

GEOLOGICAL SURVEY OPEN-FILE REPORT 87-616

**STRONG-MOTION DATA FROM THE
OCTOBER 1, 1987 WHITTIER NARROWS EARTHQUAKE**

By

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OCTOBER 1987

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STRONG-MOTION DATA FROM THE OCTOBER 1, 1987
WHITTIER NARROWS EARTHQUAKE

INTRODUCTION

The magnitude (M_L) 6.1 Whittier Narrows earthquake of October 1, 1987, triggered strong-motion instrumentation at 52 stations operated in the Los Angeles area as part of the National Strong-Motion Instrumentation Network (NSMIN). The purpose of this report is to provide information about the data recorded during the earthquake, including a table of peak accelerations and copies of the original records. The NSMIN is operated as a cooperative program and incorporates instrumentation owned by the U.S. Geological Survey (USGS) and numerous other organizations, including the Metropolitan Water District of Southern California (MWD), Army Corps of Engineers (ACOE), Veterans Administration (VA), Department of Energy (DOE), California Department of Transportation (CDOT), and several private building owners.

Interested readers of this document should be aware that significant collections of strong-motion data for this earthquake will be forthcoming from other organizations, among them the California Division of Mines and Geology, California Institute of Technology, Los Angeles County Flood Control District, Los Angeles Department of Water and Power, Southern California Edison, University of Southern California, U.S. Navy, and numerous municipalities where high-rise buildings were instrumented to comply with seismograph provisions of the building code.

A strong-motion station is defined as all the instrumentation operated at a location; thus, a minimum of 3 data channels at a ground station or a maximum of 48 data channels where two adjacent structures and associated ground sites are instrumented, such as in Norwalk. Consequently, among the 52 stations there was a potential of 362 data channels, of which 358 successfully

recorded the earthquake. One failure occurred at Carbon Canyon dam, where an unidentified triggering of the downstream instrument before the earthquake ran off 25 feet of film that jammed the take-up magazine. In a second instance, channel 18 at Norwalk failed 4 seconds after triggering. That sensor, installed on the building frame above ceiling panels, has yet to be inspected; but based upon the nature of the record at the point of failure, we suspect that it was caused by impact or cable breakage.

THE STRONG-MOTION NETWORK

The strong-motion network in the Los Angeles area includes two general categories; ground stations and structural recording stations. Ground stations consist of triaxial accelerographs that are generally, though not exclusively, installed in smaller buildings. At these locations the equipment is located only at the foundation level. In other instances ground instruments are placed on concrete pads in small fiberglass transformer housings to ostensibly act as free-field sites.

Structural recording stations contain moderate or extensive instrumentation systems. The moderate instrumentation consists of two or more triaxial accelerographs installed on or in a structure -- typified in this report by buildings in Whittier, Norwalk, Los Angeles, and several ACOE dams in the region.

Extensively instrumented structures are those where sensors are strategically located throughout the structure, usually providing a minimum of 12 data channels, and allowing a comprehensive analysis of the structural behavior during an earthquake. Extensive recordings were obtained in buildings at Norwalk, Los Angeles, Newport Beach, and Loma Linda, and at Live Oak reservoir and the Santa Ana River bridge. Instrumentation of the extensively

instrumented structures are included with their respective records later in this report.

STRONG-MOTION DATA AND RECORDS

Table 1 (see page 54) presents scaled peak accelerations for all recording components and is arranged in order of increasing epicentral distance, calculated using an epicenter at 34.058°N lat. and 18.077°W long. (Caltech). Column 1 provides a map index number to correlate the listings with Figure 1 (page 8), which shows stations out to 80 km, and Figure 2 (page 9), which shows recording stations in the epicentral area. Stations beyond 80-km have yet to be checked for triggerings. Figure 3, from page 10 through 53, shows copies of the records and associated structure drawings, also arranged by increasing epicentral distance.

Garvey Reservoir (#1), the closest station, is a ground site located on rock 3 km from the epicenter; peak accelerations were 0.47 g horizontal and 0.38 g vertical. The record exhibits strong high-frequency motion during the first 6 seconds of the earthquake.

The recording from the Whittier Narrows dam (#2) upstream site, 4-km epicentral distance, shows the same high-frequency vertical characteristics; peak accelerations are 0.31 g horizontal and 0.46 g vertical.

There were two close-in buildings with moderate instrumentation, that is, accelerographs located at the basement, mid-level, and top of each structure. The Alhambra building (#3) is a twelve-story steel frame structure (8-km epicentral distance) where accelerations reached 0.30 g in the basement and 0.47 g on the sixth floor. Accelerations at this station during the 1971 San Fernando earthquake were 0.13 g in the basement and 0.18 g on the 12th floor (Maley and Cloud, 1971). The Whittier building (#4) is a ten-story

reinforced concrete residence home (10-km epicentral distance) where the highest accelerations recorded in the USGS network were 0.63 g horizontal in the basement and 0.61 g horizontal on the 5th floor. At both buildings the duration of strong shaking was short, on the order of 2 to 4 seconds. At the time of the earthquake the Alhambra building was being retrofitted with an extensive recording system.

The USGS instrument at Vernon (#7) was located at the last remaining of the three original stations that recorded the 1933 Long Beach earthquake. The instrument, located in the basement of a six-story building, has now been removed pending demolition of the structure. Peak recorded accelerations at this site were 0.15 g in 1933, 0.11 g in the 1971 San Fernando earthquake, and 0.29 g horizontal and 0.17 g vertical during the Whittier Narrows earthquake (Neumann, 1935; Maley and Cloud, 1971). Concerning the other two 1933 stations, Long Beach was discontinued when the building was demolished, and the Subway Terminal station was removed when all operations in the tunnel were abandoned in the 1960's.

An interesting set of records was obtained from a seven-story building at 12440 Imperial Highway, Norwalk, jointly instrumented by the USGS and Bechtel Power Corporation. The structure is rectangular, 463 ft by 136 ft by 102 ft tall, and has a steel ductile moment resisting frame resting on a foundation of drilled-in-place caissons. The building has steel pan concrete floors and an exterior facing of pre-cast concrete panels.

Twenty-seven accelerometers were installed throughout the structure near the ceiling at the center and ends of floors 7, 4, 1, and basement, on the basement concrete slab, and near the bottom of a center column caisson 30 ft deep, (see page 18). Upper level sensors were attached to steel mounting plates welded to the frame at appropriate locations near column beam

connections. Basement accelerometers are bolted to the floor at the east and west ends and to the pier cap in the center of the building. The downhole accelerometers were installed during construction by strapping the sensor module to the bottom of a steel cage that was then lowered into the drill hole and oriented before the caisson concrete was poured. To our knowledge, this is the first time strong-motion sensors have been installed near the base of a pile foundation.

Four ground-level (free-field) accelerographs have been installed around the building in small fiberglass shelters. These instruments are located nominally 90 to 270 ft from the building and form the ground response network not only for that structure but also for an adjacent seven-story building instrumented with three triaxial accelerographs. The entire complex of eight accelerographs and 24 channels of remote transducer data are synchronized for simultaneous time by either common starting and time signals or by WWVB radio time (Maley and Etheredge, 1984).

Peak horizontal accelerations at the free-field sites ranged from 0.21 g to 0.29 g compared to 0.16 g at the bottom of the caisson and 0.20 g on the pier cap at the top of the caisson. The wave forms show general similarities at all five sites, although there are many smaller differences. The maximum acceleration was 0.41 g on the 7th floor.

The largest building in southern California instrumented under the USGS program is the steel frame 33-story 1100 Wilshire building (#11) in Los Angeles, 17 km west of the epicenter. The structure consists of a 23-story triangular office tower with glass curtain walls above an 11-story square parking structure clad in precast concrete panels. The design incorporates a rigid perimeter frame in both the garage and tower, supplemented by a common rigid frame in the core that connects the two configurations. The square base

is braced with coupled shear walls. The building rests on a ductile concrete frame below grade with the columns setting on massive concrete footings (Civil Engineering, 1986).

In a cooperative project with JCG Finance Corporation, the USGS installed accelerometers on the 33rd floor, on the 12th and 13th floor at the juncture of the square and triangular frames, at the street level, and in the basement (see page 22). Maximum horizontal ground accelerations were 0.18 g; those in the structure were measured in the 0.24 g to 0.26 g range on the 12th and 13 floors.

The 1010 ft MWD Santa Ana River Bridge (#43), located near Riverside at an epicentral distance of 59 km, was constructed with three 180 foot steel trusses on the north end and concrete piers on 50 foot centers at the south end. The bridge carries a 116 in diameter steel pipe used by MWD to carry import water from the Colorado River and northern California to almost half of southern California's 13 million people (Snyder and others, 1986). The structure was recently retrofitted with elastomeric bearings for base isolation. In conjunction with this project, accelerometers were placed on the truss section of the bridge below and above one bearing, at mid-span, on the abutment, and on nearby rock (see page 44). Although accelerations were relatively low, 0.05 g at the abutment and rock site and in the 0.13 g to 0.15 g range above and below the bearing, the records are of particular significance since they are the first to be obtained in the United States from a bridge fitted with a base isolation system.

Additional reports will be issued on this earthquake and the October 4 magnitude 5.5 aftershock, and will include the processing and analysis of significant records.

ACKNOWLEDGEMENTS

The National Strong-Motion Instrumentation Network includes cooperative programs with the Metropolitan Water District of Southern California, Army Corps of Engineers, Veterans Administration, Department of Energy, and several private building owners.

The USGS appreciates the assistance of numerous organizations that have allowed use of their facilities for the operation of strong-motion instrumentation.

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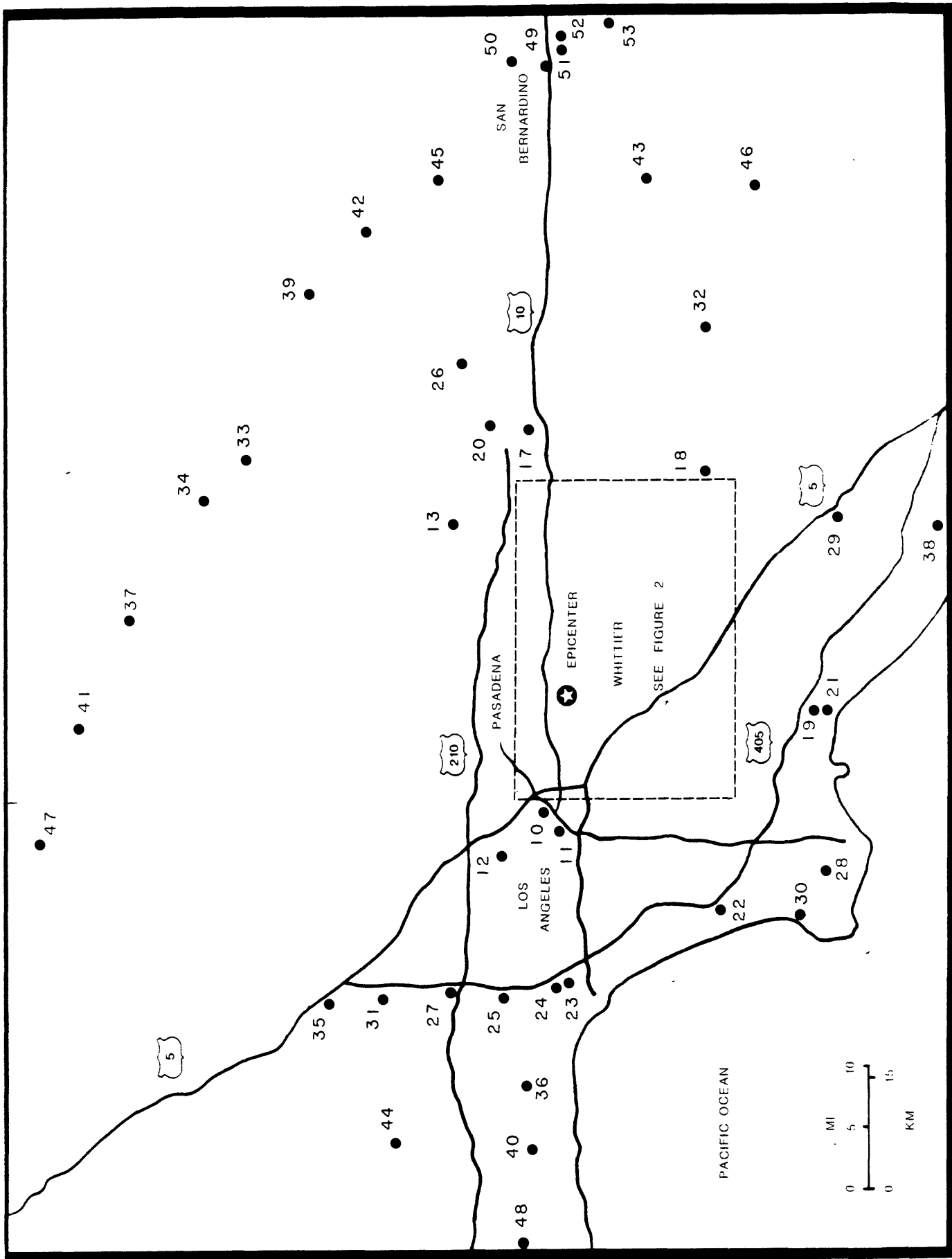


Figure 1. Regional map showing USGS stations triggered during the Whittier Narrows earthquake.

