JUN 6 1983

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GLear
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Docket Nos. 50-390/391

APPLICANT: Tennessee Valley Authority

FACILITY: Watts Bar Nuclear Plant, Units 1 and 2

SUBJECT: SUMMARY OF MEETING TO DISCUSS LIQUEFACTION OF THE SOILS BENEATH THE ERCW PIPELINE

A meeting was held in Bethesda, MD on May 20, 1983, to discuss liquefaction of the soils beneath the ERCW pipeline at TVA's Watts Bar Nuclear Plant, Units 1 and 2. A list of attendees is included as Enclosure 1.

In the first half of the meeting, TVA presented both empirical and theoretical ground motion results analyzing the potential for peak acceleration amplification in the soils at Watts Bar, a shallow soil site. The slides are included as Enclosure 2. With respect to the theoretical results, TVA concluded that an increase in the shear wave velocity contrast between the rock and soil, above about 3 to 1, does not significantly affect peak acceleration amplification. They also concluded that the shear wave velocity of the soil is the critical parameter, not the contrast between the soil and rock. The staff questioned TVA regarding some of the assumptions used in the theoretical analysis and requested that the specific computer input and output be provided for examination.

TVA also presented information and review of empirical results utilized by the staff to estimate a range of peak acceleration for the soil (0.35g to 0.42g). TVA stated that the references cited by the staff did not use enough data to be statistically significant. The staff stated that other empirical information was available which also showed peak acceleration amplification at shallow soil sites.

The second part of the meeting concerned discussion of TVA's remedial fix to the potential liquefaction problem. TVA indicated that they have analyzed the liquefaction potential of soils below the water table in all the borings along the ERCW pipeline. For these analyses, they used the 1979 Seed and Idriss procedure with a maximum horizontal acceleration of 0.4g at ground surface. TVA found, in using their analyses criteria, that soils may liquefy in several areas along the ERCW pipelines. One of the susceptible areas is found to be continuous and near sloping ground close to the ERCW pumping station (between borings #49 and #141). In other areas, the liquefaction - susceptible soils are either isolated or under very flat ground. TVA indicated that they would provide field remedial measures to stabilize the area between the pumping station and boring #141.

OFFICE							
SURNAME							
DATE							

TVA proposed to construct underground barriers along the ERCW pipelines on the side of the sloping ground. The proposed alignment and cross-section of the barriers are shown in Enclosures 3 and 4. The purpose of the barriers is to contain the soils in case of any liquefaction in this area. TVA stated that they would design the barriers to withstand 0.4g maximum ground acceleration. The present design of the barriers show that these would be about 100 feet wide at the base and about 25 feet deep from the surface to the underlying shale deposit. The distance of the barriers from the ERCW pipelines would vary from 50 feet to 500 feet. Densely compacted barriers would be formed by compacting the material excavated from the location of the barriers. The compaction criterion would be 95% standard Proctor density. TVA proposes to fill the depression in the area between the ground surface at the location of the pipelines and the top of the barriers.

TVA also indicated that they have analyzed the potential seismically-induced settlements of soils at the location of borings along the ERCW pipelines. For these analyses, they have used the method proposed by Lee and Albaisa (1974 ASCE Geotechnical Engineering Journal). However, since they do not have laboratory test data on soils to be used in these analyses, they have used lab data for Monterey sand given in the said paper. Their results show that a maximum of 1.5% volumetric strain may be used for estimating seismic settlements.

TVA stressed the urgency of coming to a resolution on this liquefaction issue so that remedial work may be complete by fuel load (01/03/84). The meeting closed with the NRC indicating that in a week TVA would receive a peak acceleration, or "g" value, and an indication as to the adequacy of their remedial fix.

/s/

Melanie A. Miller, Project Manager
Licensing Branch No. 4
Division of Licensing

Enclosures:
As stated

cc w/enclosures:
See next page

OFFICE	DL:LB#4/PM	DL:LB#4/BC					
SURNAME	MAMiller:kwl	EAdensam					
DATE	6/6/83	6/6/83					

WATTS BAR

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General Counsel
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James P. O'Reilly, Regional Administrator
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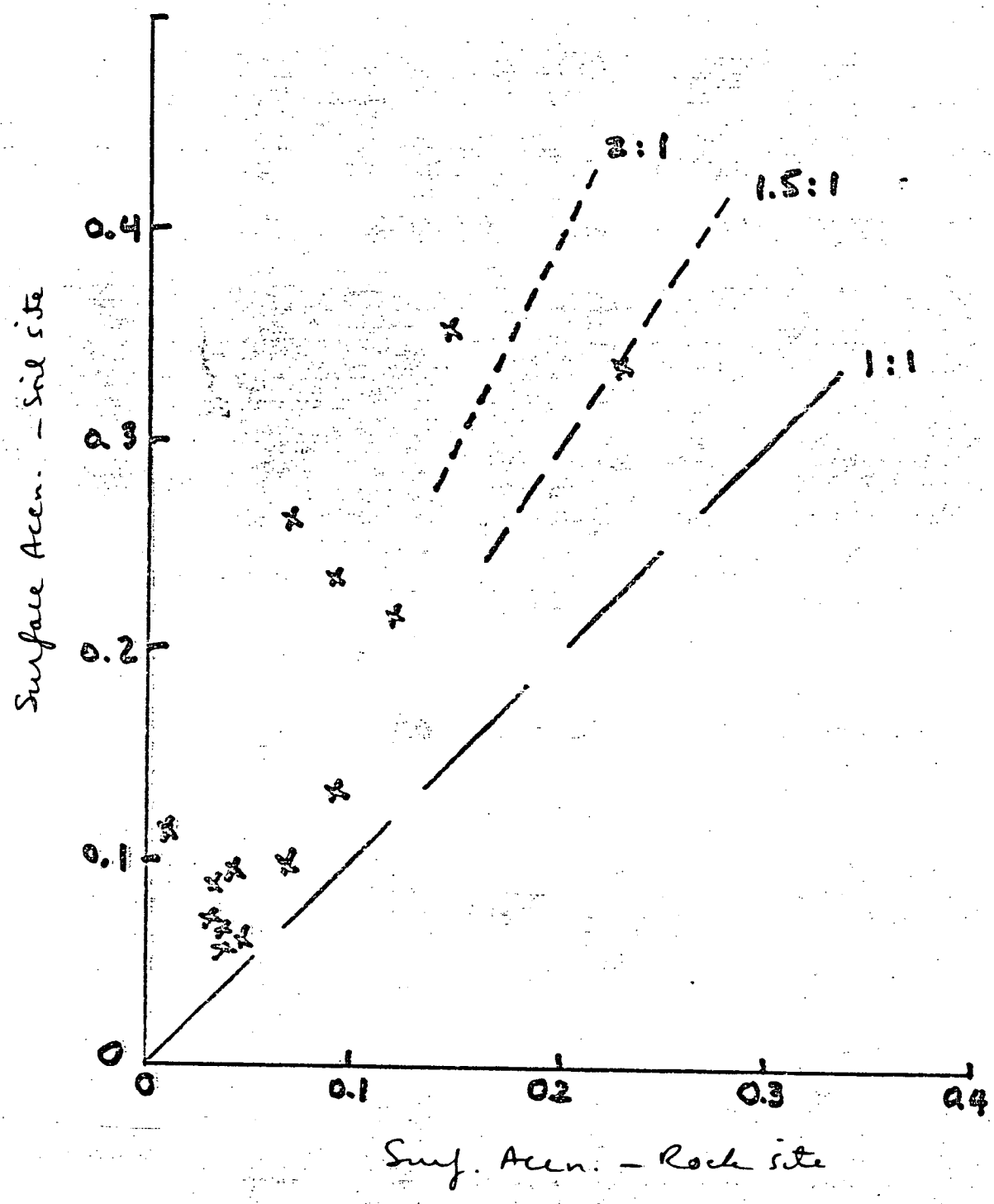
Enclosure 1

MEETING ATTENDANCE

Name	Affiliation
Robert E. Jackson	NRC
Robert L. Rothman	NRC
Jerry L. King	NRC
Vincent A. Bianco	TVA
R. O. Barnett, Jr.	TVA
R. J. Hunt	TVA
Samuel D. Stone	TVA
Jeff Kimball	NRC
Dinesh Gupta	NRC
E. G. Adensam	NRC
G. Lear	NRC
L. M. Mills	TVA
D. P. Ormsby	TVA
C. Y. Chang	Woodward-Clyde Consultants
W. M. Seay	TVA
H. Ray Threlkeld	TVA
Lyman Heller	NRC
W. D. Kovacs	National Bureau of Standards
I. M. Idriss	Woodward-Clyde Consultants
M. A. Miller	NRC

ENCLOSURE 2



Italian Earthquakes.

