flume	Monitor total runoff at location to determine losses or gains of flow. Collect supplementary precipitation data.
(SY23)	Proposed full site with flume	Dune Wash above confluence with Fortymile Wash	N744,913 E574,519	Recording stage Crest stage Rain gauge Flume	Monitor total runoff for large drainage contribution to Fortymile Wash. Collect supplementary precipitation data.

Table 3.1.2.1.2-1. Proposed and Existing Surface-Water Monitoring Sites (Continued)

Site Number (Numbers in parentheses are former station designation numbers)	Status	Location	Nevada State Coordinates	Planned Configuration	Purpose
No number yet	Existing crest stage, rain gauge site	Cane Springs Wash near Cane Springs tributary	No information available	Recording stage Crest stage Rain gauge	Monitor peak runoff. Collect supplemental precipitation data.
10251242	Existing full site	Fortymile Wash above confluence of East Cat Canyon	No information available	Recording stage Crest stage Rain gauge	Monitor total runoff. Collect supplemental precipitation data.

Table 3.1.2.1.4-1. Flood Records at Selected Crest-Stage Sites

Station #	Station Name	Water year[a]	Peak discharge (cubic meters per second)[b]
1	Penoyer Valley Tributary near Tempiute, Nevada	1964	0.00
		1965	.06
		1966	.00
	Station No. 10247860.	1967	.00
		1968	3.68
	Drainage Area = 3.83 km2	1969	1.27
		1970	.99
	Peak discharge per unit area for maximum flood recorded = 0.96 $(m^3/s^2)/km^2$	1971	.00
		1972	.93
	(i.e., 3.68 m^3/s / 3.83 km^2 = 0.96 $(m^3/s^2)/km^2$)	1973	.00
		1974	.00
		1975	.06
		1976	.02
		1977	.01
		1978	.00
		1979	.01
		1980	.01

Table 3.1.2.1.4-1 Flood Records at Selected Crest-Stage Sites (Continued)

Station #	Station Name	Water year[a]	Peak discharge (cubic meters per second)[b]
2	Indian Springs Valley Tributary near Indian Springs, Nevada	1964	.01
		1965	3.40
		1966	.01
	Station No. 10247890.	1967	.14
		1968	.02
	Drainage Area = 75.1 km^2	1969	.71
		1970	.00
	Peak discharge per unit area for maximum flood recorded = 0.19 $(m^3/s^2)/km^2$	1971	.34
		1972	14.10
		1973	.01
		1974	.02
		1975	.06
		1976	.08
		1977	2.83
		1978	.00
		1979	.03
		1980	.02
3	Amargosa River Tributary near Mercury, Nevada	1963	.28
		1964	1.13
		1965	1.05
	Station No. 10251270.	1966	.57
		1967	17.00
	Drainage Area = 284.9 km^2	1968	97.10
		1969	1.70
	Peak discharge per unit area for maximum flood recorded = 0.34 $(m^3/s^2)/km^2$	1970	6.79
		1971	2.55
		1972	43.60
		1973	5.24
		1974	.08
		1975	.02
		1976	.00
		1977	.68
		1978	.00
		1979	.68
		1980	.00

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.2.1.4-1 Flood Records at Selected Crest-Stage Sites (Continued)

Station #	Station Name	Water year[a]	Peak discharge (cubic meters per second)[b]
4	Amargosa River Tributary No. 1 near Johnnie, Nevada Station No. 10251271. Drainage Area = 5.72 km^2 Peak discharge per unit area for maximum flood recorded = 1.73 $(m^3/s^2)/km^2$	1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980	2.68 5.49 .02 9.91 2.55 .17 2.77 .11 .28 .08 2.09 .31 .00 .00
5	Amargosa River Tributary No. 2 near Johnnie, Nevada Station No. 10250272. Drainage Area = 6.45 km^2 Peak discharge per unit area for maximum flood recorded = 0.55 $(m^3/s^2)/km^2$	1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980	3.54 .06 .08 .00 .01 .00 .00 .14 .06 .08 .03 .00 .00

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.2.1.4-1 Flood Records at Selected Crest-Stage Sites (Continued)

Station #	Station Name	Water year[a]	Peak discharge (cubic meters per second)[b]
6	Amargosa River Tributary near Beatty, Nevada	1964	.71
		1965	.57
	Station No. 10251220.	1966	.00
		1967	119.00
	Drainage Area = 1,217 km^2	1968	2.55
		1969	453.00
	Peak discharge per unit area for maximum flood recorded = 0.37 $(m^3/s^2)/km^2$	1970	.00
		1971	.00
		1972	.00
		1973	.51
		1974	.00
		1975	11.7
		1976	2.83
		1977	.05
		1978	18.40
		1979	.00
7	Sarcobatus Flat Tributary, Nevada	1961	.37
		1962	.14
	Station No. 10249050.	1963	.00
		1964	.00
	Drainage Area = 96.1 km^2	1965	1.08
		1966	.00
	Peak discharge per unit area for maximum flood recorded = 0.02 $(m^3/s^2)/km^2$	1967	.28
		1968	.71
		1969	.82
		1970	.00
		1971	.03
		1972	.00
		1973	.17
		1974	.00
		1975	.42
		1976	.17
		1977	.03
		1978	.02
		1979	.02
		1980	1.78

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.2.1.4-1 Flood Records at Selected Crest-Stage Sites (Continued)

SKELETON TEXT
Date: 11/30/93

Station #	Station Name	Water year[a]	Peak discharge (cubic meters per second)[b]
8	Palmetto Wash Tributary, near Lida, Nevada	1967	.45
		1968	.51
	Station No. 10249850.	1969	5.46
		1970	.59
	Drainage Area = 12.25 km^2	1971	.70
		1972	.01
	Peak discharge per unit area for maximum flood recorded = 0.45 $(m^3/s^2)/km^2$	1973	.00
		1974	.00
		1975	.00
		1976	.03
		1977	.01
		1978	.01
		1979	---
		1980	.01
9	Stonewall Flat Tributary, near Goldfield, Nevada	1964	.03
		1965	.23
		1966	.03
	Station No. 10248970.	1967	1.02
		1968	1.75
	Drainage Area = 1.37 km^2	1969	4.25
		1970	.00
	Peak discharge per unit area for maximum flood recorded = 3.10 $(m^3/s^2)/km^2$	1971	.00
		1972	.03
		1973	.03
		1974	.00
		1975	.00
		1976	.03
		1977	.01
		1978	.00
		1979	.01

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.2.1.4-1 Flood Records at Selected Crest-Stage Sites (Continued)

Station #	Station Name	Water year[a]	Peak discharge (cubic meters per second)[b]
10	Big Smokey Valley Tributary, near Blair Junction, Nevada	1961	2.55
		1962	.00
		1963	.06
	Station No. 10249680.	1964	.00
		1965	.00
	Drainage Area = 29.5 km^2	1966	.20
		1967	.03
	Peak discharge per unit area for maximum flood recorded = 0.16 $(m^3/s^2)/km^2$	1968	.04
		1969	.34
		1970	.00
		1971	.00
		1972	1.78
		1973	.40
		1974	.00
		1975	.02
		1976	2.26
		1977	4.81
		1978	.00
		1979	.00
11	San Antonio Wash Tributary, Nevada	1965	.03
		1966	.00
	Station No. 10249135.	1967	.11
		1968	.03
	Drainage Area = 8.86 km^2	1969	.06
		1970	.62
	Peak discharge per unit area for maximum flood recorded = 2.11 $(m^3/s^2)/km^2$	1971	.00
		1972	18.70
		1973	.20
		1974	.00
		1975	.00
		1976	.00
		1977	.03
		1978	.00
		1979	.01
		1980	.00

Table 3.1.2.1.4-1 Flood Records at Selected Crest-Stage Sites (Continued)

Station #	Station Name	Water year[a]	Peak discharge (cubic meters per second)[b]
12	Saulsbury Wash, near Tonopah, Nevada	1962	.28
		1963	.00
	Station No. 10249180.	1964	.00
		1965	.00
	Drainage Area = 145 km^2	1966	1.16
		1967	.28
	Peak discharge per unit area for maximum flood recorded = 0.07 $(m^3/s^2)/km^2$	1968	.06
		1969	9.62
		1970	.06
		1971	.00
		1972	.76
		1973	.08
		1974	.00
		1975	.00
		1976	2.55
		1978	3.40
		1979	.25
		1980	.00

a A water year extends from October 1 through September 30.

b Robert Squires (U. S. Geological Survey, written communication, 1982) reported discharge values in cubic feet per second; these have been converted to cubic meters per second and rounded to three significant digits.

Table 3.1.2.1.5-1. Christensen and Spahr Flash Flood Model*

Return Period, years	Flow Equation, cfs	Range of Applicability
10	$Q= 392\ A^{0.66}E^{-1.02}L^{-0.33}$	$0.2 < A < 100$
25	$Q= 1{,}810\ A^{0.61}E^{-1.14}L^{-0.70}$	$2 < E < 10$
50	$Q= 4{,}860\ A^{0.58}E^{-1.21}L^{-0.94}$	$1 < L < 7$
100	$Q= 11{,}900\ A^{0.55}E^{-1.28}L^{-1.16}$	

With A = drainage area, mi^2
E = mean basin altitude, in thousands of feet
L = latitude of basin minus 35°
* Modified from Christensen and Spahr, p. 7, 1980.

Table 3.1.2.1.6-1. Chemical Composition of Watercourses Adjacent to Yucca Mountain

Parameter	(1) Flood sample Fortymile Wash at road M[b]	(2) Flood sample Fortymile Wash at road W[b]	(3) Flood sample Fortymile Wash above Drill Hole Wash[b]	(4) Flood sample Drill Hole Wash at mouth[b]	(5) Flood sample Fortymile Wash at J-12[b]	(6) Flood sample Busted Butte Wash[b]	(7) Stream sample Carson Slough[c]	(8) Stream sample Amargosa River near Eagle Mountain
Latitude	36°49'07"	36°49'04"	36°49'08"	36°49'11"	36°49'51"	36°47'49"	~36°25'	~36°13'
Longitude	116°23'47"	116°23'47"	116°23'46"	116°23'52"	116°23'51"	116°23'51"	~116°21'	116°22'50"
Date	7/22/84	8/15/84	8/14/84	8/14/84	8/14/84	8/14/84	1958	1958?
Specific conductance, field (micro-siemens per cm at 25°C	--[d]	170	70	100	59	120	937	1,860
Specific conductance, laboratory (micro-siemens per cm at 25°C	201	859	198	218	100	217	--	--
pH, field	--	8	8.4	8.3	8.2	8.3	8.5	8.8
pH, laboratory	7.4	7.4	7.5	7.8	7	7.8	--	--
Temperature (°C)	--	21.5	--	--	--	--	10	4.4

Table 3.1.2.1.6-1 Chemical Composition of Watercourses Adjacent to Yucca Mountain (Continued)

Parameter	(1) Flood sample Fortymile Wash at road M[b]	(2) Flood sample Fortymile Wash at road W[b]	(3) Flood sample Fortymile Wash above Drill Hole Wash[b]	(4) Flood sample Drill Hole Wash at mouth[b]	(5) Flood sample Fortymile Wash at J-12[b]	(6) Flood sample Busted Butte Wash[b]	(7) Stream sample Carson Slough[c]	(8) Stream sample Amargosa River near Eagle Mountain
Calcium (Ca)	24	31	8.1	9.5	6.7	12	40	24
Magnesium (Mg)	3.3	2.9	0.9	1.3	0.7	1.8	26	29
Sodium (Na)	8.1	8.2	4.1	8.6	2.4	7	125	344
Potassium (K)	7.8	9.1	5.6	7.4	6.3	8.1	16	40
Bicarbonate (HCO3)	--	--	--	--	--	--	362	542
Carbonate (CO3)	--	--	--	--	--	--	10	33
Alkalinity as CaCO3, lab	73	75	36	42	26	47	--	--
Chloride (Cl)	3.7	1.4	1.3	2.2	2	1.7	40	123
Sulfate (SO4)	10	10	6.2	13	6.3	7.9	122	277
Fluoride (F)	0.2	0.2	<0.1	0.3	<0.1	0.3	2	2.8
Silica (SiO_2)	25	24	8.7	20	4.5	23	28	26
Arsenic (µg/L as As)	2	2	<1	2	<1	3	0.0	2

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.2.1.6-1 Chemical Composition of Watercourses Adjacent to Yucca Mountain (Continued)

Parameter	(1) Flood sample Fortymile Wash at road M[b]	(2) Flood sample Fortymile Wash at road W[b]	(3) Flood sample Fortymile Wash above Drill Hole Wash[b]	(4) Flood sample Drill Hole Wash at mouth[b]	(5) Flood sample Fortymile Wash at J-12[b]	(6) Flood sample Busted Butte Wash[b]	(7) Stream sample Carson Slough[c]	(8) Stream sample Amargosa River near Eagle Mountain
Iron (µg/L as Fe)	110	77	18	100	28	200	210	450
Manganese (µg/L as Mn)	3.3	5	11	6	22	10	0.0	0.0
Strontium (µg/L as Sr)	100	100	34	66	31	86	1,800	800
Lithium (µg/L as Li)	6	7	6	14	5	17	--	--
Iodide (I)	0.009	0.005	0.003	0.002	0.004	0.003	--	--
Bromide (Br)	0.049	<0.01	<0.01	<0.01	<0.01	<0.01	--	--
Boron (B)	--	--	--	--	--	--	0.68	2.1
Dissolved solids (sum)	127	122	57	92	45	100	566	1,140

[a] Values for chemical constituents are in milligrams per liter unless otherwise indicated. Analyses by the U. S. Geological Survey, Denver, Colorado.
[b] Flood sample analyses (USGS) from WATSTORE files.
[c] Stream sample analyses from Hunt et al. (1966).
[d] -- indicates no data.

Table 3.1.2.1.6-2 Chemical Analysis of Water from Selected Springs

(--, no data; NA, not applicable; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius)

Site #	Site Name	Latitude	Longitude	Data Source	Aquifer	Use	Date	Specific conductance (µS/cm)	Field pH (units)	Labora-tory pH (units)	Tempera -ture (°C)	Calcium (mg/L)	Magne-sium (mg/L)
1	Ash Tree Spring 17S/49E-35ddd	36°25'35"	116° 24'42"	(1), USGS	Qal	--	3/6/74	365	8.0	7.9	18.0	14	4.4
2	Big Spring 18S/51E-19a	36°22'29"	116° 16'26"	USGS	Qal/Pzc	IRR	11/21/66	a 769	--	7.6	--	44	19
3	Bole Spring 18S/51E-30a	36°21'47"	116° 16'21"	(4)	--	--	7/27/62	a 776	--	7.1	22.2	38	19
4	Crystal Spring 18S/50E-03a	36°25'15"	116° 19'19"	USGS	Qal	IRR	11/20/66	a 658	--	8.2	--	40	20
5	Devils Hole 17S/50E-36ccd	36°25'32"	116° 17'27"	(2), USGS	Pzc	PS	12/9/66	a 677	--	8.1	33.5	50	24
6	Fairbanks Spring 17S/50E-09adc	36°29'36"	116° 20'30"	USGS	QTal	IRR	8/2/72	660	7.6	7.2	-	47	20
7	Jack Rabbit Spring 18S/51E-18b	36°23'24"	116° 16'41"	USGS	Qal/Pzc	IRR	4/6/71	2,590	--	8.0	26.2	120	75
8	Longstreet Spring 17S/50E-22aba	36°28'04"	116° 19'30"	USGS	Qal/Pzc	IRR	11/18/66	a 669	--	8.2	--	48	19
9	Point of Rocks Springs (King)	36°24'02"	116° 16'25"	USGS	Pzc	IRR	11/21/66	a 680	--	7.6	--	48	21

Table 3.1.2.1.6-2 Chemical Analysis of Water from Selected Springs (Continued)

Site #	Site Name	Latitude	Longitude	Data Source	Aquifer	Use	Date	Specific conductance (µS/cm)	Field pH (units)	Labora-tory pH (units)	Tempera -ture (°C)	Calcium (mg/L)	Magne-sium (mg/L)
10	Point of Rocks Springs Rock	36°24'05"	116° 16'15"	USGS	Qal	IRR	11/21/66	a 674	--	7.7	--	46	21
11	Rogers Spring 17S/50E-15a1	36°28'40"	116° 19'20"	USGS	Qal	IRR	11/20/66	a 677	--	7.6	--	47	21
12	Soda Spring 17S/50E--10c--1	36°29'22"	116° 20'10"	USGS	Qal	IRR	11/19/66	a 772	--	7.7	--	36	17
13	Spring 17S/50E-23bbc	36°27'36"	116° 19'04"	USGS	Qal	Unused	11/20/66	a 691	--	7.6	--	48	22
14	Spring 18S/49E-Olaba Clay Camp	36°25'30"	116° 23'50"	(1), USGS	QTal	Unused	4/6/71	680	8.6	8.0	17.5	24	12
15	Badwater Spring Death Valley	36°13'50"	116° 46'10"	(1)	--	--	1/30/59	a 35000	--	7.5	11.5	830	95
16	Daylight Spring 13S/46E-35aba	36°47'25"	116° 56"10"	USGS	Tv	--	11/19/72	250	7.5	6.5	--	25	6.1
17	Eagle Borax Spring 24N/1E-15DS1	36°12'05"	116 °51'55"	(1)	--	--	11/--/54	a 7730	--	7.1	--	610	270
18	Hidden Spring in Black Mtn	36°04'25"	116° 36'10"	(1)	--	--	4/7/67	a 265	--	7.8	13.0	5.7	1.2
19	Hole-in-the-Rock Spring Ca.	36°44'37"	116° 58'00"	USGS	Qal	Unused	11/19/72	2030	8.1	7.5	--	91	120

Table 3.1.2.1.6-2 Chemical Analysis of Water from Selected Springs (Continued)

Site #	Site Name	Latitude	Longitude	Data Source	Aquifer	Use	Date	Specific conductance (µS/cm)	Field pH (units)	Labora-tory pH (units)	Tempera -ture (°C)	Calcium (mg/L)	Magne-sium (mg/L)
20	Klare Spring 13S/45E-04LS1	36°50'34"	117° 05'35"	(1)	--	--	11/17/68	a 880	--	7.8	22.5	44	24
21	Lemonade Spring in Black Mtn	36°17'42"	116° 42'30"	(1)	--	--	11/18/68	a 800	--	7.1	12.0	2.2	2.1
22	Mesquite Spring 11S/42E-26	36°57'50"	117° 21'50"	(2)	PS	--	3/1/65	a 1240	7.7	7.9	22.0	30	13
23	Navel Spring 26N/2E-13FS1	36°22'50"	116° 42'20"	(1)	QTf	--	5/16/74	a 1030	--	8.2	23.0	30	11
24	Nevares Spring	36°30'44"	116° 49'14"	WAT STORE	--	--	4/22/82	a 1010	7.3	7.8	38.5	44	21
25	Palm Tree Spring 14S/45E-30BS1	36°43'09"	°07'50"	(1)	Qts/Tc	--	5/15/74	a 2210	--	8.1	18.5	58	65
26	Surprise Spring 11S/443E-18ES2	37°00'12"	117° 20'30"	(1)	--	--	1/21/67	a 710	--	7.9	20.0	7.3	1.3
27	Texas Spring	36°27'28"	116° 50'11"	WAT STORE	--	--	4/22/82	a 964	7.9	8.1	31.0	38	20
28	Travertine Spring	36°26'27"	116° 49'49"	WAT STORE	--	--	14/22/82	a 970	7.4	7.9	35.0	36	19
29	Willow Spring near Gold Valley	36°03'02"	116° 41'20"	(1)	--	--	1/12/66	a 729	--	7.8	20.0	60	14
30	Butte Spring (Tubb Spring)	37°14'50"	116° 04'00"	(7), USGS	Tos	Unuse d	11/10/60	a 272	--	7.8	15.0	21	2.4

Table 3.1.2.1.6-2 Chemical Analysis of Water from Selected Springs (Continued)

Site #	Site Name	Latitude	Longitude	Data Source	Aquifer	Use	Date	Specific conductance (µS/cm)	Field pH (units)	Labora-tory pH (units)	Tempera -ture (°C)	Calcium (mg/L)	Magne-sium (mg/L)
31	Cane Spring	36°47'50"	116° 05'30"	USGS	Tv	Unused	3/25/71	a 493	6.9	7.8	10.5	44	12
32	Captain Jack Spring	37°10'20"	116° 09'32"	(2)	Tos	Unused	5/01/59	a 188	--	6.9	13.3	3.2	.0
33	Indian Spring (Belted Range)	37°26'35"	116° 06'06"	(3)	Tos	Unused	5/01/58	a 358	--	7.2	10.0	42	7.8
34	Oak Spring North Yucca Flat	37°14'30"	116° 03'50"	(7)	Tos	Unused	4/28/58	a 241	--	7.5	12.8	18	4.9
35	Rainer Spring	37°11'22"	116° 11'43"	(2)	Tos	Unused	9/18/57	a 346	--	8.3	16.1	7.2	1.0
36	Tippipah Spring Yucca Flat	37°02'40"	116° 12'25"	WAT STORE	Tv	UNused	8/6/80	a 215	6.9	--	13.0	5.1	.4
37	Topopah Spring Calico Hills	36°56'21"	116° 16'14"	(3)	Tos	Unused	3/25/58	a 114	--	6.9	11.7	7.2	1.0
38	Whiterock Spring	37°12'09"	116° 07'52"	USGS	Tv	Unused	7/31/72	241	7.7	6.2	18.0	3.8	0
39	Beatty Spring 12S/47E-05cda	36°55'07"	116 44'37"	(1), USGS	Tv	DOM	7/3/67	534	8.2	7.9	24.0	13	2.8
40	Burro Hot Spring 11S/47E-16dcd	36°58'26"	116° 43'17"	(1), USGS	Tv	Unused	2/5/74	268	--	7.8	36.5	18	.5
41	Crystal Spring 11S/47E-18acb	36°59'06"	116° 45'30"	USGS	Tv	Unused	7/5/67	355	7.7	7.5	24.0	22	3.5

Table 3.1.2.1.6-2 Chemical Analysis of Water from Selected Springs (Continued)

Site #	Site Name	Latitude	Longitude	Data Source	Aquifer	Use	Date	Specific conductance (µS/cm)	Field pH (units)	Laboratory pH (units)	Temperature (°C)	Calcium (mg/L)	Magnesium (mg/L)
42	Goss Spring 11S/47E-10db	36°59'40"	116° 42'25"	EPA	--	IRR	1/21/75	a 700	--	7.1	16.0	4.8	5.3
43	Indian Springs 11S/46E-26dcc	36°56'40"	116° 47'30"	(1), USGS	Tv	DOM	7/3/67	316	7.9	7.4	21.0	6.3	1.0
44	Mud Spring 11S/46E-08bdc	36°59'40"	116° 51'20"	USGS	Qal	Stock	7/6/67	416	7.8	7.4	19.5	5	2.1
45	Peacock R. Spr. 10S/47E-31aab	37°01'51"	116° 45'17"	(1), USGS	Qal	DOM/ IND	7/5/67	597	7.6	7.7	19.5	23	4.3
46	Spring 10S/47E-14bab	37°04'27"	116° 41'24"	(1), USGS	Qal	IRR	7/5/67	a 701	8.1	7.8	29.0	7.5	.3
47	Spring 10S/47E-32dda	37°01'11"	116° 44'00"	(1), USGS	Qal	DOM	7/5/67	593	7.6	7.7	22.0	30	5.4
48	Spring 10S/47E-33aab	37°01'49"	116° 43'07"	(1), USGS	Tv	DOM/ IRR	7/5/67	889	7.8	7.6	22.0	26	4.5
49	Spring 11S/47E-03cdb	37°00'20"	116° 42'30"	(1), USGS	Tv	DOM/ IND	7/5/67	562	8.2	7.7	23.0	16	1.1
50	Spring 11S/47E-04cad	37°00'30"	116° 43'30"	(1), USGS	Qal	DOM	7/6/67	1100	7.7	7.8	21.0	26	4.5
51	Spring 11S/47E-10bcc	36°59'45"	116° 42'51"	(1), USGS	Tv	DOM	7/6/67	742	7.6	7.7	18.5	14	.4

Table 3.1.2.1.6-2 Chemical Analysis of Water from Selected Springs (Continued)

Site #	Site Name	Latitude	Longitude	Data Source	Aquifer	Use	Date	Specific conductance (µS/cm)	Field pH (units)	Labora-tory pH (units)	Tempera -ture (°C)	Calcium (mg/L)	Magne-sium (mg/L)
52	Spring 11S/47E-10caa	36°59'42"	116° 42'25"	(1), USGS	Tv	IRR	7/6/67	915	8.1	8.1	24.0	14	.7
53	Spring 11S/47E-10ccb	36°59'24"	116° 42'53"	(1), USGS	Qal	DOM	7/6/67	616	8.3	8.1	21.0	12	.9
54	Spring 11S/47E-21aba	36°58'21"	116° 43'10"	(1), USGS	Qal	DOM	7/4/67	735	7.6	7.8	41.0	13	.5
55	Spring 11S/47E-21acc(Well)	36°58'03	116° 43'21"	(1), USGS	Qal	IRR	7/4/67	1110	7.7	8.0	31.5	23	2.9
56	Spring 11S/47E-21dbb2	36°57'56"	116° 43'20"	USGS	Qal	DOM	7/4/67	1180	7.9	8.2	26.0	26	3.1
57	Spring 11S/47E-28dac	36°57'00"	116° 43'00"	(1), (2), USGS	Qal	IRR	7/4/67	1110	9.1	8.9	21.0	10	3.3
58	Spring 11S/47E-33bac	36°56'31"	116° 43'43"	(1), USGS	Tv	DOM	7/4/67	538	8.2	7.9	34.0	8.7	.1
59	Spring 12S/47E-20bbb	36°53'06"	116° 45'00"	(1), USGS	Qal	DOM? IND	7/23/67	1210	7.7	8.0	18.5	27	3.6
60	Upper Indian Springs	36°57'05"	116°48' 19"	(1), USGS	Tv	DOM	7/3/67	291	8.7	7.8	26.5	.0	.4

Table 3.1.2.1.6-2 Chemical Analysis of Water from Selected Springs (Continued)

Site #	Site Name	Sodium (mg/L)	Potassium (mg/L)	Alkalinity as HCO_3 (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Silica (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)	Lithium (mg/L)	Strontium (mg/L)	Dissolved solids (mg/L)	Anion-cation balance (percent)
1	Ash Tree Spring 17S/49E-35ddd	d 46	8.0	b 155	40	6.5	2.3	82	1.5	0.21	0.06	0.21	286	5.9
2	Big Spring 18S/51E-19a	97	8.7	318	105	25	1.4	28	0.20	0.00	0.12	1.2	480	0.1
3	Bole Spring 18S/51E-30a	106	9.2	306	113	27	1.0	33	1.0	0.00	0.17	0.60	500	1.1
4	Crystal Spring 18S/50E-03a	72	8.6	278	81	22	1.7	25	0.00	0.00	0.09	0.97	432	0.3
5	Devils Hole 17S/50E-36ccd	65	7.6	310	76	20	1.6	22	0.20	--	0.09	0.89	423	1.2
6	Fairbanks Spring 17S/50E-09adc	69	7.9	301	85	22	2.5	22	0.00	0.00	0.10	0.89	434	1.8
7	Jack Rabbit Spring 18S/51E-18b	330	19	248	820	240	1.7	23	14	0.00	0.18	3.2	2050	1.8
8	Longstreet Spring 17S/50E-22aba	69	7.8	300	75	17	1.8	22	0.40	0.00	0.18	0.92	419	0.7

Table 3.1.2.1.6-2 Chemical Analysis of Water from Selected Springs (Continued)

Site #	Site Name	Sodium (mg/L)	Potassium (mg/L)	Alkalinity as HCO_3 (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Silica (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)	Lithium (mg/L)	Strontium (mg/L)	Dissolved solids (mg/L)	Anion-cation balance (percent)
9	Point of Rocks Springs (King)	67	7.1	304	76	21	2.0	22	0.20	0.00	0.08	0.92	408	0.3
10	Point of Rocks Springs Rock	68	7.5	304	78	21	1.5	22	0.20	0.00	0.08	1.1	412	0.7
11	Rogers Spring 17S/50E-15a1	69	7.8	302	78	21	1.5	23	0.00	0.00	0.09	0.90	412	0.2
12	Soda Spring 17S/50E--10c--1	110	10	330	93	27	2.0	35	--	--	0.10	0.76	488	0.1
13	Spring 17S/50E-23bbc	68	7.7	310	80	21	2.5	22	0.20	0.00	0.08	0.94	417	0.7
14	Spring 18S/49E-Olaba Clay Camp	95	19	263	100	18	2.9	73	--	--	0.15	0.65	484	1.5
15	Badwater Spring Death Valley	8050	330	110	2800	11400	9.8	26	--	--	--	--	c 23000	3.2
16	Daylight Spring 13S/46E-35aba	17	1.5	107	16	11	.2	14	2.1	--	0.01	0.18	164	2.4
17	Eagle Borax Spring 24N/1E-15DS1	760	28	320	1400	1800	1.2	42	.7	--	--	--	c 5130	.7

Table 3.1.2.1.6-2 Chemical Analysis of Water from Selected Springs (Continued)

Site #	Site Name	Sodium (mg/L)	Potassium (mg/L)	Alkalinity as HCO_3 (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Silica (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)	Lithium (mg/L)	Strontium (mg/L)	Dissolved solids (mg/L)	Anion-cation balance (percent)
18	Hidden Spring in Black Mtn	50	5.0	110	21	15	.6	59	.6	--	--	--	c 212	.2
19	Hole-in-the-Rock Spring Ca.	200	11	353	710	130	.5	12	.17	0.03	.12	1.3	1580	1.8
20	Klare Spring 13S/45E-04LS1	130	4.9	360	140	31	5.0	20	.60	--	--	--	572	.0
21	Lemonade Spring in Black Mtn	180	7.4	260	79	64	.8	57	13	--	--	--	c 533	3.4
22	Mesquite Spring 11S/42E-26	230	13	b 435	160	80	3.8	58	0.0	.01	.16	.33	804	.1
23	Navel Spring 26N/2E-13FS1	160	8.4	300	100	76	2.0	18	31	--	--	--	590	1.7
24	Nevares Spring	150	11	b 340	170	38	3.6	27	--	--	.02	1.1	c 634	1.7
25	Palm Tree Spring 14S/45E-30BS1	340	23	670	360	210	1.5	37	2.2	--	--	--	c 1430	1.8
26	Surprise Spring 11S/443E-18ES2	150	7.6	230	93	46	1.9	64	1.7	--	--	--	c 484	.6
27	Texas Spring	150	11	330	170	37	4.3	33	--	--	.17	1.2	c 628	.6
28	Travertine Spring	140	10	330	160	40	4.4	32	--	--	.17	1.1	c 606	2.0

Table 3.1.2.1.6-2 Chemical Analysis of Water from Selected Springs (Continued)

Site #	Site Name	Sodium (mg/L)	Potassium (mg/L)	Alkalinity as HCO_3 (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Silica (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)	Lithium (mg/L)	Strontium (mg/L)	Dissolved solids (mg/L)	Anion-cation balance (percent)
29	Willow Spring near Gold Valley	67	5	360	88	57	.5	--	--	--	--	--	c 365	13.2
30	Butte Spring (Tubb Spring)	34	6.0	139	12	12	0.4	30	0.80	12	--	--	185	0.2
31	Cane Spring	46	6.9	247	34	23	.8	65	6.2	--	0.02	.13	347	0.8
32	Captain Jack Spring	47	2.2	95	25	4.0	.4	43	--	1.2	--	--	178	1.1
33	Indian Spring (Belted Range)	17	4.8	148	36	12	.4	61	--	--	--	--	c 254	0.9
34	Oak Spring North Yucca Flat	22	6.4	116	14	9.0	.3	57	--	.10	--	--	180	0.8
35	Rainer Spring	66	4.0	158	18	14.0	.6	65	.60	2.2	--	.20	250	0.1
36	Tippipah Spring Yucca Flat	40	3.1	b 92	19	8.0	.3	48	--	--	--	.01	191	.7
37	Topopah Spring Calico Hills	14	6.4	48	15	3.0	.3	50	2.0	.90	--	--	123	.6
38	Whiterock Spring	44	5.2	79	28	10	.5	47	1.5	--	.03	.03	208	1.1
39	Beatty Spring 12S/47E-05cda	106	5.8	b 196	70	26	3.8	60	0.05	0.00	0.11	0.08	408	1.8

Table 3.1.2.1.6-2 Chemical Analysis of Water from Selected Springs (Continued)

Site #	Site Name	Sodium (mg/L)	Potassium (mg/L)	Alkalinity as HCO_3 (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Silica (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)	Lithium (mg/L)	Strontium (mg/L)	Dissolved solids (mg/L)	Anion-cation balance (percent)
40	Burro Hot Spring 11S/47E-16dcd	173	7.8	268	127	47	6.1	60	0.0	.00	--	.12	572	1.2
41	Crystal Spring 11S/47E-18acb	50	3.6	b 143	22	21	.6	45	13	.00	.06	.09	261	3.2
42	Goss Spring 11S/47E-10db	170	13	290	80	65	3.1	--	1.2	.00	.07	--	c 150	.1
43	Indian Springs 11S/46E-26dcc	57	1.6	b 127	17	15	.4	48	4.5	.00	.04	.06	236	.6
44	Mud Spring 11S/46E-08bdc	75	3.2	b 125	10	34	.9	53	2.1	.00	.06	.06	287	7.2
45	Peacock R. Spr. 10S/47E-31aab	100	7.9	b 232	53	42	2.5	75	1.2	.00	.08	.23	443	1.4
46	Spring 10S/47E-14bab	143	8.1	b 212	83	51	4.2	57	.10	.00	.17	.04	458	1.2
47	Spring 10S/47E-32dda	137	.1	b 314	96	37	2.2	62	.0	.00	.11	.42	530	1.7
48	Spring 10S/47E-33aab	169	9.0	b 304	103	68	4.3	54	.20	.00	.11	.19	601	.5

Table 3.1.2.1.6-2 Chemical Analysis of Water from Selected Springs (Continued)

Site #	Site Name	Sodium (mg/L)	Potassium (mg/L)	Alkalinity as HCO_3 (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Silica (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)	Lithium (mg/L)	Strontium (mg/L)	Dissolved solids (mg/L)	Anion-cation balance (percent)
49	Spring 11S/47E-03cdb	122	4.8	b 188	90	45	2.9	47	.70	.00	.15	.10	430	1.2
50	Spring 11S/47E-04cad	223	8.7	b 388	129	80	5.1	62	.40	.00	.15	.35	722	.6
51	Spring 11S/47E-10bcc	156	7.1	b 294	91	42	4.6	51	.40	.00	.18	.07	522	1.7
52	Spring 11S/47E-10caa	196	2.3	b 306	109	54	6.1	38	.20	.00	.22	.21	599	2.0
53	Spring 11S/47E-10ccb	124	4.6	b 185	82	45	2.7	50	1.4	.00	.16	.13	422	1.2
54	Spring 11S/47E-21aba	150	7.7	b 228	116	35	6.1	70	.10	.00	.25	.10	516	.9
55	Spring 11S/47E-21acc(Well)	2321	8.5	372	159	69	6.0	60	.0	.00	.27	.23	750	0.4
56	Spring 11S/47E-21dbb2	246	8.2	b 396	167	72	6.0	54	.0	.00	.28	.26	803	.6
57	Spring 11S/47E-28dac	249	8.8	b 360	169	68	6.4	45	.0	.00	.29	.10	721	.7
58	Spring 11S/47E-33bac	112	2.4	b 178	70	27	3.8	46	.10	.00	.14	.03	339	.4

Table 3.1.2.1.6-2 Chemical Analysis of Water from Selected Springs (Continued)

Site #	Site Name	Sodium (mg/L)	Potassium (mg/L)	Alkalinity as HCO_3 (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Silica (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)	Lithium (mg/L)	Strontium (mg/L)	Dissolved solids (mg/L)	Anion-cation balance (percent)
59	Spring 12S/47E-20bbb	254	10	b 392	184	77	5.8	66	.0	.00	.10	.15	803	.5
60	Upper Indian Springs	59	1.7	b 116	14	14	.4	44	1.2	.00	.04	.03	222	.7

Table modified from USGS OFR 90-355, P. W. McKinley, M. P. Long, and L. V. Benson

Table 3.1.2.1.7-1. Quality of Texas Spring and Nevares Spring Water in Death Valley National Monument, California and Indian Springs Water, Beatty, Nevada[a].

Parameter	Texas Spring	Nevares Spring, Cow Creek	Indian Springs, Beatty, NV
Arsenic	<0.05	0.016	0.01
Barium	<0.1	0.010	
Cadmium	<0.010	0.003	
Chromium (Hexavalent)	<0.05	<0.005	
Lead	<0.05	<0.020	
Mercury	<0.002	<0.001	
Nitrate-Nitrogen	0.10	<0.01	
Selenium	<0.01	<0.004	
Silver	<0.05	<0.003	
Fluoride	1.20	1.32	0.4
Calcium	26.9	--	2.
Chloride	40.5	38.1	15.
Copper	<0.01	<0.003	
Iron	0.04	0.097	0.05
Magnesium	0.14	--	0.
Manganese	0.05	<0.003	0.08
Sodium	156.	--	46.
Sulfate	180.	96.	27.
Zinc	0.09	0.088	
Alkalinity in mg/l at CaCO3	540.	--	
Total Dissolved Solids	500.	808.	171.
pH (in pH units)	7.9	--	8.3
Potassium			1.
Bicarbonate			113.

a All units are in parts per million except where noted. From French, p. 17 and 22, 1984.

Table 3.1.2.2.1.2-1. Summary of Estimates of Annual Ground-Water Inflow, Recharge, and Outflow (All values in thousands of acre-feet per year); abstracted from Table 1 of Dettinger (1992)

Unit	Sub-surface Inflow	Local Recharge	Sub-Surface Outflow	Source of Estimates
Amargosa Desert	20	2	20	Walker and Eakin, 1963
Crater Flat	2	0	2	Rush, 1970; Rush et al., 1971
Emigrant	0	3	3	Rush, 1970; Rush et al., 1971
Indian Springs	22	10	32	Rush, 1970; Rush et al., 1971
Jackass Flat and Buckboard Mesa	6	2	8	Rush, 1970; Rush et al., 1971
Mercury and Rock	33	0	33	Rush, 1970; Rush et al., 1971
Pahrump	0	42	18	Harrill, 1986
Three Lakes	5	8	13	Rush, 1970; Rush et al., 1971
Tikaboo	6	6	12	Rush, 1970; Winograd and Friedman, 1972
Yucca and Frenchman Flats	32	1	33	Rush, 1970; Rush et al., 1971

Table 3.1.2.2.2-1 -- Summary of selected wells monitored for water levels at Yucca Mountain.
[Water-level altitude is 1988 average value unless otherwise indicated]

Local-well Number	Latitude	Longitude	Altitude of well casing (m)	Water-level altitude (m)	Drilled depth (m)	Open interval depth (m)	Geologic member or unit at water table
USW WT-1	36°49'16"	116°26'56"	1,201.11	730.40	515	471-515	Calico Hills[5]
USW WT-2	36°50'23"	116°27'18"	1,301.13	730.71	628	571-628	Prow Pass
UE-25 WT #3	36°47'57"	116°24'58"	1,030.11	729.57	348	301-348	Bullfrog
UE-25 WT #4	36°51'40"	116°26'03"	1,169.21	730.70	482	439-482	Calico Hills[5]
UE-25 WT #6	36°53'40"	116°26'46"	1,314.78	1,035.10	383	281-383	Do.
USW WT-7	36°49'33"	116°28'57"	1,196.88	775.70	491	421-491	Topopah Spring
USW WT-10	36°48'25"	116°29'05"	1,123.40	775.92	431	348-431	Do.
USW WT-11	36°46'49"	116°28'02"	1,094.11	730.72	441	364-441	Do.
UE-25 WT #12	36°46'56"	116°26'16"	1,074.74	729.52	399	345-399	Do.
UE-25 WT #13	36°49'43"	116°23'51"	1,032.51	728.98	354	303-354	Do.
UE-25 WT #14	36°50'32"	116°24'35"	1,076.05	729.71	399	346-399	Do.
UE-25 WT #15	36°51'16"	116°23'38"	1,082.94	729.24	415	354-415	Do.
UE-25 WT #16	36°52'39"	116°25'34"	1,210.63	738.32	521	473-521	Calico Hills[5]
UE-25 WT #17	36°48'22"	116°26'26"	1,124.06	729.64	443	394-443	Prow Pass
UE-25 WT #18	36°52'07"	116°26'42"	1,336.32	730.80[1]	623	607-623	Calico Hills[5]
UE-25b #1	36°51'08"	116°26'23"	1,200.73	730.66[2]	1,220	471-1,199	Do.
UE-25c #2	36°49'45"	116°25'43"	1,132.2	729.95[3]	914	416-914	Do.
UE-25c #3	36°45'46"	116°25'44"	1,132.3	730.10[3]	914	417-753	Do.
USW G-3	36°49'05"	116°28'01"	1,480.47	730.56	1,533	751-1,533	Tram
USW H-1	36°51'57"	116°27'12"	1,303.10	730.95[2]	1,829	573-673	Prow Pass
USW H-3	36°49'42"	116°28'00"	1,483.47	731.72[2]	1,219	752-1,114	Tram
USW H-4	36°50'32"	116°26'54"	1,248.74	730.33[2]	1,219	518-1,181	Prow Pass
USW H-5	36°51'22"	116°25'55"	1,478.94	775.47[2]	1,219	704-1,091	Bullfrog
USW H-6	36°50'49"	116°28'55"	1,302.06	775.96[2]	1,220	562-752	Prow Pass
USW VH-1	36°47'32"	116°30'07"	963.23	779.46	762	185-762	Tiva Canyon
J-12	36°45'54"	116°23'24"	954.54	728.00[4]	347	226-347	Topopah Spring
J-13	36°48'28"	116°23'40"	1,011.47	728.45	1,063	283-1,063	Do.

[1]Water-level altitude based on 1992 data. Data not available for 1988.
[2]Water-level altitude for uppermost interval of well. Other interval(s) also monitored.
[3]Water-level altitude based on 1989 data. Data not available for 1988.
[4]Water-level altitude based on 1990 data. Data not available for 1988.
[5]Calico Hills - abbreviation of tuffaceous beds of Calico Hills.
Ervin and Others (1993)
[INN 3.1.2.2.2-1]

Table 3.1.2.2.3-1 Pumping Response Data for the Lower Carbonate Aquifer

Ref	Well	Stratigraphic Unit	thickness (m)	Apparent Transmissivity (m^2/d)			Apparent Hydraulic Conductivity (m/d)			Remarks
				SP.CAP.	DD	REC	SP.CAP.	DD	REC	
1	67-73	Bonanza King	86	99	248	658	1.16	2.90	7.69	Full tested thickness
	67-73	Bonanza King	25					9.94	26.3	Producing horizon only
1	67-68	Bonanza King, Nopah (?)	304	75	485	1068	0.25	1.60	3.52	Full tested thickness
			206				0.36	2.35	5.18	Producing horizons only
1	66-75	Nopah	230	50	137	335	0.22	0.60	1.46	Full tested thickness
			156				0.32	0.88	2.15	Producing horizons only
1	88-66	Pogonip	266	9	16	66	0.03	0.06	0.25	Full tested thickness
	88-66	Pogonip	72				0.12	0.22	0.92	Producing horizons only
2	UE-25P#1	Lone Mtn Dolomite & Roberts Mtns formation	508		111			0.22		Full tested thickness
2	UE-25P#1	Lone Mtn Dolomite	12		10			0.83		1338-1350 m(?)
	UE-25P#1	Lone Mtn Dolomite	<10		59			>5.90		1350-1360 m(?)
	UE-25P#1	Lone Mtn Dolomite	190		33			0.17		1360-1550 m depth
		Lone Mtn Dolomite & Roberts Mtns formation	255		6			0.02		1550-1805 m depth
1	79-69a	Carrara (Upper)	49	11,180			228			Highest T reported by 1

1 Winograd and Thordarson, 1975, p.C22
2 Craig and Robison, 1984
[INN 3.1.2.2.3-1]

Table 3.1.2.2.3-2 Pumping Response Data for the Welded-Tuff Aquifer

Ref.	Well	Stratigraphic Unit	Thickness (m)	Apparent Transmissivity (m^2/d)		Apparent Hydraulic Conductivity (m/d)		Remarks
				Drawdown	Recovery	Drawdown	Recovery	
1	J-13	Topopah Spring	118.9	120		1.01		303.6-422.5 m depth Stallmas's Method
1	J-13	Topopah Spring	118.9	850		7.15		303.6-422.5 m depth Straight-line early slope
2	UE-25P#1	Crater Flat, Lithic Ridge, Older Tuffs	919	26	18	0.03	0.02	Test 1, 382-1301 m depth Straight-line early slope
2	UE-25P#1	Crater Flat, Lithic Ridge, Older Tuffs	919	60		0.07		Test 1, 382-1301 m depth Second straight-line segment
2	UE-25P#1	Prow Pass	<30	14		0.47		Main production zone
3	USW VH-1	Paintbrush, Calico Hills, Crater Flat	578.9	450	2200	0.78	3.80	Test 3 & 4; T estimated from specific capacity and harmonic fluctuations
3	USW VH-1	Paintbrush, Calico Hills, Crater Flat	578.9	1000		1.73		Test 5; T estimated from specific capacity
3	USW VH-1	Paintbrush, Crater Flat	578.9	2200		3.80		Test 1; Brown's Method (Average of 2 determinations)
4	UE-25b#1	Calico Hills, Crater Flat	749	340		0.45		Thiem Equation ; UE-25a#1 used as observation well
5	USW H-1	Crater Flat (Prow Pass)	116	151 157	 183	1.30 1.35	 1.58	Theis method 572-688 m depth Straight-line 572-688 m depth
5	USW H-1	Crater Flat (Prow Pass, Bullfrog, Tram)	1142	0.98,0.60 1.6, 0	 1.0, 0.41	6.9×10^{-4} (Avg) 9.9×10^{-4} (Avg)	 6.2×10^{-4} (Avg)	Theis method 687-1829 m depth Straight-line 687-1829 m depth

Table 3.1.2.2.3-2 Pumping Response Data for the Welded-Tuff Aquifer (Continued)

Ref.	Well	Stratigraphic Unit	Thickness (m)	Apparent Transmissivity (m^2/d)		Apparent Hydraulic Conductivity (m/d)		Remarks
				Drawdown	Recovery	Drawdown	Recovery	
6	USW H-3	Crater Flat (Mostly Tram), Lithic Ridge	465	0.4	0.5			754-1219 m depth; Brown's Method and straight-line method
6	USW H-3	Crater Flat (Mostly Tram), Lithic Ridge	397	1.0				822-1219 m depth; Theis Method
7	USW H-4	Crater Flat, some Lithic Ridge	700	200	790	0.29	1.1	519-1219 m depth; straight-line and Theis recovery methods
8	USW H-5	Crater Flat, (Bullfrog, Tram and Dacitic (?) Lava	515	34	57	0.07	0.11	Theis drawdown, straight-line recovery 704-1219 m depth
8	USW H-5	Bullfrog	146	34	57	0.23	0.39	690-836 m depth Main production zone, assuming 100% from this zone
9	USW H-6	Crater Flat; underlying tuffs and lavas	694	240	230	0.35	0.33	Dual-porosity model, drawdown from Test 1, recovery from Test 2
9	USW H-6	Crater Flat; underlying tuffs and lavas	694	470		0.68		Recharge-boundary model, average of Tests 1 & 2
9	USW H-6	Tram member	11	76		6.9		753-834 m depth isolated; all production assumed to be from 777 & 778 m
9	USW H-6	Bullfrog member	15	*	**			608-645 m depth isolated; all production assumed to be from 616-631 m

1 Thordarson, 1983 2 Craig and Robinson, 1984 3 Thordarson and Howells, 1987 4 Lahoud, et al., 1984
5 Rush, et. al., 1984 6 Thordarson and others, 1985 7 Whitfield and others, 1985 8 Robinson and Craig, 1991
9 Craig and Reed, 1991

*No lope in straight-line portion of drawdown curve, suggesting substantial transmissivity
**Anomalously rapid recovery; no analysis by Craig and Reed (1991)

Table 3.1.2.2.3-3 Results of analysis using the finite-conductivity, vertical-fracture model

Method	Ration of fracture conductivity to fracture half-length ($\mu m^2/m$)	Fracture half-length (meters)	Fracture conductivity ($\mu m^2/m$)	Calculated fracture conductivity (dimensionless)
PUMPING TEST 3				
Curve match	13.9	210	2,926	111 π
Linear flow	--	205	--	--
RECOVERY TEST 3				
Linear flow	--	133	--	--
PUMPING TEST 4				
Curve match	19.3	292	5,638	154 π
Bilinear flow	--	≥434	4,128	81 π
Linear flow	--	235	--	--
RECOVERY TEST 4				
Curve match	17.8	269	4,772	141 π
Bilinear flow	--	≥380	3,016	70 π
Linear flow	--	164	--	--

[--, not determined; ≥, equal to or greater than]
Robinson and Craig, 1991
[INN 3.1.2.2.3-4]

Table 3.1.2.2.8-1. Perennial Yield, Total Appropriations and Actual Water used for 1985 in the Hydrographic Areas Making up the Oasis Valley Subbasin

Hydrographic Area[a] Number/Name	yield (AFY)[b]	Perennial appropriations[c]	Total in 1985	Comments	Water Use
147 Gold Flat	1,900	NA[d]	ND[e]	NTS	
228 Oasis Valley		2,000	1,528.72	Minor[f]	Designated
Subbasin totals	3,900	1,528.72	Minor		

[a] Hydrographic areas are shown on Figure 8.3.1.2.2.8-1.
[b] Data from Scott et al., pg. 22, 66, 1971. AFY = Acre-feet per year.
[c] Tabulated from preliminary abstracted filed with the Office of the Nevada State Engineer.
[d] Not applicable.
[e] No data.
[f] Data from Giampaoli, p. 3, 1986.

Table 3.1.2.2.8-2. Nevada Test Site Water Wells Located in Ash Meadows Subbasin[a]

Area Number	Well	Pumping Rate (gpm)[b]	Unit Source[c]	Treatment Required	Total withdrawals for 1985, in gal (acre-feet)[d]
1	UE1t	270	ND[e]	None	5,594,200 (17.2)
2	2	165	Lower carbonate aquifer (?)[f]	None	20,630,500 (63.3)
3	A	160	Valley fill	Chlorination	39,182,300 (120.2)
5	5b	240	Valley fill	None	61,107,800 (187.5)
5	5c	325	Valley fill	None	61,170,400 (187.7)
5	UE5c	350	ND	None	4,319,000 (13.3)
6	C	270	Lower carbonate aquifer (?)	None	26,162,900 (80.3)
6	C-1	280	Lower carbonate aquifer (?)	None	26,170,300 (80.3)
6	4	650	ND	None	41,815,300 (128.3)
15	UE15d	270	Tuff	Chlorination	ND
16	UE16d	194	ND	None	15,605,000 (47.9)
22	Army Well-1	530	Lower carbonate aquifer (?)	Chlorination	53,916,700 (165.4)

[a] Data from Witherill, pg. 82-97, 1986 unless otherwise noted.
[b] gpm = gallons per minute. To convert to cubic meters per second, multiply by 6.31×10^{-5}.
[c] Based on information provided in Claassen, pg. 15-102, 1973, and Winograd and Thordarson, plate 2b, 1975.
[d] To convert gallons to cubic meters, multiply by 3.785×10^{-3}.
[e] ND = No data.
[f] (?) = uncertain.

Table 3.1.2.2.8-3. Perennial Yield, Total Appropriations, and Actual Water Use for 1985 in the Hydrographic Areas Making up the Ash Meadows Subbasin

Hydrographic Area[a] Number	Hydrographic Area Name	Perennial yield (AFY)[b]	Existing appropriations (AFY)[c]	Water Use in 1985 (AF)[d]	Comments
158A	Emigrant Valley (Groom Lake)	2,500	59.8	ND[e]	
158B	Emigrant Valley (Papoose Lake)	<10	0	0	
159	Yucca Flat	350	NA[f]	537.5	Nevada Test Site (NTS)
160	Frenchman Flat	100	NA	388.5	NTS
161	Indian Springs Valley	500	754.98	679.0[g]	
168	Three Lakes Valley (N)	4,000	11.48	ND	
169A	Tikaboo North	2,600	21.72	ND	
169B	Tikaboo South	4,000	ND	ND	
211	Three Lakes Valley (S)	5,000	ND	100[g,h]	
225	Mercury Valley	8,000	NA	165.4	NTS
226	Rock Valley	8,000	320.0	ND	
227A (East)	Fortymile Canyon (Jackass Flats)	2,000	NA	0	NTS
Subbasin totals		**37,060**	**1,167.98**	**1,870.4**	

[a] Hydrographic areas are shown on Figure 3.1.2.2.8-2.
[b] Data from Scott et al., pg. 22-26, 1971. AFY = acre-feet per year. To convert to cubic meters per year multiply by 1.23×10^3.
[c] Tabulated from preliminary abstracts filed with the Office of the Nevada State Engineer.
[d] AF = acre-feet.
[e] ND = No data.
[f] NA = Not applicable.
[g] Data from Giampaoli pg. 2, 1986.
[h] Estimated use at Indian Springs Correctional Center.

Table 3.1.2.2.8-4. Public Water Suppliers in the Community of Amargosa Valley[a, b]

Supplier	Type	Population Served
American Borate Trailer Park	Community	300
Amargos Water Company (IMV)	Community	45
Embrey's Trailer Park	Community	45
Mountain View Apartments and Shopping Center	Community	75
Amargosa Elementary School	Single User	c
Amargosa Senior Citizen's Center	Single User	c
Coach House Bar	Single User	c
Roadside Park 801NY	Single User	c
Water-N-Hole	Single User	c

[a] Source: SAIC, pg. 3-6, 1986.
[b] Wells are located in the southern portion of the Alkali Flat-Furnace Creek Ranch subbasin and in the southwestern portion of the Ash Meadows subbasin.
[c] In general these systems serve a transient population of at least 25 persons per day.

Table 3.1.2.2.8-5. Nevada Test Site water wells located in Alkali Flat-Furnace Creek Ranch Subbasin[a]

Area Number	Well	Pumping Rate (gpm)[b]	Unit Source[c]	Treatment Required	Total withdrawals for 1985, in gal (acre-feet)[d]
18	8	400	Tuff	None	63,683,000 (195.4)
19	19	360	Tuff (?)[e]	None	114,467,200 (351.2)
20	U20a-2	340	Tuff	None	20,165,900 (61.9)
25	J-12	815	Tuff	None	25,049,800 (76.9)
25	J-13	680	Tuff	None	37,811,000 (116.0)

[a] Data from Witherill, pg. 82-97, 1986 unless otherwise noted.
[b] gpm = gallons per minute. To convert to cubic meters per second, multiply by 6.31×10^{-5}.
[c] Based on information provided in Claassen, pg. 22-37, 111-133, 1973, and Winograd and Thordarson, plate 2b, 1975.
[d] To convert gallons to cubic meters, multiply by 3.785×10^{-3}.
[e] (?) = uncertain.

Table 3.1.2.2.8-6. Perennial Yield, Total Appropriations and Actual Water Used for 1985 in the Hydrographic Areas Making up the Alkali Flat-Furnace Creek Ranch Subbasin

Hydrographic Number	Area[a] Name	Perennial Yield (AFY)[b]	Total Appropirat ions[c]	Water Use in 1985[d]	Comments
227A	Fortymile Canyon (Jackass Flats)	2,000	320.0	192.9	Yucca Mountain site
227B	Fortymile Canyon (Buckboard Mesa)	3,600	NA[e]	0	
228	Oasis Valley	1,000	1.10	ND[f]	
229	Crater Flat	900	2533.48[g]	2533.48	
230	Amargosa Desert	24,000	71,613.66	9,672.0[h]	Over-appropriated; designated
147	Gold Flat	1,900	ND	292.4	NTS
157	Kawich Valley	2,200	ND	0	
173A	Railroad Valley (southern part)	ND	ND	ND	
Subbasin Totals		35,600	74,468.24	12,690.78	

[a] Hydrographic areas are shown on Figure 3.1.2.2.8-2.
[b] Data from Scott et al., pg. 22, 23, 26, 1971. AFY = Acre-feet per year. To convert to cubic meters per year, multiply by 1.23×10^3.
[c] Tabulated from preliminary abstracts filed with the Office of the Nevada State Engineer.
[d] Data from Giampaoli, pg. 2-7, 1986. AF = acre-feet. to convert to cubic meters, multiply by 1.23×10^3.
[e] NA = not applicable.
[f] ND = no data.
[g] Appropriations for mining and milling may exceed the perennial yield because (1) appropriations for mining activities are for short-term use and (2) mining and milling applications are considered preferred water uses by the State Engineer.
[h] Data from Coache, pg. 1, 1986.

Table 3.1.2.2.9-1. Water Use Estimate for Yucca Mountain Site Characterization Project (modified from State of Nevada, Exhibit #40, 1992)

Activity	**Estimated Water Use (1991) (m^3)**
ESF Construction/Operation	4.63×10^5
Surface-Based Testing	4.69×10^4
Dust Control/Construction	7.30×10^5
TOTAL	**1.24×10^6**

Table 3.1.4.1.1-1. List of All Active Regional Weather Stations, Managing Agency, Parameters Measured, Location, Sampling and Averaging Frequency, and Date Installed [INN 3.1.4.1.1-2]

Table 3.1.4.1.1.2.1-1 Temperature Data for Sites at and Around Yucca Mountain [INN 3.1.4.1.1.2.1-1]

Table 3.1.4.1.1.2.2-1 Precipitation Located in the Vicinity of Yucca Mountain [INN3.1.4.1.1.2.2-1]

Table 3.1.4.1.1.2.3-1. Relative Humidity Data for Yucca Flat, Nevada (1962-1971)

Month	Relative Humidity (%)			
	Hour (Pacific Standard Time)			
	0400	1000	1600	2200
January	67	49	35	60
February	67	45	32	56
March	58	31	23	44
April	52	27	21	38
May	46	22	17	31
June	39	19	14	26
July	40	20	15	28
August	44	23	16	30
September	43	21	17	32
October	46	24	19	36
November	61	39	31	52
December	68	50	41	64
Annual	53	31	23	41

Source: Bowen and Egami (1983)

Table 3.1.4.1.1.2.3-2 Summary of Various Relative Humidity Data in the Vicinity of Yucca Mountain [INN 3.1.4.1.1.2.3-1]

Table 3.1.4.1.1.2.3-3 Wet Bulb Depression Data in Relation to Ambient Temperature and Humidity Values [INN 3.1.4.1.1.2.3-2]

Table 3.1.4.1.1.2.5.1-1 Yucca Flat Upper Air Data for 1524 m Above Mean Sea Level (328 m above ground level)[a]

Direction[b]	%	Winter Avg. speed (m/s)	%	Spring Avg. speed (m/s)	%	Summer Avg. speed (m/s)	%	Fall Avg. speed (m/s)	%	Annual Avg. speed (m/s)
N	21.8	5.6	9.8	5.7	3.2	5.9	13.5	6.3	14.2	5.8N

[a] Calculated from Quiring (1968)
[INN 3.1.4.1.1.2.5.1-1]

[b] Winds blow from indicated direction

[c] NA = not applicable

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.4.1.1.2.5.1-2 Yucca Flat Upper Air Data for 1829 m Above Mean Sea level (633 m above ground level)[a]

Direction[b]	%	Winter Avg. speed (m/s)	%	Spring Avg. speed (m/s)	%	Summer Avg. speed (m/s)	%	Fall Avg. speed (m/s)	%	Annual Avg. speed (m/s)
N	21.8	5.6	9.8	5.7	3.2	5.9	13.5	6.3	14.2	5.8N

[a] Calculated from Quiring (1968)
[INN 3.1.4.1.1.2.5.1-2]

[b] Winds blow from indicated direction

[c] NA = not applicable

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

Table 3.1.4.1.1.2.5.1-3 Summary Data for Upper Air Winds [INN 3.1.4.1.1.2.5.1-3]

Table 3.1.4.1.1.2.6-1 Monthly Atmospheric Pressure, Means, and Extremes

Atmospheric Pressure (in. Hg)	Mean	Monthly Std Dev	Mean Daily Range	Extremes		Highest Daily Range	Adjusted to Seal Level Extremes		
				High	Low		Mean	High	Low

[INN 3.1.4.1.1.2.6-1]

Table 3.1.4.1.1.2.6-1 Monthly Atmospheric Pressure, Means, and Extremes (Continued)

Atmospheric Pressure (in. Hg)	Mean	Monthly Std Dev	Mean Daily Range	Extremes		Highest Daily Range	Adjusted to Seal Level Extremes		
				High	Low		Mean	High	Low

[INN 3.1.4.1.1.2.6-1]

Table 3.1.4.1.1.2.7-1	Monthly and Daily Average Insolation [INN 3.1.4.1.1.2.7-1]
Table 3.1.4.1.1.2.8-1	Frequency of Occurrence of Hail at Yucca Mountain [INN 3.1.4.1.1.2.8-6]
Table 3.1.4.1.1.2.8-2	Frequency of Occurrence of Fog and Sandstorms at Yucca Mountain [INN 3.1.4.1.1.2.8-7]

Table 3.1.4.1.1.2.9-1 Annual Extreme Wind Speed at 30 ft. (9.1 m) Above Ground Level and Probability of Occurrence for Yucca Flat, Nevada[a]

Probability of occurrence in 1 year	Fastest mile[b] mph	m/s
0.5	48	21
0.2	55	25
0.1	61	27
0.02	75	33
0.01	82	37

[a] Source: Quiring (1968).
[b] Fastest mile is defined as an average highest wind velocity as 1 mi of air passes the measurement point.

[INN 3.1.4.1.1.2.9-1]

Table 3.1.4.1.1.2.9-2	Extreme Wind Speeds and Probability of Occurrence at Yucca Mountain [INN 3.1.4.1.1.2.9-1]
Table 3.1.4.1.1.2.9-3	Historical Peak Wind Gusts Data for Yucca Flat, Nevada [INN 3.1.4.1.1.2.9-1]
Table 3.1.4.1.1.2.9-4	Measured Temperature Extremes at Yucca Mountain [INN 3.1.4.1.1.2.9-2]
Table 3.1.4.1.1.2.9-5	One and 24-hour Maximum Precipitation and Associated Probabilities of Occurrence [INN 3.1.4.1.1.2.9-3]
Table 3.1.4.1.2-1	List of Meteorological Monitoring Site Locations [INN 3.1.4.1.2-1]

Table 3.1.4.1.2-2. Meteorological Parameters Monitored and Measurement Height (m) at Each Station (With Accuracy)

Site ID	Horizontal Wind Speed	Wind Direction	Air Temp.	ΔTemp.	Dewpoint Temp.	Relative Humidity	Barometric Pressure	Precip.	Solar radiation	Vertical Wind Speed
SAIC 1	10 & 60	10 & 60	2	10 & 2	2	n/a	1	1	2	10
SAIC 2	10	10	2	10 & 2	n/a	2	1	1	2	10
SAIC 3	10	10	2	10 & 2	n/a	2	1	1	2	10
SAIC 4	10	10	2	10 & 2	n/a	2	1	1	2	10
SAIC 5	10	10	2	10 & 2	n/a	2	1	1	2	10
SAIC 6	10	10	2	10 & 2	n/a	2	1	1	2	10
SAIC 7	10	10	2	10 & 2	n/a	2	1	1	2	10
SAIC 8	10	10	2	10 & 2	n/a	2	1	1	2	10
SAIC 9	10	10	2	10 & 2	n/a	2	1	1	2	10
Accuracy	(1)	± 5°	±0.5 C°	±0.1 C°	±1.5 C° (3)	(4)	± 3 mb	± 10%	± 5%	(1)
USGS 1	3	3	2			2		0.5	2	
USGS 2	3	3	2			2		0.5	2	
USGS 3	3	3	2			2	1	0.5	2	
USGS 4	3	3	2			2		0.5	2	
USGS 5	3	3	2			2		0.5	2	
Accuracy	(2)	± 5°	± 1 C°			± 5%	± 0.1 kPa	± 2%	± 5%	

NOTES: n/a not applicable:
(1) For speeds <5 m/s: ± 0/25 m/s; for speeds > 5 m/s ± 5 percent o speed
(2) For speeds <5 m/s: ± 0.5 m/s; for speeds > 5 m/s: ± 10 percent of speed
(3) Only applies at temperatures - 30° to +30° C
(4) For RH < 40 percent: for RH > 40 percent, use RH equivalent to dewpoint ± 1.5°C

Table 3.1.4.1.3-1 Significant Features of Stability Distributions [INN 3.1.4.1.3-2]

FIGURES FOR SECTION 3.1

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

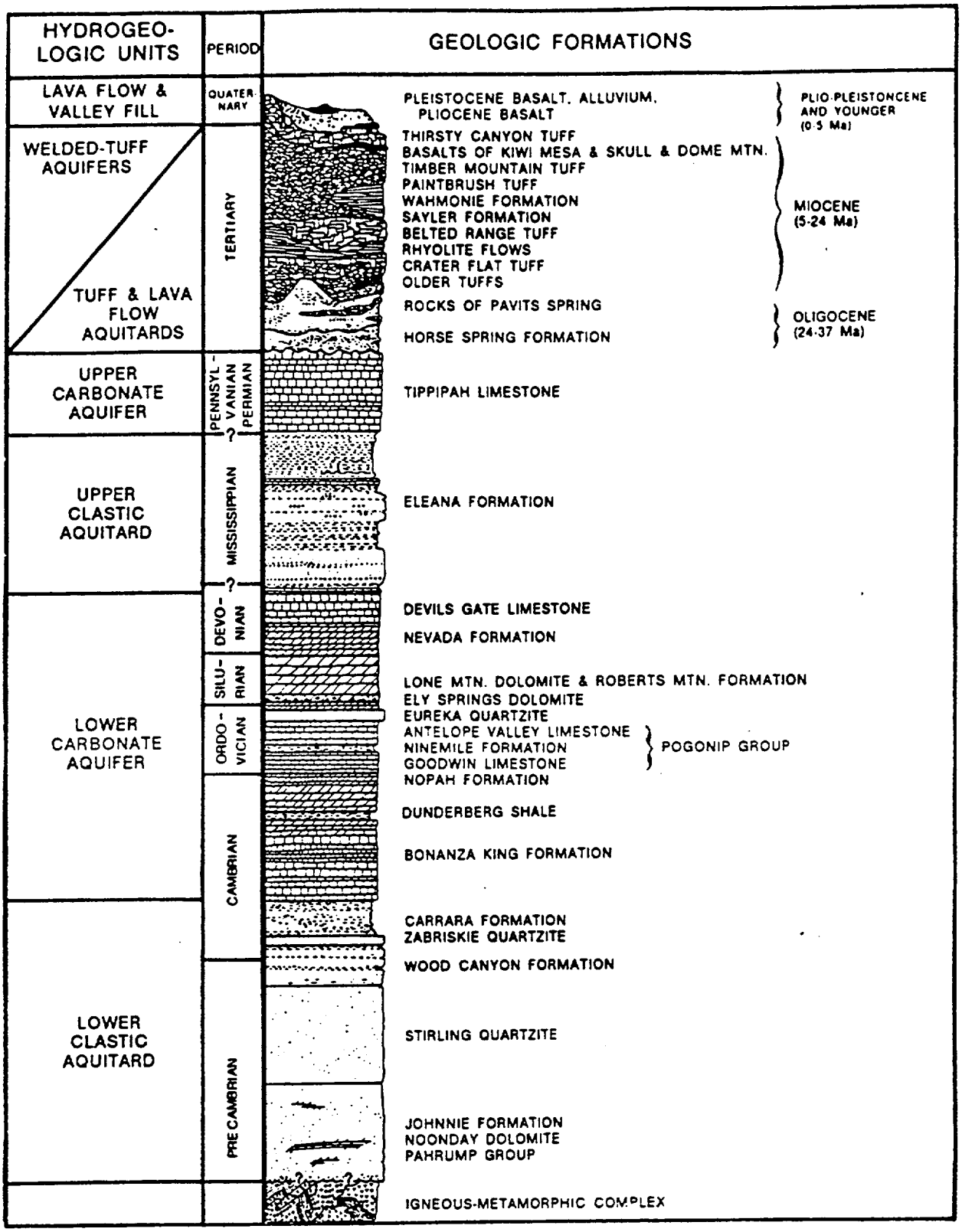


Figure 3.1.1.1.2-1. Generalized Regional Stratigraphic Column Showing Geologic Formations and Hydrogelogic Units in the Nevada Test Site Area. Modified from Sinnock (1982) and Carr et al. (1986)

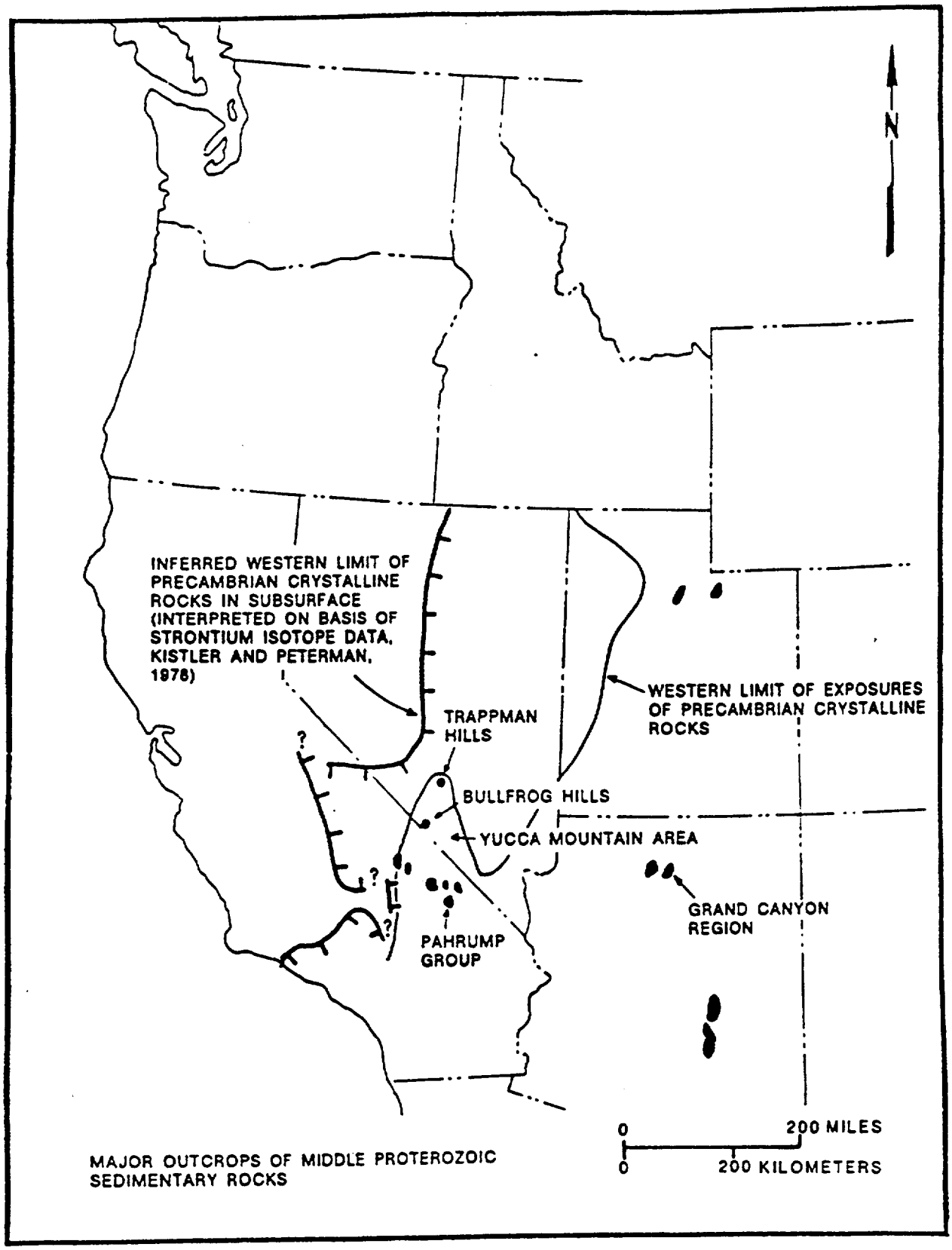


Figure 3.1.1.1.2.1-1. Distribution of Lower and Middle Proterozoic Crystalline Rocks and Middle Upper Proterozoic Restricted Basin Deposits in the Great Basin. Modified from USGS (1984)

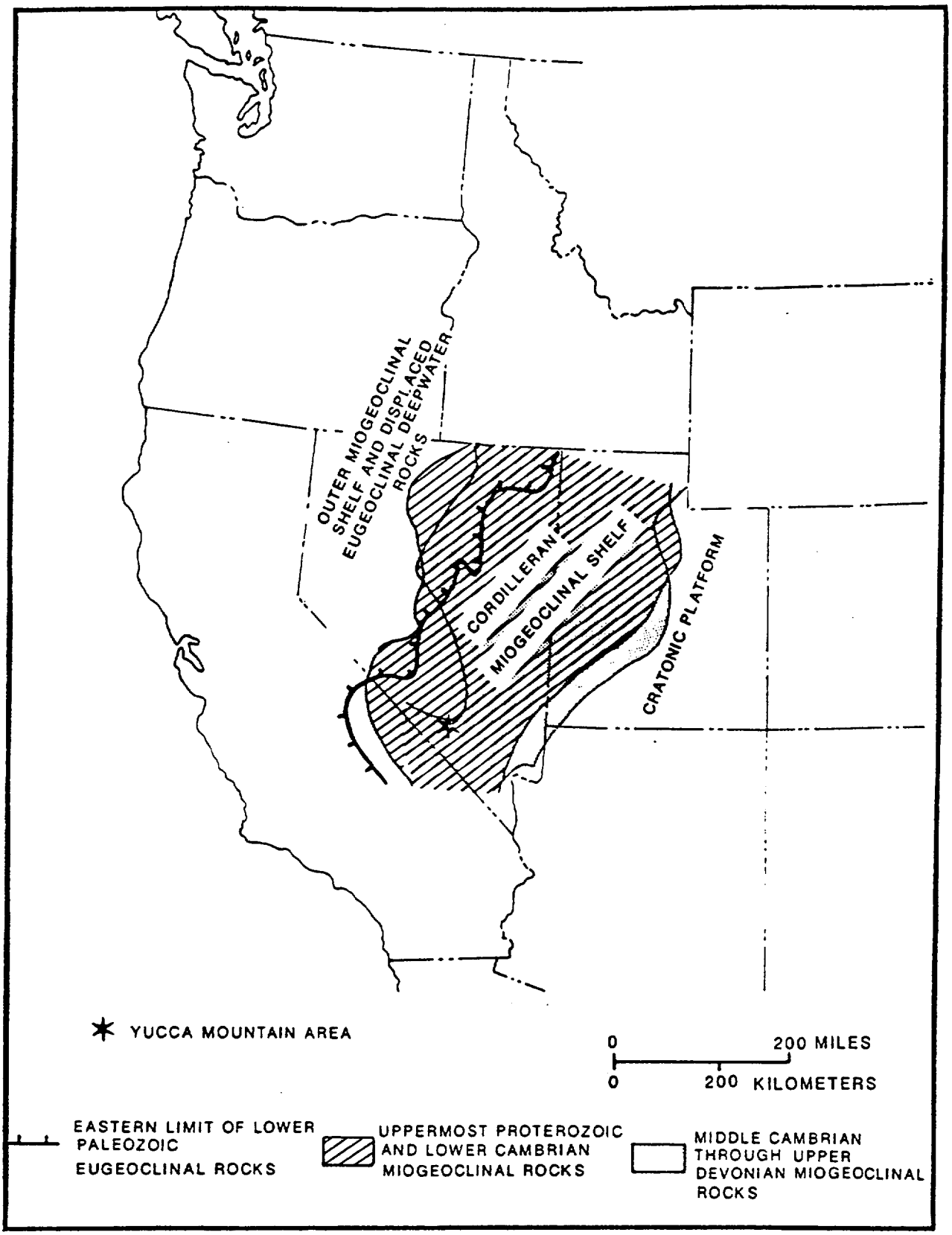


Figure 3.1.1.1.2.2-1. Latest Precambrian Through Mid-Paleozoic Paleogeography of the Great Basin. Modified from USGS (1984)

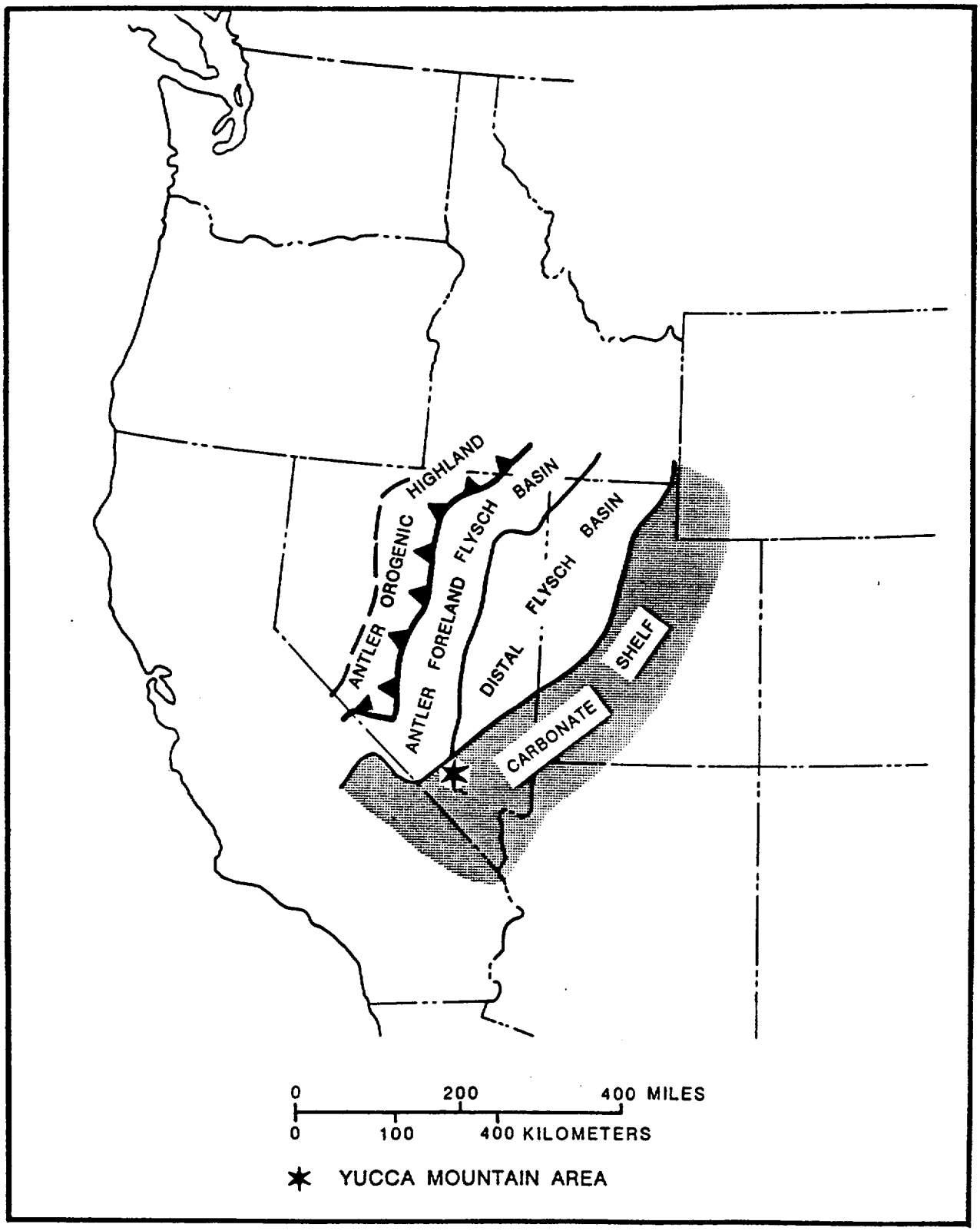


Figure 3.1.1.1.2.4-1. Late Devonian and Mississippian Paleogeography of the Great Basin. Modified from USGS (1984)

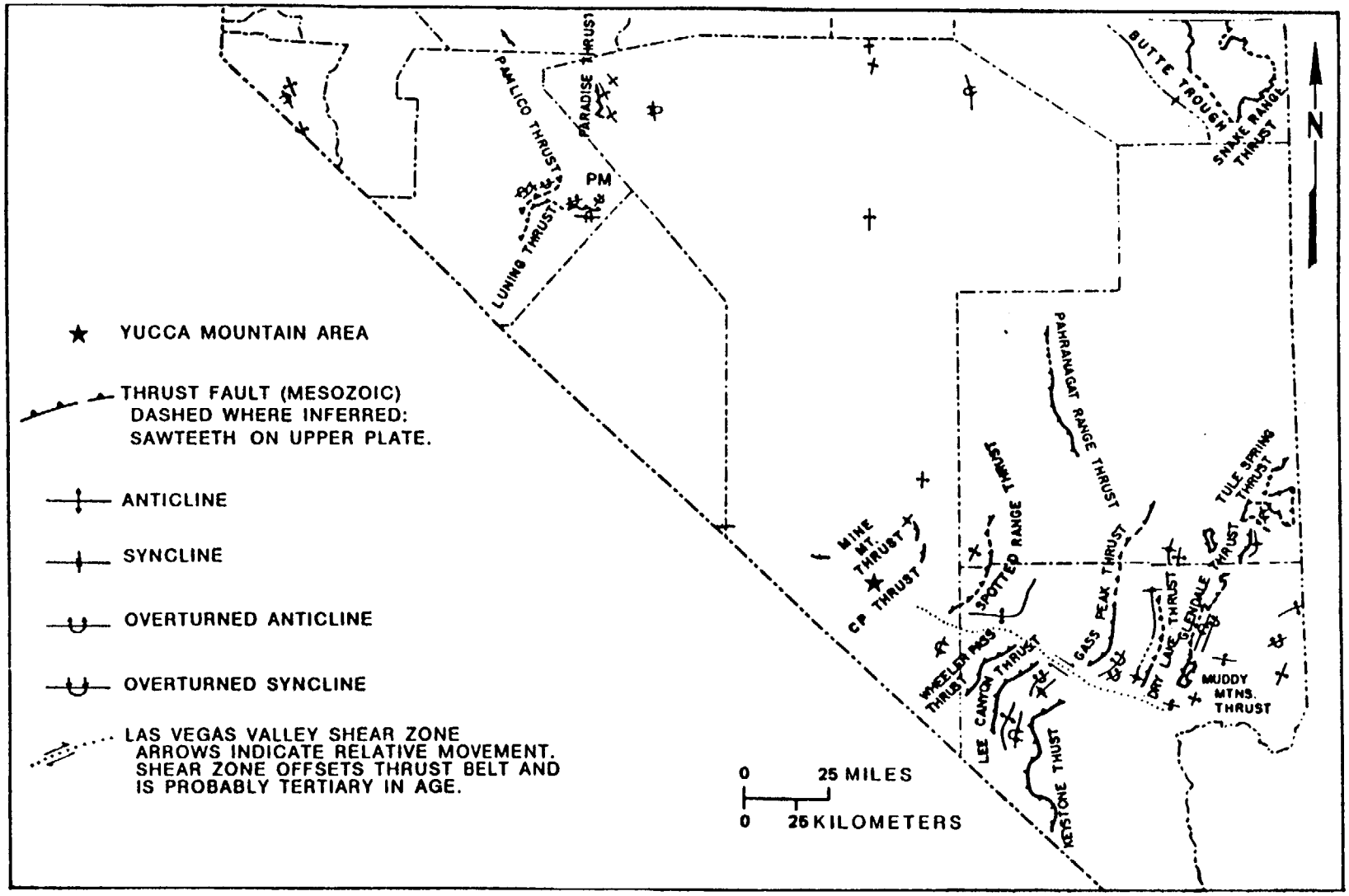


Figure 3.1.1.1.2.5-1. Major Mesozoic Thrust Faults in Southern Nevada. Modified from Stewart (1980a)

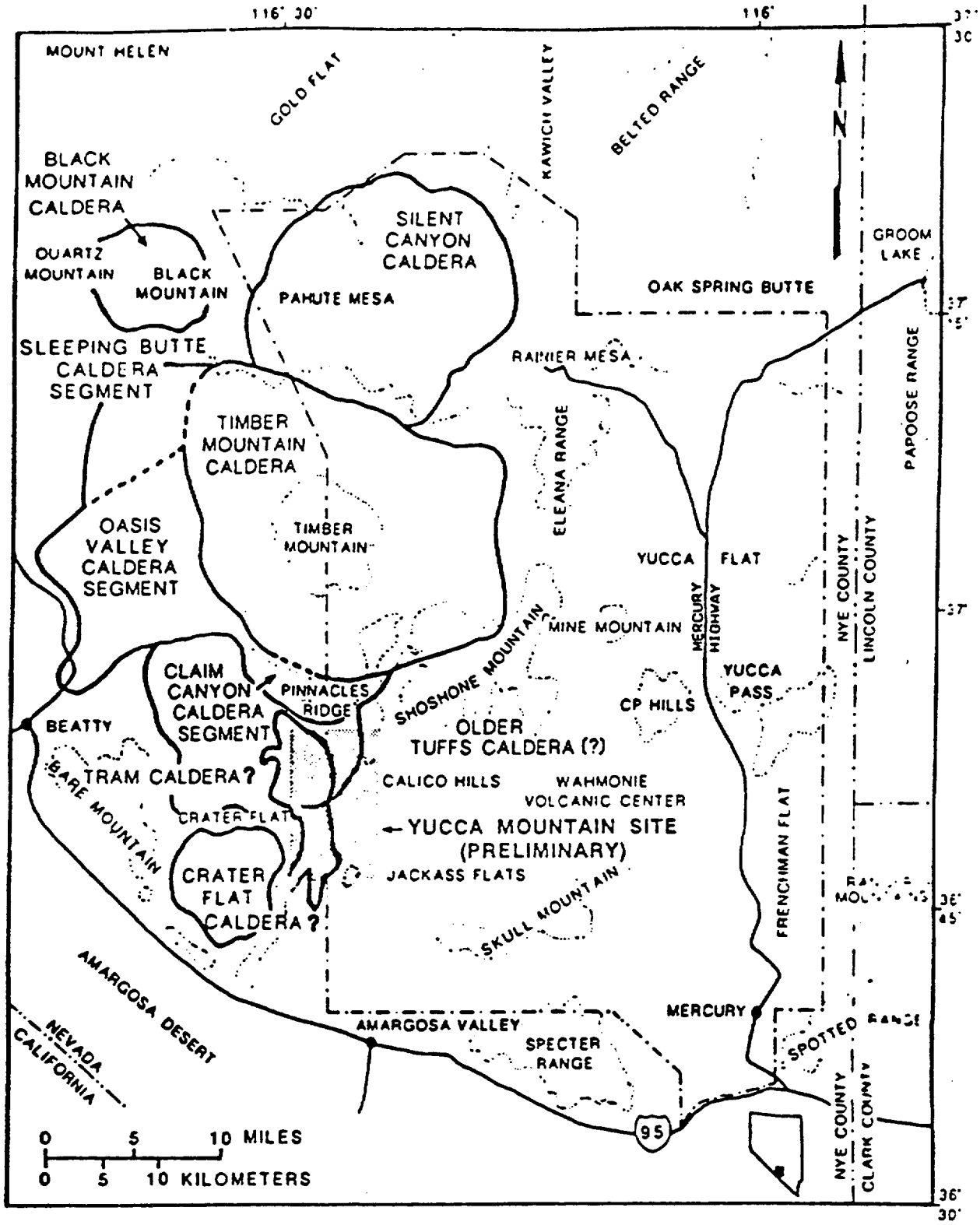


Figure 3.1.1.1.2.7-1. Calderas of the Southwest Nevada Volcanic Field Near Yucca Mountain. Modified from Maldonado and Koether (1983)

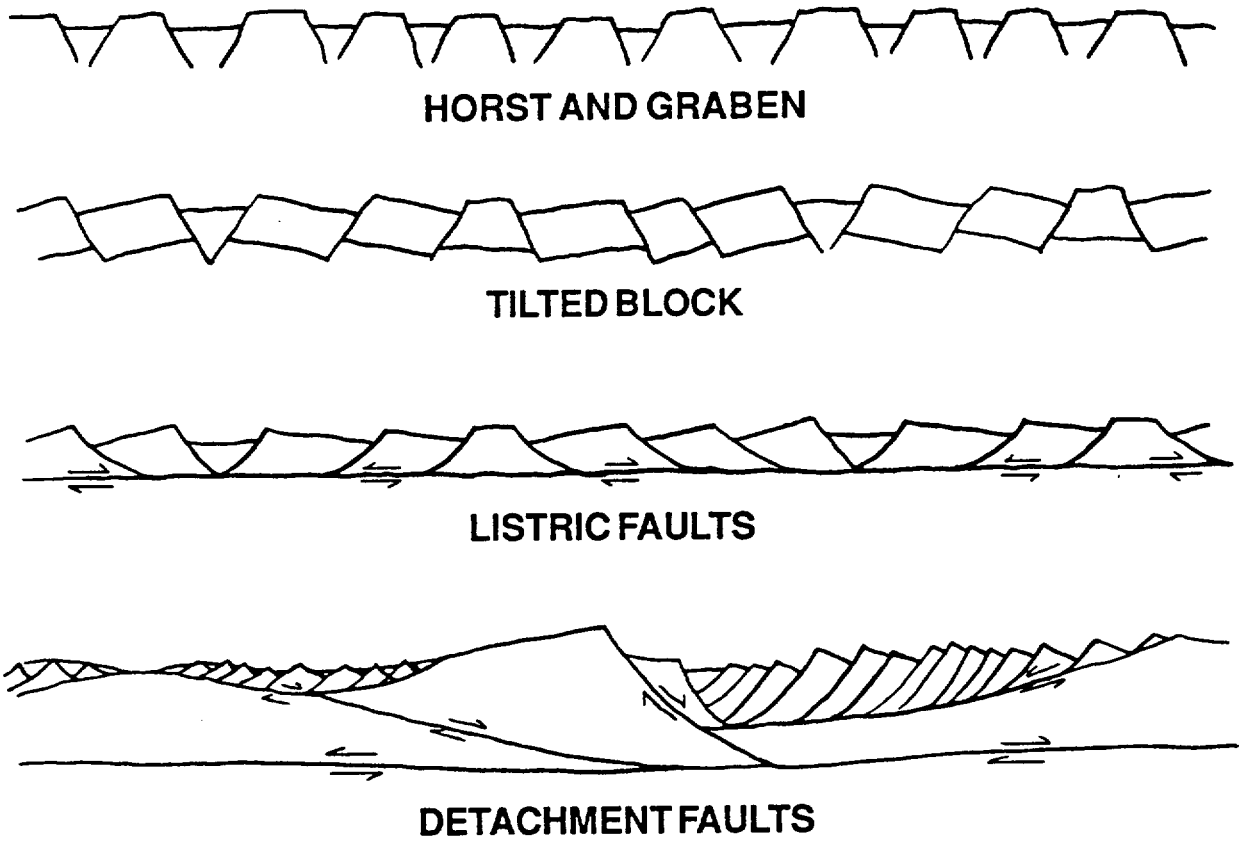


Figure 3.1.1.1.3.1-1 This schematic (modified from Stewart, 1980, and Scott, 1990) illustrates some of the mechanisms and geometric configurations proposed for extensional faulting in the Basin and Range. The geometry of the Horst and Graben and the Tilted Block models allows for fairly limited extension (approximately 15%), while that of the Listric Faults and Detachment Faults models allows for progressively greater amounts of extension. Using detachment models, Wernike et al. (1988) has proposed up to 300% extension for parts of the Basin and Range.