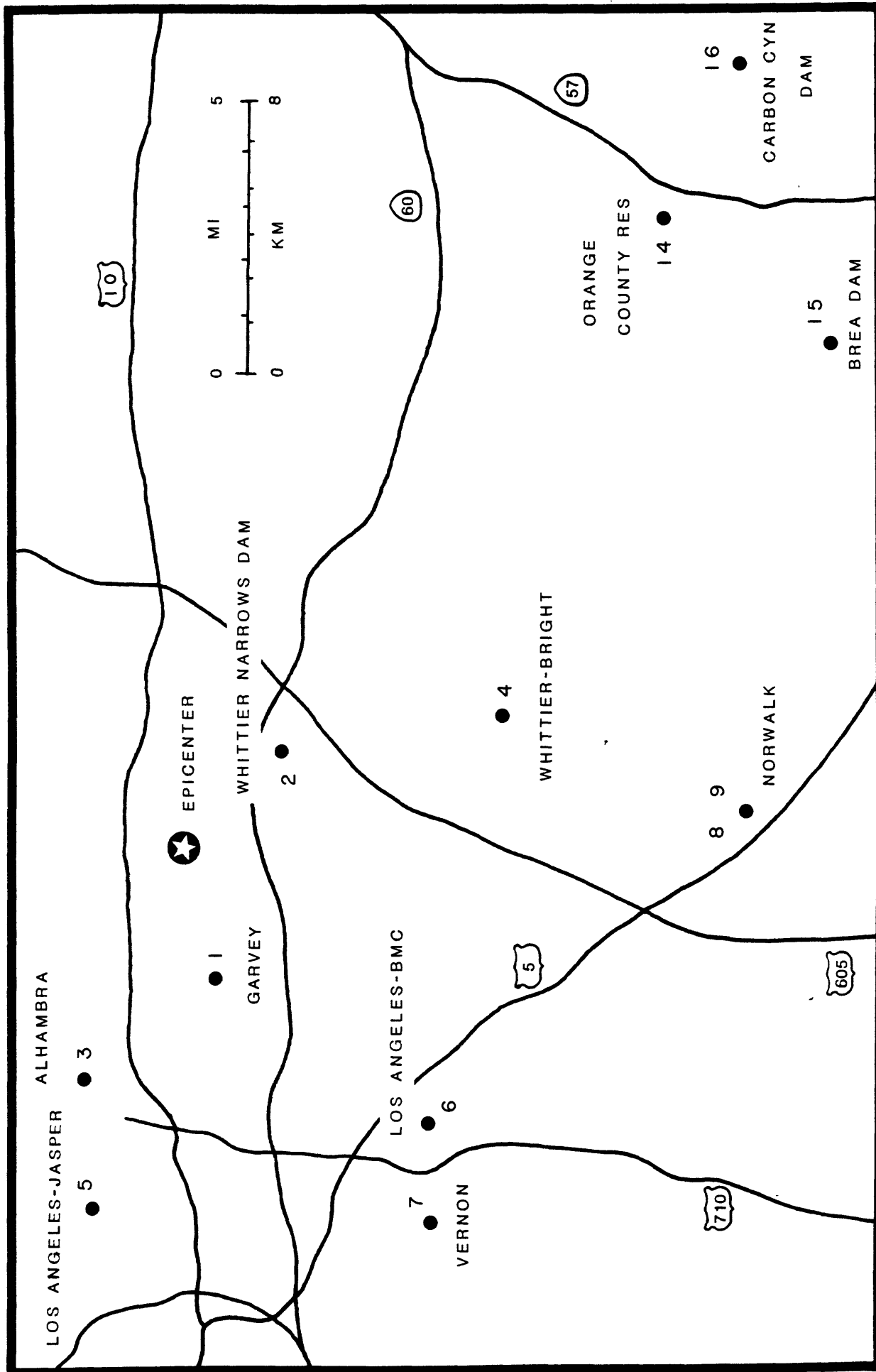
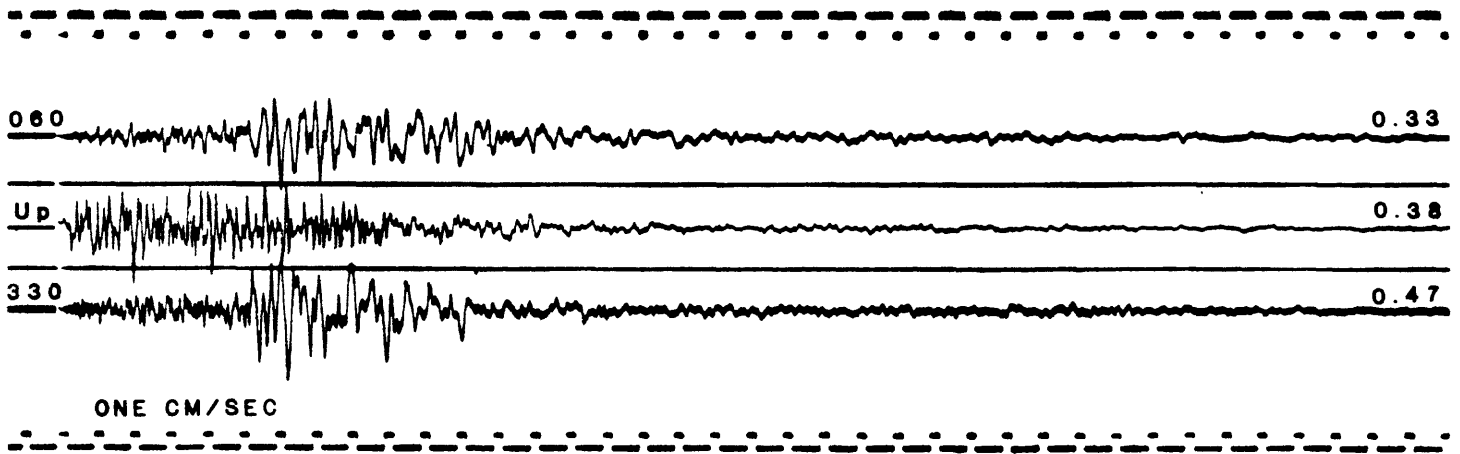


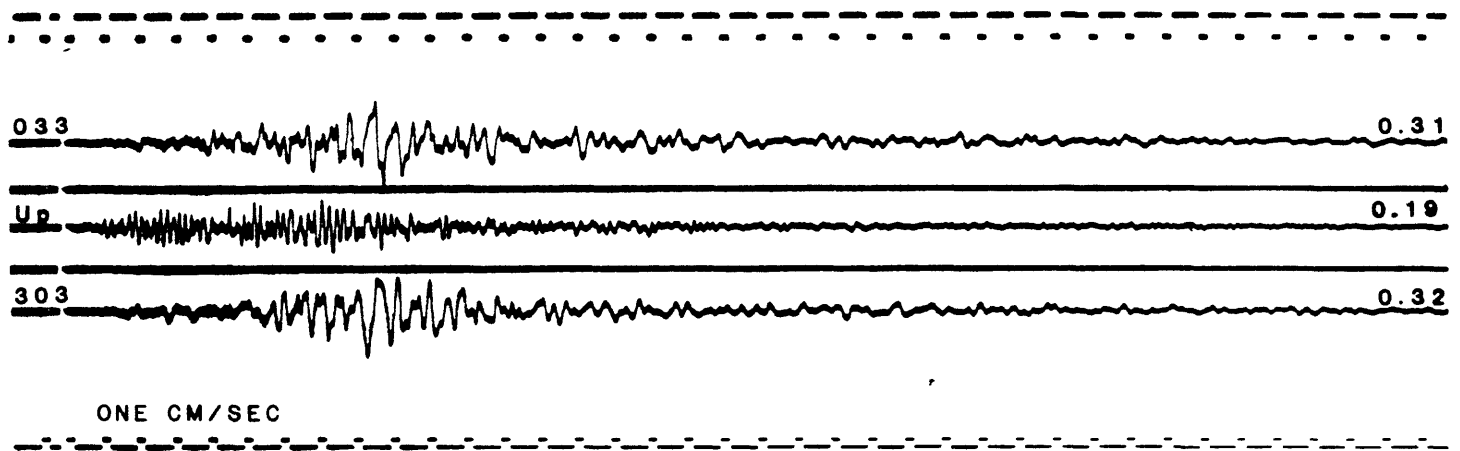
Figure 2. Close-in map of USGS stations triggered during the Whittier Narrows earthquake.

GARVEY RESERVOIR, ABUTMENT BLDG



WHITTIER NARROWS DAM

Crest



Upstream

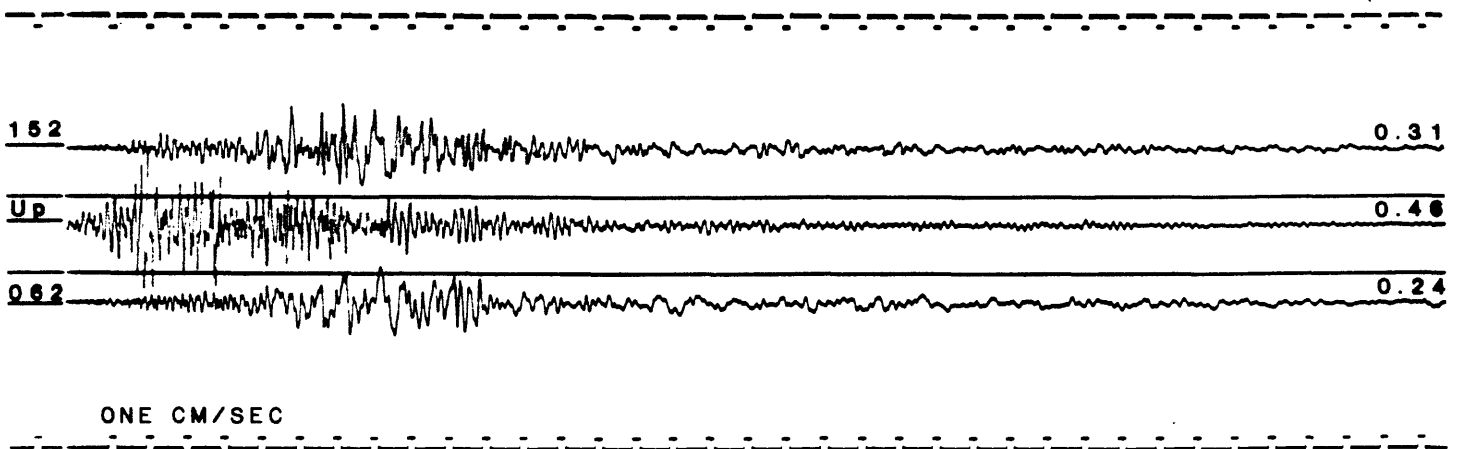
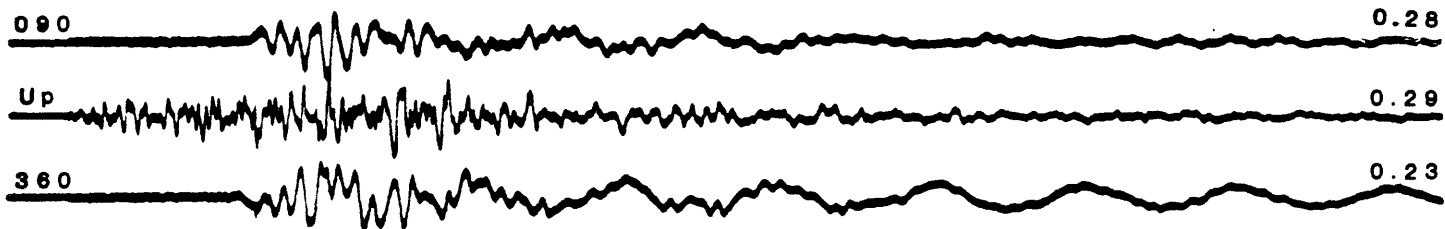
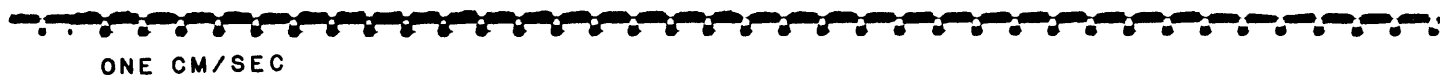


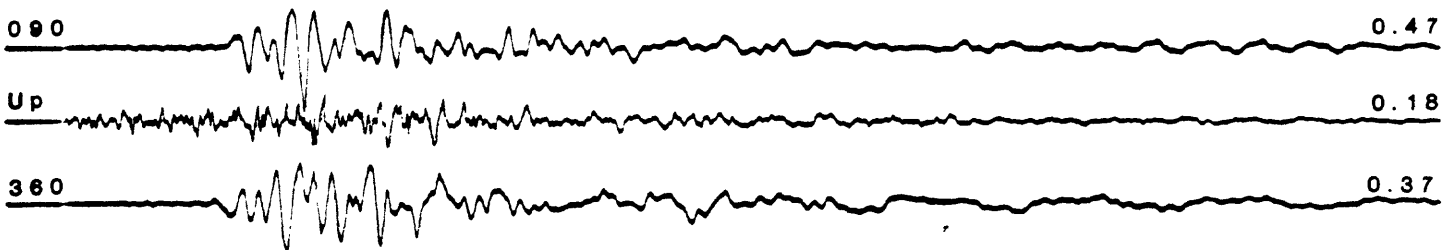
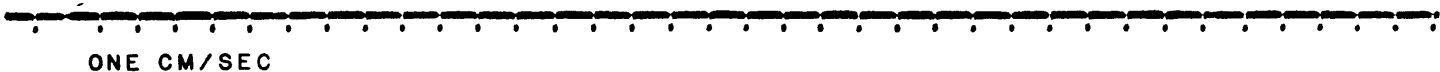
Figure 3. Strong-motion records including structure drawings.