Table 2

Selected Recordings for Site Specific M_L 5.8 ±0.5 Data Set

EARTHQUAKE	DATE Y M D	TIME H M S	MAGNITUDE MB	ML	MS	DEPTH (KM)	RECORDING STATION	USGS STAT NO	SITE CLAS	DISTANCE TO: HYPOC (KM)	EPIC (KM)	RUPT (KM)	RECORD	COMP	PEAK ACCEL VOL 1 (G)	VOL 2 CM/S/S
LYTLE CREEK, CALIF.	70 912	63053	5.2	5.4		8.0	6074 PARK DRIVE WRIGHTWOOD, CA	290	BAB	15.4	13.2		W334	S65E	.146	139.0
													W334	S25W	.205	194.4
FRIULI SEQUENCE	76 5 9	05348	5.1	5.5		1.0	FORGARIA-CORN., ITALY	8014	ABB	25.2	25.2		F051	NORT	.043	42.2
													F051	EAST	.037	34.7
							MAIANO (CNEN), ITALY	8015	ACB	24.8	24.8		F052	NORT	.084	80.1
													F052	EAST	.048	44.9
							TOLMEZZO, ITALY - ENEL FIXED	8012	ABB	22.0	22.0		F054	NORT	.041	36.2
													F054	EAST	.035	31.3
FRIULI SEQUENCE	76 511	2244 2	5.2	5.3		19.0	FORGARIA-CORN., ITALY	8014	ABB	21.3	9.7		F059	NORT	.190	182.7
													F059	EAST	.308	299.4
							MAIANO (CNEN), ITALY	8015	ACB	22.4	11.8		F060	NORT	.075	68.6
													F060	EAST	.082	67.5
							TARCENTO, ITALY	8011	ABB	22.3	11.7		F061	NORT	.036	35.0
													F061	EAST	.077	69.6
							TOLMEZZO, ITALY - ENEL FIXED	8012	ABB	23.2	13.4		F063	NORT	.030	27.8
													F063	EAST	.032	26.9
FRIULI SEQUENCE	76 911	163112	5.2	5.5	5.5	9.0	FORGARIA-CORN., ITALY	8014	ABB	18.2	15.8		F131	NORT	.095	92.1
													F131	EAST	.115	105.6
							TARCENTO, ITALY	8011	ABB	11.7	7.5		F133	NORT	.204	201.6
													F133	EAST	.105	93.9
FRIULI SEQUENCE	76 911	1635 0	5.3	5.9	5.4	6.0	FORGARIA-CORN., ITALY	8014	ABB	15.7	14.5		F138	NORT	.131	119.7
													F138	EAST	.233	223.7
FRIULI SEQUENCE	76 915	31519	5.7	6.1	6.0	9.0	FORGARIA-CORN., ITALY	8014	ABB	13.5	10.0		F152	NORT	.263	255.0
													F152	EAST	.218	208.0
FRIULI SEQUENCE	76 915	92118	5.4	6.0	5.9	12.0	TARCENTO, ITALY	8011	ABB	22.5	19.0		F172	NORT	.139	135.1
													F172	EAST	.110	108.3
							FORGARIA-CORN., ITALY	8014	ABB	23.3	20.0		F168	NORT	.353	337.5
													F168	EAST	.335	323.8
LIVERMORE SEQUENCE : SHOCK A	80 124	11 0 9	5.3	5.9	5.9	5.9	DEL VALLE DAM	1265	ABB	25.9	25.2	12.9	LA23	S66W	.240	249.9
													LA23	S24E	.140	126.7

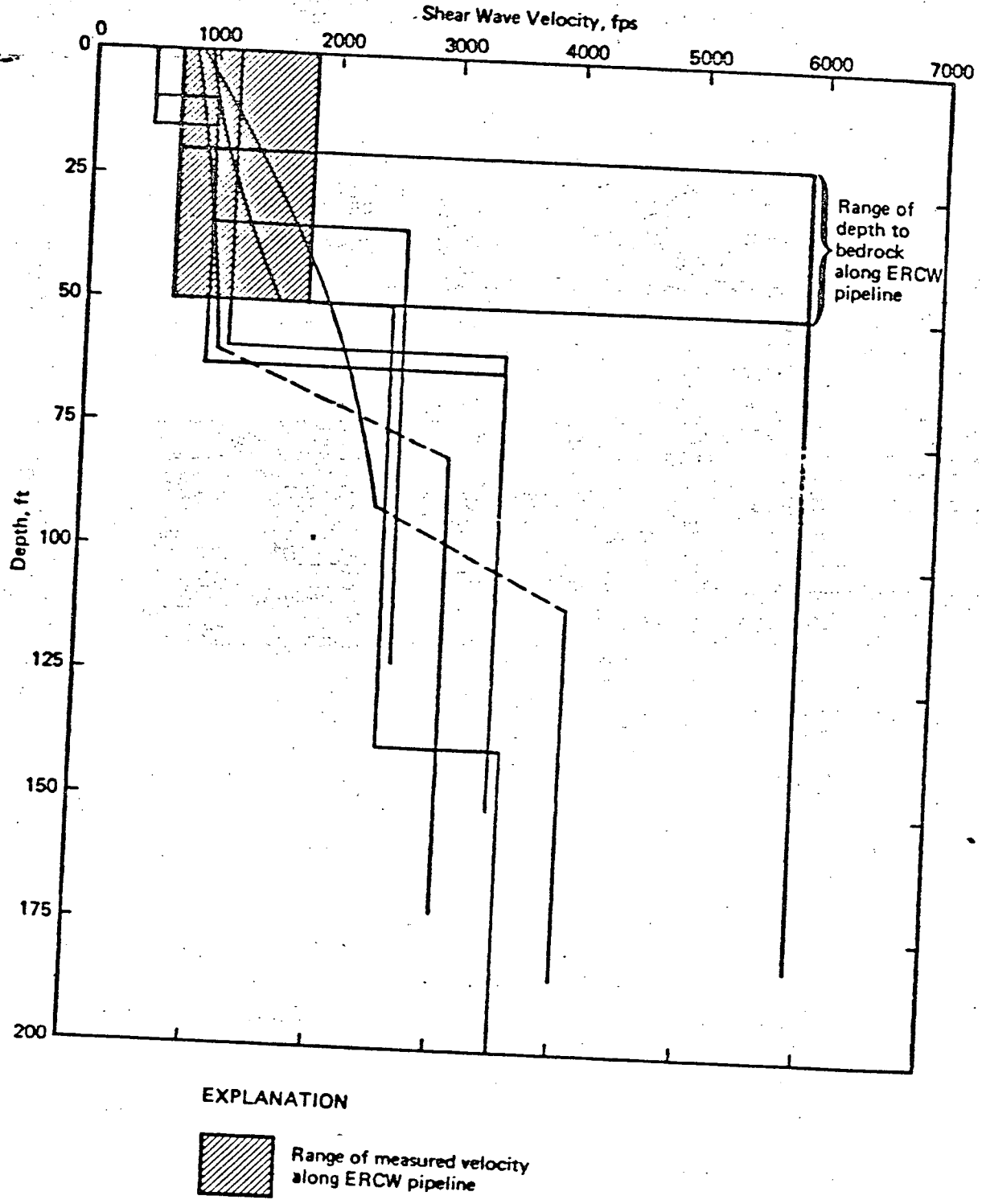
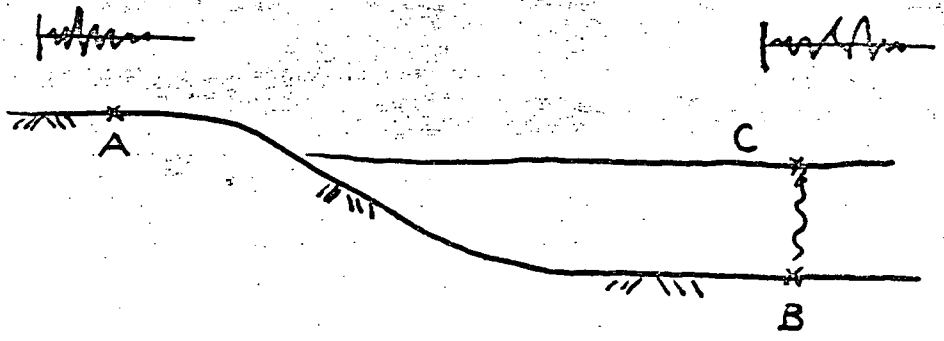
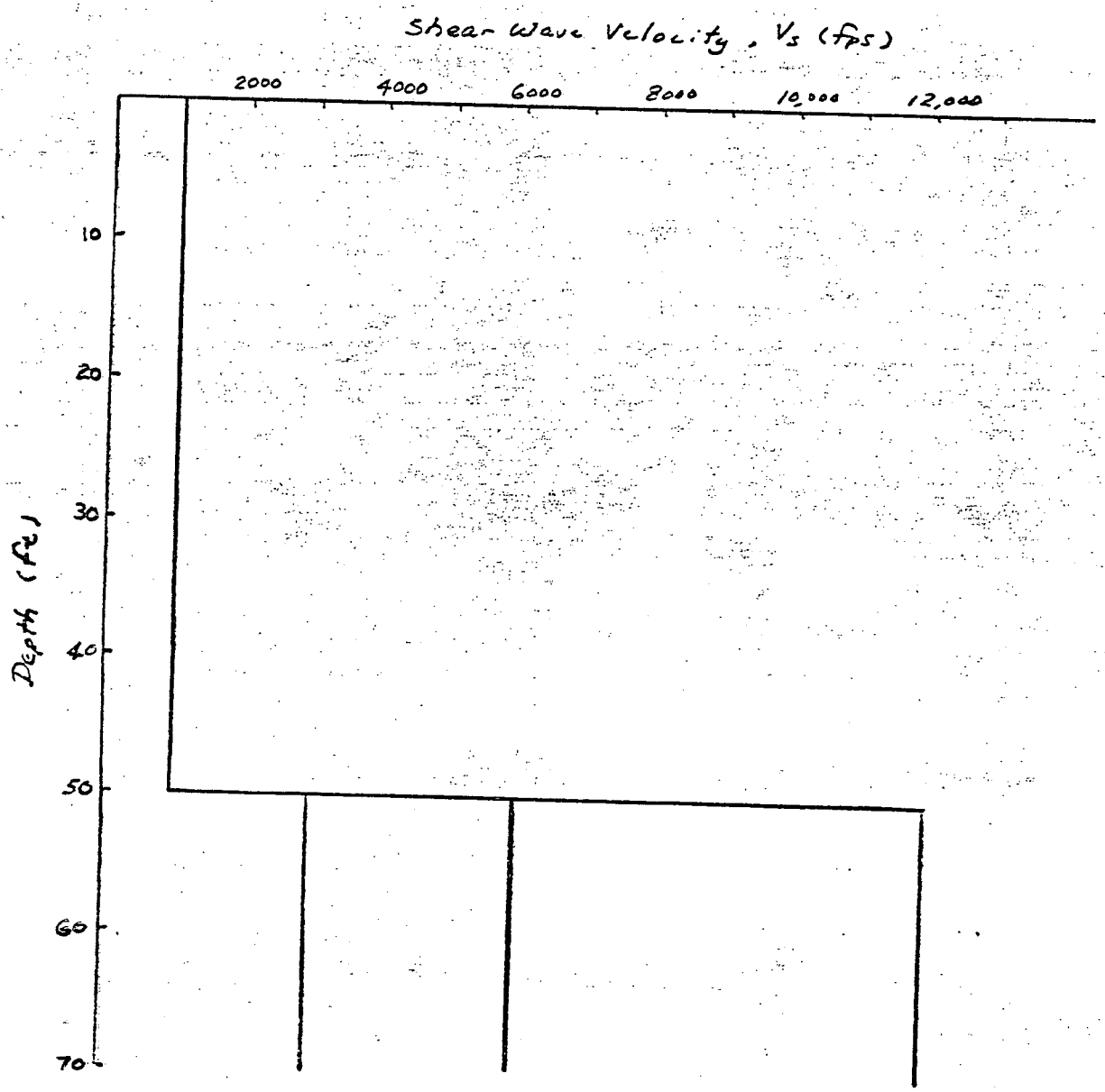