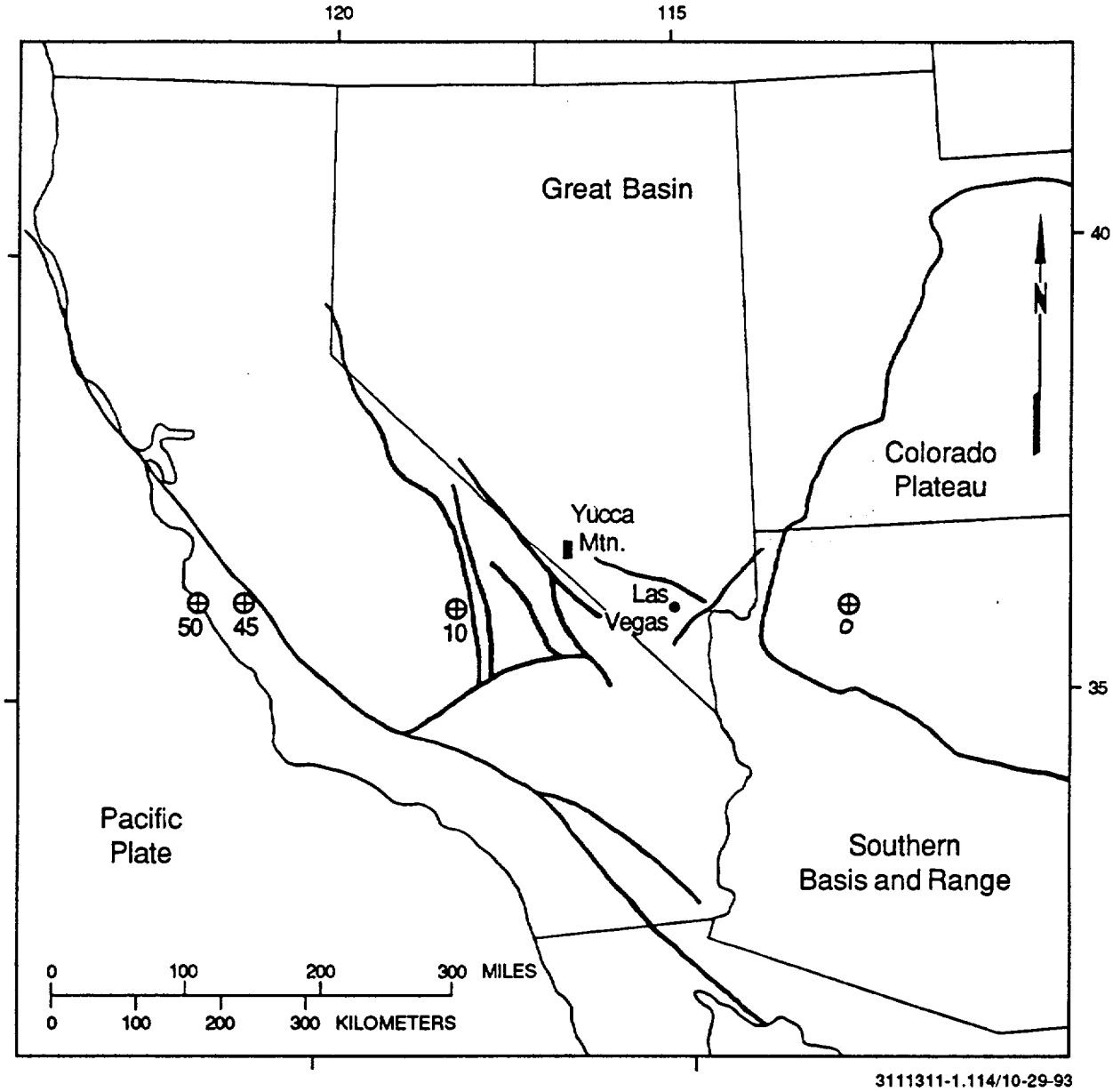


Figure 3.1.1.1.3.1.1-1 Sketch map of the western United States showing some major structural features. Symbols (⊕ 45) at the latitude of Las Vegas give approximate motions toward the NW in mm/yr relative to a "stable North America" (data modified [rounded] from Argus and Gordon, 1991). This interpretation suggests that 10 mm/yr of NW movement occurs between the Colorado Plateau and the crest of the Sierra Nevada Range, 35 mm/yr occurs on the San Andreas Fault, and 5 mm/yr occurs west of the San Andreas Fault. This is consistent with paleoseismic data and historic observations of strike slip faulting in this region.

Figure 3.1.1.1.3.1.2-1. Sketch Map of the Walker Lane Belt [INN 3.1.1.1.3.1.2-1]

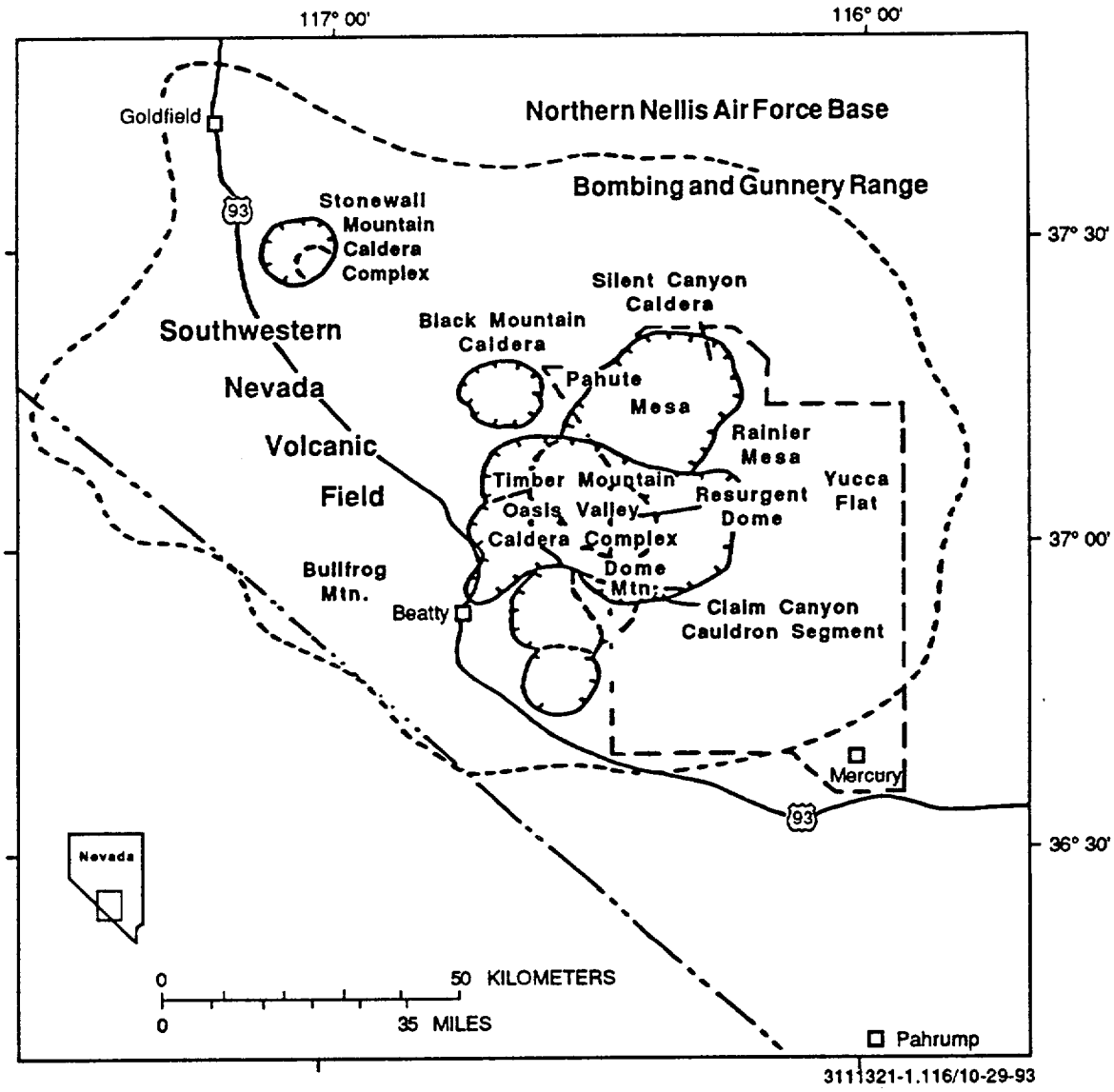


Figure 3.1.1.1.3.2.1-1 The Southwestern Nevada Volcanic Field (from Byers et al. 1989). Yucca Mountain is upheld by a thick sequence of ignimbrites derived from multiple caldera-forming, eruptive cycles of the Claim Canyon and Timber Mountain-Oasis Valley caldera complexes. The presence of caldera complexes of Crater Flat, which border Yucca Mountain to the west, is regarded as controversial by some workers.

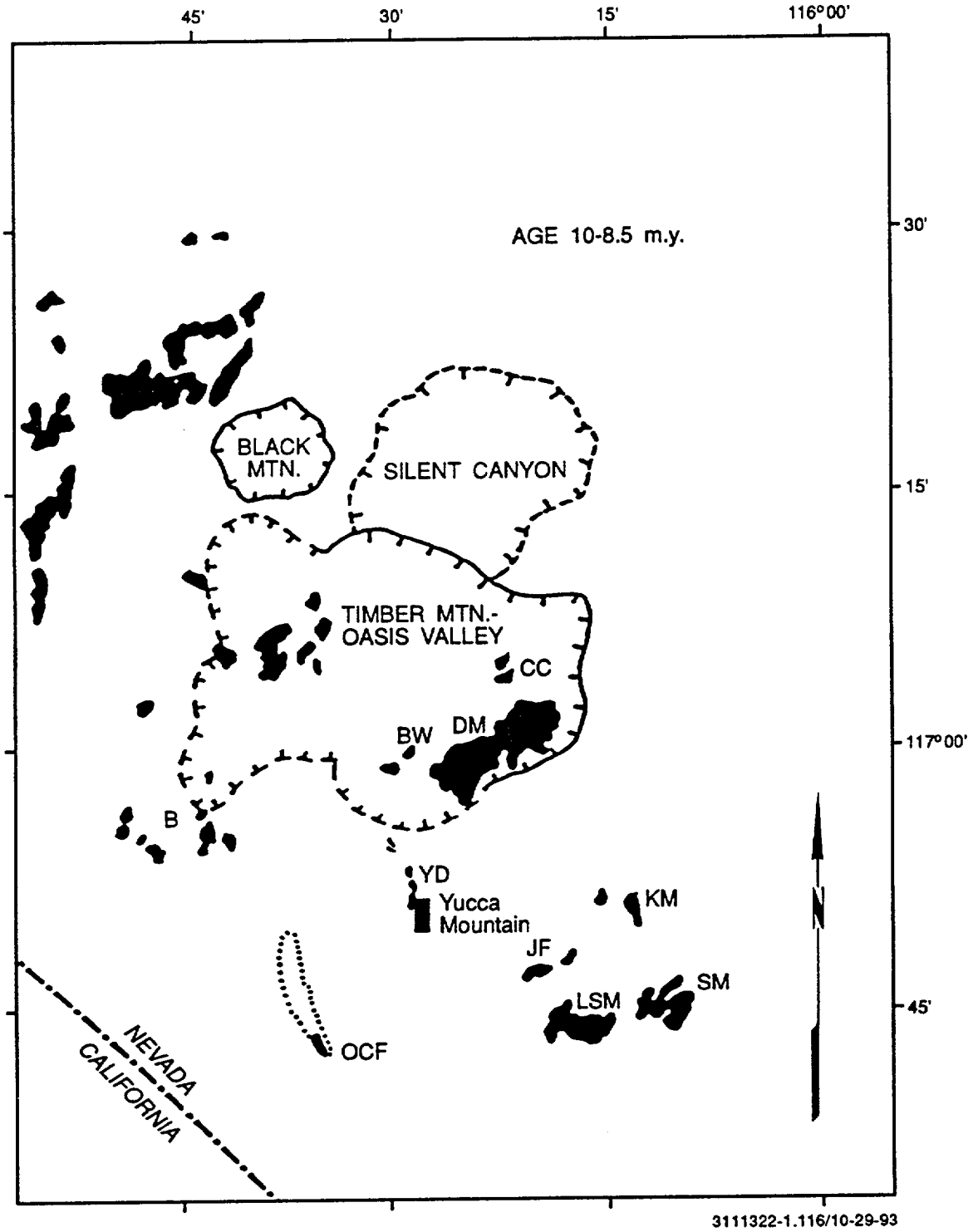


Figure 3.1.1.1.3.2.2-1 Distribution of the Basalt of the Silicic Episode (BSE). CC: basalt of Cat Canyon, DM: basalt of Dome Mountain, BW: basalt of Beatty Wash, B: basalt of the Beatty area, SM: basaltic andesite of Skull Mountain, LSM: Little Skull Mountain, KM: mafic rocks of Kiwi Mesa, JF: basalt of Jackass Flat, YD: dike of Yucca Mountain, OCF: older basalt of Crater Flat (modified from Crowe, 1990).

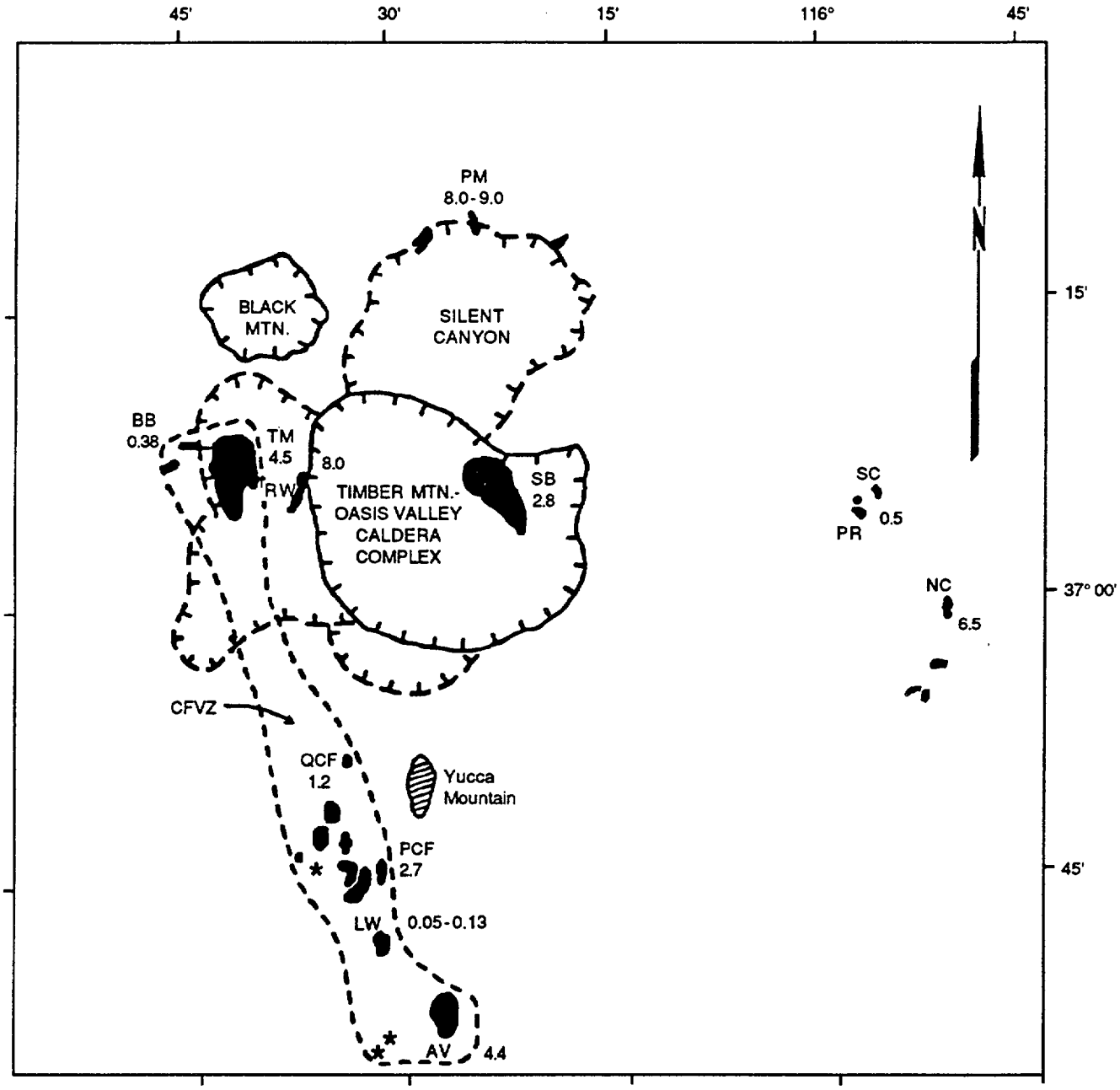


Figure 3.1.1.1.3.2.2-2 Post-Caldera Basalt of the Yucca Mountain region. Shaded areas are the Basalts including: RW: basalt of Rocket Wash, PM: basalt of Pahute Mesa, SC: basalt of Scarp Canyon, NC: basalt of Nye Canyon, TM: basalt of Thirsty Mesa, AV: basalt of Amargosa Valley, PCF: Pliocene basalt of southeast Crater Flat, BB: basalt of Buckboard Mesa, QCF: Quaternary basalt of Crater Flat, SB: basalt of Sleeping Butte, LW: basalt of Lathrop Wells. Asterisks mark aeromagnetic anomalies identified as potential buried basalt centers or intrusions (Kane and Bracken, 1983, Crowe et al. 1986). Dashed lines encloses the area of the Crater Flat Volcanic Zone (CFVZ). Numbers associated with the symbols for the volcanic units are the age of the volcanic centers in million years. Modified from Crowe and Perry (1989).

Figure 3.1.1.1.4.1-1. Map Showing major tectonic elements in the wester Great Basin and Boundary Regions [INN 3.1.1.1.4.1-2]

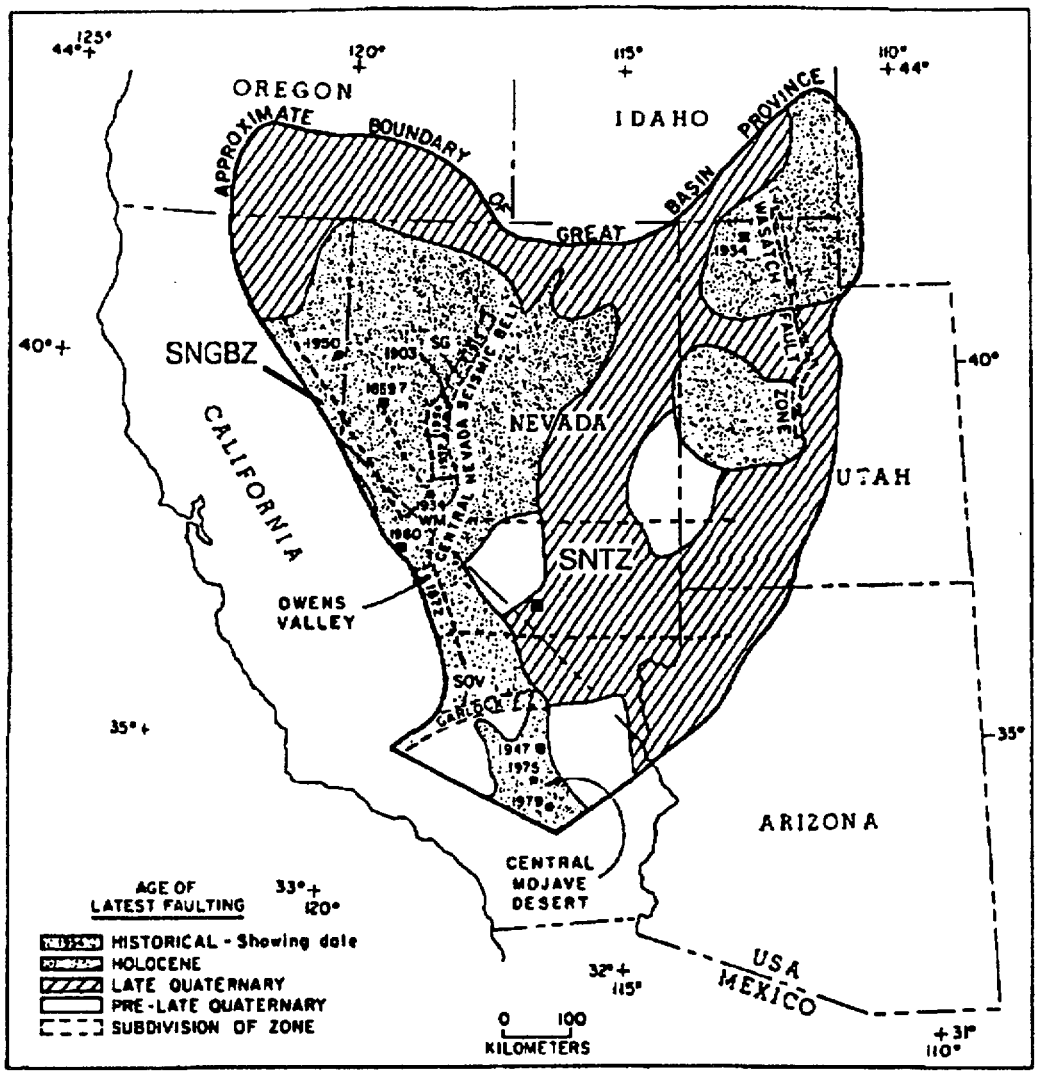


Figure 3.1.1.1.4.1-2. Map of the Great Basin Province Showing Seismic Source Zones. Patterned areas identify regions of coeval Quaternary faulting. Dates refer to historic earthquakes located in the zones. SNGBZ: Sierra Nevada-Great Basin Boundary Zone; SNTZ: Southern Nevada Transverse Zone; SG: Stillwater seismic gap; WM: White Mountains seismic gap; SOV: southern Owens Valley seismic gap. Black square in southern Nevada shows the approximate location of Yucca Mountain. Modified from Wallace (1984).

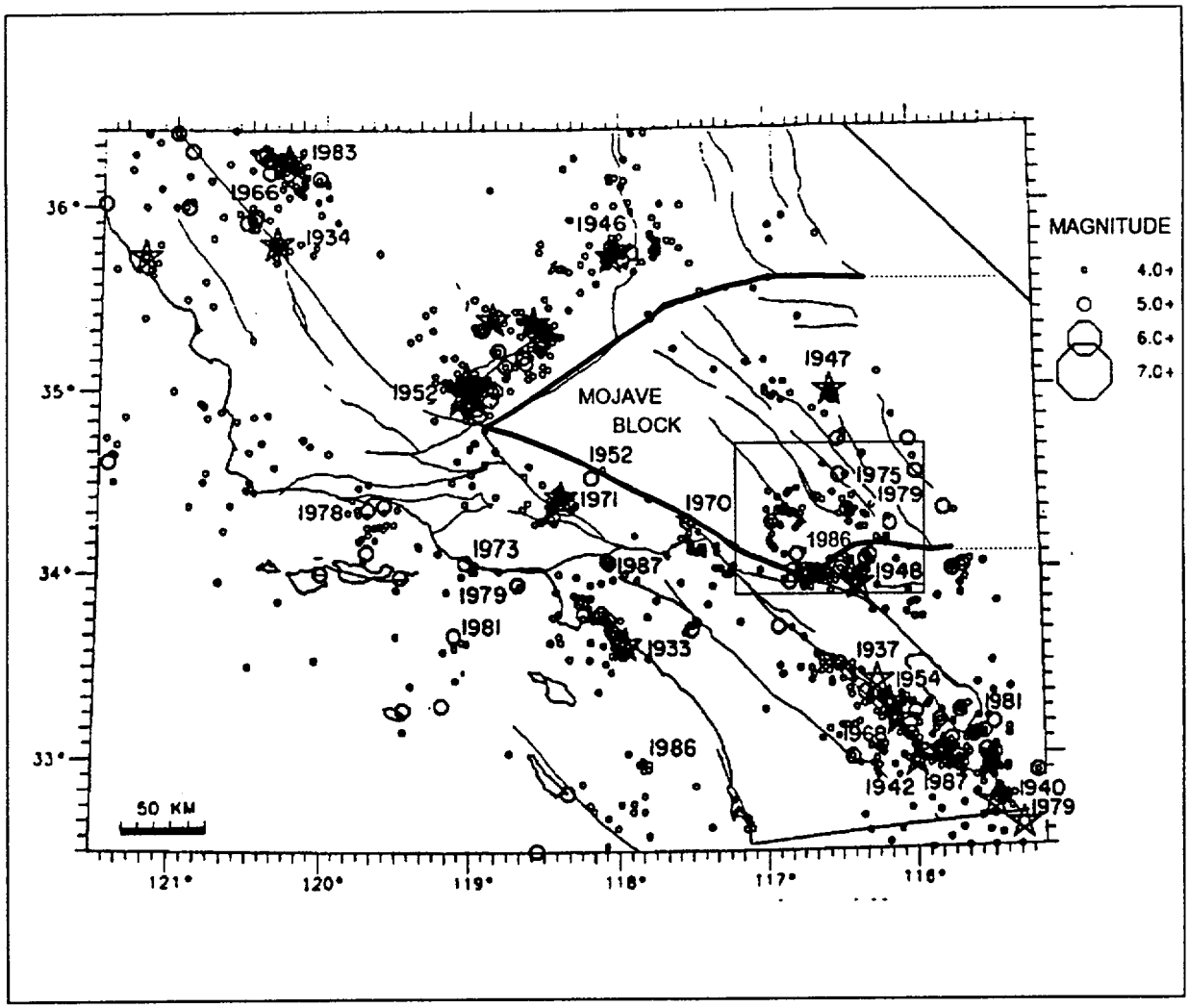


Figure 3.1.1.1.4.1-3. Seismicity in Southern California. Earthquakes ($M_L \geq 4$) recorded by the Southern California Seismic Network (CIT) from 1932 to 1987. Earthquakes of $M_L \geq 6$ are shown by a star and a date. Light lines identify Quaternary faults in the region (Jennings, 1975) and the bold line outlines the Mojave Block discussed in the text. Dashed lines show the projection of the Mojave Block to the state border. The square represents the location of Figure 3.1.1.1.3.2.2-10 showing the events in the 1992 M_s 7.6 Landers earthquake sequence. Modified from Hutton et al. (1991).

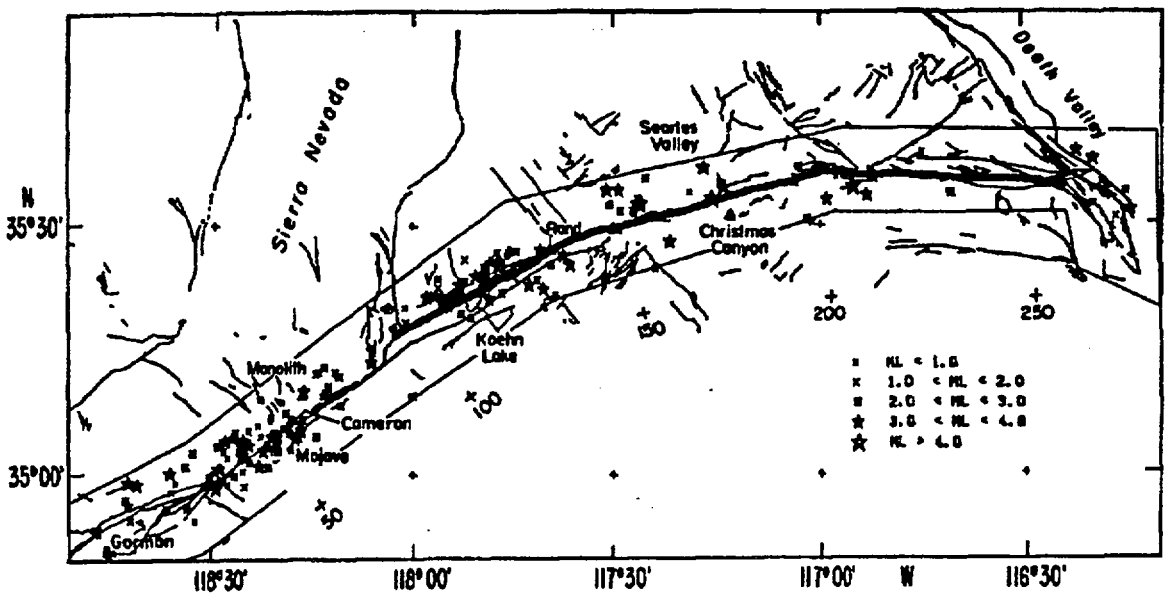


Figure 3.1.1.1.4.2-1. Map of the Garlock Fault Zone. GFZ outlined by light lines; stars represent earthquakes recorded from 1932 to 1981 (Astiz and Allen, 1983). Heavy line identifies the central and eastern segments of the fault considered by Astiz and Allen (1983) to be a seismic gap. Numbers in the figure correspond to distances in kilometers from Gorman near the intersection with the San Andreas fault. Modified from Astiz and Allen (1983).

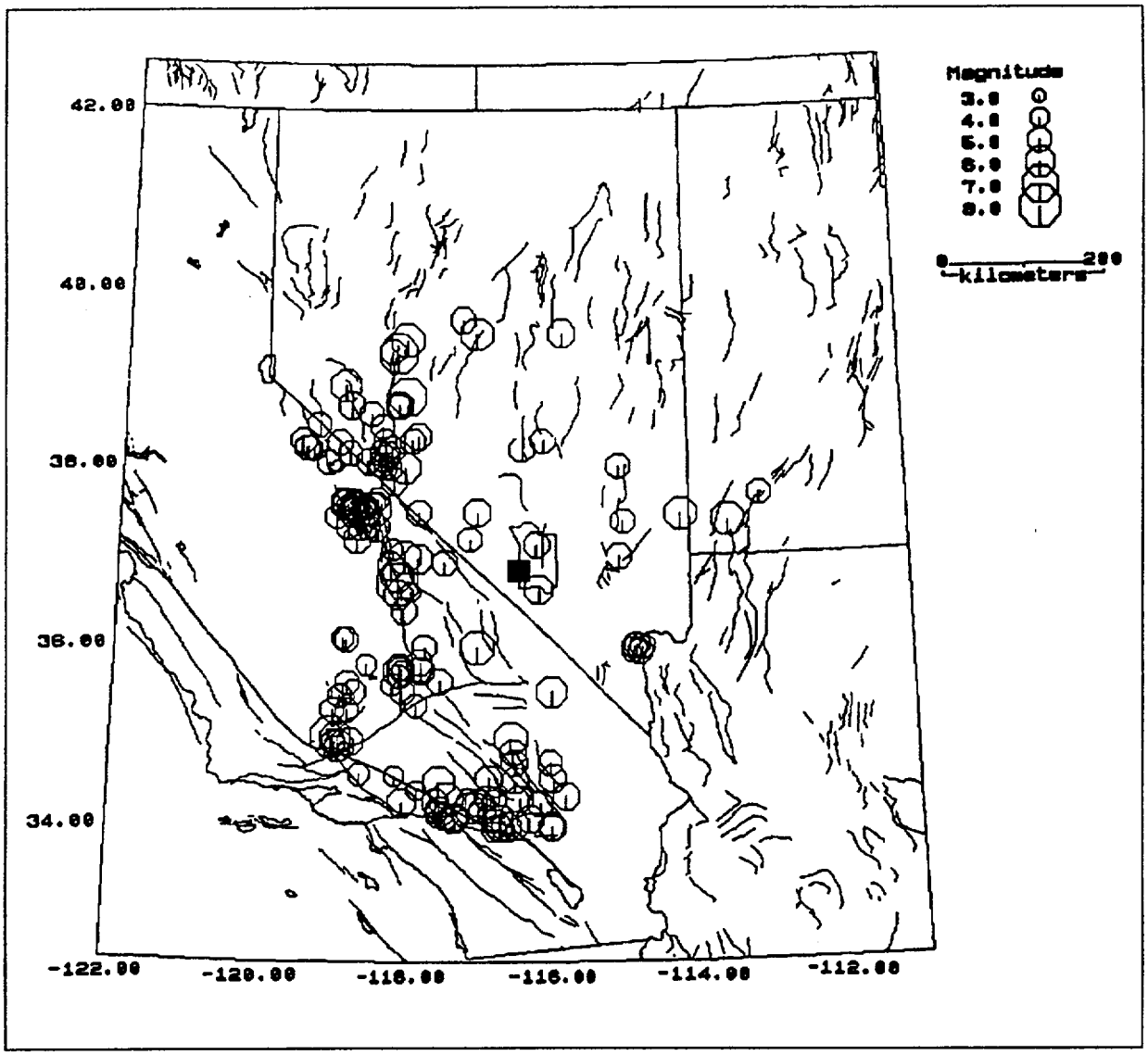


Figure 3.1.1.1.4.2.1-1. Magnitude 5 or Greater Earthquakes within 200 Miles of Yucca Mountain. Octagons represent epicentral location of earthqukaes, scaled in size relative to the magnitude. Light lines are Quaternary faults in the region; in California from Jennings (1975). Solid square is approximate location of Yucca Mountain. See text for sources of earthquake data.

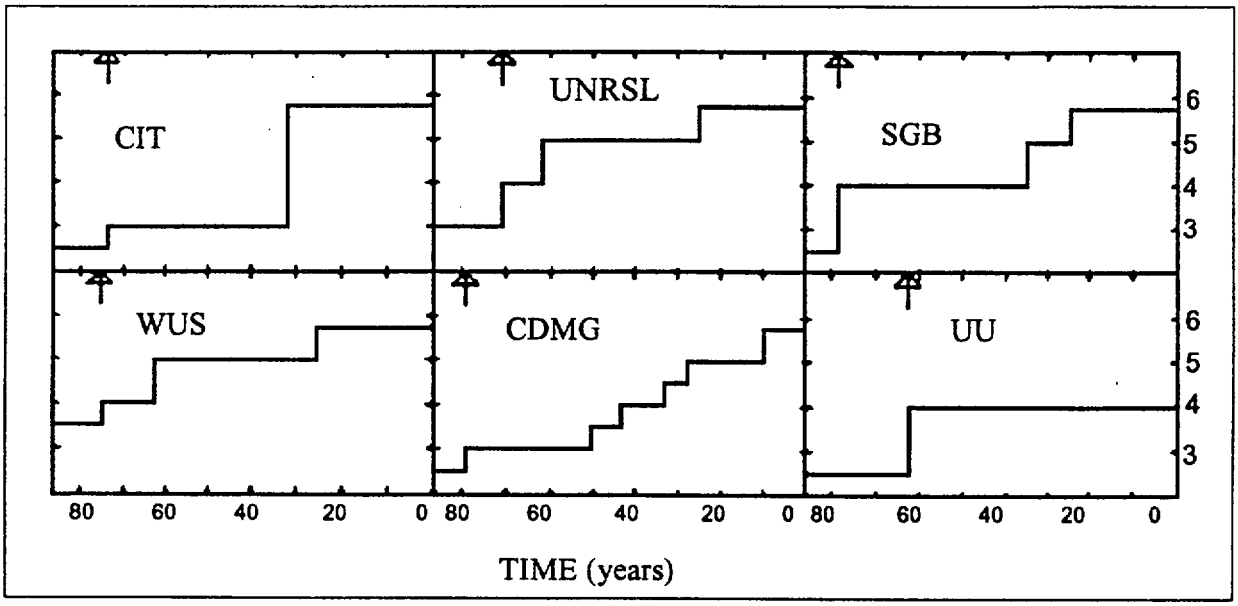


Figure 3.1.1.1.4.2.1-2. Time -Dependent Magnitude Completeness Thresholds for Regional Seismic Networks Covering the Great Basin. The transition from historic data to modern data is shown for each region by the vertical arrows. Horizontal axis represents time in years from 1900. Vertical axis represents earthquake magnitude. Abbreviations in each frame identify the seismic network or the region covered by several networks: CIT = California Institute of Technology; UNRSL = University of Nevada, Reno Seismological Laboratory; SGB = Southern Great Basin network; UU = University of Utah; CDMG = California Division of Mines and Geology; WUS = Western U.S. region covered by several networks. See text for further discussion. Modified from Engdahl and Rinehart (1991).

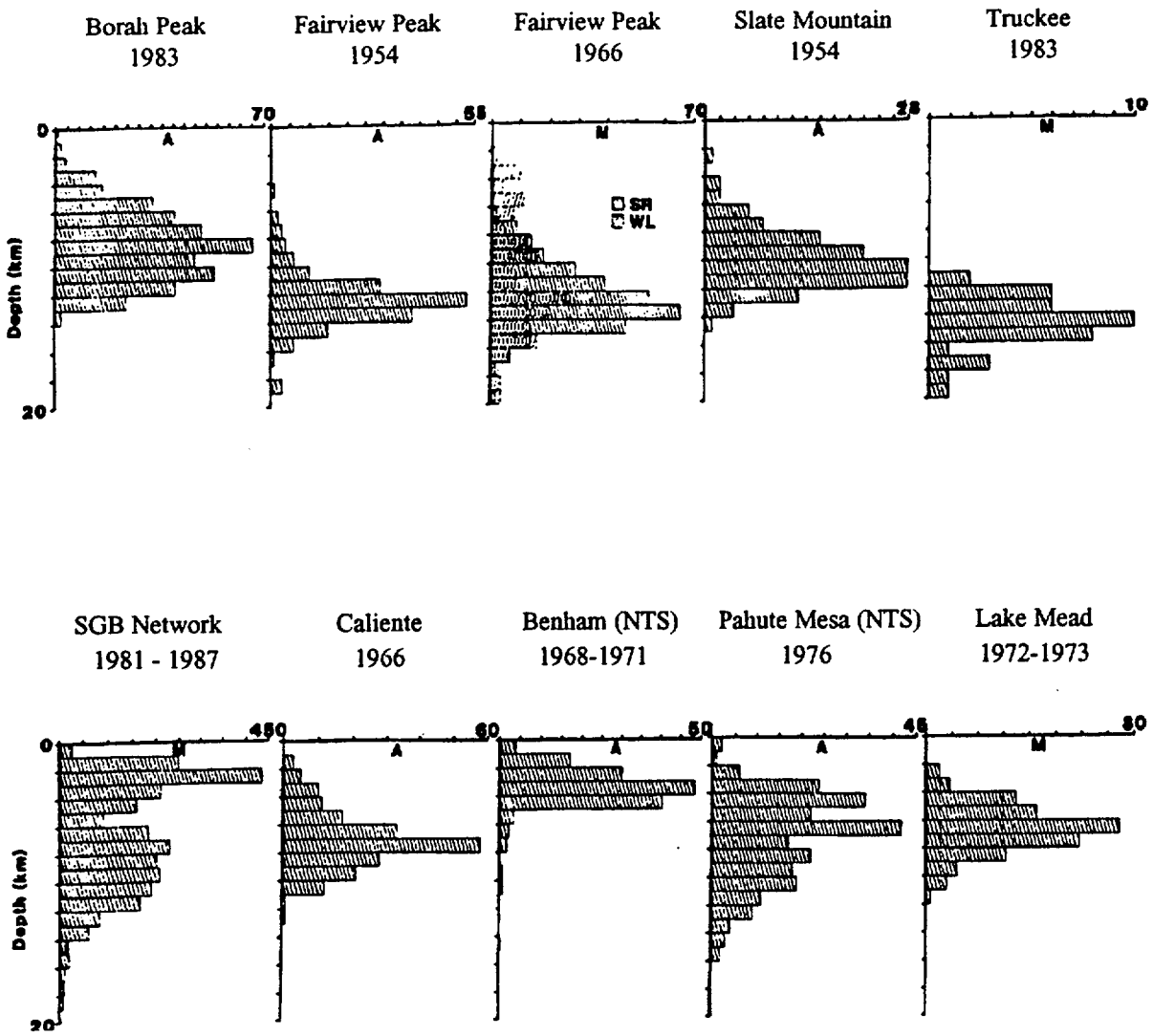


Figure 3.1.1.1.4.2.1-3. Focal Depth Distribution for Various Source Regions in the Great Basin. Data from aftershock studies are denoted by **A** and include studies of seismicity following nuclear tests (Benham and Pahute Mesa histograms). Data from microearthquake monitoring are denoted by **M**. Date refers to the year of the mainshock or blast for aftershock studies and monitoring period for microearthquake surveys. The number of earthquakes in each region is shown by the bars and the scale on the abscissa. For 9 out of 10 data sets, less than 1 percent of the events are located below 20 km. For the Fairview Peak region about 8 percent of the events have focal depths greater than 20 km (Westphal and Lange, 1967; **WL** in the figure). A study by Stauder and Ryall (1967) show a different depth distribution for Fairview Peak events (**SR** in the figure). Modified from Rogers et al. (1991).

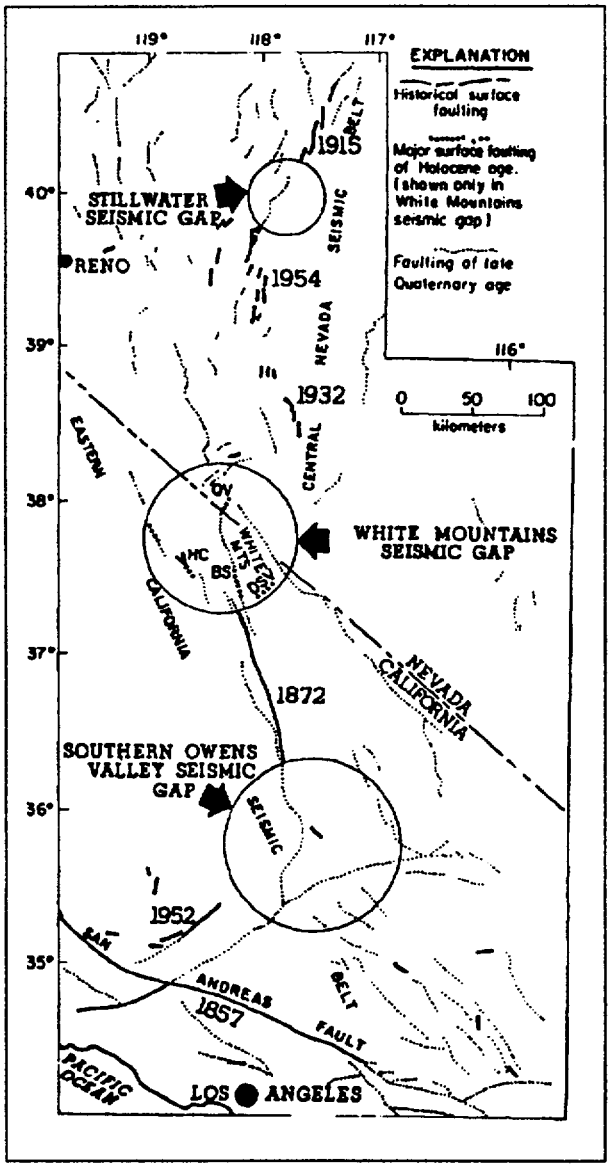


Figure 3.1.1.1.4.2.1-4. Map of a Portion of the Western Great Basin Showing Seismic Gaps Located in the SNGBZ, CNSB, and the GFZ. The eastern California seismic belt is coincident with the SNGBZ netween 39° north and the GFZ. Dates and bold lines represent surface ruptures of historic earthquakes larger than M 6.8. Major Holocene surface faults shown in the White Mountains seismic gap are: the Hilton Creek fault (HC); two segments in the White Mountains fault zone (QV and BS); and the Deep Springs Valley fault (DSV). Figure taken from Hill et al. (1985).

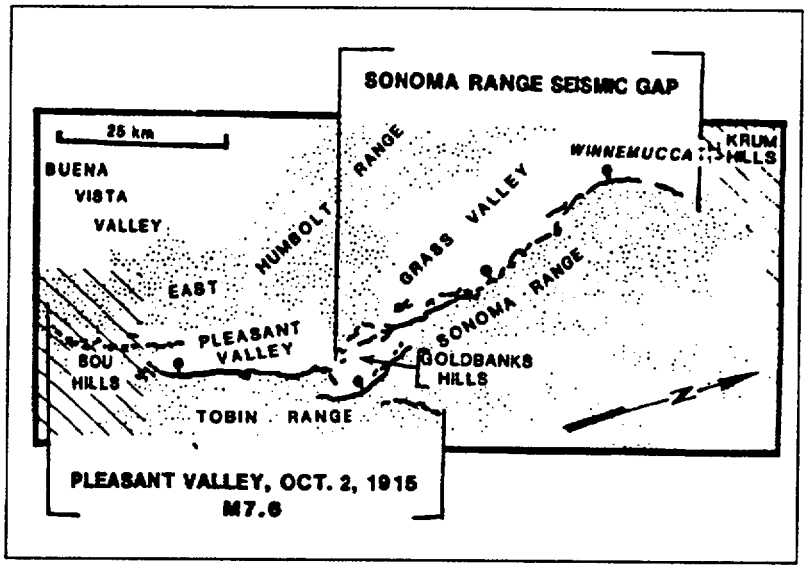


Figure 3.1.1.1.4.2.1-5. Map of Surface Faulting in the Northern CNSB. Surface ruptures of the 1915 Pleasant Valley, Nevada, earthquake are from Wallace (1979, 1984). Sonoma Range seismic gap (Thenhaus and Barnard, 1989) shows Holocene scarps from Wallace (1979). Ruled regions represent intersection of the central (left side of figure) and northern (right) extensional accommodation zones where they cross the fault zone. Figure taken from Thenhaus and Barnard (1989).

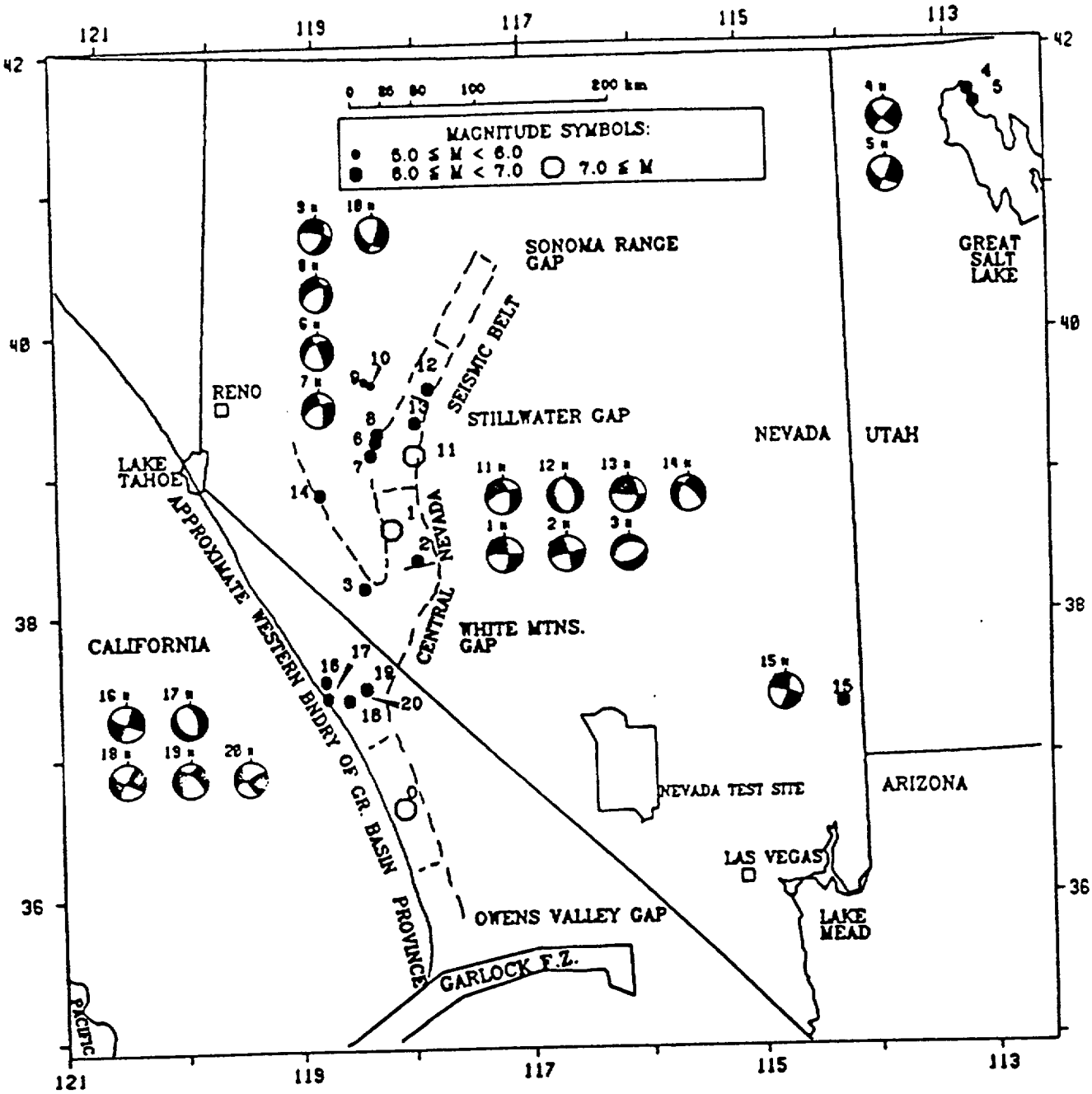


Figure 3.1.1.1.4.2.1-6. Map Showing Earthquake Locations and their Focal Mechanisms Computed by Body-Waveform Inversion for Great Basin Earthquakes having M ≥ 5.0 for the Time Period 1932 through 1986. In the case of Mammoth Lakes, the non-double-couple component of the solution is substational (Sipkin, 1986). Focal mechanisms 1 to 14 were computed to Doser (1986, 1987), 15 by Wallace et al. (1983), 16 and 17 by Sipkin (1986), 18 by Barker and Wallace (1986), 19 and 20 by Cockerham and Corbett (1987). Boundaries of Central Nevada Seismic Belt from Wallace (1984a), and Garlock Fault Zone from Astiz and Allen (1983). From Rogers et al., 1991

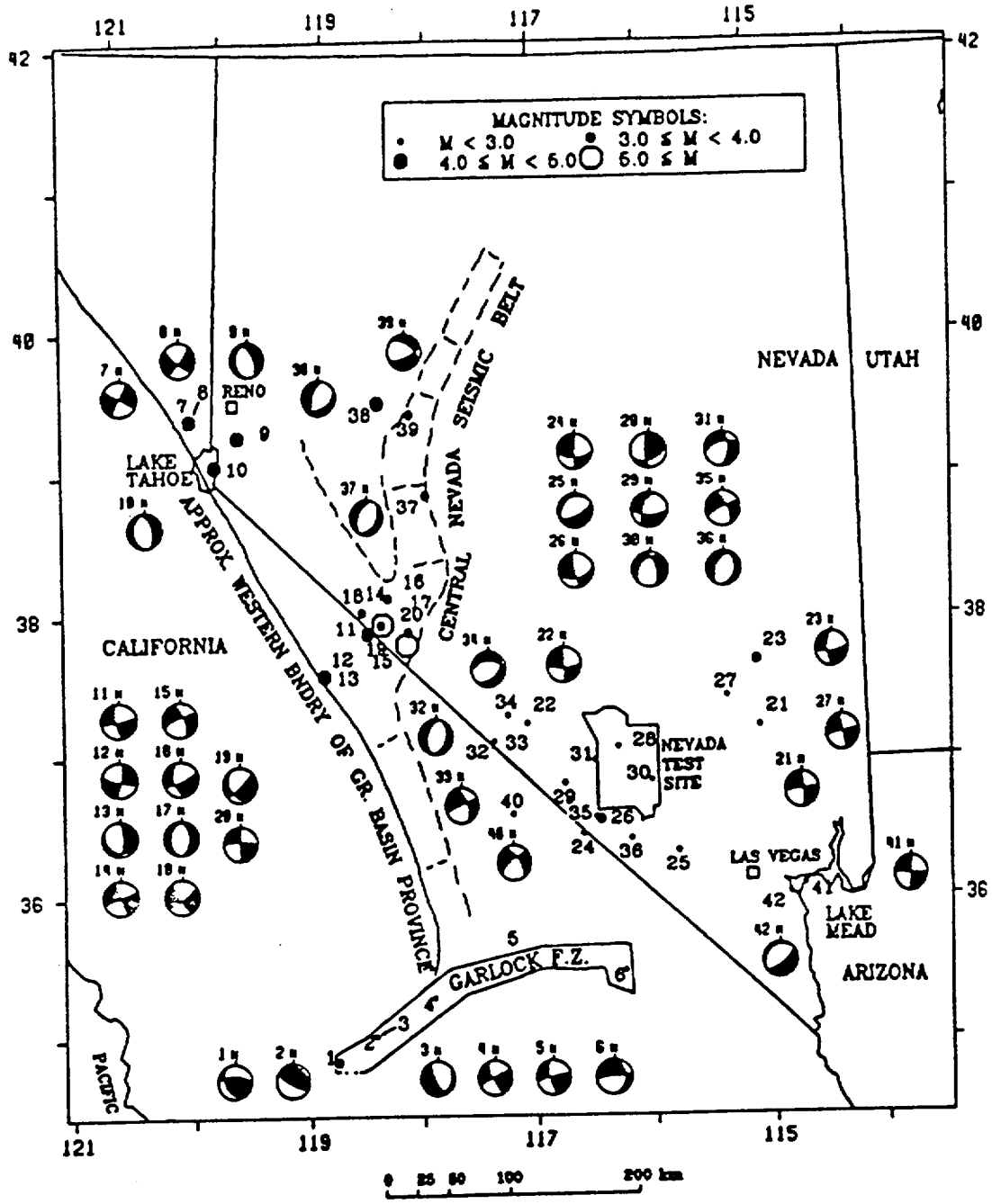


Figure 3.1.1.1.4.2.1-7. Map Showing Earthquake Locations and Their Focal Mechanisms Computed from First-Motion P-Wave Arrivals at Local Seismograph Networks in the Great Basin and Garlock Fault Zone. Focal mechanisms 1 through 6 from Astiz and Allen (1983), 7 through 20 and 37 through 39 from Vetter and Ryall (1983) and Vetter (1984), 21 through 24 Rogers et al. (1987), and 25 through 36 and 40 from Harmsen and Rogers (1987). From Rogers et al., 1991

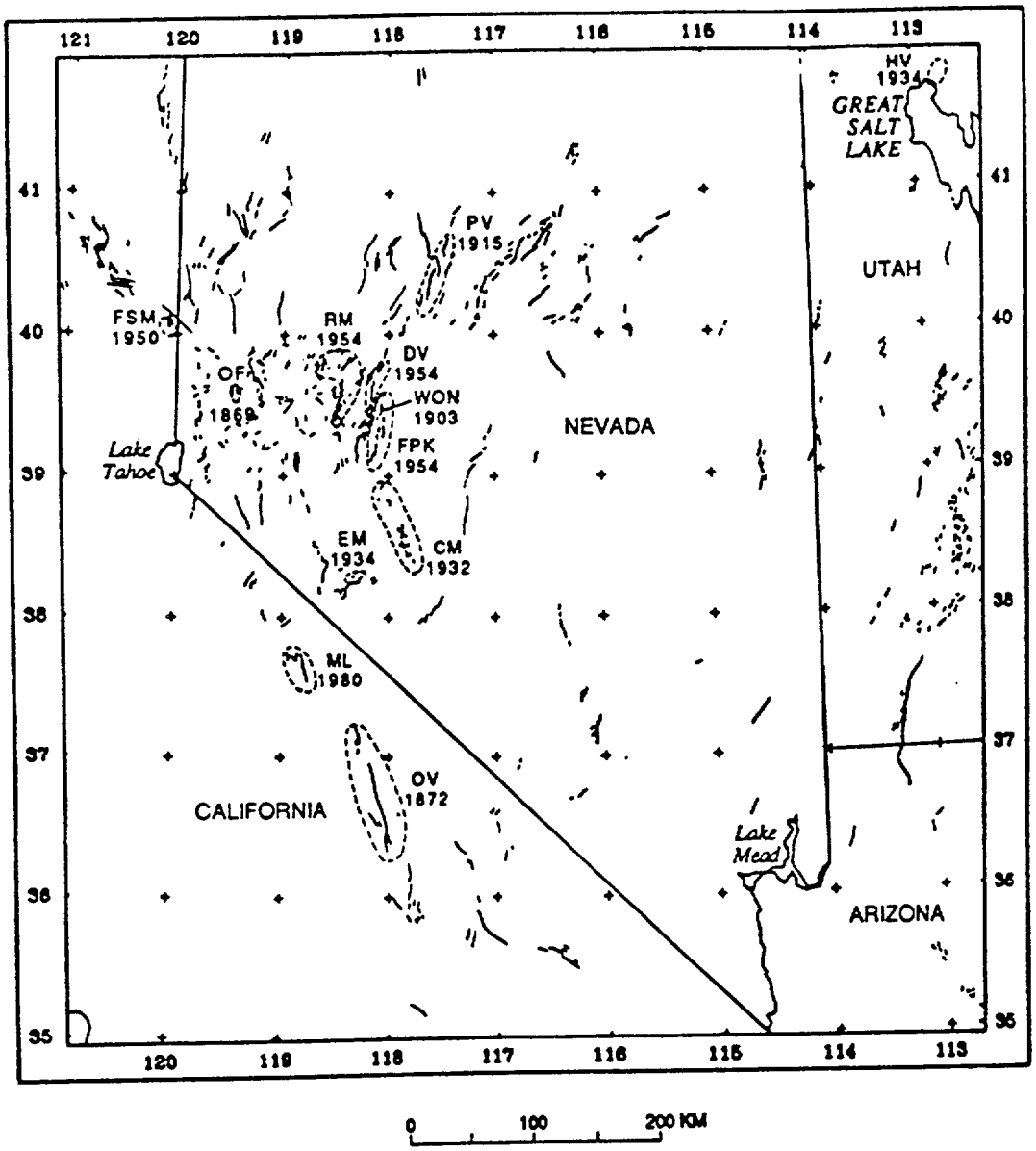


Figure 3.1.1.1.4.2.2-1. Map of Historic (Red), Holocene (Shaded Red), and Late Quaternary (Gray) Faulting in Nevada and Vicinity. Faulting has been adopted from Nakata et al. (1982) by Thenhaus and Barnard (1989). Symbols are: CM-Cedar Mountain; DV-Dixie Valley; EM-Excelsior Mountain; FPK-Fairview Peak; FSM-Fort Sage Mountain; HV-Hansel Valley; ML-Mammoth Lakes; OV-Owens Valley; OF-Olinghouse; PV-Pleasant Valley; RM-Rainbow Mountain; WON-Wonder

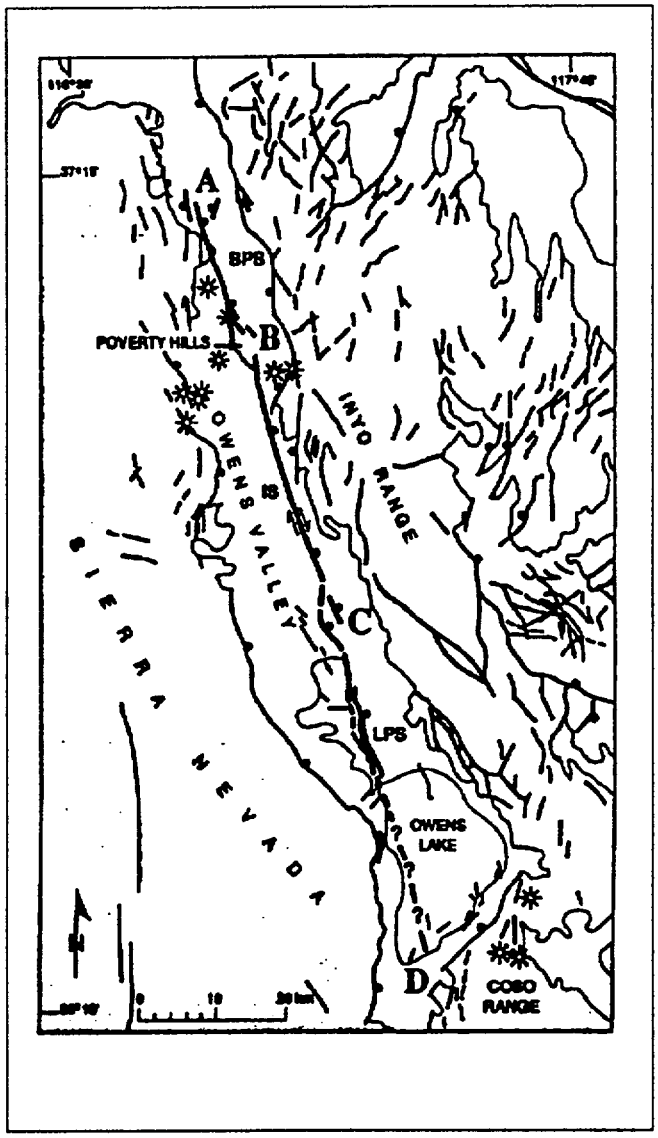


Figure 3.1.1.1.4.2.2-2. Surface Ruptures from the 1872 Owens Valley Earthquake. Bold lines represent ruptures from the 1872 event. Medium weight lines denote other faults. Balls are shown on the downthrown side of faults with normal components. Arrows indicate sense of slip on strike slip segments of the rupture. Stars represent Quaternary volcanic centers. Letters refer to points discussed in the text. Figure taken from dePolo et al. (1991).

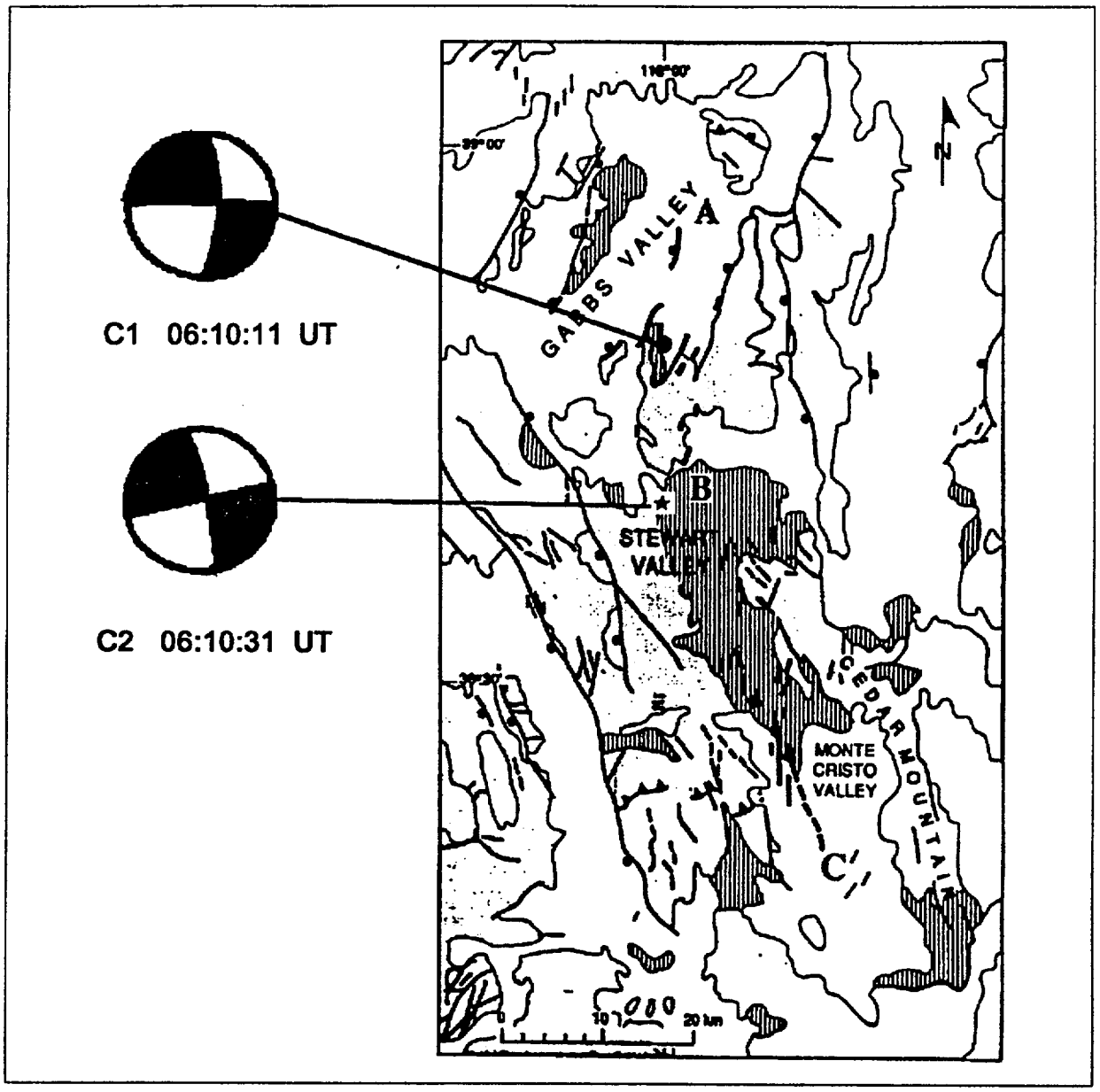


Figure 3.1.1.1.4.2.2-3. Surface Ruptures and Focal Mechanisms from the 1932 Cedar Mountain Earthquake. Vertical patterns are Tertiary sediments. Focal mechanisms are equal-area, lower focal sphere projections; white indicates regions of dilatation (from Doser, 1988). Mechanism **C1** is for the first subevent in the mainshock; **C2** is for the subevent occurring 20 sec later. The location for **C2** (star) follows Doser's hypothesized projection. **A**, **B**, and **C** refer to locations discussed in the text. Modified from dePolo et al. (1991).

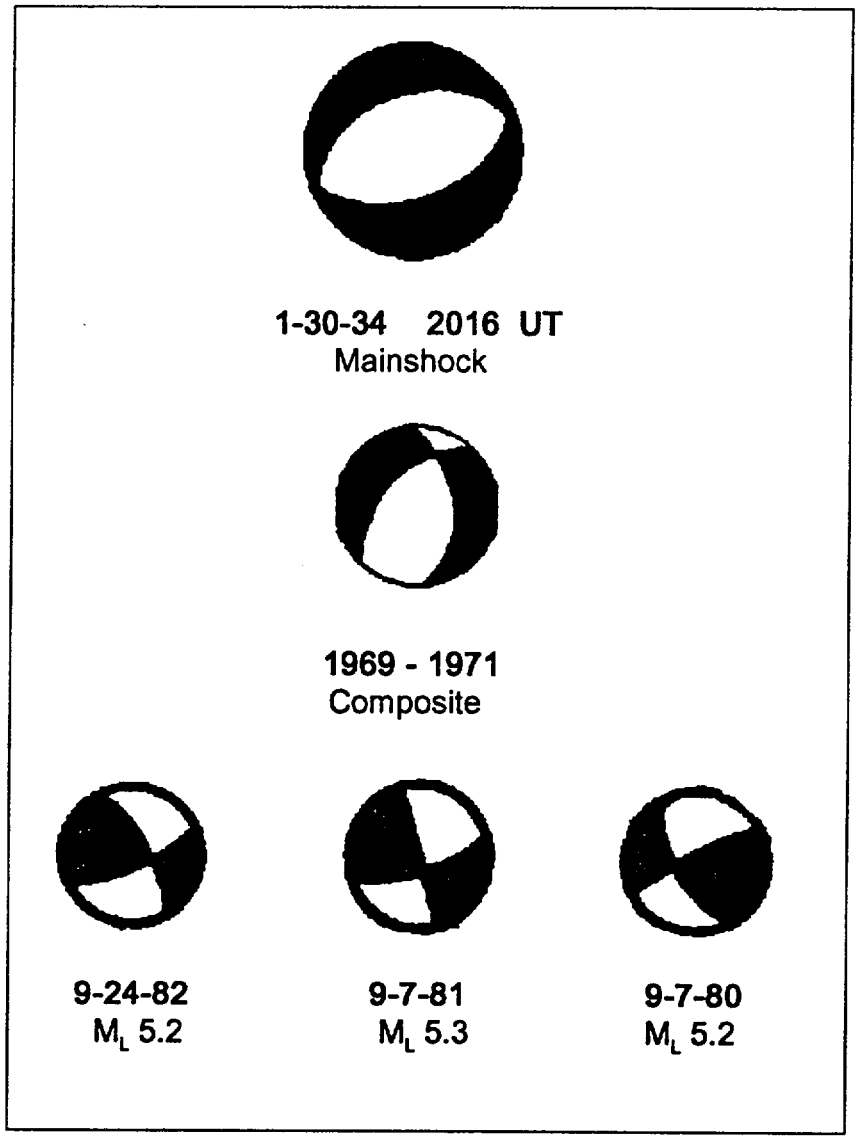


Figure 3.1.1.1.4.2.2-4. Focal Mechanisms for Earthquakes in the Excelsior Mountain Region. Top: 1934 mainshock (Doser, 1988). Middle: composite data from 1969-1971 UNRSL network recordings in the region (Ryall and Priestly, 1975). Bottom: three M 5 earthquakes located southwest of Excelsior Mountain (Vetter, 1990).

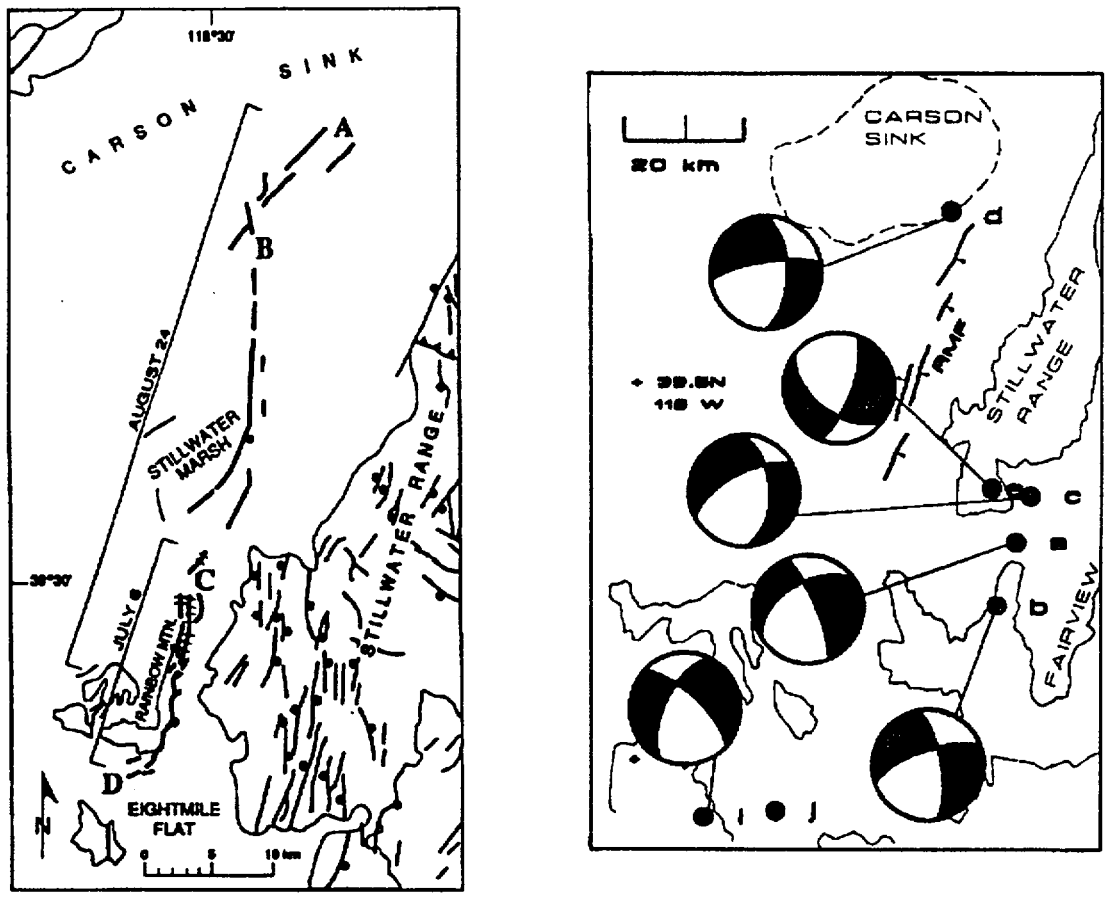


Figure 3.1.1.1.4.2.2-5. Surface Ruptures and Focal Mechanisms for Earthquakes in the 1954 Rainbow Mountain-Stillwater Sequence. The detailed surface ruptures from dePolo et al. (1991) are shown as bold lines in the left frame. The hachured line show the ruptures that occurred in both the July 6 (Rainbow Mountain) and August 24 (Stillwater) earthquakes. Brackets show the extent of rupture in each event. Letters refer to locations discussed in the text. Left frame from dePolo et al. (1991). Right frame is a larger scale map showing the focal mechanisms from earthquakes in this sequence. Focal mechanisms are based on body-wave inversion by Doser (1986). Events are: 7/6/54 - 1113 UT (a); 7/6/54 - 2207 UT (b); 8/24/54 (c); 8/31/54 (d); 9/1/93 (e); 6/23/59 - 1435 UT (i); 6/23/59 - 1504 UT (j). Right frame modified from Doser (1986).

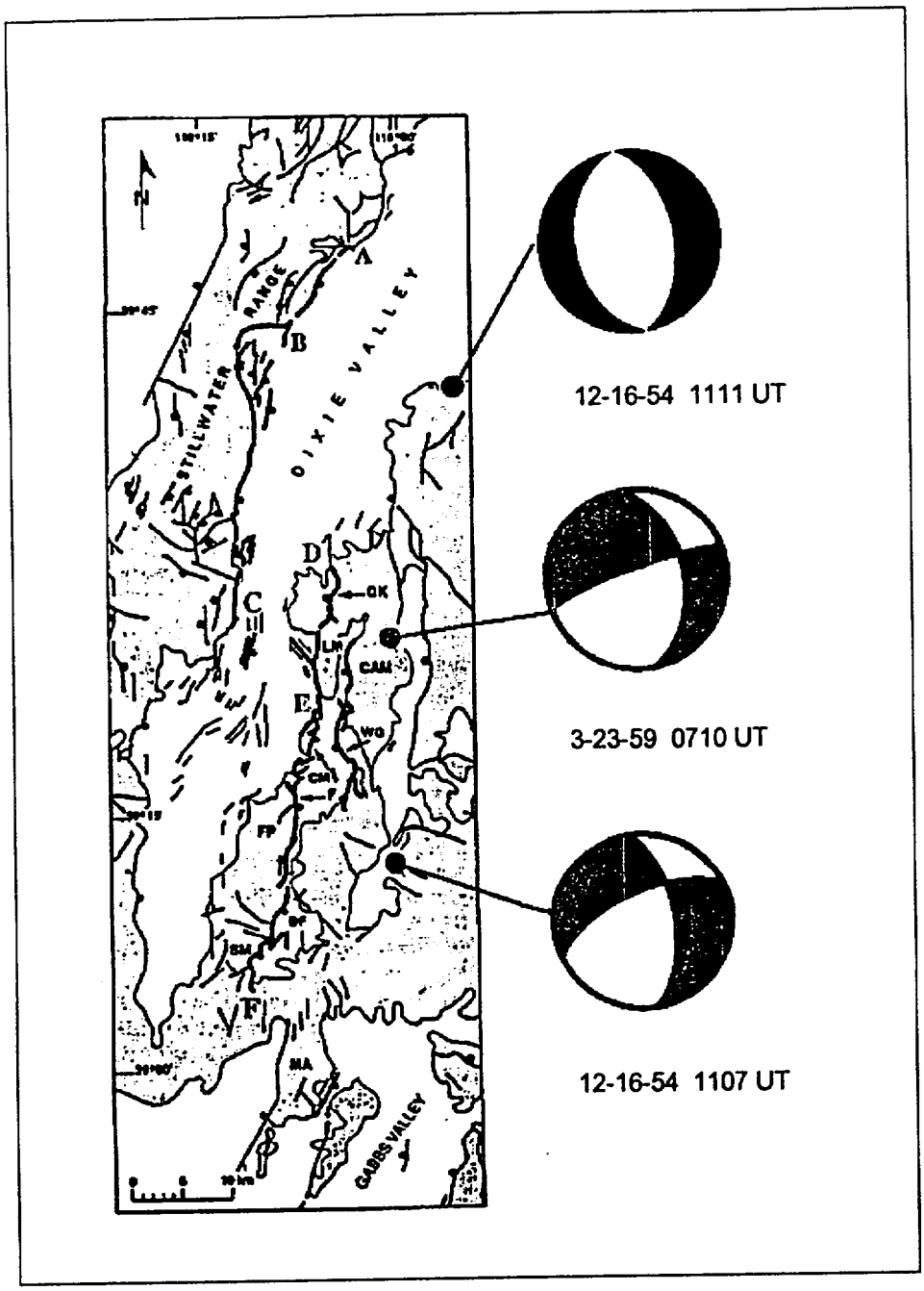


Figure 3.1.1.1.4.2.2-6. Surface Ruptures and Focal Mechanisms for Earthquakes in the Fairview Peak-Dixie Valley Sequence. Surface ruptures from the 1954 Fairview Peak and Dixie Valley earthquakes are shown as bold lines (dePolo et al., 1991). Letters identify fault segments from de Polo et al. (1991) as follows: GK = Gold King segment, LM = Louderback Mountain, CAM = Clan Alpine Mountains, WG = West Gate segment, CM = Chalk Mountain, MA = Mounta Anna. Earthquake epicenters (dark circles) and focal mechanisms are from Doser (1986). Base map modified from dePolo et al. (1991).

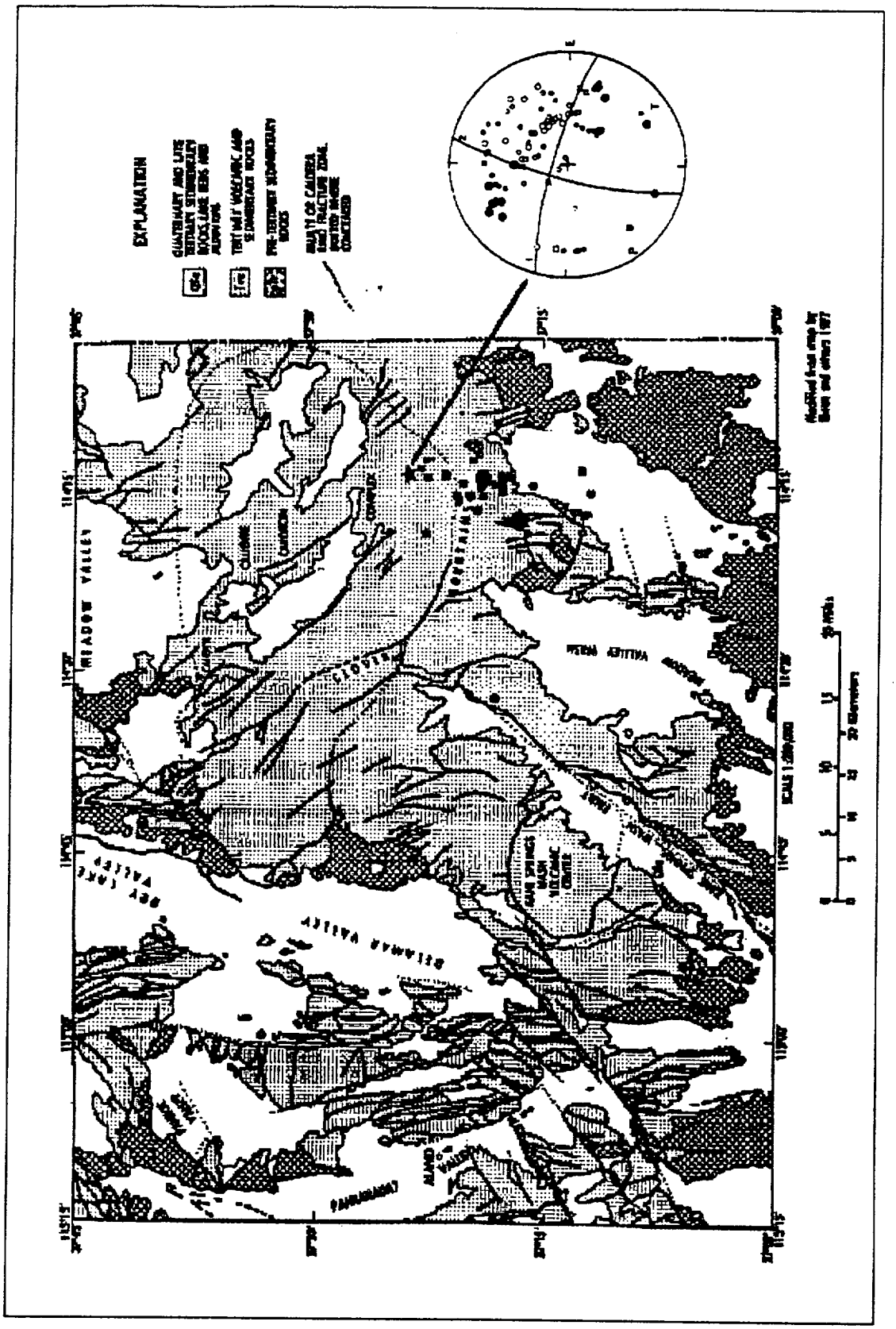


Figure 3.1.1.1.4.2.2-7. Caliente-Clover Mountain Earthquake. Focal mechanism from Smith and Sbar (1974).

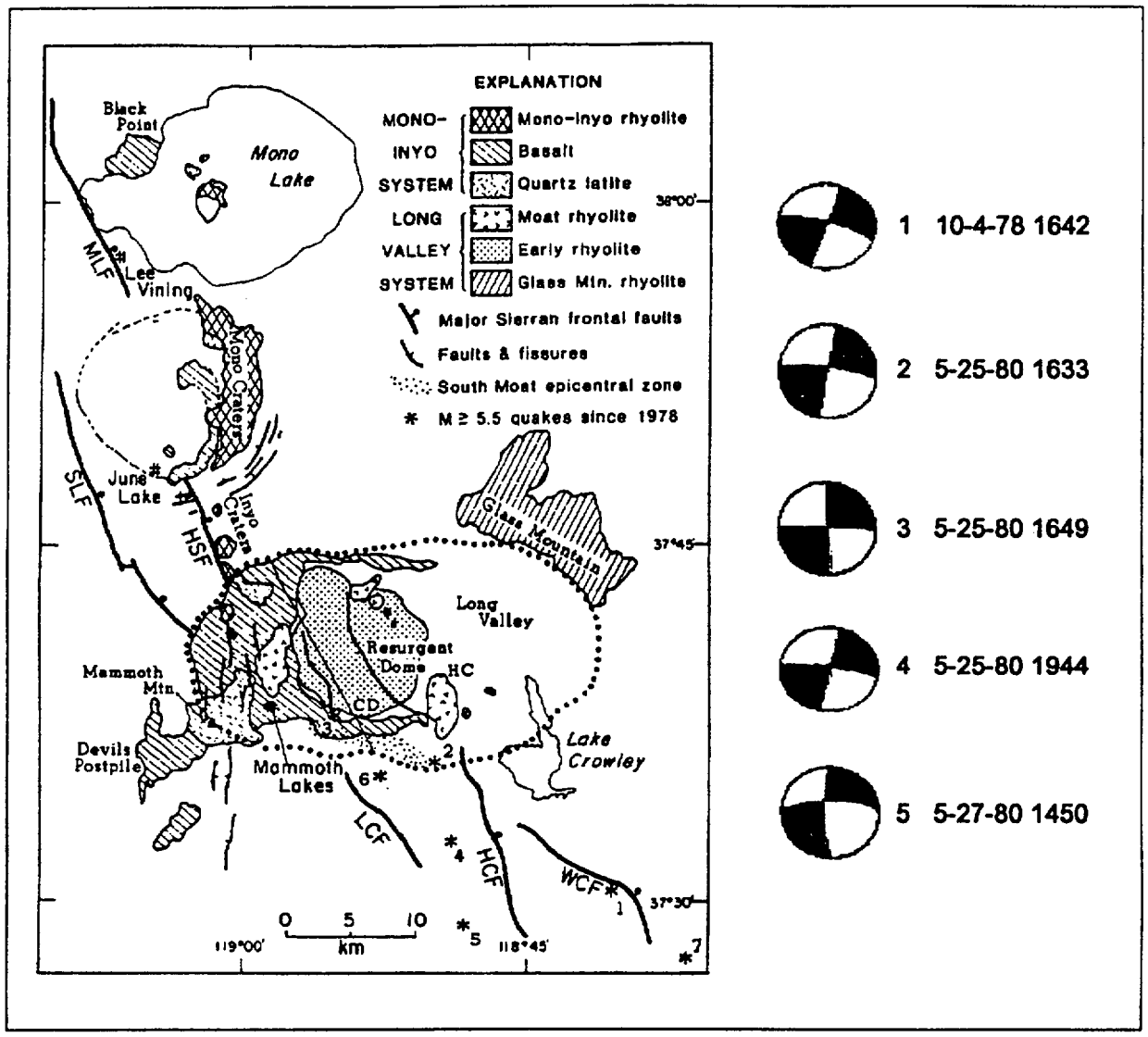


Figure 3.1.1.1.4.2.2-8. Geologic Map of the Long Valley Region with Earthquake Focal Mechanisms. Map shows the distribution of volcanic rocks related to the Long Valley and Inyo/Mono magmatic systems (Hill et al., 1985). HSF, Hartly Springs fault, HCF; Hilton Creek fault; SLF, Silver Lake fault; WCF, Wheeler Crest fault; CD, Casa Diablo hot spring; HC, Hot Creek hot spring. Focal mechanisms are based on short period data from Cramer and Toppozada (1980). Numbers to the right of focal mechanisms refer to map locations. See Table 3.1.1.1.4.2.-1 for magnitudes of the events.