ALHAMBRA, 900 SOUTH FREMONT

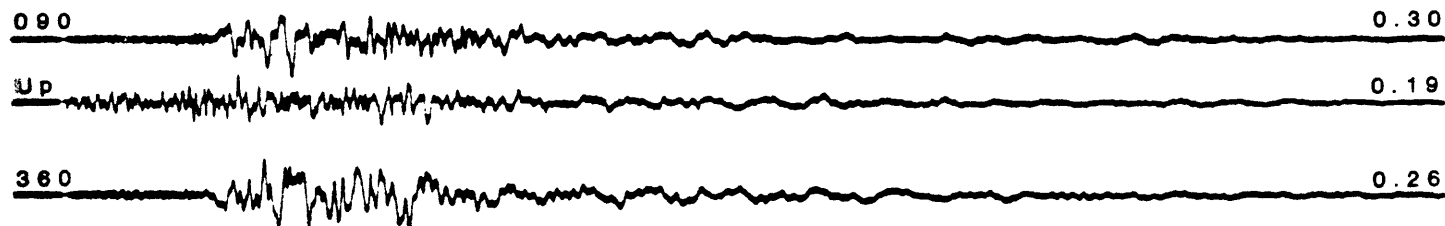
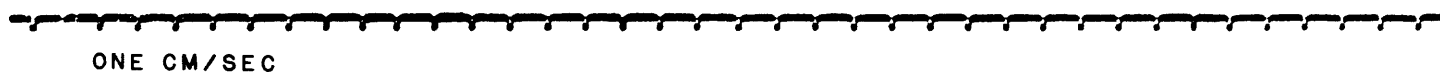
12th Floor