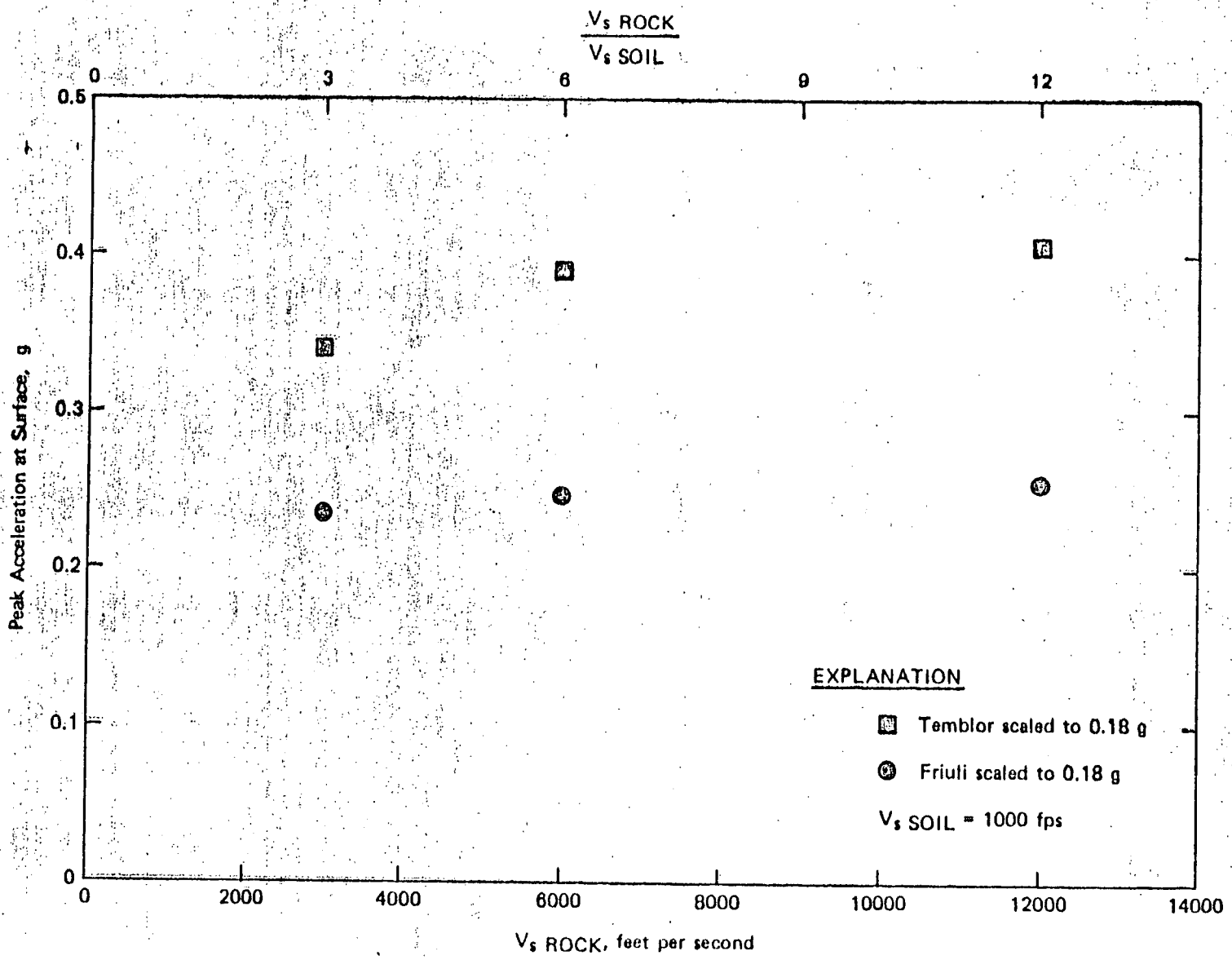
Figure 2 – Overplot of Shear Wave Velocity Profiles for Selected Recording Stations

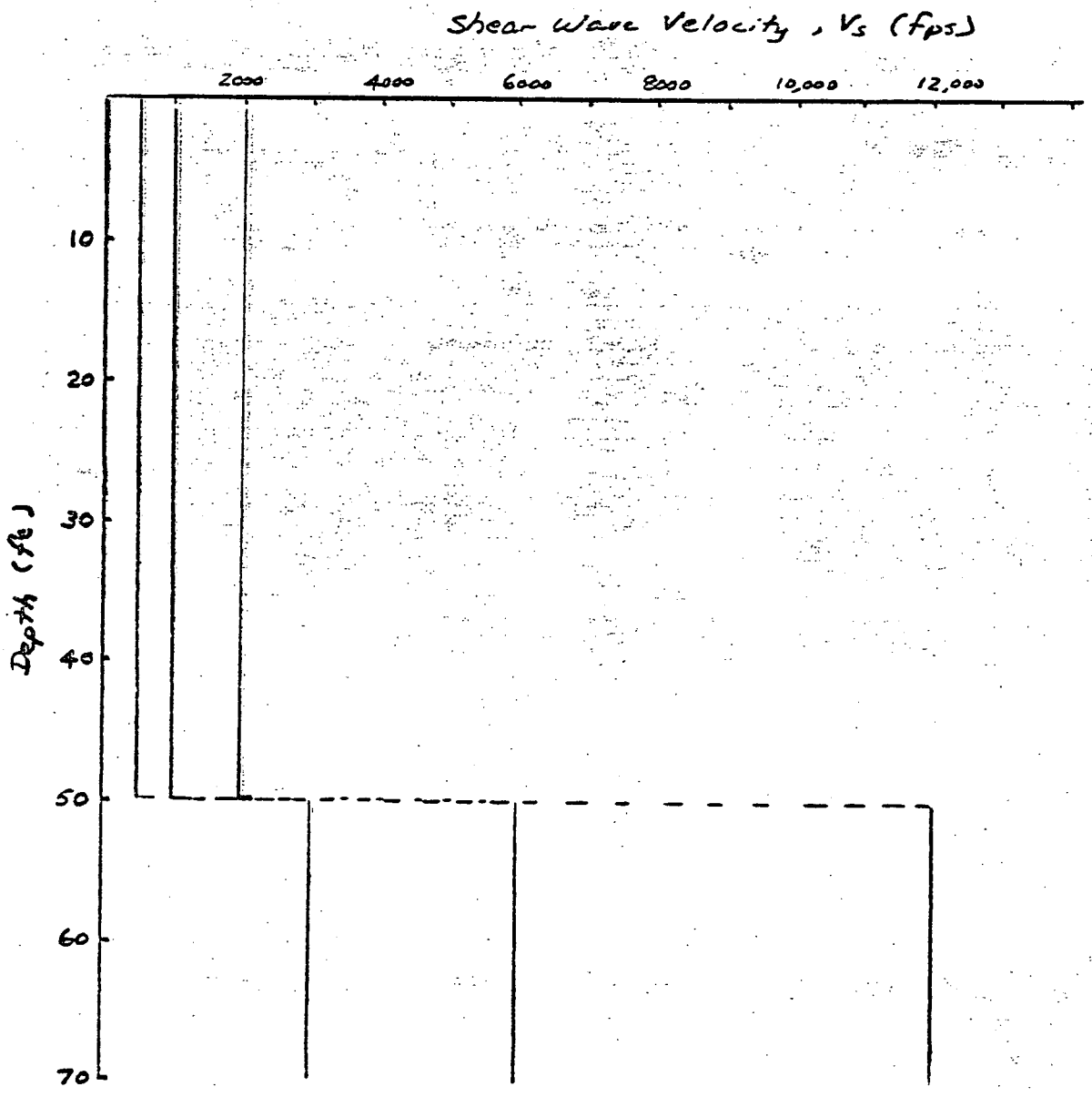


Ground Response Analysis



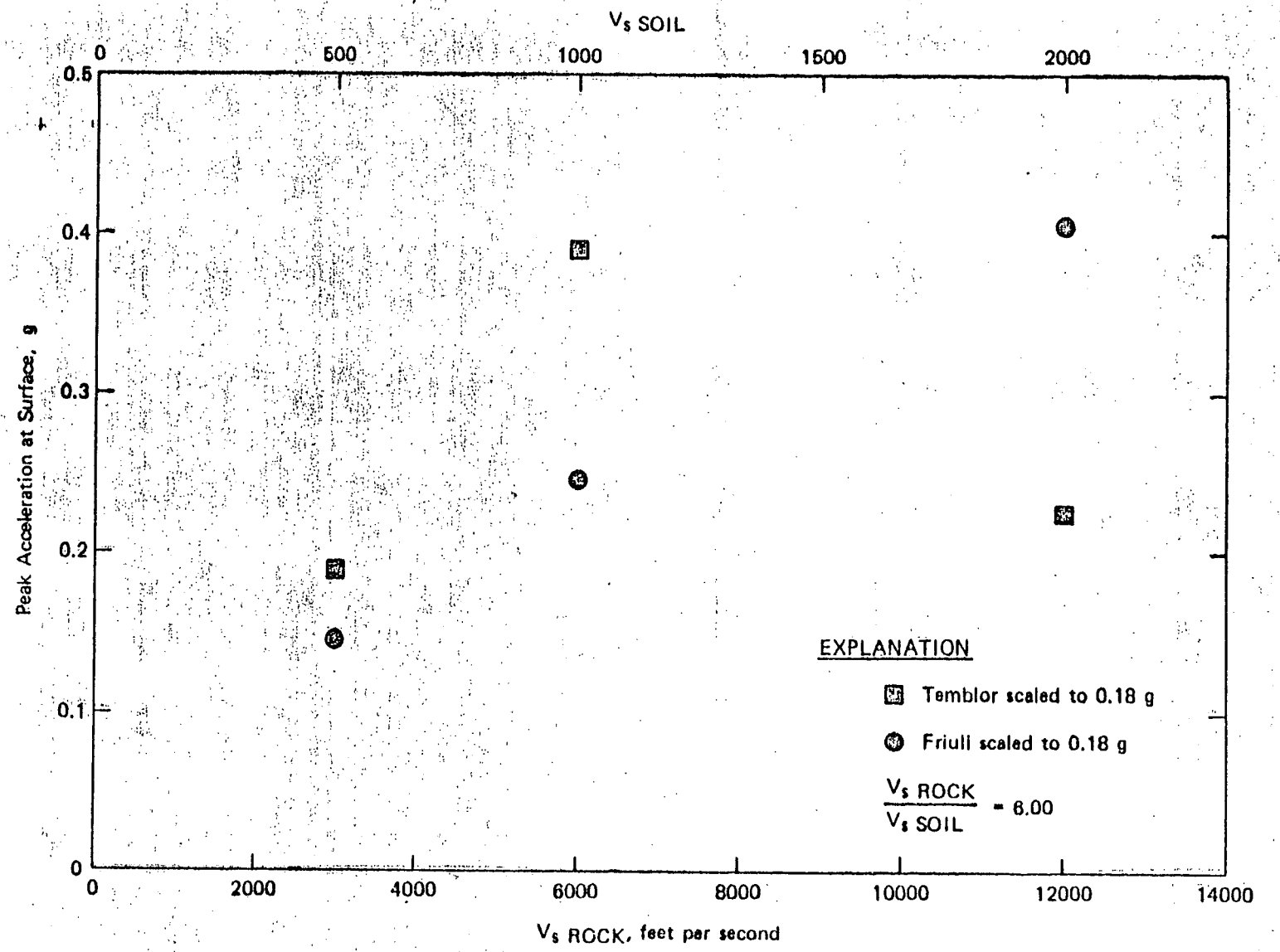
Various Shear Wave Velocity Contrasts Examined
($V_{s\,rock} / V_{s\,soil}$ = 3:1, 6:1, 12:1)