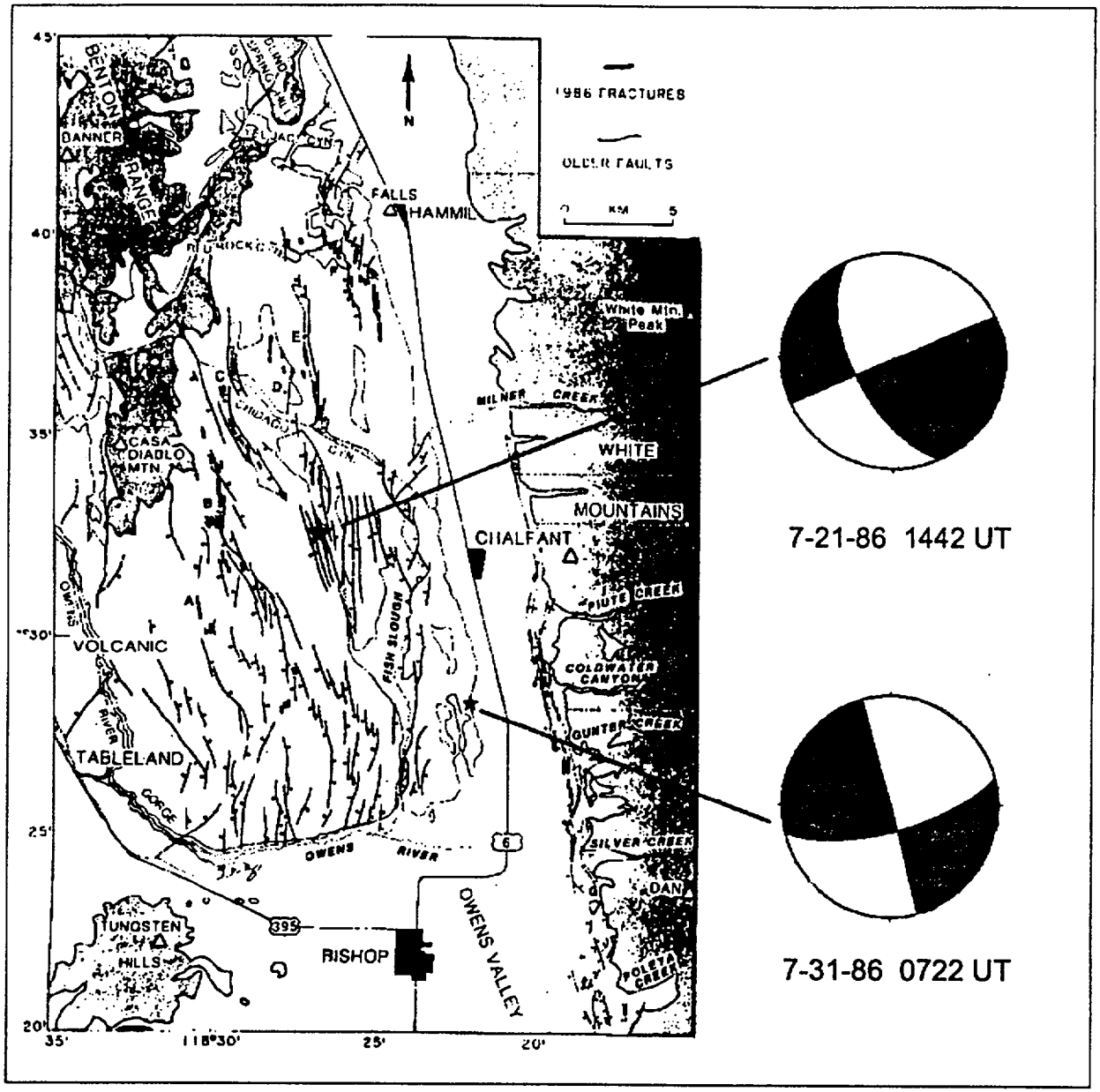


Figure 3.1.1.1.4.2.2-9. Surface Ruptures and Focal Mechanisms for 1986 Chalfant Valley Earthquake Sequence. Surface ruptures shown as bold lines in the Volcanic Tableland and along the White Mountains frontal fault zone (Lienkaemper et al., 1987). Letters **A** - **F** identify fracture zones in the Volcanic Tableland. Large star indicates the location of the July 21 mainshock (M_w 6.2); small star indicates location of the largest aftershock on July 31 (M_w 5.5). Focal mechanisms from Cockerham and Corbett (1987). Base map from Lienkaemper et al. (1987).

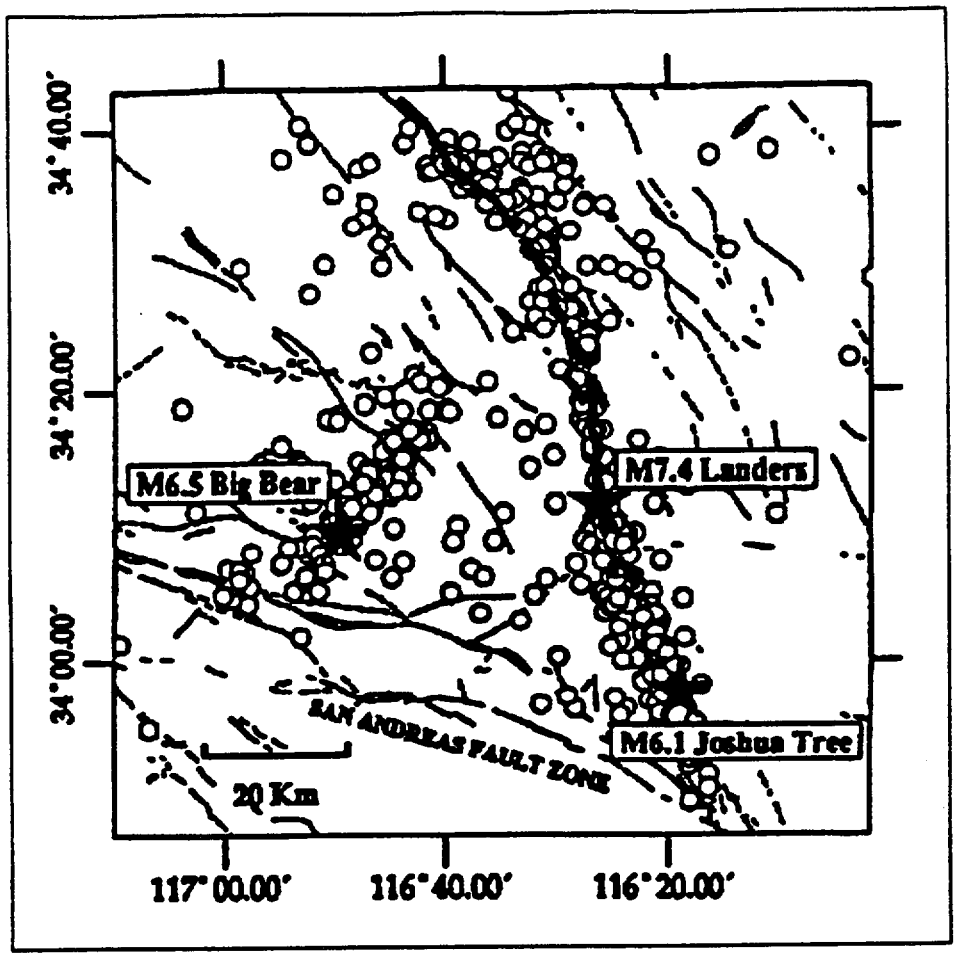


Figure 3.1.1.1.4.2.2-10. Epicentral Region of the 1992 Landers, California, Earthquake. Stars represent significant events in the sequence, circles are locations of aftershocks. Bold lines denote surface rupture in the mainshock, light lines are other Quaternary faults. Taken from Campillo and Archuleta (1993).

AREA (MINE, DISTRICT, FIELD, STATE, ETC.) UNITS (TONS, BARRELS, OUNCES, ETC.)

CUMULATIVE PRODUCTION	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	DEMONSTRATED		INFERRED	PROBABILITY RANGE (or)	
	MEASURED	INDICATED		HYPOTHETICAL	SPECULATIVE
ECONOMIC	RESERVES		INFERRED RESERVES		
MARGINALLY ECONOMIC	MARGINAL RESERVES		INFERRED MARGINAL RESERVES		
SUB-ECONOMIC	DEMONSTRATED SUBECONOMIC RESOURCES		INFERRED SUBECONOMIC RESOURCES		

OTHER OCCURRENCES	INCLUDES NONCONVENTIONAL AND LOW-GRADE MATERIAL

Figure 3.1.1.1.5-1. Major Elements of Mineral-Resource Classification. Modified from USBM/USGS (1980) from the SCP

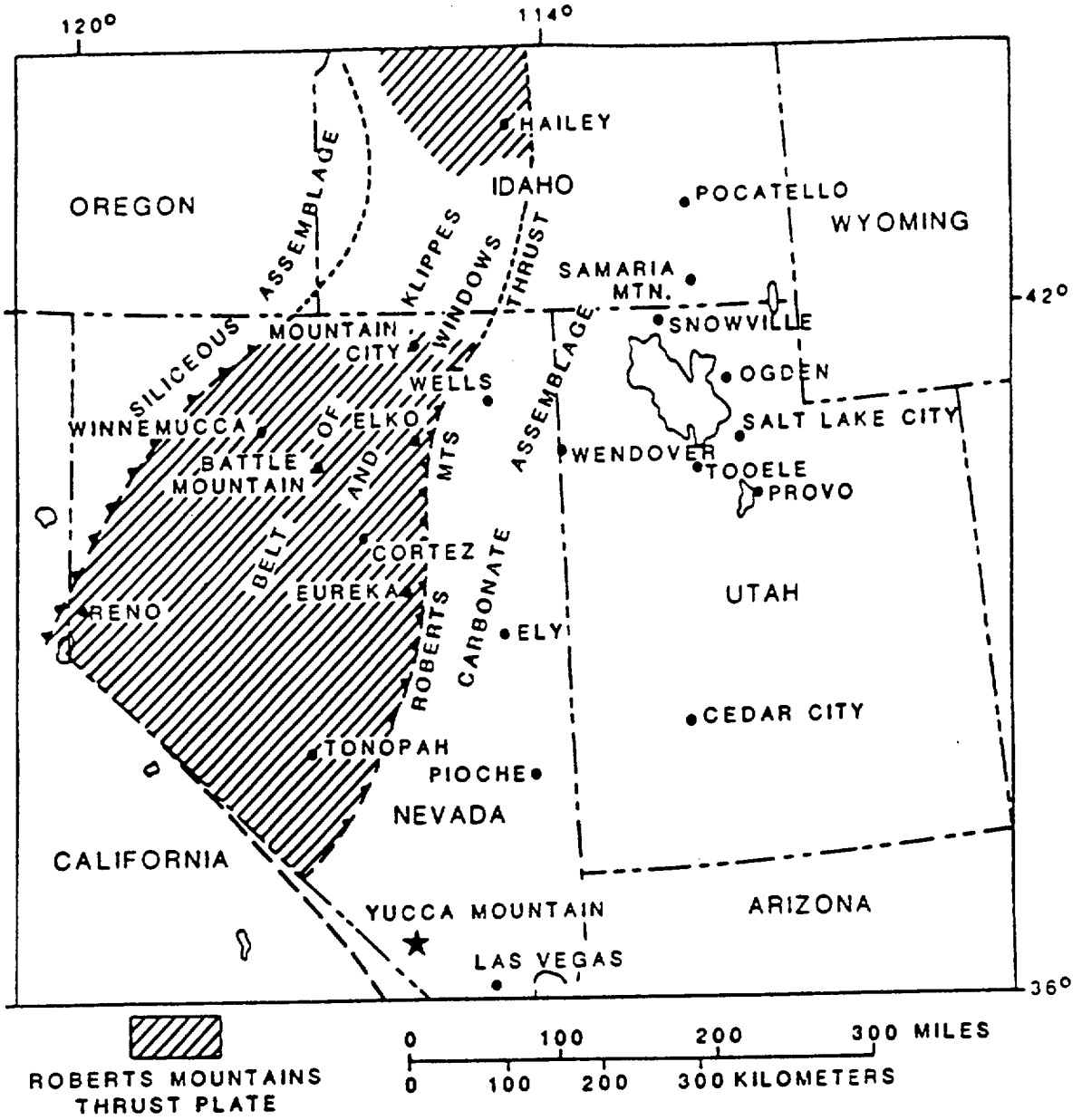


Figure 3.1.1.1.5.2.1-1. Map Showing Distribution of Paleozoic Rocks in Roberts Mountains Thrust Plate after Mississippian Thrusting. Modified from Roberts, et al. (1971).

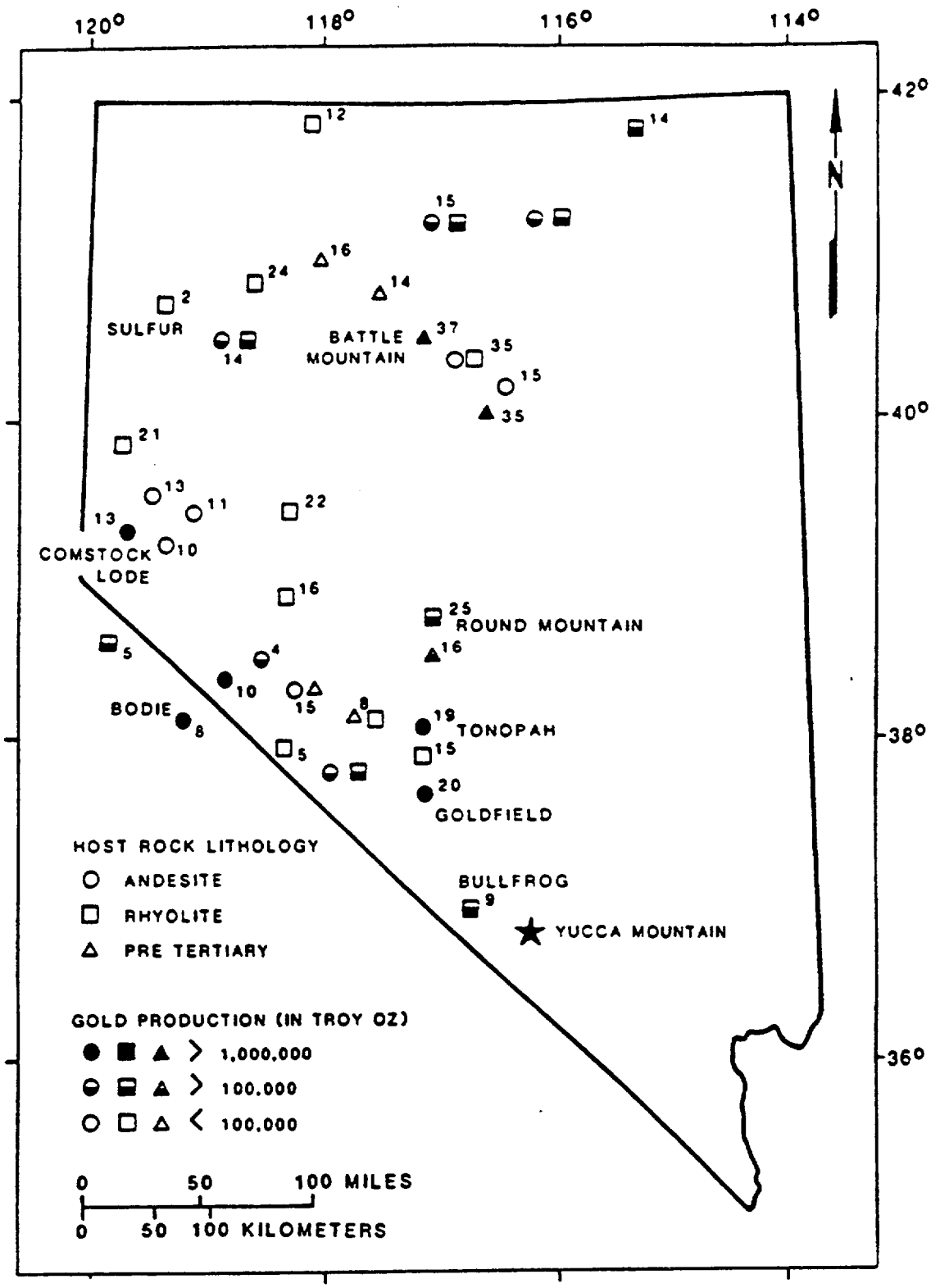


Figure 3.1.1.1.5.2.1-2. Map Showing the Distribution of Ore Deposits Dated by Potassium-Argon Dating Methods, Lithologies of the Host Rock, and Approximate Production of Gold. Potassium-argon dates are mineralization ages and are represented by numbers (million years) next to symbols. Modified from Silberman, et al. (1976) and Silberman (1985). Further information on the location of gold deposits and Prospects in Nevada can be found in Bonham (1986) from the SCP

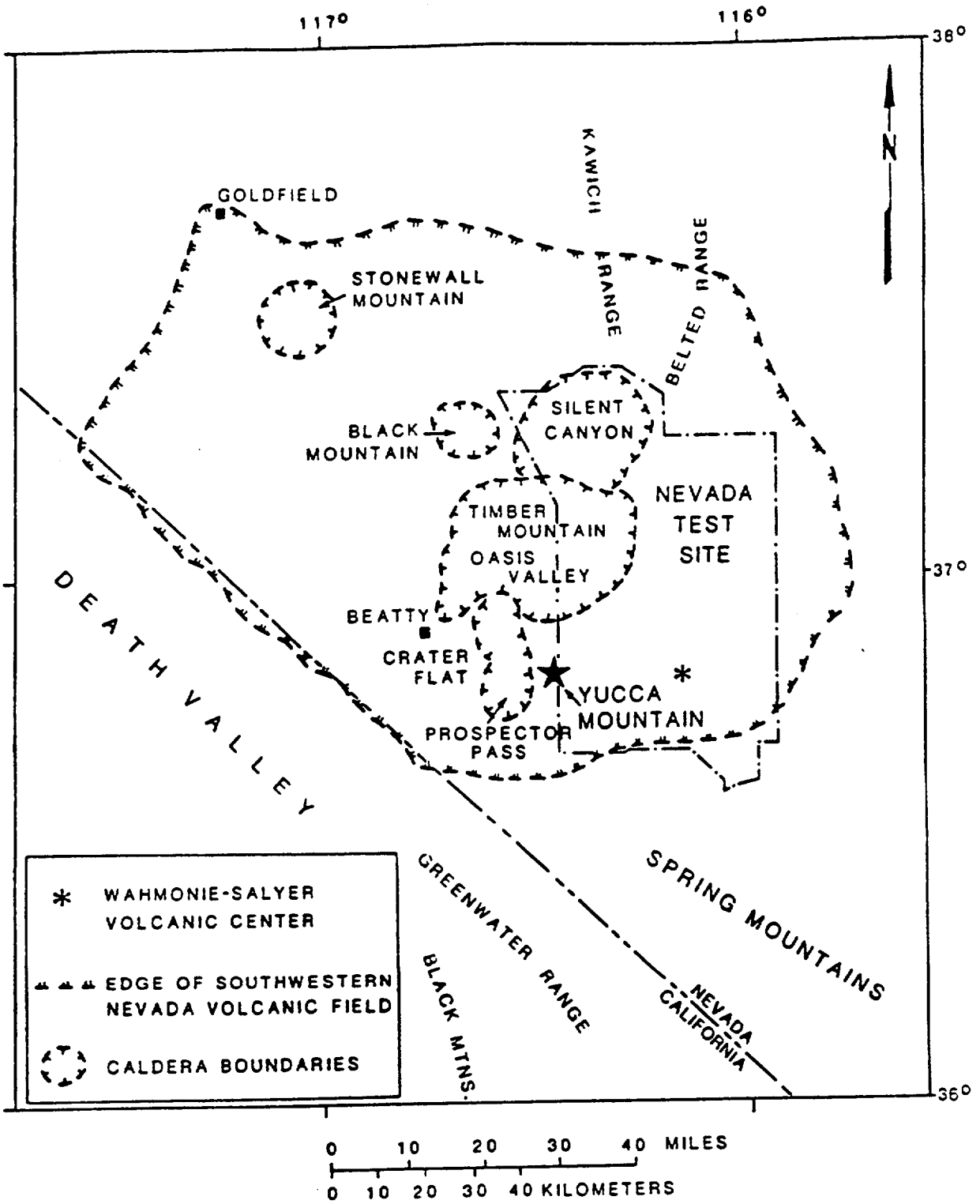


Figure 3.1.1.1.5.2.1-3. Calderas Within the Southwestern Nevada Volcanic Field. Modified from Carr (1984) from the SCP

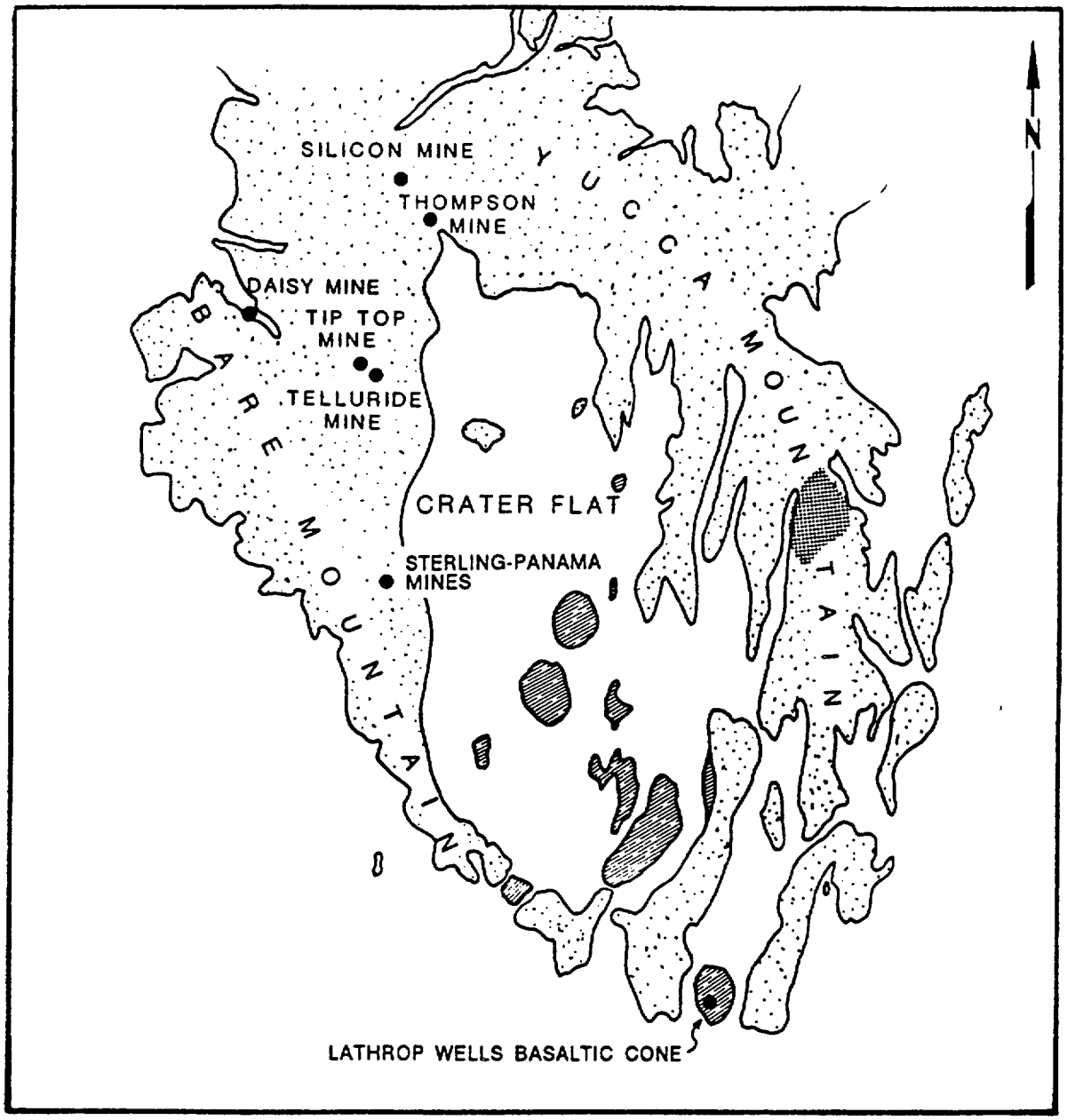


Figure 3.1.1.1.5.2.2-1. Bedrock Map Showing Locations of the Sterling, Daisy, Silicon, Harvey (Telluride), Tip Top, and Thompson Mines Relative to the Proposed Repository Site. Modified from the Geologic Map of Cornwall and Kleinhampl (1964) from the SCP.

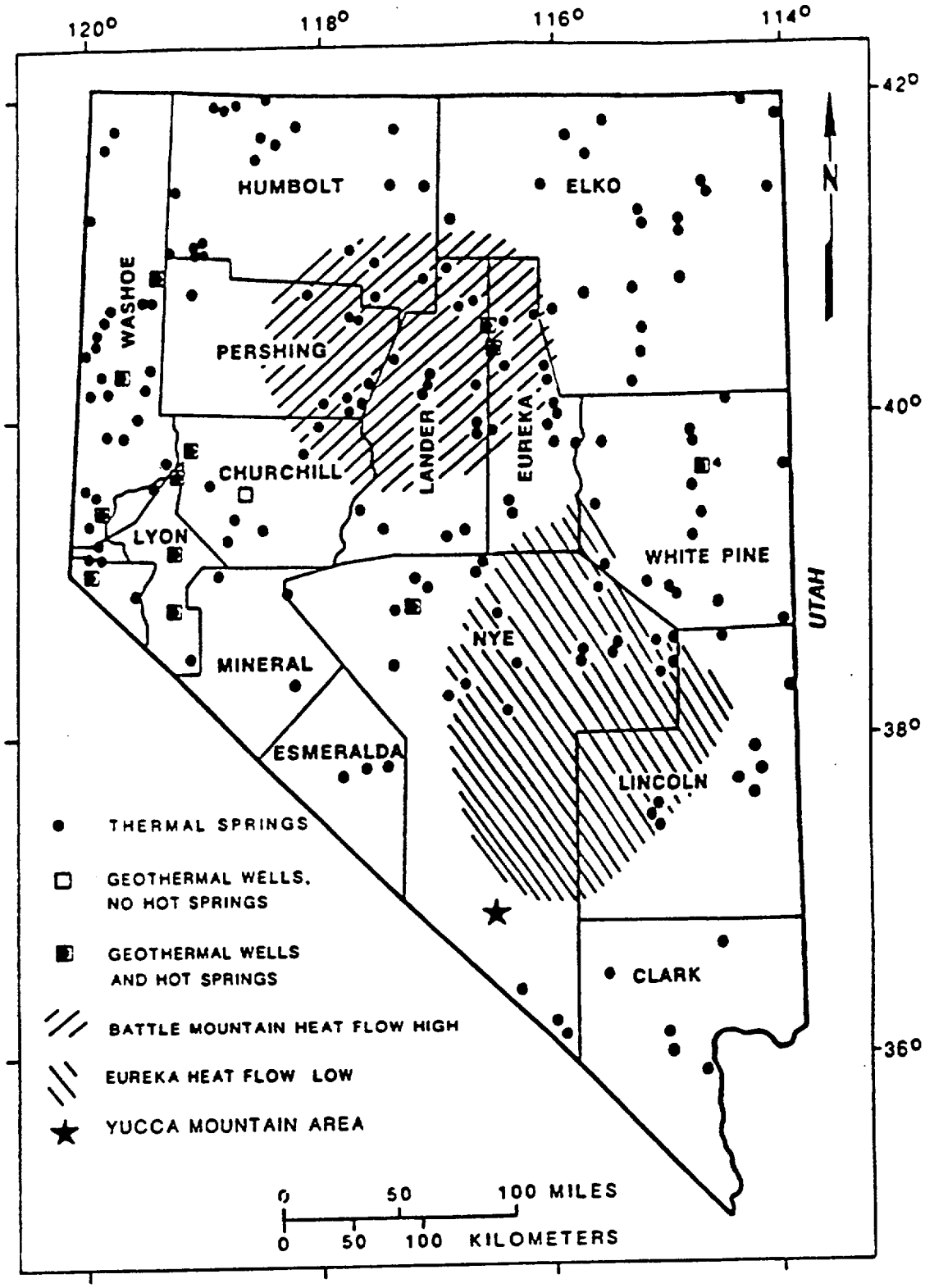


Figure 3.1.1.1.5.3-1. Hot Springs, Geothermal Wells, and Low-Temperature Thermal Resources in Nevada. The Battle Mountain High and the Eureka Low Heat-Flow Regions are also shown. Modified from Garside (1974) from the SCP.

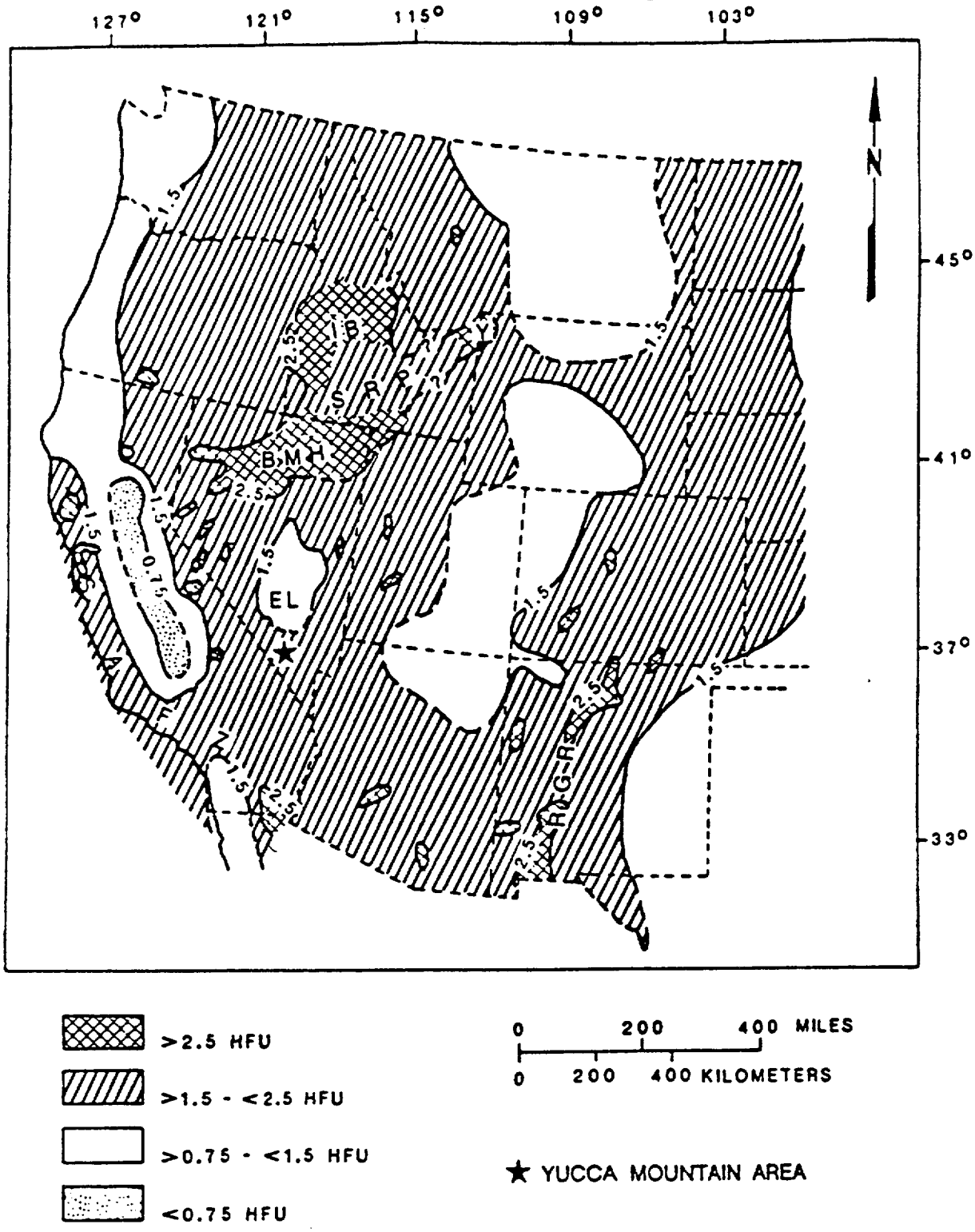


Figure 3.1.1.1.5.3-2. Regional Heat Flow and Distribution of Hydrothermal Systems. Abbreviations are BMH for Battle Mountain High, EL for Eureka Low, IB for Idaho Batholith, SRP for Eastern and Central Snake River Plain, Y for Yellowstone Thermal Area, RGR for Rio Grande Rift, and SAFZ for San Andreas Fault Zone. Modified from Lachenbruch and Sass (1977) from the SCP.

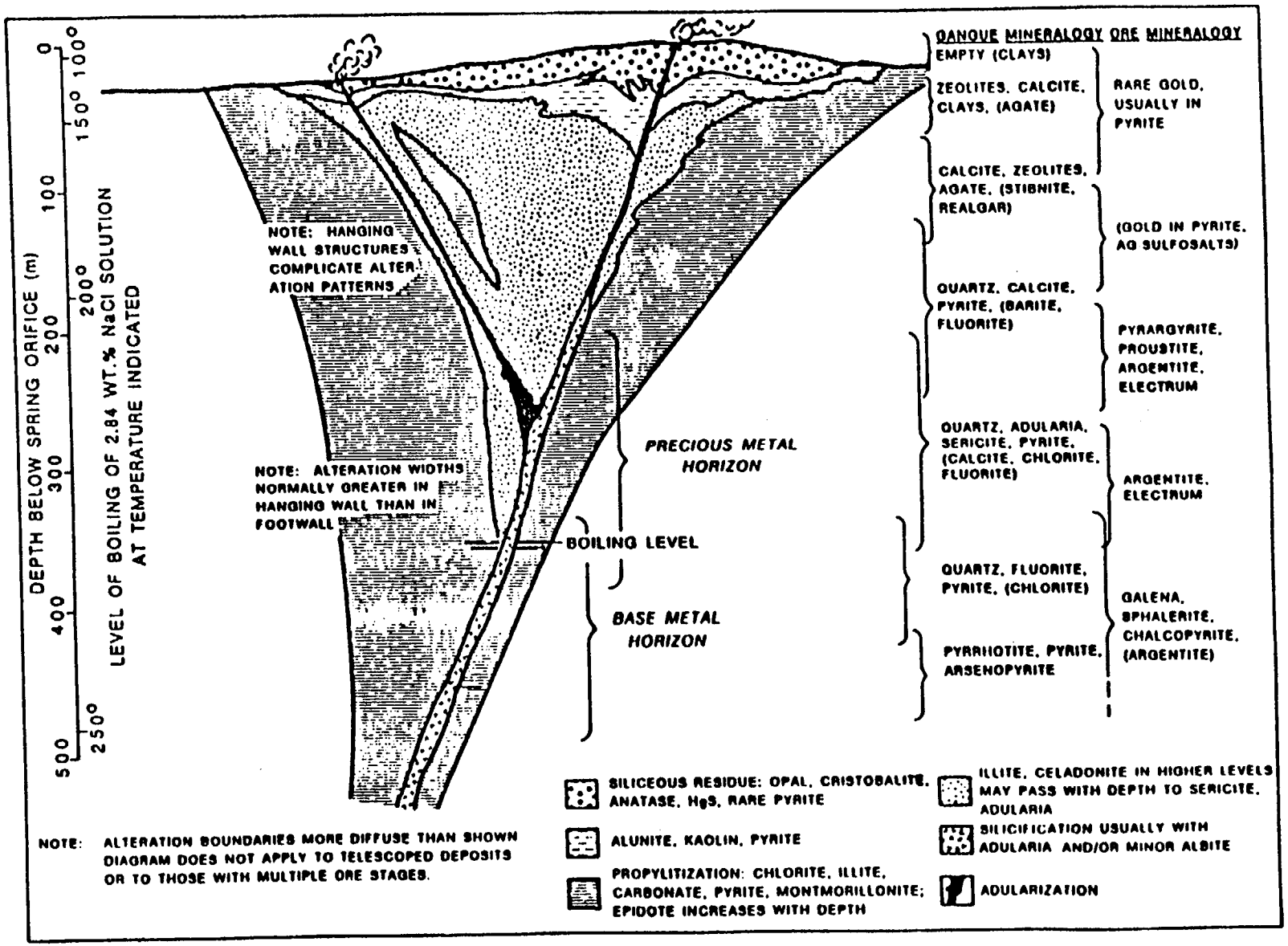


Figure 3.1.1.1.5.5-1. Idealized Model of Epithermal Precious-Metal Deposits. Modified from Buchanan (1981) and Sawkins (1984) from the SCP.

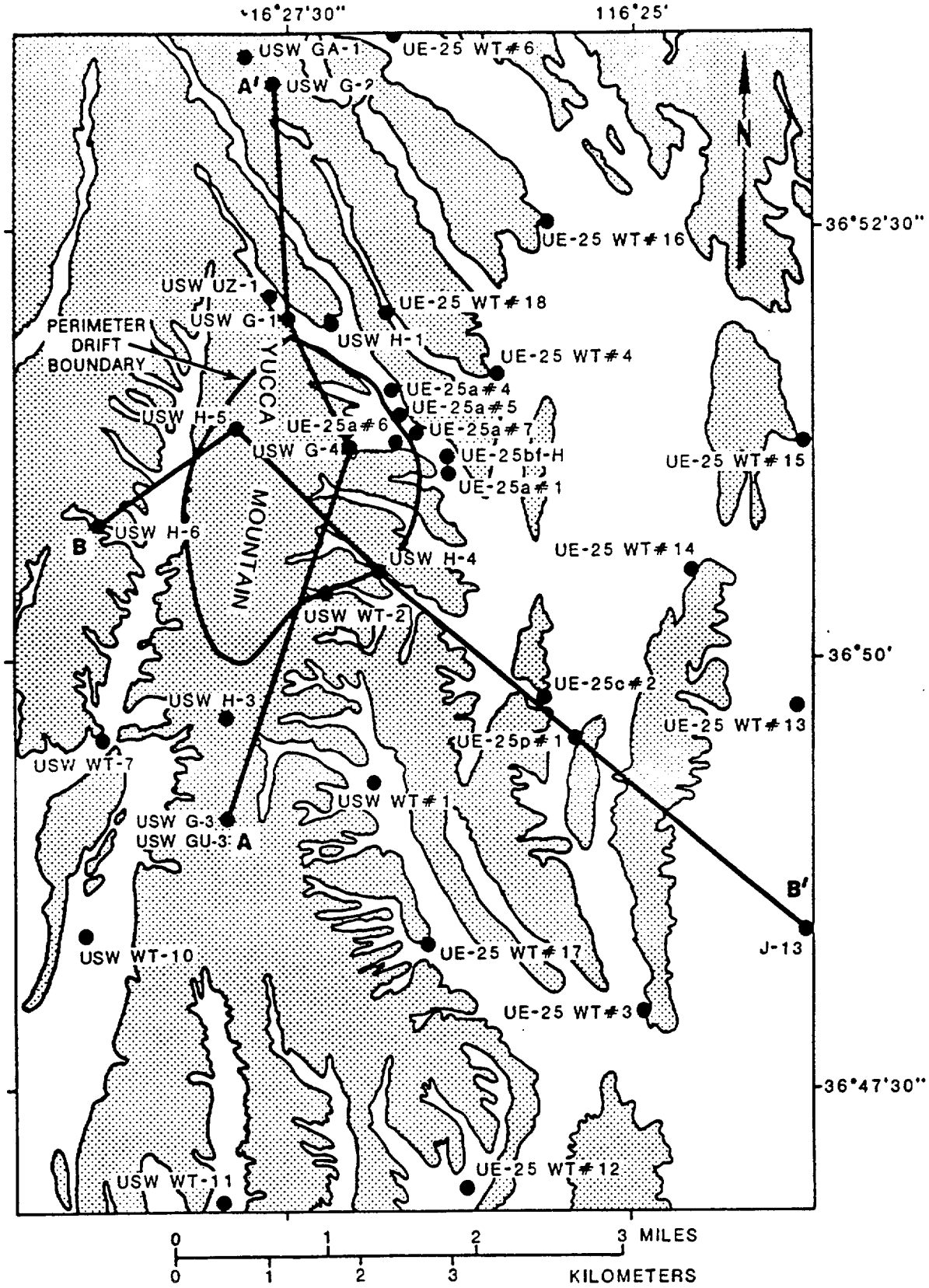


Figure 3.1.1.2.2.3-1. Index Map Showing the Locations of Selected Drillholes in the Vicinity of Yucca Mountain and the Locations of Cross Sections Shown on Figures 3.1.1.2.2.3-2 and 3.1.1.2.2.3-3

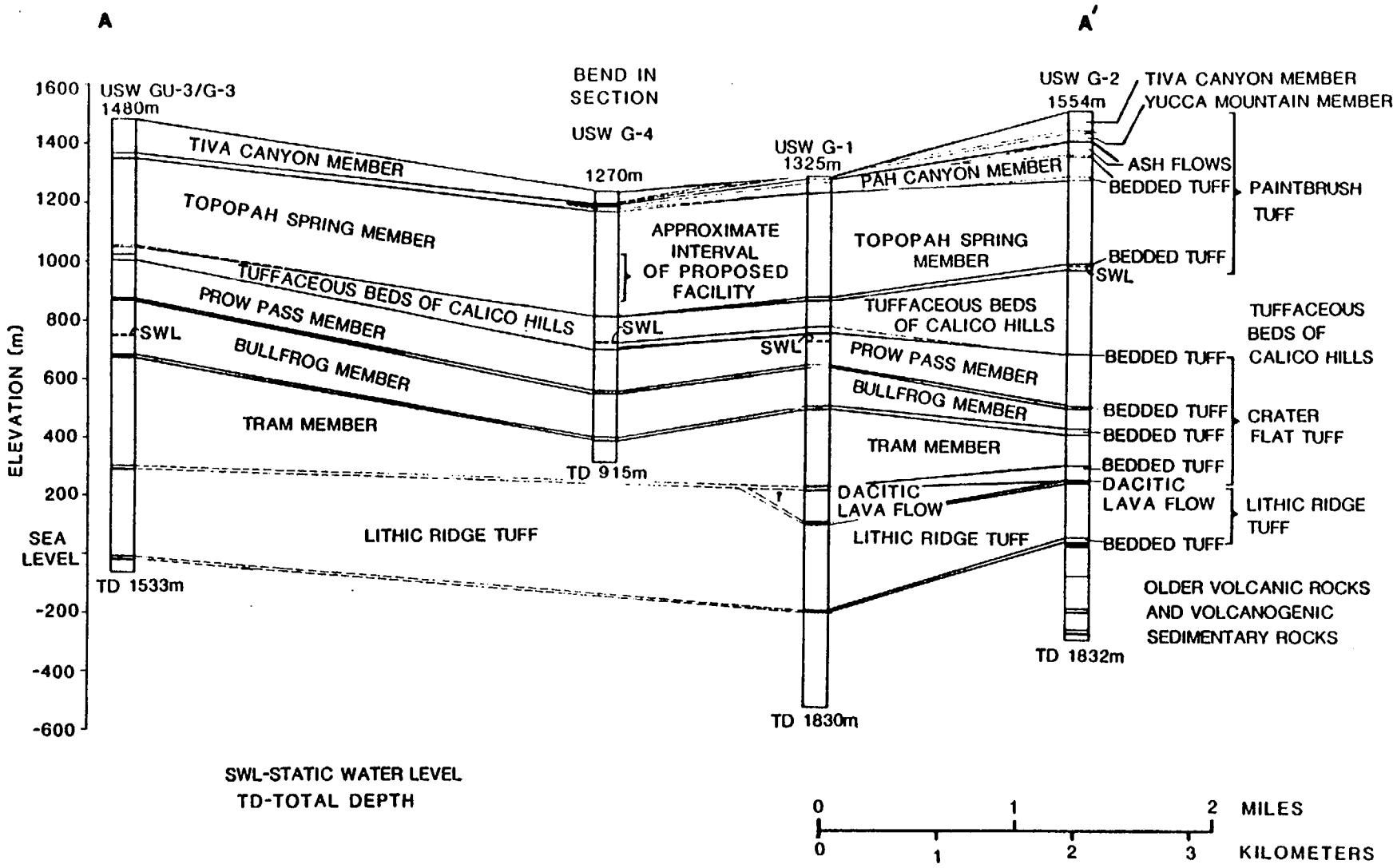


Figure 3.1.1.2.2.3-2. North-South Stratigraphic Cross Section Between Selected Drillholes at Yucca Mountain

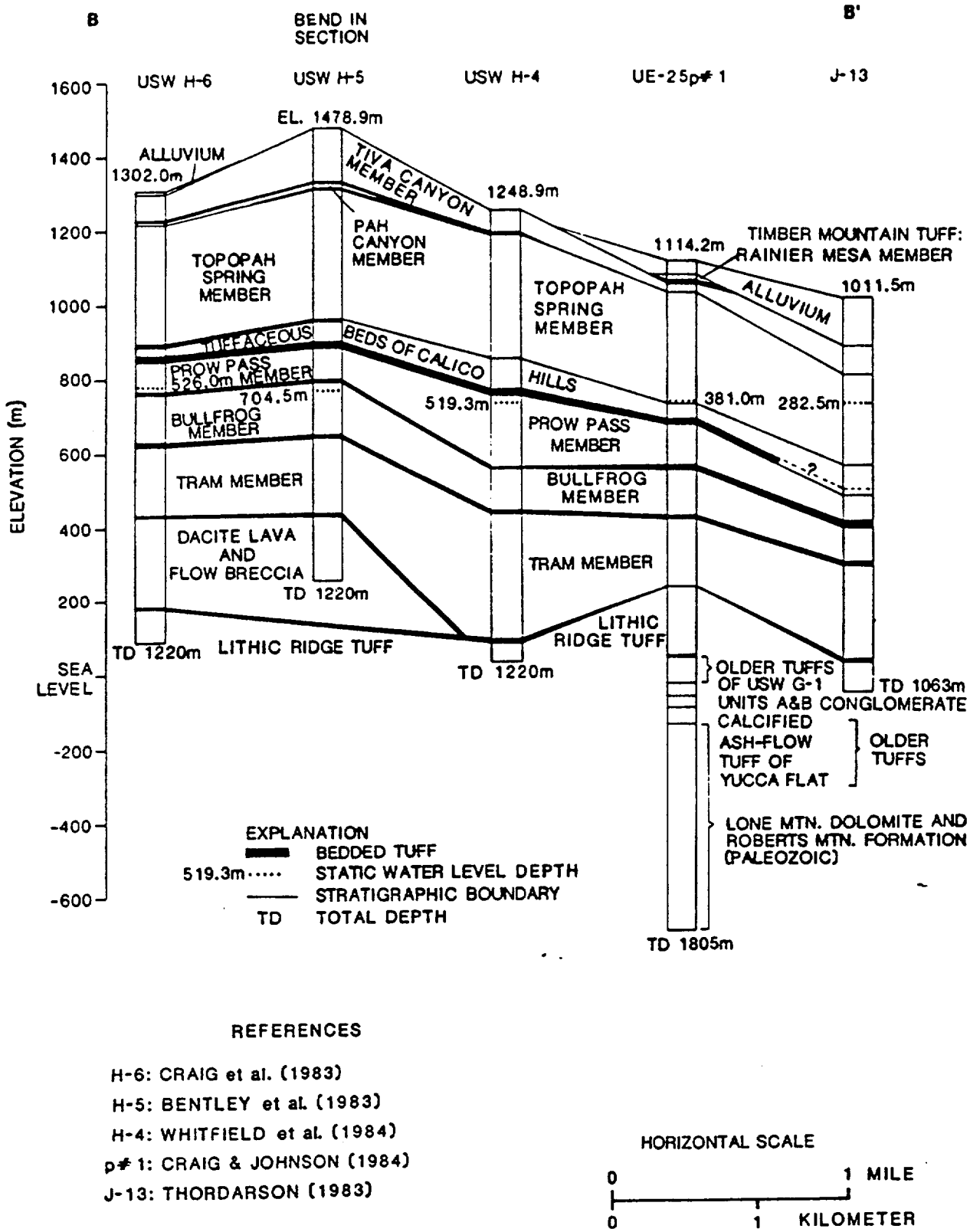
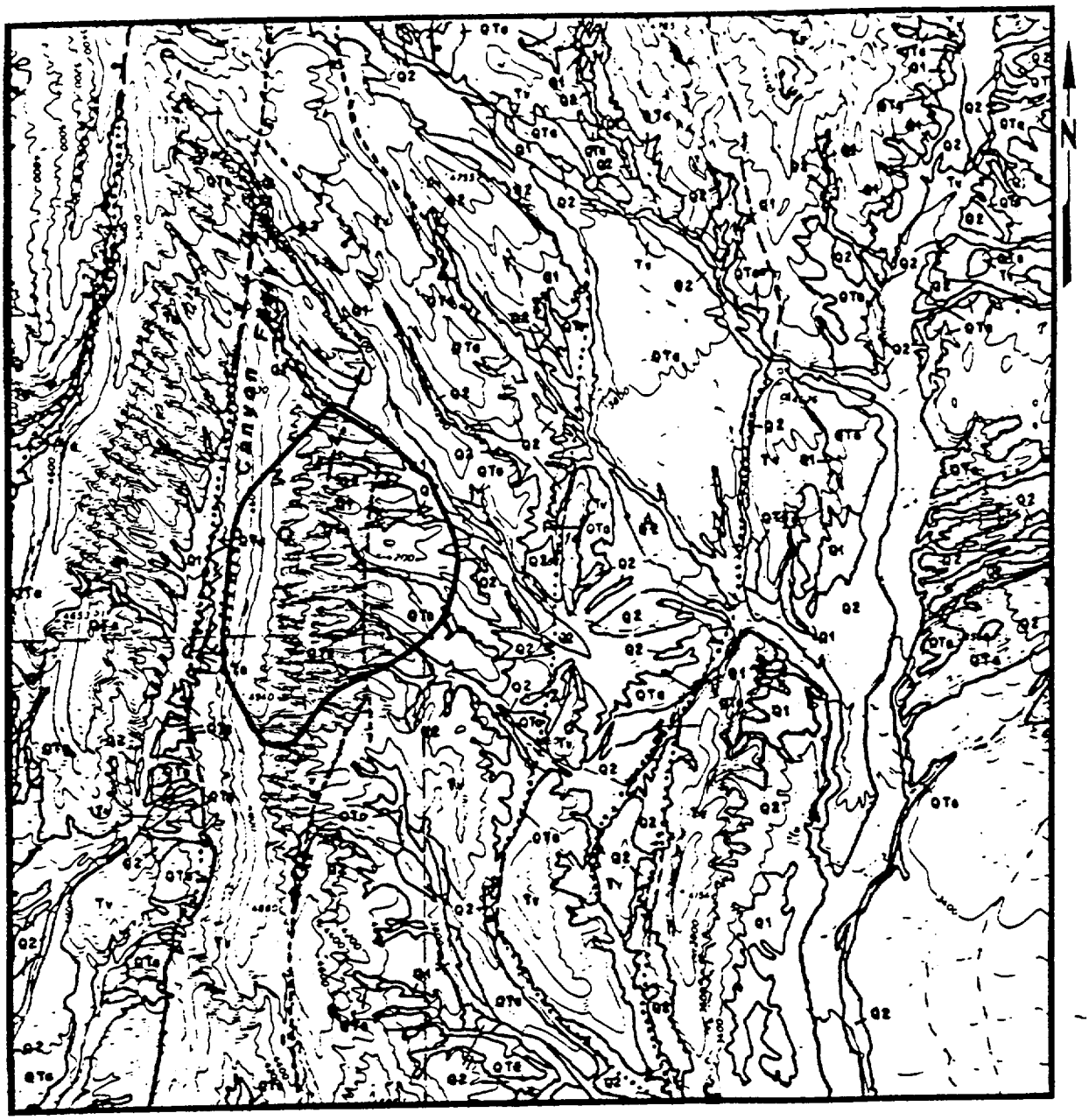


Figure 3.1.1.2.2.3-3. East-West Stratigraphic Cross Section Between Selected Drillholes at Yucca Mountain



PERIMETER DRIFT BOUNDARY

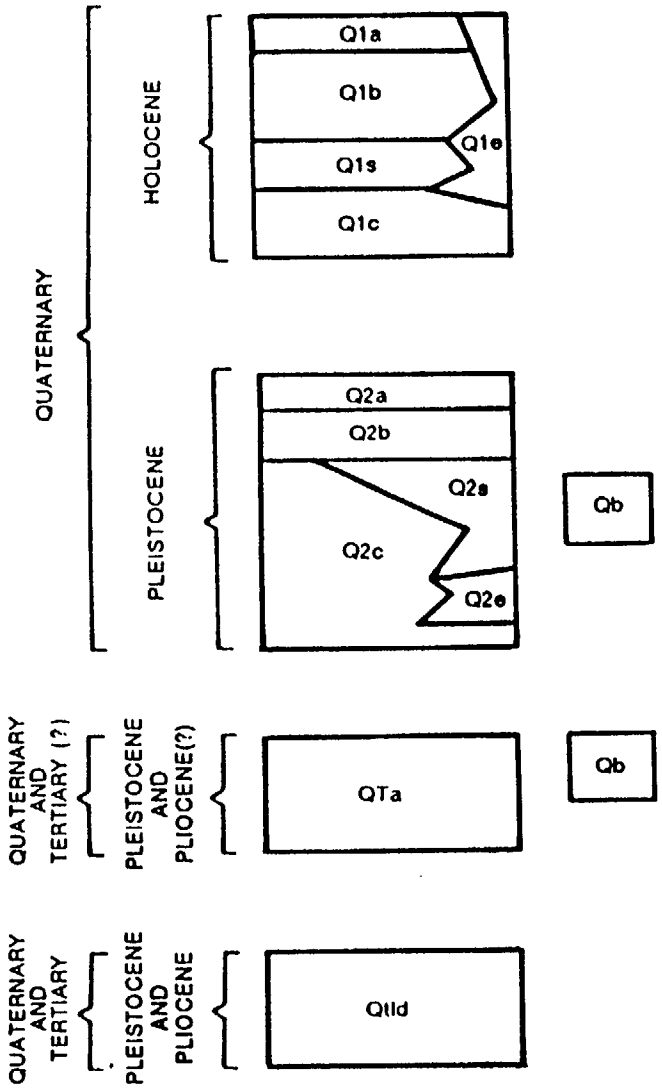
CONTACT

FAULT THAT OFFSETS QUATERNARY DEPOSITS. SHOWN BY LONG DASHES WHERE FAULT EXTENDS INTO TERTIARY ROCKS AND QUATERNARY MOVEMENT IS UNKNOWN. DOTTED WHERE CONCEALED. BAR AND BALL ON DOWNTHROWN SIDE. LETTER SYMBOL REFERS TO DESCRIPTION IN TEXT.

FAULT OF TERTIARY AGE THAT WAS TRENCHED BUT NO EVIDENCE OF QUATERNARY MOVEMENT WAS FOUND. DOTTED WHERE CONCEALED.

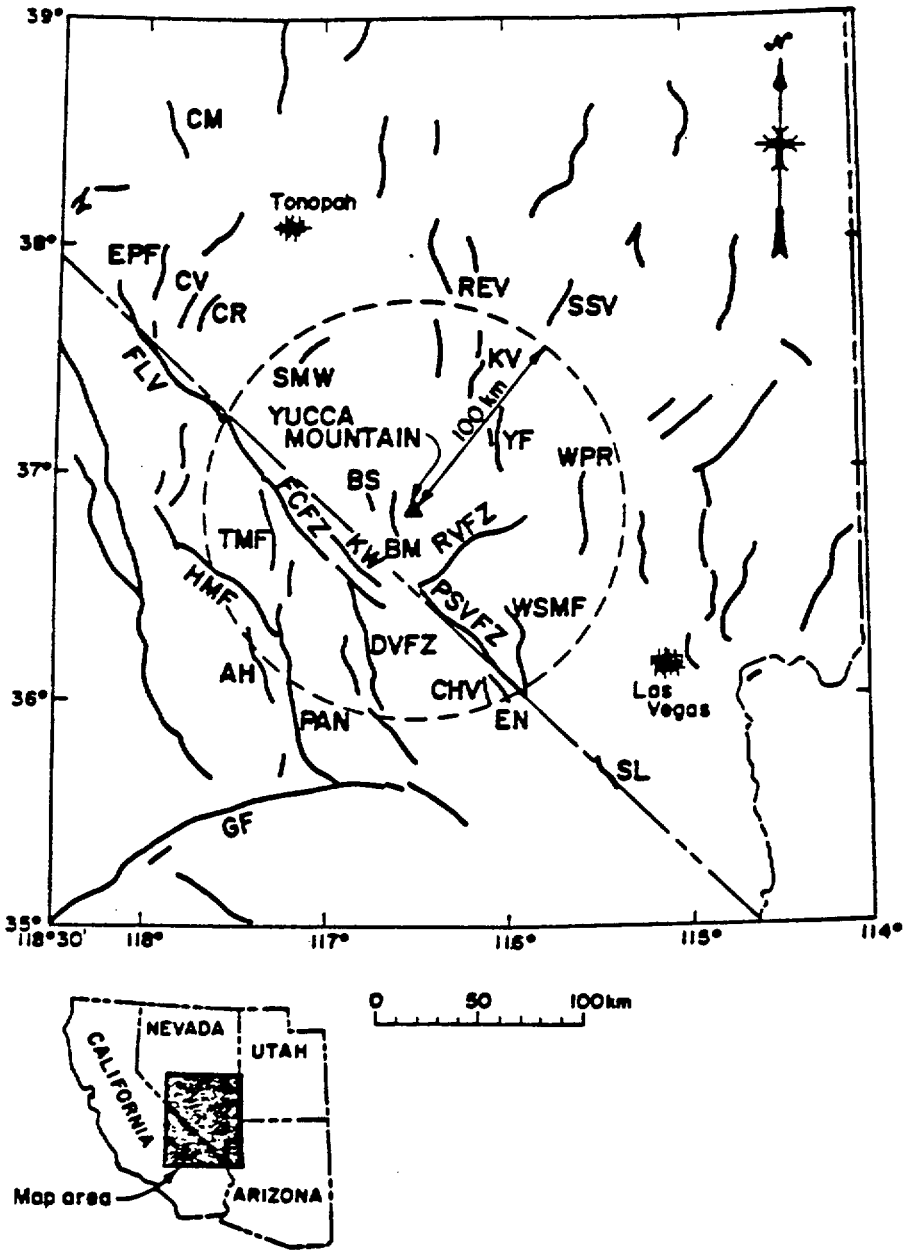
TRENCH SITE AND NUMBER

Figure 3.1.1.2.2.5-1. Map of Surficial Sedimentary and Volcanic Deposits in the Yucca Mountain Area. Map units are shown on Figure 3.1.1.1.2.2.5-2. Modified from Swadley et al. (1984)

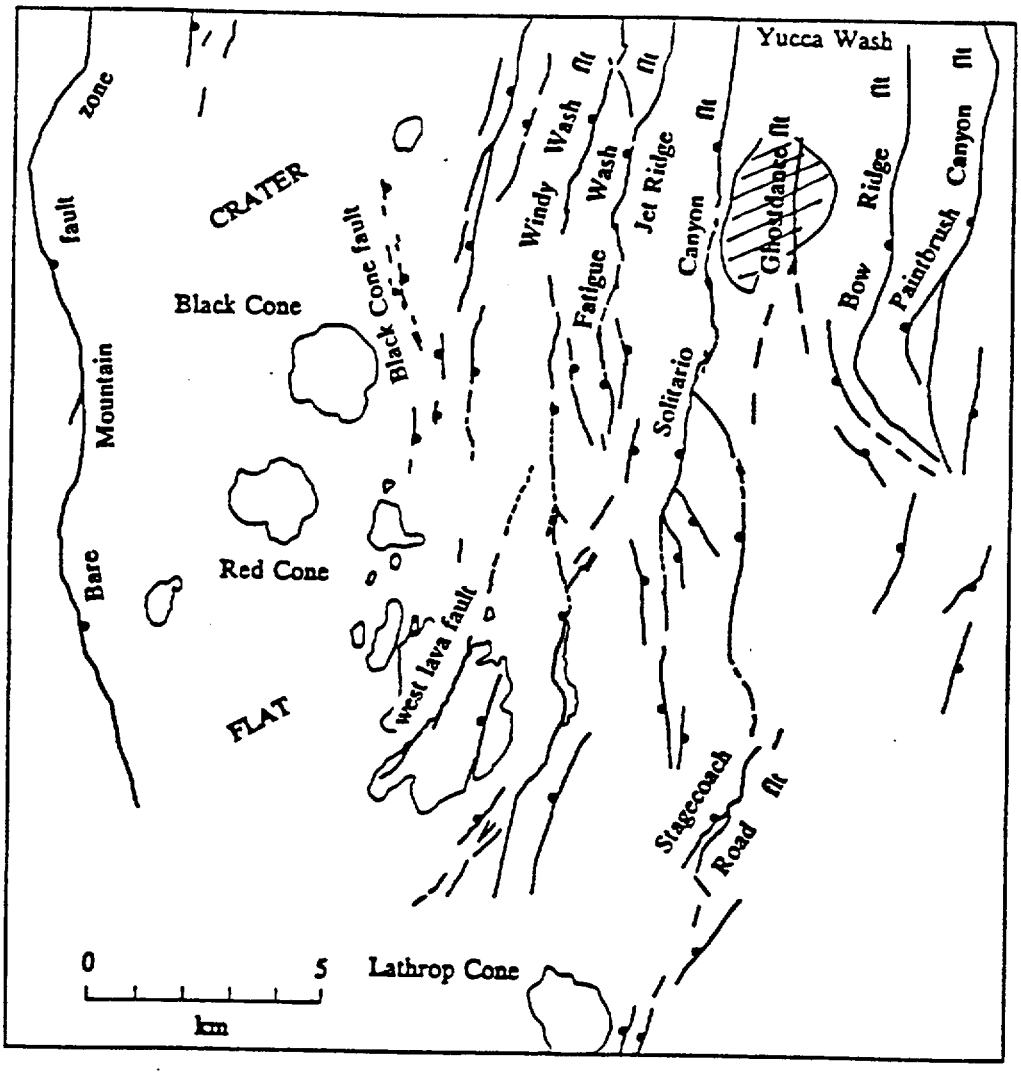


UNIT	ESTIMATED AGE RANGE (IN YEARS)
HOLOCENE DEPOSITS	
Q1a - FLUVIAL DEPOSITS	PRESENT TO 150
Q1b - FLUVIAL DEPOSITS AND DEBRIS FLOWS	150 TO 4,000
Q1e - EOLIAN DUNES AND SAND SHEETS	PRESENT TO 8,000
Q1s - FLUVIAL SAND SHEETS	4,000 TO 7,000
Q1c - COARSE FLUVIAL DEPOSITS	7,000 TO 9,000
MIDDLE AND LATE PLEISTOCENE-PLIOCENE (?) DEPOSITS	
Q2a - LOCAL DEBRIS FLOWS	≈40,000
Q2b - FLUVIAL DEPOSITS	160,000 TO 250,000
Q2s - FLUVIAL SAND SHEETS	270,000 TO 700,000
Qb - BASALT FLOWS AND CINDERS	100,000 TO 300,000
Q2e - EOLIAN DUNES AND SHEETS	700,000 TO 750,000
Q2c - COARSE FLUVIAL DEPOSITS	270,000 TO 800,000
EARLY PLEISTOCENE (?) DEPOSITS	
QTa - DEBRIS FLOWS, MINOR FLUVIAL DEPOSITS	1.1×10^6 TO 2×10^6
Qb - BASALT FLOWS AND CINDERS	1.1×10^6 TO 1.3×10^6
PLIOCENE-PLEISTOCENE DEPOSITS	
QTld - LACUSTRINE DEPOSITS	$< 2 \times 10^6$ TO 4×10^6

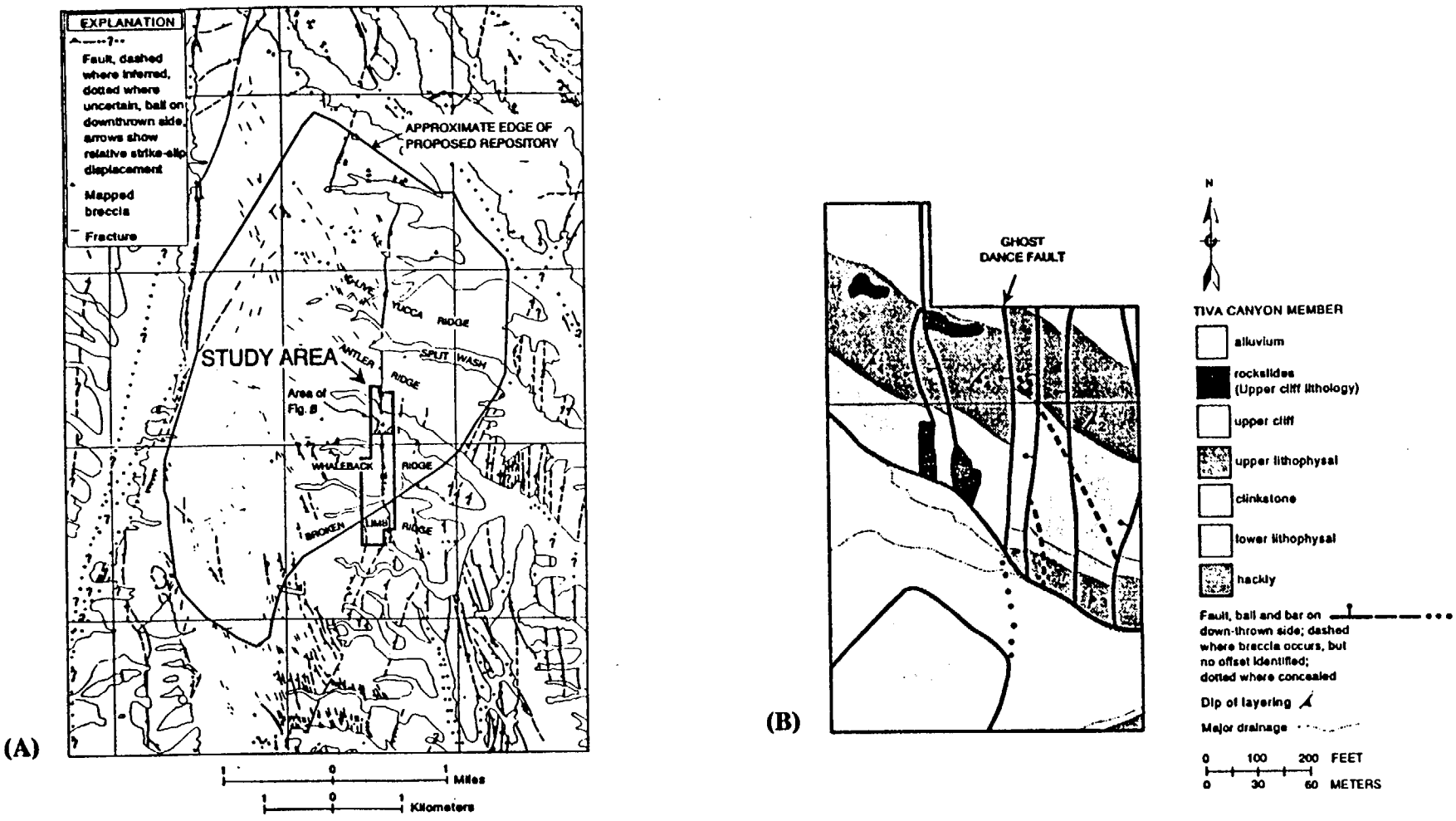
Figure 3.1.1.2.2.5-2. Quaternary Units Present in the Yucca Mountain Area and Mapped on Figure 3.1.1.2.2.5-1



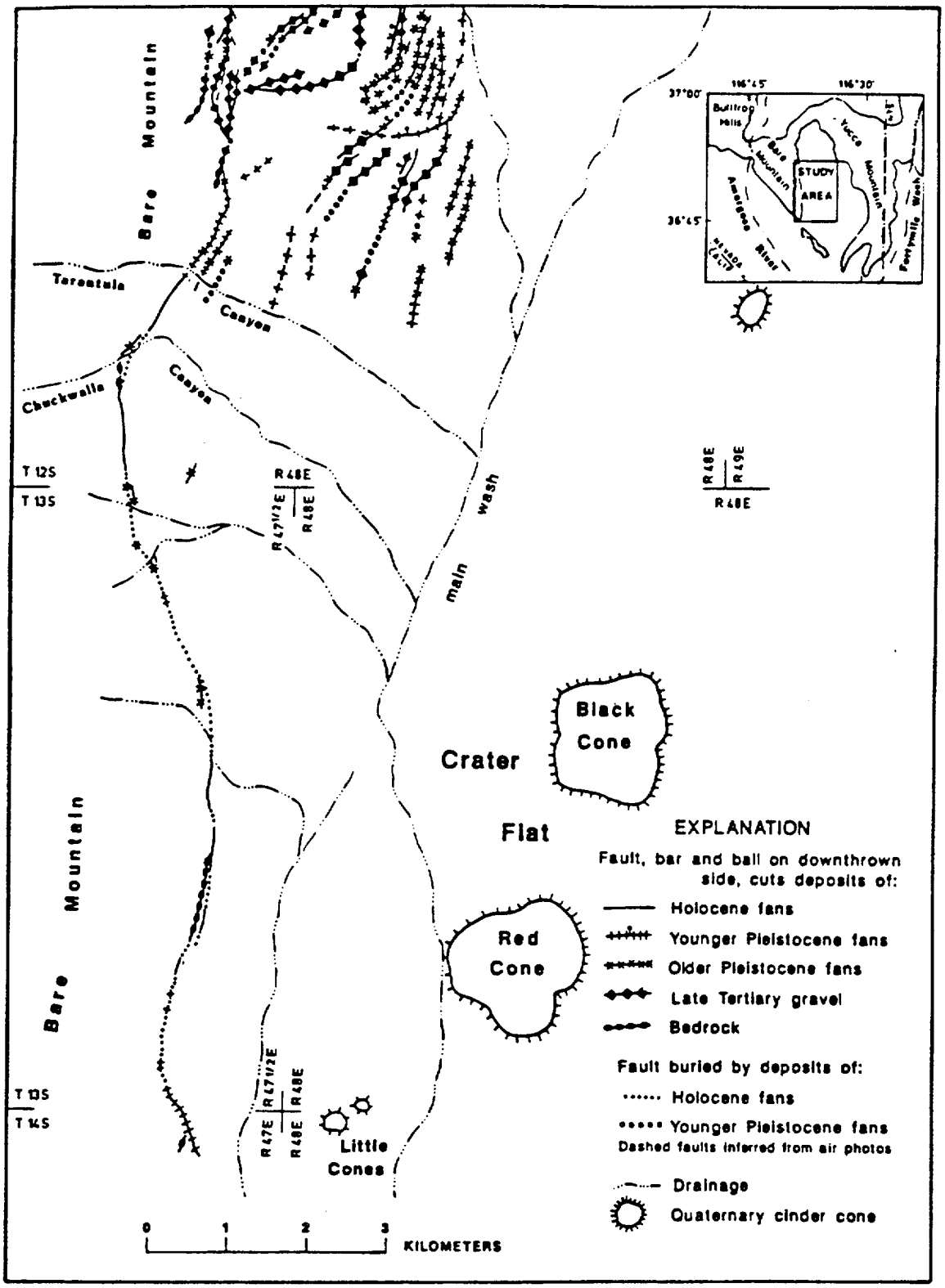
3.1.1.2.3.2-1 Preliminary generalized map of known and suspected Quaternary faults within 100 km of Yucca Mountain (modified from Piety et al., 1992). Abbreviations are for the following fault names: AH, Ash Hill; BM, Bare Mountain fault zone; BS, Beatty scarp; CHV Chicago Valley fault; CM, Cedar Mountain fault; CR, Clayton Ridge fault; DVFZ, Death Valley fault zone; EN, East Nopah fault zone; EPR, Emigrant Peak fault; FCFZ, Furnace Creek fault zone; Fish Lake Valley fault zone; GF Garlock fault zone; HMF Hunter Mountain fault; KV, Kawich Valley fault; KW, Keane Wonder fault; PAN, Panamint Valley fault zone; PSVFZ, Pahrump-Stewart Valley fault zone; REV, Reveille Valley faults; RVFZ, Rock Valley fault zone; SL, State Line fault; SSV, Sand Spring Valley fault; SWM, Stonewall Mountain fault; TMF, Tin Mountain fault; WPR, West Pintwater Range fault; WSMF, West Spring Mountains fault; and YF Yucca fault.



3.1.1.2.3.2-2 Generalized map of Quaternary faults and Pliocene/Quaternary basalts in the Yucca Mountain vicinity (modified after Ramelli et al., 1991). Hachures show the location of the proposed repository.



3.1.1.2.3.2-3 (A) Map of bedrock structural features within and surrounding the proposed repository at Yucca Mountain; and, (B) geologic map of the Antler Ridge area along the Ghost Dance fault zone (modified from Spengler et al., 1993).



3.1.1.2.3.2-4 Map of the Bare Mountain fault on the east side of Bare Mountain (modified after Reheis, 1988). Faults with no bar and ball are down to the south or east.

Figure 3.1.1.2.4.1-1. Map of Regional Seismicity (Quaternary Faults) [INN 3.1.1.2.4.1-1]

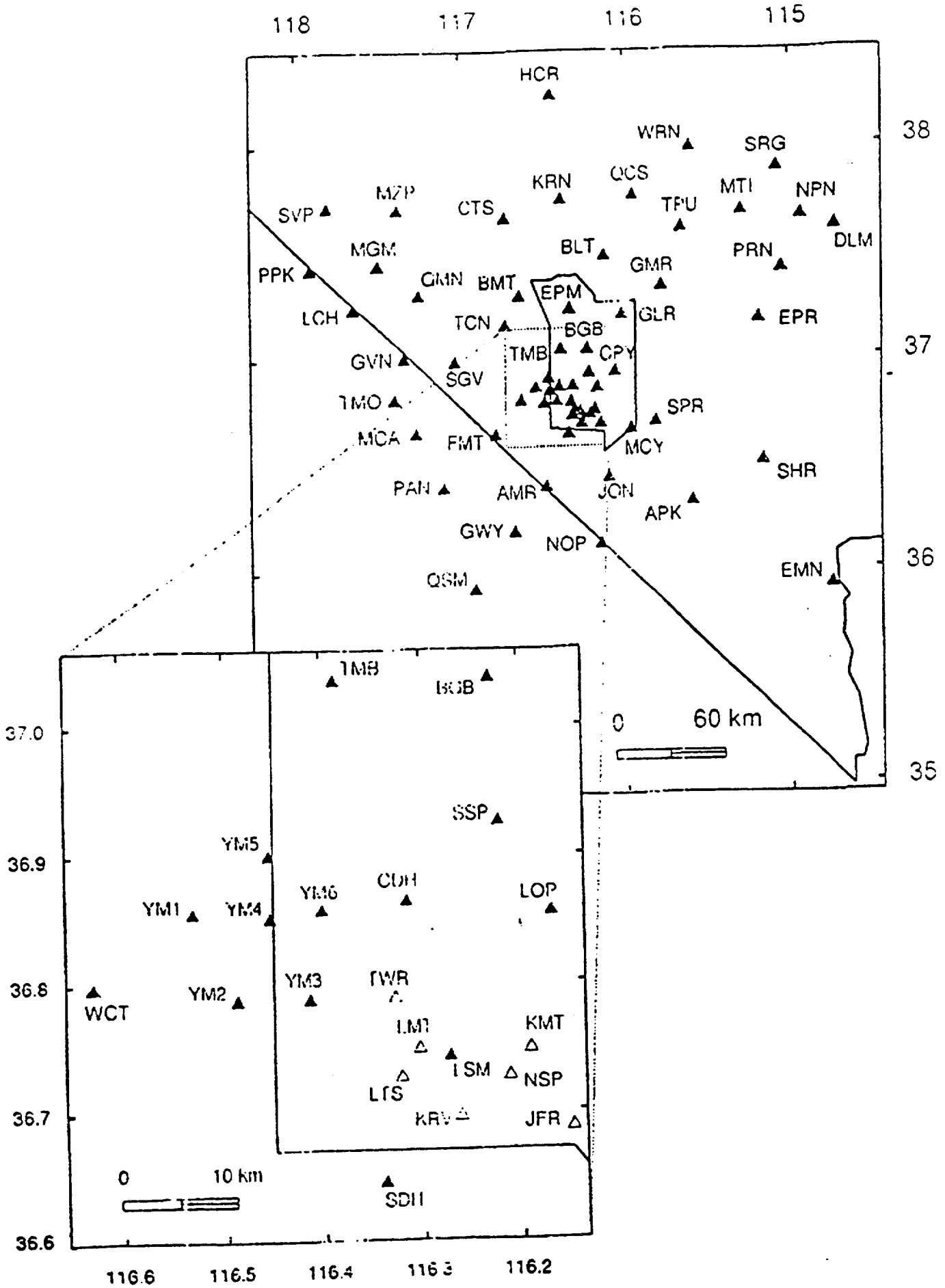


Figure 3.1.1.2.4.2.2-1. Location of Seismic Recording Stations of the Southern Great Basin Seismic Network Source: Sheehan et al. (1993) [INN 3.1.1.2.4.2.2-1]

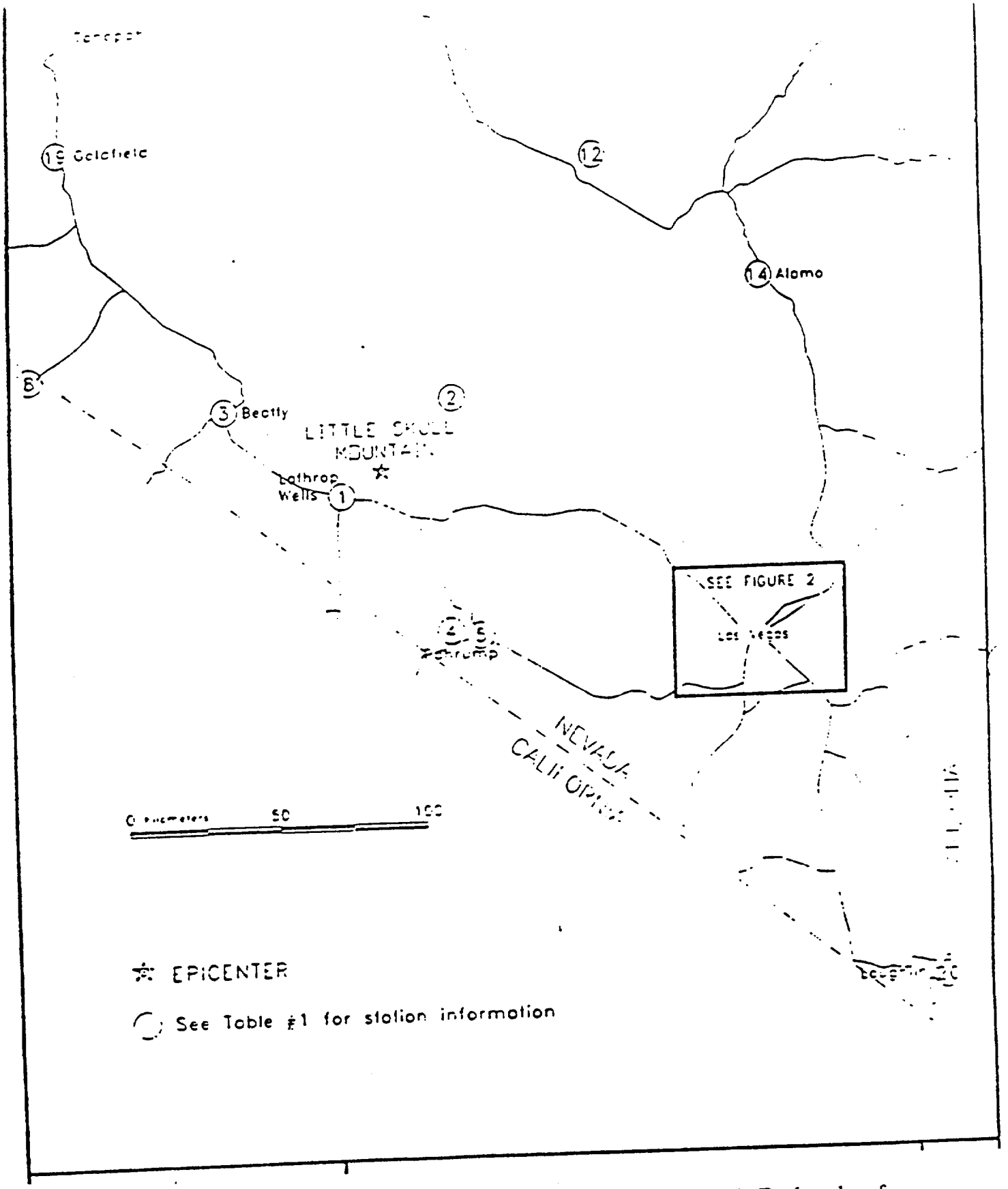


Figure 3.1.1.2.4.2.2-2. Stations Recording the Little Skull Mountain, Nevada Earthquake of 29 June 1992 in Southern Nevada. Source: URS/Blume & Assoc. (1992). [INN 3.1.1.2.4.2.2-2]

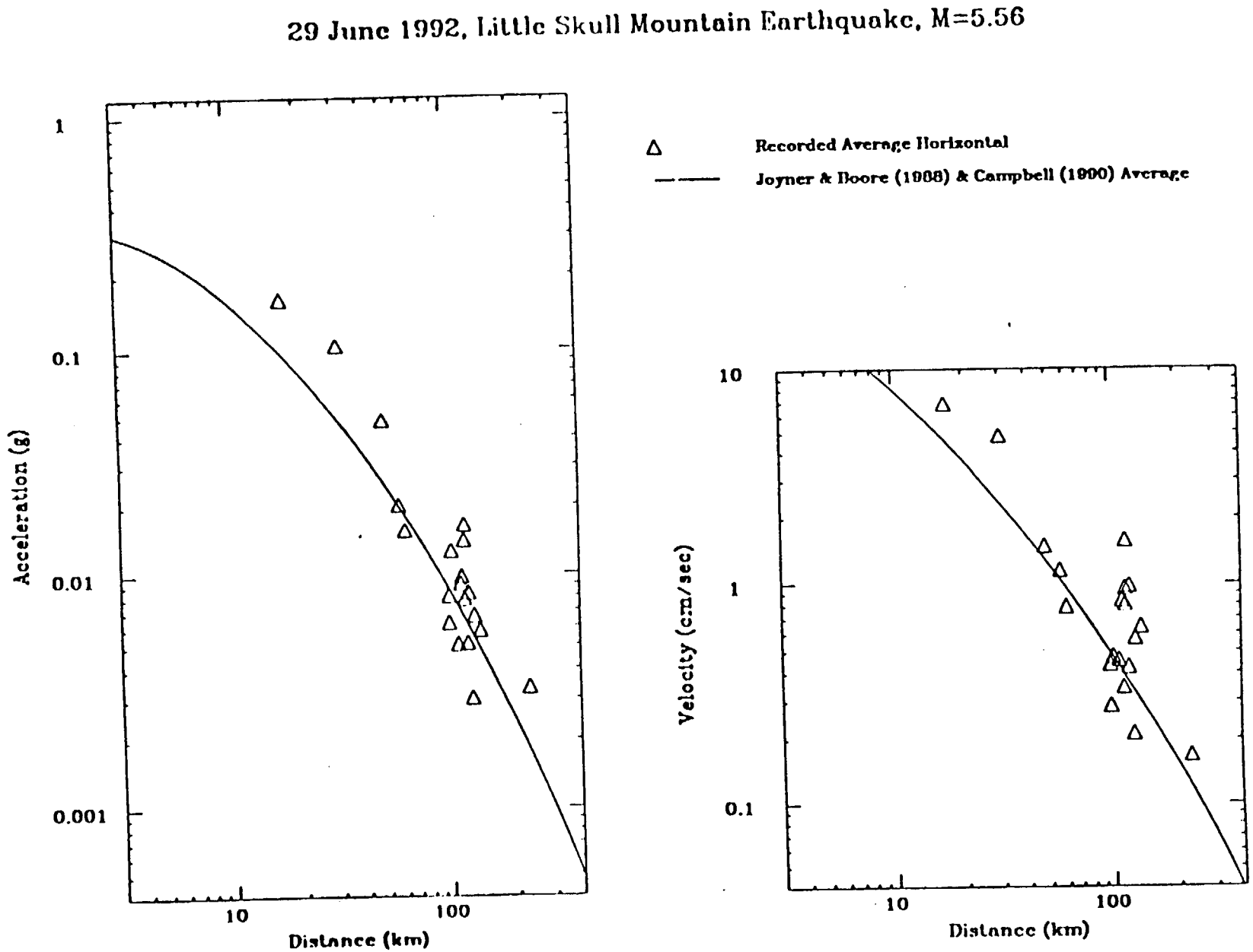


Figure 3.1.1.2.4.2.2-3. Attenuation of Peak Acceleration and Peak Velocity of the Little Skull Mountain, Nevada Earthquake of 29 June 1992 in Southern Nevada, Compared with the Average of the Estimates Derived from J er and Boor (1988) and Campbell (1990). Data Source: URS/Blume & Assoc. (19[illegible]). [INN 3.1.1.2.4.2.2-3]

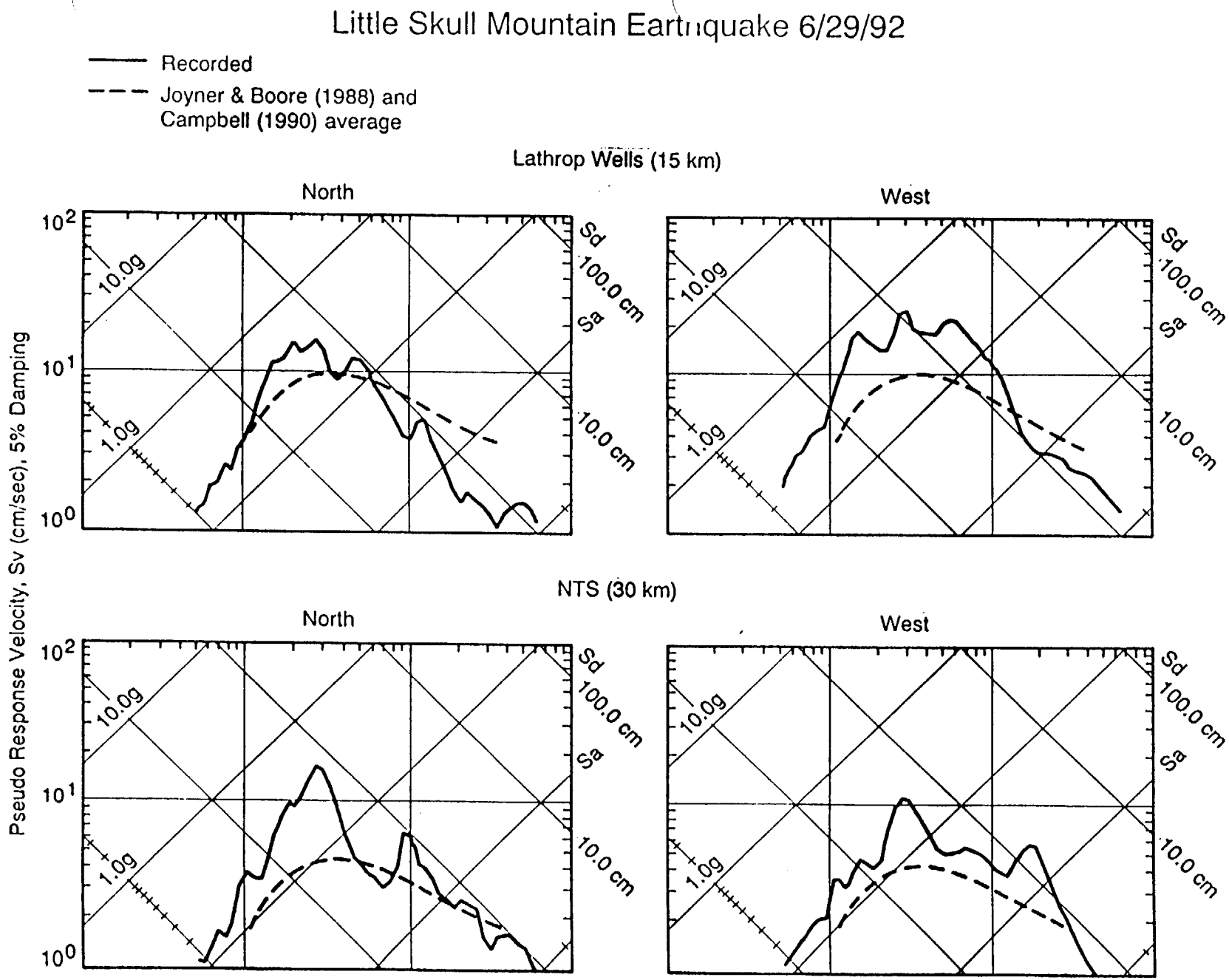
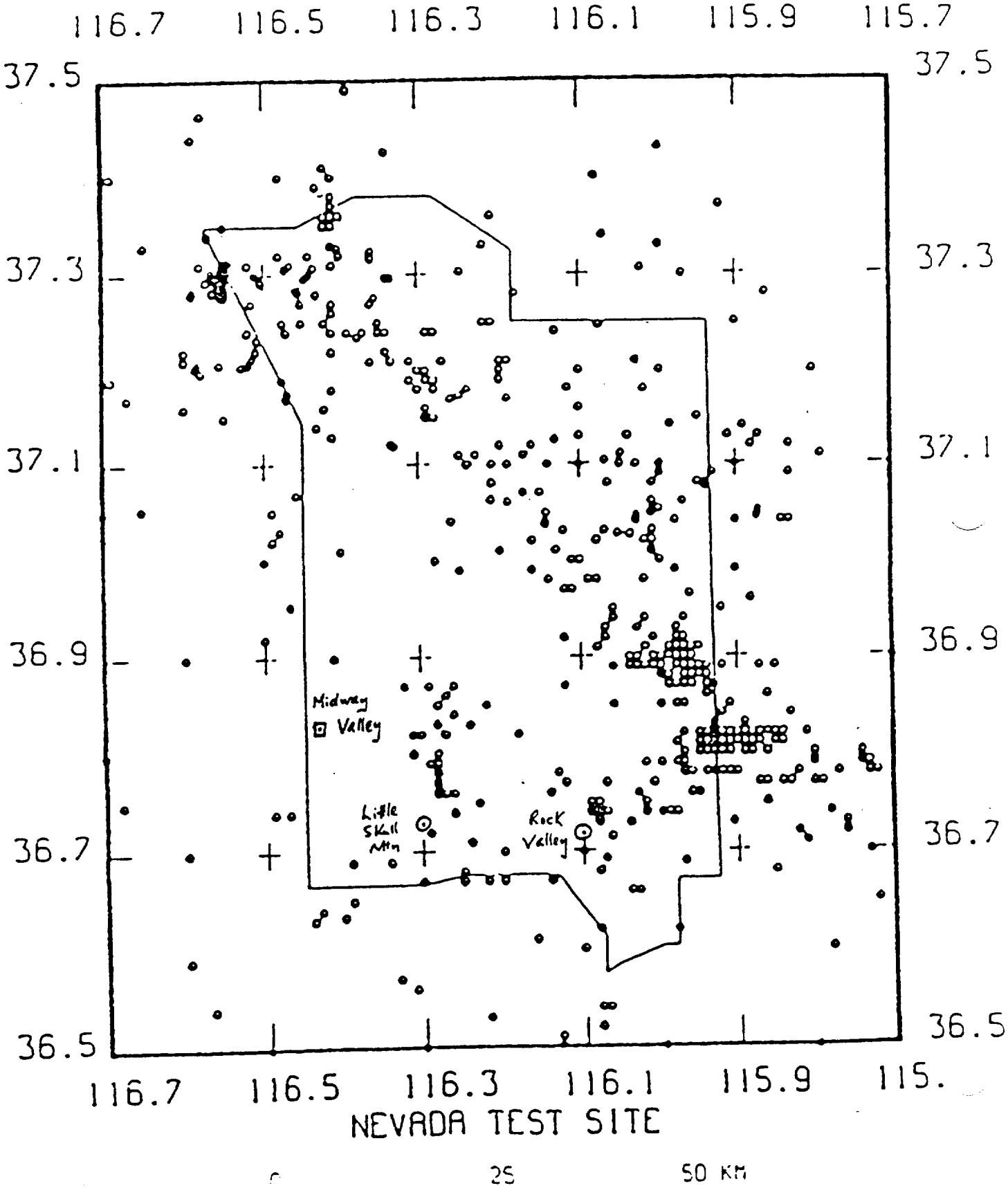


Figure 3.1.1.2.4.2.2-4. Response Spectral Velocity at 5% Damping Recorded at Lathrop Wells (epicentral distance 15 km) during the Little Skull Mountain, Nevada Earthquake of 29 June 1992 in Southern Nevada, Compared with the Average of the Estimates Derived from Joyner and Boor (1988) and Campbell (1990). Data Source: URS/Blume & Assoc. (1992).