6th Floor

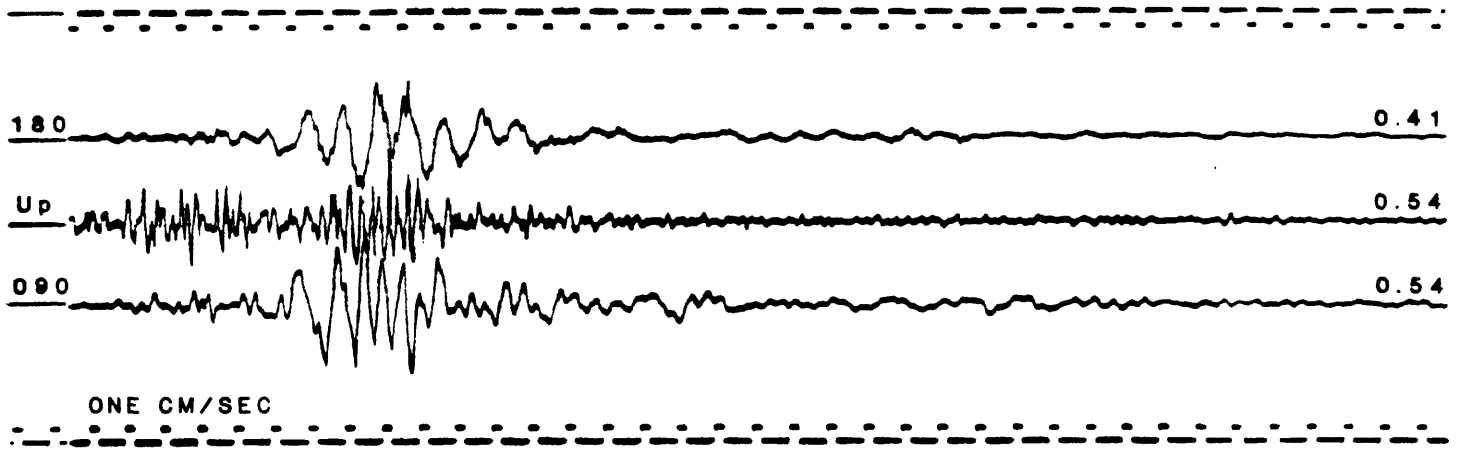


Basement

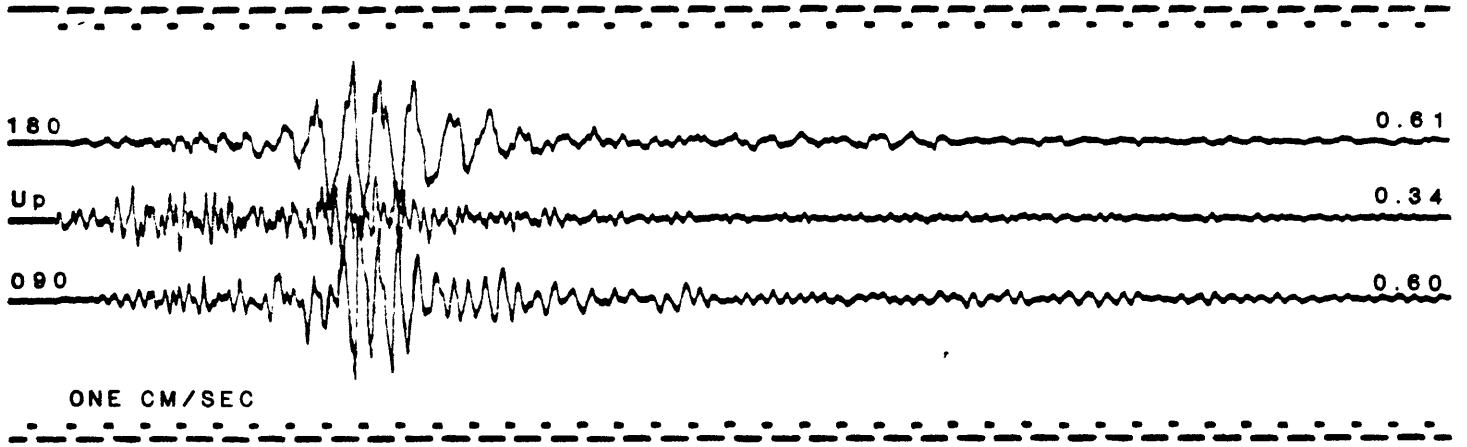


WHITTIER, 7215 BRIGHT AVE

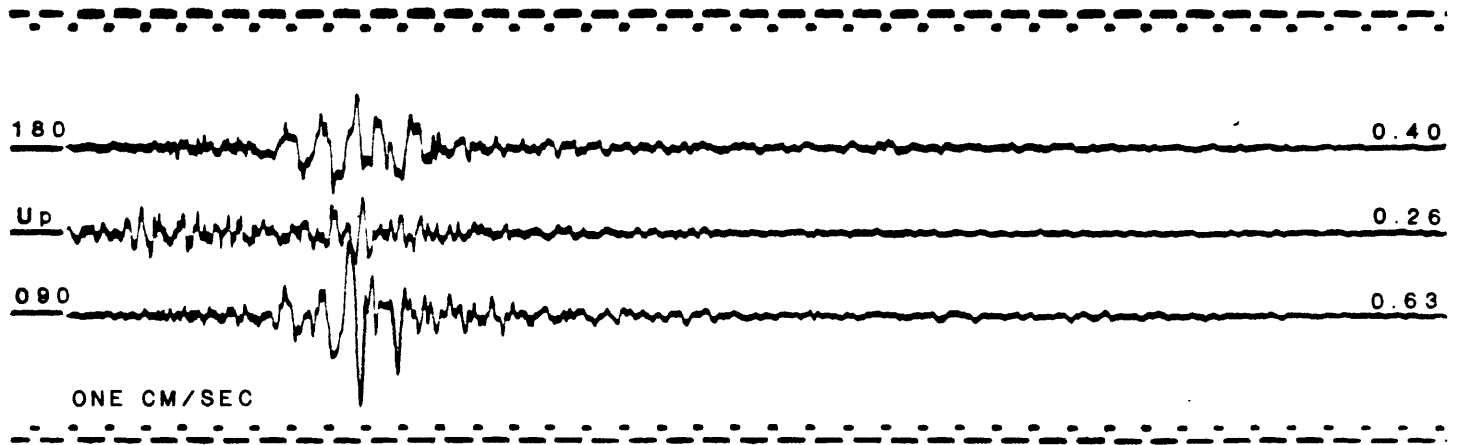
10th Floor



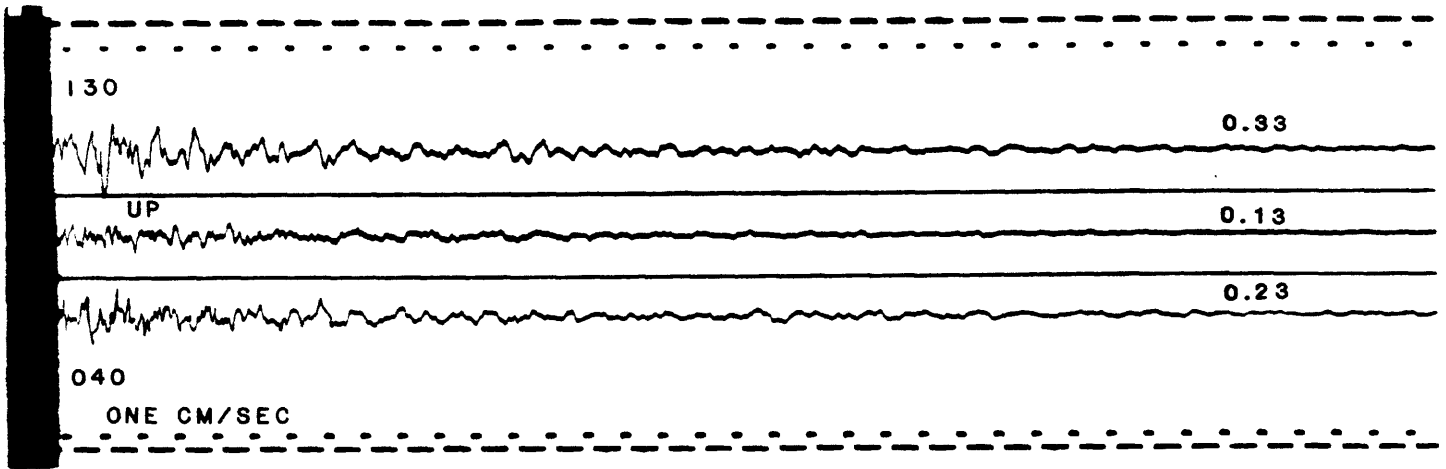
5th Floor



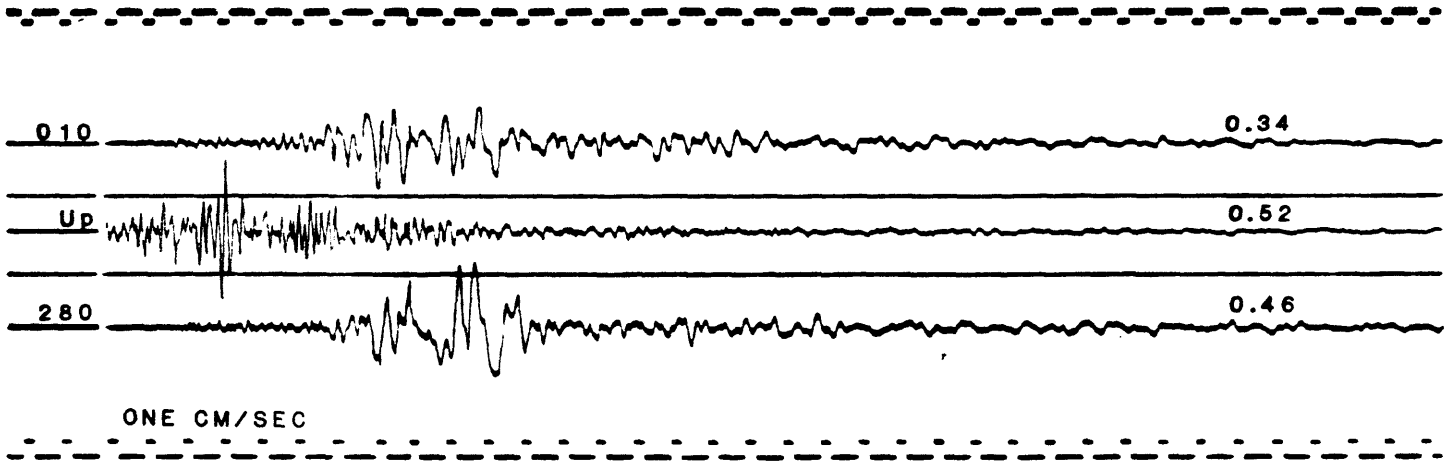
Basement



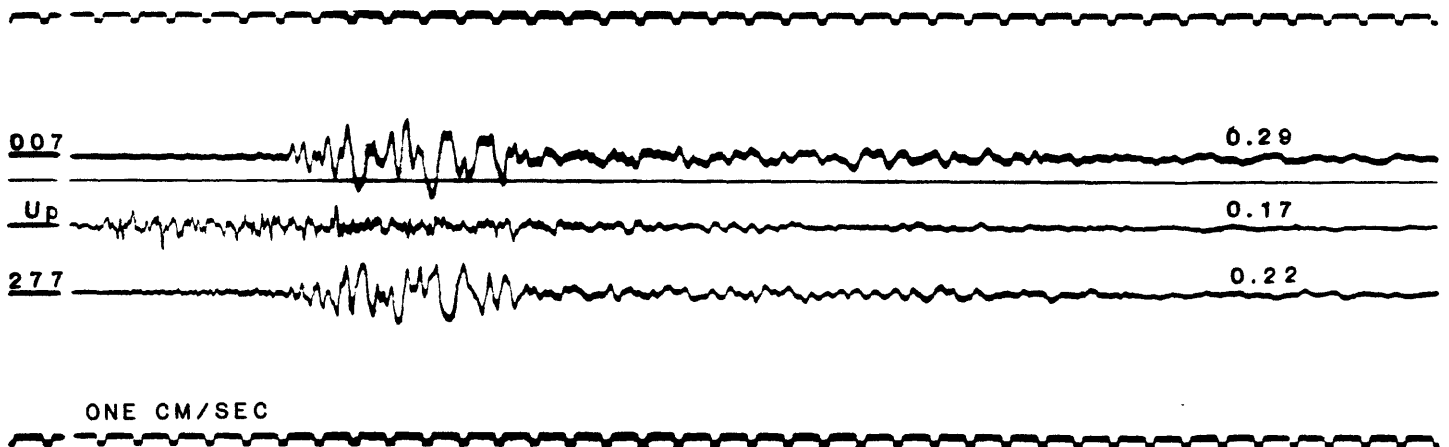
LOS ANGELES, 4407 JASPER STREET



LOS ANGELES BULK MAIL CENTER

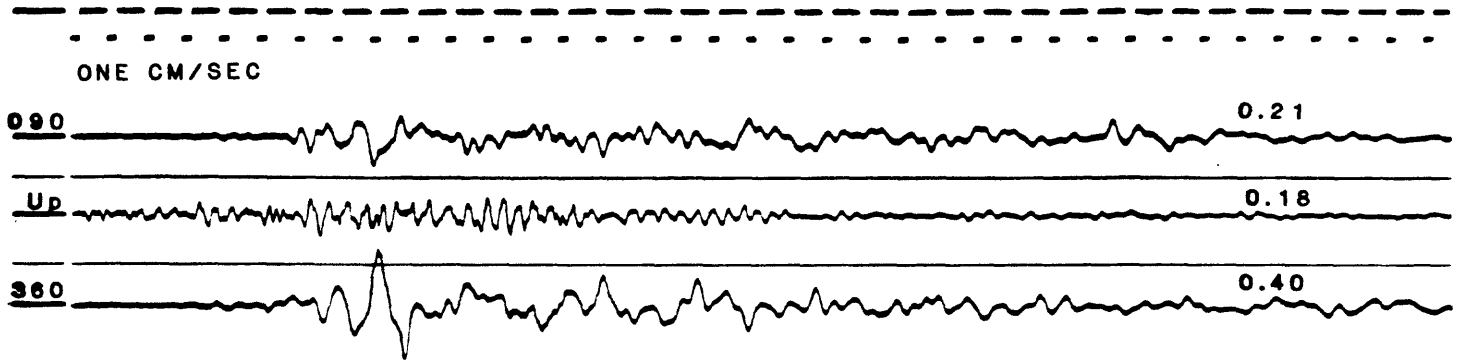


VERNON, 4814 LOMA VISTA AVE

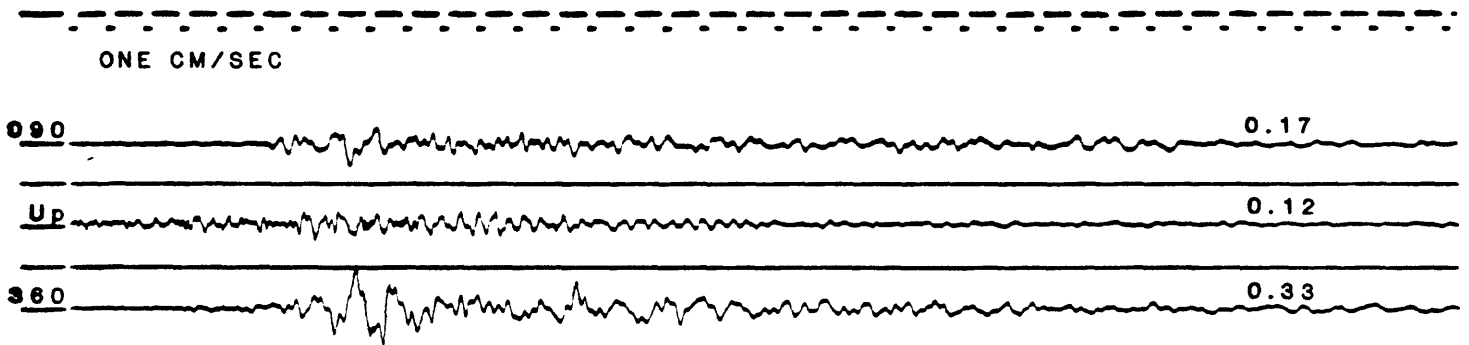


NORWALK, 12400 IMPERIAL HIWAY

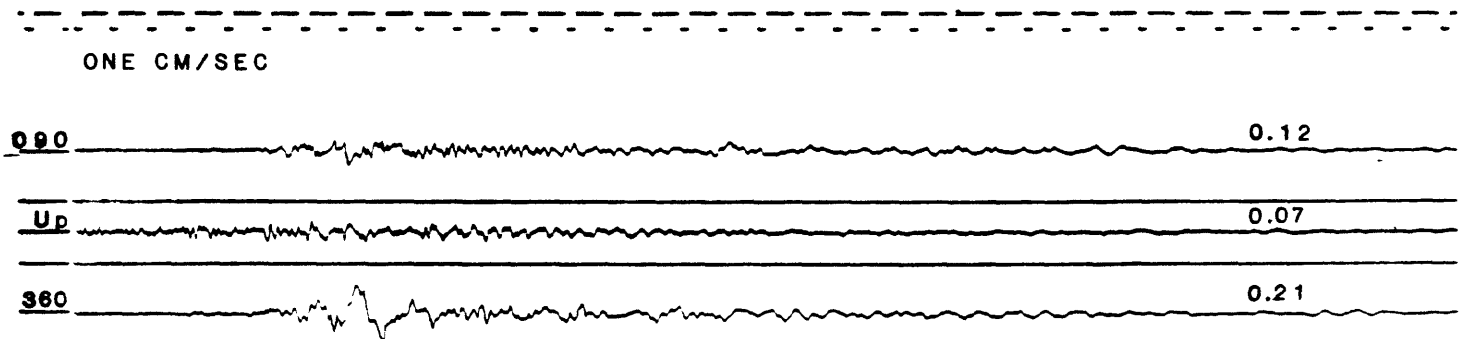
Roof



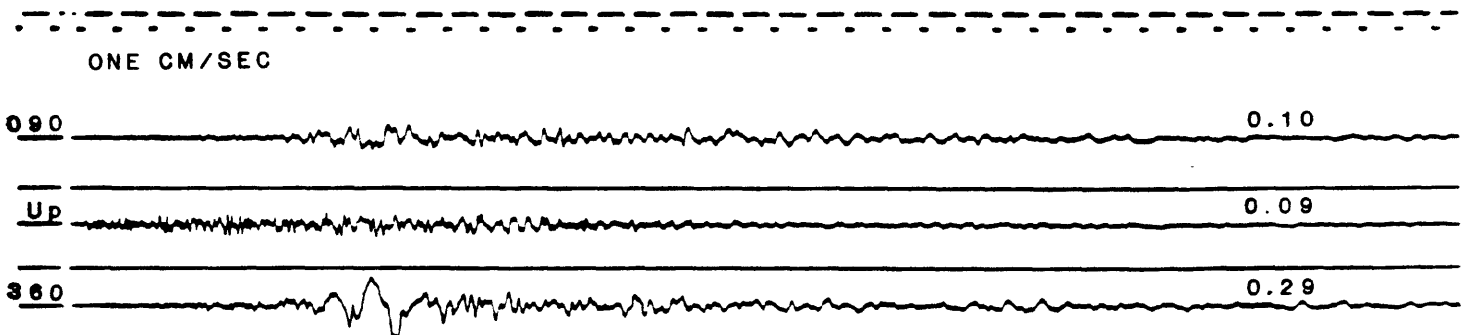
4th Floor



Basement

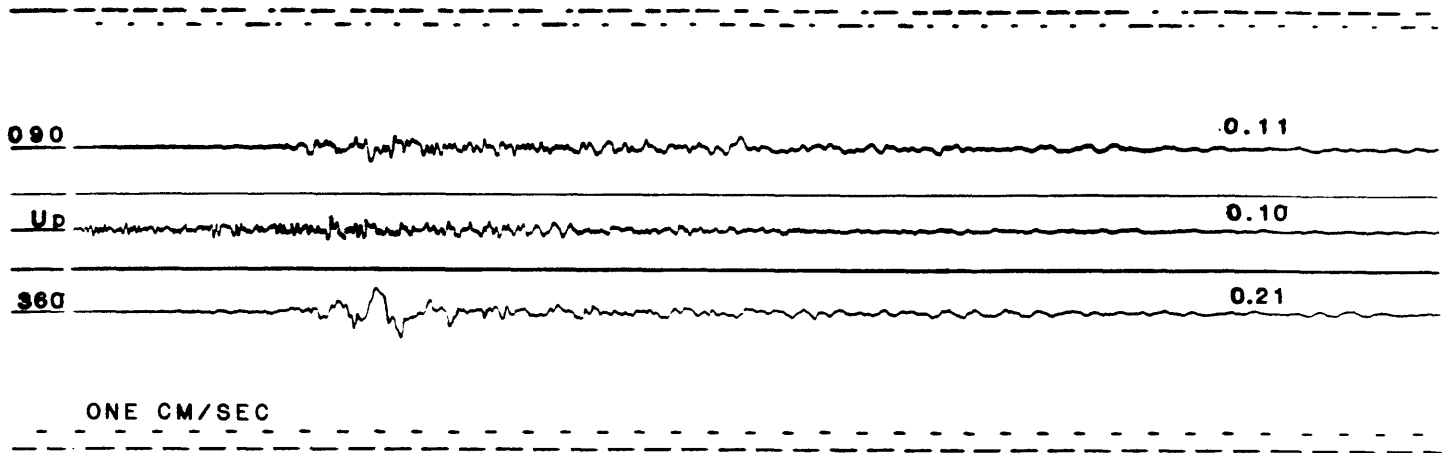


South Ground Site

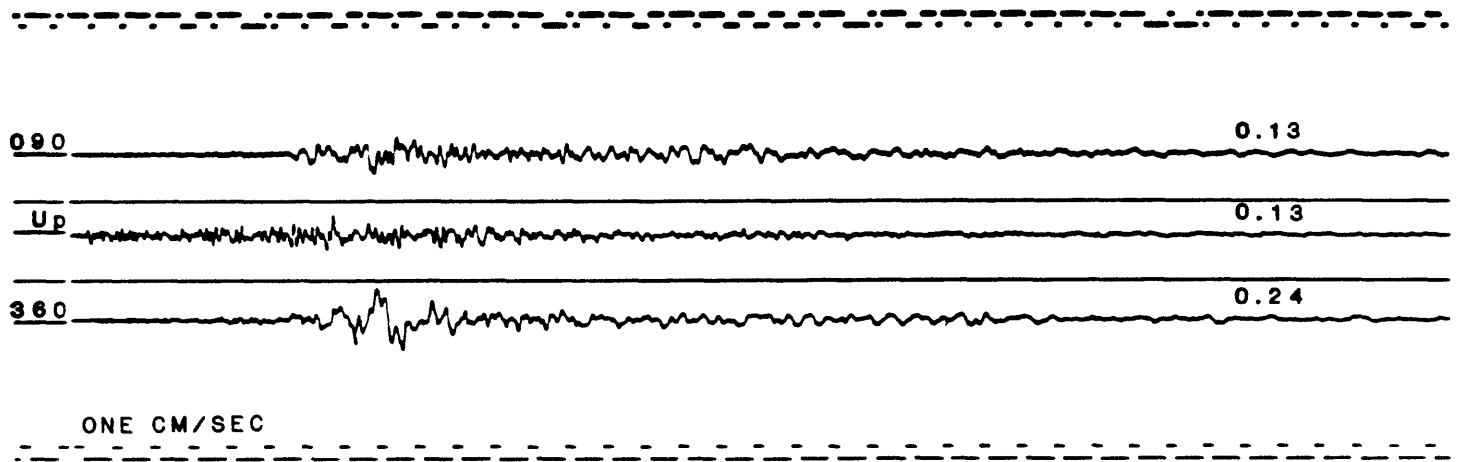


NORWALK, 12440 IMPERIAL HIWAY

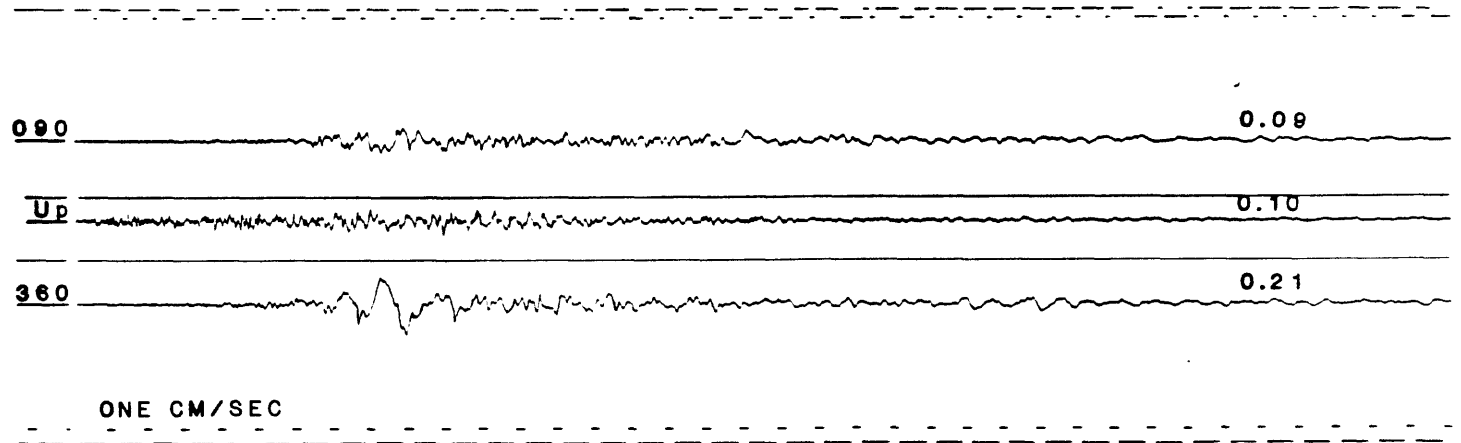