$\frac{V_s \text{ ROCK}}{V_s \text{ SOIL}}$
0
3
6
9
12
0.5
0.4
0.3
0.2
0.1
0
Peak Acceleration at Surface, g
EXPLANATION
Temblor scaled to 0.18 g
Friuli scaled to 0.18 g
V_s SOIL = 1000 fps
0
2000
4000
6000
8000
10000
12000
14000
V_s ROCK, feet per second



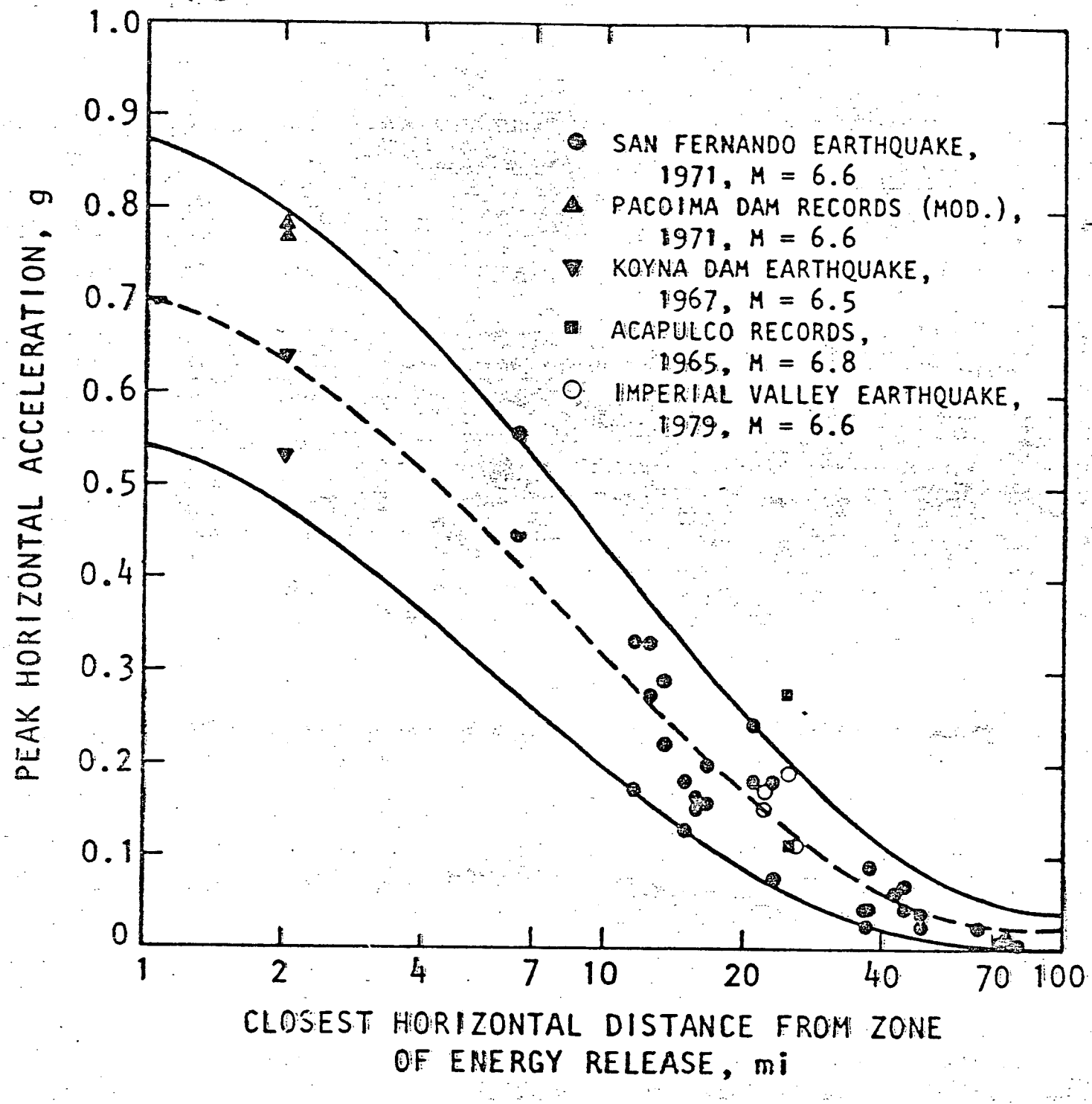
Various Shear Wave Velocity Profiles Examined

($V_{s\,rock}$ / $V_{s\,soil}$ = 6 : 1)

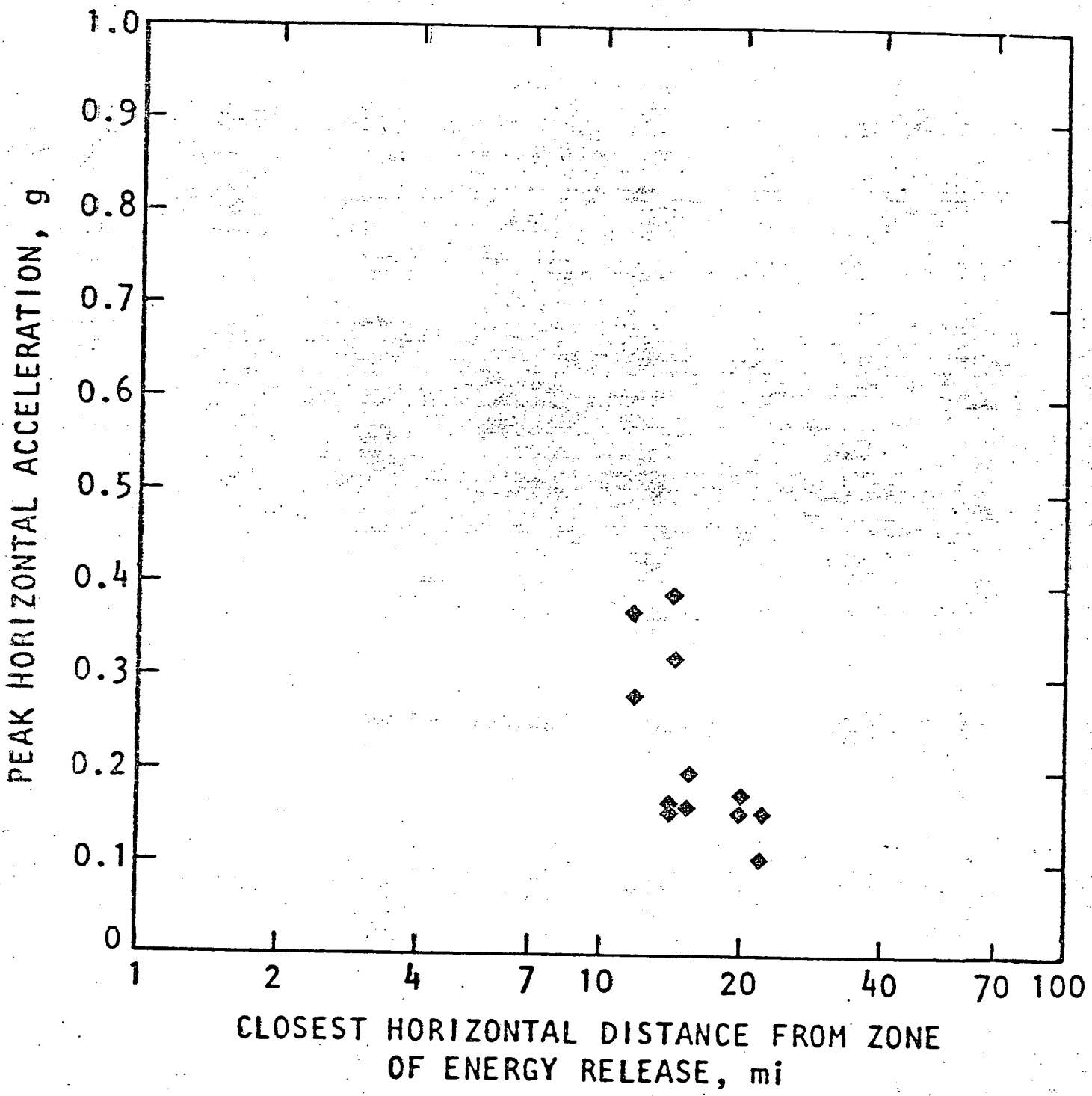

V_s SOIL
0
500
1000
1500
2000
0.5
0.4
0.3
0.2
0.1
0
Peak Acceleration at Surface, g
0
2000
4000
6000
8000
10000
12000
14000
V_s ROCK, feet per second
EXPLANATION
Temblor scaled to 0.18 g
Friuli scaled to 0.18 g
$\frac{V_s \text{ ROCK}}{V_s \text{ SOIL}} = 6.00$