Figure 3.1.1.2.4.2.2-5. Locations of the Little Skull Mountain Earthquake, the Rock Valley Earthquake, and the Recording Station at Midway Valley. Source: Sheehan et al (1993). [INN 3.1.1.2.4.2.2-4]



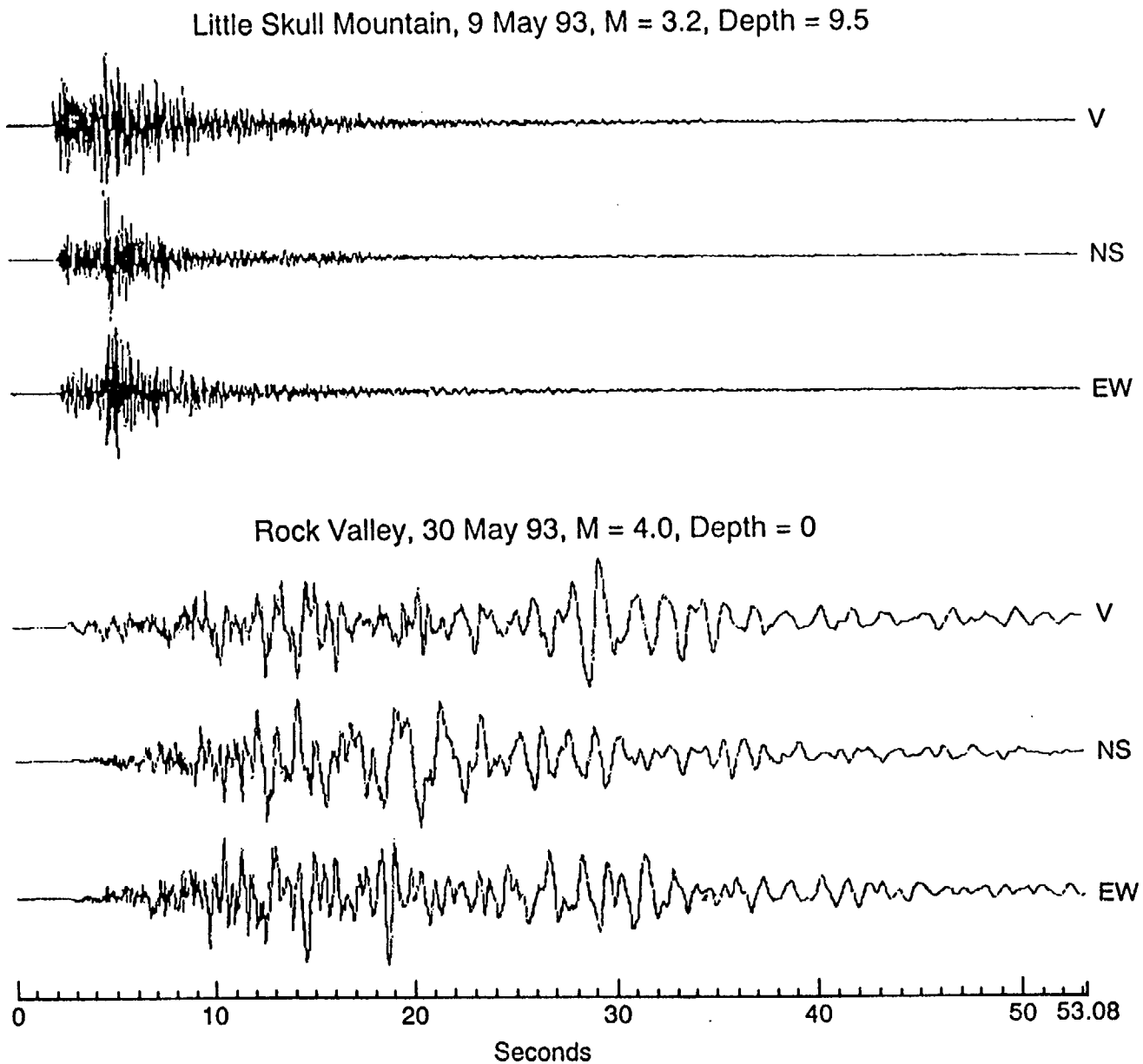


Figure 3.1.1.2.4.2.2-6. Velocity Seismograms of the Little Skull Mountain Aftershock of May 9, 1993 (magnitude 3.2, depth 9.5 Km) and the Rock Valley earthquake of May 30, 1993 (magnitude 4.0, depth 0 Km). Source: Sheehan et al (1973).

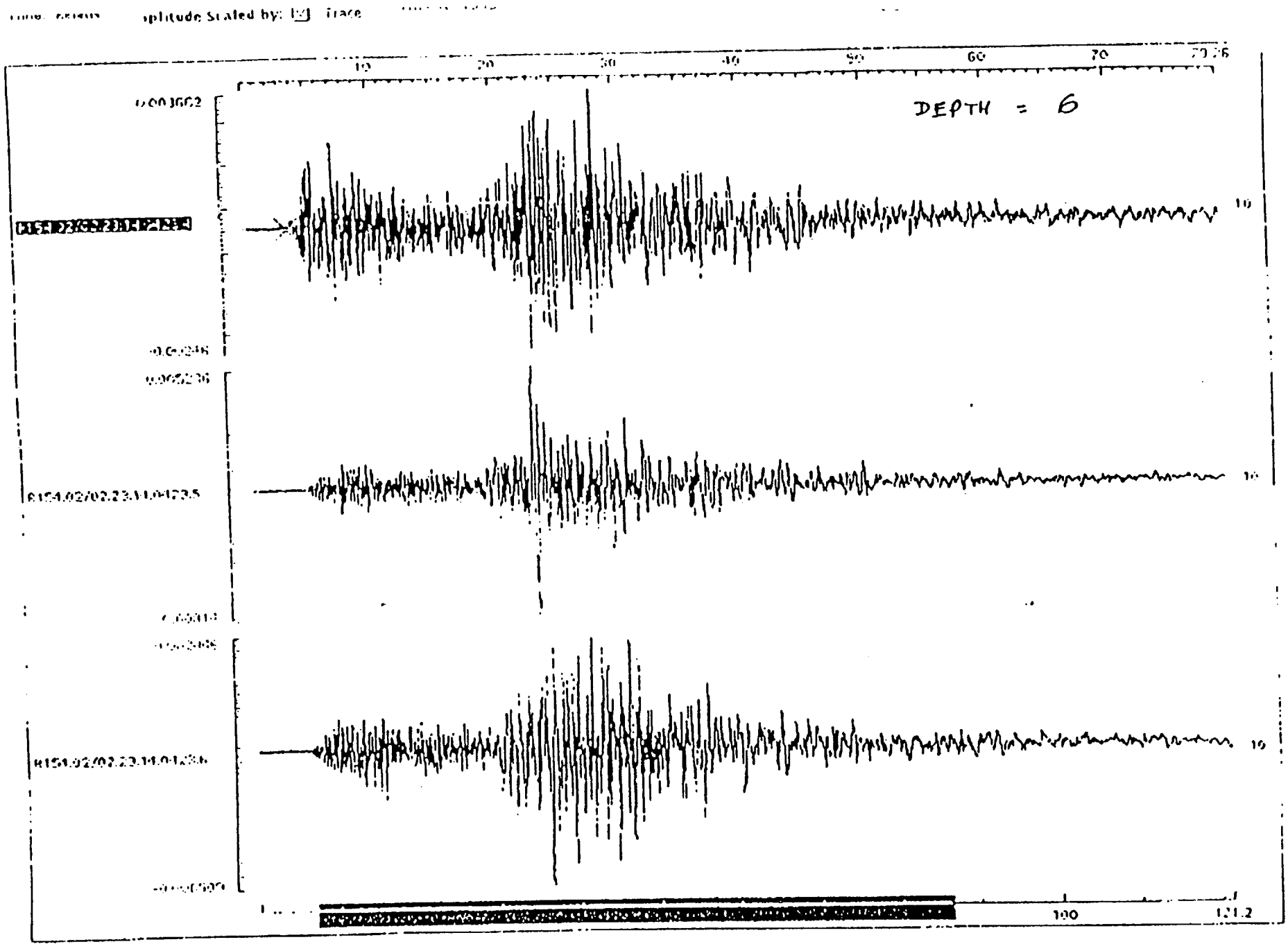


Figure 3.1.1.2.4.2.2-7. Velocity seismograms of the Eureka Valley aftershock of June 8, 1993 (magnitude 3.9, depth 5.9 km). Source: Sheehan et al. (1993). [INN 3.1.1.2.4.2.2-5]

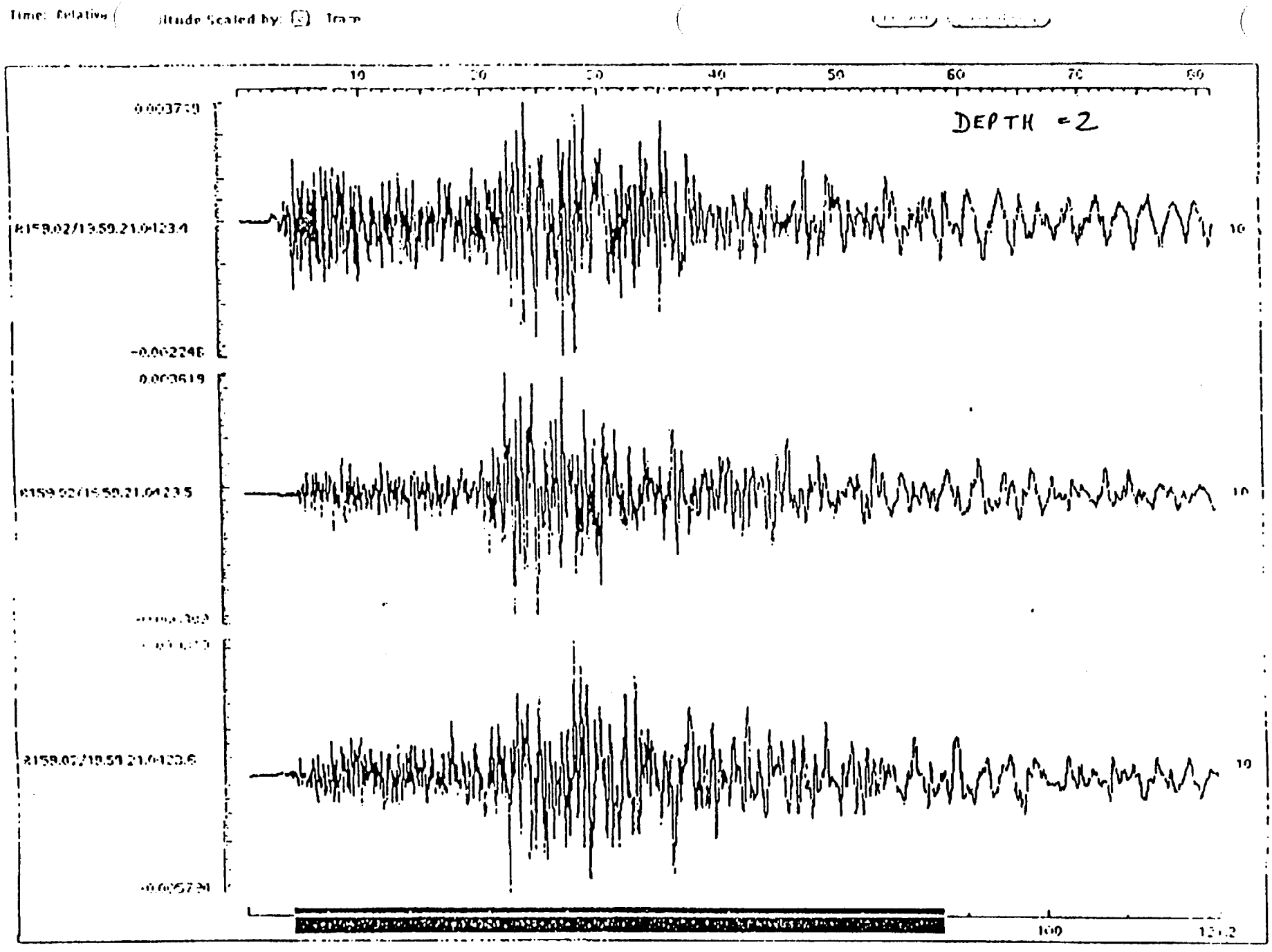


Figure 3.1.1.2.4.2.2-8. Velocity seismograms of the Eureka Valley aftershock of June 8, 1993 (magnitude 4.0, depth 1.7 km). Source: Sheehan et al. (1993) [INN 3.1.1.2.4.2.2-6]

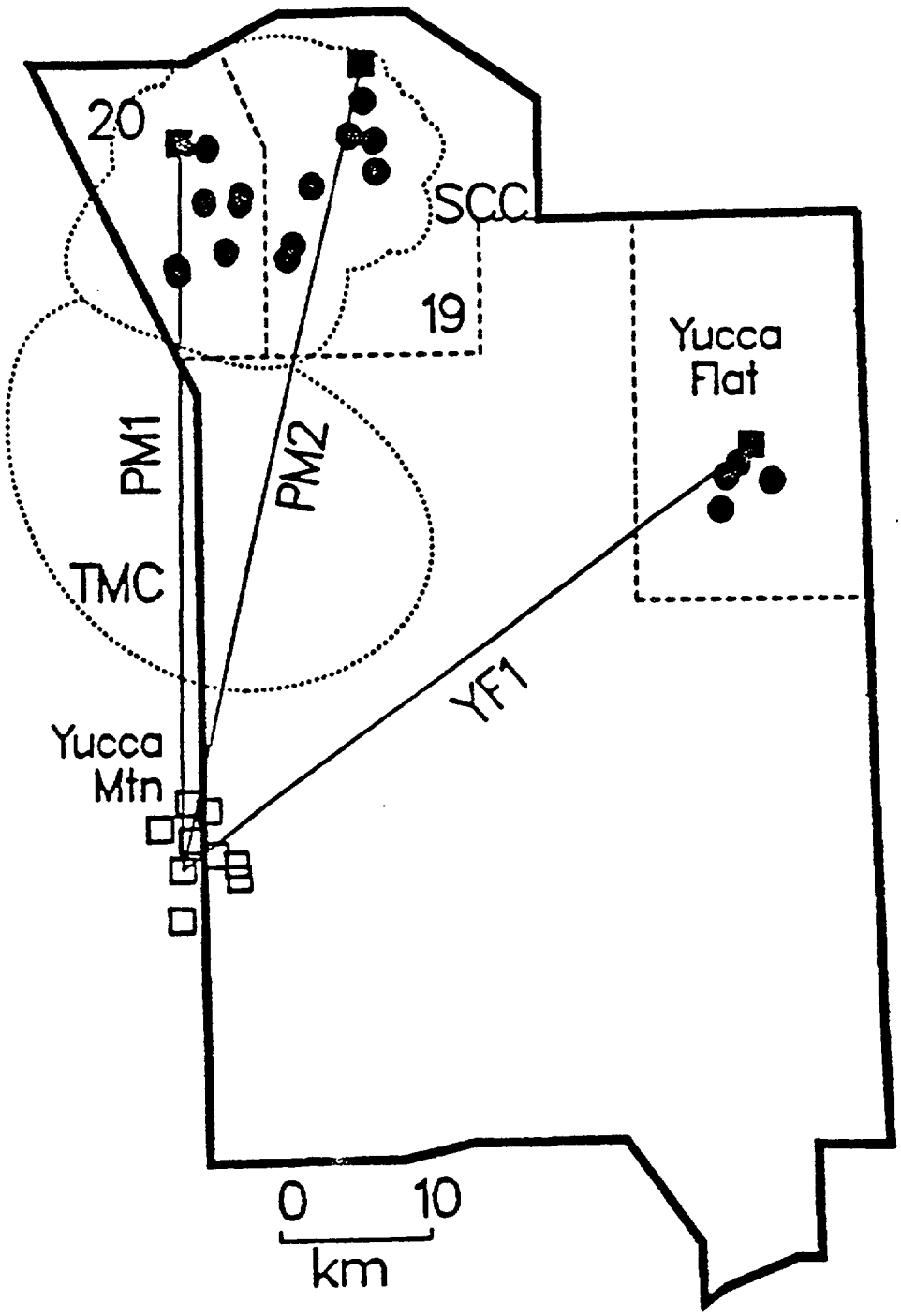


Figure 3.1.1.2.4.2.2-9. Location map showing Nevada Test Site, Yucca Mountain seismic stations (open squares), explosion locations (solid symbols), and velocity profiles PM1, PM2, and YF1. Also denoted are the Timber Mountain Caldera (TMC) and the Silent Canyon Caldera (SCC). Areas 19 and 20 comprise Pahute Mesa. Source: Walck and Phillips (1990). [INN 3.1.1.2.4.2.2-7]

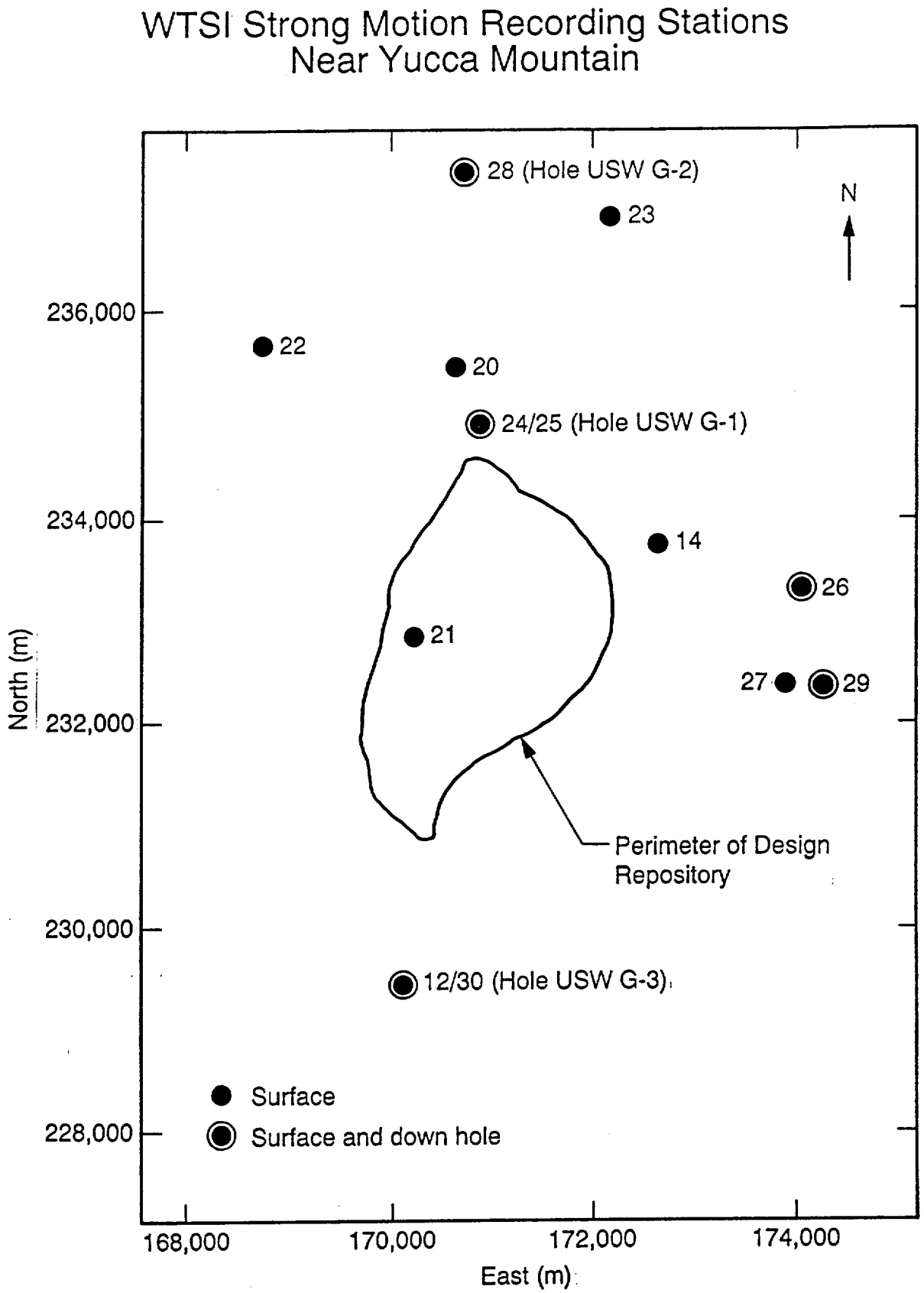


Figure 3.1.1.2.4.2.2-10. Location Map of Strong Motion Recording Stations at Yucca Mountain. Source: Phillips (1991).

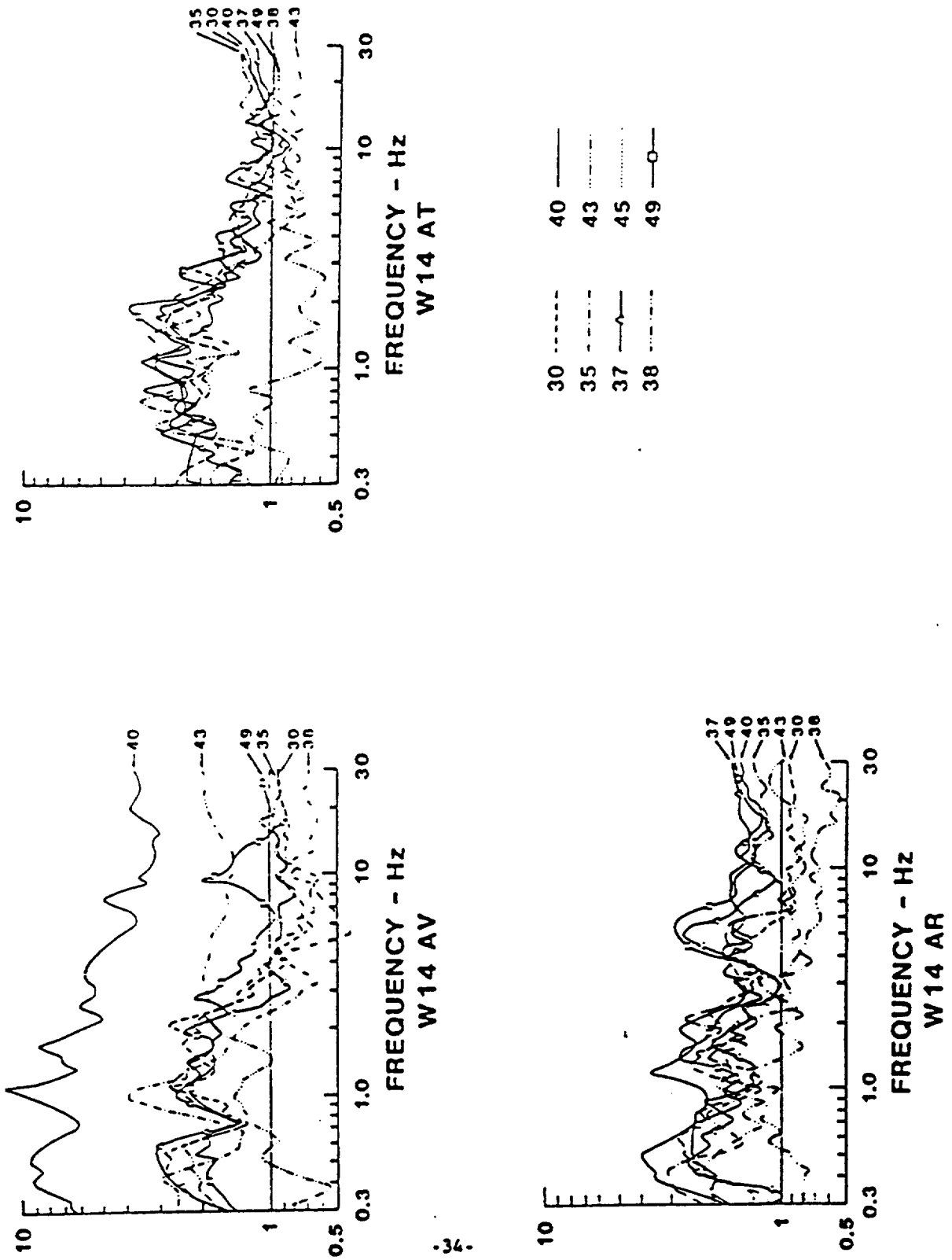
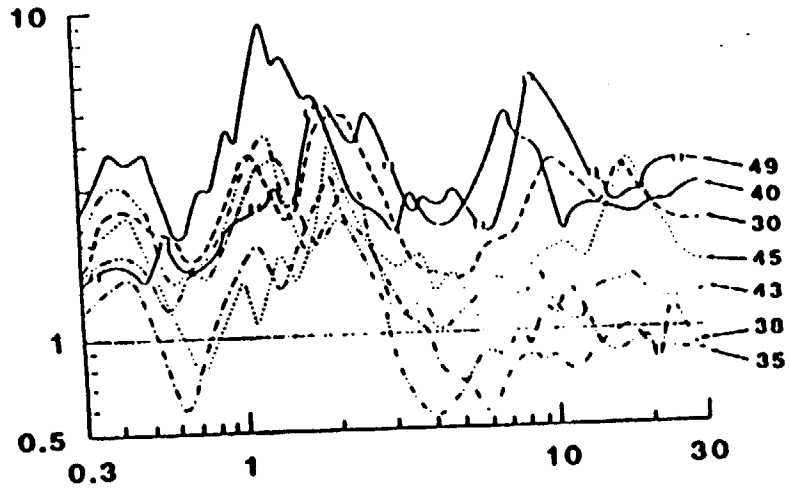
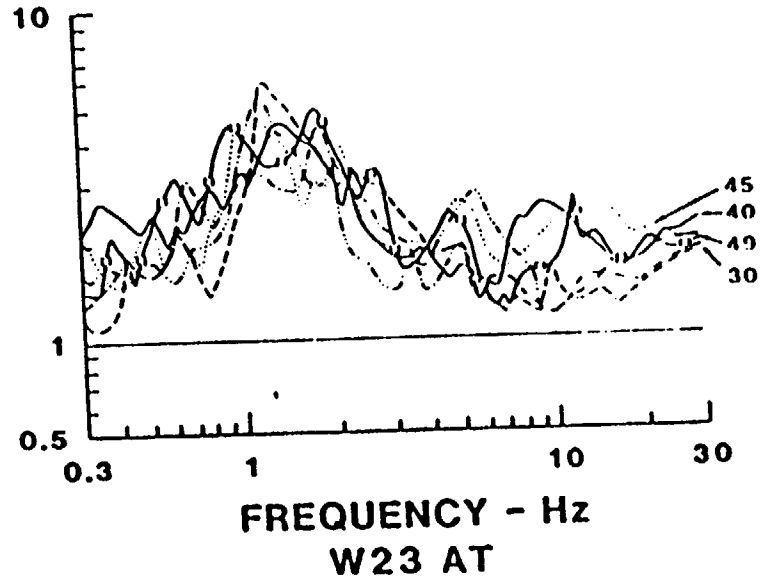
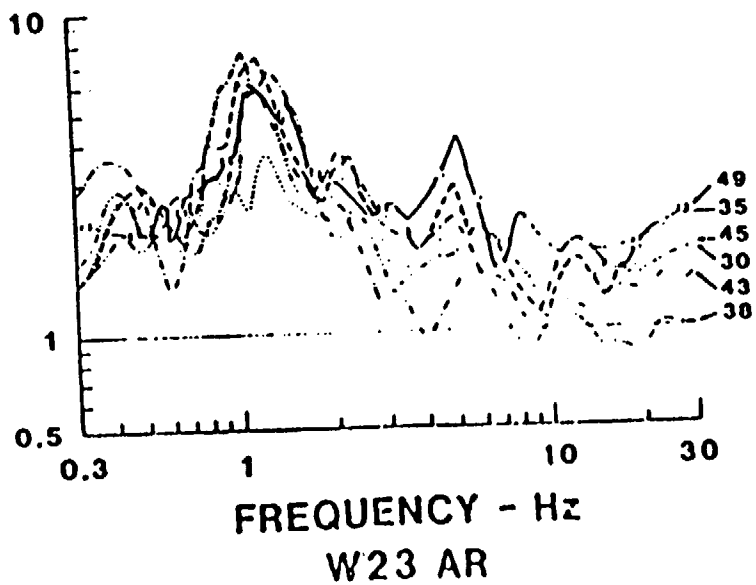


Figure 3.1.1.2.4.2.2-11. Ratios of Measured PSRV at Station W-14 to Average Values for NTS Sites. Source: Phillips (1991). [INN 3.1.1.2.4.2.2-8]

Figure 3.1.1.2.4.2.2-12. Ratios of Measured PSRV at Station W-23 to Average Values for NTS Sites. Source: Phillips (1991). [INN 3.1.1.2.4.2.2-9]







30 ------ 40 ——
35 -·-·-· 43 -- --
37 —o— 45 ····
38 -·-·-· 49 —o···

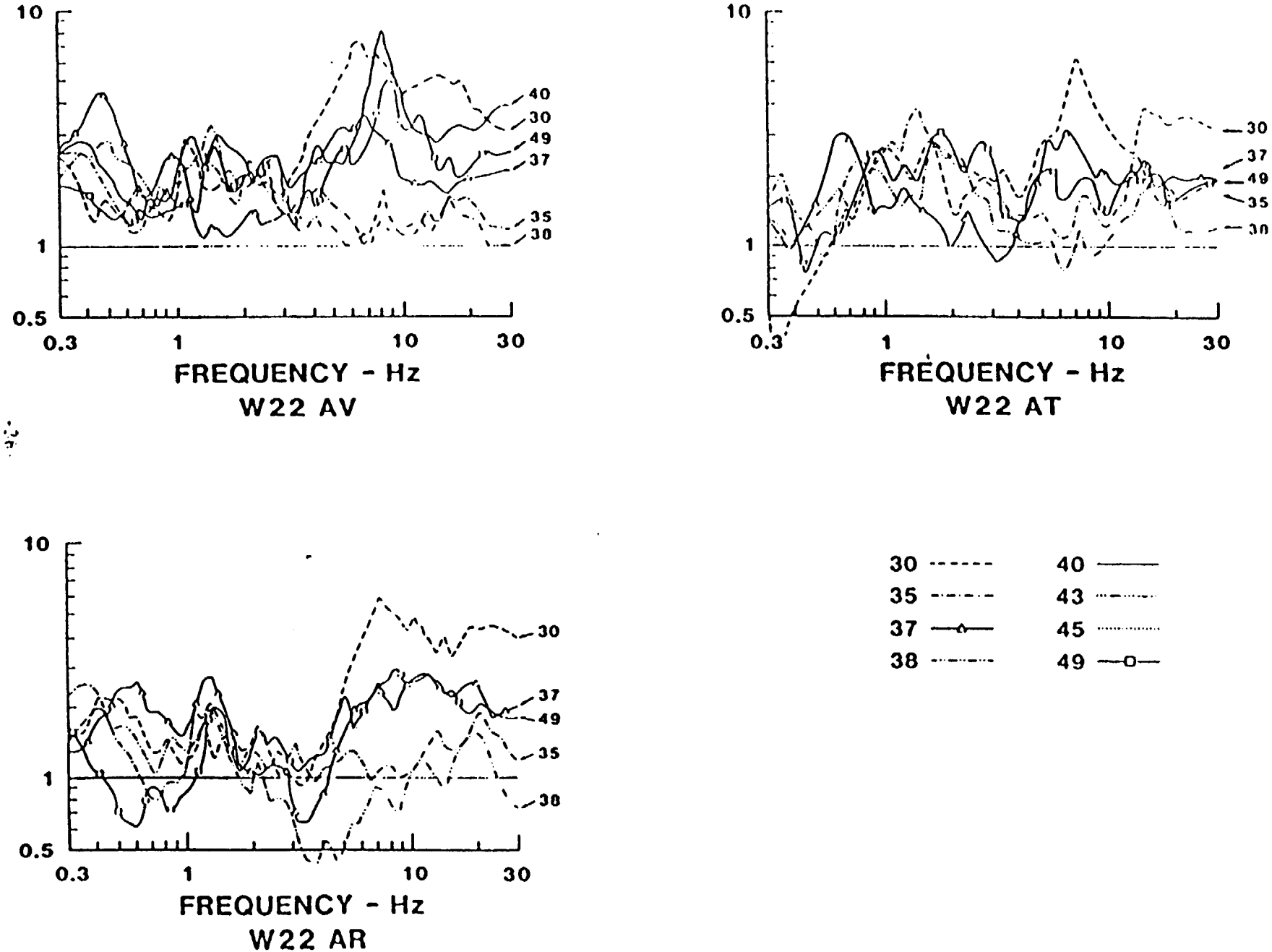
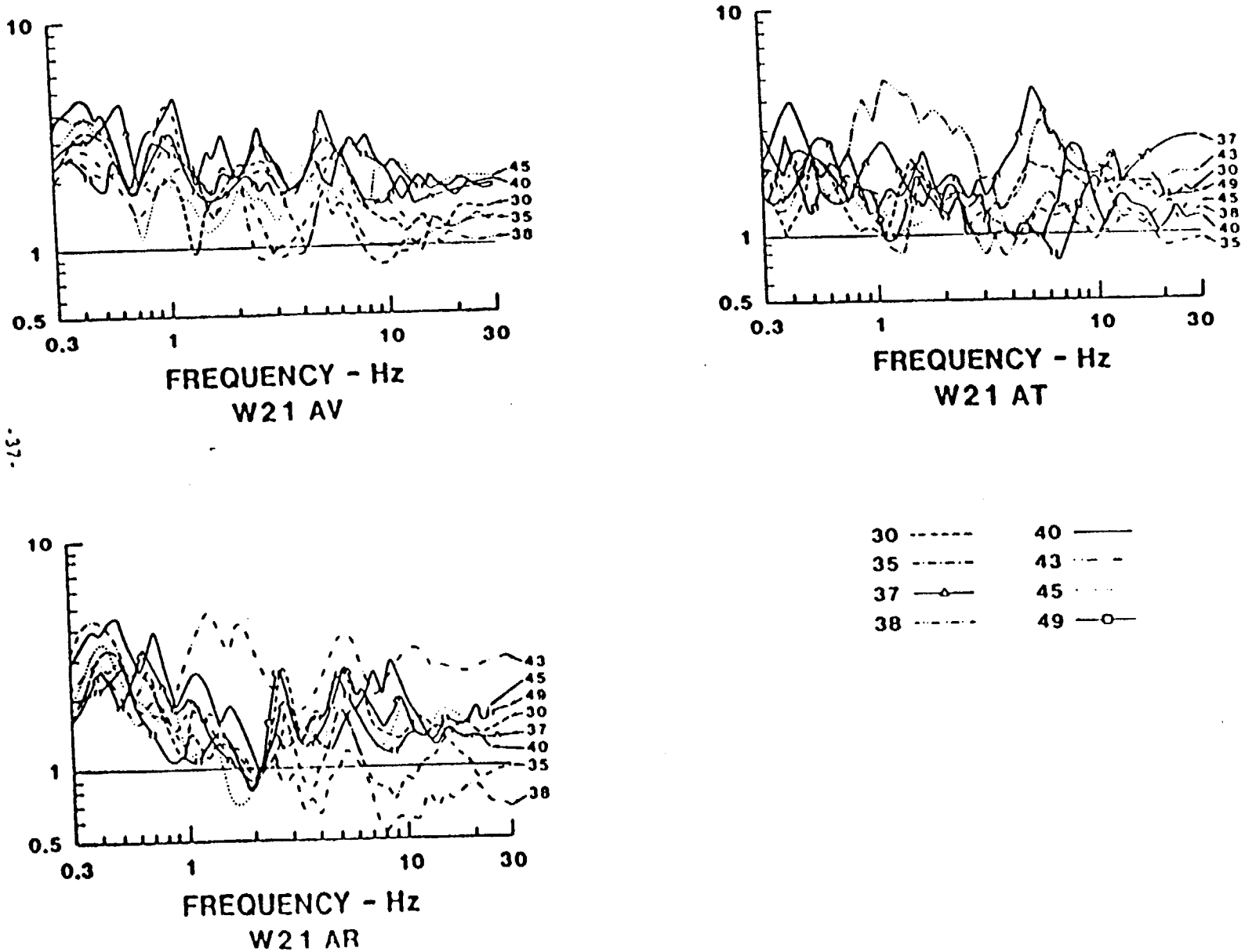


Figure 3.1.1.2.4.2.2-13. Ratios of Measured PSRV at Station W-22 to Average Values for NTS sites. Source: Phillips (1991). [INN 3.1.1 .2.2-10]

Figure 3.1.1.2.4.2.2-14. Ratios of Measured PSRV at Station W-21 to Average Values for NTS Sites. Source: Phillips (1991). [INN 3.1.1.2.4.2.2-11]



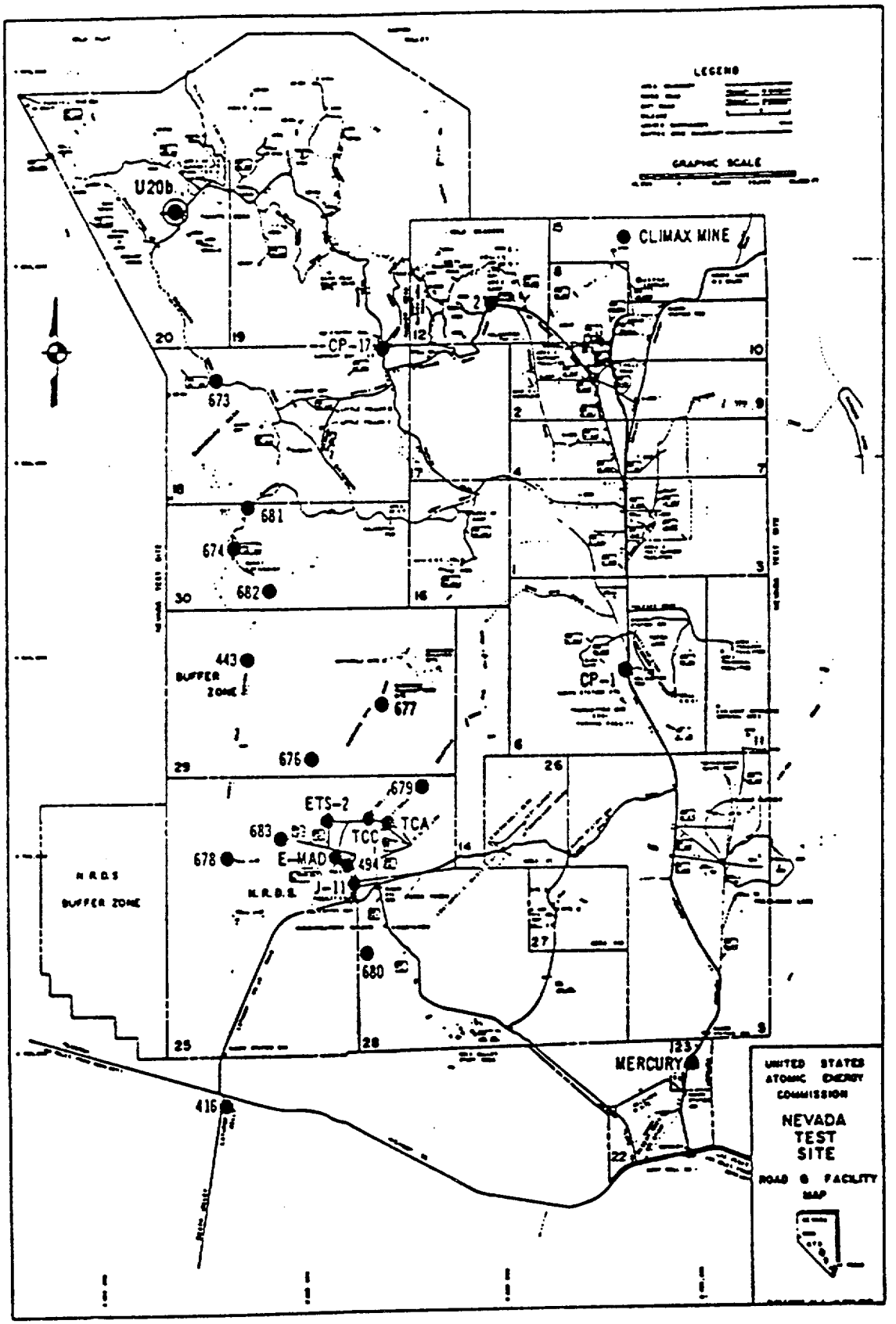


Figure 3.1.1.2.4.2.2-15. Location Map of Strong Motion Stations that Recorded the Pipkin Nuclear Explosion at Pahute Mesa. Source: Weetman et al. (1970). [INN 3.1.1.2.4.2.2-12]

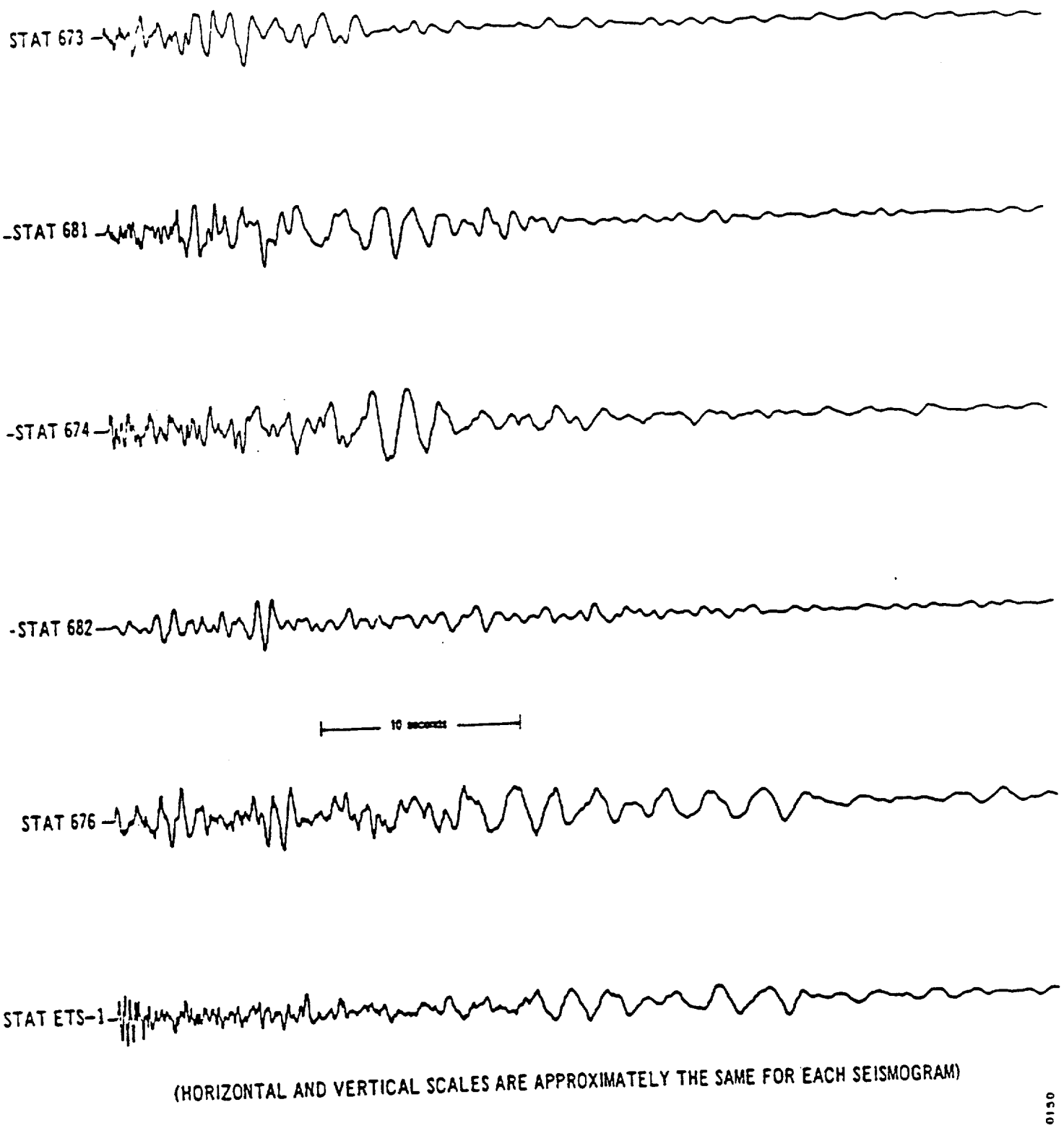
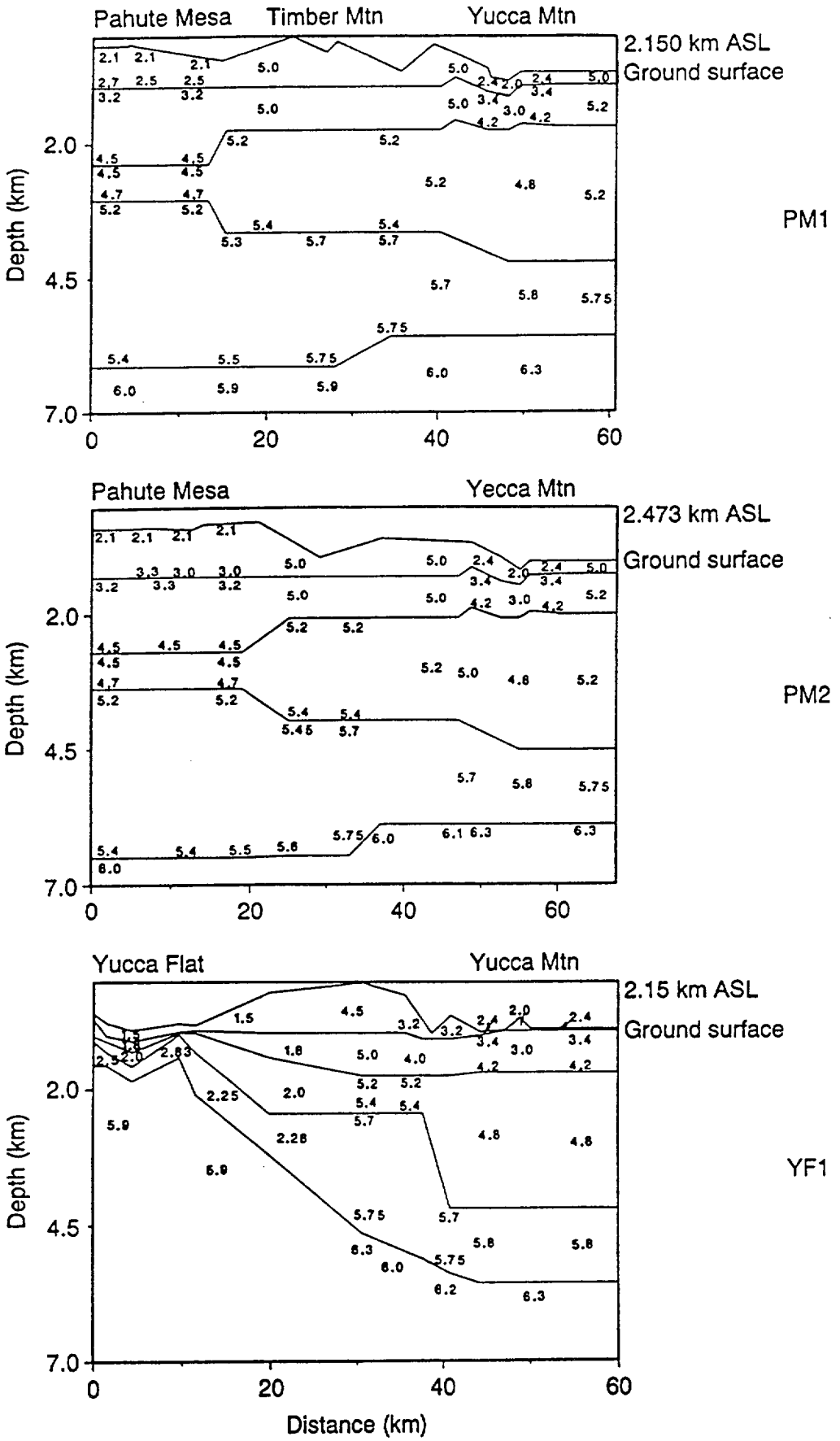


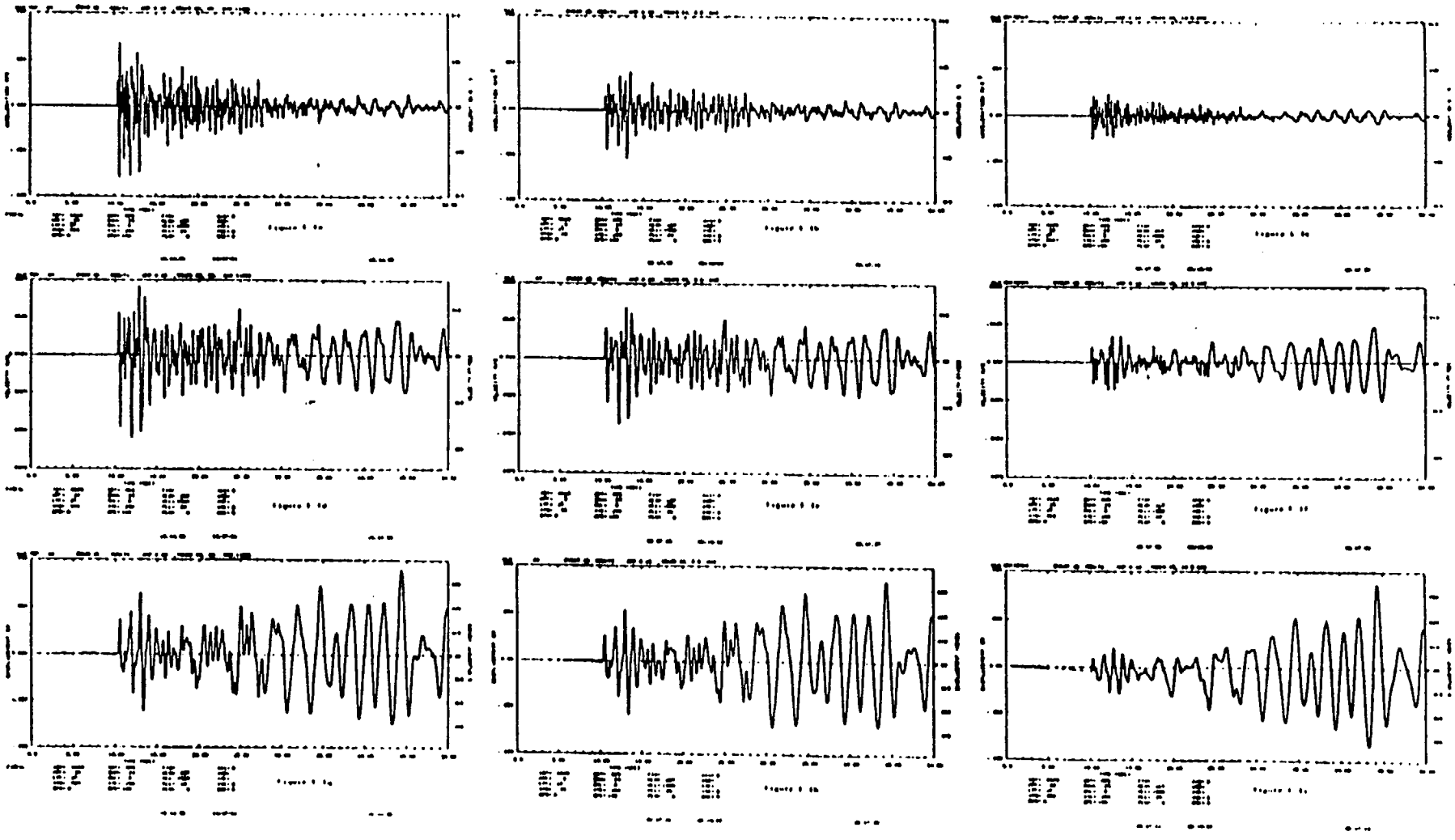
Figure 3.1.1.2.4.2.2-16. Profile of Radial Velocity Time Histories of the Pipkin Nuclear Explosion at Pahute Mesa Recorded to the South at Stations Shown in Figure 15. Source: Weetman et al. (1970). [INN 3.1.1.2.4.2.2-13]

Figure 3.1.1.2.4.2.2-17. Velocity Models for Travel Paths PM1, PM2, and YF1 Shown in Figure-9. Source: Walck and Phillips (1990).



Note: ASL = Above Sea Level

Figure 3.1.1.2.4.3.4-1. Seismograms recorded in a downhole array at Jackass Flats (Station 10, Well J-11) from a nuclear explosion at Pahute Mesa. Top row: accelerations; middle row; velocity; bottom row; displacement. Left column: surface station on alluvium; middle column: -61 meters near the base of alluvium; right column: -356 meters in tuff. Source: Vortman and Long, 1982. [INN 3.1.1.2.4.3.4-1]



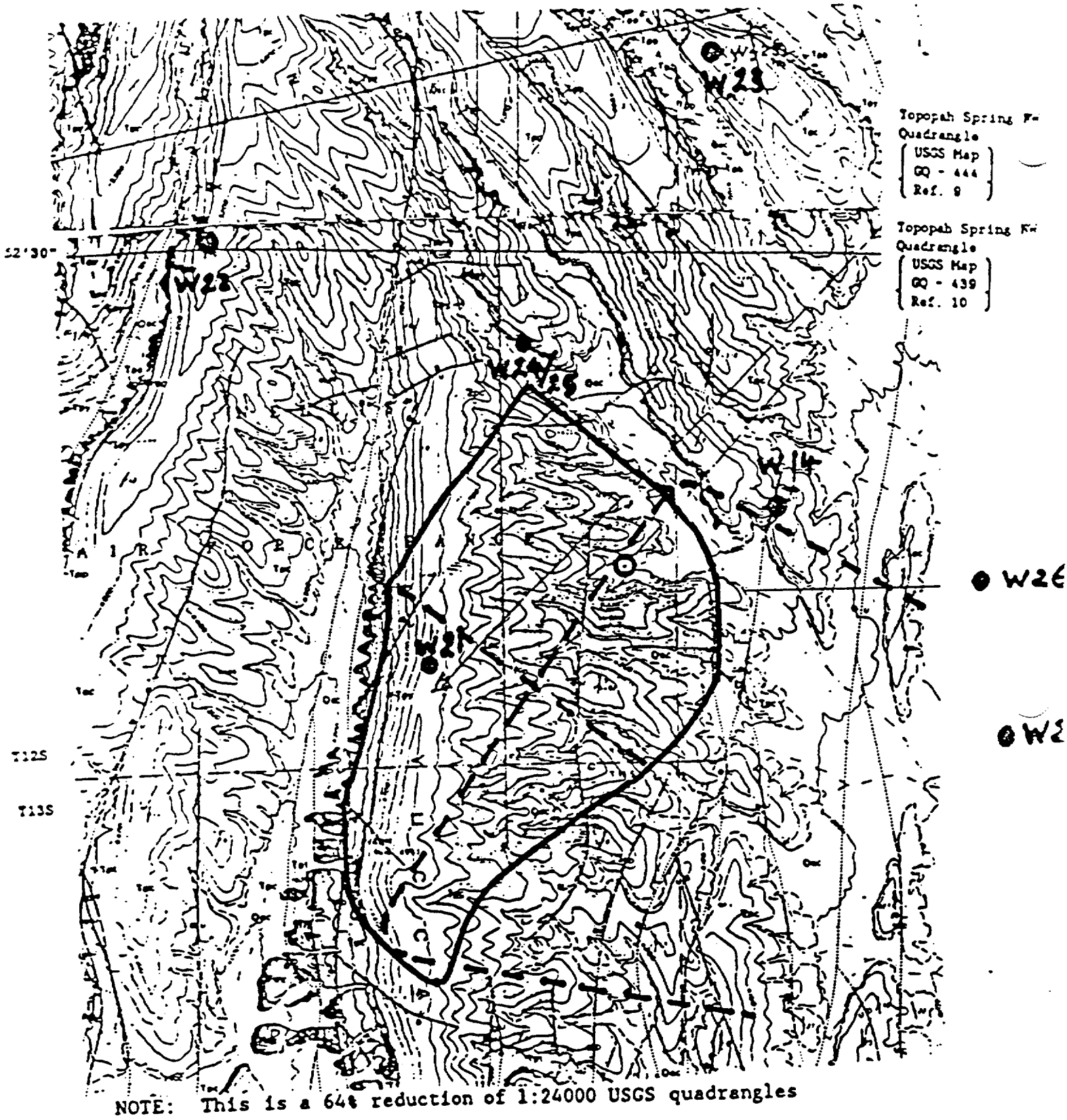


Figure 3.1.1.2.4.3.4-2. Location map of downhole ground motion recordings stations at Yucca Mountain and regional topography. Source: Phillips (1991). [INN 3.1.1.2.4.3.4-2]

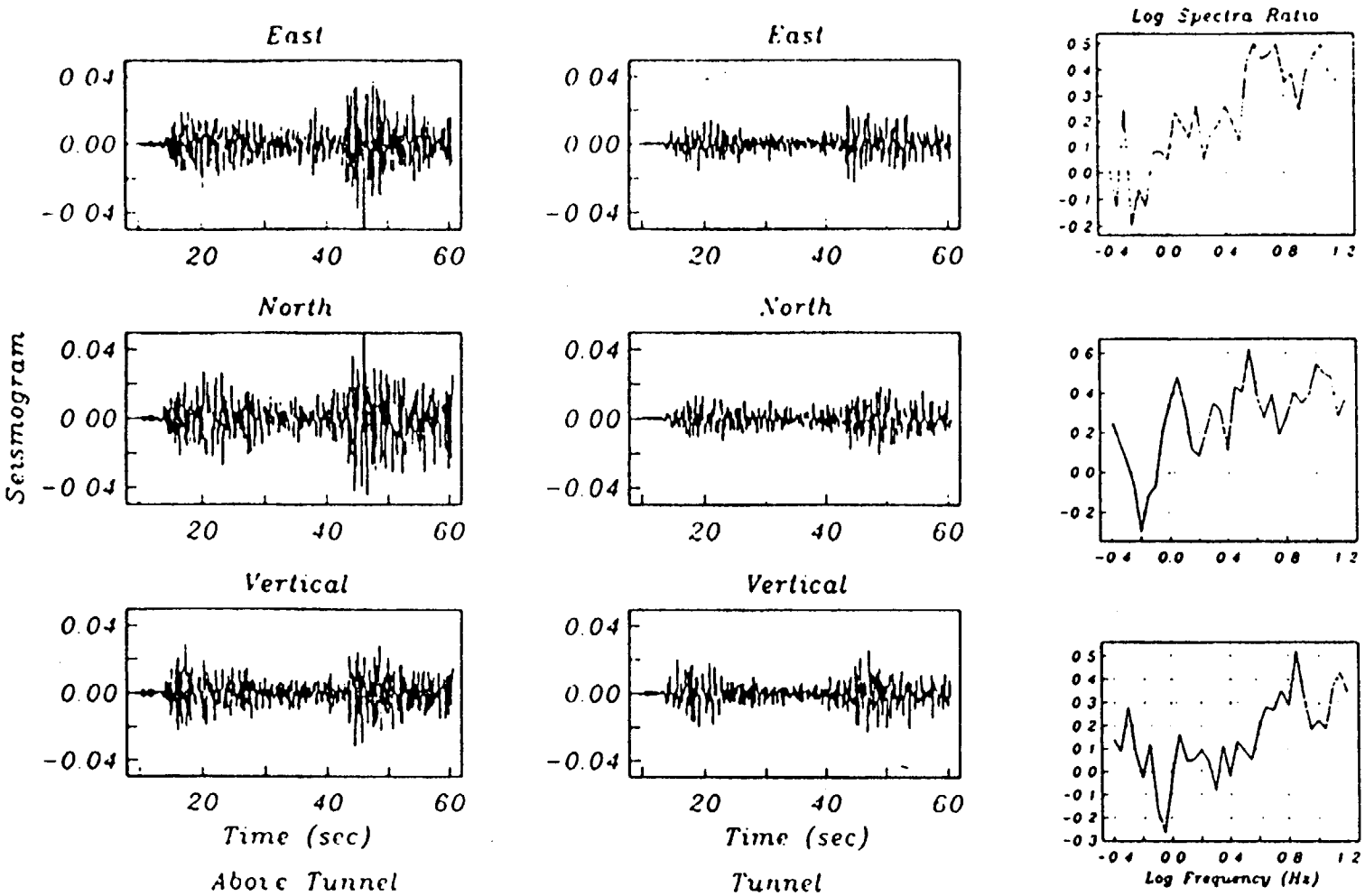


Figure 3.1.1.2.4.3.4-3. Top: Seismograms from the September 2, 1992 magnitude 5.9 earthquake in southern Utah recorded at Little Skull Mountain seismic stations RXTN (tunnel) and RLSM (above tunnel) of the above seismograms. Source: Anderson et al. (1993).

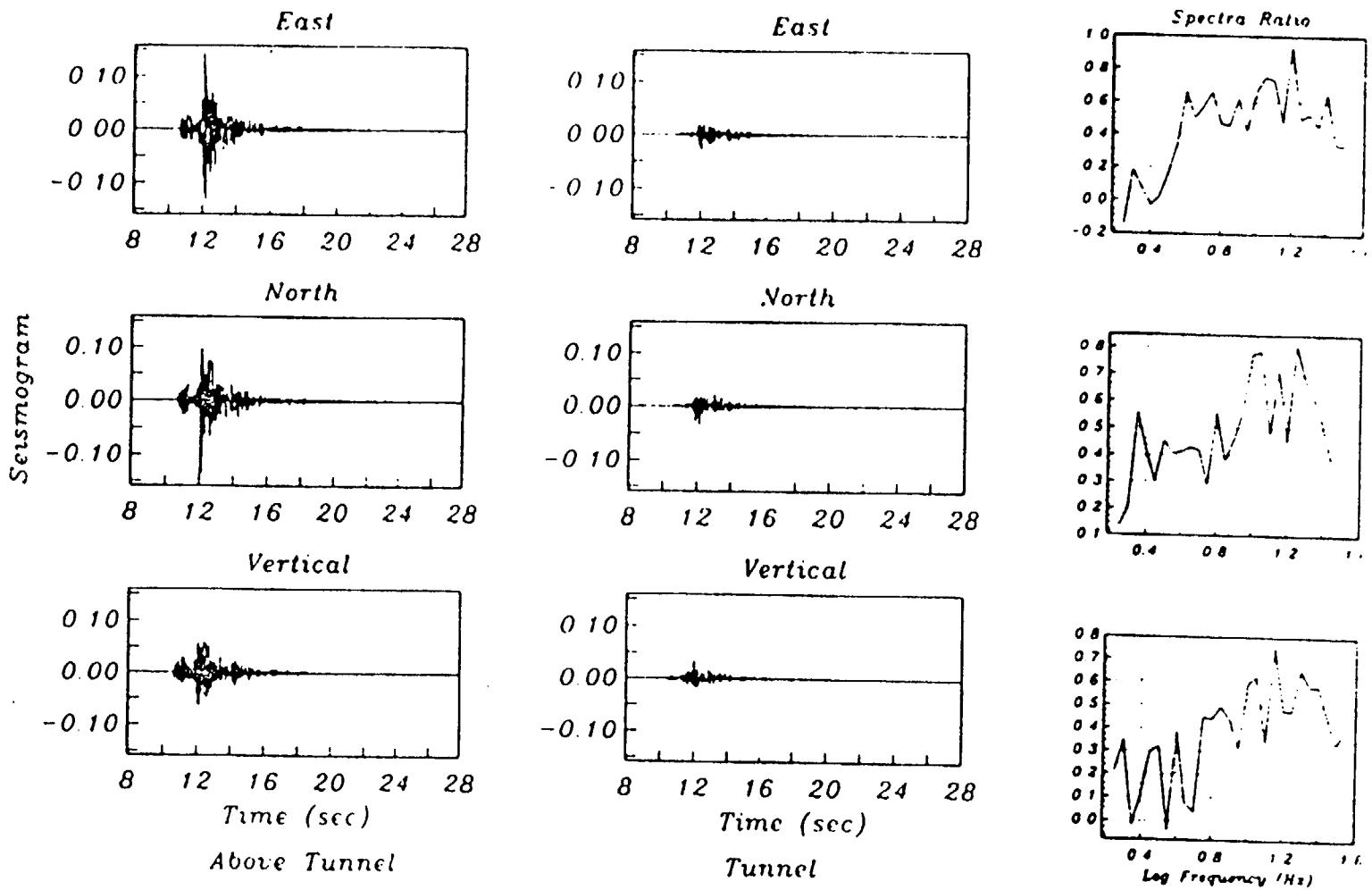


Figure 3.1.1.2.4.3.4-4. Seismograms from a September 7, 1992 M 3.15 earthquake in southern Utah recorded at Little Skull Mountain seismic stations RXTN (tunnel) and RLSM (above tunnel). Bottom: Amplitude spectra and spectral ratios (surface/tunnel) of the above seismograms. Source: Anderson et al. (1993)

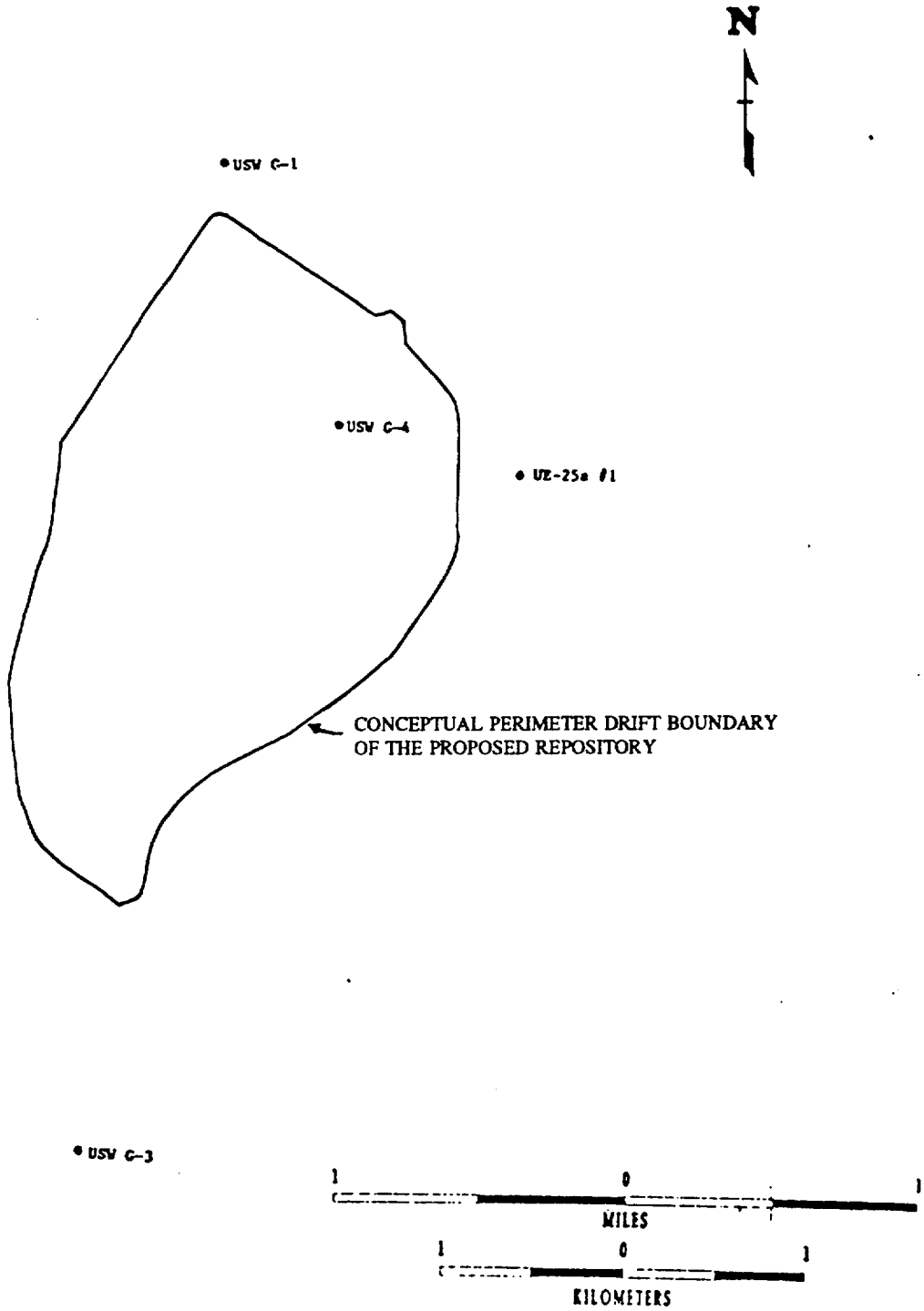
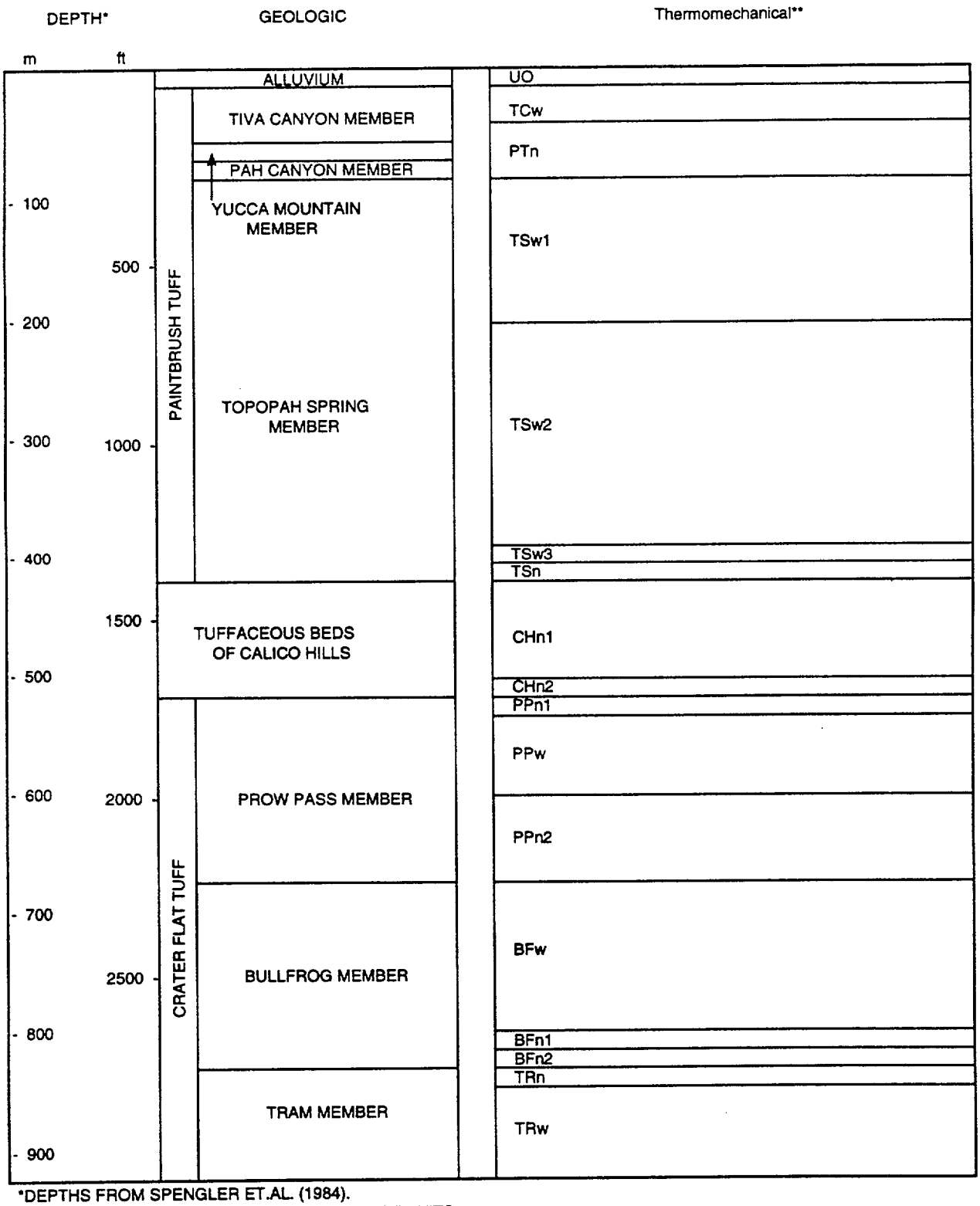


Figure 3.1.1.2.7.1-1 Location of Existing Coreholes for Geoengineering Database



*DEPTHS FROM SPENGLER ET.AL. (1984).
**SEE TABLE 3.1.1.2.7-001 FOR DESCRIPTION OF UNITS.

Figure 3.1.1.2.7.1.1-1 Thermomechanical and Geologic Stratigraphy at hole USW G-4

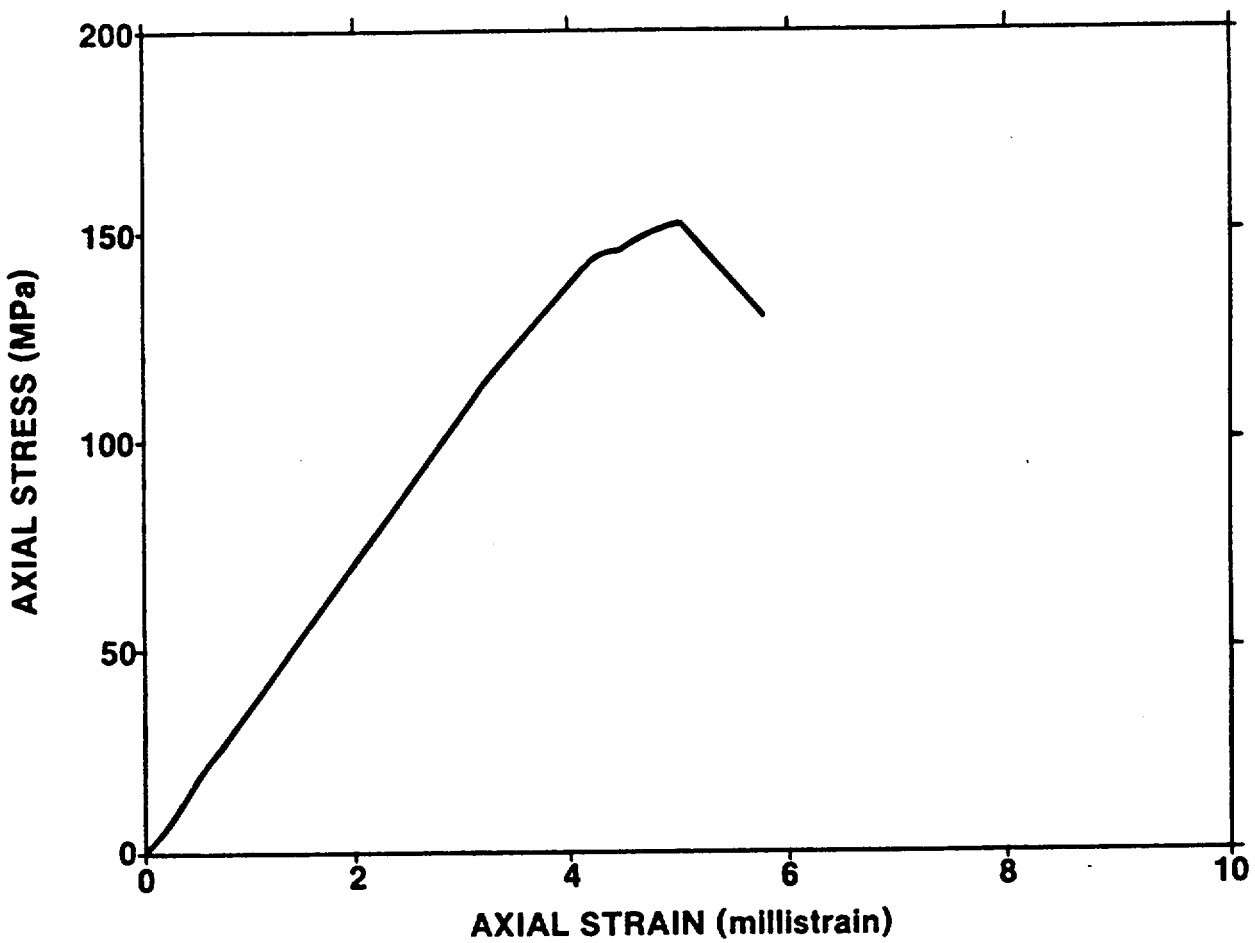


Figure 3.1.1.2.7.3.1-1 Representative axial stress-axial strain plot for welded devitrified Topopah Spring Member (test sample GU-3 1050.4/3; test conditions ambient temperature and pressure, strain rate $10^{-5}/s$). Modified from price etal. (1984)

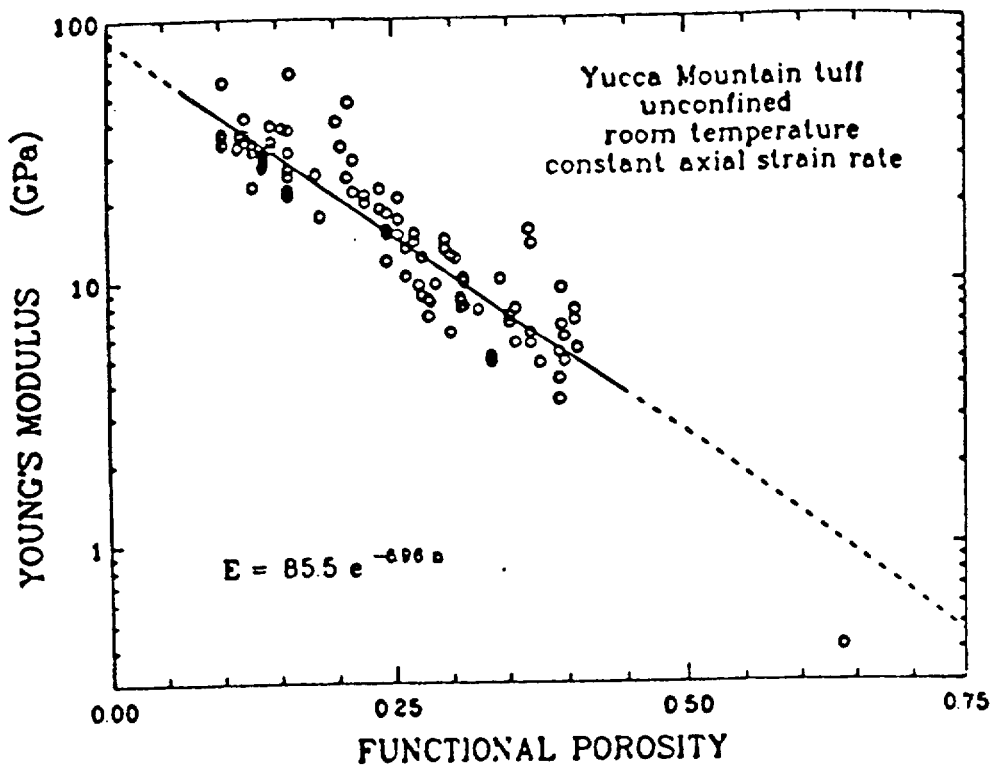


Figure 3.1.1.2.7.3.1-2 Young's Modulus Vs. Functional Porosity (After Price and Bauer, 1985)

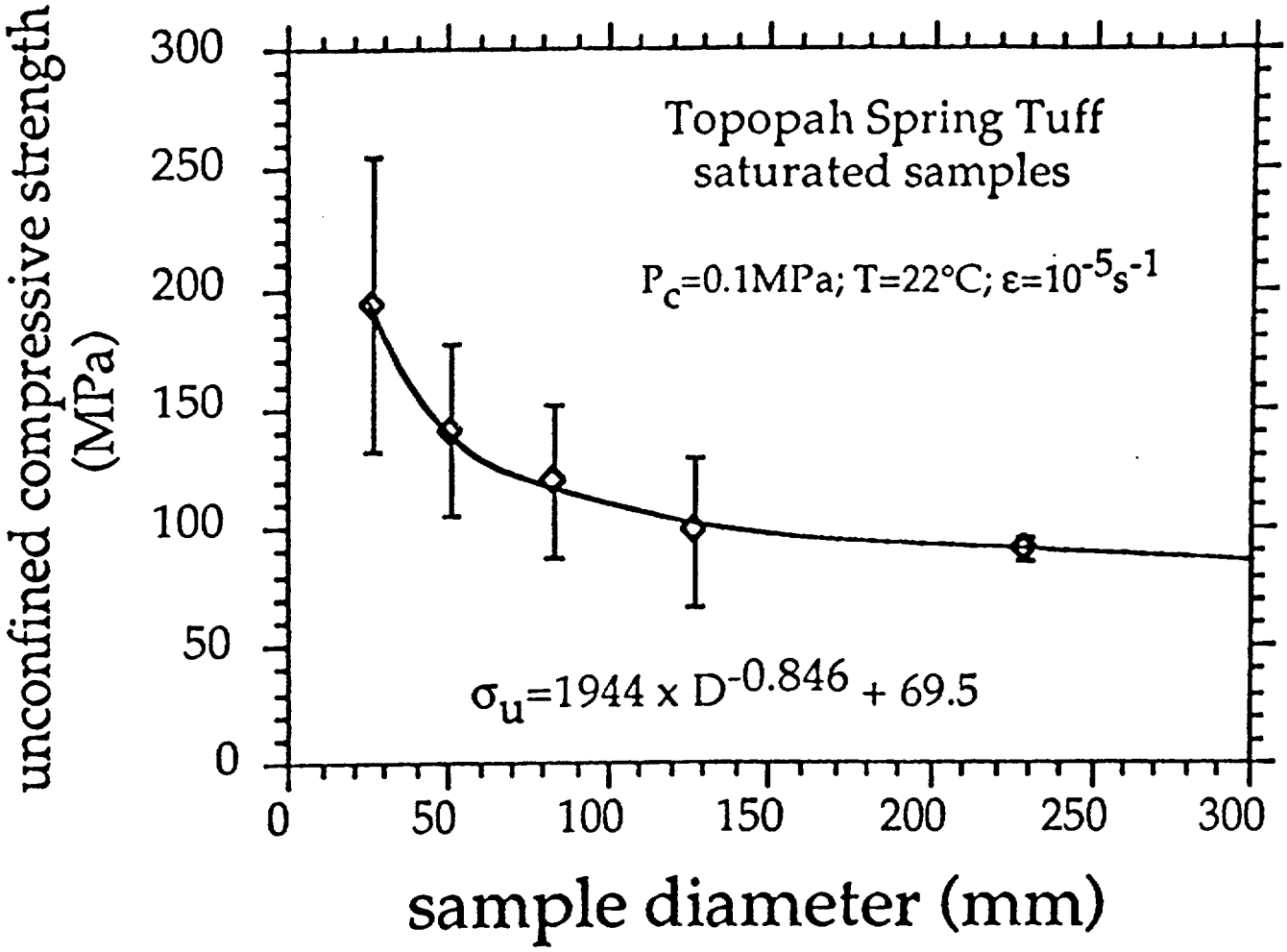


Figure 3.1.1.2.7.3.2-1 Compressive Strength Vs. Sample Size

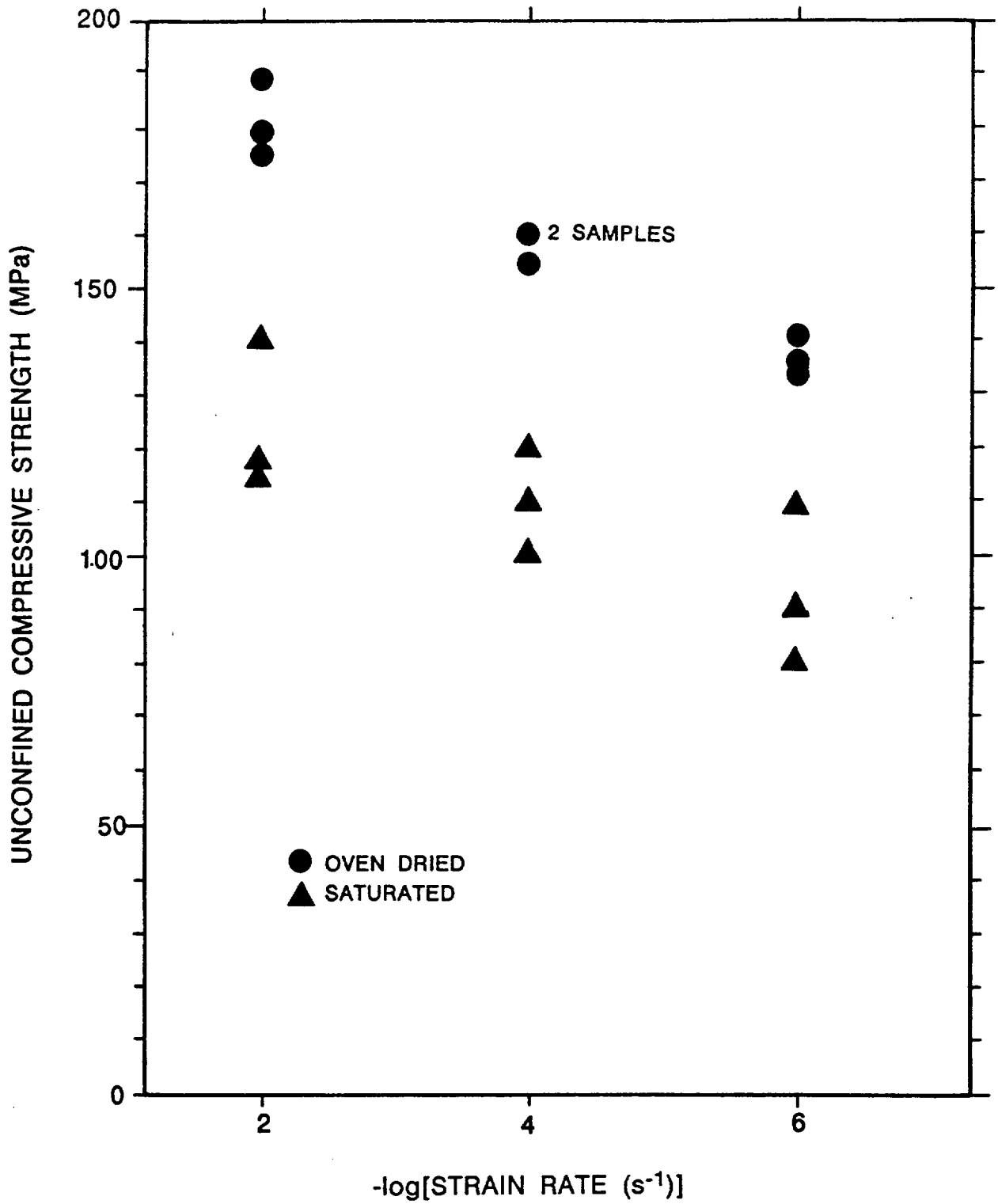


Figure 3.1.1.2.7.3.2-2 Effect of Saturating Samples on Comprehensive Strength.