Basement



North Ground Site

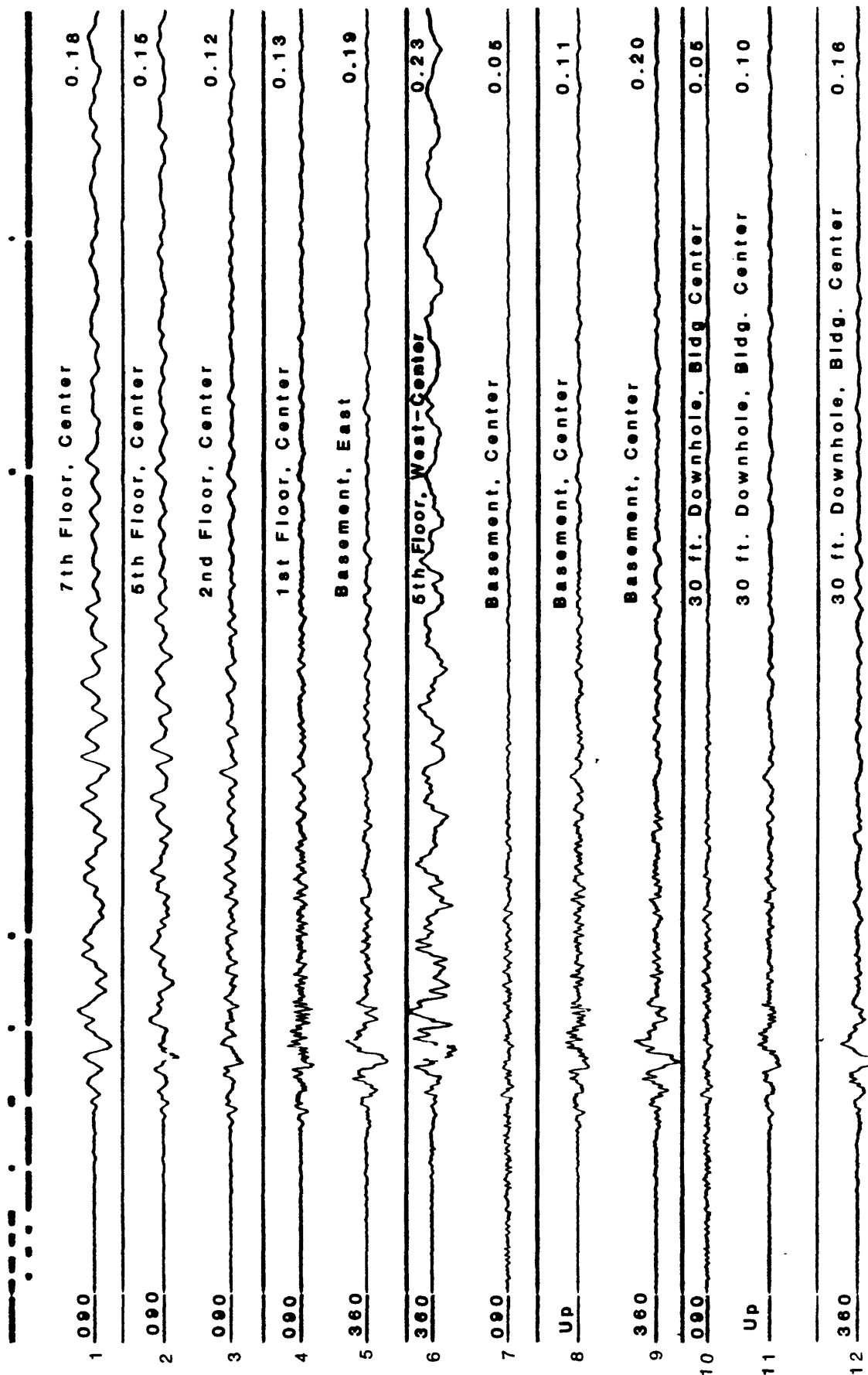


South Ground Site



NORWALK, 12440 IMPERIAL HIWAY

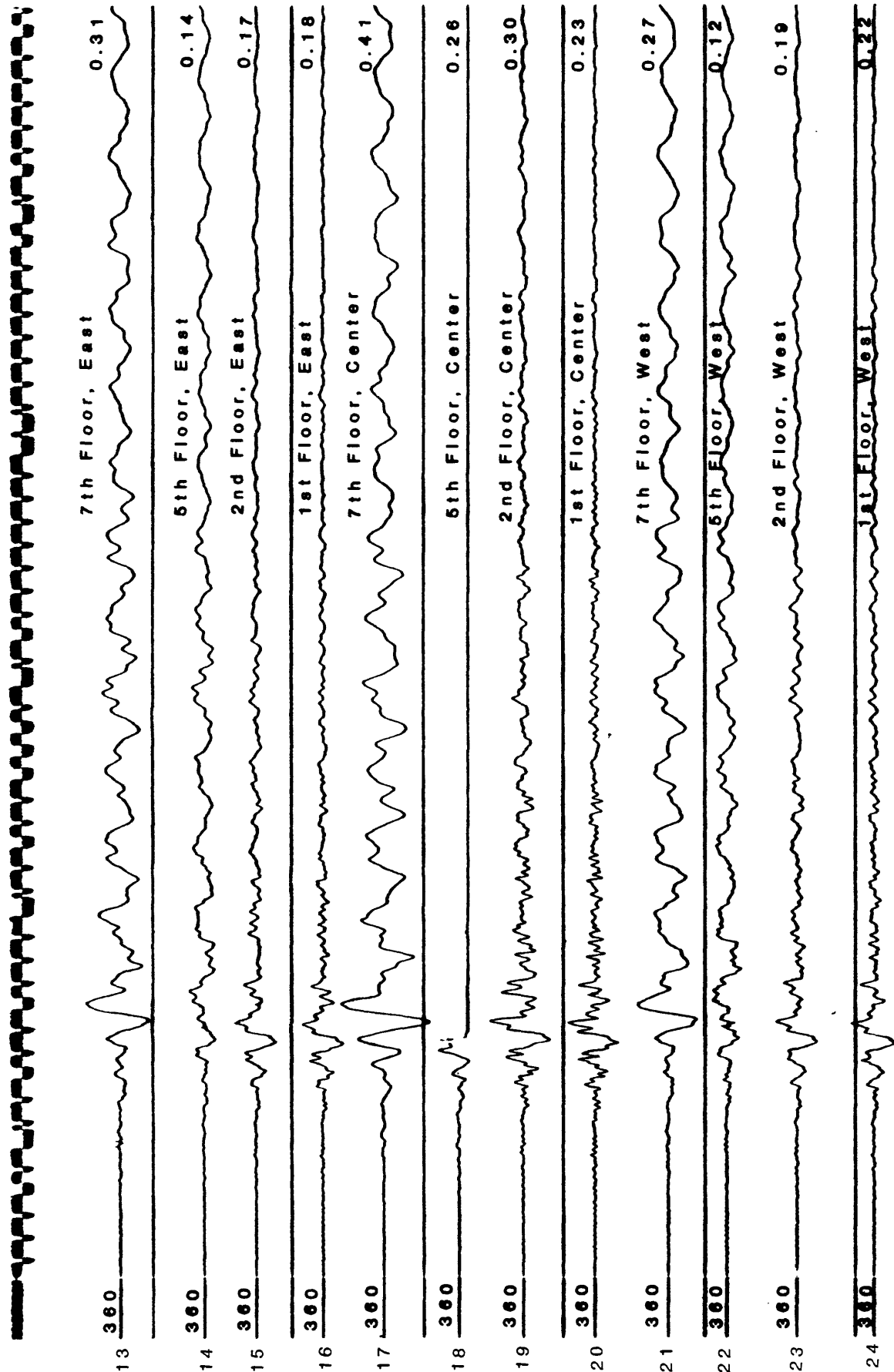
Structure Array 1



ONE CM/SEC

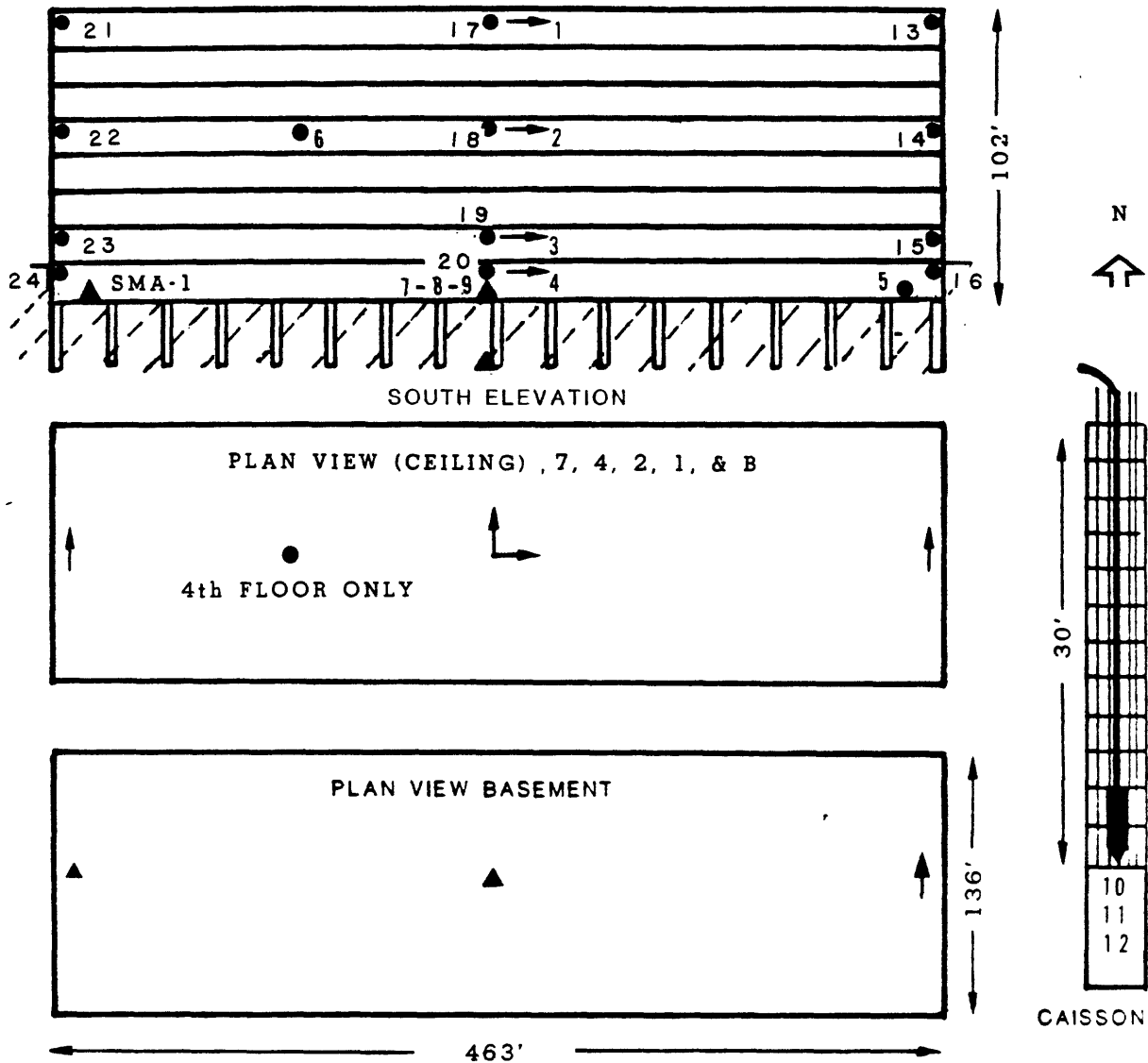
NORWALK, 12440 IMPERIAL HIWAY

Structure Array 2



ONE CM/SEC

NORWALK
12440 IMPERIAL



STRUCTURE

FRAME, Steel ductile moment resisting

FOUNDATION, Drilled in place 30' caissons

ACCELEROMETER DIRECTIONS

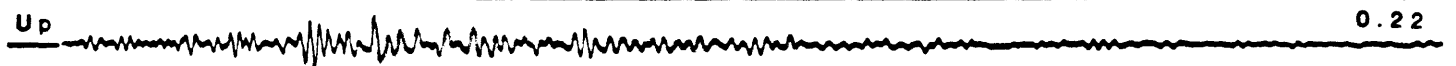
● INTO PLANE OF PLAN/ELEVATION

← AS SHOWN

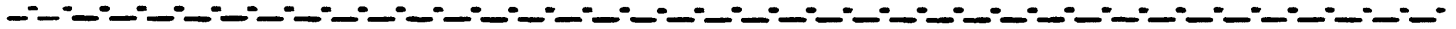
▲ TRIAXIAL ACCELEROMETER

LOS ANGELES, 1111 SUNSET BLVD

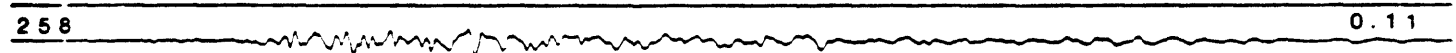
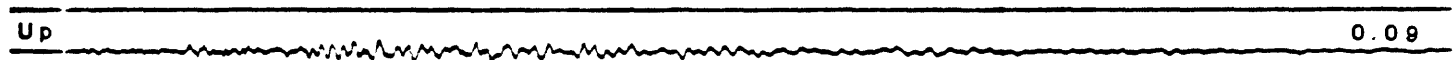
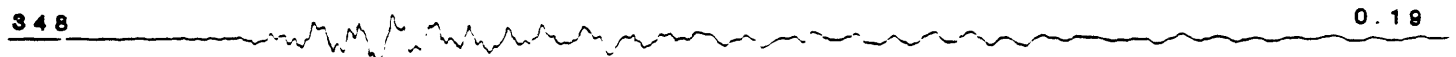
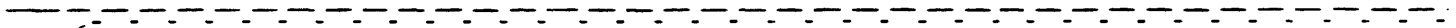
Roof