STATIONS CLASSIFIED AS SHALLOW SOIL BY CAMPBELL (1981)

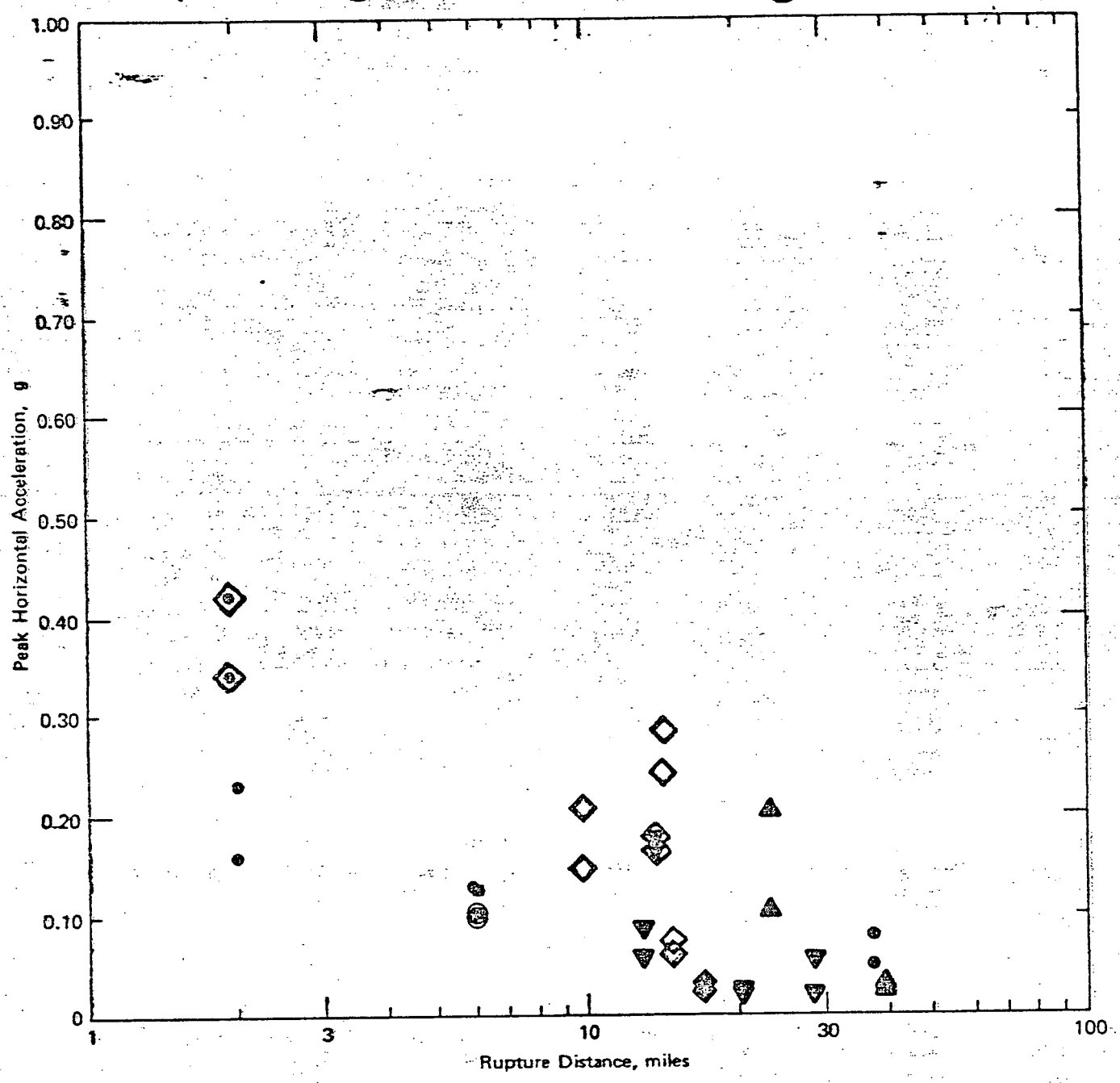
Magnitude	Station Name	Distance (km)	Acceleration (g's)	
5	Topanga Fire Station	18.1	0.09	0.07
5	Kilpatrick Boys School	20.2	0.07	0.06
5.4	Devils Canyon	19.	0.18	0.17
5.4	Wrightwood	15.	0.21	0.14
5.4	Cedar Springs	18.	0.073	0.062
5.7	Goleta Substation	11.8	0.28	0.24
5.7	Cachuma Dam Toe	25.9	0.07	0.07
5.9	Gilroy #6	4.	0.42	0.34
6.0	Cholame - Shendon, Temblor	10.6	0.41	0.29
6.6	Lake Hughes #4	24.9	0.19	0.16
6.6	Lake Hughes #9	22.6	0.16	0.15
6.6	Lake Hughes #12	18.7	0.37	0.28
6.6	Fairmont Reservoir	32.1	0.17	0.15
6.6	Castaic, Old Ridge Route	22.8	0.39	0.32
6.6	Pearblossom Pump Plant	35.5	0.15	0.10
7.1	Hilo, Hawaii	45.	0.22	0.11



From Seed & Idriss (1982) - Maximum accelerations in rock for earthquakes with magnitude ≈ 6.6



◇ Campbell (1981) - E sites - San Fernando EQ (Campbell distance to fault rupture & acceleration values)



- San Francisco — 1957 $M_L = 5.3$
- Ferndale, CA. — 1975 $M_S = 5.7$
- Lytle Creek, CA. — 1970 $M_L = 5.4$
- Oroville, CA. — 1975 $M_S = 5.6$
- Coyote Lake, CA. — 1979 $M_S = 5.6$
- Imperial Valley Aftershock — 1979 $M_S = 5.7$

} Rock Sites

- Campbell (1981) — E sites — Earthquakes with Magnitude 5¼ to 5¾

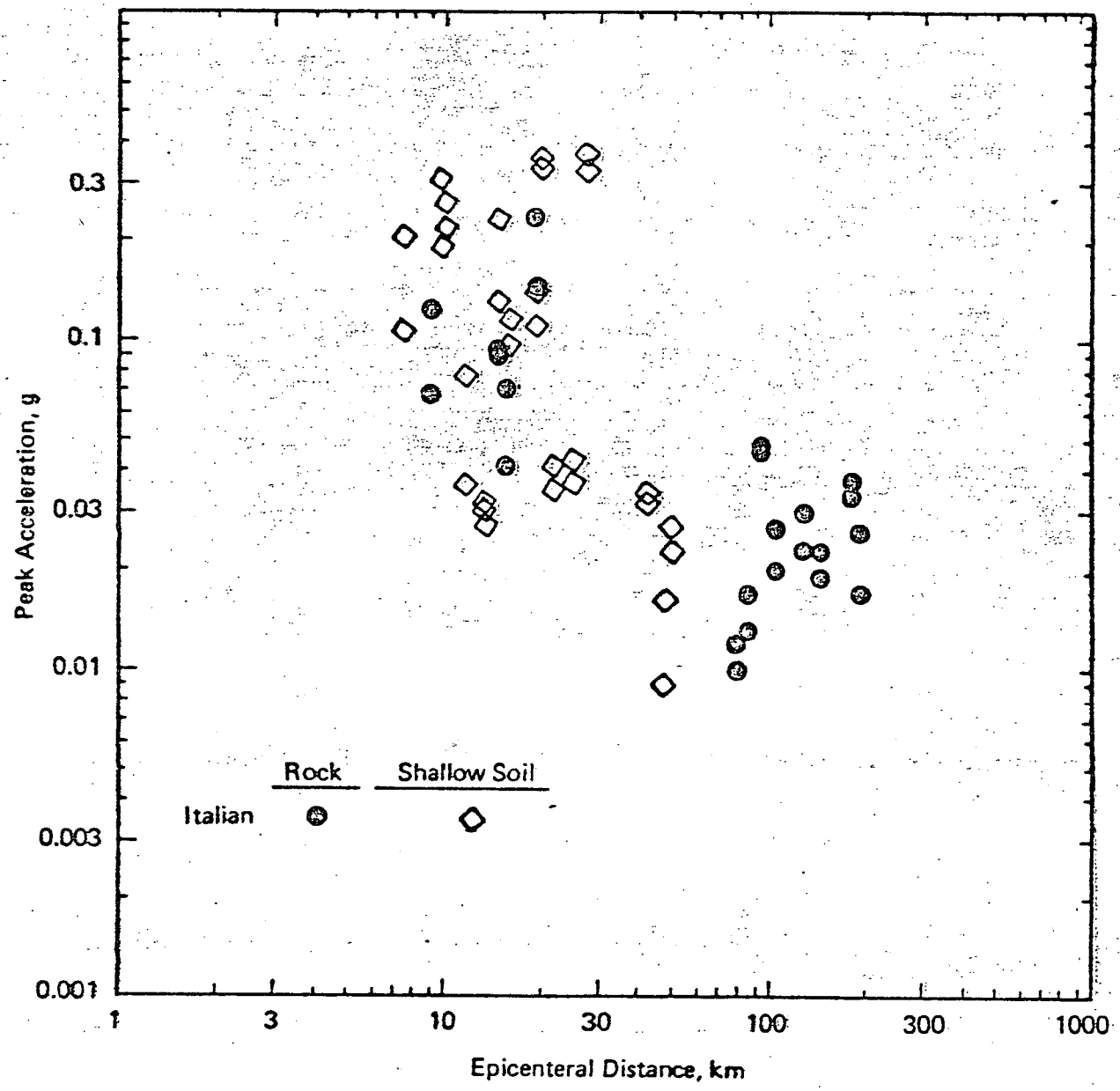
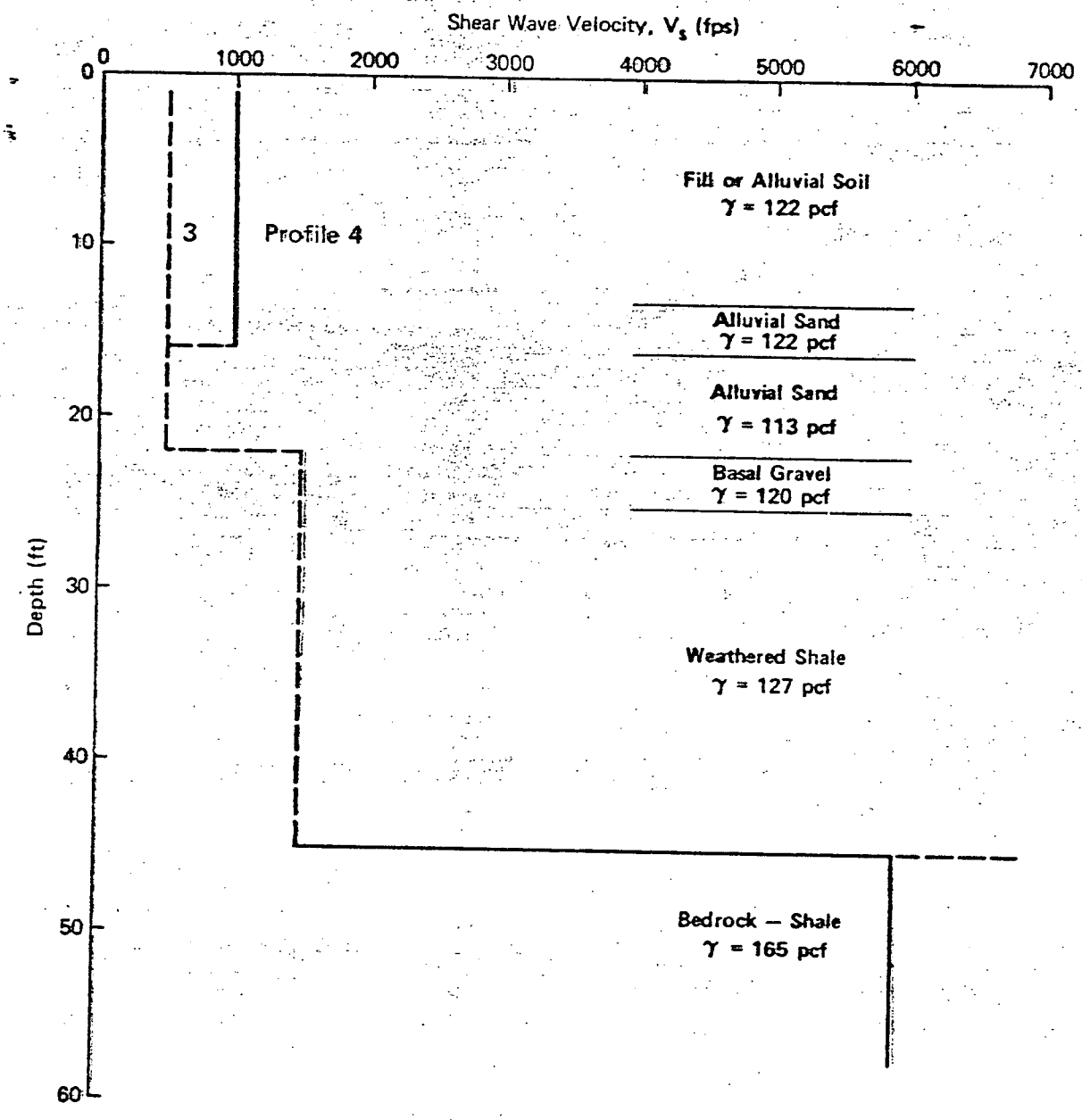