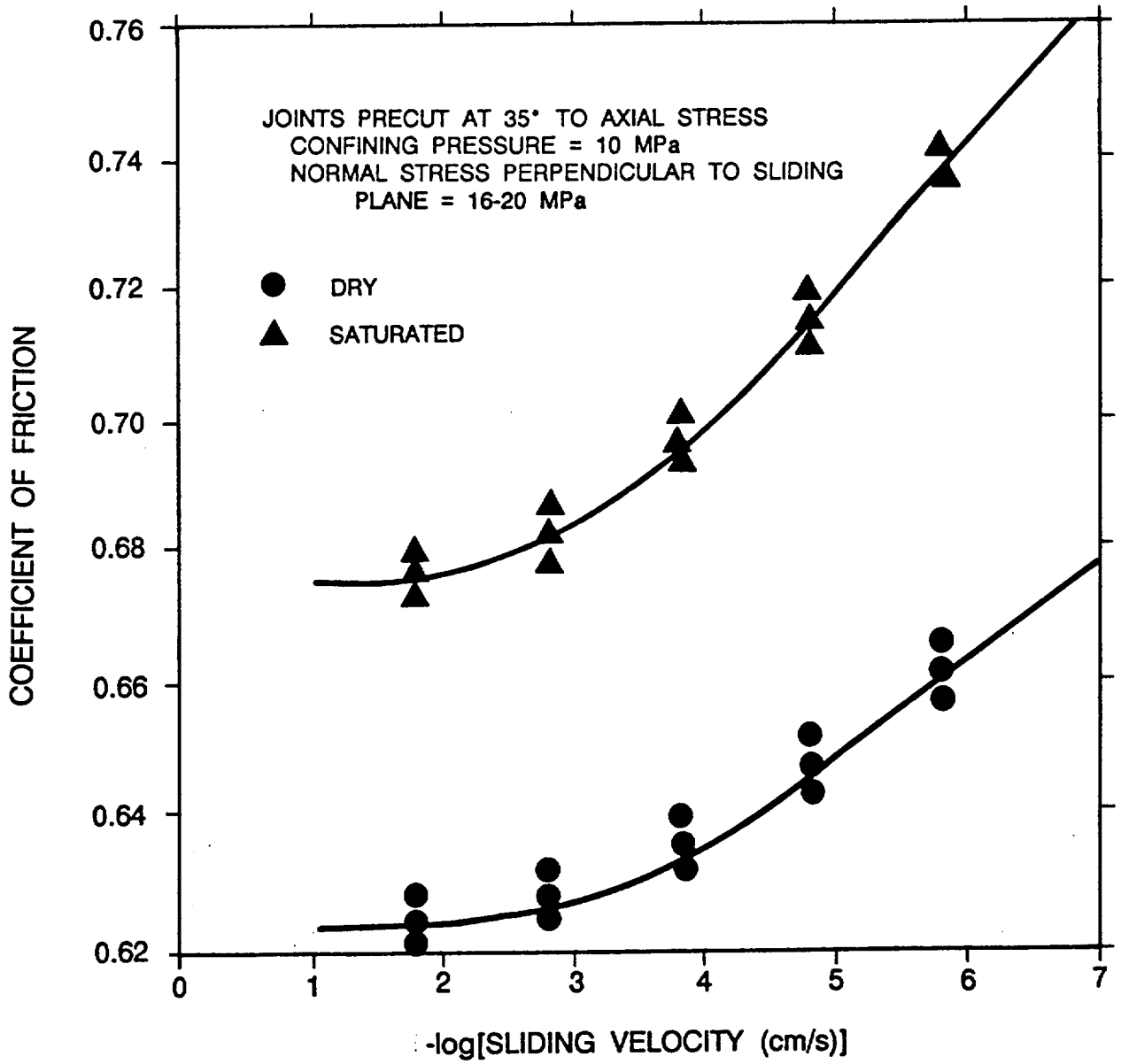


Figure 3.1.1.2.7.4.5-1 Plot of the coefficient of friction against log sliding velocity for oven-dried and water-saturated joints for Grouse Canyon Member welded tuff. Modified from Teufel (1981).

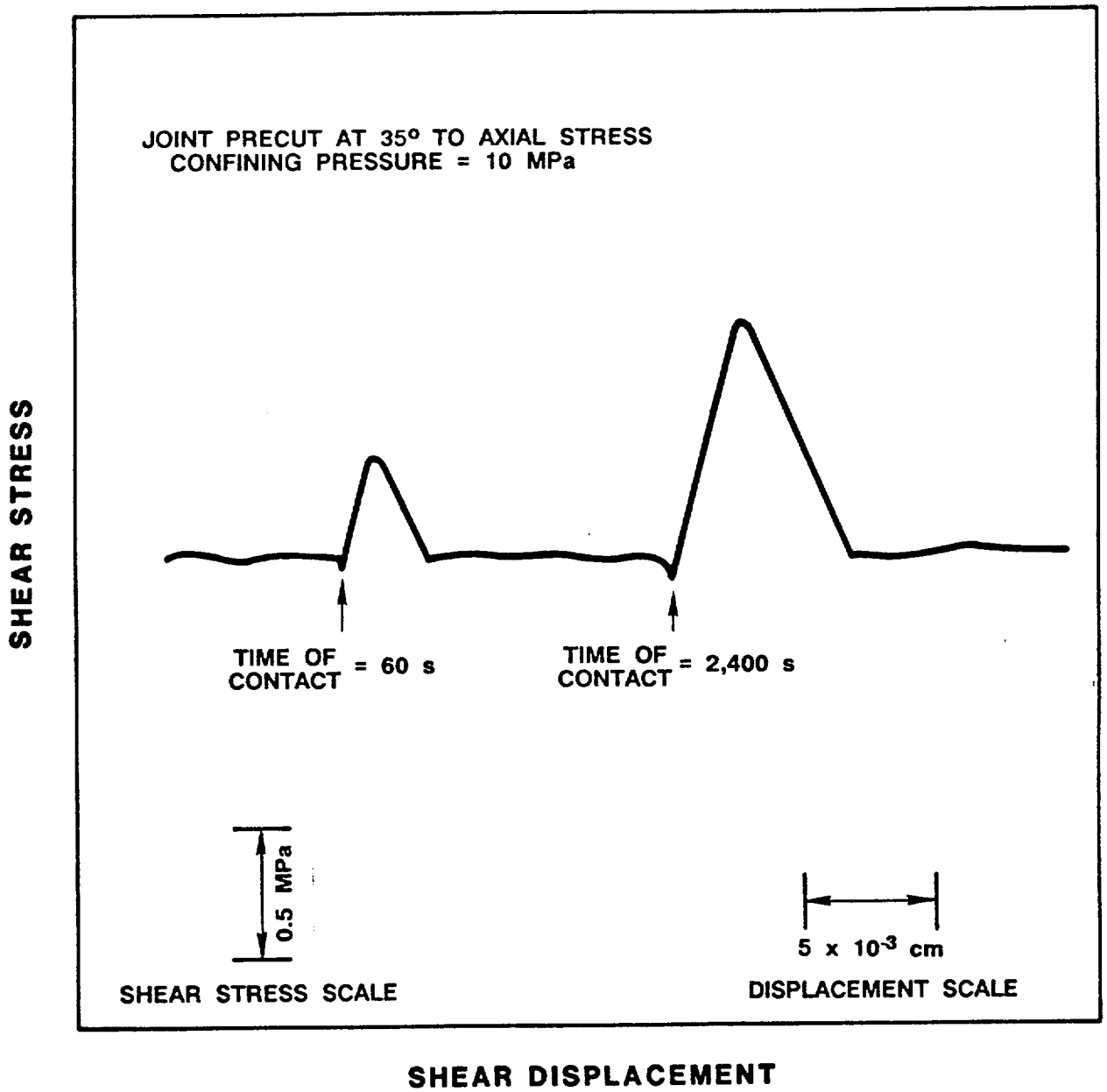


Figure 3.1.1.2.7.4.5-2 Shear stress versus shear displacement for oven-dried Grouse Canyon Member welded tuff sample for 60 and 2,400 s. periods of static contact. Modified from Teufel (1981).

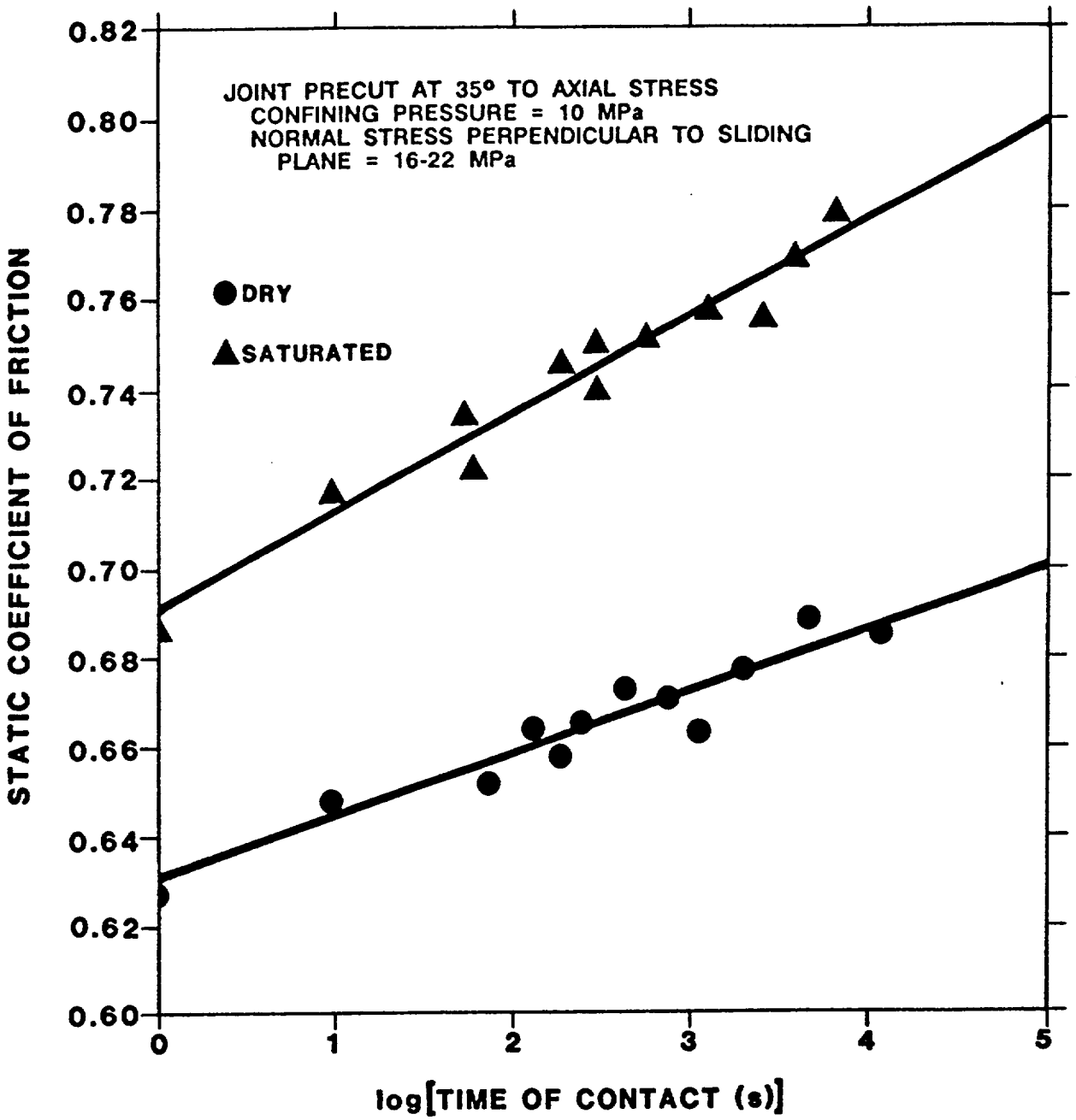


Figure 3.1.1.2.7.4.5-3 Plot of the coefficient of friction against log sliding velocity for oven-dried and water-saturated joints for Grouse Canyon Member welded tuff. Modified from Teufel (1981).

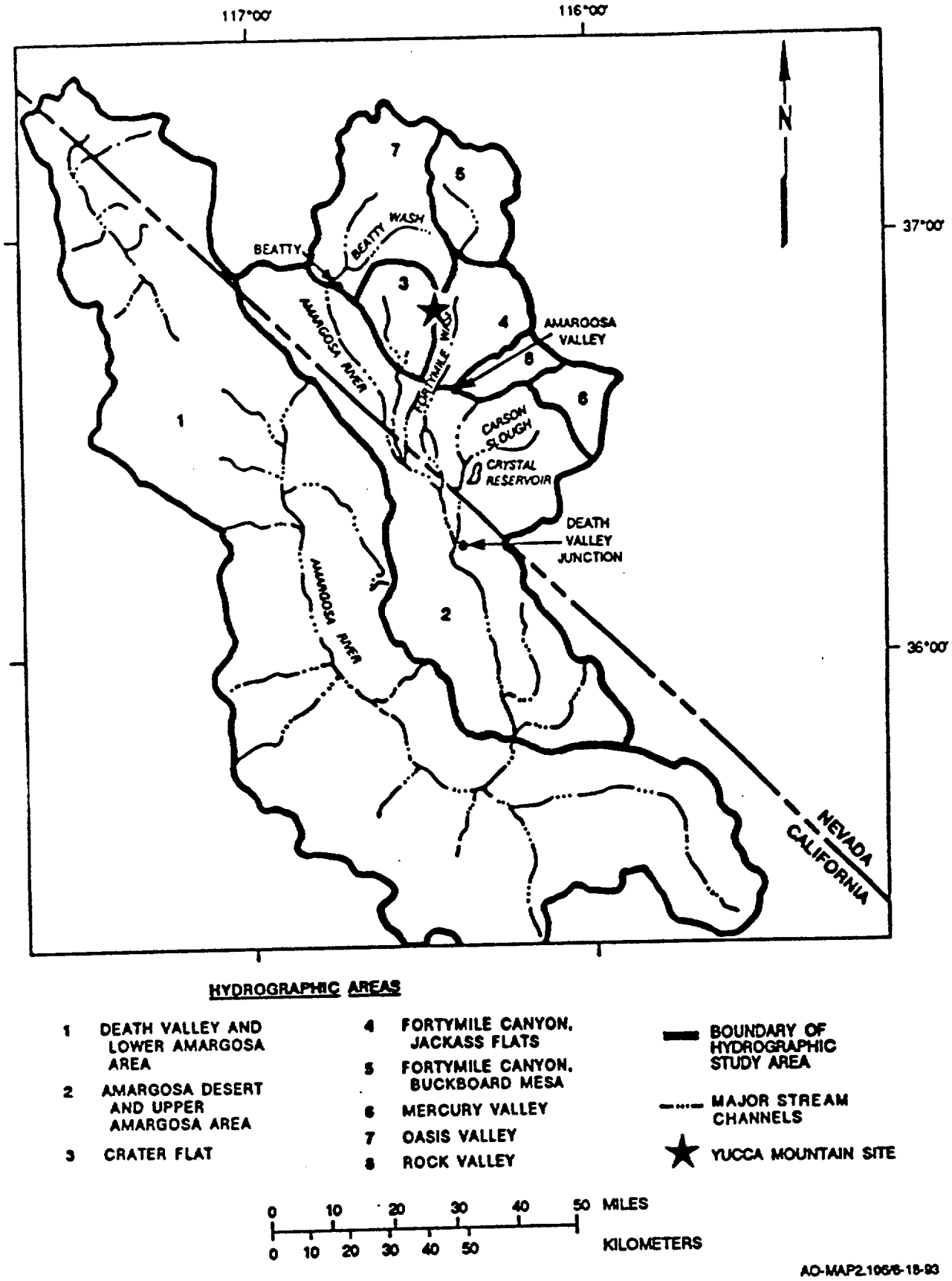


Figure 3.1.2.1.1-1. Hydrographic Study Area, Showing the Eight Hydrographic Areas and Major Stream Channels. Modified from Waddell, et al. (1984)

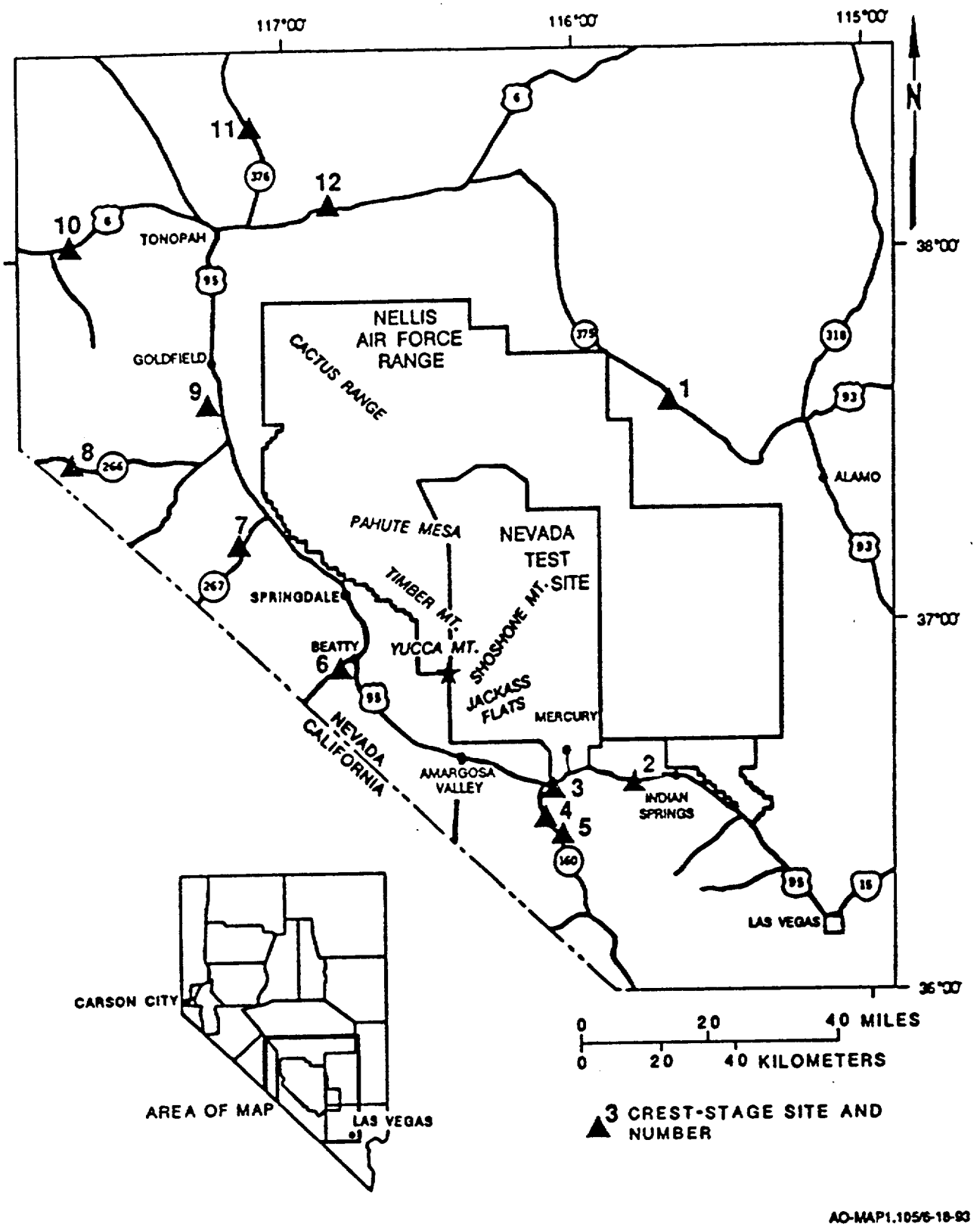


Figure 3.1.2.1.1-2. Locations of Crest-stage Sties in the Hydrologic Study Area and Adjacent Areas. Modified from Squires and Young (1984)

Figure 3.1.2.1.1-3. Surface-Water Bodies Including Springs. [INN 3.1.2.1.1-3]

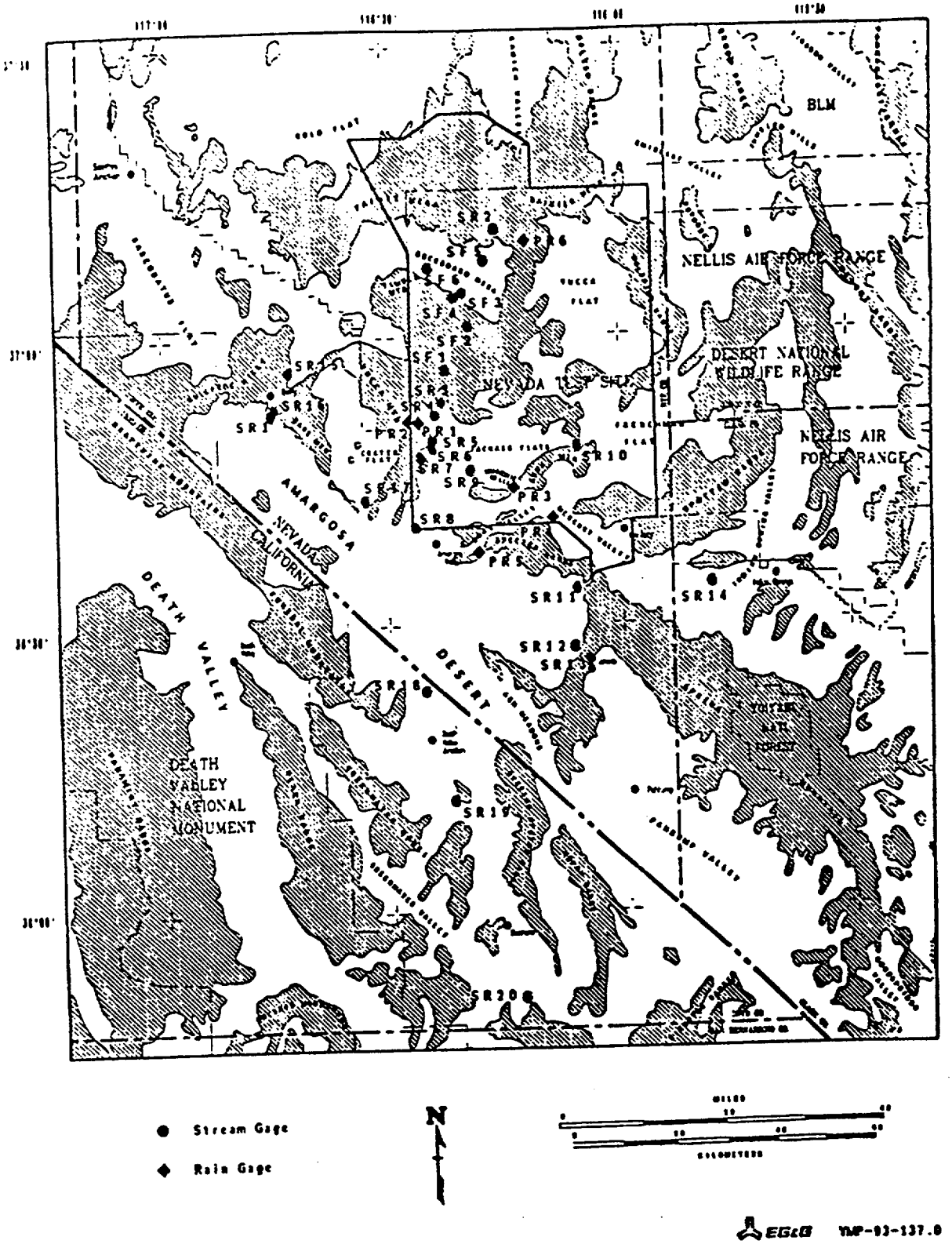


Figure 3.1.2.1.2-1: Regional Surface-Water Monitoring Network

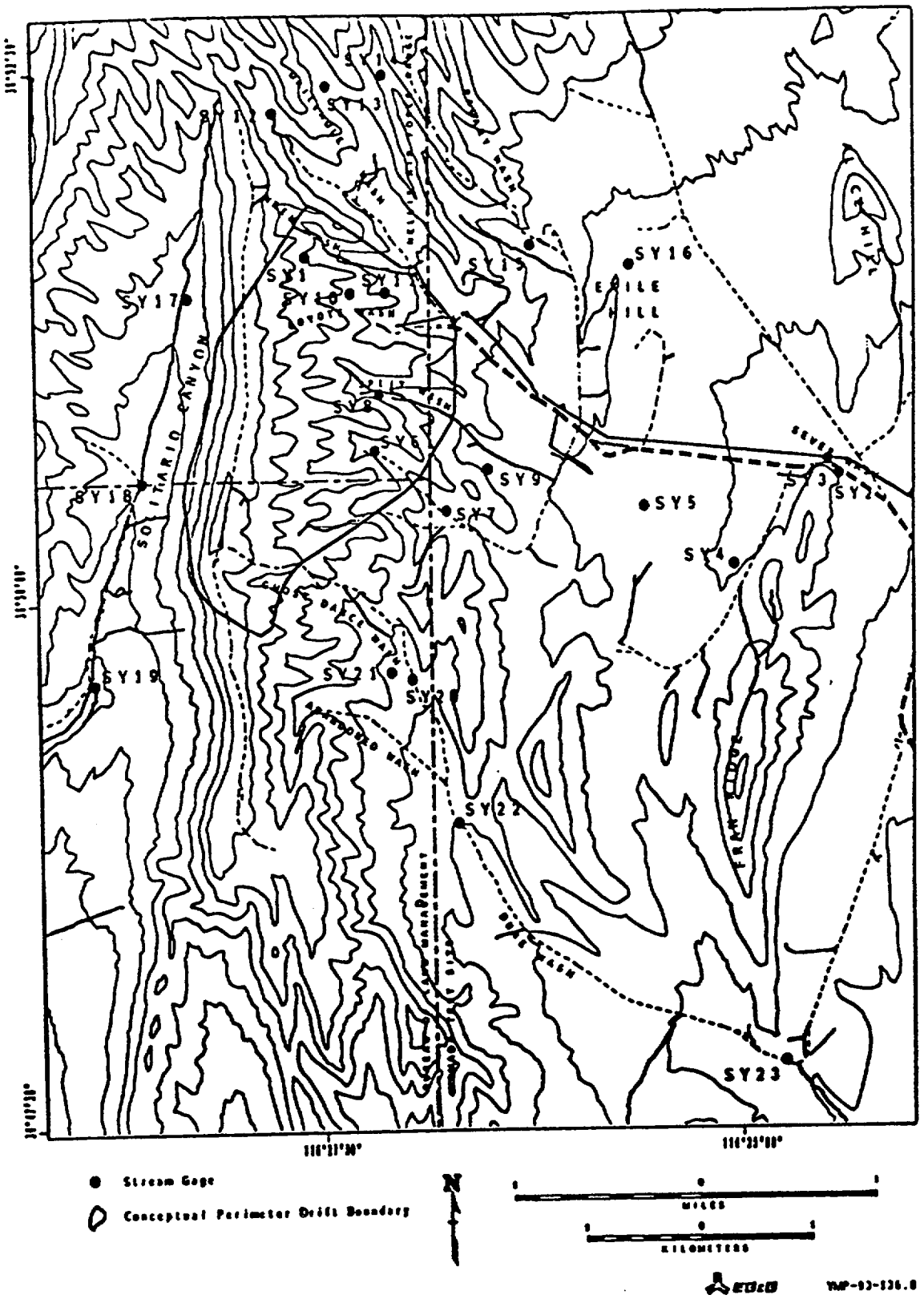


Figure 3.1.2.1.2-2: Site Surface-Water Monitoring Network

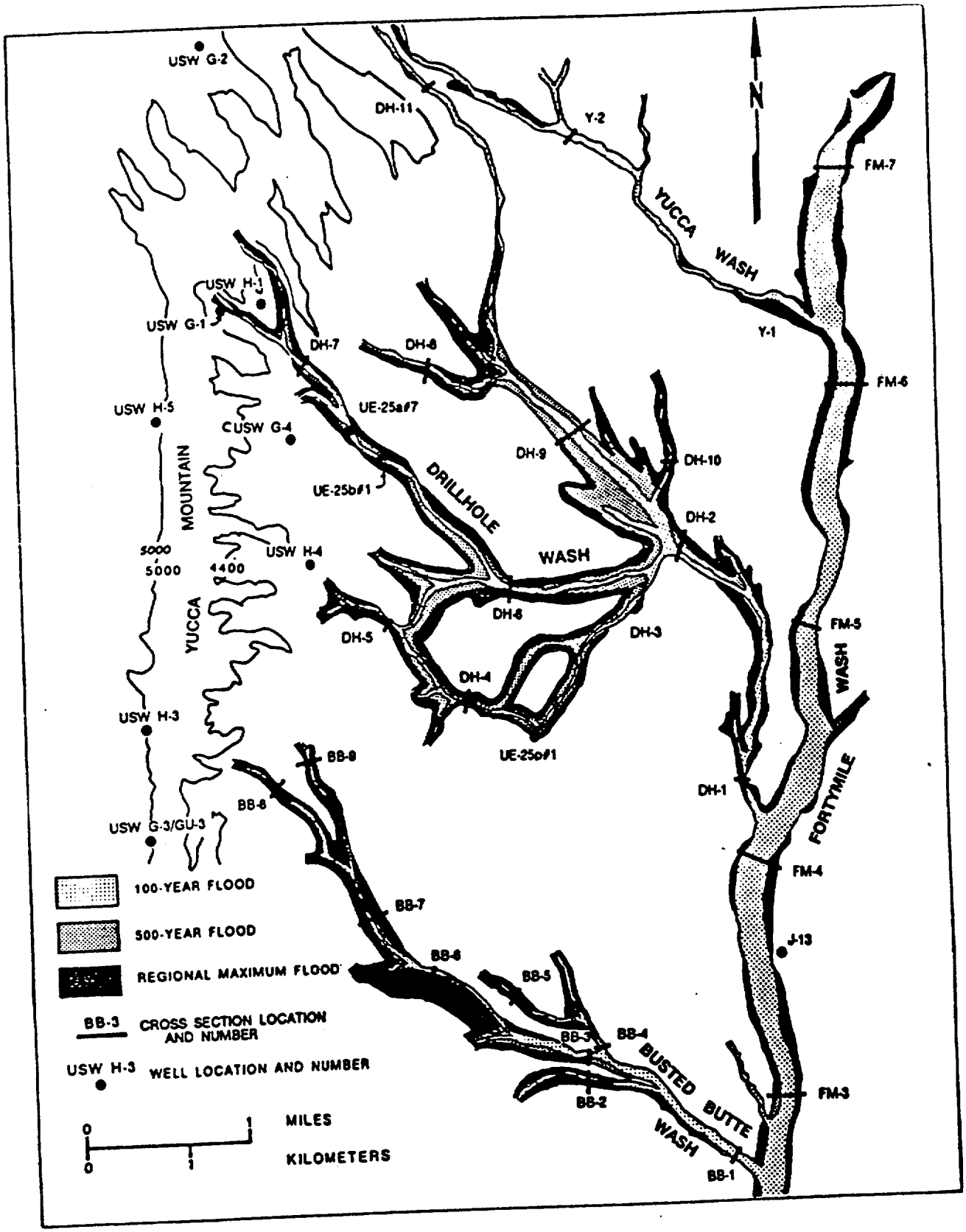


Figure 3.1.2.1.5-1: Flood-prone areas in the vicinity of Fortymile Wash. Modified from Squires and Young (1984).

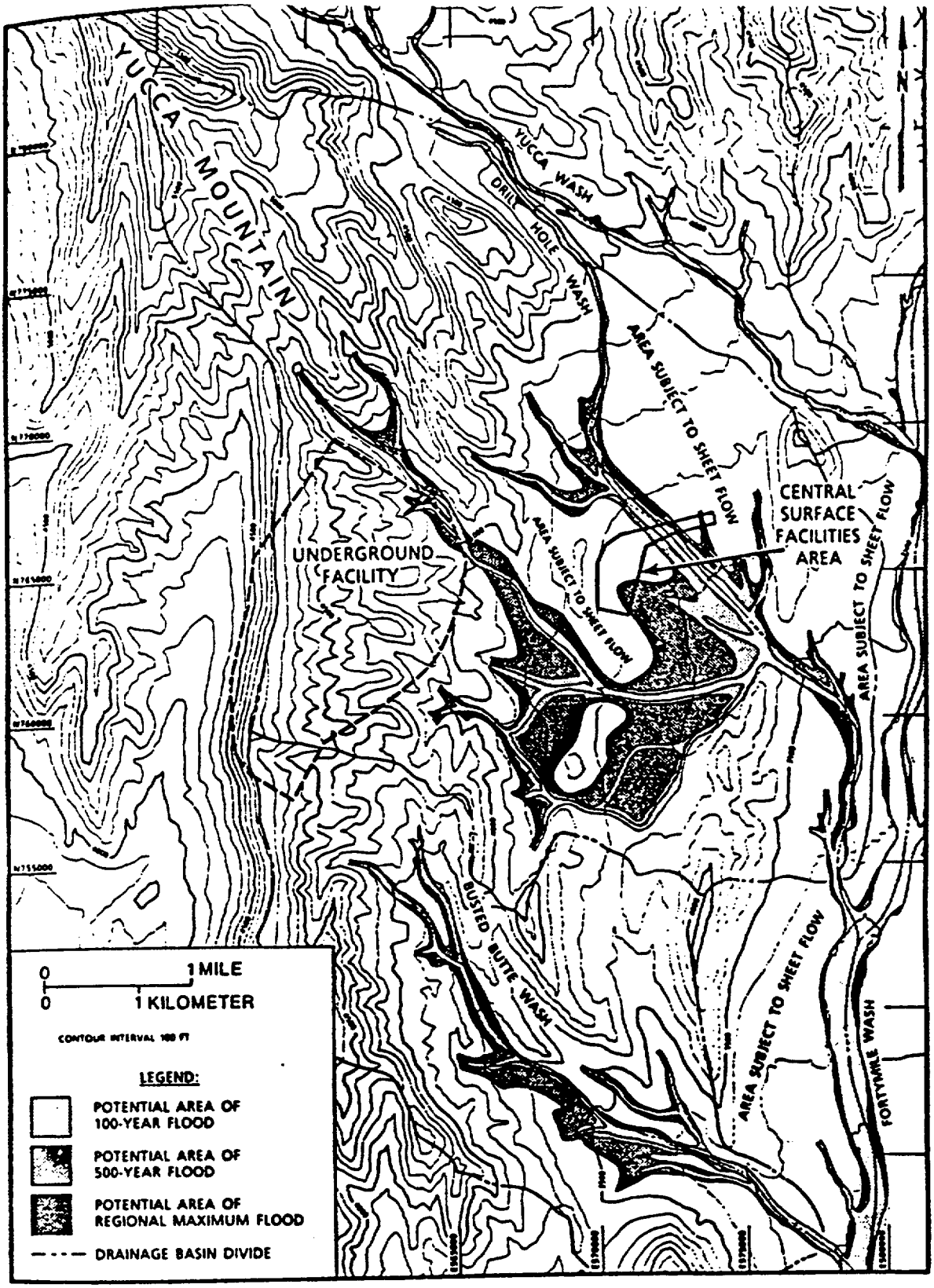


Figure 3.1.2.1.5-2: Site topography and flood potential areas. Modified from Squires and Young (1984).

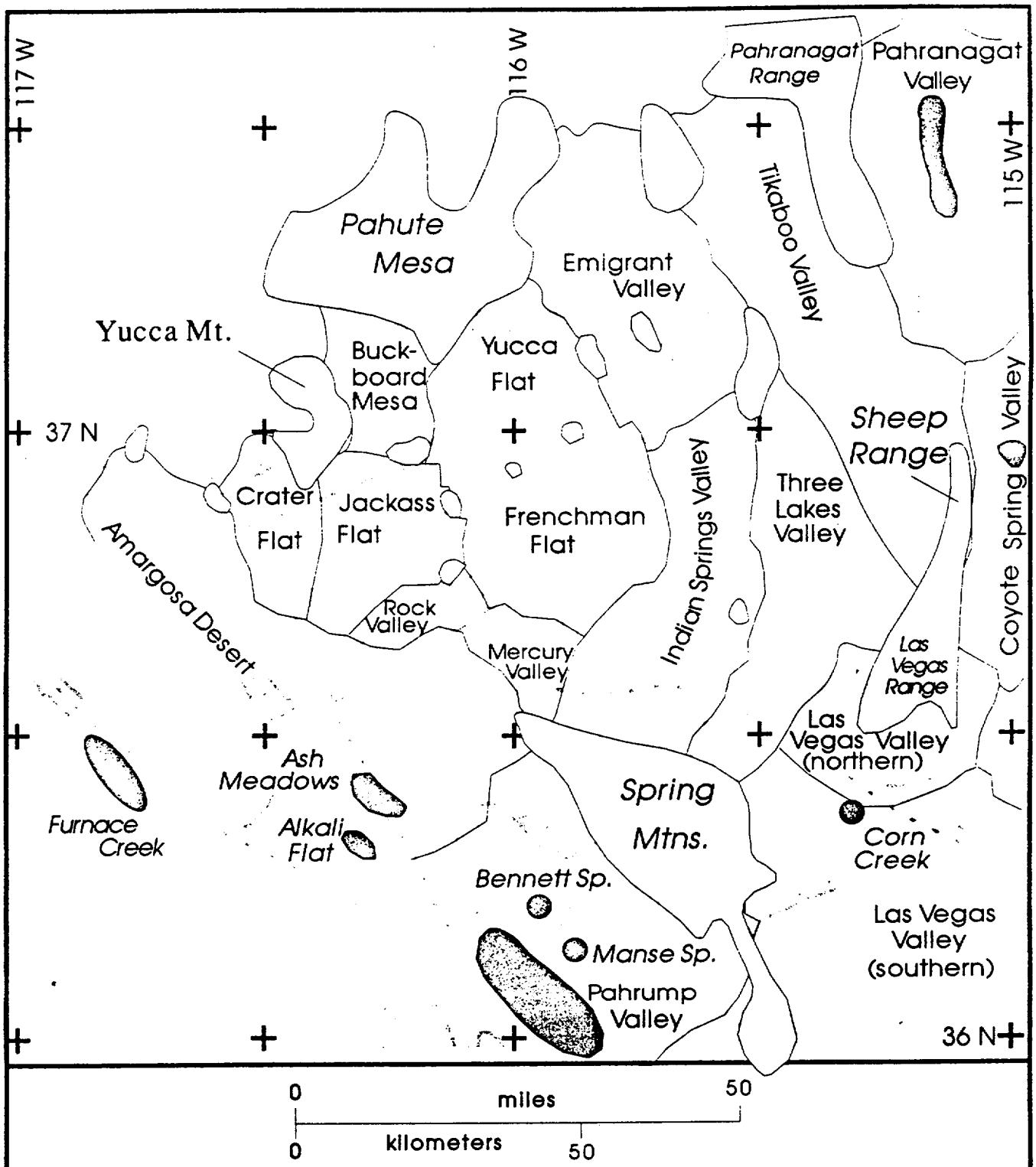


Figure 3.1.2.2.1.2-1

Recharge, Discharge, and Hydrographic Areas

Light shading bounded by solid lines indicates principal recharge areas; dark shading bounded by solid lines indicates principal discharge areas.

See Fig. 3.1.2.2.1.2-3 for background symbols and related references

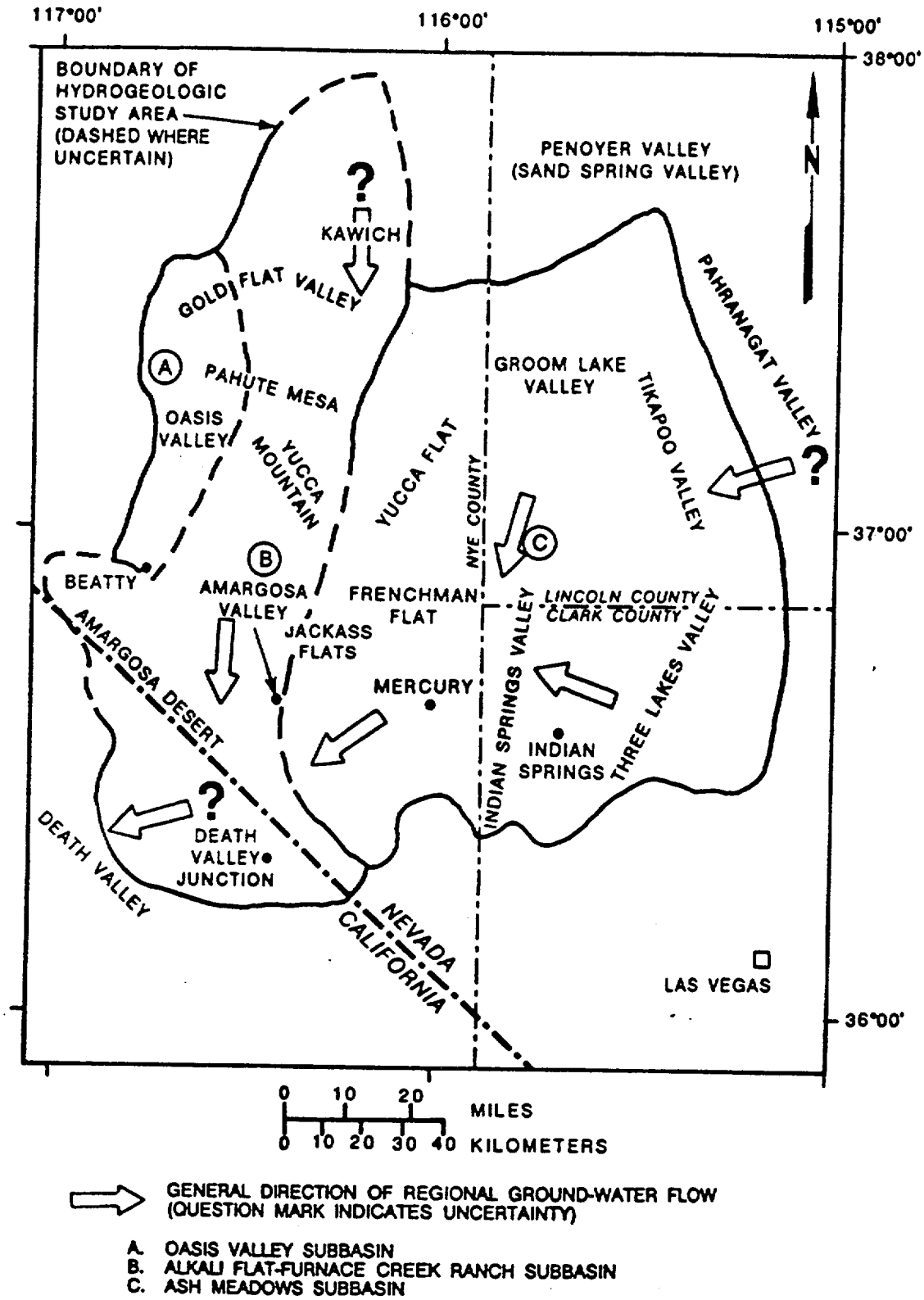


Figure 3.1.2.2.1.2-2. Hydrogeologic Study Area Showing Three Ground-Water Subbasins. Modified from Rush (1970), Blankennagel and Weir (1973), Winograd and Thordarson (1975), Dudley and Larsen (1976), Waddell (1982), and Waddell et al. (1984). Modified by Dudley - solid arrows--flow in Cenozoic Units. Open arrows -- flow in Pre-Cenozoic Units. Added arrows--in Oasis Valley and--to Alkali Flat. From Dudley's Exhibits for J-13 Hearings

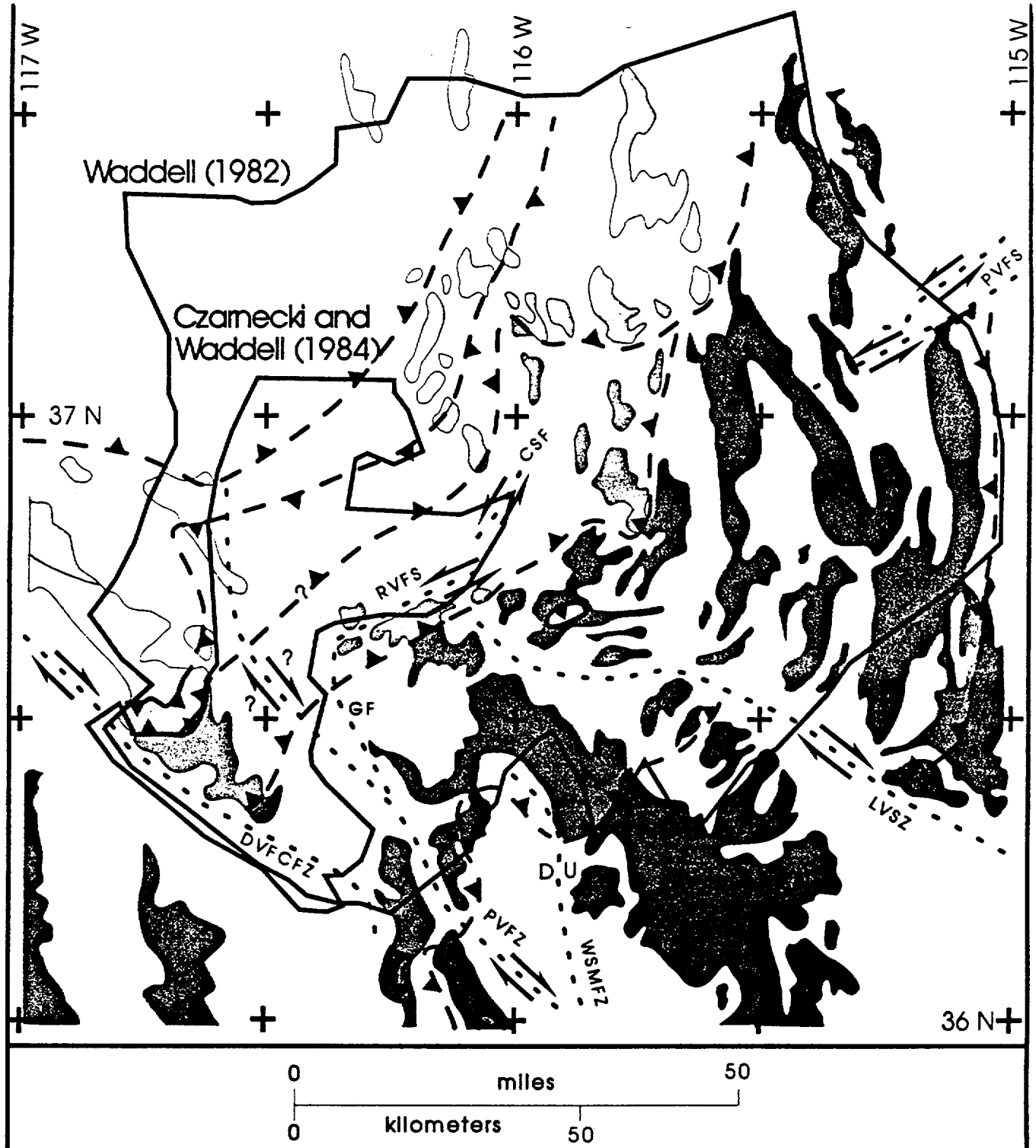


Figure 3.1.2.2.1.2-3.

Regional and Sub-Regional Hydrologic Model Boundaries

Thrust fault correlations from Wernicke and others (1988b) and Jayko (1990). High-angle faults shown include Death Valley - Furnace Creek Fault Zone (DVFCFZ), Pahrump Valley Fault Zone (PVFZ), "Gravity Fault" (GF), Western Spring Mountains Fault Zone (WSMFZ), Las Vegas Shear Zone (LVSZ), Pahranagat Valley Fault System (PVFS), Rock Valley Fault System (RVFS), and Cane Spring Fault (CSF).

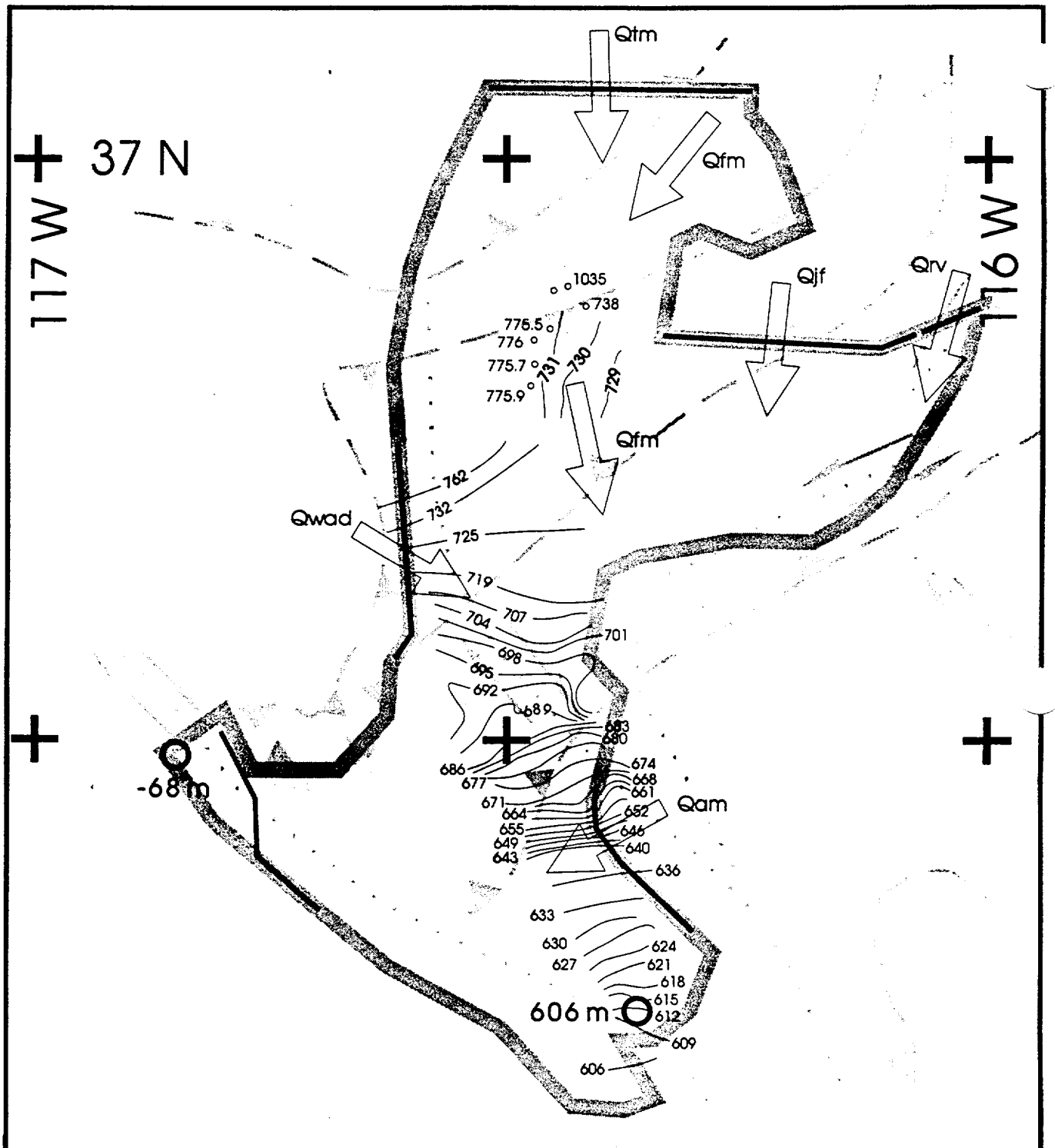


Figure 3.1.2.2.1.2-4.

Potentiometric Levels in Cenozoic Rocks and Boundary Conditions for Two-Dimensional, Sub-Regional Model of Ground-Water Flow.

Water levels from Ervin and others (1993) and Czarnecki (1990). Contours in meters AMSL. Arrows and highlighted boundary segments represent boundary conditions prescribed by Czarnecki and Waddell (1984); solid circles represent constant-head nodes.

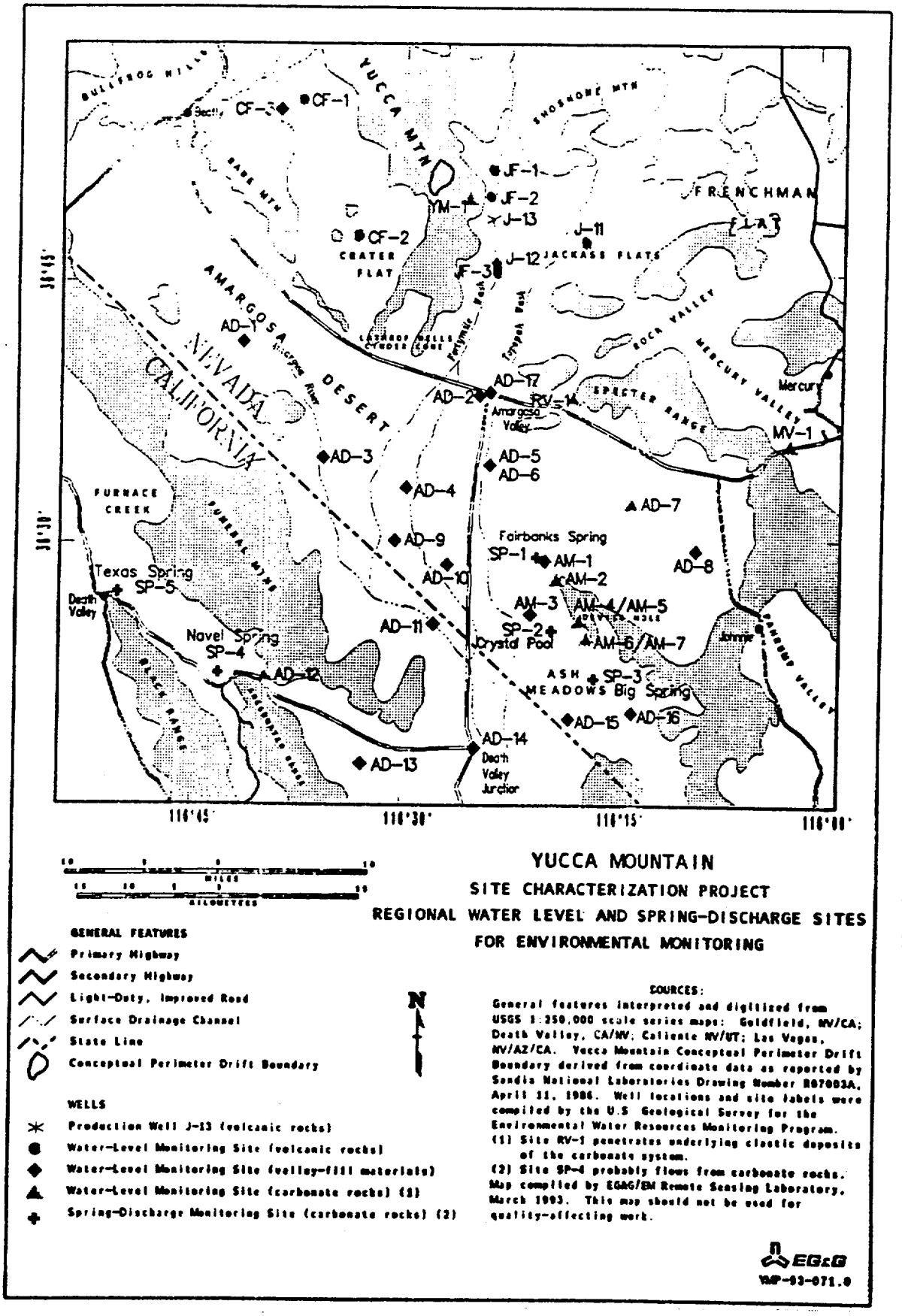


Figure 3.1.2.2.2-1. Yucca Mountain Site Characterization Project Regional Water Level and Spring-Discharge Sites for Environmental Monitoring

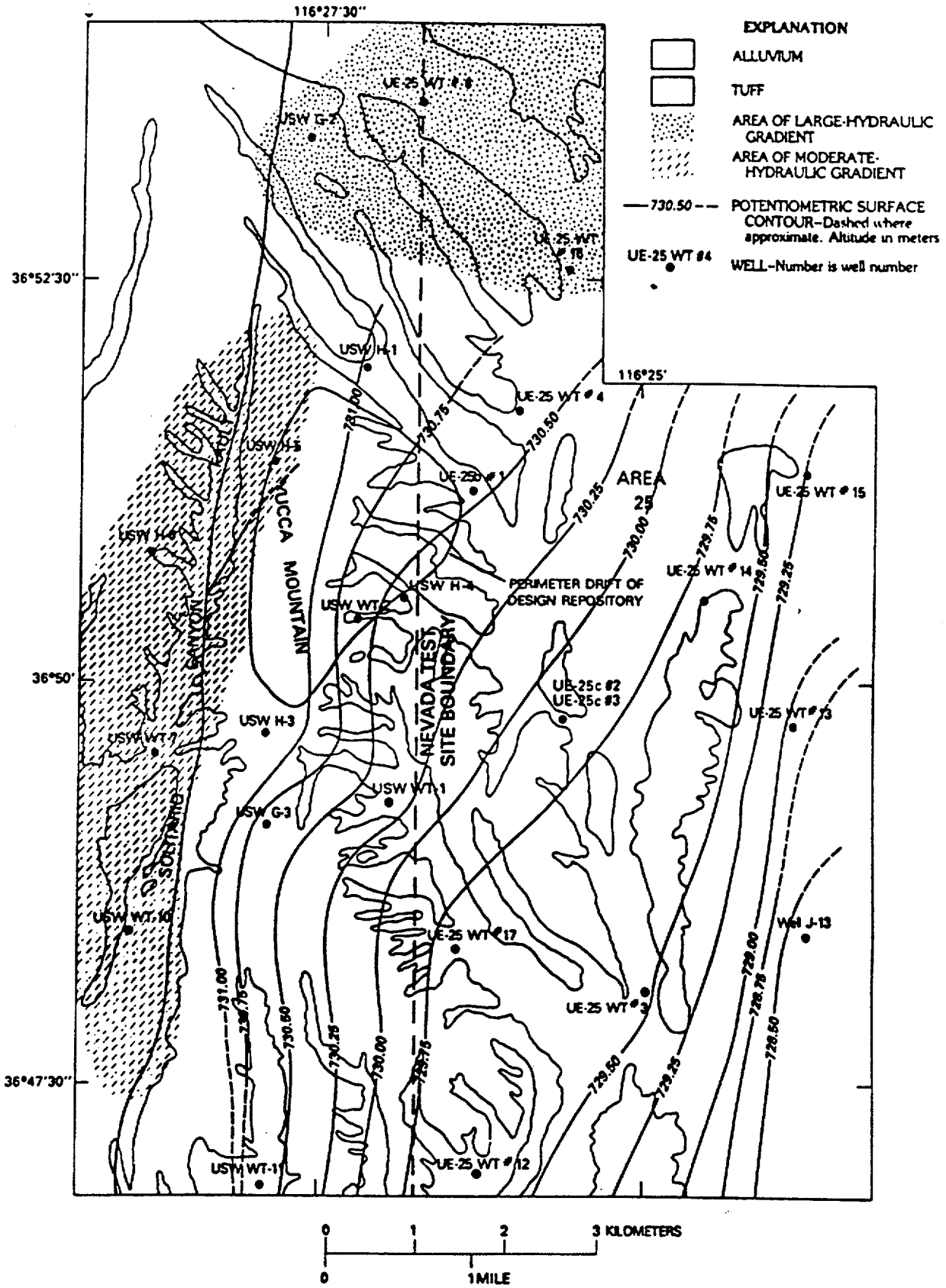


Figure 3.1.2.2.2-2. Potentiometric Surface Map, Yucca Mountain

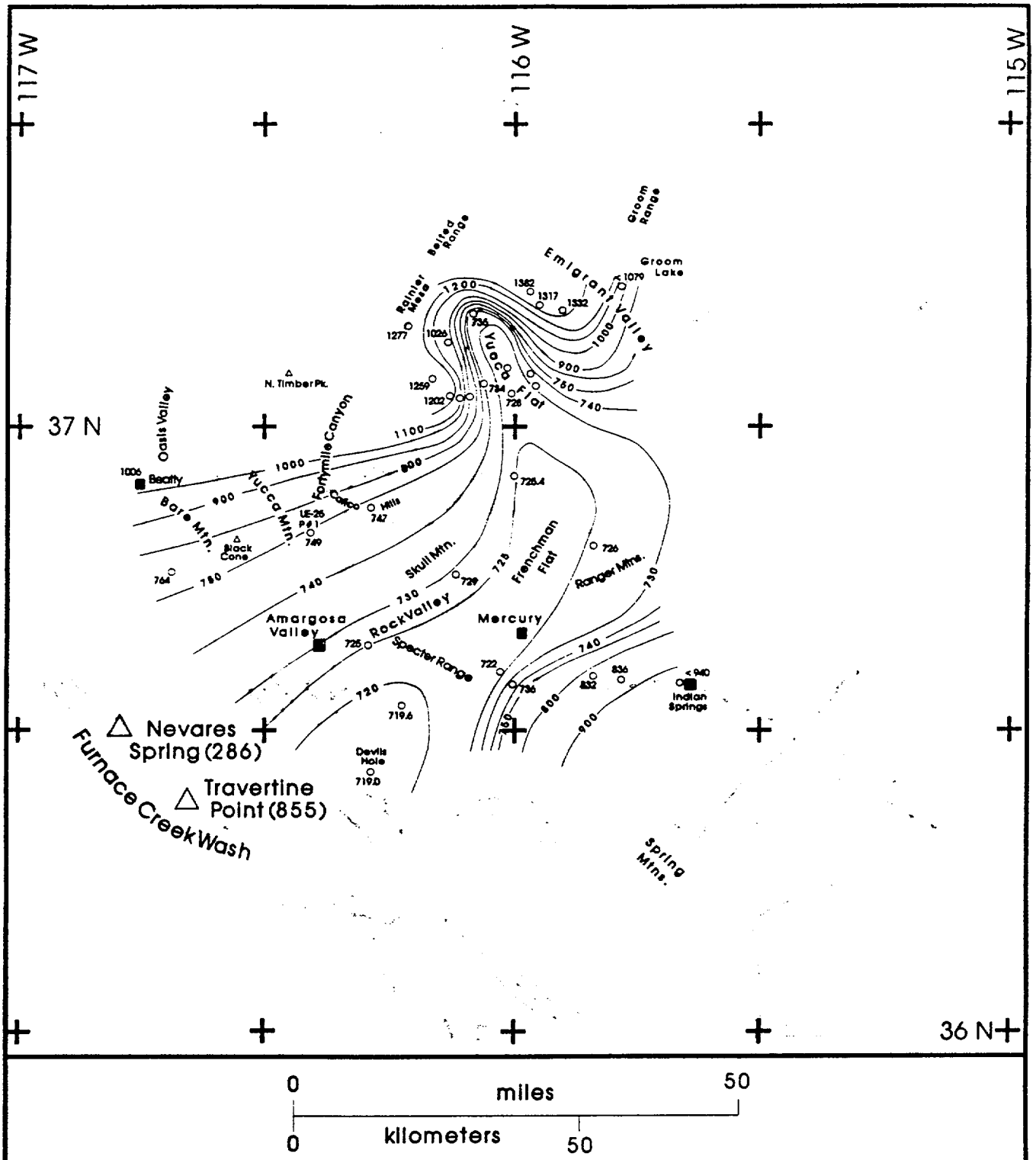


Figure 3.1.2.2.2-3. (Modified after Dudley, 1991)

Potentiometric Levels in Pre-Tertiary Rocks, Yucca Mountain Region.

Elevations are given in meters above mean sea level. Contours are conjectural due to sparse data. Heads at Groom Lake, Indian Springs, Beatty, and southwest of Bare Mountain are composite measurements, representing both Cenozoic and Pre-Cenozoic rocks. Travertine Point is a paleodischarge site.

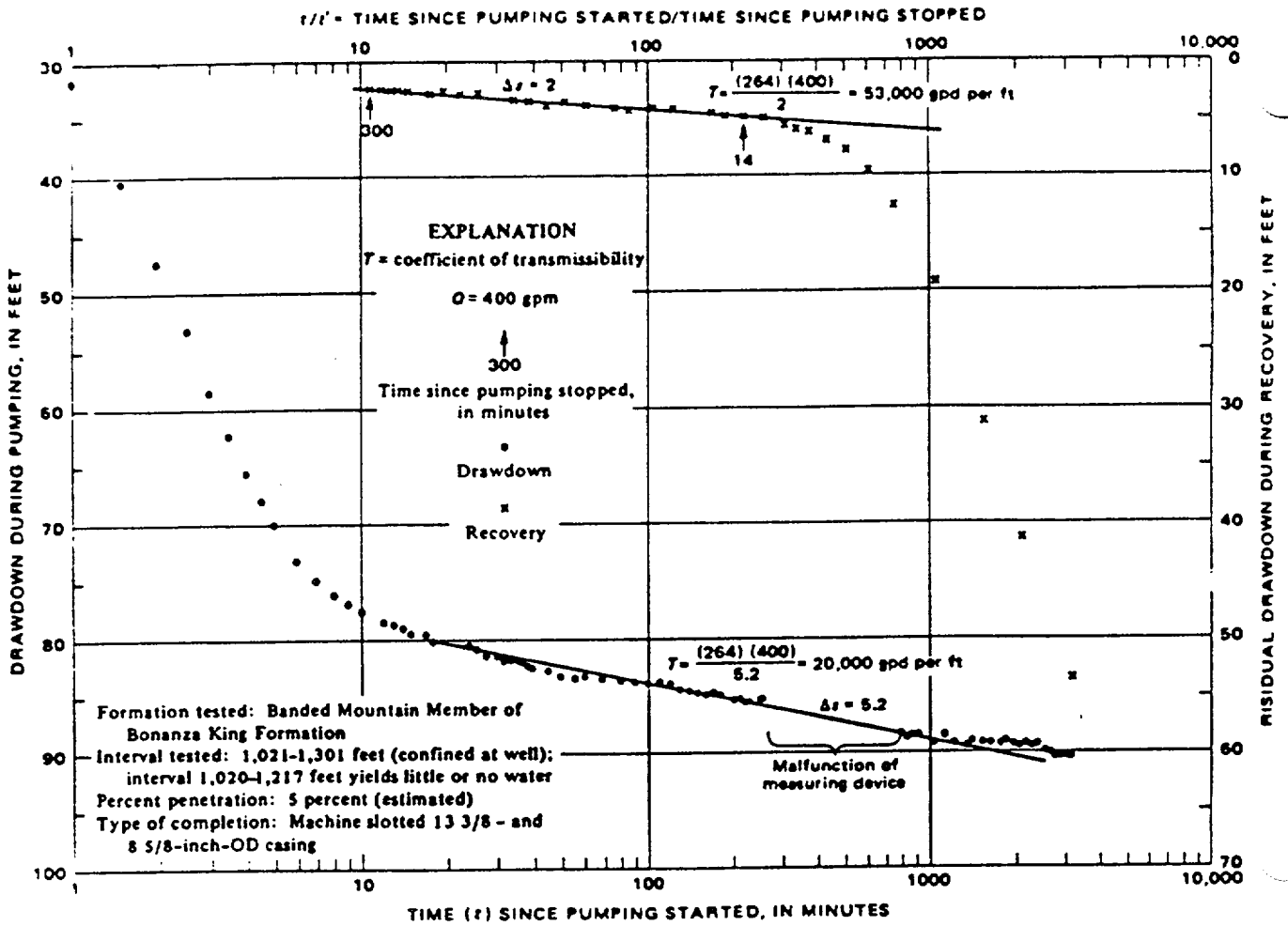


Figure 3.1.2.2.3-1. Semilog Graphs of Drawdown and Residual Drawdown of Water Level During Pumping Test in Test Well 67-73, February 24-26, 1963

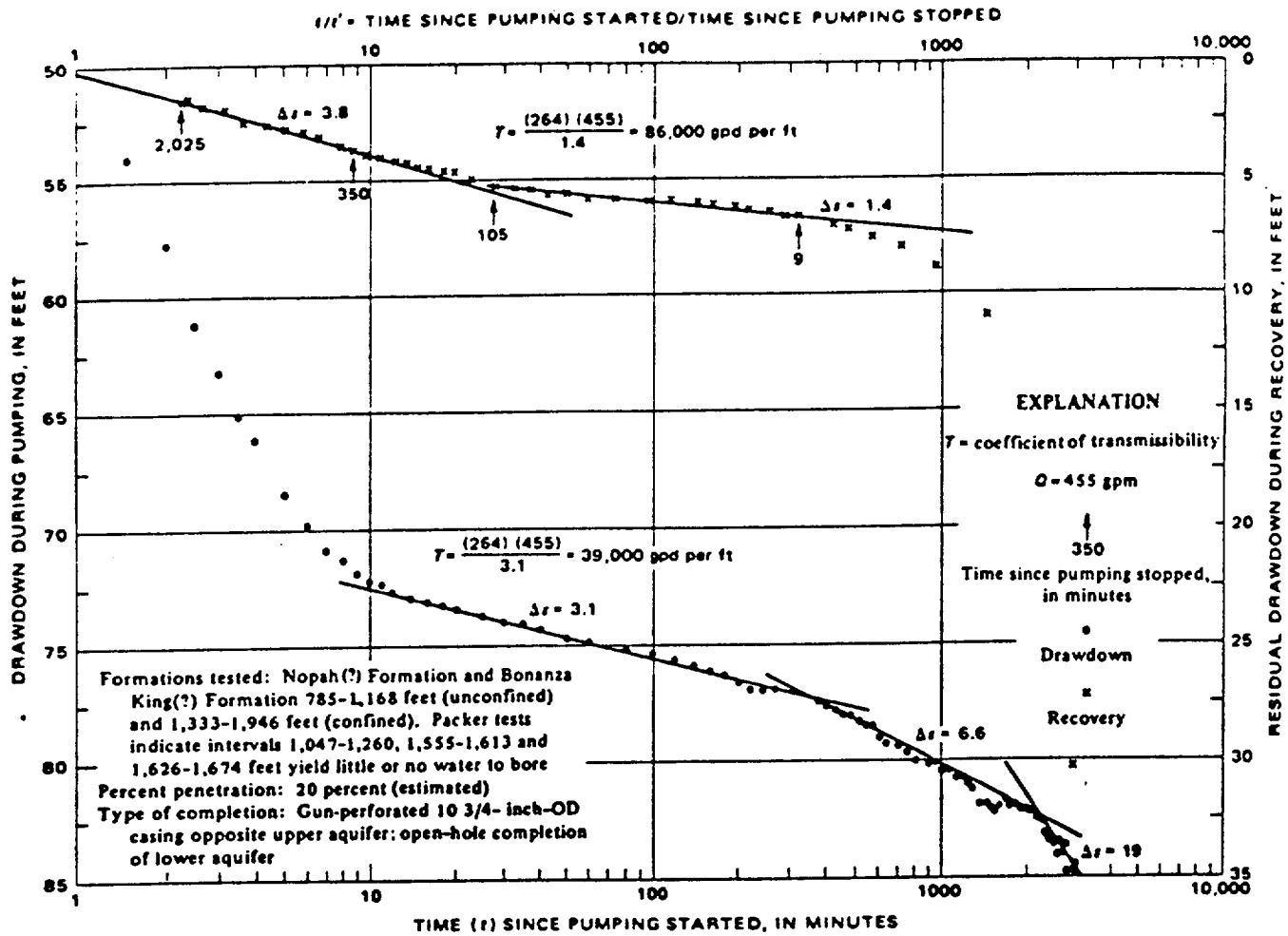


Figure 3.1.2.2.3-2. Semilog Graphs of Drawdown and Residual Drawdown of Water Level During Pumping Test in Test Well 67-68, September 11-14, 1962

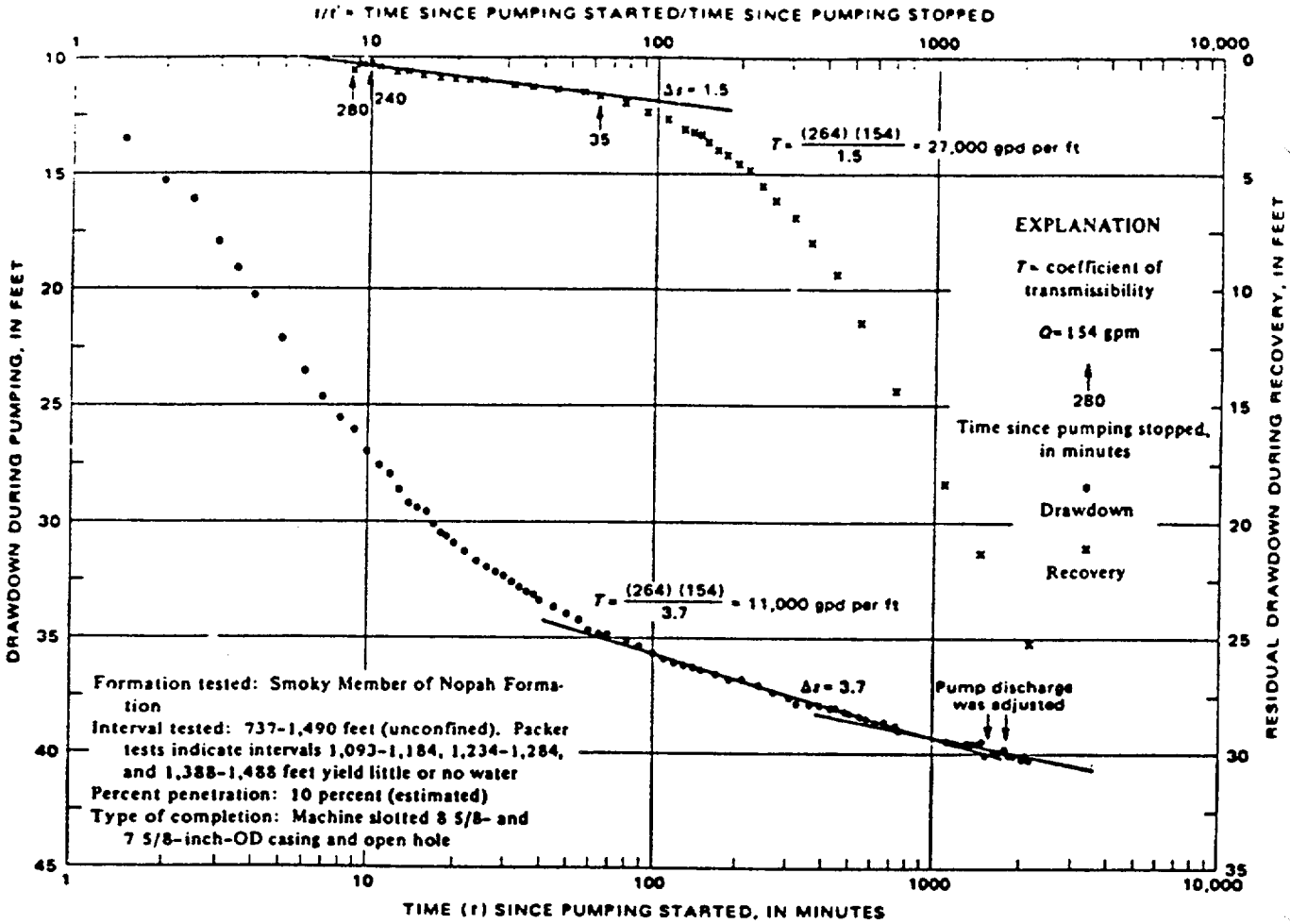


Figure 3.1.2.2.3-3. Semilog Graphs of Drawdown and Residual Drawdown of Water Level During Pumping Test in Test Well 66-75, September 11-13, 1962

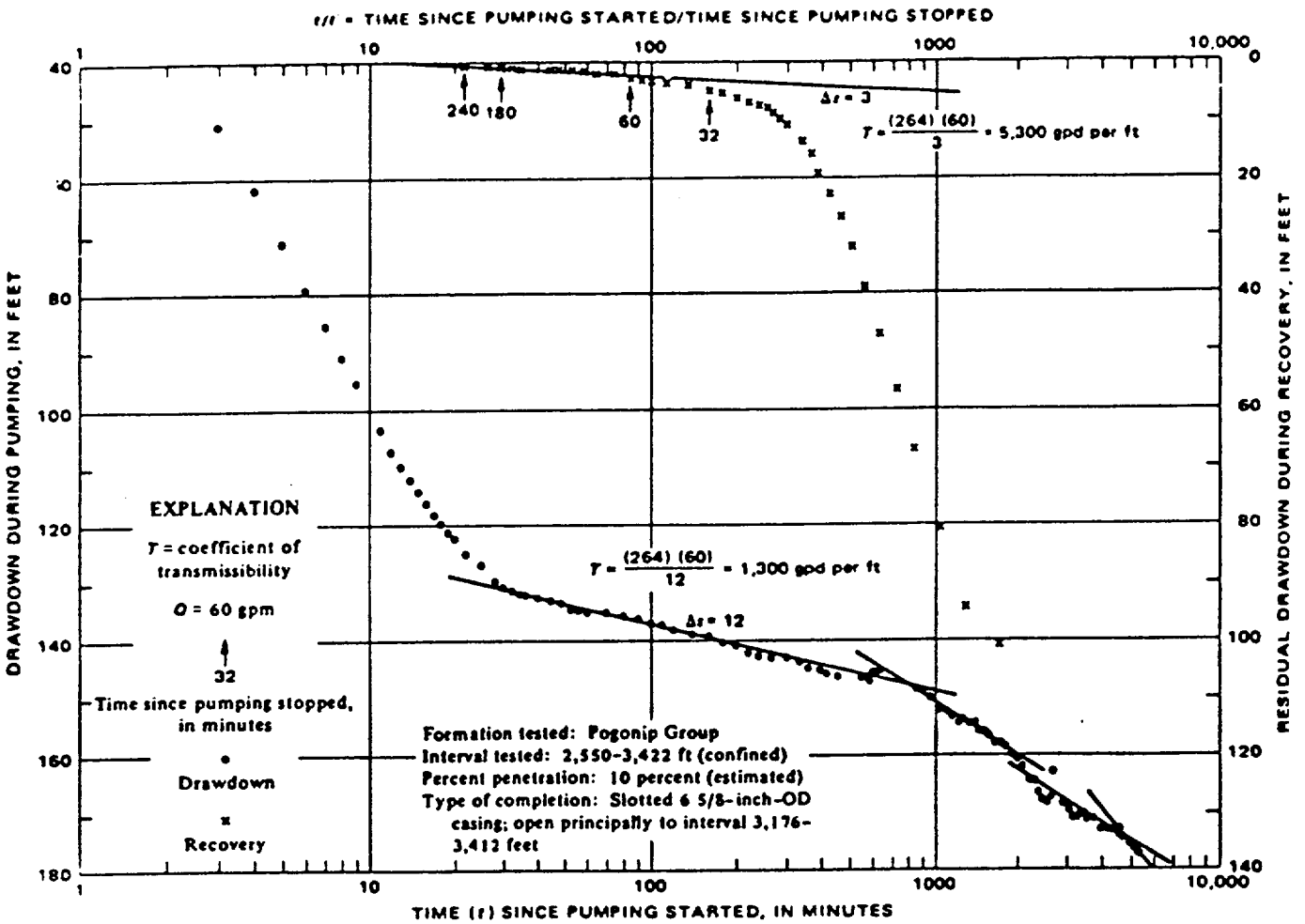


Figure 3.1.2.2.3-4. Semilog Graphs of Drawdown and Residual Drawdown of Water Level During Pumping Test in Test Well 88-66, March 16-20, 1962

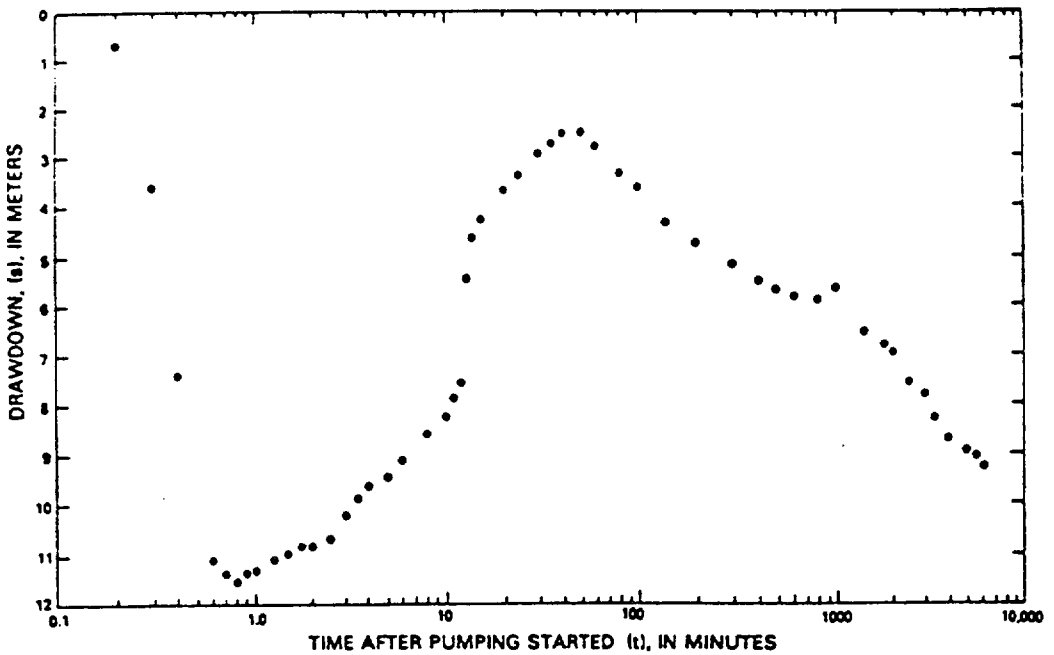


Figure 3.1.2.2.3-5. Water-Level Drawdown, Pumping Test 2, Depth Interval 1,297 to 1,805 Meters

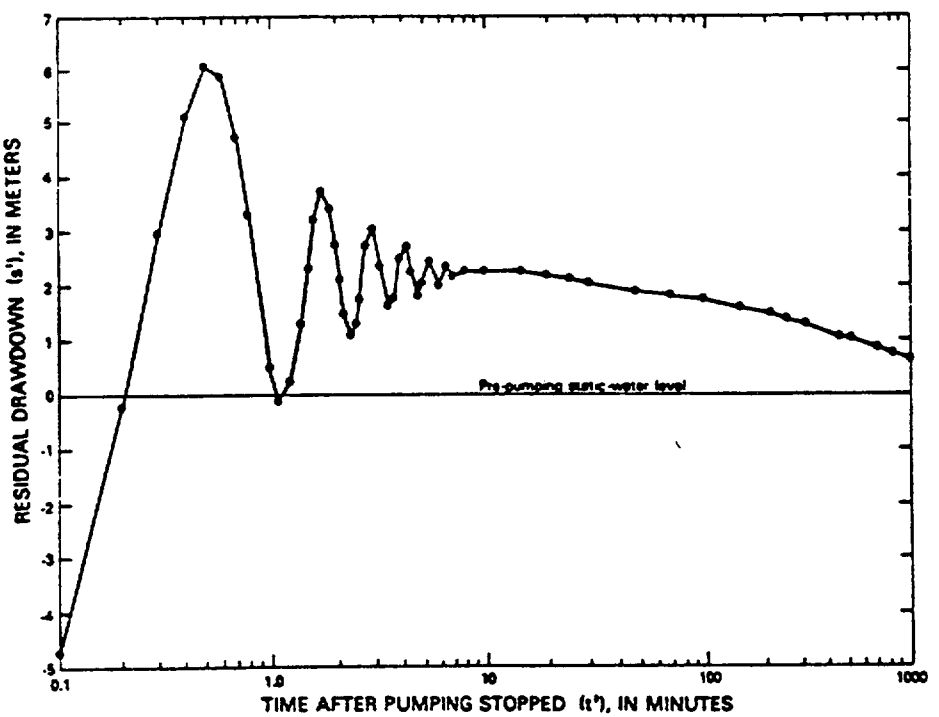


Figure 3.1.2.2.3-6. Residual Drawdown, Recovery Test 2, Depth Interval 1,297 to 1,805 Meters. Craig and Robison 1984