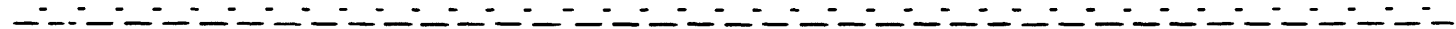
ONE CM/SEC



4th Floor



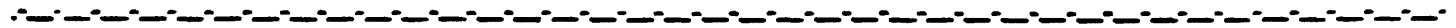
ONE CM/SEC



Basement



ONE CM/SEC



LOS ANGELES, 1100 WILSHIRE BLVD

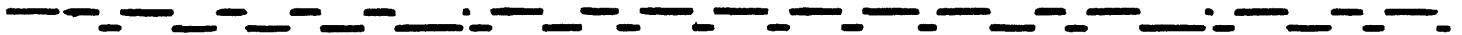
Basement 3, NE



ONE CM/SEC



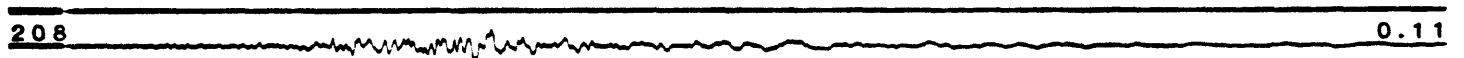
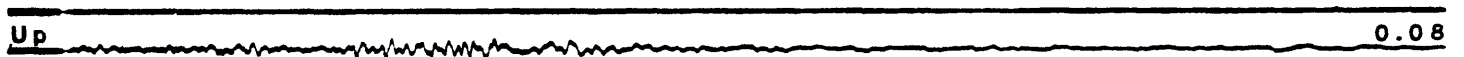
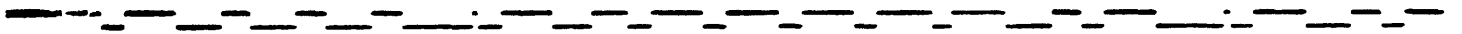
Basement 3, SE



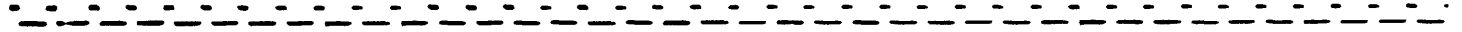
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Basement 4, NW

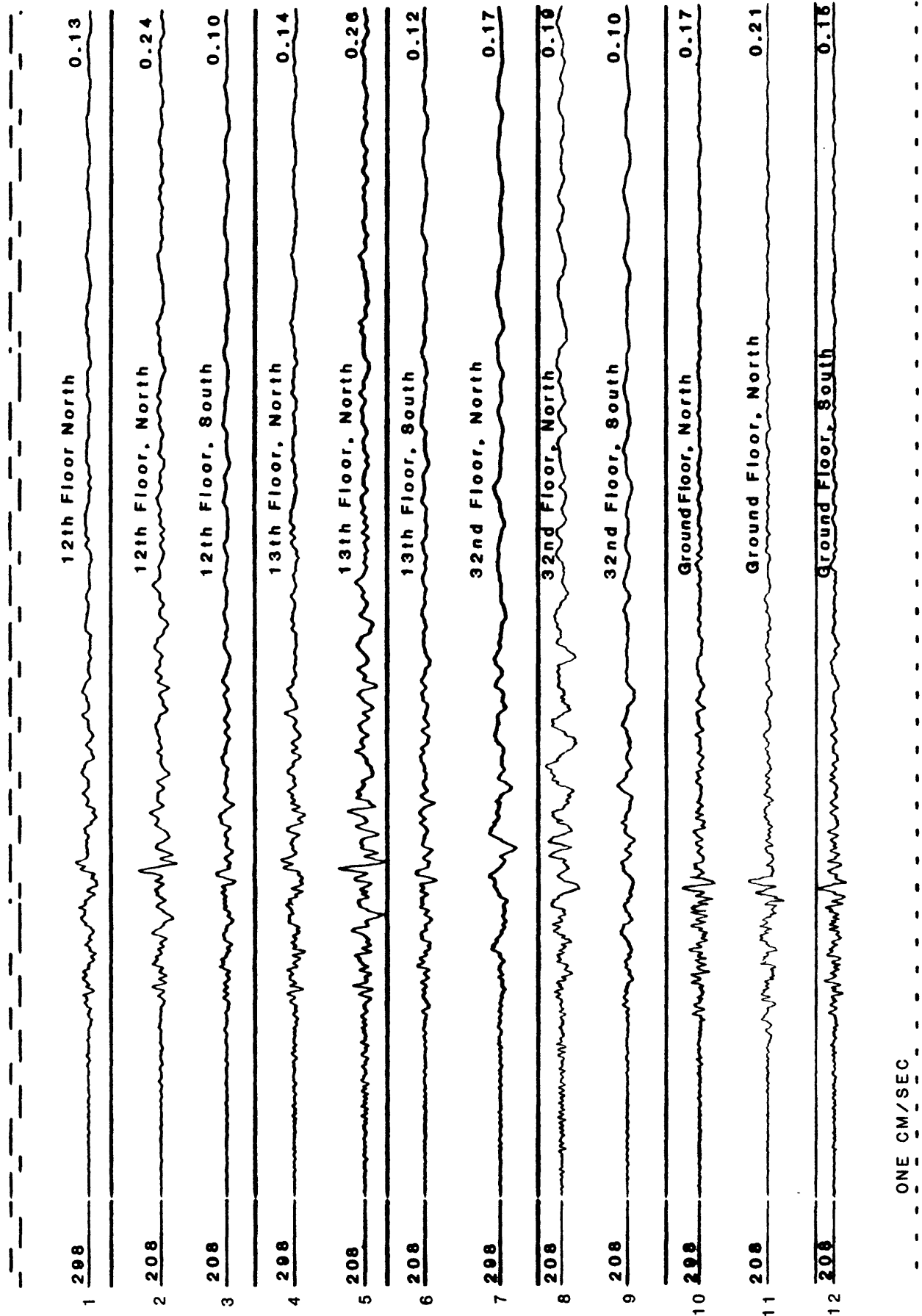


ONE CM/SEC

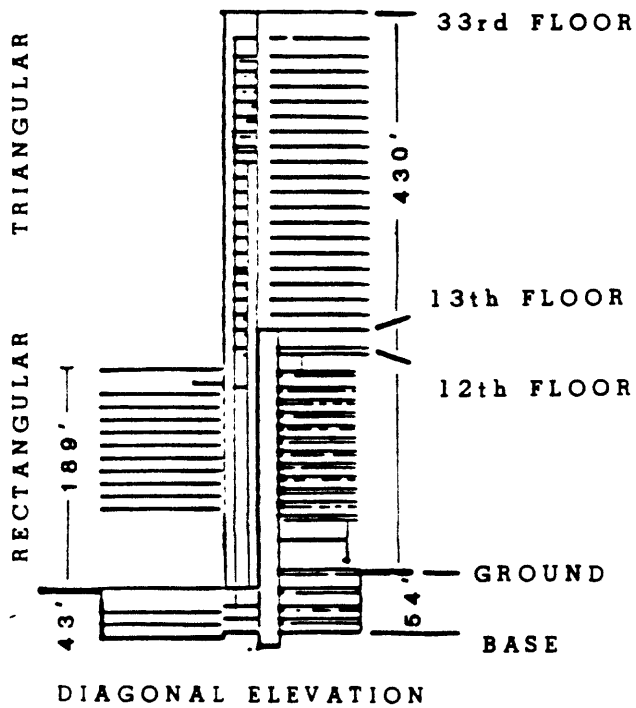


LOS ANGELES, 1100 WILSHIRE BLVD

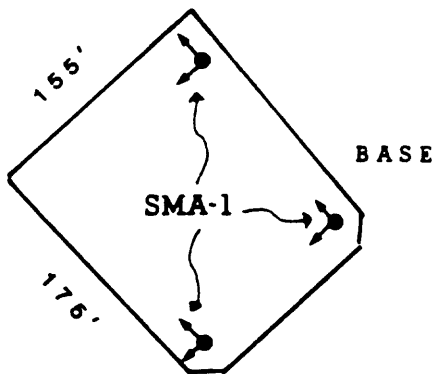
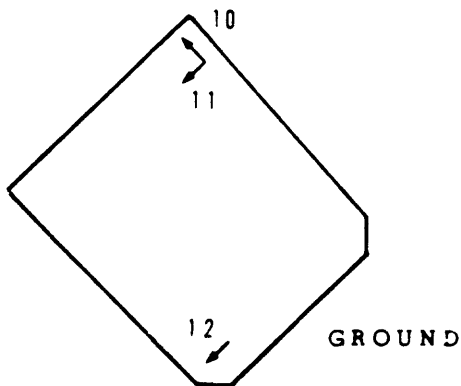
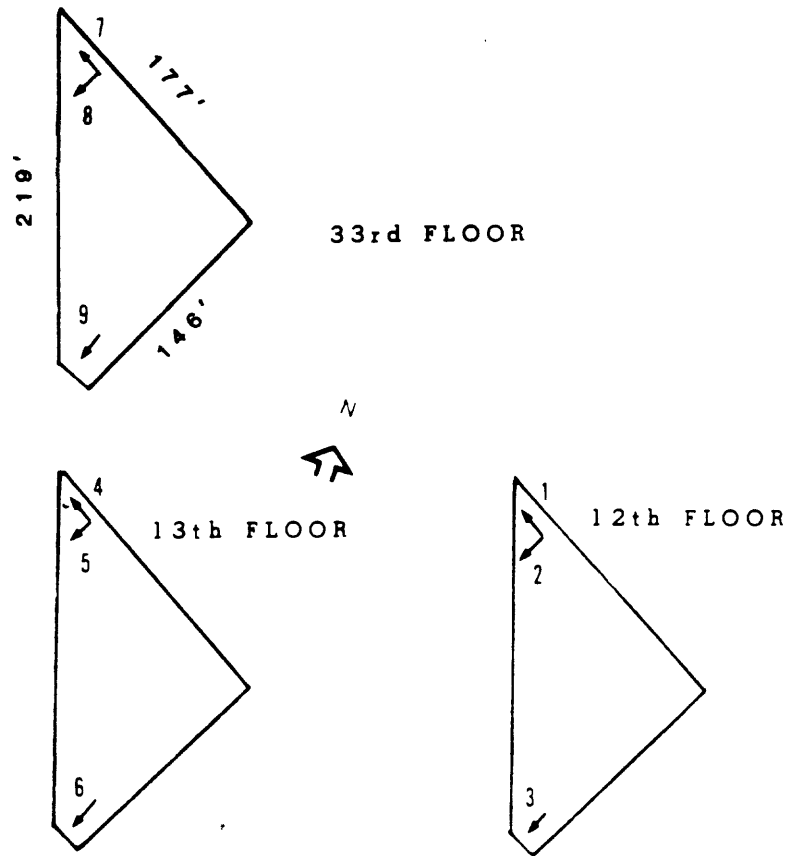
Structure Array



LOS ANGELES
1100 WILSHIRE BLVD



STRONG-MOTION INSTRUMENTATION



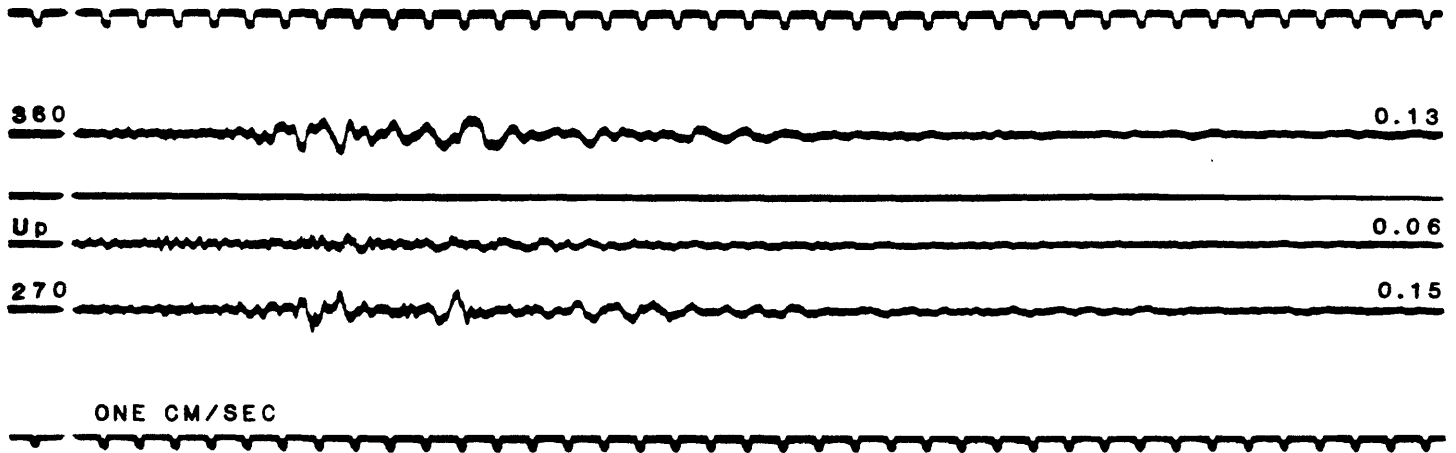
STRUCTURE

Rectangular base 12 stories
Triangular tower 21 stories
Steel frame
Coupled shear wall
Post-tensioned slabs