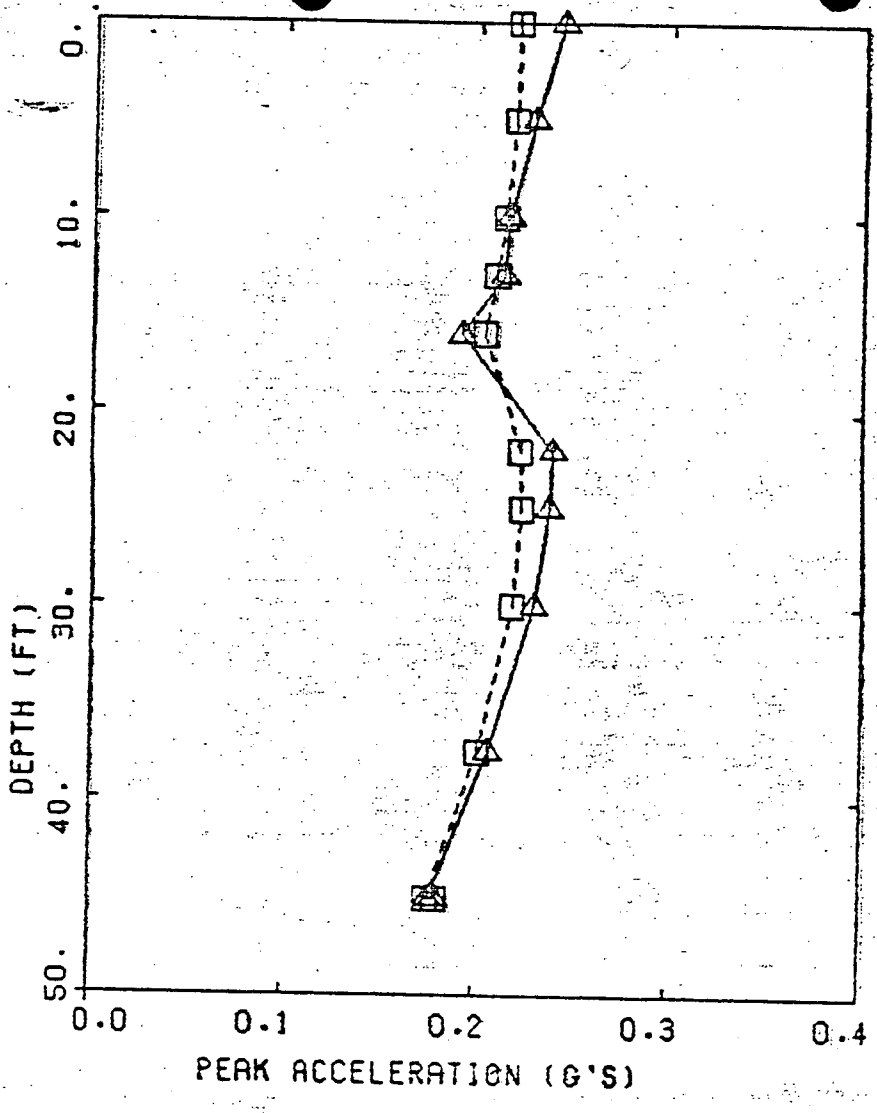
Figure 6 — Recordings from Friuli Sequence for Magnitude M_L 5.3 to 6.2



SHEAR WAVE VELOCITY PROFILES ALONG ERCW PIPELINE,
WATTS BAR N.P. SITE

Table 1
UPDATED SITE SPECIFIC TOP OF ROCK DATA SET

EARTHQUAKE	DATE Y M D	TIME H M S	MAGNITUDE MB	ML	MS	DEPTH (KM)	RECORDING STATION	USGS STAT NO	SITE CLAS	DISTANCE TO HYPOC (KM)	EPIC (KM)	RUPT (KM)	RECORD	COMP	PEAK ACCEL VOL 1 (G)	VOL 2 CM/S/S
SAN FRANCISCO	57 322	114421		5.3		8.5	SF GOLDEN GATE PARK	1117	ABA	14.8	11.7	9.8	A015	N10E	.105	81.9
													A015	S80E	.127	102.8
PARKFIELD, CALIF.	66 627	202614	5.8	5.6	6.4	8.0	TEMBLOR CA (OLD STATION PRE 1969)	1438	ABA	39.3	38.4	9.9	B037	N65W	.282	264.3
													B037	S25W	.411	340.6
LYTLE CREEK, CALIF.	70 912	63053	5.2	5.4		8.0	ALLEN RANCH CEDAR SPRINGS MILLE	111	AAA	20.6	18.9		W335	S85E	.086	69.9
													W335	S05W	.057	54.9
							DEVILS CANYON FILTER PLANT, CDWR S	116	AAA	21.9	20.4		W337	SOUT	.164	158.1
													W337	EAST	.179	162.0
OROVILLE CA MAIN SHOCK	75 8 1	122013	5.9	5.7	5.6	8.0	OROVILLE SEISMOGRAPH STATION	1051	AAA	14.9	12.6	9.5	OSSA	N53W	.103	103.2
													OSSA	N37E	.108	110.4
FRIULI SEQUENCE	76 911	163112	5.2	5.5	5.5	9.0	S. ROCCO, ITALY	8022	ABA	17.9	15.5		F132	NORT	.042	
													F132	EAST	.071	
FRIULI SEQUENCE	76 911	1635 0	5.3	5.9	5.4	6.0	S. ROCCO, ITALY	8022	ABA	15.7	14.5		F139	NORT	.091	87.9
													F139	EAST	.093	85.9
FRIULI SEQUENCE	76 915	31519	5.7	6.1	6.0	9.0	S. ROCCO, ITALY	8022	ABA	12.7	9.0		F153	NORT	.069	63.4
													F153	EAST	.123	120.8
FRIULI SEQUENCE	76 915	92118	5.4	6.0	5.9	12.0	S. ROCCO, ITALY	8022	ABA	22.5	19.0		F169	NORT	.146	136.2
													F169	EAST	.238	235.0
COYOTE LAKE, CA	79 8 6	10 522	5.3	5.7	5.6	9.6	COYOTE CREEK (C217)	1445	ABA	9.8	1.8	3.2	CL01	N70E	.230	
													CL01	N20W	.160	
							GILROY ARRAY STA #1	1408	ABA	18.4	15.7	9.3	CL02	S40E	.130	
													CL02	N50E	.100	
							GILROY ARRAY # 6 SAN YSIDRO	1413	ABA	14.1	10.3	3.1	CL06	S40E	.340	
													CL06	N50E	.420	
IMPERIAL AFTERS HOCK A31	791015	235843	5.2	5.5	5.7	9.1	SUPERSTITION MOUNTAIN	286	AAA	27.4	25.9		A31K	S45E	.031	
													A31K	N45E	.025	
LIVERMORE SEQUENCE SHOCK A	80 124	11 0 9	5.3	5.9	5.9	5.9	WALNUT CREEK FIDELITY SAVINGS	1530	DBA	26.2	24.2	33.1	LA04	S00E	.027	
													LA04	S90E	.031	
MAMMOTH LAKES SHOCK A	80 525	93345	6.1	6.1	6.1	8.9	LONG VALLEY DAM FREE FIELD	1444	AAA	15.6	12.8		ML04	N90E	.069	
													ML04	N00E	.110	
MAMMOTH LAKES SHOCK B	80 525	94927	5.5	6.0		13.8	LONG VALLEY DAM FREE FIELD	1444	AAA	24.4	20.1		ML14	N90E	.010	
													ML14	N00E	.040	
MAMMOTH LAKES SHOCK C	80 525	124451	5.5	6.1	5.8	16.4	LONG VALLEY DAM FREE FIELD	1444	AAA	19.9	11.9		ML23	N90E	.062	
													ML23	N00E	.110	
MAMMOTH LAKES SHOCK D	80 527	75057	5.7	6.2	6.0	14.2	LONG VALLEY DAM FREE FIELD	1444	AAA	20.0	14.0		ML33	N90E	.172	
													ML33	N00E	.243	
							COMG TEMP STAT AT PARADISE LODGE	19	AAA	24.5	20.0		ML34	S30E	.119	
													ML34	N60E	.090	