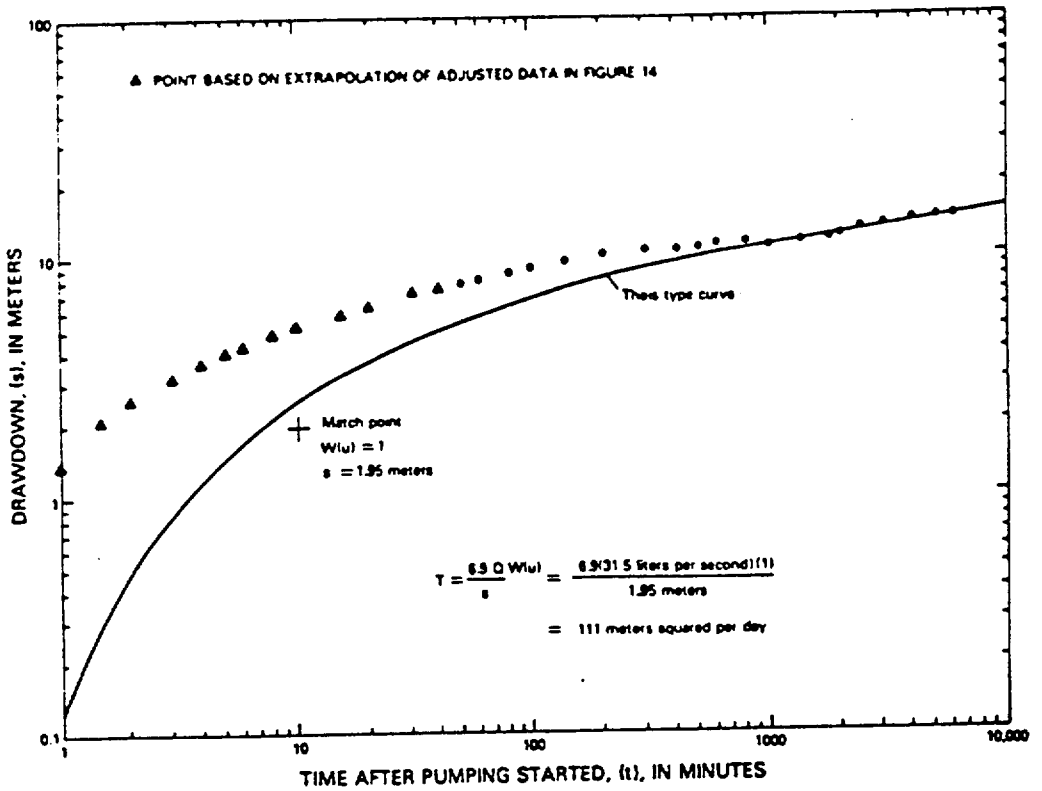


Figure 3.1.2.2.3-7. Analysis of Adjusted Water-Level Drawdown, Pumping Test 2, Depth Interval 1,297 to 1,805 Meters, Theis Method. Craig and Robison

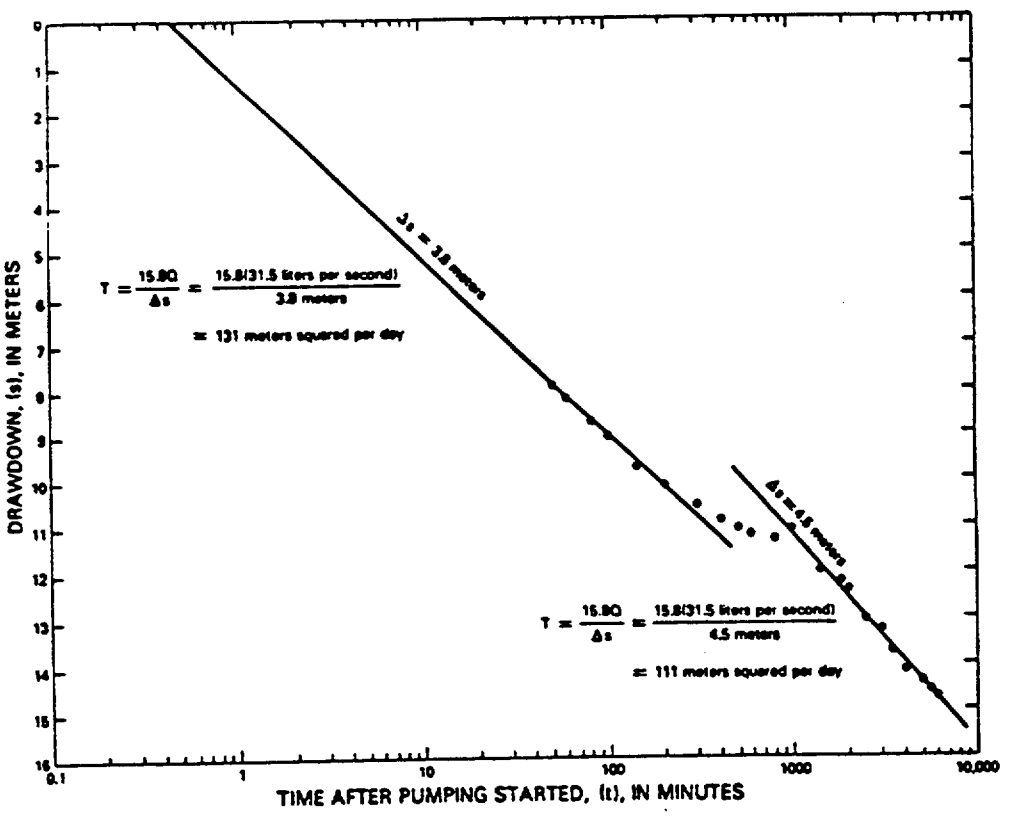


Figure 3.1.2.2.3-8. Analysis of Adjusted Water-Level Drawdown, Pumping Test 2, Depth Interval 1,297 to 1,805 Meters, Straight-Line Method. Craig and Robison 1984

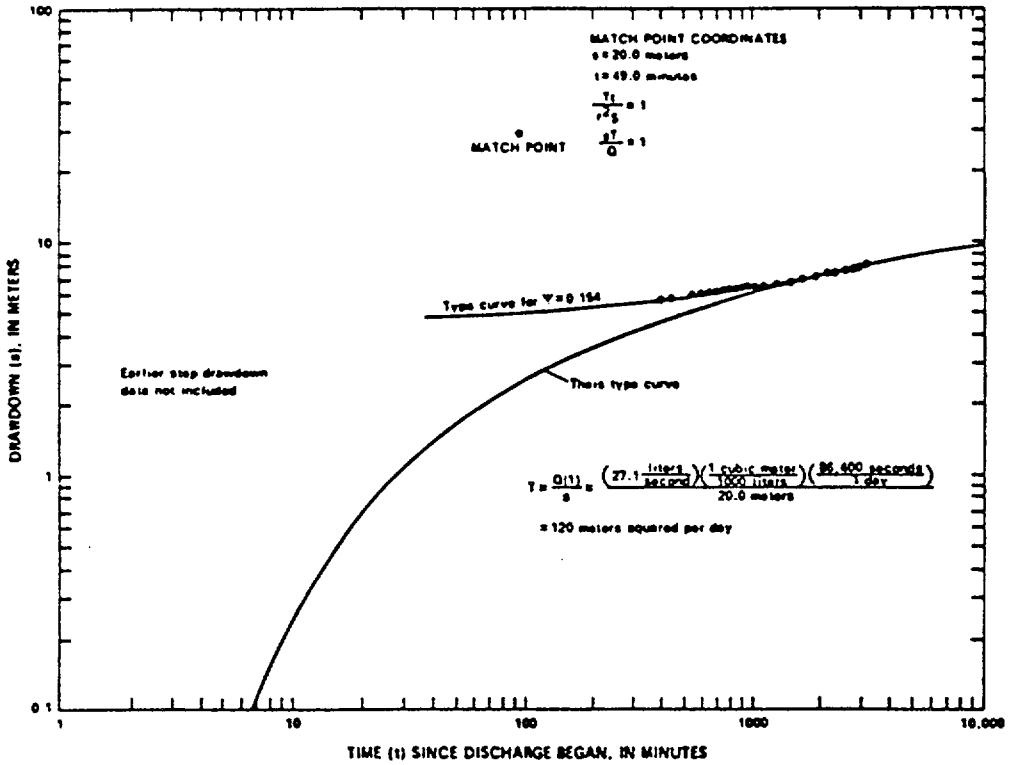


Figure 3.1.2.2.3-9. Drawdown and Analysis of Drawdown During Step-Drawdown Test of Pumping Test 1, Stallman's Method. Thordarson, 1983

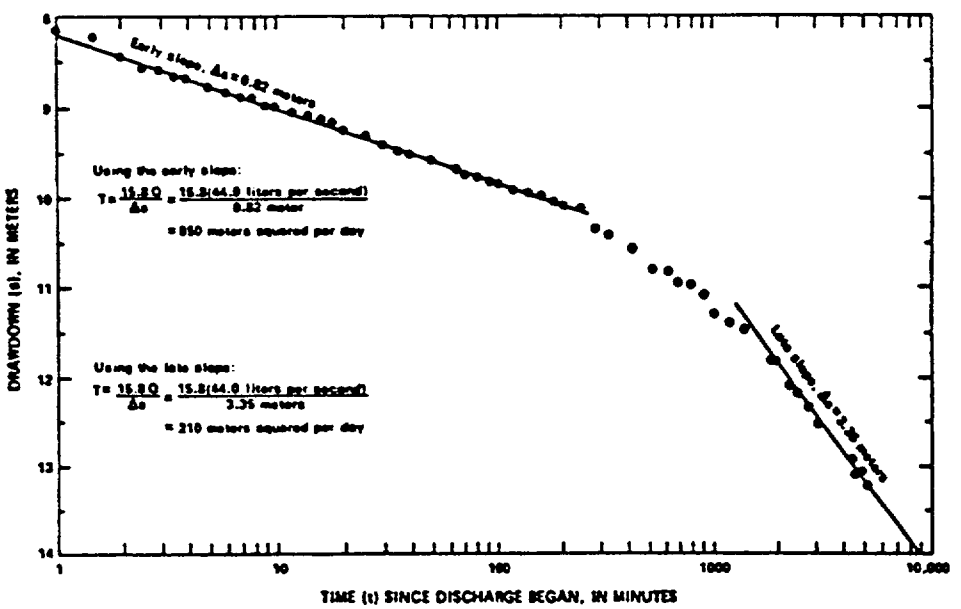


Figure 3.1.2.2.3-10. Drawdown and Analysis of Drawdown During Pumping Test 3, Straight-Line Method, Thordarson, 1983

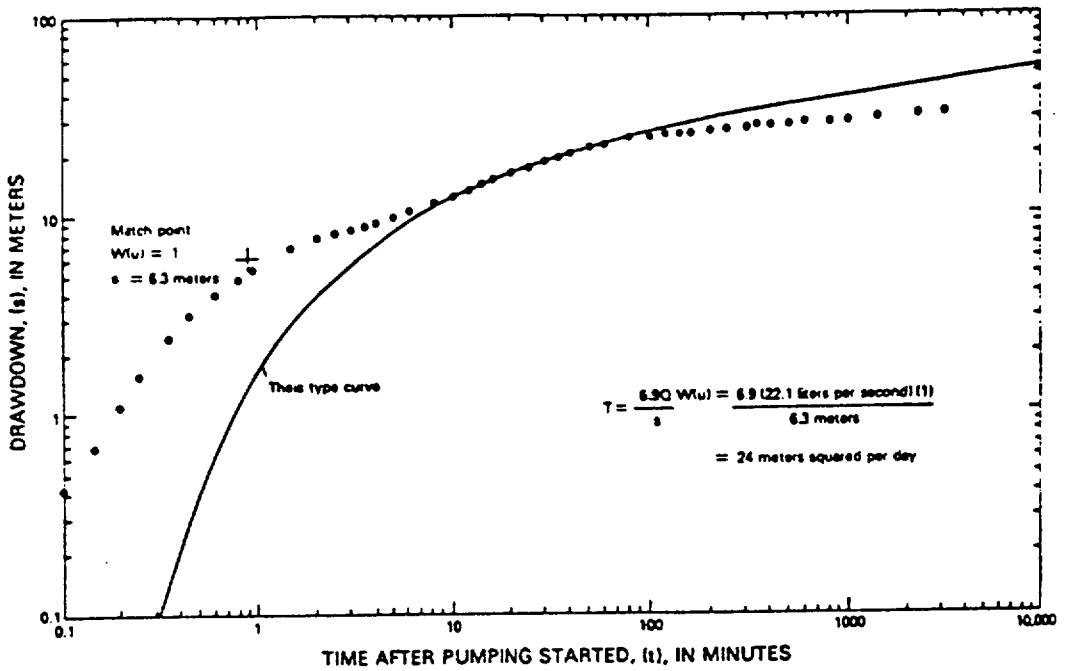


Figure 3.1.2.2.3-11. Analysis of Water-Level Drawdown, Pumping Test 1, Depth Interval 382 to 1,301 Meters, Theis Method. Craig and Robison, 1984

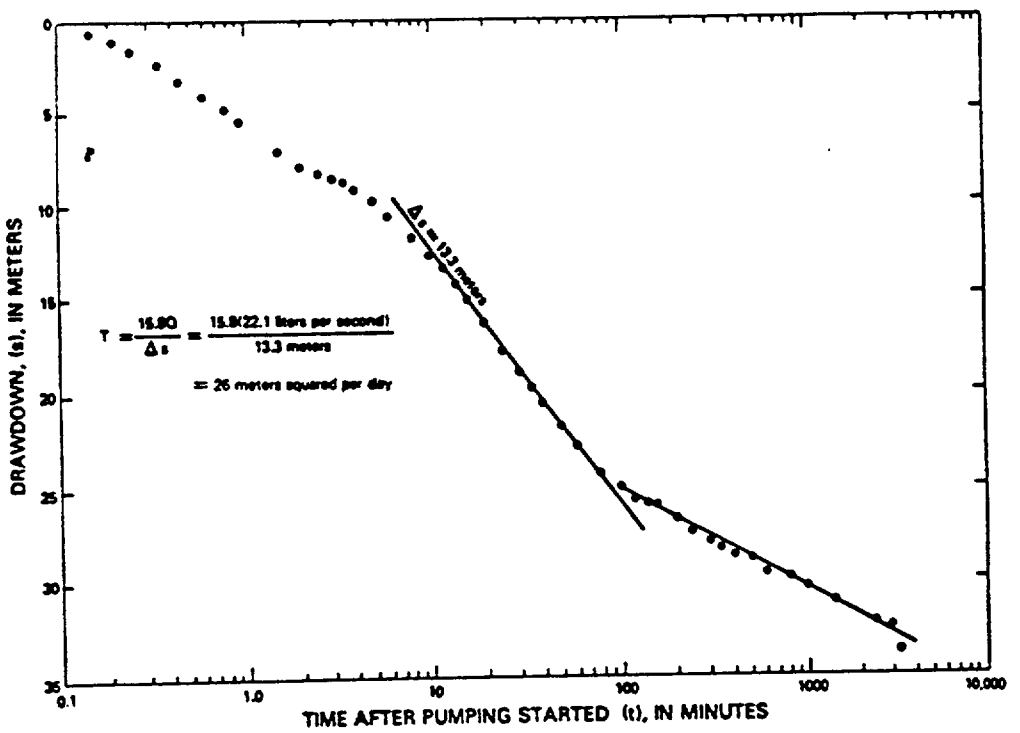


Figure 3.1.2.2.3-12. Analysis of Water-Level Drawdown, Pumping Test 1, Depth Interval 382 to 1,301 Meters, Straight-Line Method. Tuffs

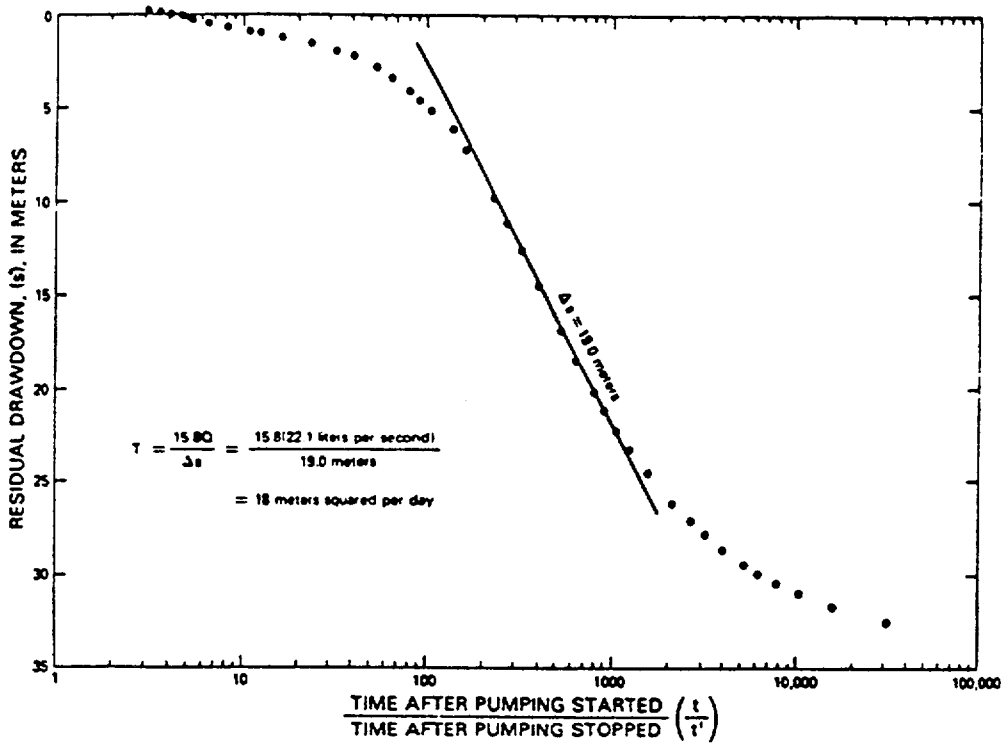


Figure 3.1.2.2.3-13. Analysis of Residual Drawdown, Recovery Test 1, Depth Interval 382 to 1,301 Meters, Straight-Line Method. Craig and Robison, 1984

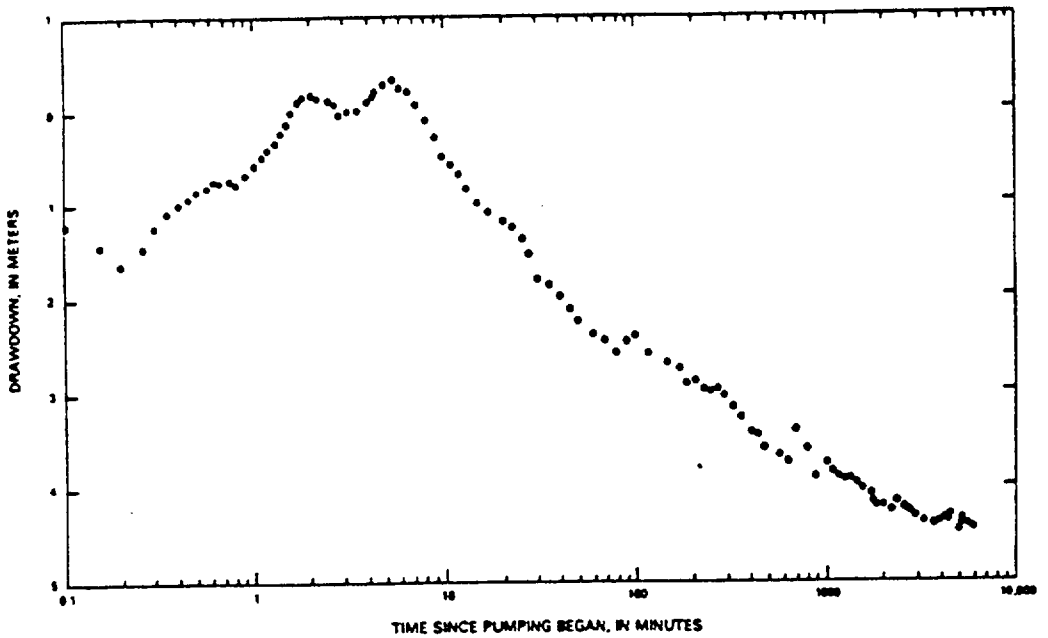


Figure 3.1.2.2.3-14. Drawdown in Well USW VH-1 During Test 3. Thordarson and Howells, 1987

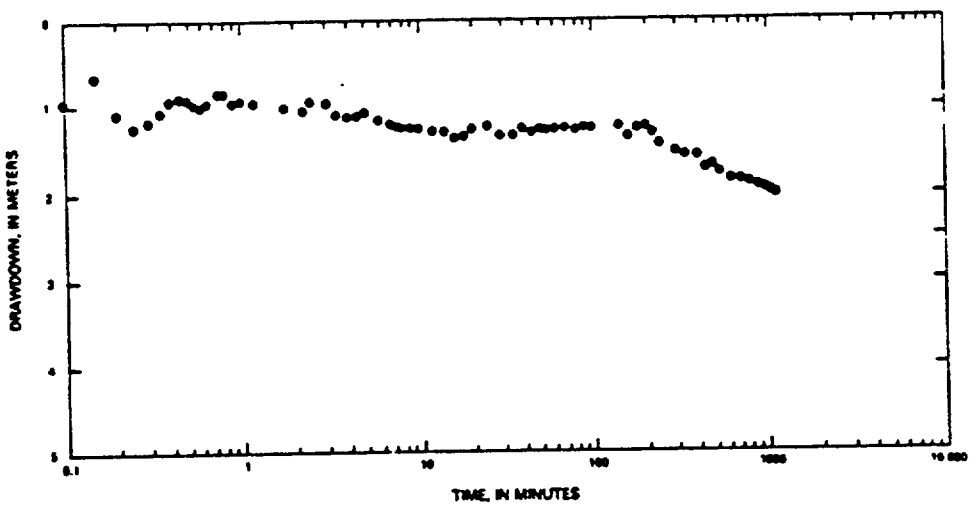


Figure 3.1.2.2.3-15. Drawdown in Well USW VH-1 During Test 5. Thordarson and Howells, 1987

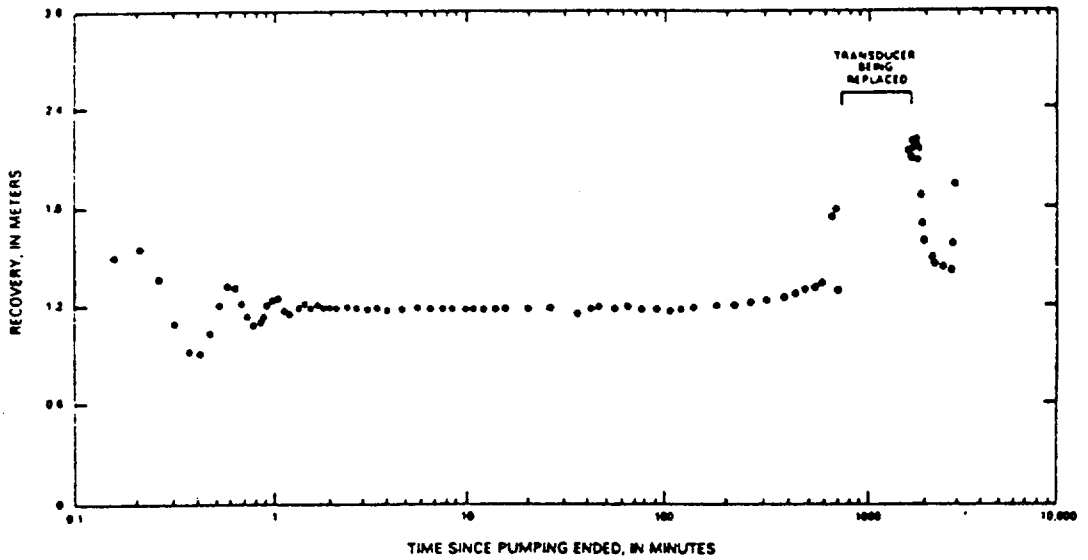


Figure 3.1.2.2.3-16. Recovery in Well USW VH-1 During Test 4. Thordarson and Howells, 1987

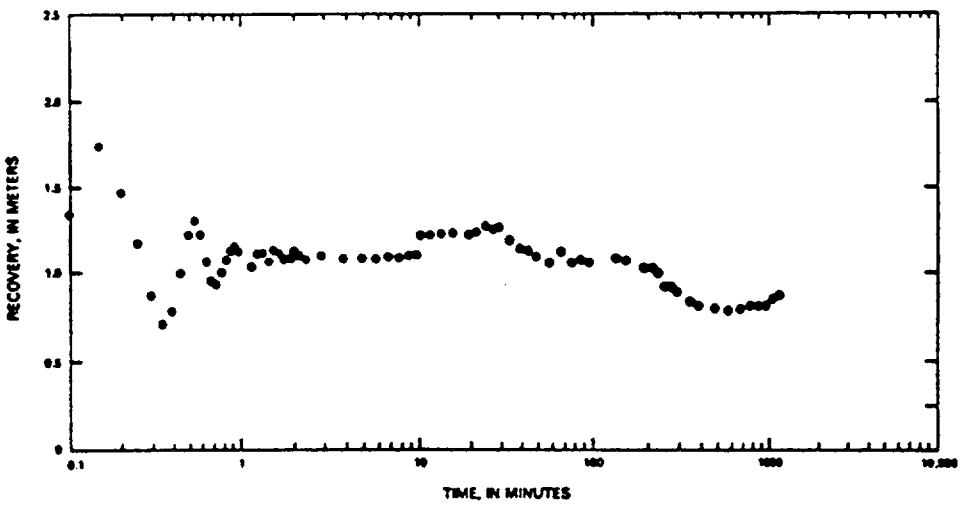


Figure 3.1.2.2.3-17. Recovery in Well USW VH-1 During Test 6. Thordarson and Howells, 1987

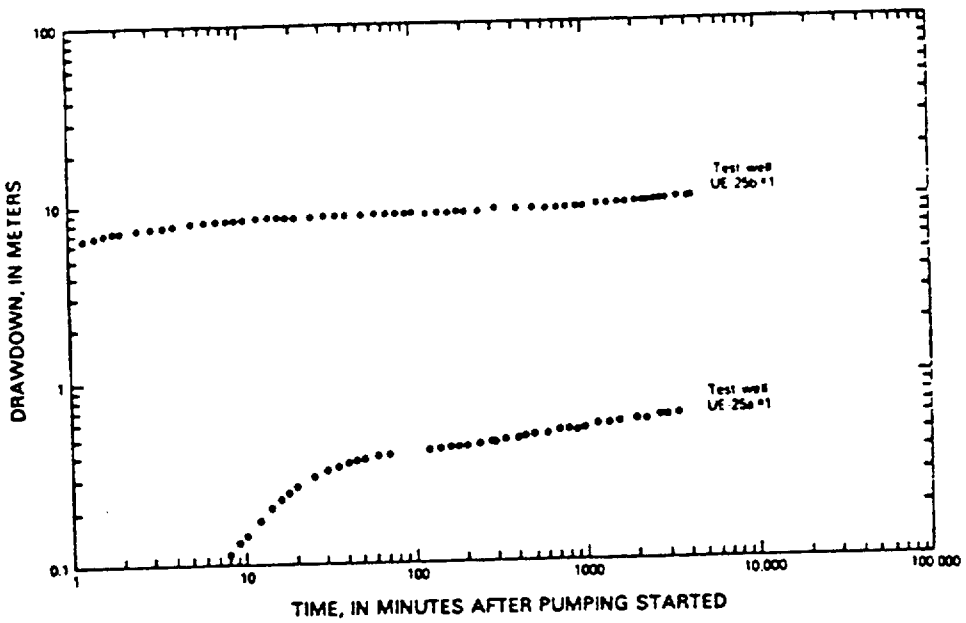


Figure 3.1.2.2.3-18. Drawdown in Test Wells UE-25b#1 and UE-25a#1 During Pumping Test 3. Lahoud et al., 1984

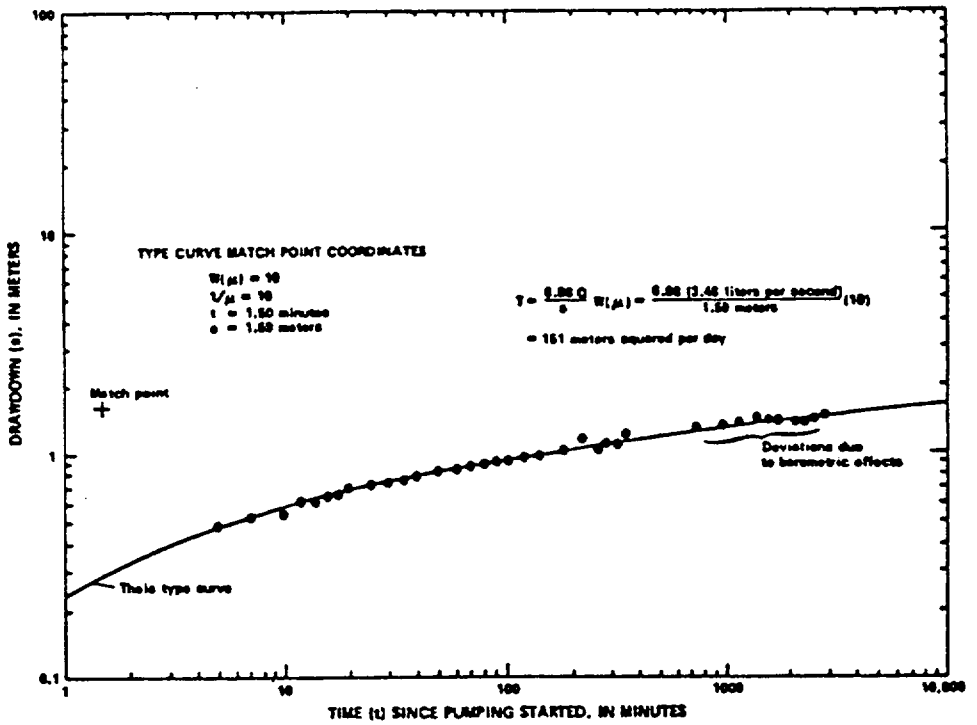


Figure 3.1.2.2.3-19. Analysis of Water-Level Drawdown, Pumping Test 1, Zone from 572 to 688 Meters in the Well, Theis Method. Rush et al., 1984

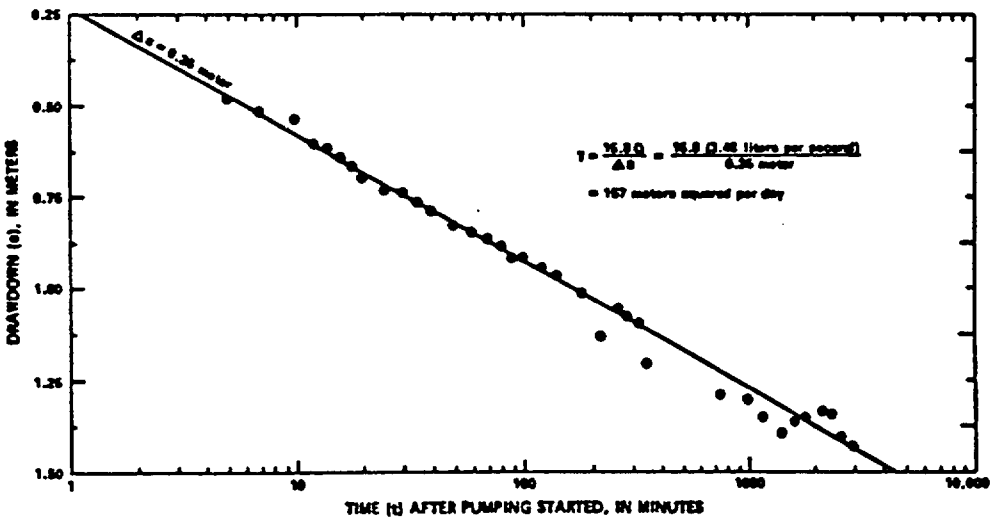


Figure 3.1.2.2.3-20. Analysis of Water-Line Drawdown, Pumping Test 1, Zone from 572 to 688 Meters in the Well, Straight-Line Solution

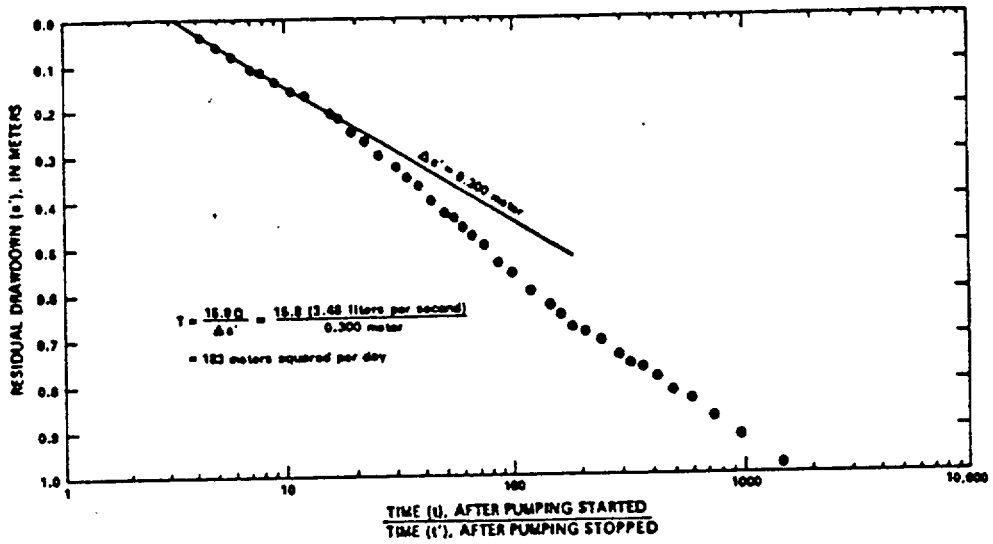


Figure 3.1.2.2.3-21. Analysis of Water-Level Recovery, Pumping Test 1, Zone from 572 to 688 Meters in the Well, Straight-Line Solution

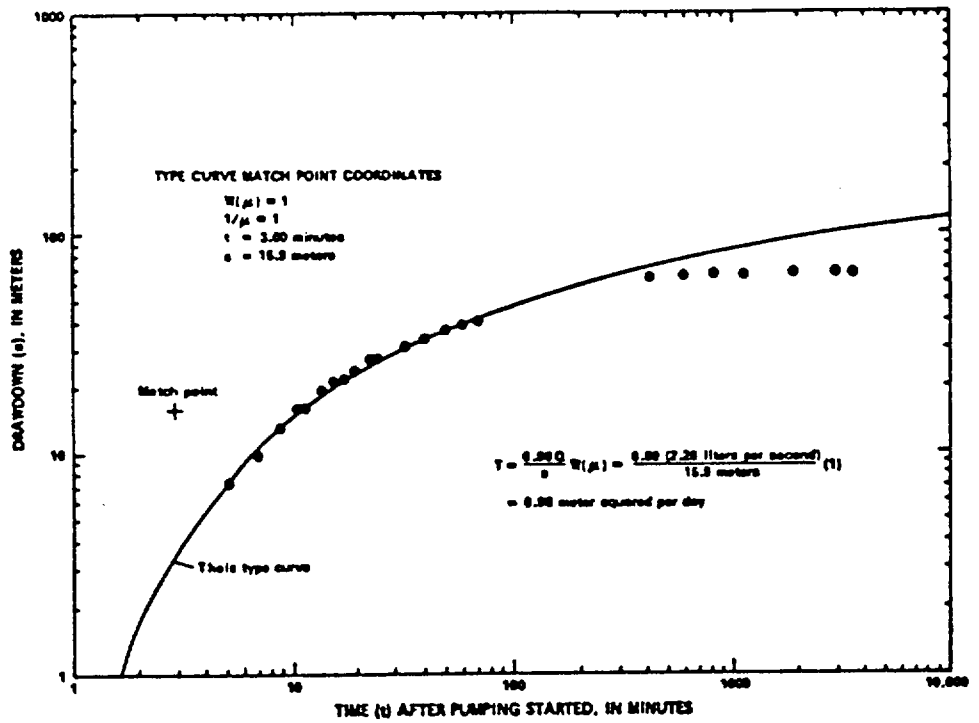


Figure 3.1.2.2.3-22. Analysis of Water-Line Drawdown, Pumping Test 2, Zone from 687 to 1,879 Meters in the Well, Theis Method

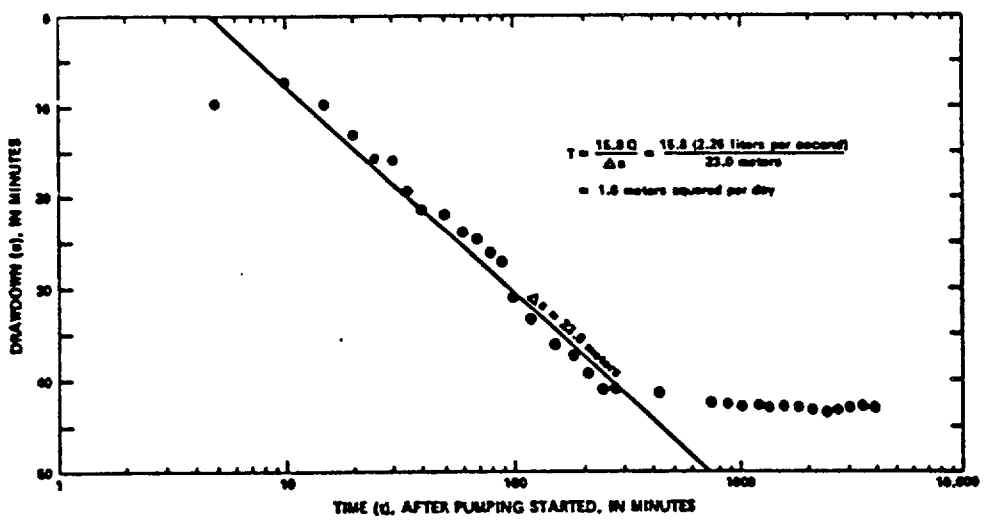


Figure 3.1.2.2.3-23. Analysis of Water-Level Drawdown, Pumping Test 2, Zone from 687 to 1,829 Meters in the Well, Straight-Line Solution. Rush et al., 1984

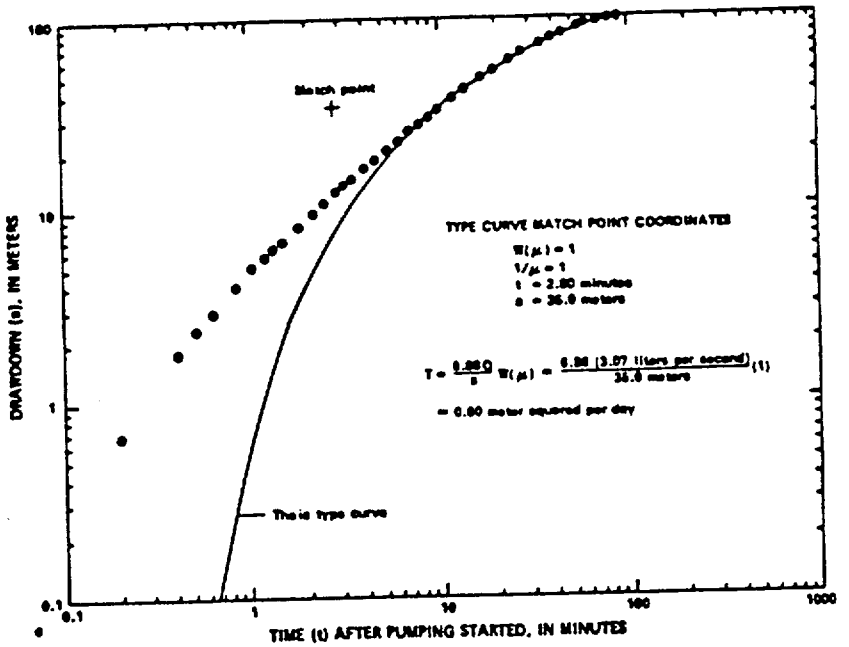


Figure 3.1.2.2.3-24. Analysis of Water-Level Drawdown, Pumping Test 3, Zone from 687 to 1,829 Meters in the Well, Theis Method. Rush et al., 1984

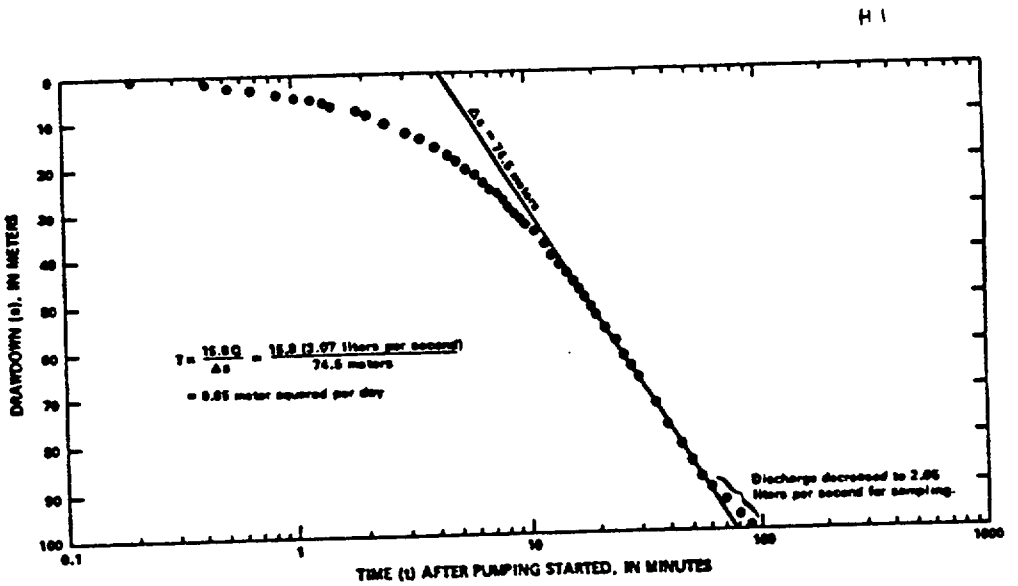


Figure 3.1.2.2.3-25. Analysis to Water-Level Drawdown, Pumping Test 3, Zone from 687 to 1,829 Meters in the Well, Straight-Line Solution

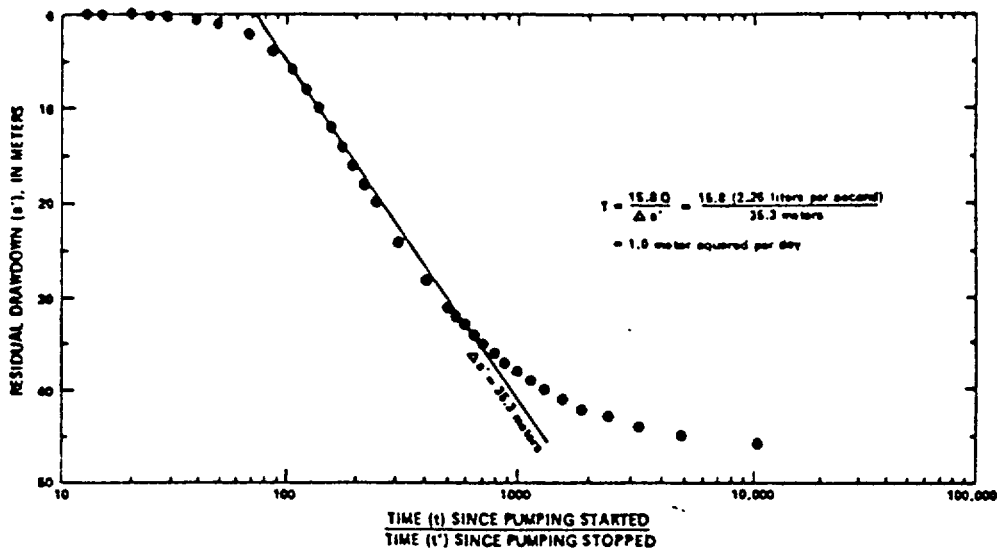


Figure 3.1.2.2.3-26. Analysis of Water-Level Recovery, Pumping Test 2, Zone from 687 to 1,829 Meters in the Well, Straight-Line Solution. Rush et al., 1984

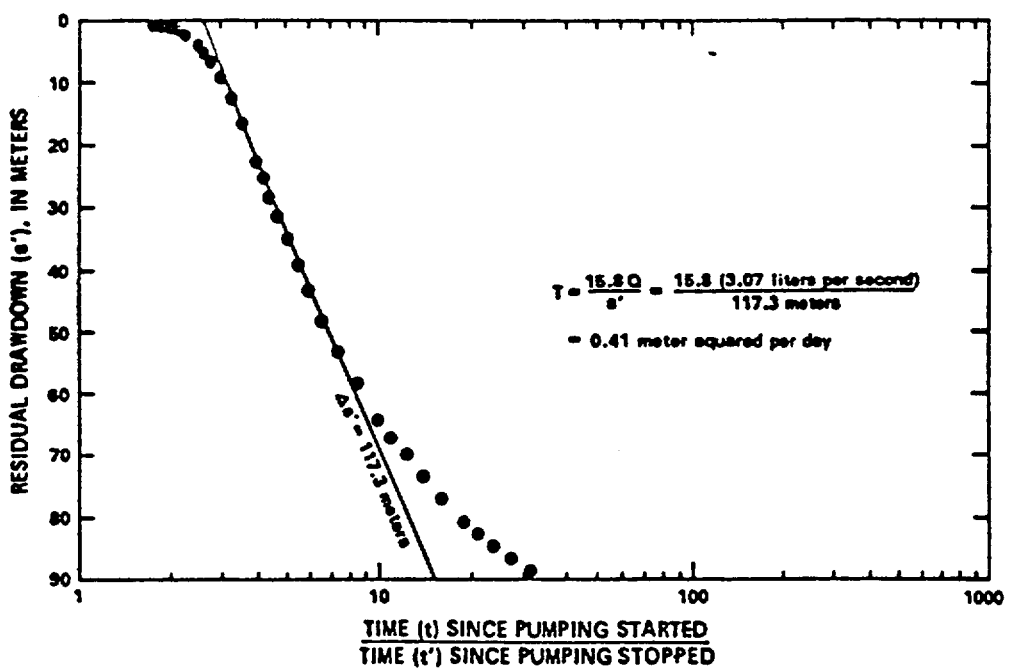


Figure 3.1.2.2.3-27. Analysis of Water-Line Recovery, Pumping Test 3, Zone from 687 to 1,829 Meters in the Well, Straight-Line Method. Rush et al., 1984

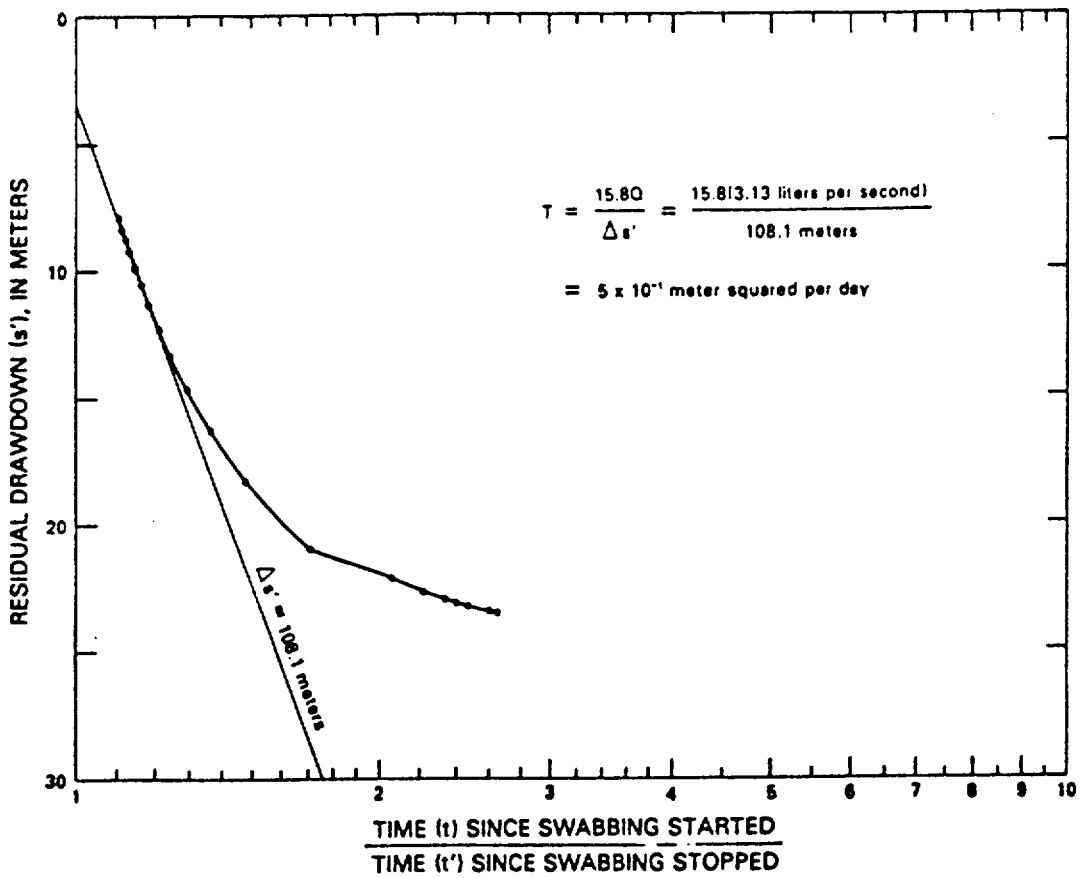


Figure 3.1.2.2.3-28. Analysis of Water-Level Recovery Following Second Cycle of Pumping of the Interval from 754 to 1,219 Meters, Using the Straight-Line Method

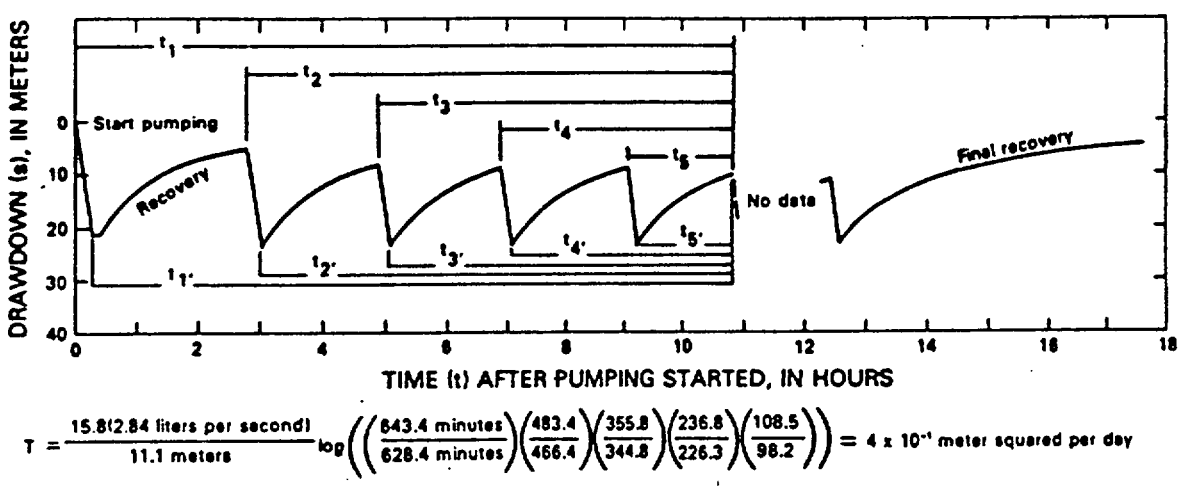


Figure 3.1.2.2.3-29. Analysis of the Pumping Test of the Interval from 754 to 1,219 Meters, Using Brown's Method for a Cyclically Pumped Well. Thordarson et al., 1985

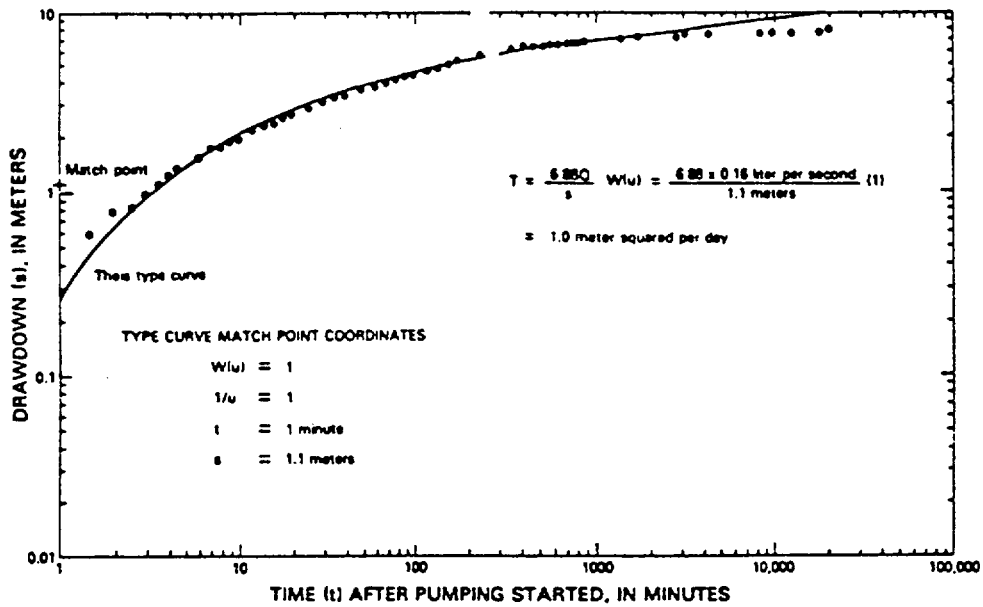


Figure 3.1.2.2.3-30. Analysis of Water-Level Drawdown of the Interval from 822 to 1,219 Meters, Using the Theis Method. Thordarson et al., 1985

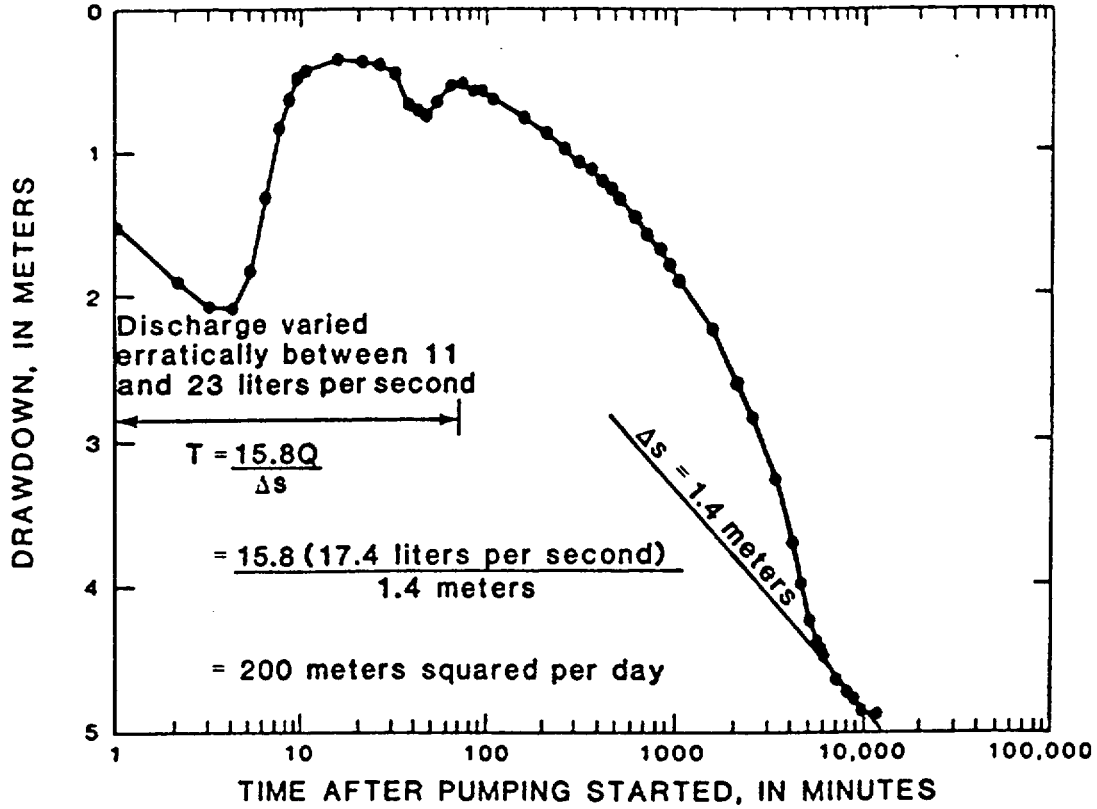


Figure 3.1.2.2.3-31. Analysis of Water-Level Drawdown Versus Time for Pumping Test 6, Depth Interval from 519 to 1,219 Meters, Using the Straight-Line Method of Analysis. Whitfield et al., 1985

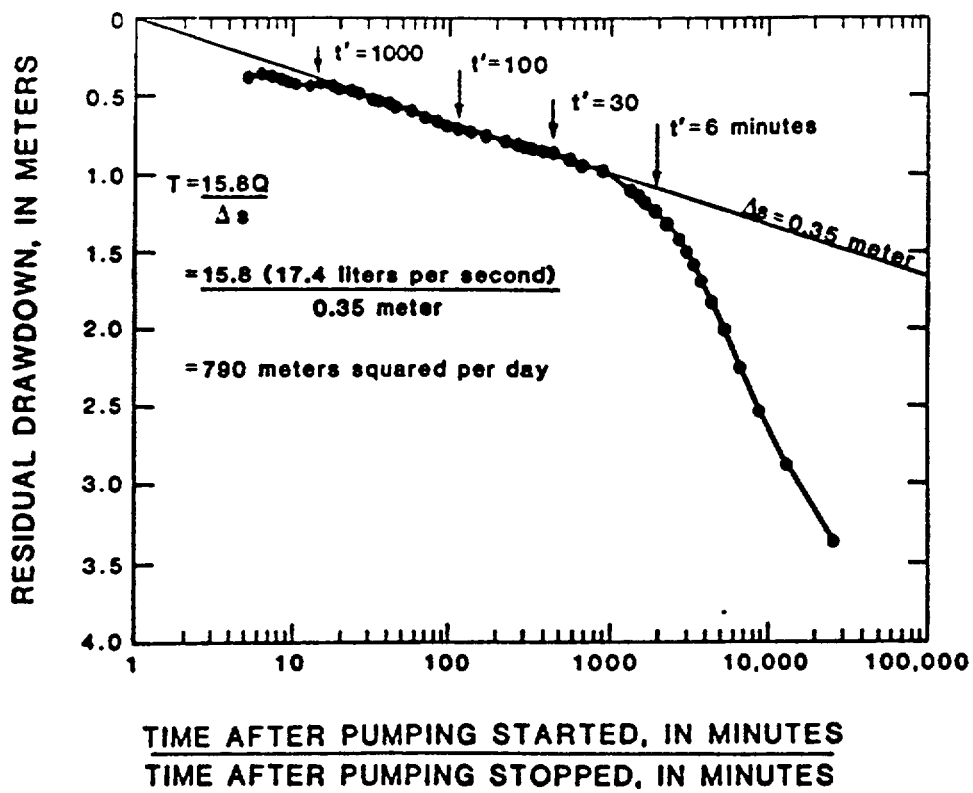


Figure 3.1.2.2.3-32. Analysis of Water-Level Recovery Versus Time for Pumping Test 6, Depth Interval from 519 to 1,219 Meters

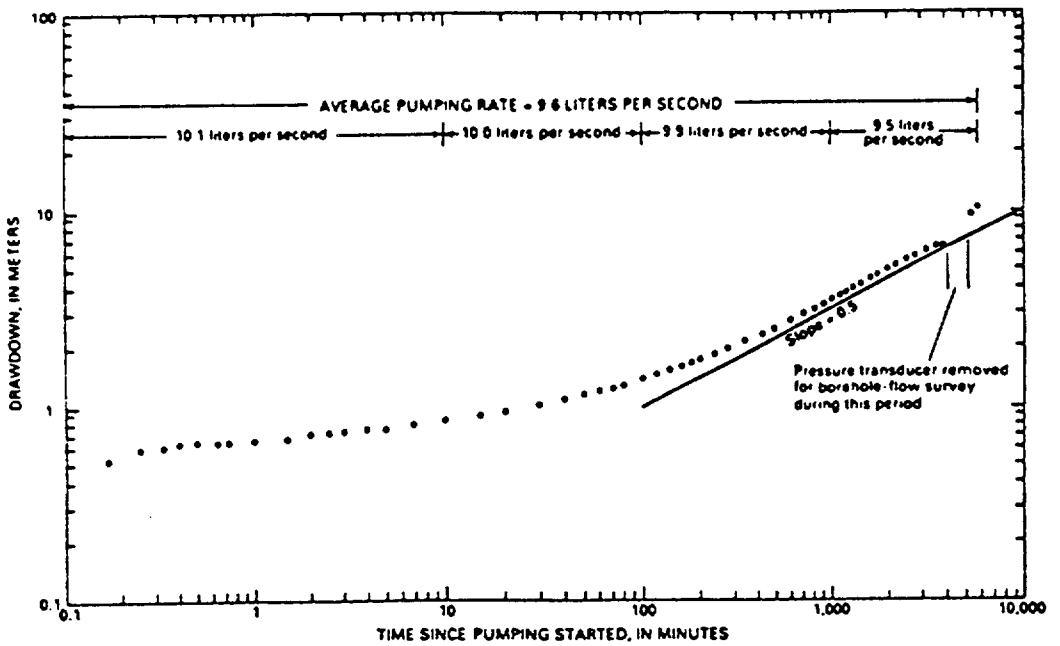


Figure 3.1.2.2.3-33. Water-Level Drawdown, Pumping Test 3, Depth Interval From 704 to 1,219 Meters. Robison and Craig, 1991

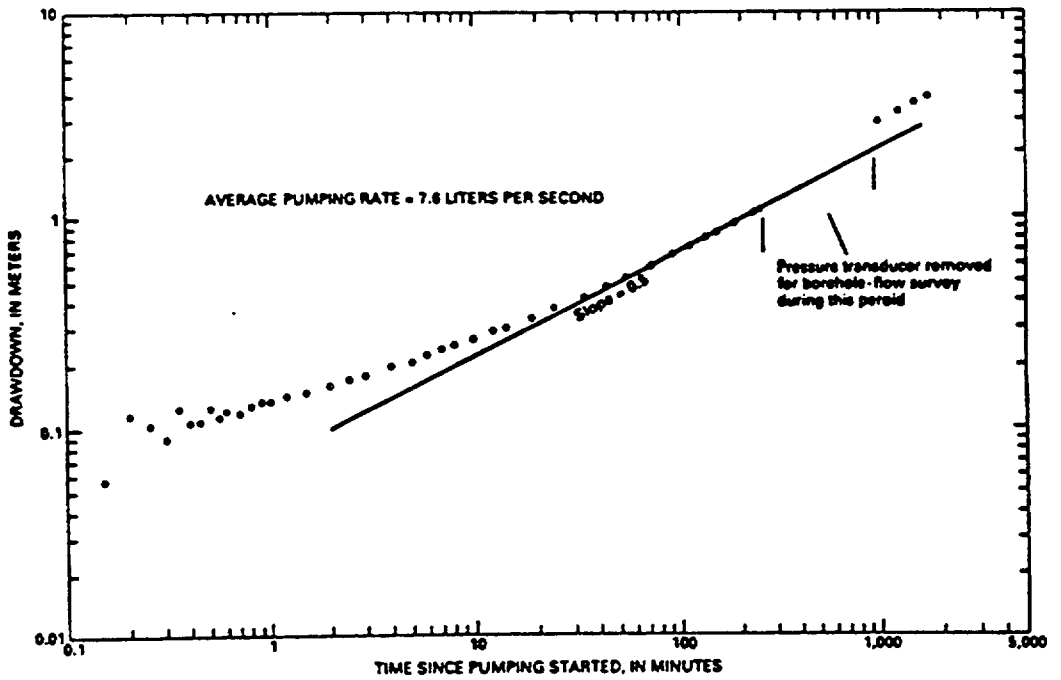


Figure 3.1.2.2.3-34. Water-Level Drawdown, Pumping Test 4, Depth Interval from 704 to 1,219 Meters

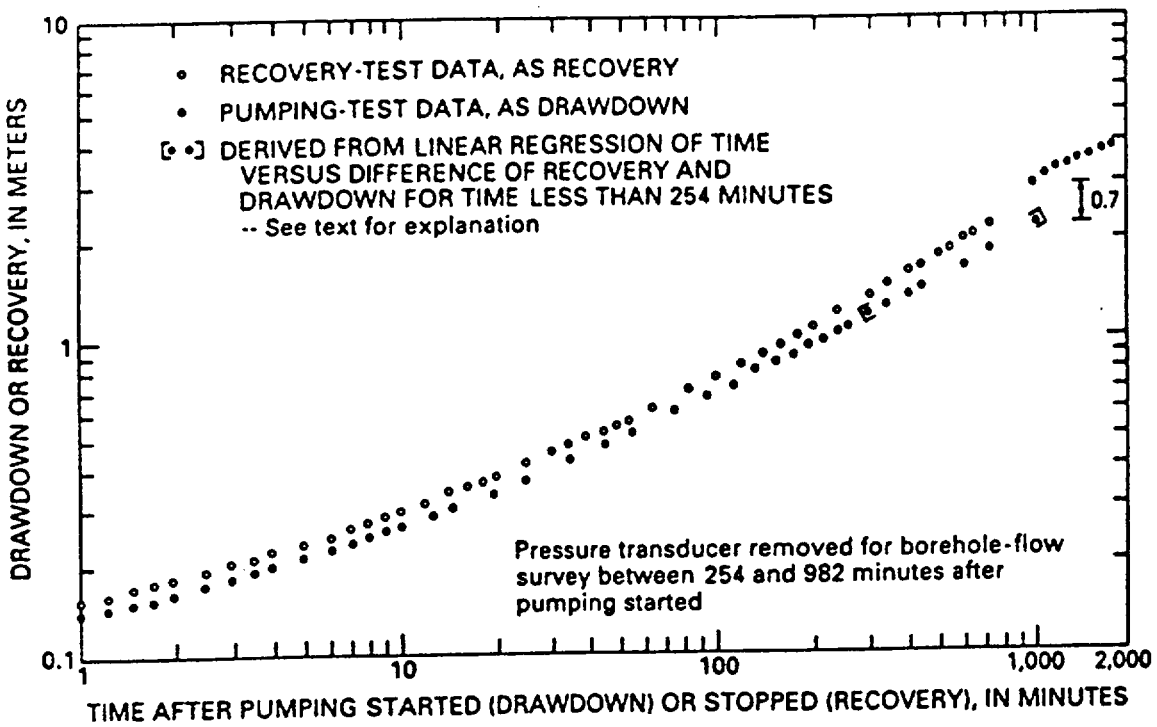


Figure 3.1.2.2.3-35. Data for Pumping and Recovery Tests 4, Depth Interval from 704 to 1,219 Meters

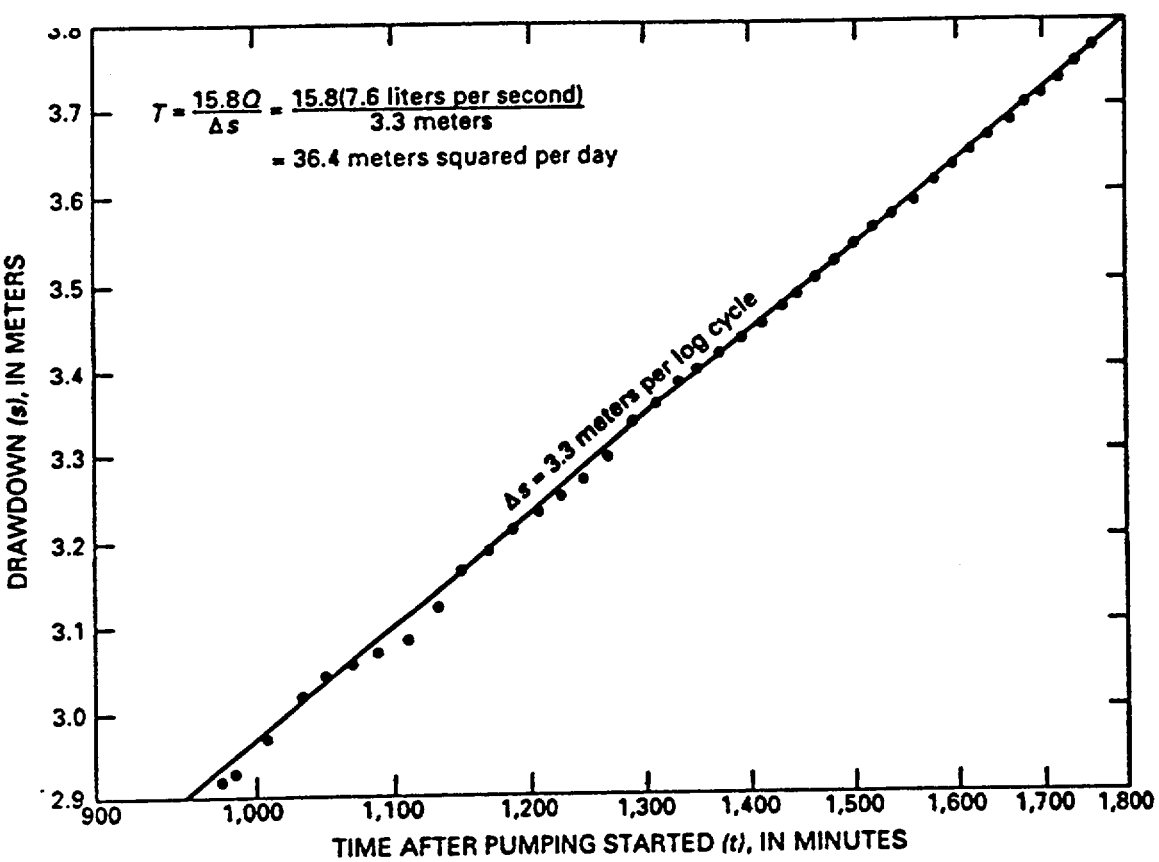


Figure 3.1.2.2.3-36. Analysis of Late-Time Data, Pumping Test 4, Depth Interval from 704 to 1,219 Meters, Straight-Line Method. Robison and Craig, 1991

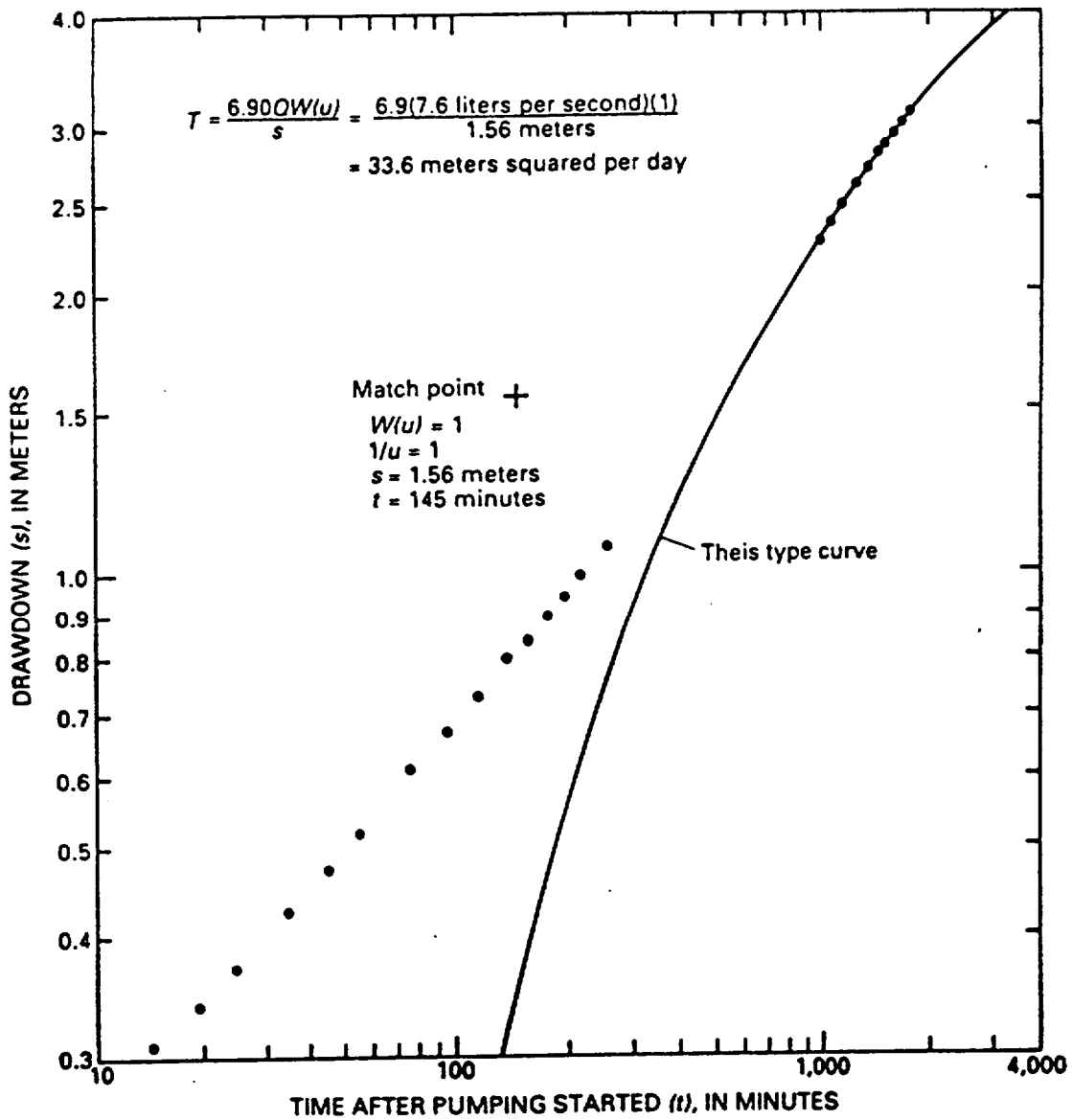


Figure 3.1.2.2.3-37. Analysis of Adjusted Water-Level Drawdown, Pumping Test 4, Depth Interval from 704 to 1,219 Meters, Theis Method (Lohman, 1972). Robison and Craig, 1991

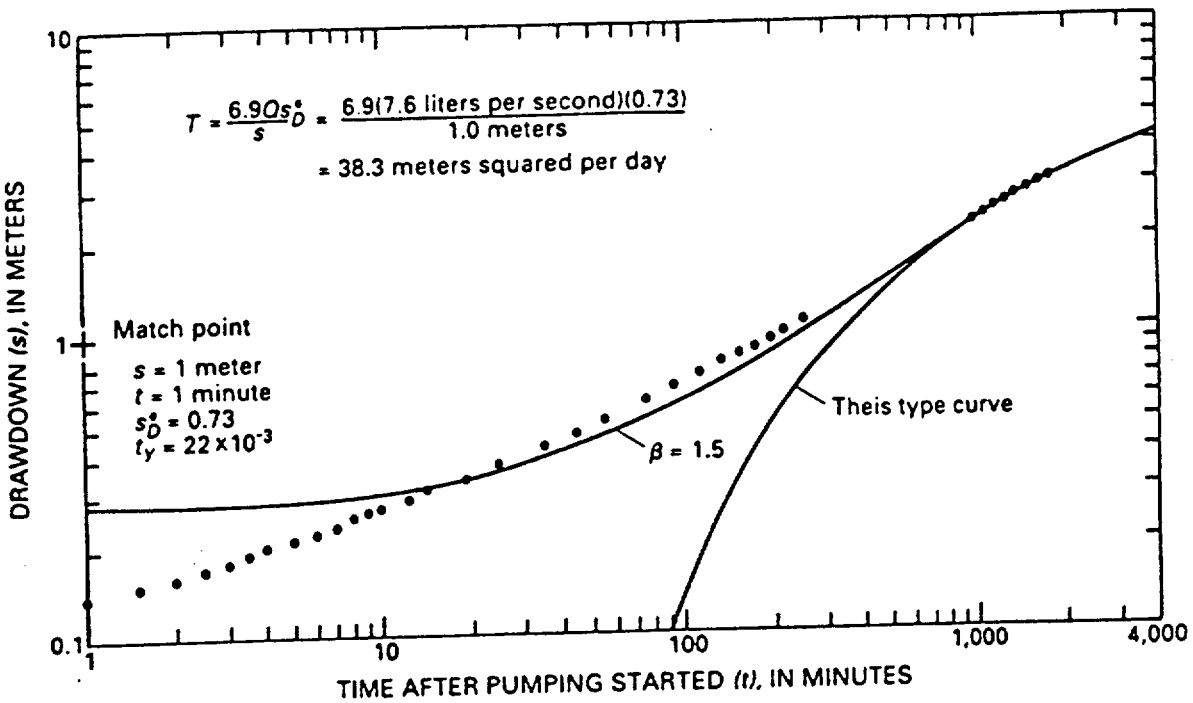


Figure 3.1.2.2.3-38. Analysis of Adjusted Water-Level Drawdown, Pumping Test 4, Depth Interval from 704 to 1,219 Meters, Method of Neuman (1975)

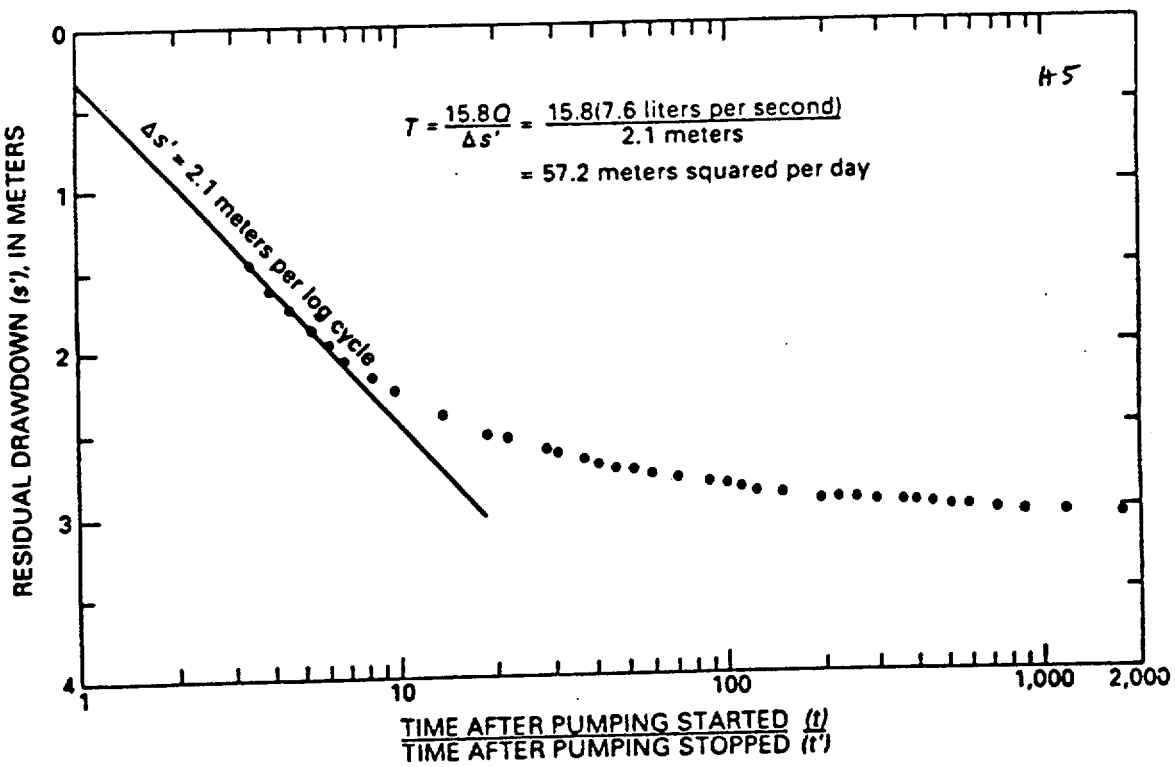


Figure 3.1.2.2.3-39. Analysis of Residual Drawdown, Recovery Test 4, Depth Interval from 704 to 1,219 Meters, Straight-Line Method

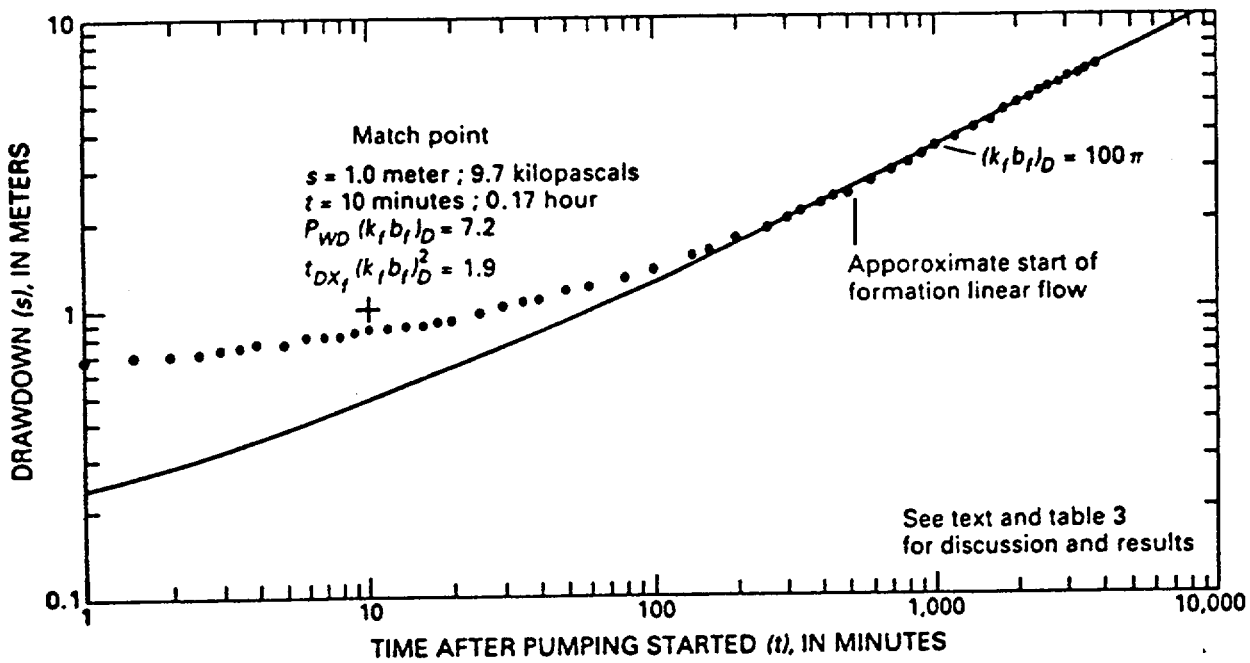


Figure 3.1.2.2.3-40. Analysis of Pumping Test 3, Depth Interval from 704 to 1,219 Meters, Vertical-Fracture Model, Curve-Match Method

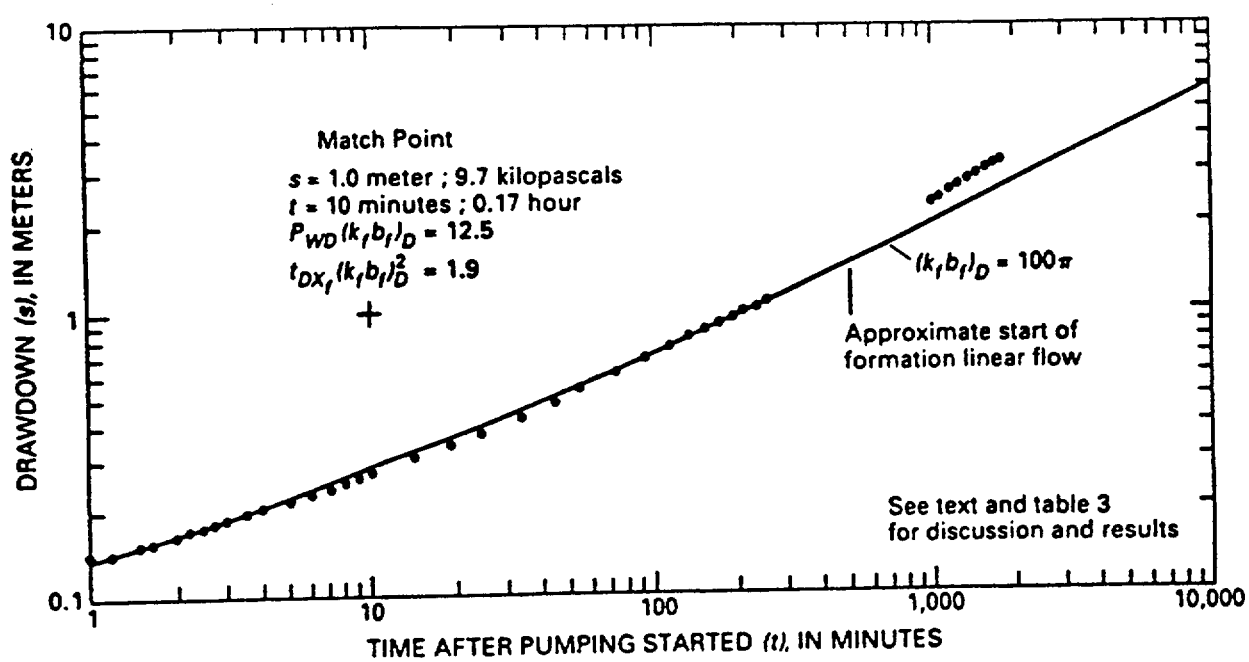


Figure 3.1.2.2.3-41. Analysis of Pumping Test 4, Depth Interval from 704 to 1,219 Meters, Vertical-Fracture Model, Curve-Match Method. Robison and Craig, 1991

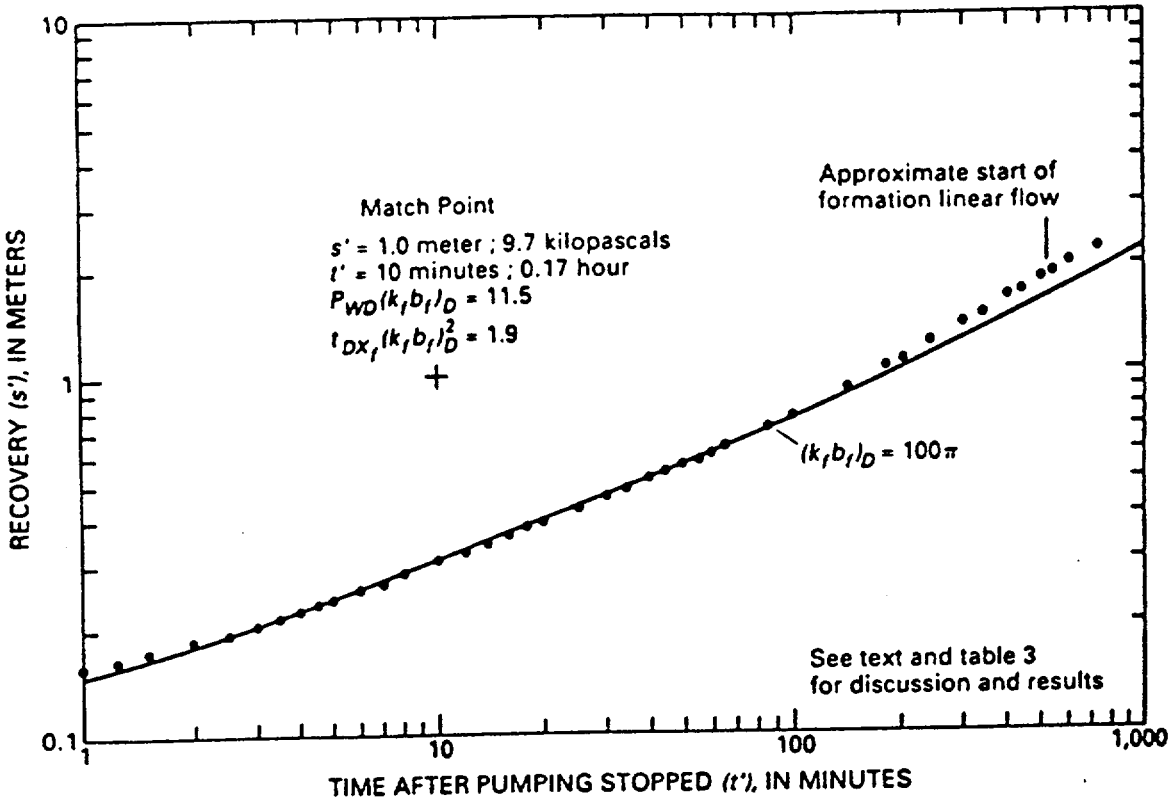


Figure 3.1.2.2.3-42. Analysis of Recovery Test 4, Depth Interval from 704 to 1,219 Meters, Vertical-Fracture Model, Curve-Match Method