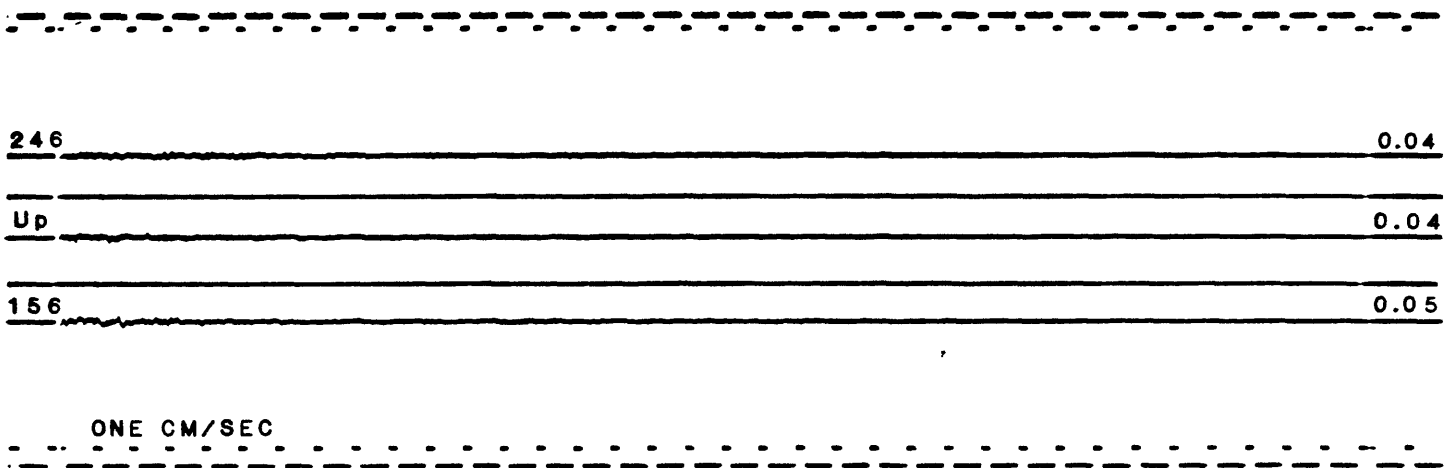
ACCELEROMETER DIRECTIONS

● VERTICAL
← HORIZONTAL

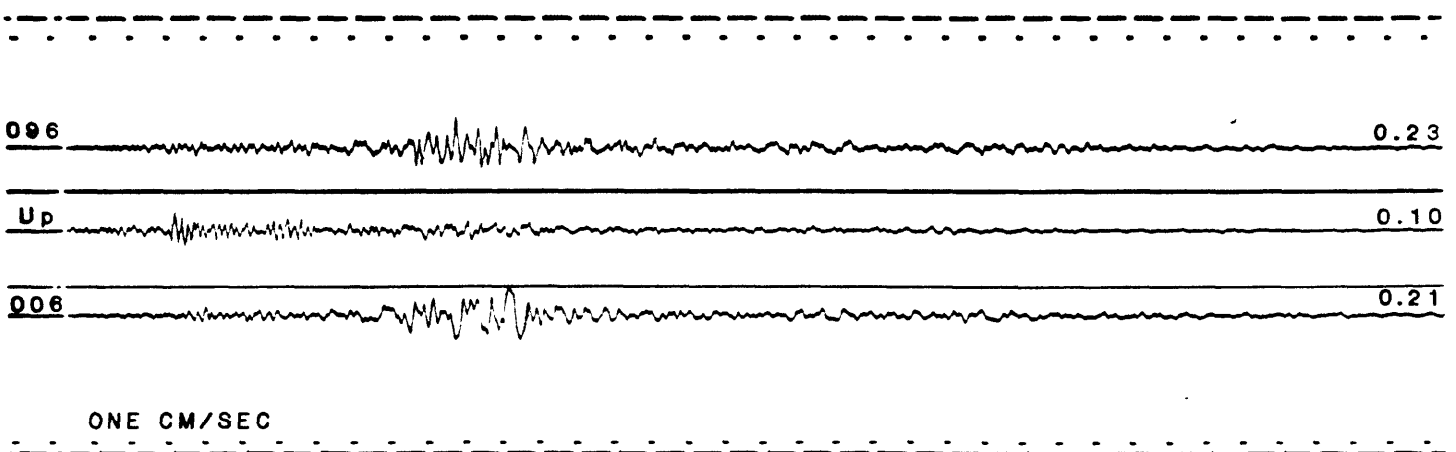
LOS ANGELES, GRIFFITH PARK OBSERVATORY



MORRIS DAM, ABUTMENT

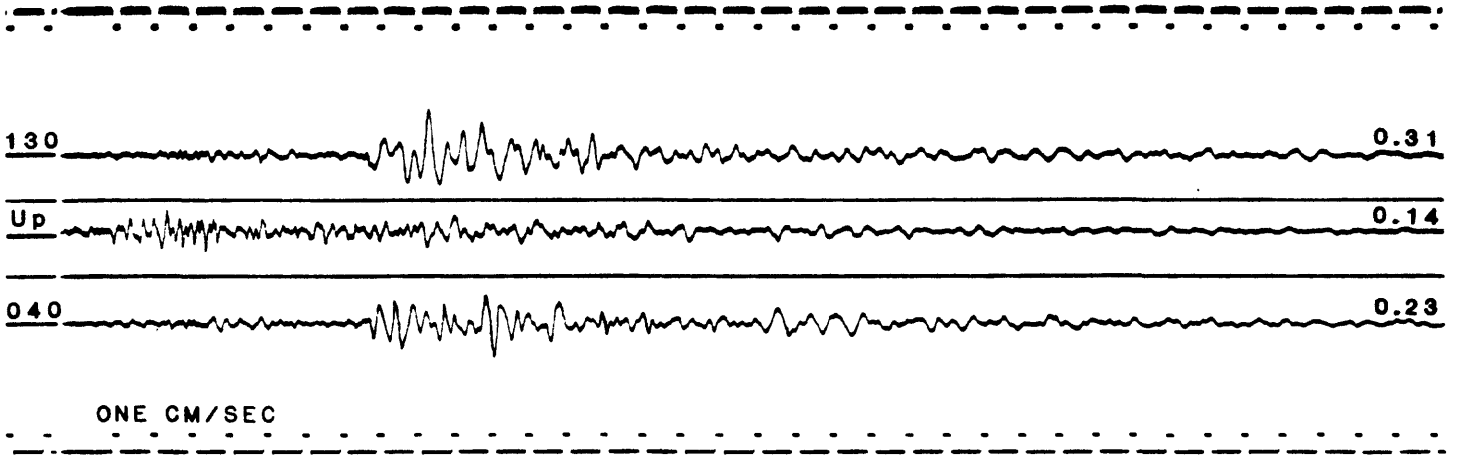


ORANGE COUNTY RESERVOIR, ABUTMENT

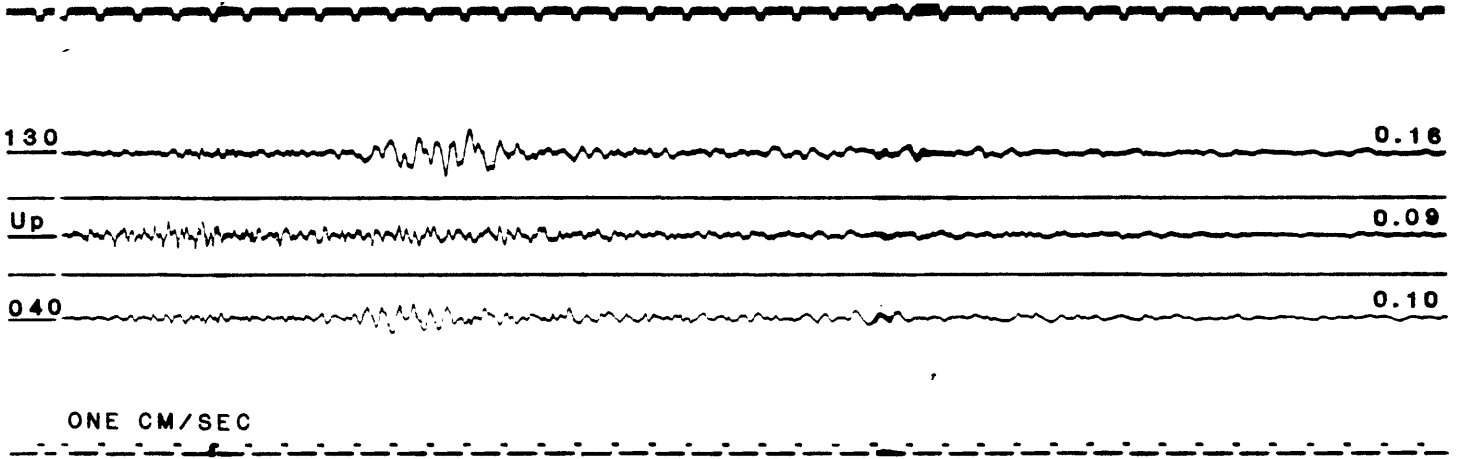


BREA DAM

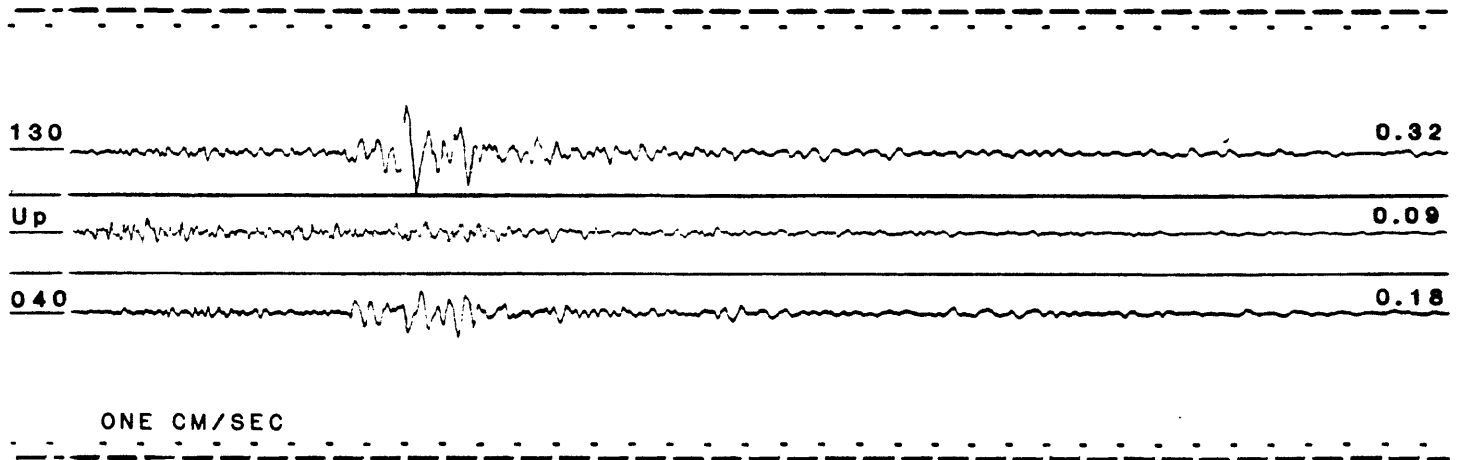
Crest



Left Abutment

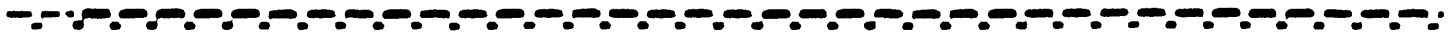


Downstream

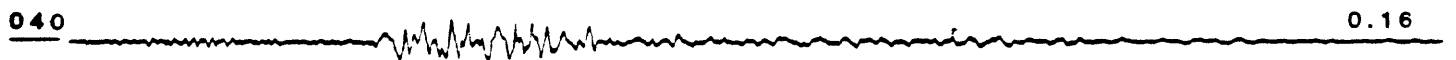
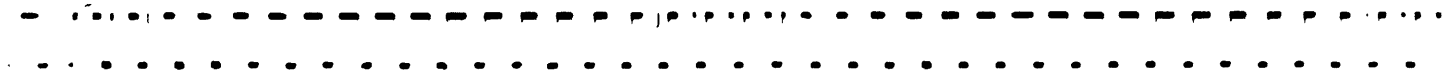