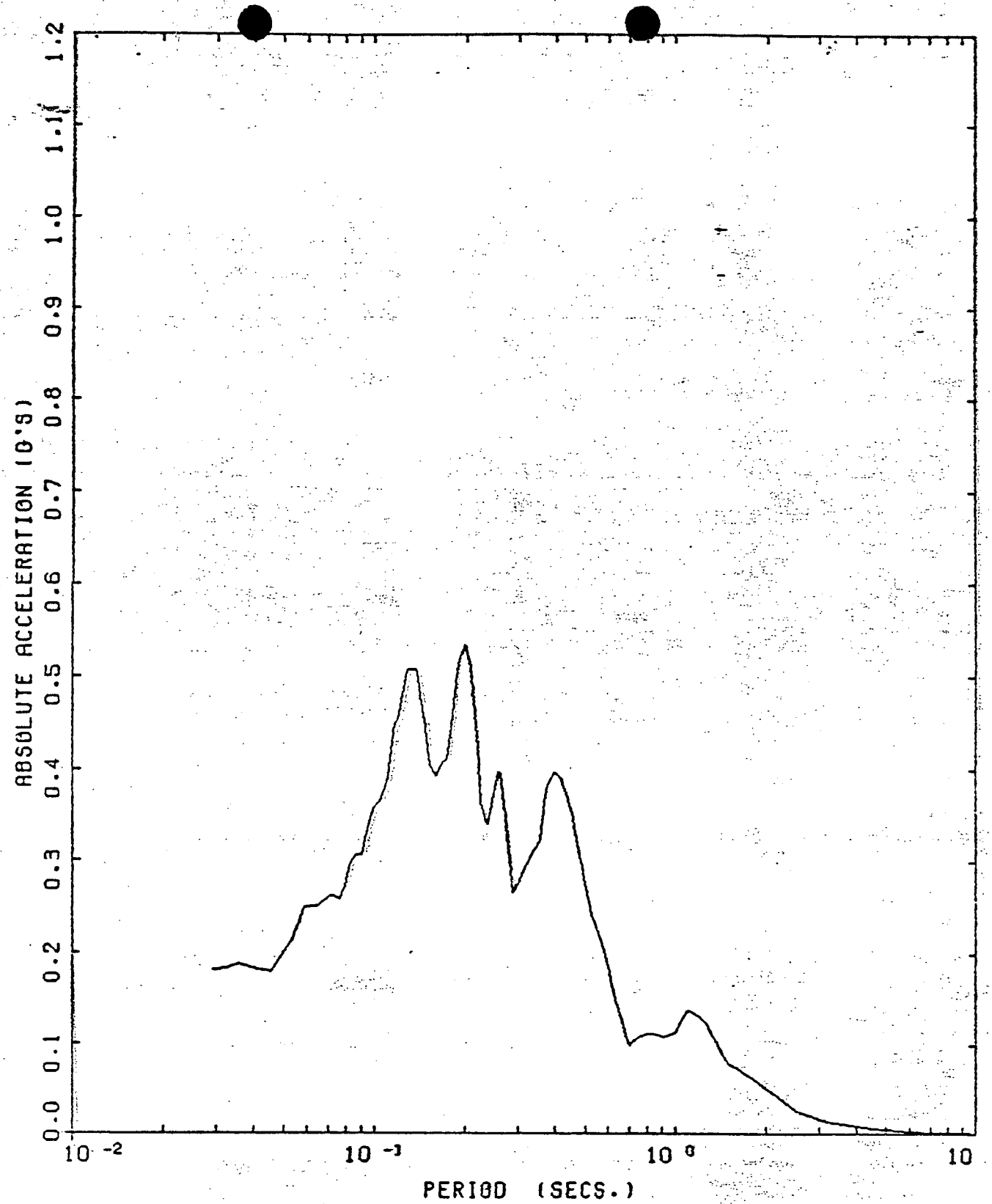


PROFILES 3 AND 4
FRIULI 169 EAST

LEGEND

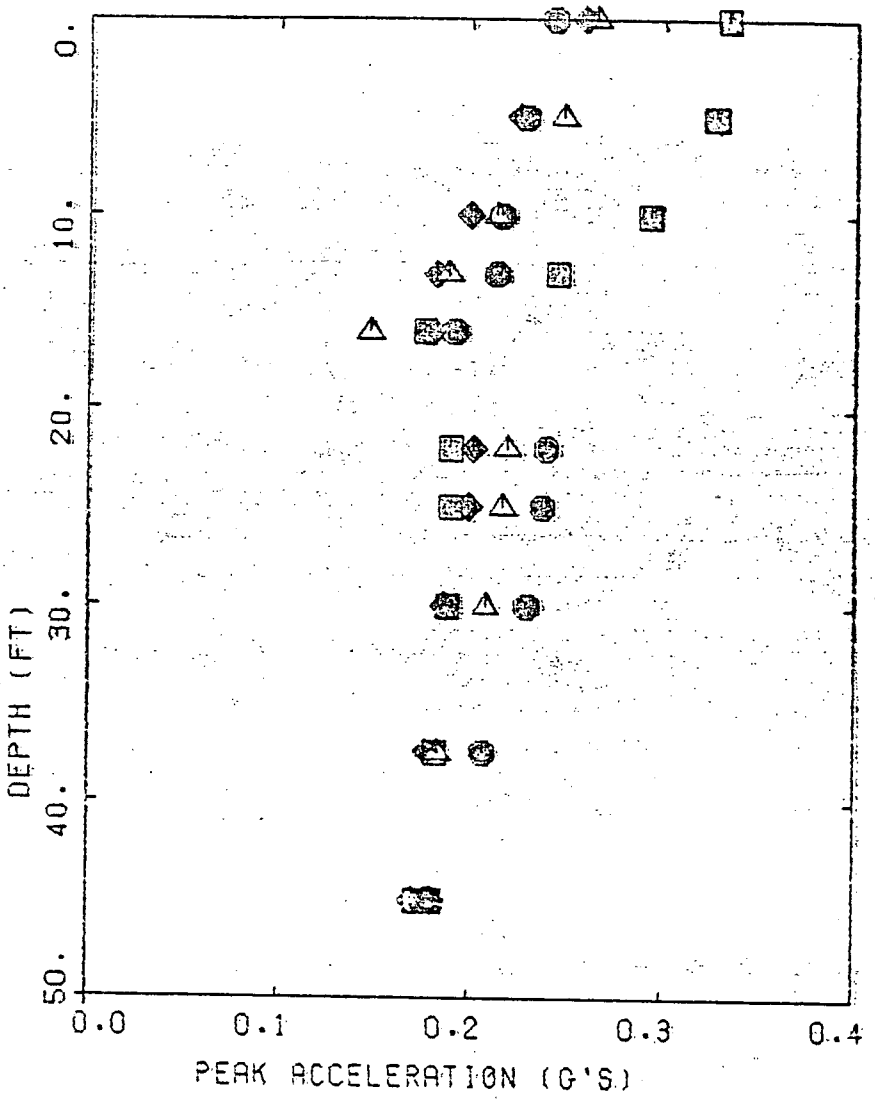
MAX ACCEL - CASE3B

MAX ACCEL - CASE4B



FRIULI INPUT MOTION
TVA WATTS BAR

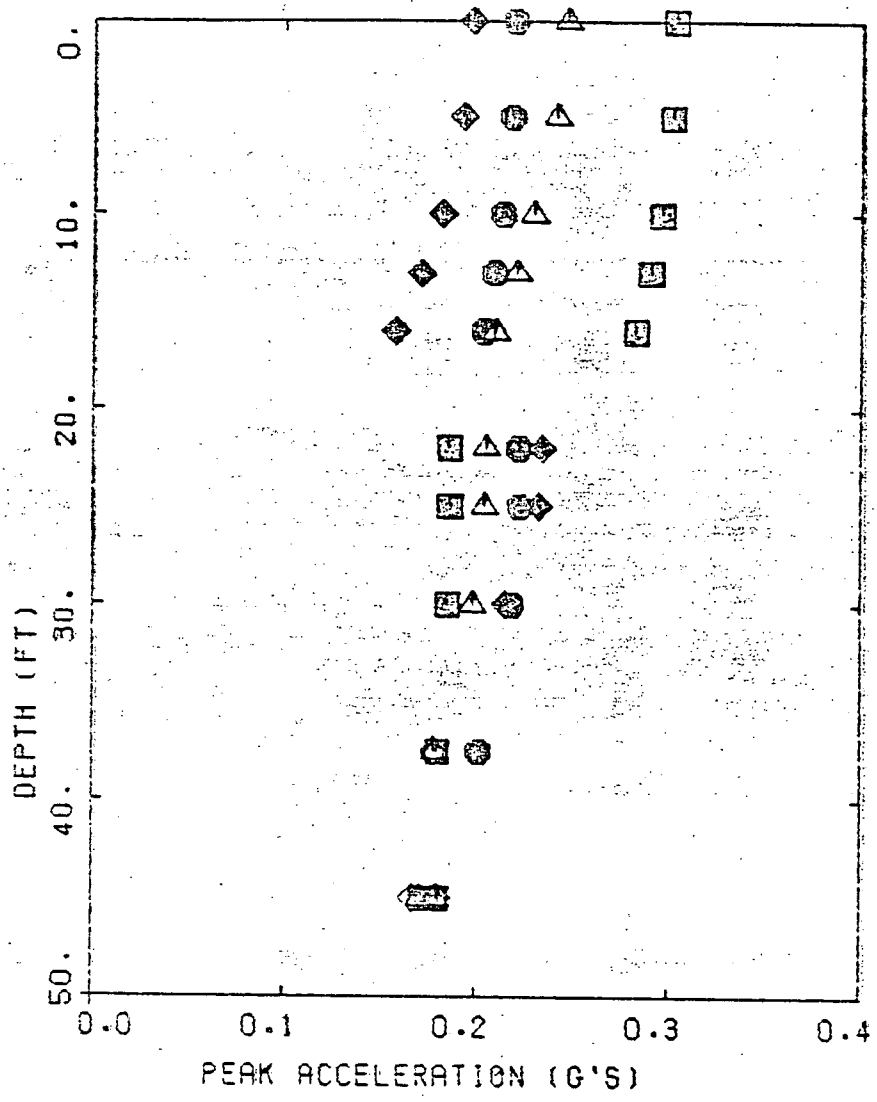
—— 5%. FRIULI EARTHQUAKE



PROFILE 3

LEGEND

▣ MAX ACCEL -	PROF3	Temblor
◍ MAX ACCEL -	CASE3B	Friuli
⚠ MAX ACCEL -	CASE3C	Lytle Creek
◆ MAX ACCEL -	CASE3D	Oraville

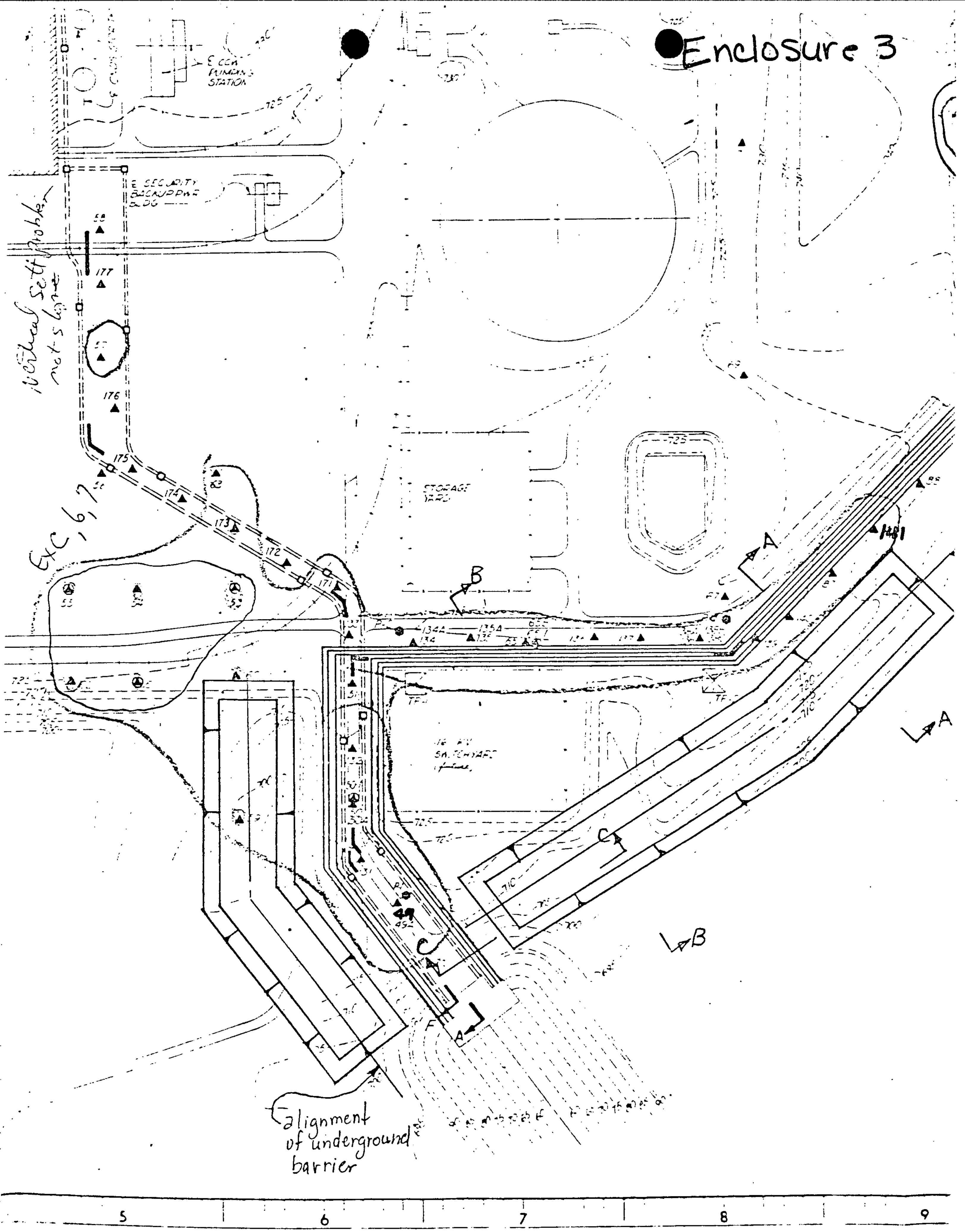