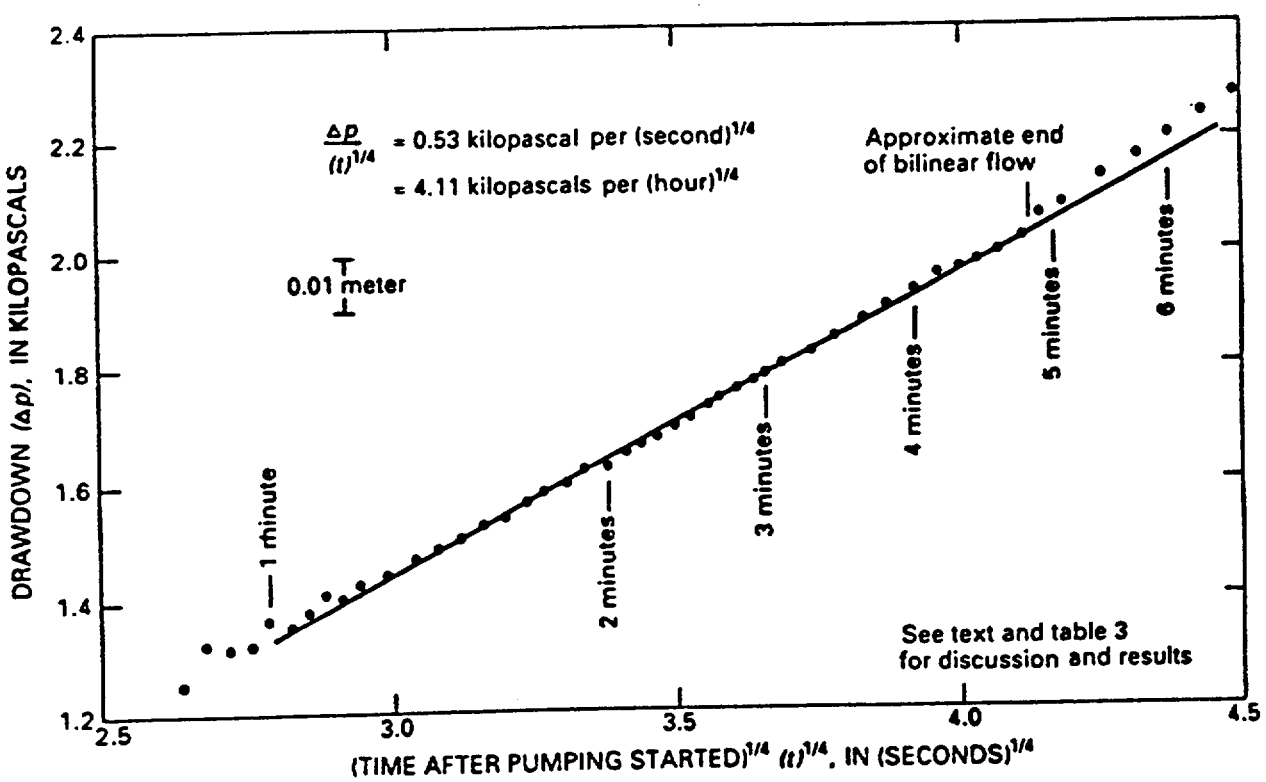


Figure 3.1.2.2.3-43. Analysis of Pumping Test 4, Depth Interval from 704 to 1,219 Meters, Vertical-Fracture Model, Bilinear-Flow Method. Robison and Craig, 1991

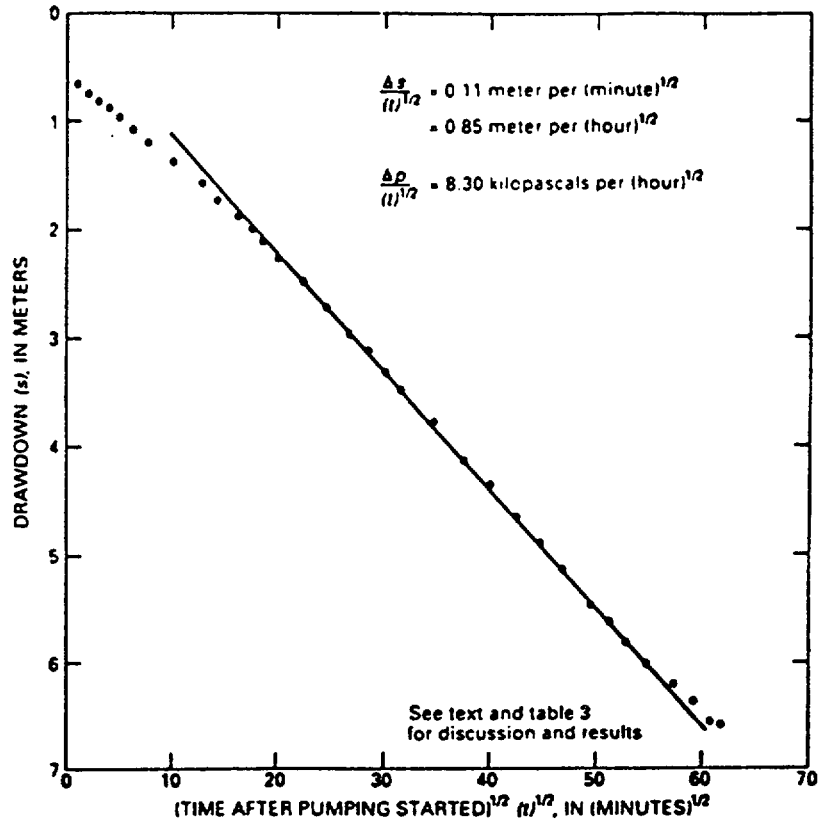


Figure 3.1.2.2.3-44. Analysis of Pumping Test 3, Depth Interval from 704 to 1,219 Meters, Vertical-Fracture Model, Linear-Flow Method

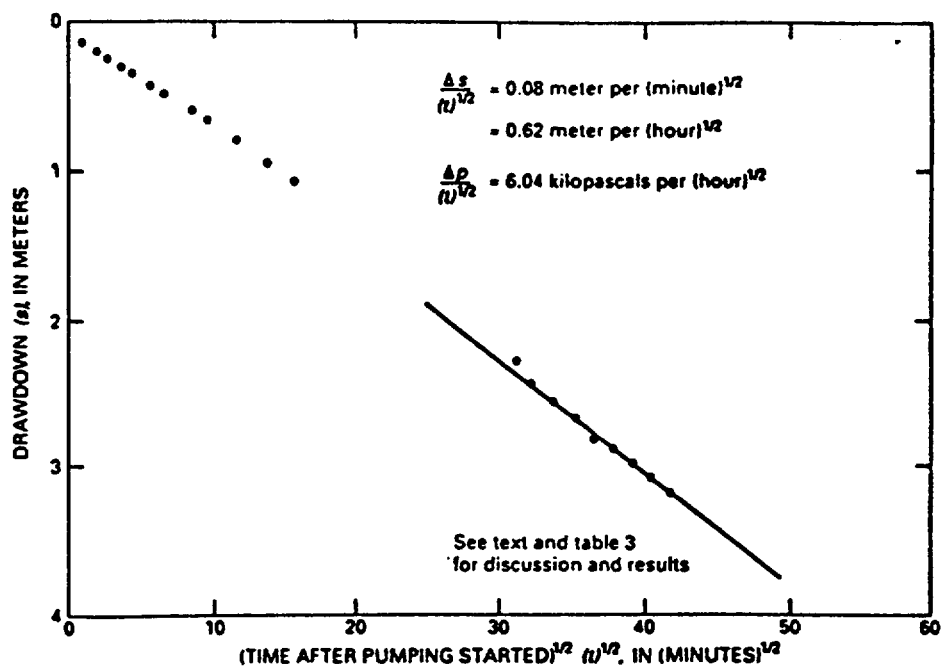


Figure 3.1.2.2.3-45. Analysis of Pumping Test 4, Depth Interval from 704 to 1,219 Meters, Vertical-Fracture Model, Linear-Flow Method. Robison and Craig, 1991

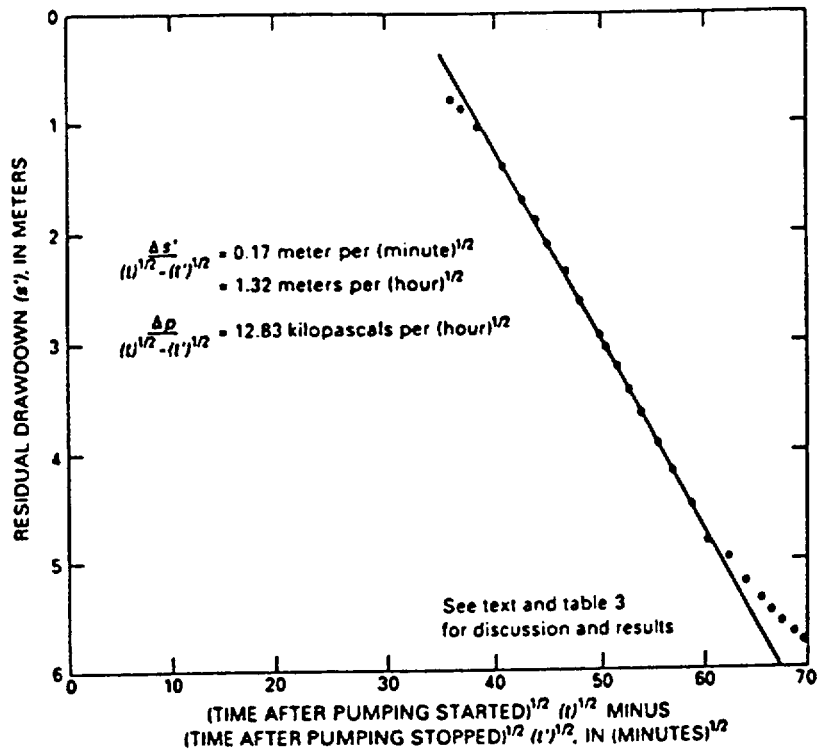


Figure 3.1.2.2.3-46. Analysis of Recovery Test 3, Depth Interval from 704 to 1,219 Meters, Vertical-Fracture Model, Linear-Flow Method

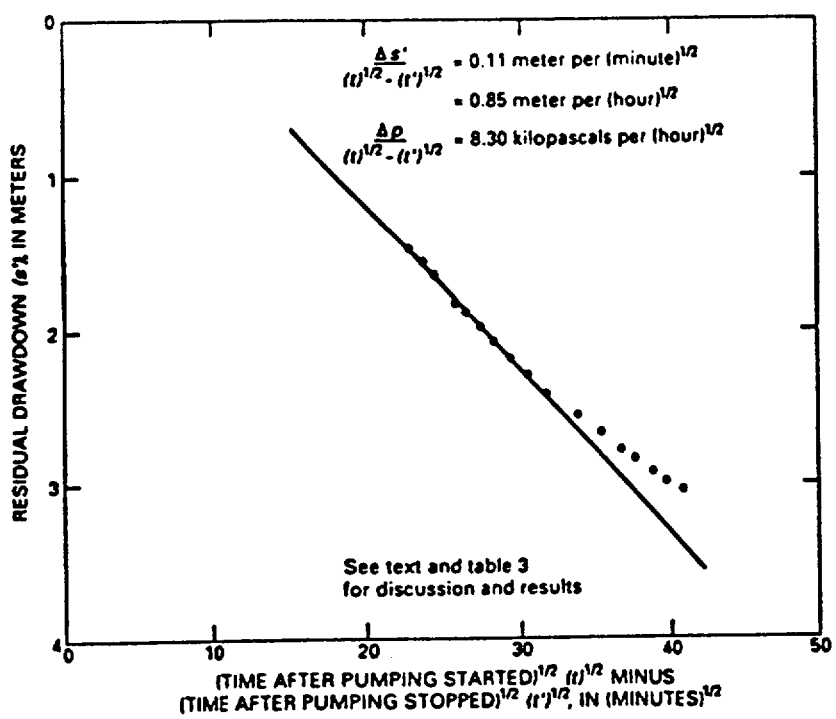


Figure 3.1.2.2.3-47. Analysis of Recovery Test 4, Depth Interval from 704 to 1,219 Meters, Vertical-Fracture Model, Linear-Flow Method. Robison and Craig, 1991

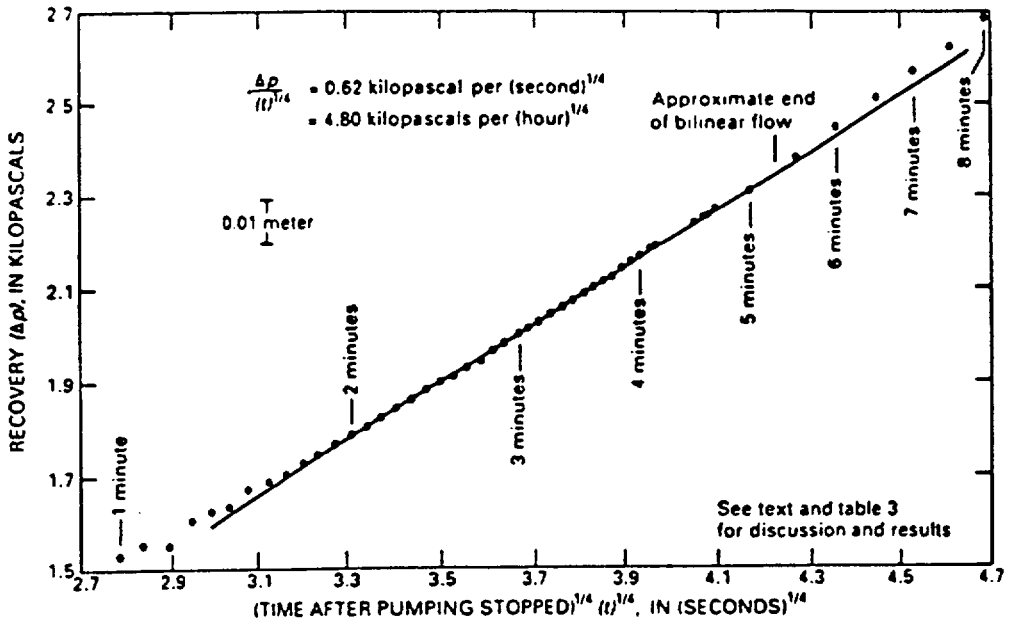


Figure 3.1.2.2.3-48. Analysis of Recovery Test 4, Depth Interval from 704 to 1,219 Meters, Vertical-Fracture Model, Bilinear-Flow Method. Robison and Craig, 1991

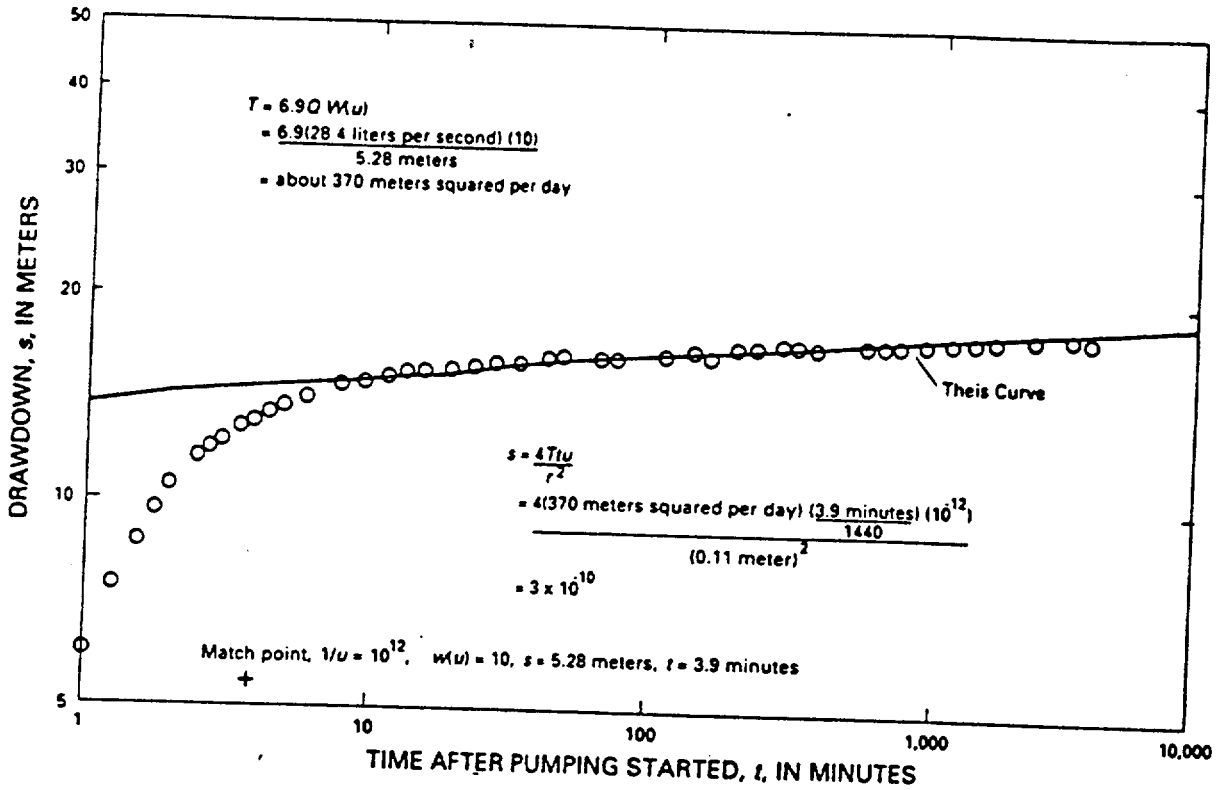


Figure 3.1.2.2.3-49. Analysis of Water-Level Drawdown, Pumping Test 1: Depth Interval from 526 to 1,220 Meters; Theis Method. Craig and Reed, 1991

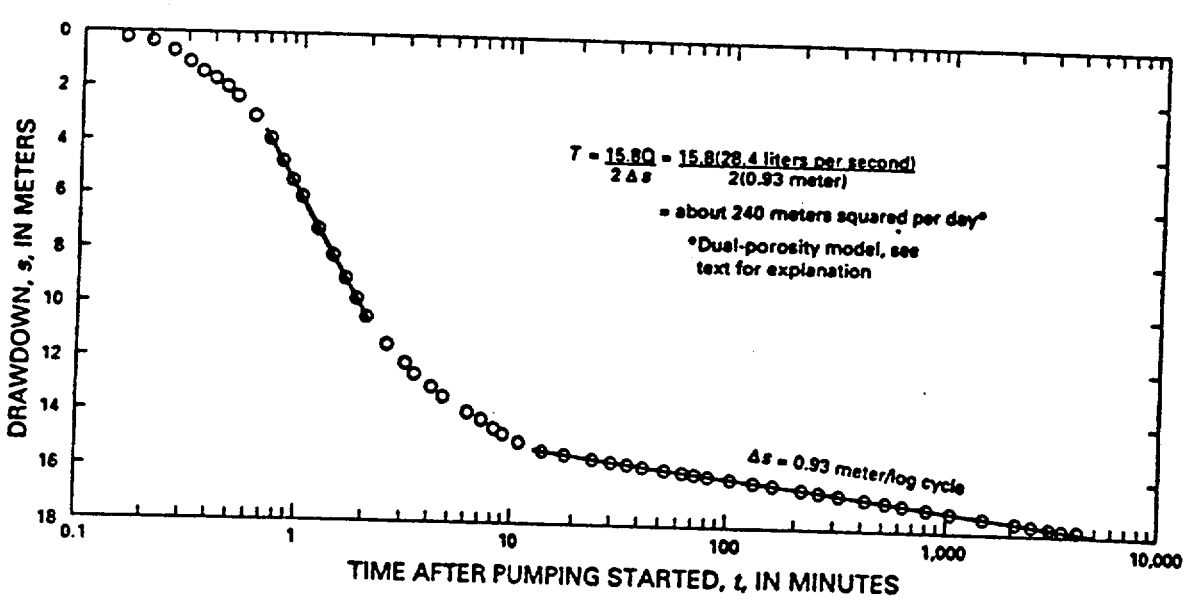


Figure 3.1.2.2.3-50. Analysis of Water-Level Drawdown, Pumping Test 1: Depth Interval from 526 to 1,220 Meters; Straight-Line Solution with Dual-Porosity Model. Craig and Reed, 1991

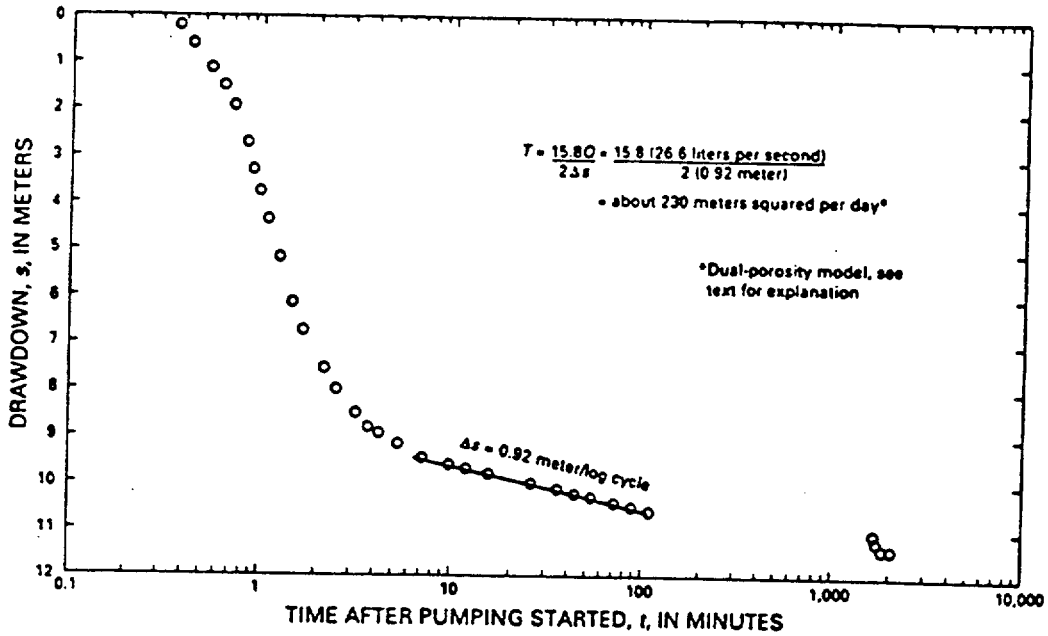


Figure 3.1.2.2.3-51. Analysis to Water-Level Drawdown, Pumping Test 2: Depth Interval from 526 to 1,220 Meters; Straight-Line Solution with Dual-Porosity Model

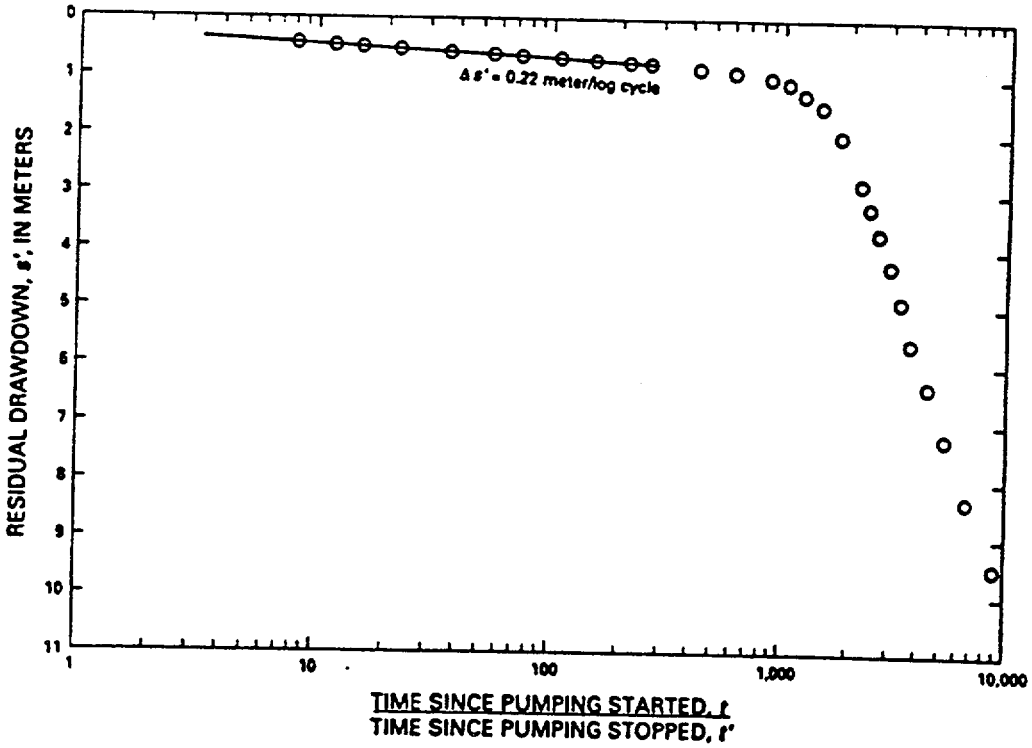


Figure 3.1.2.2.3-52. Water-Level Recovery, Pumping Test 2: Depth Interval from 526 to 1,220 Meters. Craig and Reed, 1991

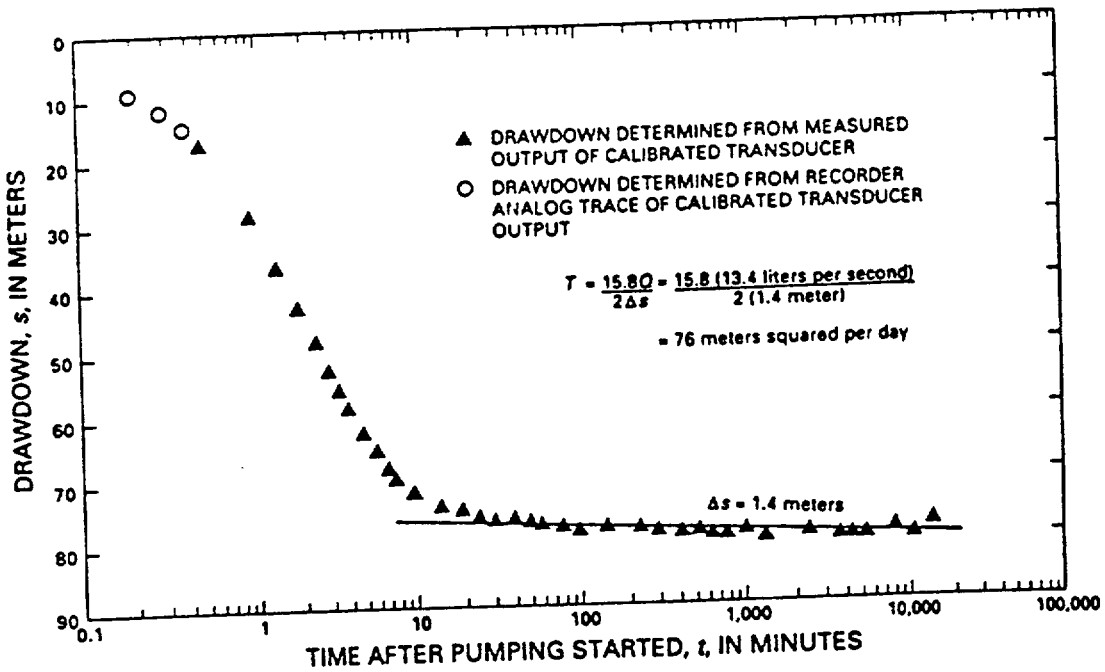


Figure 3.1.2.2.3-53. Analysis of Water-Level Drawdown, Pumping Test 3: Depth Interval from 753 to 834 Meters; Straight-Line Solution with Dual-Porosity Model

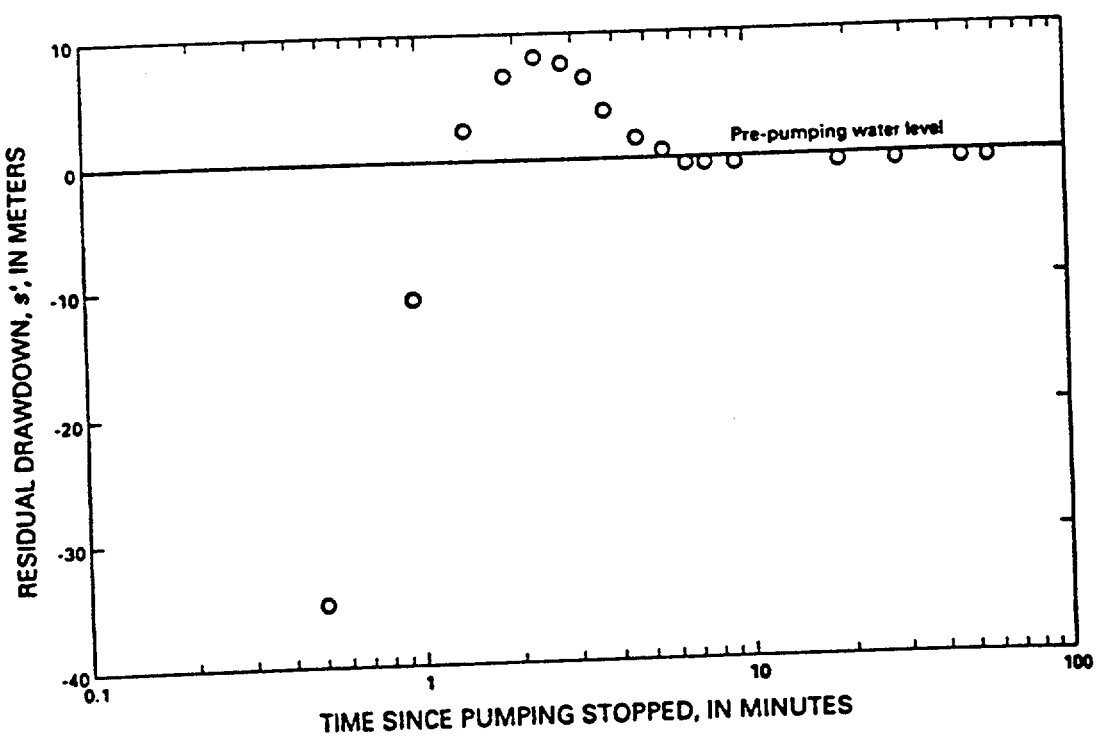


Figure 3.1.2.2.3-54. Residual Drawdown, Recovery Test 3: Depth Interval 753 to 834 Meters. Craig and Reed, 1991

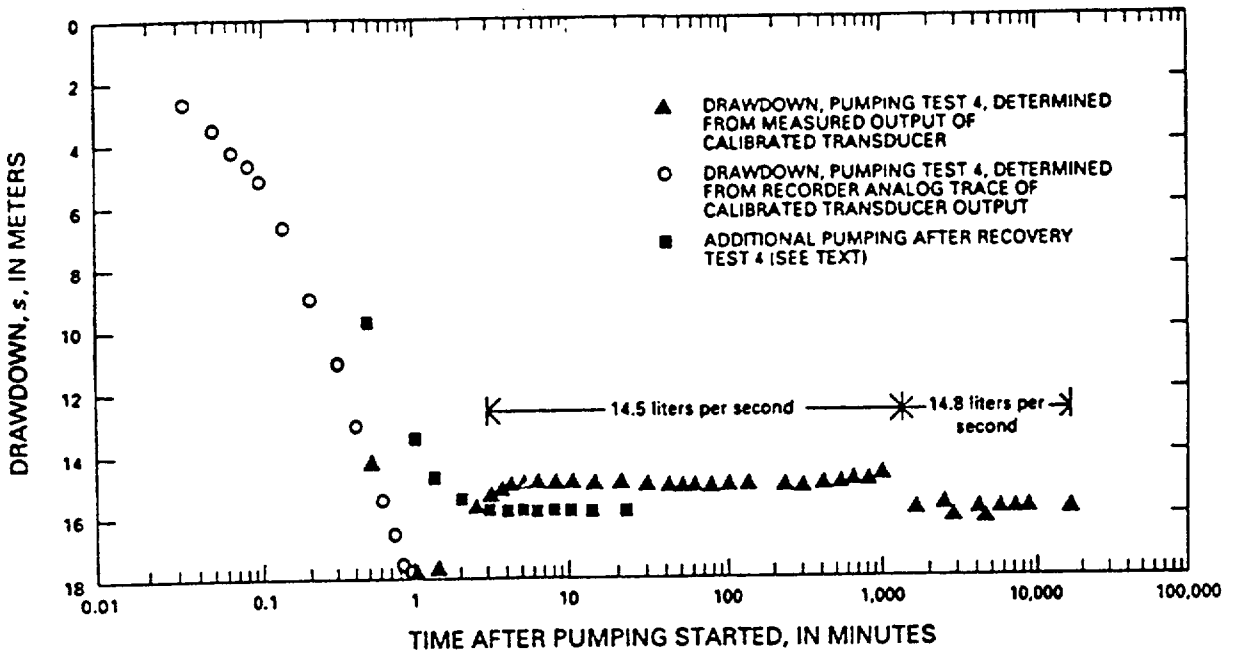


Figure 3.1.2.2.3-55. Water-Level Drawdown, Pumping Test 4: Depth Interval from 608 to 645 Meters

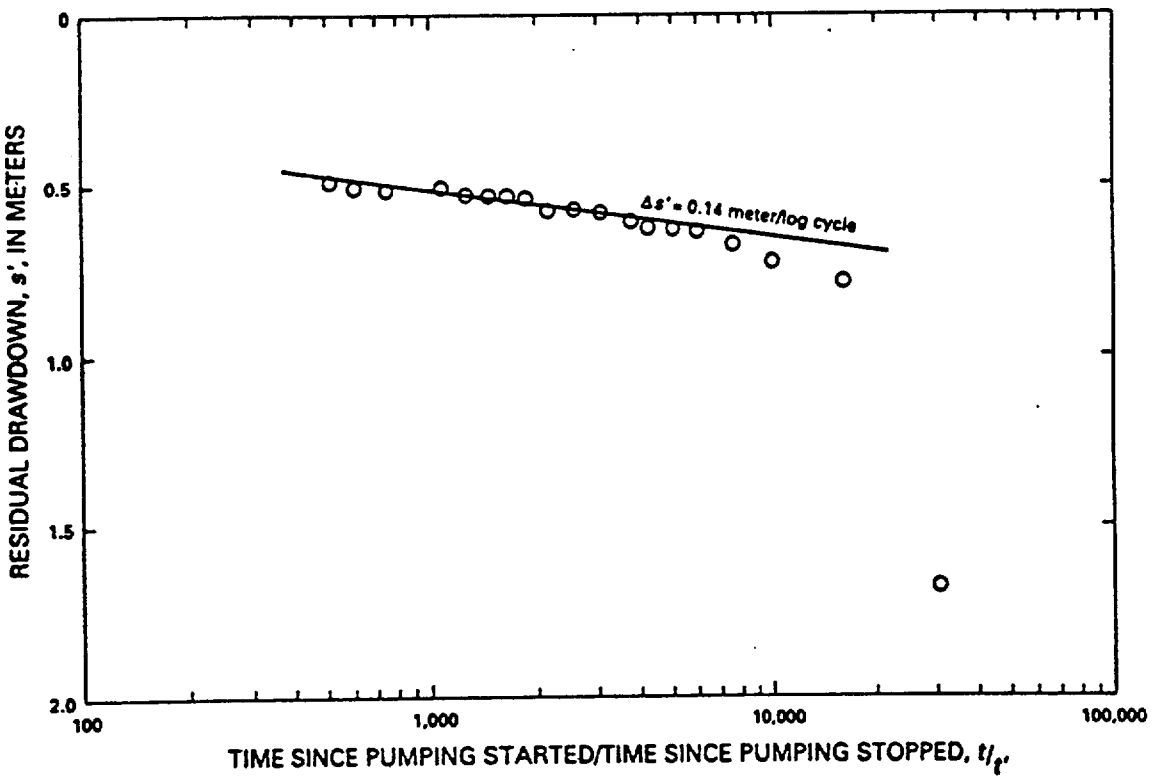


Figure 3.1.2.2.3-56. Water-Level Recovery, Recovery Test 4: Depth Interval from 608 to 645 Meters. Craig and Reed, 1991

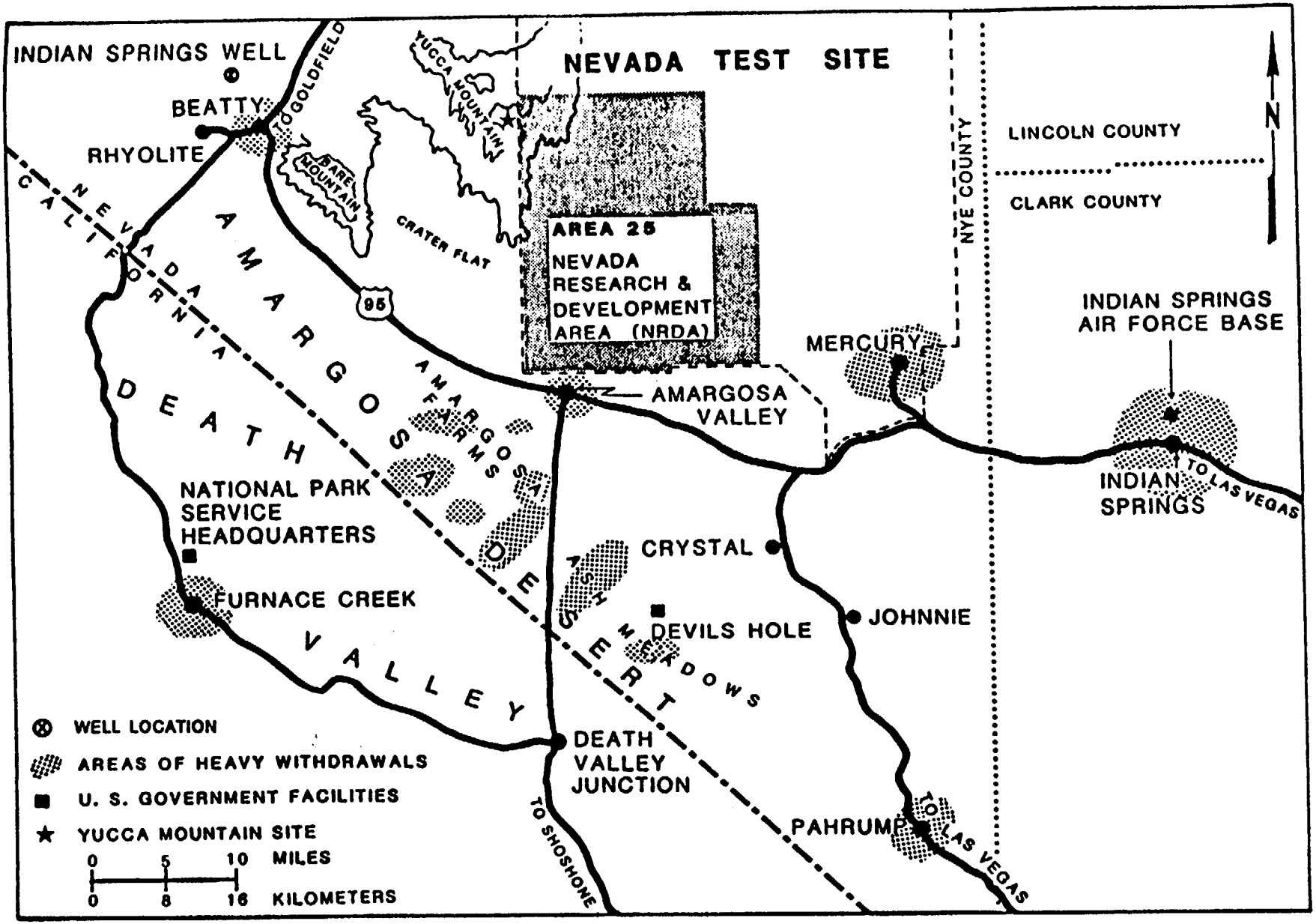


Figure 3.1.2.2.8-1: Map showing areas of heavy withdrawals near Yucca Mountain. Modified from French et al., (pg. 3, 1984).

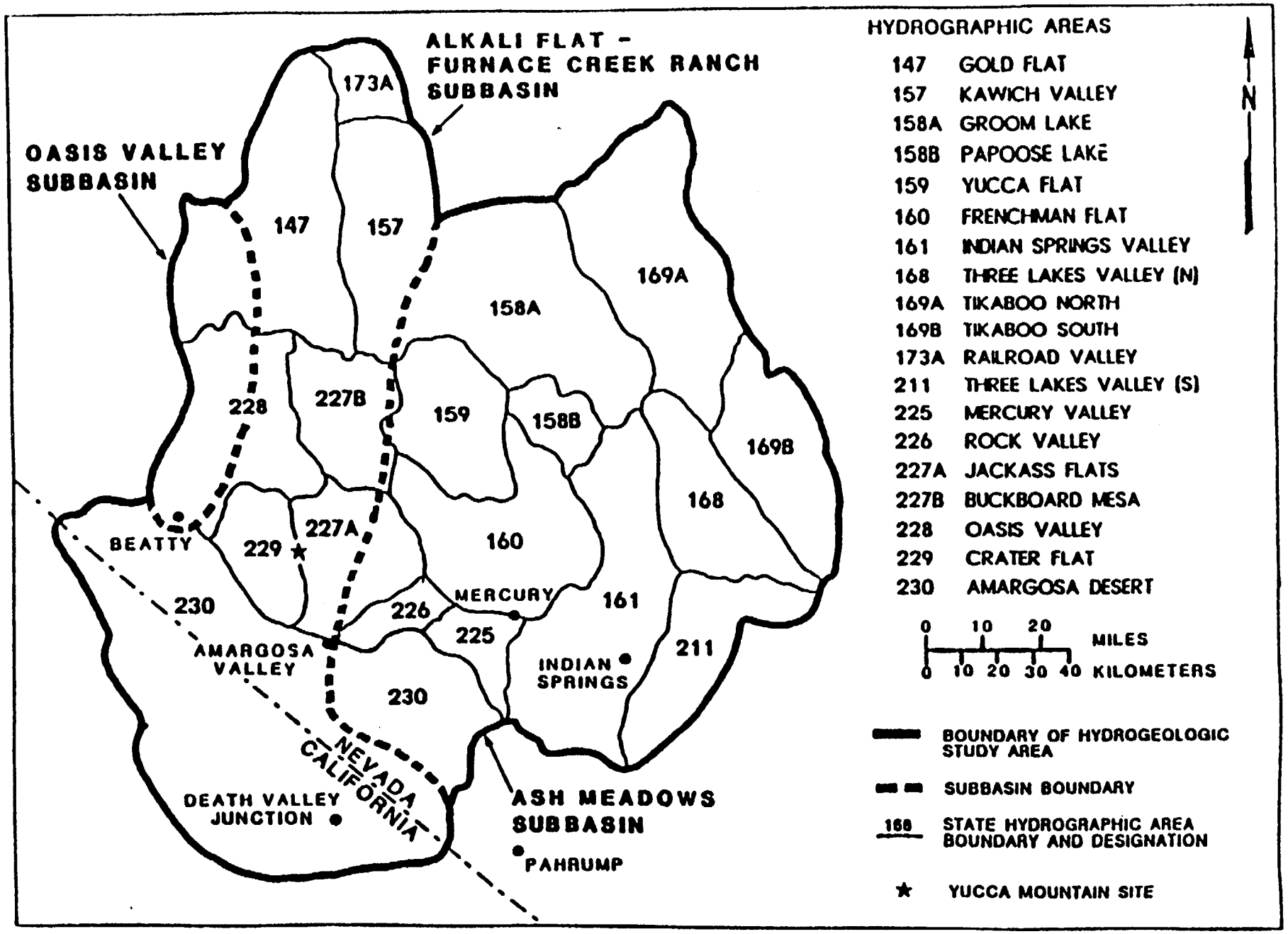


Figure 3.1.2.2.8-2: State Hydrographic Areas within the Hydrogeologic Study Area

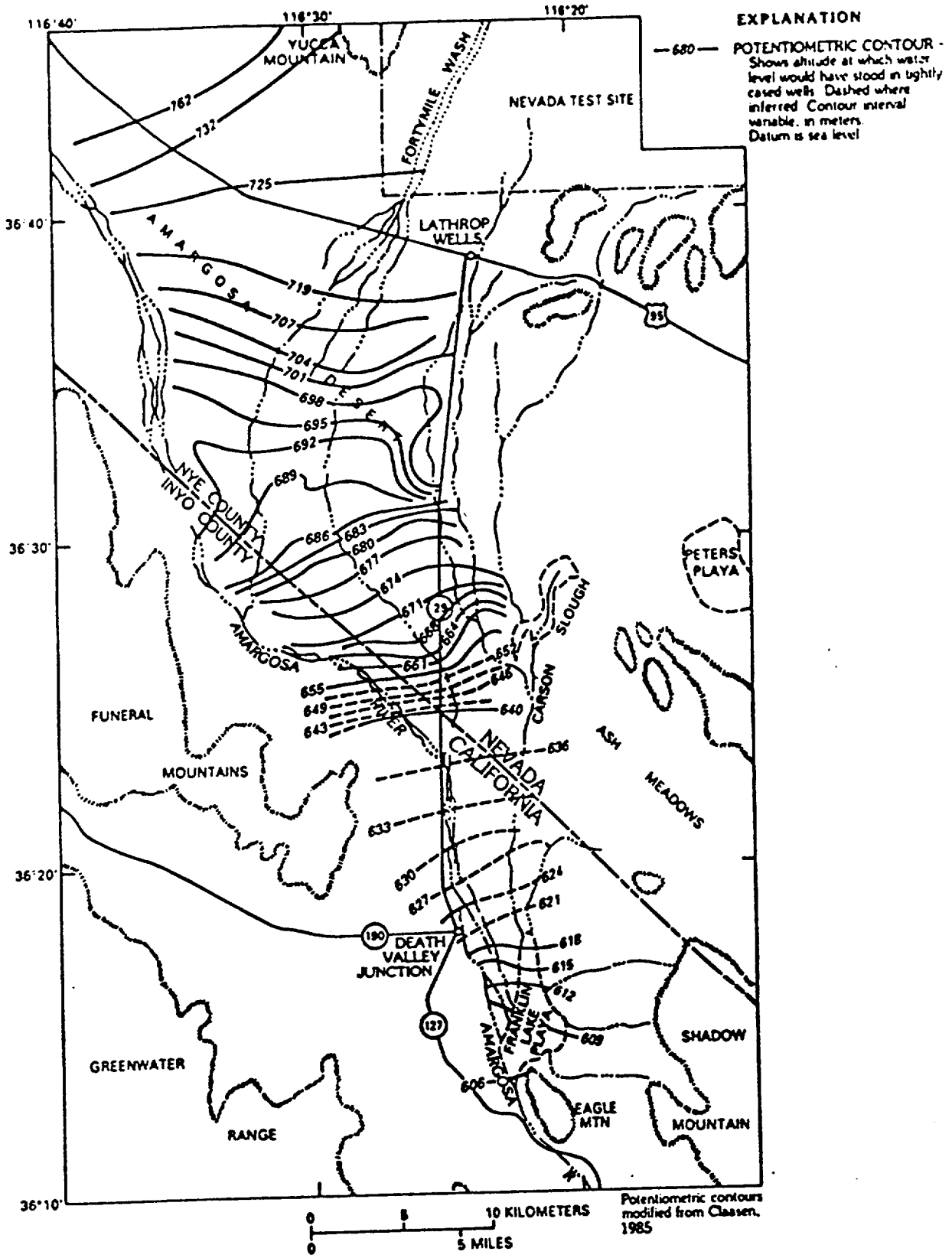
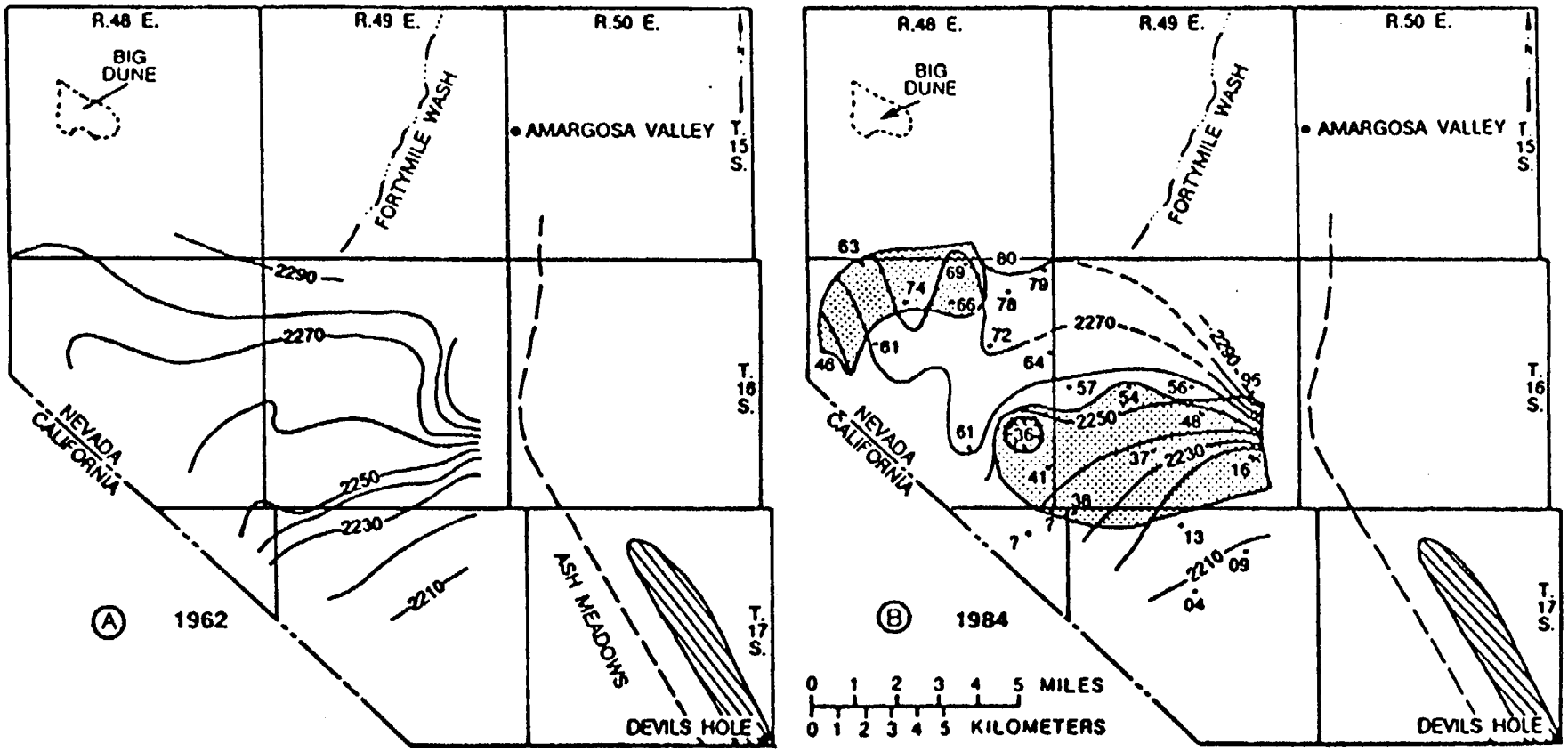


Figure 3.1.2.2.8-3. Potentiometric Surface of the Amargosa Desert



Altitude: National Geodetic Vertical Datum of 1929 (sea level)

EXPLANATION

INFERRED FAULT -- From Winograd and Thordarson (1975, page C70, plate 1); delineated on basis of gravity survey

GENERALIZED AREA OF SPRING DISCHARGE

GENERALIZED AREA WHERE NET WATER-LEVEL DECLINE BETWEEN 1962 AND 1984 EXCEEDED 10 FEET

--2270-- WATER-LEVEL CONTOUR -- Shows altitude of ground-water level in valley-fill deposits. Dashed where approximately located. Contour interval 10 feet. Datum is sea level. Contours for 1962 from Walker and Eakin (1963, plate 3)

• 72 WELL -- Number is water-surface altitude, January 1984, in feet above 2,200 feet (question mark indicates lack of water-level measurement in 1984). Datum is sea level

Figure 3.1.2.2.8-4. Potentiometric Maps of the Amargosa Desert (Valley Fill Aquifer) Based on the Well Data from (1962) (A) and 1984 (B). Modified from Nichols and Akers (1985)

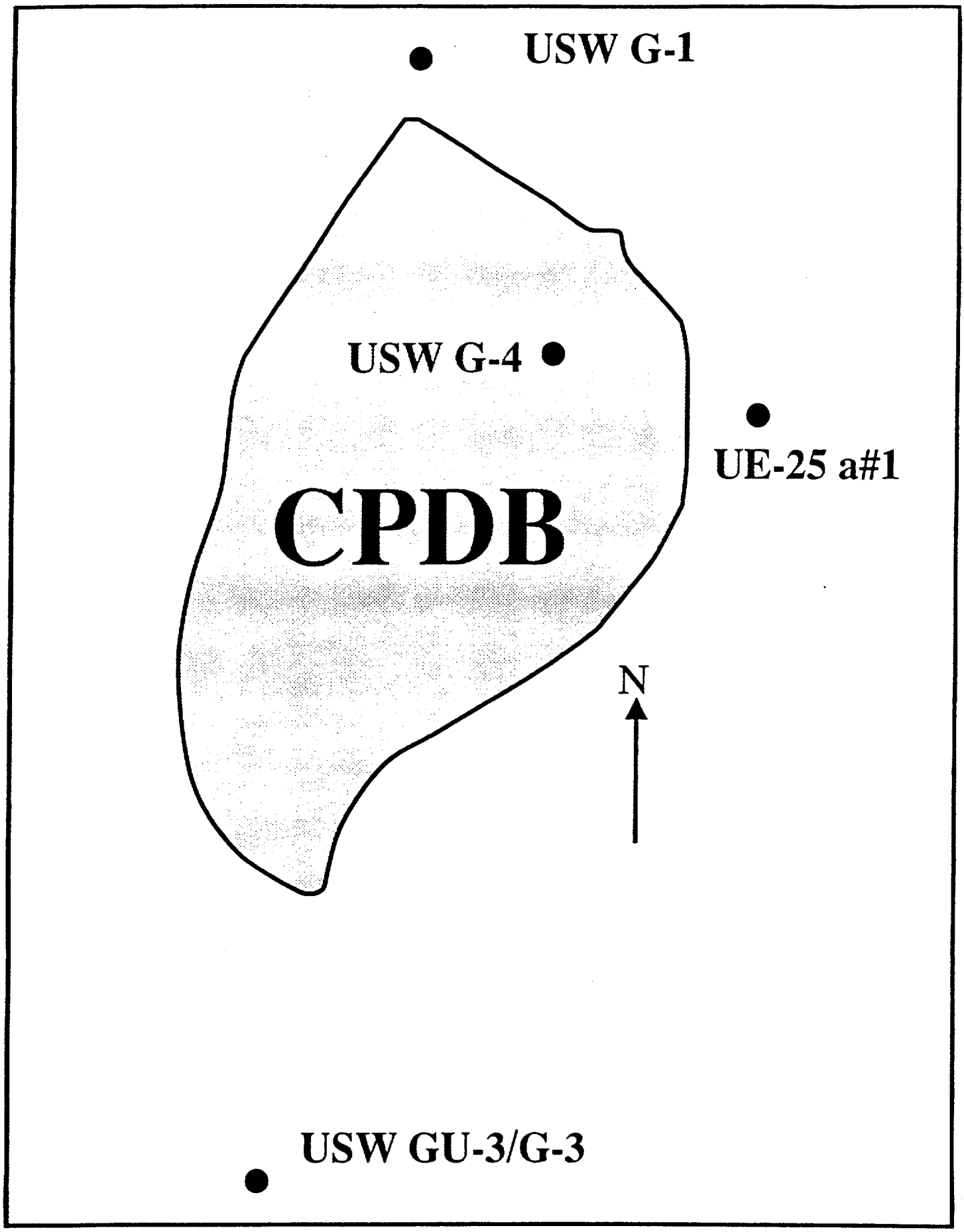


Figure 3.1.3.2.1.1-1. Index Map Showing the Location of Drill Holes in Relation to the CPDB from Which Data Primarily were Derived for this Section of the Annotated Outline

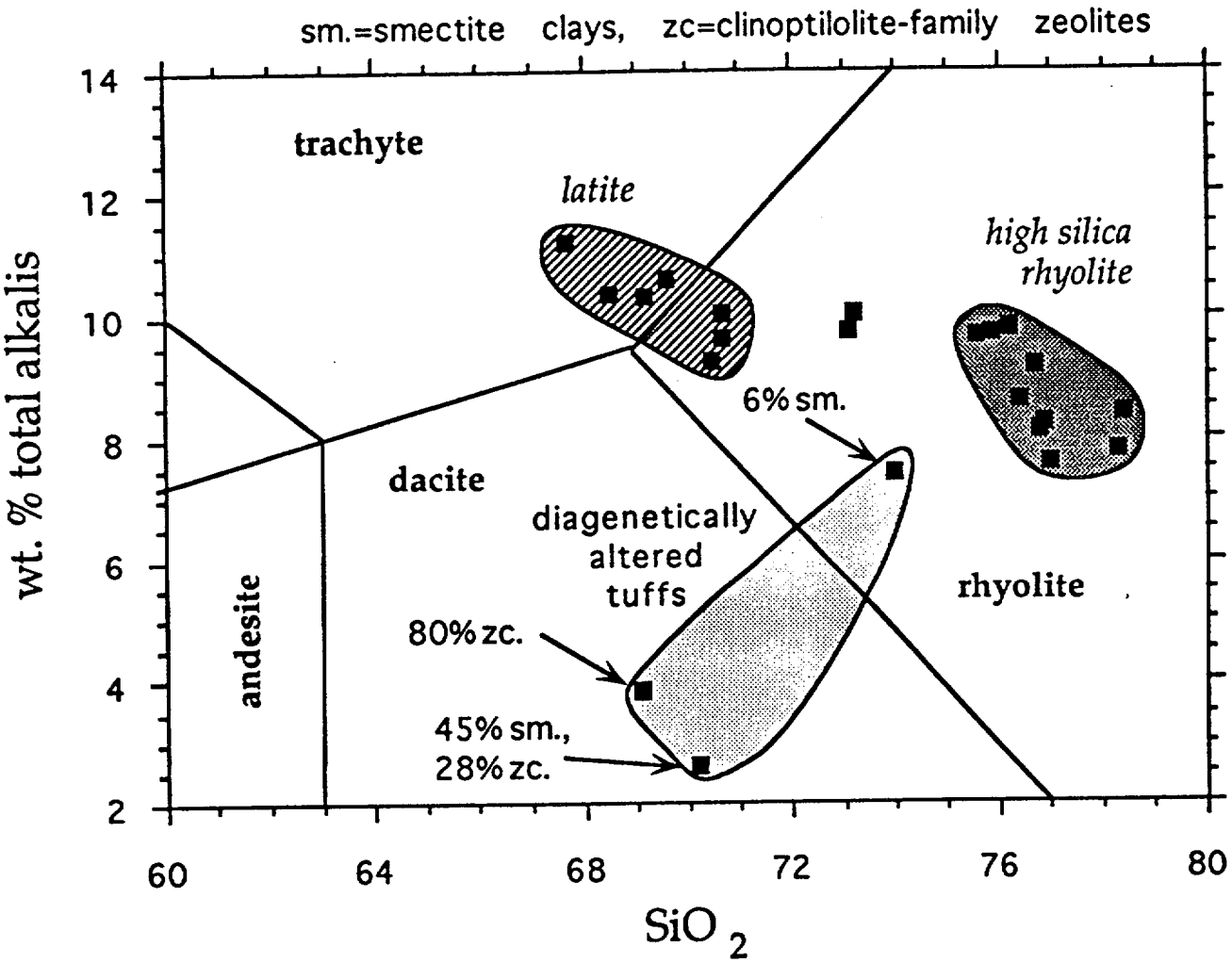


Figure 3.1.3.2.1.1.1-1. Total Alkali Silica Diagram (Le Bas et al., 1986) for Representative Fresh and Altered Samples of Latite and Rhyolite Tuff of the Topopah Spring Member of the Paintbrush tuff. Data from Schuryatz et al. (1989), and Broxton et al. (1986).

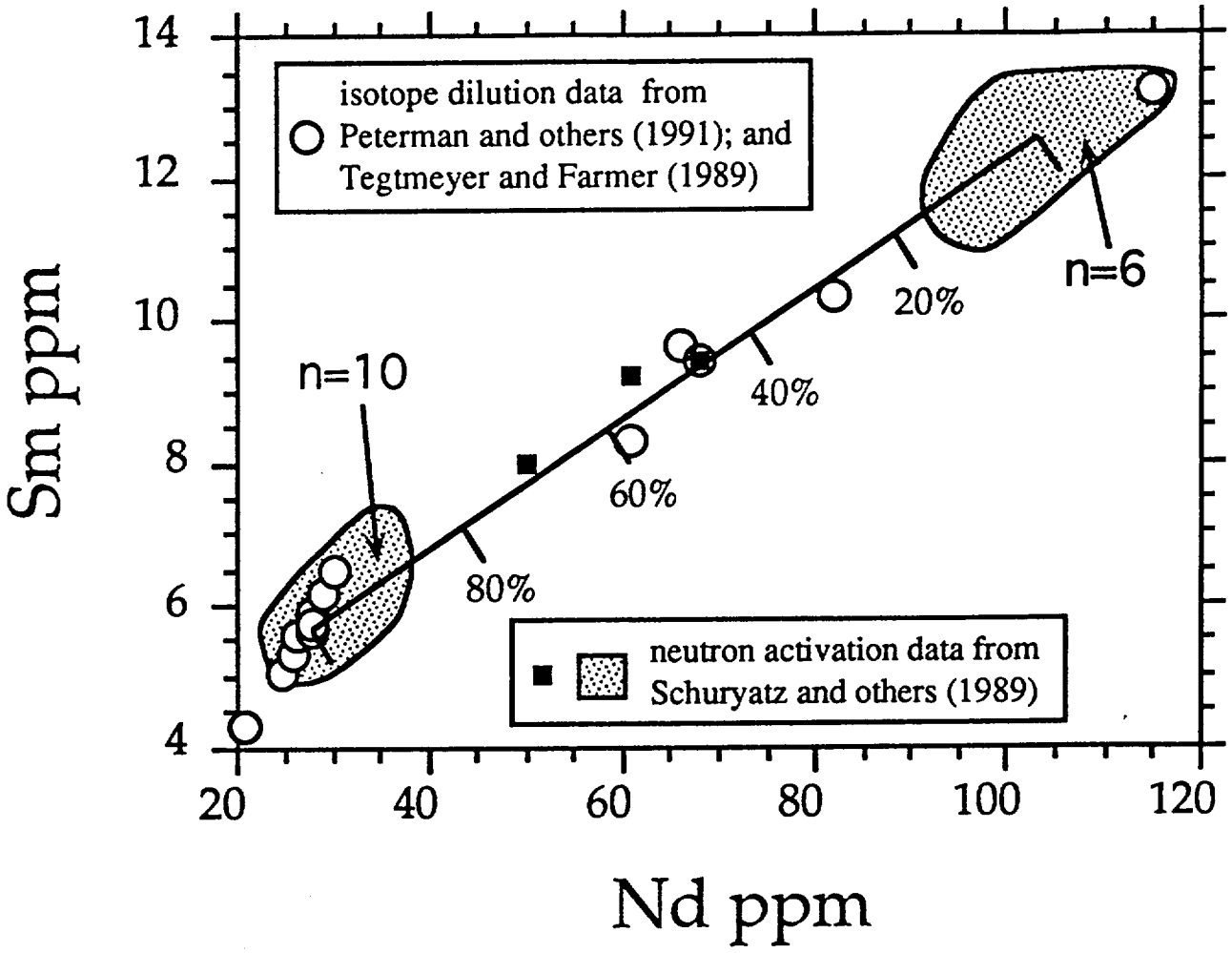


Figure 3.1.3.2.1.1.1-2. Sm-Nd plot for representative samples of the Topopah Spring Member of the Paintbrush Tuff. Note the Distinct Break Between the Latites and Rhyolites in that the Latite has Distinctly Higher REE Abundances and is LREE enriched (Lower Sm/Nd ratio). Plotted Data from Peterman et al. (1991) and Tegtmeyer and Farmer (1989). Data from Schuryatz et al. (1989) Cited for Comparative Purposes.

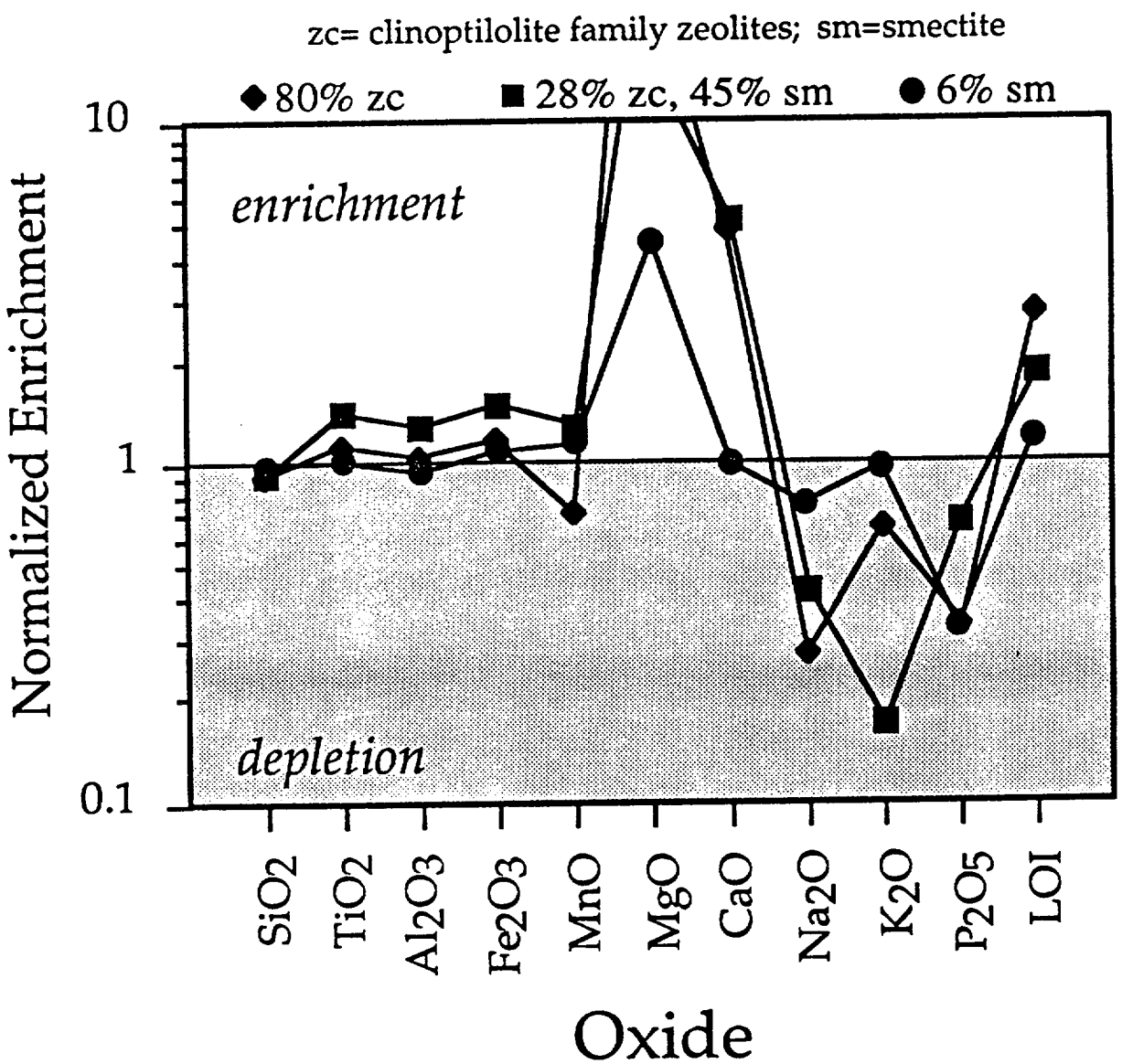


Figure 3.1.3.2.1.1.1-3. Enrichment diagram for major elements in altered Topopah Spring Rhyolite. Normalization value from sample BB8-85WR of Schuryatz et al. (1989).

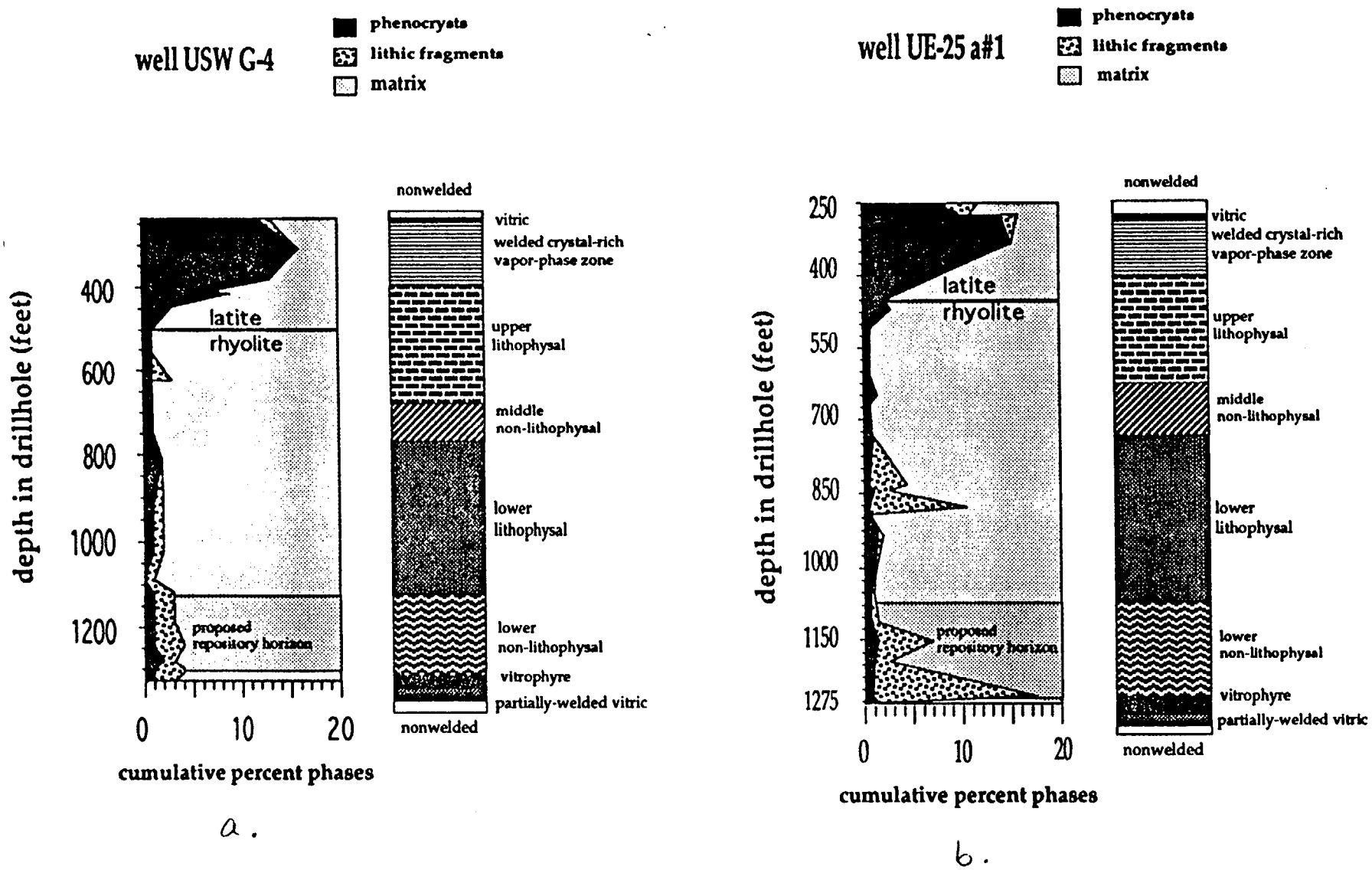


Figure 3.1.3.2.1.1.2-1. Illustration of the cumulative percent of phenocrysts and lithic fragments with depth in the Topopah Spring Member for a) drill hole USW G-4 and b) UE-25 a#1. Data from Broxton et al. (1989).

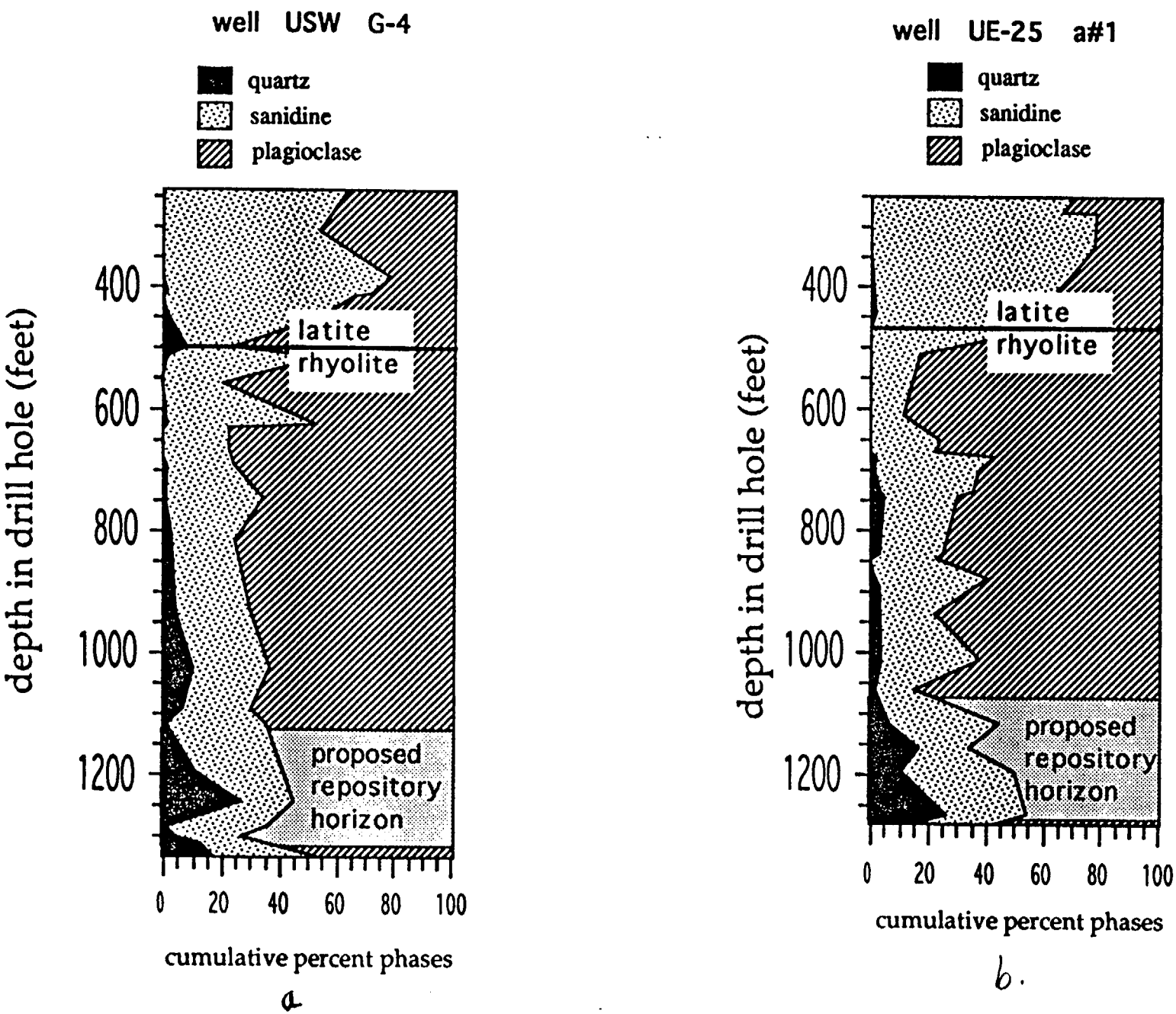


Figure 3.1.3.2.1.1.2-2. Illustration of the cumulative percent felsic phenocrysts with depth in the Topopah Spring Member for a) drill hole USW G-4 an UE-25 a#1. Data from ton et al. (1989).

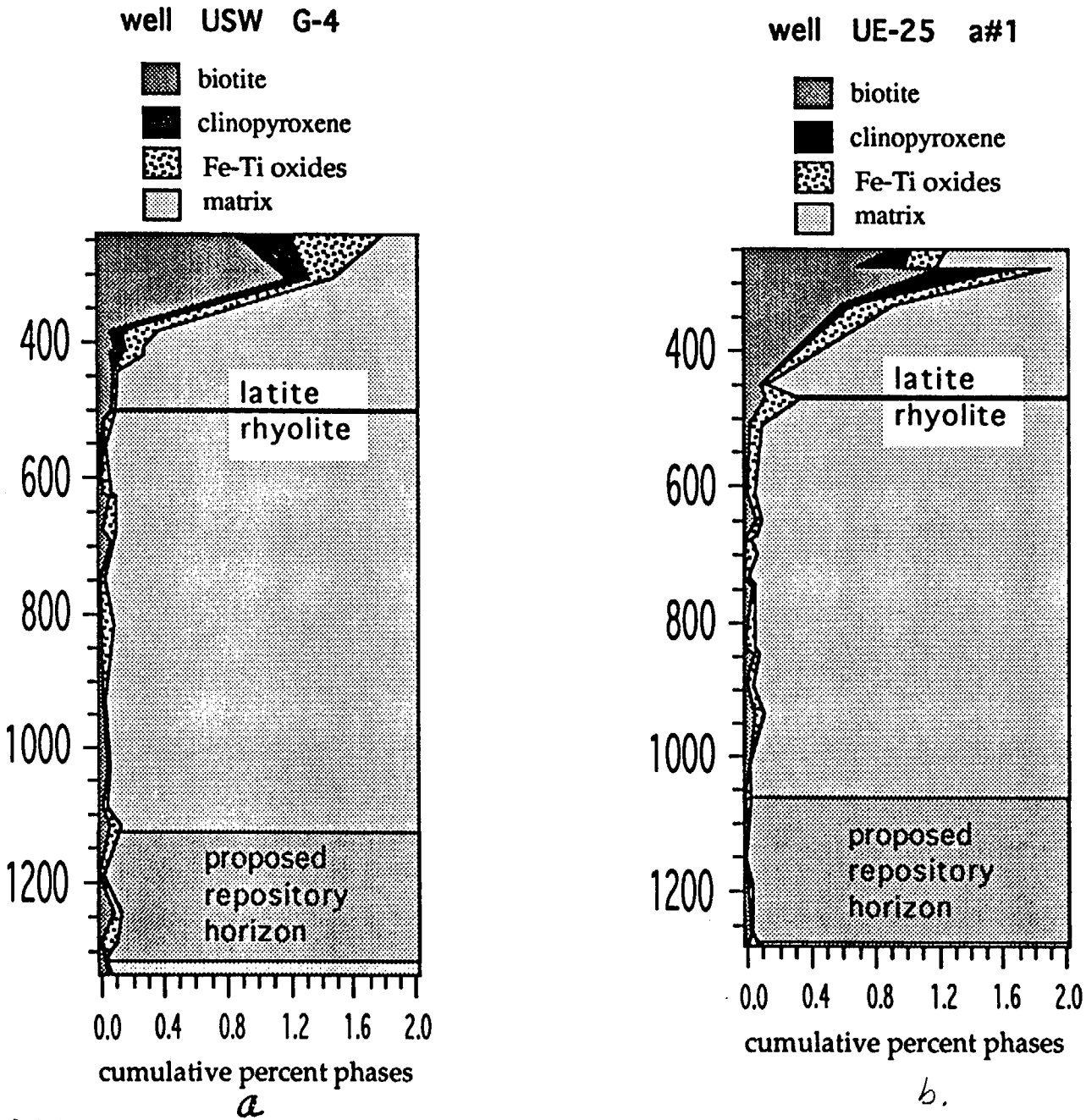


Figure 3.1.3.2.1.1.2-3. Illustration of the cumulative percent mafic phenocrysts with depth in the Topopah Spring Member for a) drill hole USW G-4 and b) UE-25 a#1. Data from Broxton et al. (1989).

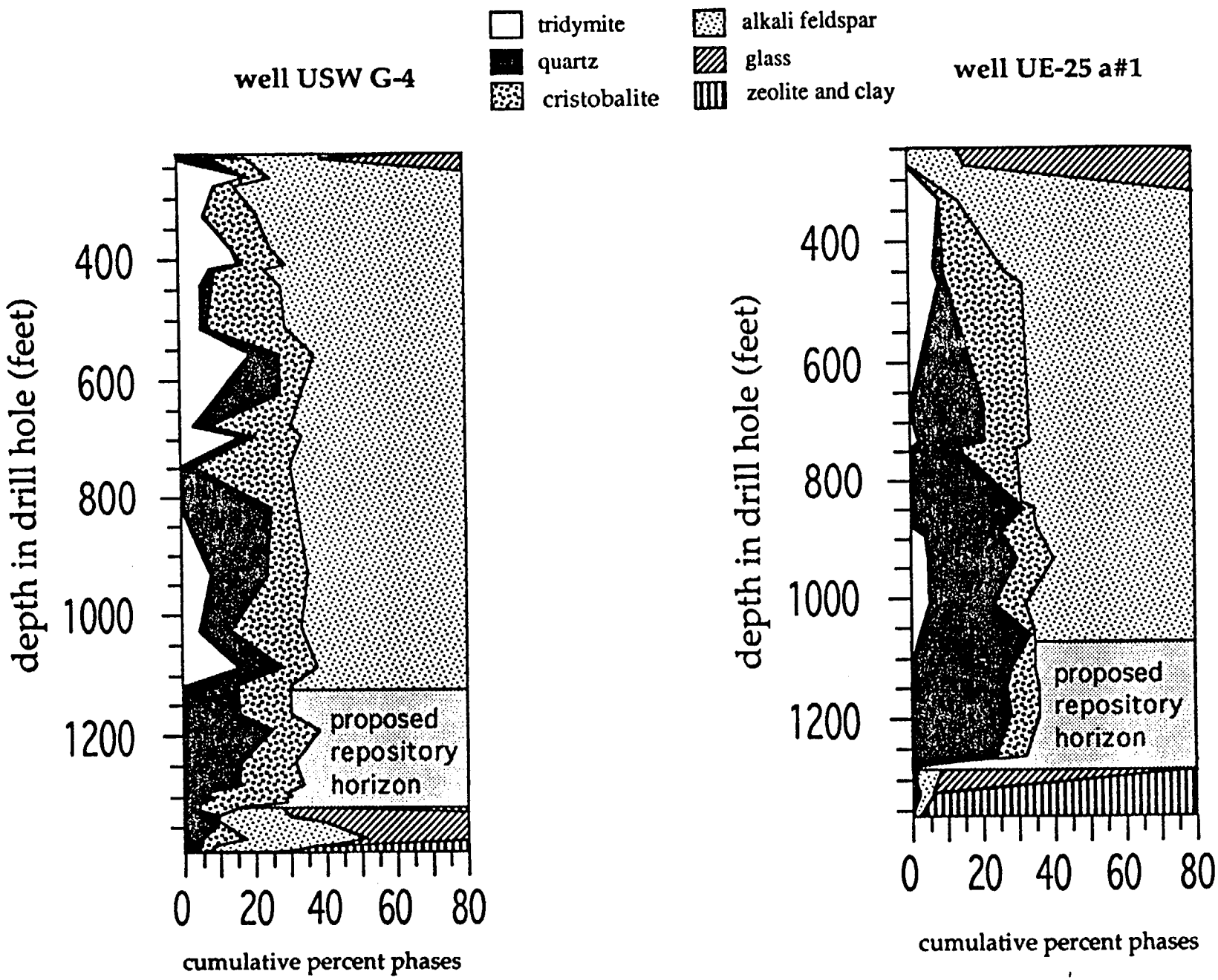


Figure 3.1.3.2.1.1.2-4. Illustration of the cumulative percent phases as determined by quantitative x-ray diffraction with depth in the Topopah Spring Member for: (a) drill hole W G-4 and (b) UE-25 a#1. Data from Bish and Chipera ('89).

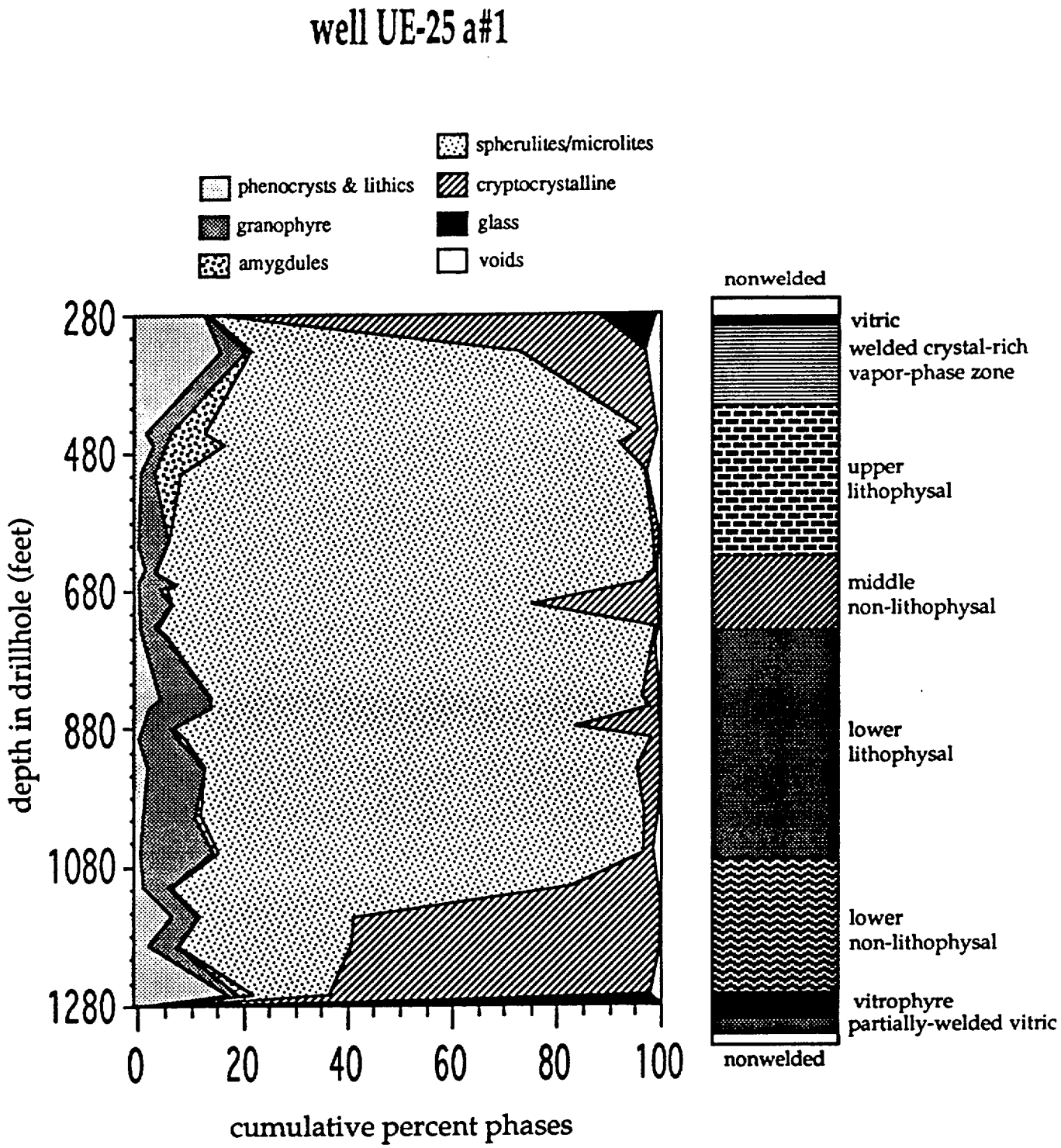


Figure 3.1.3.2.1.1.3-1. Illustration of the cumulative percentage of matrix textures with depth in the Topopah Spring Member compared to macroscopic welding horizons for drill hole UE-25 a#1. Data from Byers and Moore (1987).

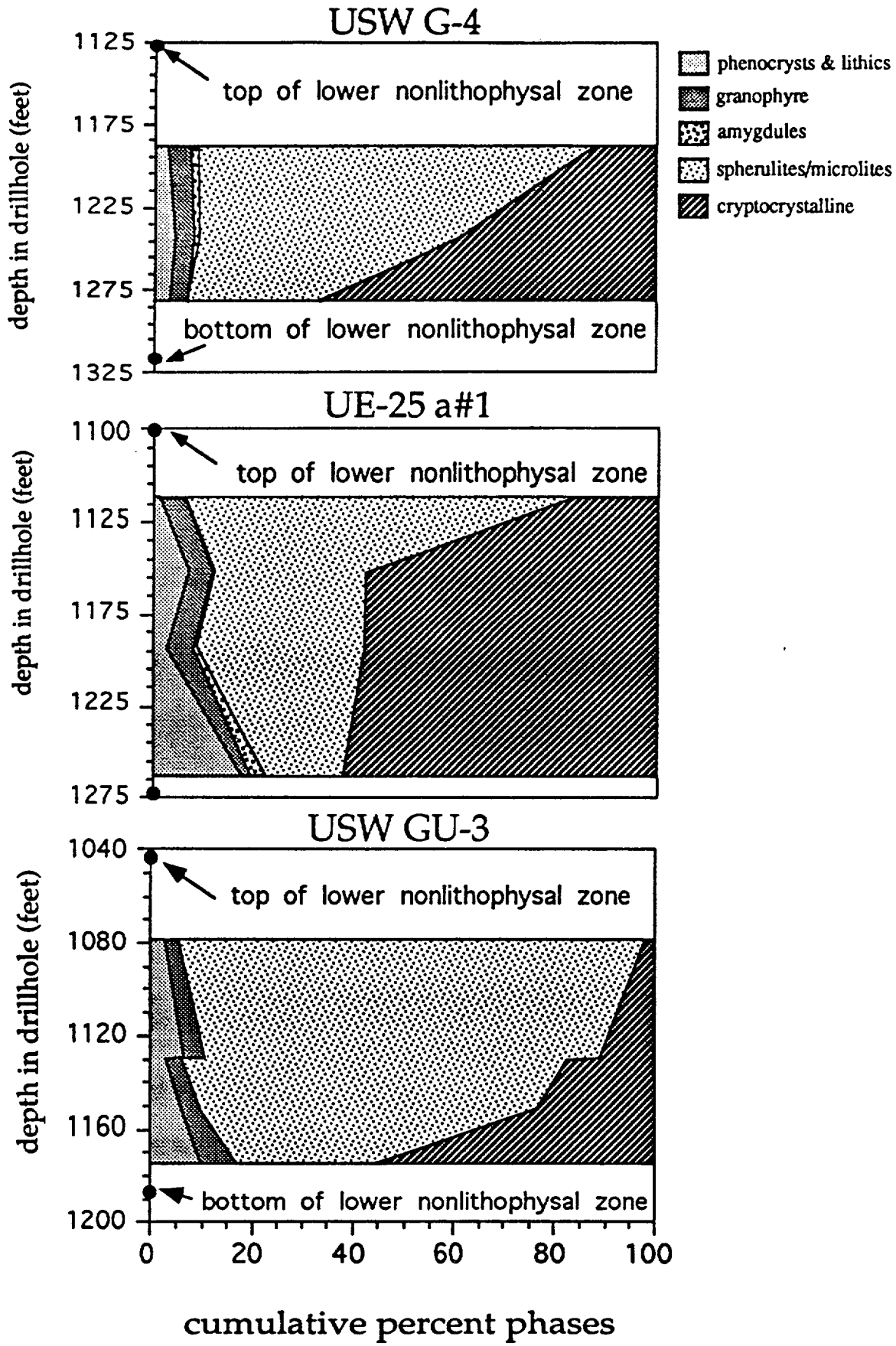


Figure 3.1.3.2.1.1.3-2. Comparison of the matrix textures within the proposed repository horizon for drill holes USW G-4, UE-25 a#1, and USW GU-3. Data from Byers and Moore (1987) and Byers (1985).

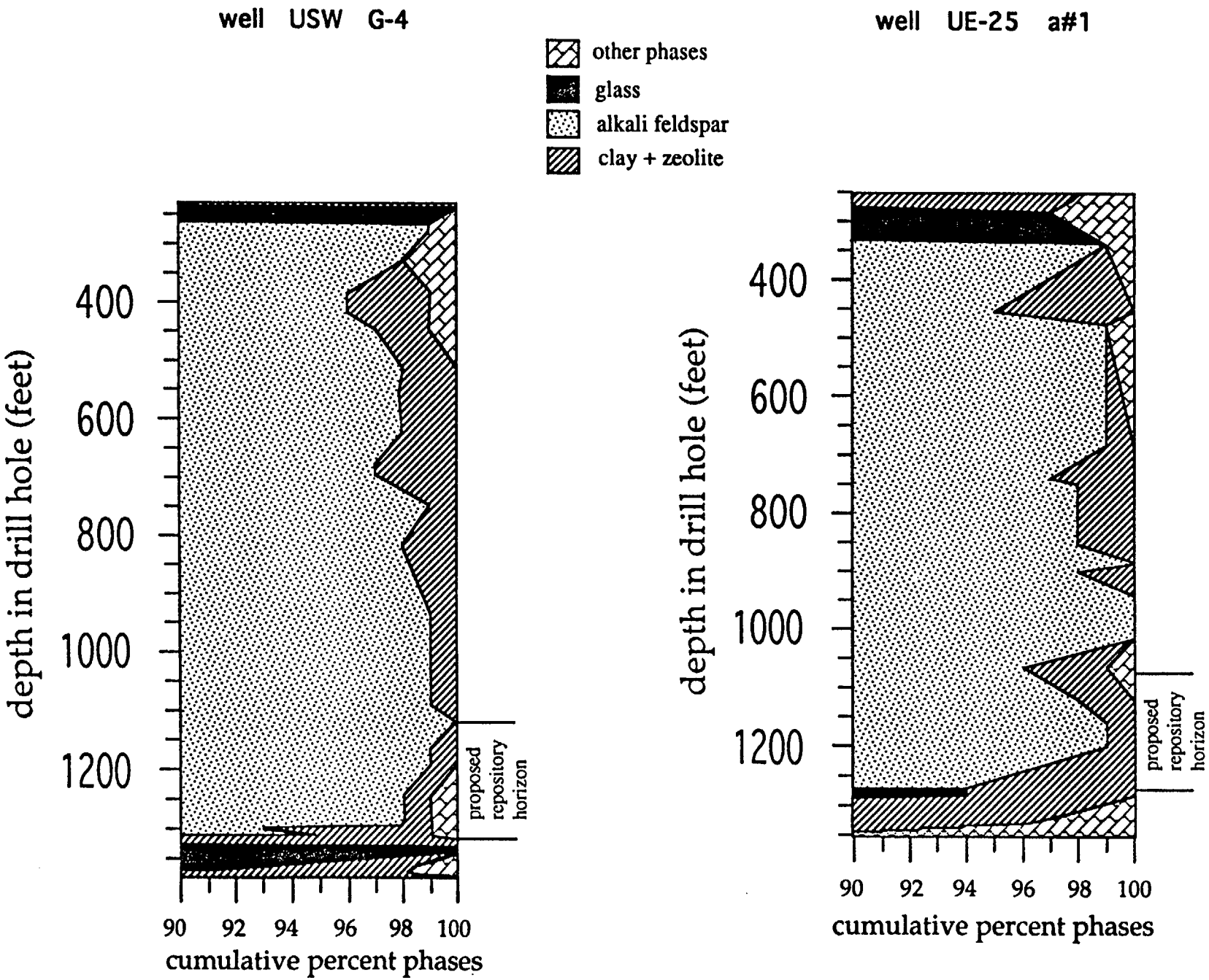
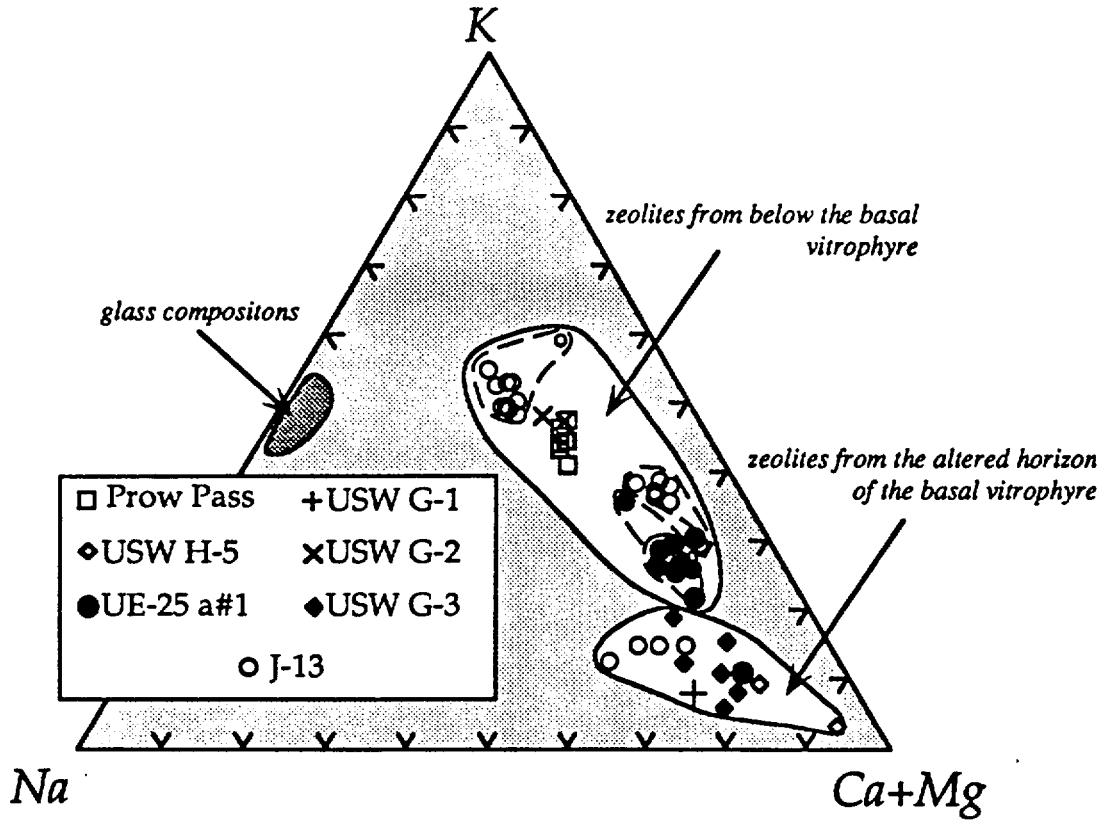


Figure 3.1.3.2.1.1..4-1. These Plots are an Expansion of the Horizontal Scale for Data not Shown in Figure 8 to Better Illustrate the Distribution of Digenetic Phases in the Topopah Spring Member for a) drill hole USW G-4 and b) UE-25 a#1. Data from Bish and Chipera (1989).



CLINOPTILOLITE-FAMILY ZEOLITES FROM THE TOPOPAH SPRING MEMBER

Figure 3.1.3.2.1.1.4-2. Ternary Plot of Exchangeable Cations in Clinoptilolite and Heulandite Zeolites in the Topopah Spring Member.

Figure 3.1.4.1.1-2 Locations of Site Specific Monitoring Sites at Yucca Mountain. [INN 3.1.4.1.1-1]

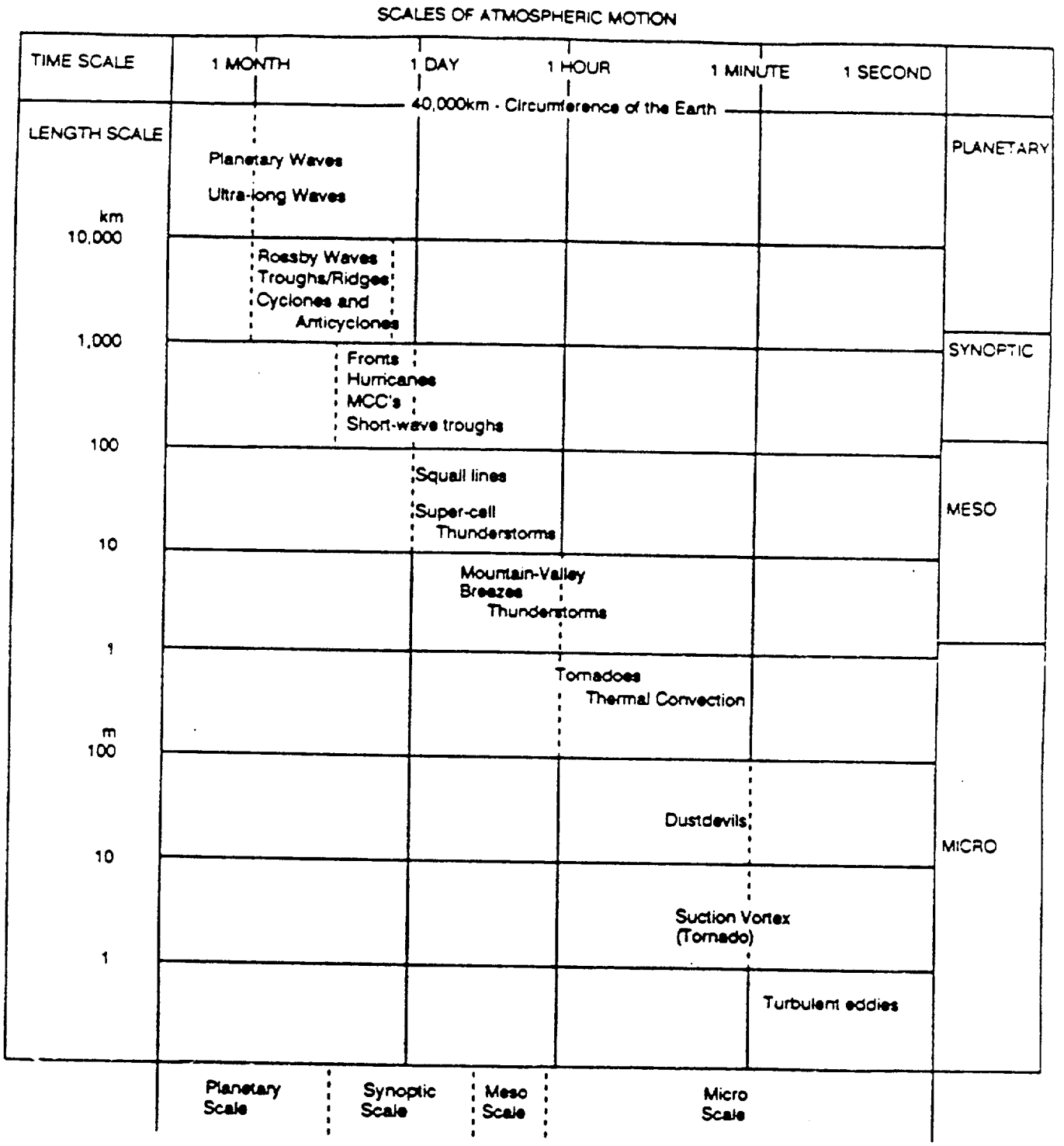


Figure 3.1.4.1.1.1-1. Examples of Atmospheric Motions or "Disturbances" Shown in Context of their Relationship in Space and Time. The time and length scales measure the duration and wavelength of each disturbance respectively. Modified from Hirschboeck, 1987.

Figure 3.1.4.1.1.1.2-1. Average Position of the Polar Front in January. A dashed line indicates the front is not well defined. Air masses are also indicated. (After Gedzelman, 1985) [INN 3.1.4.1.1.1.2-1]

Figure 3.1.4.1.1.1.2-2. Winter Weather Type A. Successive Time-Lapse Positions of the Low-Pressure Cyclone are Shown as the System Develops and Matures. (From Elliott, 1943) [INN 3.1.4.1.1.1.2-2]

Figure 3.1.4.1.1.1.2-3. Winter Weather Type B. Shown are the Successive Time-Lapse Positions of the Low-Pressure System as it Develops. The System Remains Well to the North of the U.S., as High Pressure Dominates the Southwest. (From Elliott, 1943) [INN 3.1.4.1.1.1.2-2]

Figure 3.1.4.1.1.1.2-4. Winter Weather Type C. Shown is the Belt of High Pressure which is Displaced Northwest from its Normal Position. The Low-Pressure Centers Develop in the Gulf of Alaska and off the Coast of San Diego. Then They Move Inland as Depicted in this Time-Lapse Sequence. (from Elliott, 1943) [INN 3.1.4.1.1.1.2-2]

Figure 3.1.4.1.1.1.2-5. Winter Weather Type D. Depicted are Time-Lapse Positions of the Low-Pressure Center as it Tracks Across the Northern U.S. (From Elliott, 1943) [INN 3.1.4.1.1.1.2-2]

Figure 3.1.4.1.1.1.2-6. Winter Weather Type E. The Strong Canadian High-Pressure Ridge is Depicted. This Ridge forces Developing Low-Pressure Systems Southward into the Great Basin. These Pacific Storms cross the Sierra-Nevada, Weaken, then Redevelop on Lee side of the Mountain Range. (From Elliott, 1943) [INN 3.1.4.1.1.1.2-2]

Figure 3.1.4.1.1.1.2-7. Summer Southwest Monsoon. Shown is a lobe of the Bermuda High over the four-corners region. The Resulting Pressure Gradient causes a Gentle Flow of Moisture to begin from the Tropical Eastern Pacific Ocean. The Gulf of Mexico Contributes only an Insignificant Amount of Moisture to the Southwestern U.S. (From Elliott, 1943) [INN 3.1.4.1.1.1.2-3]

Figure 3.1.4.1.1.1.3-1. Dominant Summer and Winter Moisture Sources for the Southern Nevada Area [INN 3.1.4.1.1.1.3-1]

Figure 3.1.4.1.1.1.3-2. Regression Curves Relating Annual Average Precipitation (mm) with Precipitation Gage Elevation (ft). Also included are the data from 42 precipitation stations used to obtain the regression curve by Hevesi [INN 3.1.4.1.1.1.3-3]

Figure 3.1.4.1.1.2.2-1 Precipitation Amounts [INN 3.1.4.1.1.2.2-2]

Figure 3.1.4.1.1.2.4-1 to -n Wind Rose Plot (1 - n) [INN 3.1.4.1.1.2.4-1]

Figure 3.1.4.1.1.2.5.1-1. Seasonal and Annual Wind Distribution at 1.524 m Above Mean Sea Level (328 m Above Ground Level) for Yucca Flat (1957 to 1964). Note: Scale is not the same for all distributions. Based on data from Quiring (1968) [INN 3.1.4.1.1.2.5.1-1]

Figure 3.1.4.1.1.2.5.1-2. Seasonal and Annual Wind Distributions at 1.829 m Above Mean Sea Level (633 m Above Ground Level) for Yucca Flat (1957 to 1964). Note: Scale is not the same for all distributions. Based on data from Quiring (1968) [INN 3.1.4.1.1.2.5.1-2]

Figure 3.1.4.1.1.2.5.1-3 Upper Air Data [INN 3.1.4.1.1.2.5.1-3]

Figure 3.1.4.1.1.2.6-1. Monthly Mean Atmospheric Pressure [INN 3.1.4.1.1.2.6-1]

Figure 3.1.4.1.1.2.6-2. Hourly Mean Atmospheric Pressure [INN 3.1.4.1.1.2.6-1]

Figure 3.1.4.1.1.2.8-1 Patter of Detected Lightening [INN 3.1.4.1.1.2.8-3]

Figure 3.1.4.1.1.2.8-2 Spatial Relationships between Lightening-Strike Data and Rainfall-Runoff Data [INN 3.1.4.1.1.2.8-5]

Figure 3.1.4.1.3-1 Wind Rose Plots [INN 3.1.4.1.3-1]

Figure 3.1.4.1.3-2 Wind Rose Plots [INN 3.1.4.1.3-1]

Figure 3.1.4.1.3-3 Wind Rose Plots [INN 3.1.4.1.3-1]

Figure 3.1.4.1.3-4 Wind Rose Plots [INN 3.1.4.1.3-1]

Figure 3.1.4.1.3-5 Wind Rose Plots [INN 3.1.4.1.3-1]

Figure 3.1.4.1.3-6 Wind Rose Plots [INN 3.1.4.1.3-1]

Figure 3.1.4.1.3-7 Wind Rose Plots [INN 3.1.4.1.3-1]

SKELETON TEXT
Date 11/30/93

INFORMATION NEED FORMS FOR SECTION 3.1

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.1.3.1.2-1**

Section number and Title: **3.1.1.1.3.1.2**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Map sketch of the Walker Lane Belt and associated selected faults and earthquakes

When is the information needed?

Next revision

Information Source: **N/A**

Source Document Description: **N/A**

Document Number: **N/A**

Table and/or Figure Number: **Figure 3.1.1.1.3.1.2-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.1.4.1-1**

Section number and Title: **3.1.1.1.4.1 Regional Seismotectonic Setting**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Seismic Hazard Methodology

When is the information needed?

Next revision

Information Source: **Topical Report**

Source Document Description:

Document Number:

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.1.4.1-2**

Section number and Title: **3.1.1.1.4.1 Regional Seismotectonic Setting**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

A regional map showing the major seismotectonic elements in the western great basin with an overlay of regional seismicity

When is the information needed?

Next revision

Information Source: **Literature**

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure 3.1.1.1.4.1-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.1.4.2.1-1**

Section number and Title: **3.1.1.1.4.2.1 Distribution of Seismicity**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Southern Great Basin Seismic Network Catalog.

When is the information needed?

Information Source: **USGS**

Source Document Description: **Southern Great Basin Seismic Network Catalog**

Document Number:

Table and/or Figure Number: **Table 3.1.1.1.4.2.1-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.4-1**

Section number and Title: **3.1.1.2.4.4 Identification of Seismic Sources**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Table of fault parameters for faults considered to be potential seismic sources for the Yucca Mountain Site

When is the information needed?

Next revision

Information Source:

Source Document Description: **Piety, et al., 1993 (in review)**

Document Number:

Table and/or Figure Number: **Table 3.1.1.2.4.4-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.2.2-1**

Section number and Title: **3.1.1.2.2.2 Pre-Cenozoic Aged Rocks**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Additional information on the stratigraphy and distribution of Pre-Cenozoic aged rocks beneath Yucca Mountain.

When is the information needed?

Information Source:

Source Document Description: **Results from boreholes USW G-5- collected as part of SP 8.3.1.4.2.1.**

Document Number: **TBD**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.2.3-1**

Section number and Title: **3.1.1.2.2.3 Mid-Tertiary Aged Pyroclastic Rocks**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Additional data on the volcanic stratigraphy at Yucca Mountain.

When is the information needed?

Information Source: **Results from Surface and ESF based testing programs (all drilling, field mapping, and geophysical studies.)**

Source Document Description:

Document Number: **TBD**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.2.3-2**

Section number and Title: **3.1.1.2.2.3 Mid-Tertiary Aged Pyroclastic Rocks**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Additional data on the Calico Hills stratigraphic section.

When is the information needed?

Information Source: **Results from boreholes USW G-5, USW G-6, UE-25G#7, and UE-25G#8/WT#19, collected as part of SP 8.3.1.4.2.1.**

Source Document Description:

Document Number: **TBD**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.2.5-1**

Section number and Title: **3.1.1.2.2.5 Surficial Deposits**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Additional data on the Quaternary stratigraphy at Yucca Mountain.

When is the information needed?

Information Source: **Results from SP 8.3.1.17.4.2 and 8.3.1.5.1.2**

Source Document Description:

Document Number: **TBD**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.3.2-1**

Section number and Title: **3.1.1.2.3.2 Quaternary Faulting History**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Maps of Quaternary faults (site and regional scale).

Figure -1: A preliminary map of known and suspected quaternary faults within 100 km of Yucca Mountain

Figure -2: A preliminary map of known and suspected quaternary faults in the vicinity of Yucca Mountain

When is the information needed?

Next revision

Information Source: **USGS**

Source Document Description: **U.S Geological Survey Open-file reports (L.W. Anderson and others; W.F. Simonds and J.W. Whitney)**

Document Number:

Table and/or Figure Number: **Figure 3.1.1.2.3.2-1**
Figure 3.1.1.2.3.2-2

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.1-1**

Section number and Title: **3.1.1.2.4.1 Local Site Seismicity**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Data from the UNR Northern Nevada and Southern Great Basin networks; Map of quaternary faults (unpublished).

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure 3.1.1.2.4.1-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.2.1-1**

Section number and Title: **3.1.1.2.4.2.1 Ground Motion Model Introduction**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Detailed map of the Ghost Dance fault

When is the information needed? **TBD**

Information Source:

USGS open-file report

Source Document Description: **TBD**

Document Number:

Table and/or Figure Number: **TBD**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.2.2-1**

Section number and Title: **3.1.1.2.4.2.2 Characteristics of Ground Motions at Yucca Mountain**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Location of seismic recording stations of the Southern Great Basin Seismic Network. Source : Sheehan et al.(1993)

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure Number 3.1.1.2.4.2.2-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.2.2-2**

Section number and Title: **3.1.1.2.4.2.2 Characteristics of Ground Motions at Yucca Mountain**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Stations recording the Little Skull Mountain earthquake of 29 June, 1992 in southern Nevada. Source : URS/Blume & Associates (1992)

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure 3.1.1.2.4.2.2-2**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.2.2-3**

Section number and Title: **3.1.1.2.4.2.2 Characteristics of Ground Motions at Yucca Mountain**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Attenuation of peak acceleration and peak velocity of the Little Skull Mountain, Nevada earthquake of 29 June, 1992 in southern Nevada compared with the average of the estimates derived from Joyner and Boore(1988) and Campbell (1990). Source: URS/Blume & Associates (1992)

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure 3.1.1.2.4.2.2-3**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.2.2-4**

Section number and Title: **3.1.1.2.4.2.2 Characteristics of Ground Motions at Yucca Mountain**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Locations of the Little Skull Mountain earthquake, the Rock Valley earthquake, and the recording station at Midway Valley. Source: Sheehan et al.(1993)

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure 3.1.1.2.4.2.2-5**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.2.2-5**

Section number and Title: **3.1.1.2.4.2.2 Characteristics of Ground Motions at Yucca Mountain**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Velocity seismograms of the Eureka Valley aftershock of June 3, 1993 (magnitude 3.9, depth 5.9 km). Source Sheehan et al. (1993)

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure Number 3.1.1.2.4.2.2-7**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.2.2-6**

Section number and Title: **3.1.1.2.4.2.2 Characteristics of Ground Motions at Yucca Mountain**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Velocity seismograms of the Eureka Valley aftershock of June 8, 1993 (magnitude 4.0, depth 1.7 km). Source: Sheehan et al. (1993)

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure Number 3.1.1.2.4.2.2-8**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.2.2-7**

Section number and Title: **3.1.1.2.4.2.2 Characteristics of Ground Motions at Yucca Mountain**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Location map showing Nevada Test Site, Yucca Mountain seismic stations(open squares), explosion locations (solid symbols), and velocity profiles PM1, PM2 and YF1. Also denoted are the Timber Mountain Caldera and the Silent Canyon Caldera (SCC). Areas 19 and 20 comprise Pahute Mesa. Source : Walck and Phillips (1990).

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure Number 3.1.1.2.4.2.2-9**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.2.2-8**

Section number and Title: **3.1.1.2.4.2.2 Characteristics of Ground Motions at Yucca Mountain**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Ratios of measured PSRV at Station W-14 to average values for NTS sites. Source: Phillips(1991).

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure 3.1.1.2.4.2.2-11**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.2.2-9**

Section number and Title: **3.1.1.2.4.2.2 Characteristics of Ground Motions at Yucca Mountain**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Ratios of measured PSRV at Station W-23 to average values for NTS sites. Source: Phillips (1991).

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure 3.1.1.2.4.2.2-12**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.2.2-10**

Section number and Title: **3.1.1.2.4.2.2 Characteristics of Ground Motions at Yucca Mountain**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Ratios of measure PSRV at Station W-22 to average values for NTS sites. Source : Phillips (1991)

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure 3.1.1.2.4.2.2-13**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.2.2-11**

Section number and Title: **3.1.1.2.4.2.2 Characteristics of Ground Motions at Yucca Mountain**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Ratios of measured PSRV at Station W-21 to average values for NTS sites. Source: Phillips (1991).

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure Number 3.1.1.2.4.2.2-14**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.2.2-12**

Section number and Title: **3.1.1.2.4.2.2 Characteristics of Ground Motions at Yucca Mountain**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Location map of strong motion stations that recorded the Piokin nuclear explosion at Pahute Mesa. Source: Weetman et al. (1970)

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure 3.1.1.2.4.2.2-15**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.2.2-13**

Section number and Title: **3.1.1.2.4.2.2 Characteristics of Ground Motions at Yucca Mountain**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Profile of radial velocity time histories of the Pipkin nuclear explosion at Pahute Mesa recorded to the south at stations shown in Figure 3.1.1.2.4.2.2-15. Source: Weetman et al.(1970)

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure 3.1.1.2.4.2.2-16**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.3.4-1**

Section number and Title: **3.1.1.2.4.2.2 Characteristics of Site Responses at Yucca Mountain**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Seismograms recorded in a downhole array at Jackass Flats (Station 10, Well J-11) from a nuclear explosion at Pahute Mesa . Top row: acceleration; middle row: velocity; bottom row: displacement. Left column: surface station on alluvium; middle column: -61 meters near the base of alluvium; right column: -356 meters in tuff. Source: Vortman and Long (1982).

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure 3.1.1.2.4.3.4-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.4.3.4-2**

Section number and Title: **3.1.1.2.4.3.4 Characteristics of Site Responses at Yucca Mountain**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Location map of downhole ground motion recording stations at Yucca Mountain and regional topography. Source : Phillips (1991)

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Figure 3.1.1.2.4.3.4-2**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.1.1-1**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Information about the spatial location of the various units of the thermomechanical stratigraphy in and in the vicinity of the repository block.

Elevations of the contacts between the various units of the thermomechanical stratigraphy. The spacing between the holes should preferably be in the range of one-half to three-quarters of a mile. Additional drilling may be necessary depending on the variability of the data encountered.

When is the information needed?

Information on the TMS with intermediate spacing between drillholes is needed before the advanced conceptual design of the repository.

Information about the TMS with appropriate spacing between drillholes is needed before the License Application Design of the repository.

Information Source: **Study Plan**

Source Document Description:

Holes to be drilled under the Systematic Drilling Program (Study Plan 8.3.1.4.3.1) will provide majority of the information for the TMS. Additional information will come from drilling under the study "Characterization of Percolation in the Unsaturated Zone-surface-based studies" (8.3.1.2.2.3) and the NRG and SRG holes in Study Plan 8.3.1.14.2.

Document Number: **8.3.1.4.3.1, 8.3.1.2.2.3, 8.3.1.14.2**

Table and/or Figure Number: **Figure 3.1.1.2.7.1.1-1**
Table 3.1.1.2.7.1.1-1
Figure 3.1.1.2.7.1-1

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.3.1-1**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Data to verify whether measurements of elastic properties of the thermomechanical units, especially the emplacement unit, made under conditions of zero confining pressure, room temperature(23° C) and full saturation (baseline conditions) are applicable to the values of these properties for in situ conditions.

Results of tests in which the elastic properties are measured on comparable samples of the thermomechanical units under the baseline conditions as well as under the expected state of these conditions in situ. If the results show that measurements made under baseline conditions are not applicable to values of these properties under expected conditions, additional testing under the expected conditions may have to be performed.

When is the information needed?

Information Source: **Study Plan**

Source Document Description: **Study Plan for the laboratory determination of the mechanical properties of intact rock.**

Document Number: **8.3.1.15.1.3**

Table and/or Figure Number: **Table 3.1.1.2.7.3.1-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.3.1-2**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Sufficient test results on the measurement of Young's Modulus and Poisson's Ratio of the various thermomechanical units to adequately characterize these properties of the repository block.

When is the information needed?

Information Source: **Study Plan**

Source Document Description: **Study Plan for laboratory determination of the properties of intact rock.**

Document Number: **8.3.1.15.1.3**

Table and/or Figure Number: **Table 3.1.1.2.7.3.1-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.3.1-3**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Sufficient test results to determine the anistropy of elastic properties of the various thermomechanical units including values of Young's Modulus and Poisson's Ratio measured perpendicular and parallel to the rock fabric.

When is the information needed?

Information Source: **Study Plan**

Source Document Description: **Study plan for the laboratory determination of the mechanical properties of intact rock.**

Document Number: **8.3.1.15.1.3**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.3.2-1**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Unconfined compressive strength of the various units of the thermomechanical stratigraphy.

Sufficient test results on the unconfined compressive strength of the TSw2 unit of the thermomechanical stratigraphy so as to adequately characterize the spatial variability, if any, of the strength of this unit within the zone of interest in the repository block.

When is the information needed?

Information Source: **Study Plan**

Source Document Description: **Study plan for the laboratory determination of the mechanical properties of intact rock.**

Document Number: **8.3.1.15.1.3**

Table and/or Figure Number: **Table 3.1.1.2.7.3.1-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.3.2-2**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Test results on the unconfined compressive tests of various units of the thermomechanical stratigraphy under as close to the in situ moisture content as possible.

Values of unconfined compressive strength.

When is the information needed?

Information Source: **Study Plan**

Source Document Description: **Study plan on the laboratory determination of the mechanical properties of intact rock.**

Document Number: **8.3.1.15.1.3**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.3.2-3**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Effect of elevated temperatures on the strength of various units of the thermomechanical stratigraphy.

Values of unconfined compressive strengths at elevated temperatures.

When is the information needed?

Information Source: **Study Plan**

Source Document Description: **Study plan on the laboratory determination of the mechanical properties of intact rock.**

Document Number: **8.3.1.15.1.3**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.3.2-4**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Test results to evaluate the strength anistropy of TSw2. Values of compressive strength of TSw2 measured both perpendicular and parallel to the rock fabric.

When is the information needed?

Before advanced conceptual design of the repository.

Information Source: **Study Plan**

Source Document Description: **Study plan on the laboratory determination of the mechanical properties of intact rock.**

Document Number: **8.3.1.15.1.3**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.3.2-5**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Geological maps of the ESF exposures showing the locations, if any, of zones of high lithophysae content in the TSw2. Information is needed to verify whether there are zones of high lithophysae content within the proposed emplacement zone of TSw2.

When is the information needed?

For advanced conceptual design of the repository

Information Source: **Study Plan**

Source Document Description: **Activity of geologic mapping of the exploratory studies facilities under Study Plan number 8.3.1.4.2.2**

Document Number: **8.3.1.4.2.2**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.3.2-6**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Test results that show the effect of lithophysae content on the mechanical properties of the Topopah Spring tuff.

When is the information needed?

For advanced conceptual design.

Information Source: **Study Plan**

Source Document Description: **Study plan on the laboratory determination of the mechanical properties of intact rock.**

Document Number: **8.3.1.15.1.3**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.3.3-1**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Information on the tensile strength of the various units of the thermomechanical stratigraphy.

When is the information needed?

For license application design.

Information Source: **Study Plan**

Source Document Description: **Study plan on the laboratory determination of the mechanical properties of intact rock.**

Document Number: **8.3.1.15.1.3**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.3.4-1**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Triaxial tests on various units of the thermomechanical stratigraphy, especially TSw2 and CHn. Specifically, values of cohesion and angle of internal friction at various confining pressures and temperatures.

When is the information needed?

Information Source: **Study Plan**

Source Document Description: **Study plan on the laboratory determination of the mechanical properties of intact rock**

Document Number: **8.3.1.15.1.3**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.3.5-1**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Long-term time-dependent deformational behavior of TSw2 at elevated temperatures expected in emplacement areas during the preclosure period. Specifically, values for steady state creep strain rate at various temperatures.

When is the information needed?

For advanced conceptual design of the repository.

Information Source: **Study Plan**

Source Document Description: **Study plan for laboratory determination of the mechanical properties of intact rock.**

Document Number: **8.3.1.15.1.3**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.4.1-1**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Test results to evaluate the effect of normal stress level on the coefficient of friction of natural joints. Specifically, measured values of coefficient of friction at various levels of normal stress.

When is the information needed?

For the advanced conceptual design of the repository.

Information Source: **Study Plan**

Source Document Description: **Study plan on the laboratory determination of the mechanical properties of fractures.**

Document Number: **8.3.1.15.1.4**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.4.2-1**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Information on the effect of infilling materials on the mechanical properties of joints. Specifically, results of tests in which natural joints with various types of infilling material are tested for their mechanical properties.

When is the information needed?

For advanced conceptual design of the repository.

Information Source: **Study Plan**

Source Document Description: **Study plan on the laboratory determination of the mechanical properties of fractures.**

Document Number: **8.3.1.15.1.4**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.4.3-1**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

a) Test results to show the differences, if any, of the mechanical properties of healed and unhealed natural joints

b) Test results to show the effects, if any, of various test conditions such saturation level, temperature, etc., on the mechanical properties of natural joints.

The measured values of joint properties under various test conditions from these tests are needed.

When is the information needed?

For the advanced conceptual design.

Information Source: **Study Plan**

Source Document Description: **Study plan on the laboratory determination of the mechanical properties of fractures.**

Document Number: **8.3.1.15.1.4**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.4.5-1**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Test results on the effect of short-term time-dependent factors on the mechanical properties of joints. Specifically, values of mechanical properties parameters under various displacement rates etc.

When is the information needed?

For advanced conceptual design of the repository.

Information Source: **Study Plans**

Source Document Description: **Study plan on the laboratory determination of the mechanical properties of fractures.**

Document Number: **8.3.1.15.1.4**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.1.2.7.4.6-1**

Section number and Title: **3.1.1.2.7 Geoengineering**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Test results showing the long-term time-dependent properties of joints at elevated temperatures expected during the preclosure period. Specifically, values of long-term displacement rates at constant normal and shear stresses.

When is the information needed?

For the advanced conceptual design of the repository.

Information Source: **Study Plan**

Source Document Description: **Study plan on the laboratory determination of the mechanical properties of joints.**

Document Number: **8.3.1.15.1.4**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.2.1.1-1**

Section number and Title: **3.1.2.1.1 Description of Surface-Water Bodies and Physical Characteristics of Drainage Areas**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Surface water monitoring data such as flow duration data that indicate maximum, minimum and average historical observations of surface water bodies, water quality data, snow pillow and precipitation data that is currently being recorded at all recording stations.

When is the information needed?

Information Source: **Study Plan**

Source Document Description: **Characterization of Streamflow and Runoff.**

Document Number: **8.3.1.2.1.2**

Table and/or Figure Number: **Table 3.1.2.1.4-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.2.1.1-2**

Section number and Title: **3.1.2.1.1 Description of Surface-Water Bodies and Physical Characteristics of Drainage Areas**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Provide information on the characteristics of playas including location, discharge and chemical quality of water.

When is the information needed?

Information Source: **Study Plan**

Source Document Description: **Study Plan Activity 8.3.1.2.1.3.4, Evapotranspiration Studies**

Document Number: **8.3.1.2.1.3**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.2.1.1-3**

Section number and Title: **3.1.2.1.1 Description of Surface-Water Bodies and Physical Characteristics of Drainage Areas**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Figure showing the location of all surface water bodies in the Yucca Mountain region including springs and major playas.

When is the information needed?

Information Source: **EG&G**

Source Document Description: **Source documents have been provided to EG&G.**

Document Number:

Table and/or Figure Number: **Figure 3.1.2.1.1-3**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.2.1.1-4**

Section number and Title: **3.1.2.1.1 Description of Surface-Water Bodies and Physical Characteristics of Drainage Areas**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Update of phreatophyte data in Table 3.1.2.1.1-3

When is the information needed? **Next Revision?**

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number: **Table 3.1.2.1.1-3**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.2.1.4-1**

Section number and Title: **3.1.2.1.4 Flood History**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

More geologic evidence of Quaternary flooding in the region of Yucca Mountain with emphasis on the Holocene may be developed during site characterization studies.

When is the information needed?

Information Source: **Study Plan**

Source Document Description: **Characterization of the Quaternary Regional Hydrology**

Document Number: **8.3.1.5.2.1**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.2.1.5-1**

Section number and Title: **3.1.2.1.5 Flood Potential**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Additional flooding study results.

When is the information needed?

Information Source: **Study Plan**

Source Document Description: **Characterization of Flood Potential of the Yucca Mountain Site**

Document Number: **8.3.1.16.1.1**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.2.1.5-2**

Section number and Title: **3.1.2.1.5 Flood Potential**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Design basis water levels and elevations of all surface facilities and underground openings may be available, but could not be collected for this revision. These design basis water levels and elevations and locations of all surface facilities and underground openings may change during advanced conceptual design.

When is the information needed?

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.2.1.5-3**

Section number and Title: **3.1.2.1.5 Flood Potential**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

A review and reference of two T&MSS floodplain assessments, "Floodplain Assessment of Surface-Based Investigations at the Yucca Mountain Site, Nye County, Nevada" dated 8/91 and "Floodplain Assessment of Site Characterization Activities at the Yucca Mountain Site, Nye County, Nevada" dated 8/92

When is the information needed? **Next Revision**

Information Source: **See description above**

Source Document Description:

Document Number:

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.2.2.2-1**

Section number and Title: **3.1.2.2.2 Potentiometric levels and hydraulic gradient**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Summary of selected wells monitored for water levels at Yucca Mountain

When is the information needed?

Next revision

Information Source: **Literature**

Source Document Description:

Document Number:

Table and/or Figure Number: **Table 3.1.2.2.2-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.2.2.3-1**

Section number and Title: **3.1.2.2.2.3 Characteristics of Hydrogeologic Units**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Hydraulic properties for the Lower Carbonate Aquifer

When is the information needed?

Information Source: **USGS**

Source Document Description:

Document Number:

Table and/or Figure Number: **Table 3.1.2.2.3-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.2.2.3-2**

Section number and Title: **3.1.2.2.3 Characteristics of hydrogeologic units**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Pumping response data for the welded tuff aquifer

When is the information needed?

Information Source: **USGS**

Source Document Description:

Document Number:

Table and/or Figure Number: **Table 3.1.2.2.3-2**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.2.2.3-3**

Section number and Title: **3.1.2.2.3 Characteristics of hydrogeologic units**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Results of interference tests at the C-well complex in 1983-1984

When is the information needed?

Information Source: **USGS**

Source Document Description:

Document Number:

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.2.2.3-4**

Section number and Title: **3.1.2.2.3 Characteristics of hydrogeologic units**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Analyses using the finite-conductivity, vertical fracture model

When is the information needed?

Information Source: **USGS**

Source Document Description:

Document Number:

Table and/or Figure Number: **Table 3.1.2.2.3-3**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.2.2.8-1**

Section number and Title: **3.1.2.2.8 Regional Ground-Water Use**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Update of water appropriations data used in tables

When is the information needed? **Next Revision**

Information Source:

Source Document Description:

Document Number:

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.3.2.1-1**

Section number and Title: **3.1.3.2.1-1 Geochemistry of the Site Rock**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Analyses of samples from additional bore holes and the ESF, Mineralogy, petrology, and chemistry of the Topopah Spring Member

When is the information needed? **TBD**

Information Source:

Source Document Description: **Los Alamos technical reports**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN-3.1.3.2.1.1.-1**

Section number and Title: **3.1.3.2.1.1 Geochemistry of the Topopah Spring Member**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Hydrothermal alteration of the Topopah Spring Member

When is the information needed? **TBD**

Information Source:

Results of Study Plan 8.3.1.3.2.2 (History of mineralogic and geochemical alteration at Yucca Mountain)

Source Document Description: **Los Alamos Technical reports**

Document Number:

Table and/or Figure Number: **NA**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1-1**

Section number and Title: **3.1.4.1.1 Climate**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Locations of the regional and site-specific meteorological monitoring stations

When is the information needed?

Information Source: **Results of:**

Study Plan 8.3.1.2.1.1 (Characterization of Meteorology for Regional Hydrology)
Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at Yucca Mountain)

Source Document Description: **Regional and site-specific station locations**

Document Number: **TBD**

Table and/or Figure Number: **Figure 3.1.4.1.1-1**
Figure 3.1.4.1.1-2

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.-2**

Section number and Title: **3.1.4.1.1 Climate**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

List of parameters measured at the regional and site-specific meteorological monitoring stations.

When is the information needed?

Information Source: **Results of:**

Study Plan 8.3.1.2.1.1 (Characterization of Meteorology for Regional Hydrology)
Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **Table 3.1.4.1.1-1**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.1-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.1.2-1**

Section number and Title: **3.1.4.1.1.1.2 Large-Scale Atmospheric Features**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Average position of the polar front in January.

When is the information needed?

Information Source: **TBD**

Source Document Description: **Average position of the polar front in January.**

Document Number: **TBD**

Table and/or Figure Number: **Figure 3.1.4.1.1.1.2-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.1.2-2**

Section number and Title: **3.1.4.1.1.1.2 Large-Scale Atmospheric Features**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Time-lapse movements of winter storms systems.

When is the information needed?

Information Source: **TBD**

Source Document Description: **Time-lapse movements of winter storms systems.**

Document Number: **TBD**

Table and/or Figure Number: **Figure 3.1.4.1.1.1.2-2 through 3.1.4.1.1.1.2-6**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.1.2-3**

Section number and Title: **3.1.4.1.1.1.2 Large-Scale Atmospheric Features**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Summer southwest monsoon.

When is the information needed?

Information Source: **TBD**

Source Document Description: **Summer southwest monsoon.**

Document Number: **TBD**

Table and/or Figure Number: **Figure 3.1.4.1.1.1.2.7 Summer southwest monsoon showing a lobe of the Bermuda high over the four corners region.**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.1.3-1**

Section number and Title: **3.1.4.1.1.1.3 Mesoscale Atmospheric Features**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Dominant summer and winter moisture sources for the southern Nevada area.

When is the information needed?

Information Source: **TBD**

Source Document Description: **Figure dominant summer and winter moisture sources for the southern Nevada area.**

Document Number: **TBD**

Table and/or Figure Number: **Figure 3.1.4.1.1.1.3-1 Dominant summer and winter moisture for the southern Nevada area.**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.1.3-2**

Section number and Title: **3.1.4.1.1.1.3 Mesoscale Atmospheric Features**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Effect of varying air flow regime on the Yucca Mountain site.

When is the information needed?

Information Source: **TBD**

Source Document Description: **Effect of varying air flow regime on the Yucca Mountain site.**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.1.3-3**

Section number and Title: **3.1.4.1.1.1.3 Mesoscale Atmospheric Features**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Plot of average annual precipitation as a function of station elevation.

When is the information needed?

Information Source: **TBD**

Source Document Description: **Figure showing a plot of average annual precipitation as a function of station elevation.**

Document Number: **TBD**

Table and/or Figure Number: **Figure 3.1.4.1.1.1.3-2**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.1-1**

Section number and Title: **3.1.4.1..1.2.1 Temperature**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Summary data on temperature from site and regional monitoring sites.

When is the information needed?

Information Source: **TBD**

Source Document Description: **Table: summary data on temperature from site and regional monitoring sites.**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.1.2.1-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.2-1**

Section number and Title: **3.1.4.1.1.2.2 Precipitation**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Precipitation data.

When is the information needed?

Information Source: **Results of:**

Study Plan 8.3.1.2.1.1 (Characterization of Meteorology for Regional Hydrology)
Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **Parameter precipitation data.**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.1.2.2-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.2-2**

Section number and Title: **3.1.4.1.1.2.2 Precipitation**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Precipitation amounts for each month, based on average data from Table 3.1.4.1.1.2.2-1.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **Table: precipitation amounts for each month, based on average data from Table 3.1.4.1.1.2.2-1.**

Document Number: **TBD**

Table and/or Figure Number: **Figure 3.1.4.1.1.2.2-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.3-1**

Section number and Title: **3.1.4.1.1.2.3 Atmospheric Moisture**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Relative humidity.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **Table: relative humidity.**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.1.2.3-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.3-2**

Section number and Title: **3.1.4.1.1.2.3 Atmospheric Moisture**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Wet bulb depression data.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **Table: wet bulb depression data.**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.1.2.3-2**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.4-1**

Section number and Title: **3.1.4.1.1.2.4 Wind Speed and Direction**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Surface wind data.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **Figure: surface wind data (wind rose plots).**

Document Number: **TBD**

Table and/or Figure Number: **Figures 3.1.4.1.1.2.4-1 through 3.1.4.1.1.2.4-n**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.4-2**

Section number and Title: **3.1.4.1.1.2.4 Wind Speed and Direction**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Wind roses with date split for daytime versus nighttime wind frequencies.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **Figure wind roses with date split for daytime versus nighttime wind frequencies with data plotted on terrain maps.**

Document Number: **TBD**

Table and/or Figure Number: **Figures 3.1.4.1.1.2.4-1 through 3.1.4.1.1.2.4-n**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.5.1-1**

Section number and Title: **3.1.4.1.1.2.5.1 Winds**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Wind speed and directions at 1524 m above mean sea level.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **Table and figure wind speed and directions at 1524 m above mean sea level.**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.1.2.5.1-1 and Figure 3.1.4.1.1.2.5.1-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.5.1-2**

Section number and Title: **3.1.4.1.1.2.5.1 Winds**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Wind speed and directions at 1829 m above mean sea level.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **Table and figure wind speed and directions at 1829 m above mean sea level.**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.1.2.5.1-2 and Figure 3.1.4.1.2.5.1-2**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.5.1-3**

Section number and Title: **3.1.4.1.1.2.5.1 Winds**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Data from upper air winds.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **Table and figure data from upper air winds.**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.1.2.5.1-3 and Figure 3.1.4.1.2.5.1-3**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.5.1-4**

Section number and Title: **3.1.4.1.1.2.5.1 Winds**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Comparison of Desert Rock data with historical Yucca Flat upper air data.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **Upper air data.**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.5.2-1**

Section number and Title: **3.1.4.1.1.2.5.2 Mixing Heights**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Average morning and afternoon mixing height.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **See average morning and afternoon mixing height**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.6-1**

Section number and Title: **3.1.4.1.1.2.6 Atmospheric Pressure**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Standard atmospheric pressure.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **See standard atmospheric pressure.**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.1.2.6-1, Figure 3.1.4.1.1.2.6-1 and Figure 3.1.4.1.1.2.6-2**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.7-1**

Section number and Title: **3.1.4.1.1.2.7 Insolation (Sunshine)**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Monthly and average insolation.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **See monthly and average insolation.**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.1.2.7-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.8-1**

Section number and Title: **3.1.4.1.1.2.8 Severe Weather and Obstruction to Visibility**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Evidence of tornadic weather.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **See evidence of tornadic weather.**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.8-2**

Section number and Title: **3.1.4.1.1.2.8 Severe Weather and Obstruction to Visibility**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Evidence of dust devil activity.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **See evidence of dust devil activity.**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.8-3**

Section number and Title: **3.1.4.1.1.2.8 Severe Weather and Obstruction to Visibility**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Pattern of detected lightning.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **See pattern of detected lightning.**

Document Number: **TBD**

Table and/or Figure Number: **Figure 3.1.4.1.1.2.8-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.8-4**

Section number and Title: **3.1.4.1.1.2.8 Severe Weather and Obstruction to Visibility**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Lightning data.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **See lightning data.**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.8-5**

Section number and Title: **3.1.4.1.1.2.8 Severe Weather and Obstruction to Visibility**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Lightning strike Data. Rainfall-runoff data.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **See lightning strike data and rainfall-runoff data.**

Document Number: **TBD**

Table and/or Figure Number: **Figure 3.1.4.1.1.2.8-2. Spatial relationships between lightning-strike data and rainfall-runoff data.**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.8-6**

Section number and Title: **3.1.4.1.1.2.8 Severe Weather and Obstruction to Visibility**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Frequency of occurrence of hail.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **See frequency of occurrence of hail.**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.1.2.8-1. Frequency of occurrence of hail.**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.8-7**

Section number and Title: **3.1.4.1.1.2.8 Severe Weather and Obstruction to Visibility**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Frequency of occurrence of fog and sandstorms.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **See frequency of occurrence of fog and sandstorms.**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.1.2.8-2. Frequency of occurrence of fog and sandstorms.**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.9-1**

Section number and Title: **3.1.4.1.1.2.9 Extremes**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Extreme wind speeds and probability of occurrence.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **Table extreme wind speeds and probability of occurrence.**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.1.2.9-1. Extreme wind speeds and probability of occurrence for the NTS.**
Table 3.1.4.1.1.2.9-2. Extreme wind speeds and probability of occurrence for Yucca Mountain.
Table 3.1.4.1.1.2.9-3 Historical Peak Wind Gusts Data for Yucca Flat, Nevada

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.9-2**

Section number and Title: **3.1.4.1.1.2.9 Extremes**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Probability of occurrence of extreme temperatures.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **Table probability of occurrence of extreme temperatures.**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.1.2.9-4. Probability of occurrence of extreme temperature.**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.1.2.9-3**

Section number and Title: **3.1.4.1.1.2.9 Extremes**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

1- and 24 hour maximum precipitation and probability of occurrence.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **Table 1 and 24-hour maximum precipitation and probability of occurrence.**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.1.2.9-5. Probability of occurrence of 1 and 24-hour maximum precipitation.**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.2-1**

Section number and Title: **3.1.4.1.2 Meteorological Monitoring Network**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Location map of the Yucca Mountain site showing monitoring sites.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: **Composite USGS/SAIC maps of the Yucca Mountain site showing monitoring sites.**

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.2.-1**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.3-1**

Section number and Title: **3.1.4.1.3 Site Meteorology**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Wind roses for each stability class.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site)

Source Document Description: Figures wind roses for each stability class.

Document Number: **TBD**

Table and/or Figure Number: **Figures 3.1.4.1.3-1 through 3.1.4.1.3.7**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date: 11/30/93

Log Number: **INN 3.1.4.1.3-2**

Section number and Title: **3.1.4.1.3 Site Meteorology**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Stability Class Distributions

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.12.2.1 (Meteorological data collection at the Yucca Mountain site.)

Source Document Description:

Document Number: **TBD**

Table and/or Figure Number: **Table 3.1.4.1.3-1**

QA Data Needed:

MGDS Annotated Outline

Section 3.3 Assessment of Compliance with 10 CFR 60

TABLE OF CONTENTS

Page

3.3 ASSESSMENT OF COMPLIANCE WITH 10 CFR 60 . . . . . 3.3-1

3.3.1 Favorable Conditions 3.3-1
3.3.2 Potentially Adverse Conditions 3.3-3

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

3.3.1.1-1 Results of the site characterization programs for tectonics, geohydrology, geochemistry, and geomorphology. In particular, data, interpretations of data, figures, and tables supporting the interpretations.

3.3.1.3-1 Results of studies of radionuclide sorption and solubility.

3.3.1.4-1 Anticipated thermal load, water chemistry, and mineralogy, petrology, and rock chemistry.

3.3.1.6-1 Population density.

3.3.1.7-1 Estimates of ground-water travel time.

3.3.1.8-1 Hydrologic characteristics of the unsaturated zone and climatic regime.

3.3.2.1-1 Probable maximum flood.

3.3.2.3-1 Potential for natural phenomena to create surface water impoundments that could change the regional ground-water system.

3.3.2.4-1 Structural deformation that could affect the regional ground-water system.

3.3.2.5-1 Effects of tectonic processes, climate change, and human activities on hydrologic conditions.

3.3.2.6-1 Effects of future climate change on hydrologic conditions

3.3.2.7-1 Ground-water condition that could increase the solubility or chemical reactivity of the EBS.

3.3.2.8-1 Anticipated thermal load and tectonic processes and human activities that significantly change the ground-water composition.

3.3.2.9-1 Ground-water conditions in the host rock that are not reducing.

3.3.2.11-1 Structural Deformation During the Quaternary.

3.3.2.12-1 Evaluation of historical earthquakes.

3.3.2.15-1 Probability and consequences of an igneous intrusion penetrating the repository history of igneous activity during the Quaternary.

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

3.3.2.17-1 Natural resources within the site that may be economically extracted within the foreseeable future or that have greater or net value than the average for other areas of similar size that are representative of and located in the geologic setting.

3.3.2.19-1 Evidence of drilling.

3.3.2.20-1 Rock or ground-water conditions that require complex engineering measures for design and construction of the underground facility or insealing of boreholes and shafts.

3.3.2.21-1 Geomechanical properties that do not permit design of stable underground openings through permanent closure.

3.3.2.22-1 Potential for the water table to rise and saturate the potential repository at Yucca Mountain.

3.3.2.23-1 Potential for existing or future perched water bodies that may saturate the underground facility or provide a faster flow path to the accessible environment.

3.3.2.24-1 Potential for movement of radionuclides in a gaseous state through the unsaturated zone.

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

3.3 ASSESSMENT OF COMPLIANCE WITH 10 CFR 60

This section provides an analysis of the favorable and potentially adverse conditions of 10 CFR Part 60, including the extent to which each of these conditions are present or absent. For the favorable conditions found to be present, Section 3.3.1 provides an analysis to determine the extent to which each favorable condition has been characterized and the extent to which it contributes to isolation. For each potentially adverse condition found to be present, Section 3.3.2 provides an analysis to determine the degree to which the potentially adverse condition has been characterized and the extent to which it detracts from isolation.

3.3.1 Favorable Conditions

3.3.1.1 The nature and rates of tectonic, hydrogeologic, geochemical, and geomorphic processes (or any such process) operating within the geologic setting during the Quaternary Period, when projected, would not affect or would favorably affect the ability of the geologic repository to isolate waste. [60.122(b)(1)]

[A complete analysis of this favorable condition is not yet available. Studies planned for site characterization will evaluate process operating in the geologic setting during the Quaternary Period (INN 3.3.1.1-1) and the results of these studies will provide a basis to evaluate the extent to which this favorable condition may be present.]

3.3.1.2 [60.122(b)(2)] This favorable condition applies to disposal in the saturated zone and therefore does not apply to the Yucca Mountain site.

3.3.1.3 Geochemical conditions that:

1. Promote precipitation or sorption of radionuclides
2 Inhibit the formation of particulates, colloids, and inorganic and organic complexes that increase the mobility of radionuclides
3. Inhibit the transport of radionuclides of particulates, colloids, and complexes. [60.122(b)(3)]

[A complete analysis of this favorable condition is not yet available. Studies planned in the geochemistry program for site characterization (INN 3.3.1.3-1) will evaluate the geochemical conditions at the Yucca Mountain site and the results of these studies will provide a basis to evaluate the extent to which this favorable condition may be present.]

3.3.1.4 Mineral assemblages that, when subjected to anticipated thermal loading, will remain unaltered or alter to mineral assemblages having equal or increased capacity to inhibit radionuclide migration. [60.122(b)(4)]

[A complete analysis of this favorable condition is not yet available. Studies planned in the geochemistry program for site characterization (INN 3.3.1.4-1) will provide information needed to evaluate the extent this favorable condition may be present, given the anticipated thermal load (INN 3.3.1.4-2).]

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

3.3.1.5 Conditions that permit the emplacement of waste at a minimum depth of 300 meters from the ground surface. (The ground surface shall be deemed to be the elevation of the lowest point on the surface above the disturbed zone.) [60.122(b)(5)]

This favorable condition is not present at the Yucca mountain site. (DOE, 1988).

3.3.1.6 A low population density within the geologic setting and a controlled area that is remote from population centers. [60.122(b)(6)]

[A complete analysis of this favorable condition is not available yet. The information needed to complete an analysis of this favorable condition (INN 3.3.1.6-1) will be identified through environmental scoping hearings and documented in an environmental impact statement.]

3.3.1.7 Pre-water-emplacement ground-water travel time along the fastest path of likely radionuclide travel from the disturbed zone to the assessable environment that substantially exceeds 1,000 years. [60.122(b)(7)]

[A complete analysis of this favorable condition is not yet available. Preliminary analysis suggest that for expected conditions and assuming that matrix flow dominates, ground-water travel times are "likely to exceed 1,000 years along paths of likely and significant radionuclide flow" (Younker, et. al., 1992). Studies planned for site characterization will provide additional data to characterize potential flow paths, rates and distribution of infiltration, and representative data to model the geohydrologic system (INN 3.3.1.7-1) and the results of these studies will provide a basis to evaluate the extent to which this favorable condition is present at the Yucca Mountain site.]

3.3.1.8 For disposal in the unsaturated zone, hydrologic conditions that provide:

1. Low moisture flux in the host rock and in the underlying hydrologic units
2. A water table sufficiently below the underground facility such that fully saturated voids contiguous with the water table do not encounter the underground facility
3. A laterally extensive low permeability hydrogeologic unit above the host rock that would inhibit the downward movement of water or divert downward moving water to a location beyond the limits of the underground facility
4. A host rock that provides for free drainage
5. A climatic regime in which the average annual precipitation is a small percentage of the annual potential evaporation. [60.122(b)(8)]

[A complete analysis of this favorable condition is not yet available. Studies planned in the geohydrology program and the climate program (INN 3.3.1.8-1) will evaluate the hydrologic characteristics of the unsaturated zone and the climatic regime of the site. The results of these studies will provide a basis to evaluate the extent to which this favorable condition may be present at the site.]

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

3.3.2 Potentially Adverse Conditions

3.3.2.1 Potential for flooding of the underground facility, whether resulting from the occupancy and modification of floodplains or from the failure of existing or planned man-made surface water impoundments. [60.122(c)(1)]

[A final analysis of this potentially adverse condition (PAC) is not yet available. Design analyses that take into account the probable maximum flood (PMF) (INN 3.3.2-1) will provide the basis to evaluate the extent to which this potentially adverse condition is present.]

3.3.2.2 Potential for foreseeable human activity to adversely affect the ground-water flow system, such as ground withdrawal, extensive irrigation, subsurface injection of fluids, underground pumped storage, military activity or construction of large scale surface water impoundments. [60.122(c)(2)]

[A final analysis of this PAC is not yet available. Studies that address future human activities that could affect postclosure performance will be completed as part of the total systems performance assessment (INN 6.5-002)]

3.3.2.3 Potential for natural phenomena such as landslides, subsidence, or volcanic activity of such a magnitude that large scale surface water impoundments could be created that could change the regional ground-water flow system and thereby adversely affect the performance of the geologic repository. [960.122(c)(3)]

[A final analysis of this PAC is not yet available. Studies planned for site characterization (INN 3.3.2.3-1) will provide additional data to evaluate the extent to which this PAC may be present.]

3.3.2.4 Structural deformation, such as uplift, subsidence, folding, or faulting that may adversely affect the regional ground-water flow system. [60.122(c)(4)]

[A final analysis of this PAC is not yet available. Studies planned in the tectonics program for site characterization (INN 3.3.2.4-1) will provide additional data that will provide a basis to evaluate the extent to which this PAC may be present.]

3.3.2.5 Potential for changes in hydrologic conditions that would affect the migration of radionuclides to the accessible environment, such as changes in hydraulic gradient, average interstitial velocity, storage coefficient, hydraulic conductivity, natural recharge, potentiometric levels, and discharge points. [60.122(c)(5)]

[A final analysis of this PAC is not yet available. Studies planned to assess tectonics, climate, and future human activities during site characterization (INN 3.3.2.5-1) will provide additional data to evaluate the extent to which this condition may be present.]

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

3.3.2.6 Potential for changes in hydrologic conditions resulting from reasonably foreseeable climatic changes. [60.122(c)(6)]

[A final analysis of this PAC is not yet available. Studies planned to evaluate the potential for reasonably foreseeable climate changes to change the hydrologic conditions at the site (INN 3.3.2.6-1) will provide additional data to evaluate the extent to which this PAC may be present.]

3.3.2.7 Ground water conditions in the host rock, including chemical composition, high ionic strength or ranges of Eh-pH, that could increase the solubility or chemical reactivity of the engineered barrier system. [60.122(c)(7)]

[A final analysis of this PAC is not yet available. Studies planned in the geochemistry program for site characterization (INN 3.3.2-7-1) will provide additional data to evaluate the extent to which this adverse condition may be present.]

3.3.2.8 Geochemical processes that would reduce sorption of the radionuclides, result in degradation of the rock strength, or adversely affect the performance of the engineered barrier system. [60.122(c)(8)]

[A final analysis of this PAC is not yet available. Studies planned in the geochemistry program for site characterization (INN 3.3.2.8-1) will provide additional data to evaluate the extent to which this potentially adverse condition may be present.]

3.3.2.9 Ground water conditions in the host rock that are not reducing. [60.122(c)(9)]

[A final analysis of this PAC is not yet available. Because the water in the Topopah Spring unit is oxidizing, this PAC is present at the Yucca Mountain site. Studies planned in the geochemistry program for site characterization (INN 3.3.2.9-1) will provide additional data to evaluate the extent to which this PAC may adversely affect postclosure performance.]

3.3.2.10 Evidence of dissolutioning such as breccia pipes, dissolution cavities, or brine pockets. [60.122(c)(10)]

This PAC is not present at the Yucca Mountain site. There are no dissolution features such as breccia pipes, dissolution cavities, or brine pockets within the controlled area (DOE, 1988).

3.3.2.11 Structural deformation such as uplift, subsidence, folding, and faulting during the Quaternary Period. [60.122(c)(11)]

[A final analysis of this PAC is not yet available. Structural deformation has occurred during the Quaternary within the controlled area of the Yucca Mountain site. Studies planned in the tectonics program for site characterization (INN 3.3.2.11-1) will provide additional data to evaluate the extent to which this PAC may adversely impact postclosure performance.]

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

3.3.2.12 Earthquakes which have occurred historically that if they were to be repeated could affect the site significantly. [60.122(c)(12)]

[A final analysis of this PAC is not yet available. Studies planned in the tectonics program for site characterization (INN 3.3.2.12-1) will provide additional data to evaluate whether or not this PAC is present at the Yucca Mountain site.]

3.3.2.13 Indications, based on correlations of earthquakes with tectonic processes and features, that either the frequency of occurrence or magnitude of earthquakes may increase. [60.122(c)(13)]

[A final analysis of this PAC is not yet available. Studies planned in the tectonics program for site characterization (INN 3.3.2.12-1) will provide additional data to evaluate the extent to which this PAC may be present at the Yucca Mountain site.]

3.3.2.14 More frequent occurrence of earthquakes of higher magnitude than is typical of the areas in which the geologic setting is located. [60.122(c)(14)]

[A final analysis of this PAC is not yet available. Studies planned in the tectonics program for site characterization (INN 3.3.2.12-1) will provide additional data to evaluate the extent to which this PAC may be present at the Yucca Mountain site.]

3.3.2.15 Evidence of igneous activity since the start of the Quaternary Period. [60.122(c)(15)]

[A final analysis of this PAC is not yet available. Because basaltic volcanism has occurred in the vicinity of Yucca Mountain since the start of the Quaternary Period, this PAC is present at the Yucca Mountain site. Studies planned in the tectonics program for site characterization (INN 3.3.2.15-1) will provide additional data to evaluate the extent to which this PAC may have adversely affect postclosure performance.]

3.3.2.16 Evidence of extreme erosion since the start of the Quaternary Period. [60.122(c)(16)]

This subsection demonstrates that the potentially adverse condition identified in 10 CFR 60.122(c)(16), evidence of extreme erosion during the Quaternary Period, is absent at Yucca Mountain. This conclusion is supported by and documented in a topical report, Evaluation of the Potentially Adverse Condition "Evidence of Extreme Erosion During the Quaternary Period" at Yucca Mountain, Nevada, March 1993 (DOE, 1993).

This conclusion is based on a regulatory and technical evaluation. The regulatory evaluation provides an assessment of the regulatory requirements and boundaries associated with the determination of whether a potentially adverse condition exists. The technical evaluation provides an assessment of the scientific studies conducted to characterize and quantify the erosion rates in the Yucca Mountain area and compares these rates to erosion rates in other geologic and climate settings in the United States and the world. This comparison was used to establish that the erosion rates at and in the vicinity of Yucca Mountain during the Quaternary are not extreme.

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

The data and analyses used to develop the regulatory conclusion include the assumptions made, representativeness of data, interpretations, data uncertainties, and qualification of data. The methodologies and references are sufficient to allow an independent analysis of the results.

Low to moderate erosion rates in the United States range from 2 to 50 centimeters per thousand years (cm/ka) in semiarid environments. Long-term average hillslope erosion rates established for Yucca Mountain were determined to be 0.19 cm/ka. The Yucca Mountain rates were established using cation ratio dating of rock varnish on colluvial boulder deposits to establish age control and by measuring hillslope denudation and hillslope channel incision marginal to these boulder deposits. The geologic record examined for Yucca Mountain area hillslopes extends from 170 ka to about 1400 ka, and represents the longest geologic record obtained from hillslopes in the southwestern United States. Based upon a comparative evaluation of Yucca Mountain hillslope erosion with erosion rates in other analogous geologic and climatic regimes, extreme erosion has not occurred at Yucca Mountain during the Quaternary Period. Therefore, the potentially adverse condition of evidence of extreme erosion during the Quaternary Period identified in 10 CFR 60.122(c) does not exist at Yucca Mountain.

3.3.2.17 The presence of naturally occurring materials, whether identified or undiscovered, within the site, in such form that:

1. Economic extraction is currently feasible or potentially feasible during the foreseeable future
2. Such materials have greater gross value or net value than the average for other areas of similar size that are representative of and located within the geologic setting. [60.122(c)(17)]

[A final analysis of this PAC is not yet available. Studies planned in the natural resources program for site characterization (INN 3.3.2.17-1) will provide additional information to evaluate whether or not this PAC is present at the Yucca Mountain site.]

3.3.2.18 Evidence of subsurface mining for resources within the site.

This PAC is not present at the Yucca Mountain site. There is no evidence of subsurface mining for resources within 10 km of the site (DOE, 1988).

3.3.2.19 Evidence of drilling for any purpose within the site. [60.122(c)(19)]

[A final analysis of this PAC is not yet available. A total of 184 drillholes within 10 km of the site have been documented (DOE, 1988). Additional studies (INN 3.3.2.19-1) planned for site characterization will provide additional data to evaluate the extent to which this PAC may adversely affect postclosure performance.]

3.3.2.20 Rock or ground water conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts. [60.122(c)(20)]

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

[A final analysis of this PAC is not yet available. Studies planned in rock characteristics and geohydrology for site characterization [INN 3.3.2.20-1] will provide additional data to evaluate whether or not this PAC is present at the Yucca Mountain site.]

3.3.2.21 Geomechanical properties that do not permit design of underground opening that will remain stable through permanent closure. [60.122(c)(21)]

[A final analysis of this PAC is not yet available. Studies planned in the rock characteristics program for site characterization (INN 3.3.2.21-1) will provide additional data to evaluate whether or not this PAC is present at the Yucca Mountain site.]

3.3.2.22 Potential for the water table to rise sufficiently so as to cause saturation of an underground facility located in the unsaturated zone. [60.122(c)(22)]

[A final analysis of this PAC is not yet available. Studies planned in the geohydrology, tectonics, geochemistry and climate programs for site characterization (INN 3.3.2.22-1) will provide additional data to evaluate whether or not this PAC is present at the Yucca Mountain site.]

3.3.2.23 Potential for existing or future perched water bodies that may saturate portions of the underground facility or provide a faster flow path from an underground facility located in the unsaturated zone to the accessible environment. [60.122(c)(23)]

[A final analysis of this PAC is not yet available. Studies planned in the geohydrology and program for site characterization (INN 3.3.2.23-1) will provide additional data to evaluate whether or not this PAC is present at the Yucca Mountain site.]

3.3.2.24 Potential for the movement of radionuclides in a gaseous state through air-filled pore spaces on an unsaturated geologic medium to the accessible environment. [60.122(c)(24)]

[A final analysis of this PAC is not yet available.]

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

SKELETON TEXT
Date 11/30/93

INFORMATION NEED FORMS FOR SECTION 3.3

The above Annotated Outline text is guidance that may be used for the future development of an MGDS facility License Application.

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.1.1-1**

Section number and Title: **3.3.1.1**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Results of the site characterization programs for tectonics, geohydrology, geochemistry, and geomorphology.

When is the information needed?

Information Source: **Technical Reports**
INN 6.5-001

Source Document Description: **Data, interpretations of data, figures, and tables supporting the interpretations.**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.1.3-1**

Section number and Title: **3.3.1.3**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Results of studies of radionuclide sorption and solubility.

When is the information needed?

Information Source: **Results of:**

Study Plan 8.3.1.3.4.1 (Batch Sorption)
Study Plan 8.3.1.3.4.2 (Biological Sorption and Transport)
Study Plan 8.3.1.3.4.3 (Development of Sorption Models)
Study Plan 8.3.1.3.5.1 (Dissolved Species Concentration Limits)
Study Plan 8.3.1.3.5.2 (Colloid Behavior)
Study Plan 8.3.1.3.6.1 (Diffusion)
Study Plan 8.3.1.3.7.1 (Retardation Sensitivity Analysis
INN 6.5-001

Source Document Description: **Radionuclide retardation by sorption processes**
Radionuclide retardation by precipitation processes
Radionuclide dispersion, diffusion, and advection
Radionuclide retardation by all processes

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.1.4-1**

Section number and Title: **3.3.1.4**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Anticipated thermal load, water chemistry, and mineralogy, petrology, and rock chemistry.

When is the information needed?

Information Source: **Results of:**

Repository LAD
Study Plan 8.3.1.3.1.1 (Ground-water geochemistry model)
Study Plan 8.3.1.3.2.2 (Alteration History)
Study Plan 8.3.1.3.3.1 (Natural Analogs of Hydrothermal Systems in Tuff)
Study Plan 8.3.1.3.3.2 (Kinetics and Thermodynamic of Mineral Evolution)
Study Plan 8.3.1.3.3.3 (Conceptual Model of Mineral Evolution)

Source Document Description: **TBD**

Document Number: **TBD**

Table and/or Figure Number:

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.1.6-1**

Section number and Title: **3.3.1.6**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Population density.

When is the information needed?

Information Source: **Environmental Impact Statement**

Source Document Description: **TBD**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.1.7-1**

Section number and Title: **3.3.1.7**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Estimates of ground-water travel time.

When is the information needed?

Information Source: **Results of:**

Study Plan 8.3.1.2.2.1 (Characterization of Unsaturated Zone Infiltration)
Study Plan 8.3.1.2.2.2 (Water Movement Test)
Study Plan 8.3.1.2.2.3 (Characterization of Percolation in the Unsaturated Zone-Surface-Based Studies
Study Plan 8.3.1.2.2.4 (Characterization of the Unsaturated Zone-Exploratory Studies Facility)
Study Plan 8.3.1.2.2.5 (Diffusion)
Study Plan 8.3.1.2.2.6 (Characterization of Gas-Phase Movement)
Study Plan 8.3.1.2.2.8 (Fluid Flow in Unsaturated Zone)
Study Plan 8.3.1.2.2.9 (Site Saturated Zone Synthesis and Modeling)
INN 6.5-001

Source Document Description: **TBD**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.1.8-1**

Section number and Title: **3.3.1.8**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Hydrologic characteristics of the unsaturated zone and climatic regime.

When is the information needed?

Information Source:

Study Plan 8.3.1.2.2.1 (Characterization of Unsaturated Zone Infiltration)
Study Plan 8.3.1.2.2.2 (Water Movement Test)
Study Plan 8.3.1.2.2.3 (Characterization of Percolation in the Unsaturated Zone-Surface-Based Studies)
Study Plan 8.3.1.2.2.4 (Characterization of the Unsaturated Zone-Exploratory Studies Facility)
Study Plan 8.3.1.3.2.2 (Characterization of Alteration History)
Study Plan 8.3.1.5.1.1 (Characterization of Modern Regional Climate)

Source Document Description: **TBD**

Document Number: **TBD**

Table and/or Figure Number: **N/A**
QA Data Needed:Log Number: **INN 3.3.2.1-1**

Section number and Title: **3.3.2.1**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Probable maximum flood.

When is the information needed?

Information Source: **Technical Document**

Source Document Description: **TBD**

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.3-1**

Section number and Title: **3.3.2.3**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Potential for natural phenomena to create surface water impoundments that could change the regional ground-water system.

When is the information needed?

Information Source:

Study Plan 8.3.1.2.1.2 (Characterization of Runoff and Stream Flow)
Study Plan 8.3.1.5.2.2 (Characterization of Future Regional Hydrology Due to Climate Change)
Study Plan 8.3.1.8.1.1 (Probability of Magmatic Eruption Penetrating the Repository)
Study Plan 8.3.1.8.1.2 (Physical Processes of Magmatism and Effects)
Study Plan 8.3.1.17.4.6 (Quaternary Faulting Within the Site Area)
Study Plan 8.3.1.17.4.7 (Subsurface Geometry and Concealed Extension of Quaternary Faults)
Study Plan 8.3.1.17.4.12 (Tectonic Models and Synthesis)

Source Document Description: **Rates of Vertical Slip and Tilting**
Locations of Faults and Recurrence Intervals
Probability of a Volcanic Event
Runoff Estimates

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.4-1**

Section number and Title: **3.3.2.4**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Structural deformation that could affect the regional ground-water system.

When is the information needed?

Information Source: **Results of:**

Study Plan 8.3.1.8.3.1 (Analysis of the Effects of Tectonic Processes and Events on Average Percolation Flux Rates Over the Repository)
Study Plan 8.3.1.8.3.2 (Analysis of the Effects of Tectonic Processes and Events on Changes in the Water Table Elevation)
Study Plan 8.3.1.8.3.3 (Analysis of the Effects of Tectonic Processes and Events on Local Fracture Permeability)
INN 6.5-001

Source Document Description: **Location of Quaternary Faults and recurrence intervals on Quaternary Faults. Effect of faulting on permeability and porosity and effects of faulting on ground-water flux.**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.5-1**

Section number and Title: **3.3.2.5**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Effects of tectonic processes, climate change, and human activities on hydrologic conditions.

When is the information needed?

Information Source: **Results of:**

INN-3.3.2.4-1
Study Plan 8.3.1.5.2.2 (Characterization of Future Regional Hydrology Due to Climate Change)
Study Plan 8.3.1.9.3.2 (Evaluation of Potential Effects of the Exploitation of Natural Resources on the Hydrologic Characteristics of Yucca Mountain)
INN 6.5-002

Source Document Description: **Radionuclide retardation by sorption processes**
Radionuclide retardation by precipitation processes
Radionuclide dispersion, diffusion, and advection
Radionuclide retardation by all processes

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.6-1**

Section number and Title: **3.3.2.6**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Effects of future climate change on hydrologic conditions

When is the information needed?

Information Source:

Study Plan 8.3.1.5.1.6 (Characterization of Future Regional Climate and Environments)
Study Plan 8.3.1.5.2.2 (Characterization of Future Regional Hydrology Due to Climate Change)
INN 6.5-002

Source Document Description: **TBD**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.7-1**

Section number and Title: **3.3.2.7**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Ground-water condition that could increase the solubility or chemical reactivity of the EBS.

When is the information needed?

Ground-water conditions in the host rock.

Information Source: **Results of:**

Study Plan 8.3.1.3.1.1 (Ground-Water Chemistry Model)
Study Plan 8.3.1.3.2.1 (Mineralogy, Petrology, and Chemistry along Transport Pathways)
Study Plan 8.3.1.3.2.2 (History of Geochemical Alteration)
Study Plan 8.3.1.3.4.1 (Batch Sorption Studies)
Study Plan 8.3.1.3.4.2 (Biological Sorption and Transport)
Study Plan 8.3.1.3.4.3 (Development of Sorption Models)
Study Plan 8.3.1.3.5.1 (Dissolved Species Concentration Limits)
Study Plan 8.3.1.3.5.2 (Colloid Behavior)
Study Plan 8.3.1.3.6.1 (Dynamic Transport Column Experiments)
Study Plan 8.3.1.3.6.2 (Diffusion)
Study Plan 8.3.1.3.7.1 (Retardation Sensitivity Analysis)

Source Document Description: **TBD**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.8-1**

Section number and Title: **3.3.2.8**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Anticipated thermal load and tectonic processes and human activities that significantly change the ground-water composition.

When is the information needed?

Information Source: **Results of:**

Repository LAD
INN 3.3.2.7-1
Study Plan 8.3.4.2.4.5 (Effects of Man-Made Materials on Ground-Water Chemistry)
Study Plan 8.3.1.2.2.7 (Hydrochemical Characterization of the Unsaturated Zone)

Source Document Description: **TBD**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.9-1**

Section number and Title: **3.3.2.9**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Ground-water conditions in the host rock that are not reducing.

When is the information needed?

Information Source: **Results of:**

Study Plan 8.3.1.2.2.7 (Hydrochemical Characterization of the Unsaturated Zone)

Source Document Description: **Ground-water conditions in the host rock.**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.11-1**

Section number and Title: **3.3.2.11**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Structural Deformation During the Quaternary.

When is the information needed?

Information Source: **Results of:**

INN 3.3.2-4 and 3.3.2-5
Study Plan 8.3.1.17.3.1 (Relevant Earthquake Sources)
Study Plan 8.3.1.17.3.3 (Ground Motion from Regional Earthquakes and UNEs)
Study Plan 8.3.1.17.3.4 (Effect of Local Site Geology on Surface and Subsurface Motions)
Study Plan 8.3.1.17.3.5 (Ground Motion from Controlling Seismic Events)
Study Plan 8.3.1.17.3.6 (Probabilistic Seismic Hazard)
Study Plan 8.3.1.17.4.1 (Historic and Current Seismicity)
Study Plan 8.3.1.17.4.6 (Quaternary Faulting Within the Site Area)
Study Plan 8.3.1.17.4.8 (Stress Field Within and Proximal to the Site)
Study Plan 8.3.1.17.4.9 (Tectonic Geomorphology)
Study Plan 8.3.1.17.4.12 (Tectonic Models and Synthesis)
INN 6.5-002

Source Document Description: **Structural Deformation During the Quaternary.**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.12-1**

Section number and Title: **3.3.2.12**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Evaluation of historical earthquakes.

When is the information needed?

Information Source: **Results of:**

Study Plan 8.3.1.17.3.1 (Relevant Earthquake Sources)
Study Plan 8.3.1.17.3.3 (Ground Motion from Regional Earthquakes and UNEs)
Study Plan 8.3.1.17.3.4 (Effect of Local Site Geology on Surface and Subsurface Motions)
Study Plan 8.3.1.17.3.5 (Ground Motion from Controlling Seismic Events)
Study Plan 8.3.1.17.3.6 (Probabilistic Seismic Hazard)
Study Plan 8.3.1.17.4.1 (Historic and Current Seismicity)
INN 6.5-002

Source Document Description: **Earthquake catalog.**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.15-1**

Section number and Title: **3.3.2.15**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Probability and consequences of an igneous intrusion penetrating the repository history of igneous activity during the Quaternary.

When is the information needed?

Information Source: **Results of:**

Study Plan 8.3.1.8.1.1 (Probability of Magmatic Eruption Penetrating the Repository)
Study Plan 8.3.1.8.1.2 (Physical Processes of Magmatism and Effects)
Study Plan 8.3.1.8.5.1 (Characterization of Volcanic Feature)
Study Plan 8.3.1.8.5.2 (Characterization of Igneous Intrusive Features)
Study Plan 8.3.1.17.4.12 (Tectonic Models and Synthesis)
UBB 6.5-002

Source Document Description: **TBD**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.17-1**

Section number and Title: **3.3.2.17**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Natural resources within the site that may be economically extracted within the foreseeable future or that have greater or net value than the average for other areas of similar size that are representative of and located in the geologic setting.

When is the information needed?

Information Source: **Results of:**

Study Plan 8.3.1.9.2.1 (Natural Resource Assessment at the Yucca Mountain Site)
Study Plan 8.3.1.9.2.2 (Water Resource Assessment at the Yucca Mountain Site)
Study Plan 8.3.1.9.3.1 (Data Needed to Support the Assessment of the Likelihood of Future Inadvertent Human Intrusion for Exploration/Extraction of Natural Resources)
Study Plan 8.3.1.9.3.2 (Evaluation of the Potential Effect of Exploitation of Natural Resources)

Source Document Description: **TBD**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.19-1**

Section number and Title: **3.3.2.19**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Evidence of drilling.

When is the information needed?

Information Source: **Borehole Catalog**
INN 6.5-002

Source Document Description: **Borehole catalog**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.20-1**

Section number and Title: **3.3.2.20**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Rock or ground-water conditions that require complex engineering measures for design and construction of the underground facility or insealing of boreholes and shafts.

When is the information needed?

Rock Characteristics
Unsaturated Zone Hydrologic Characteristics

Information Source: **Results of:**

Study Plan 8.3.1.2.2.1 (Characterization of Unsaturated-Zone Infiltration)
Study Plan 8.3.1.2.2.3 (Characterization of Percolation in the Unsaturated Zone-Surface-Based Study)
Study Plan 8.3.1.2.2.4 (Characterization of the Yucca Mountain Unsaturated Zone Percolation-Exploratory Studies Facility)
Study Plan 8.3.1.4.2.2 (Characterization of Structural Features in the Site Area)
Investigation 8.3.1.15 (Thermal and Mechanical Properties)

Source Document Description: **TBD**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.21-1**

Section number and Title: **3.3.2.21**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Geomechanical properties that do not permit design of stable underground openings through permanent closure.

When is the information needed?

Information Source:

Study Plan 8.3.1.4.2.2 (Structural Features Within the Site Area)
Investigation 8.3.1.15 (Thermal and Mechanical Properties)

Source Document Description: **TBD**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.22-1**

Section number and Title: **3.3.2.22**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Potential for the water table to rise and saturate the potential repository at Yucca Mountain.

When is the information needed?

Information Source:

Results of Study Plan 8.3.1.2.2.9 (Site Saturated Zone Synthesis and Modeling)

Source Document Description: **TBD**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.23-1**

Section number and Title: **3.3.2.23**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Potential for existing or future perched water bodies that may saturate the underground facility or provide a faster flow path to the accessible environment.

When is the information needed?

Hydrologic characteristics of the unsaturated zone.

Information Source: **Results of:**

Study Plan 8.3.1.2.2.1 (Characterization of Infiltration in the Unsaturated Zone)
Study Plan 8.3.1.2.2.2 (Water Movement Test)
Study Plan 8.3.1.2.2.3 (Characterization of Yucca Mountain Percolation in the Unsaturated Zone-Surface-Based Studies)
Study Plan 8.3.1.2.2.4 (Characterization of Yucca Mountain Percolation in the Unsaturated Zone-Exploratory Studies Facility)
Study Plan 8.3.1.2.2.8 (Fluid Flow in Unsaturated Rock)
Study Plan 8.3.1.2.2.9 (Site Unsaturated Zone Modeling and Synthesis)

Source Document Description: **TBD**

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

MGDS LA Annotated Outline Information Need Form
Form A: Information Request

Date 11/30/93

Log Number: **INN 3.3.2.24-1**

Section number and Title: **3.3.2.24**

Lead Author and Phone: **Martha Pendleton (702) 794-1828**

Description of Information Needed:

Potential for movement of radionuclides in a gaseous state through the unsaturated zone.

When is the information needed?

Information Source: **INN 6.5-002**

Source Document Description:

Document Number: **TBD**

Table and/or Figure Number: **N/A**

QA Data Needed:

The above Annotated Outline is guidance that may be used for the future development of an MGDS facility License Application.