PROFILE 4

LEGEND

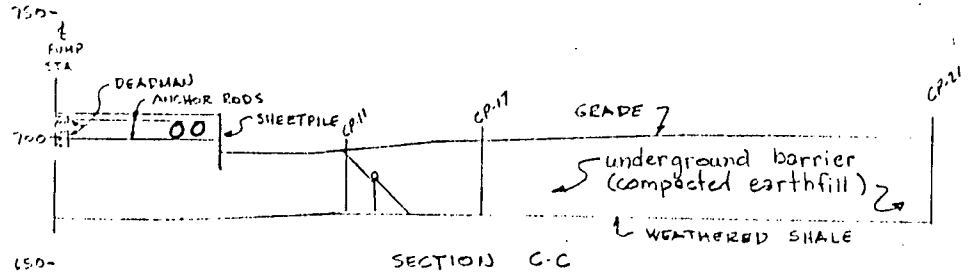
▣	MAX ACCEL -	PROF4	Temblor
●	MAX ACCEL -	CASE4B	Friuli
△	MAX ACCEL -	CASE4C	Lytle Creek
◆	MAX ACCEL -	CASE4D	Oroville

Enclosure 3

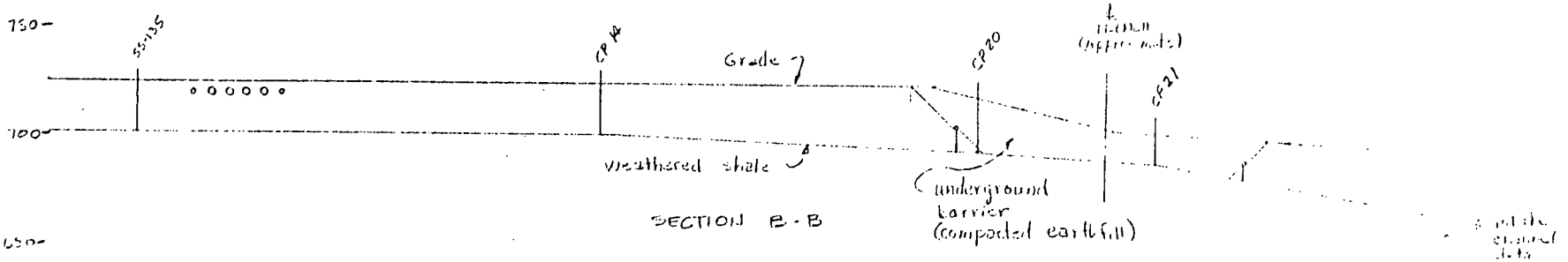


STORAGE YARD
EXC, 6, 7
alignment of underground barrier
5
6
7
8
9

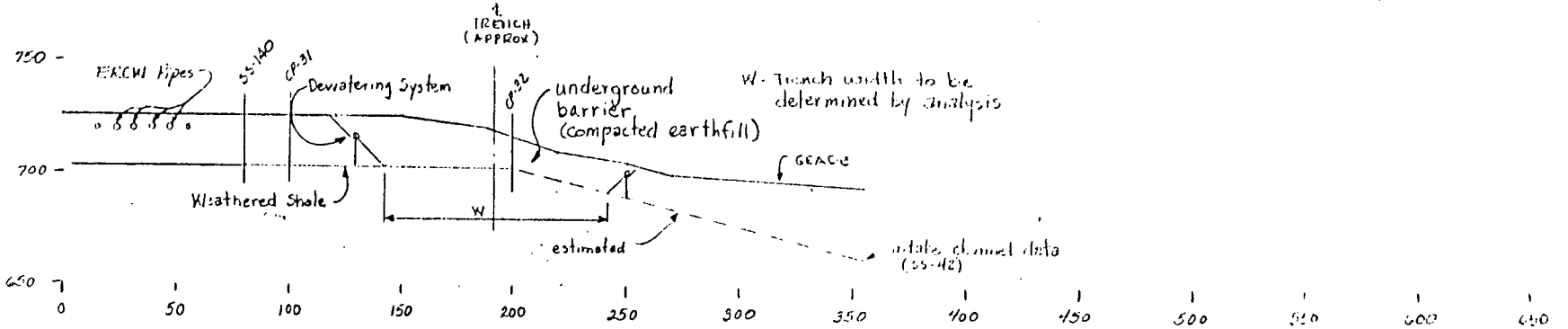
Barrier Cross-sections



SECTION C-C



SECTION B-B



SECTION A-A

Exhibit D

Enclosure 4