CARBON CANYON DAM

Crest



Left Abutment

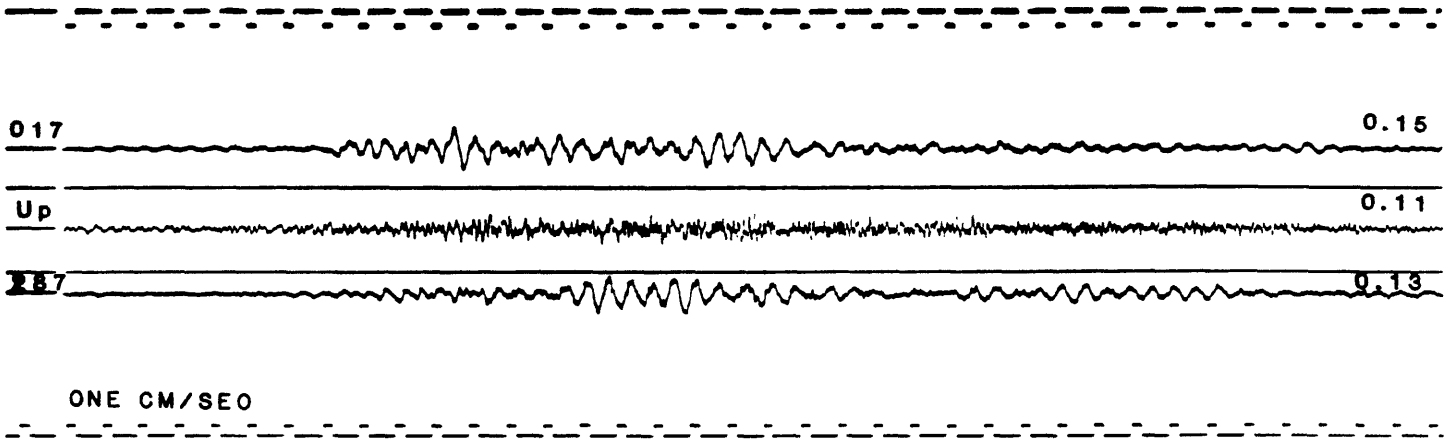


LONG BEACH, CSULB

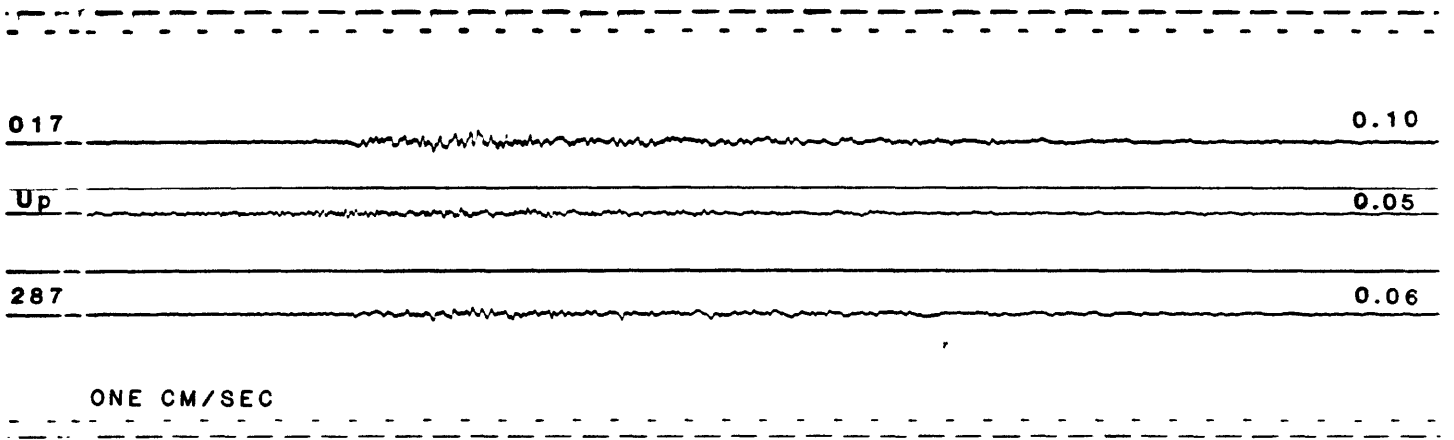


WEYMOUTH FILTER PLANT

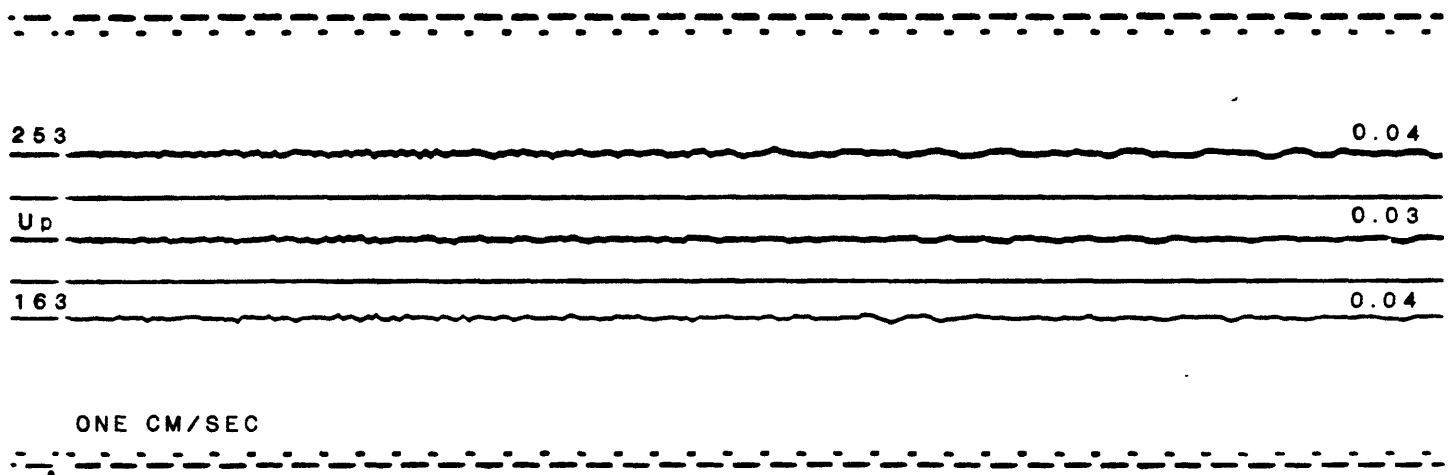
Water Tank, Top



Bldg, Ground Level

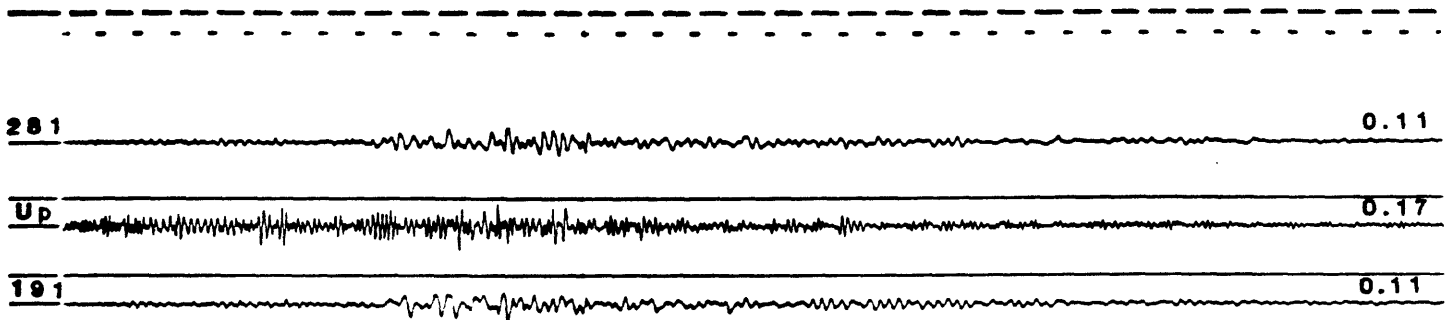


PALOS VERDES RESERVOIR, ABUTMENT



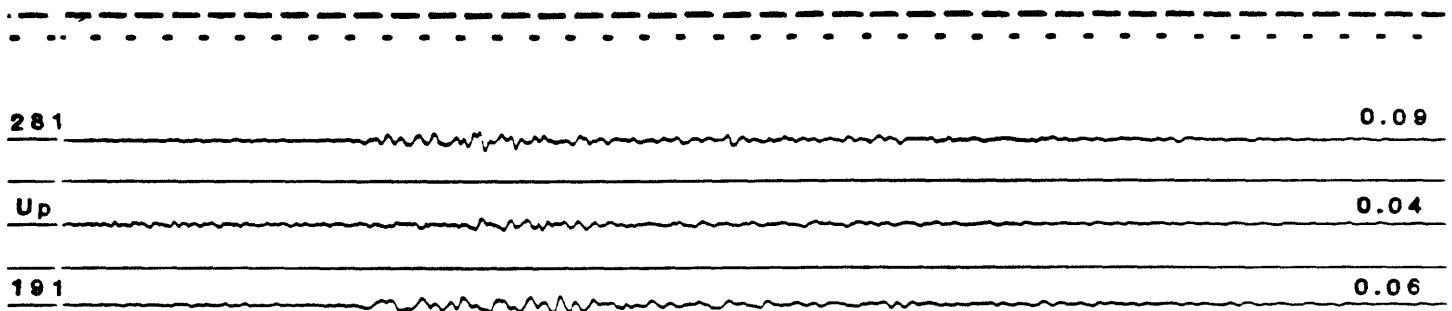
DIEMER FILTER PLANT

Reservoir Roof



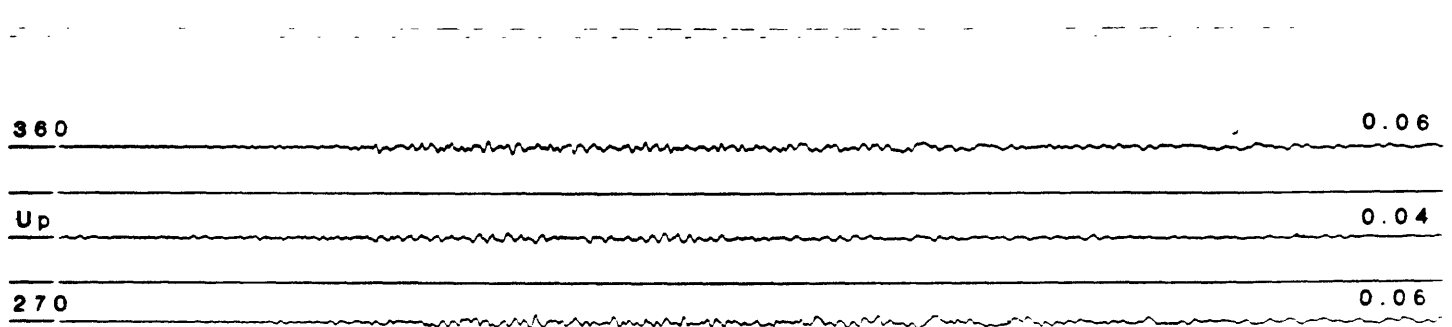
ONE CM/SEC

Admin. Bldg Basement



ONE CM/SEC

LAWNDALE, 15000 AVIATION BLVD



ONE CM/SEC

LIVE OAK RESERVOIR

Structure Array

155	1	Center Crest	0.07
Up	2	Center Crest	0.04
245	3	Center Crest	0.07
155	4	Left Crest	0.09
245	5	Left Crest	0.08
245	6	Left Slope	0.04
155	7	Center Slope	0.09
Up	8	Center Slope	0.04
245	9	Center Slope	0.06
155	10	Center Toe	0.05
Up	11	Center Toe	0.02
245	12	Center Toe	0.03

ONE CM/SEC

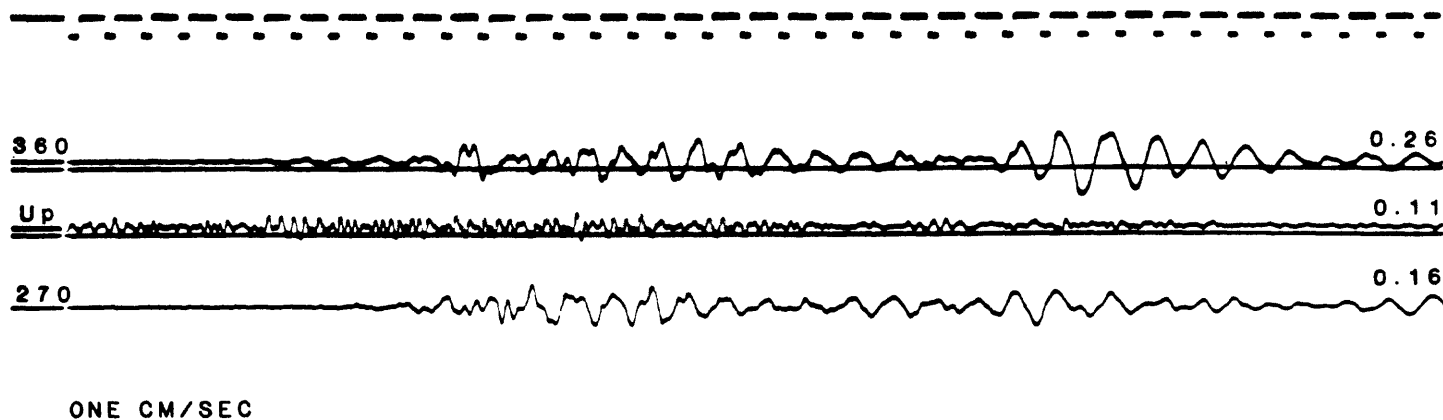
Abutment

ONE CM/SEC

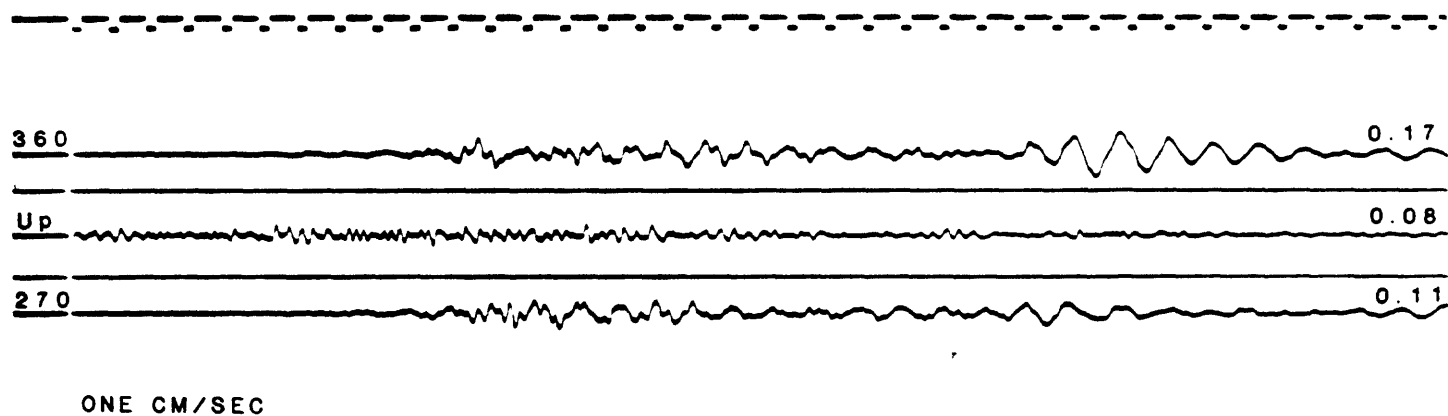
180	0.04
Up	0.02
090	0.03

11th Floor

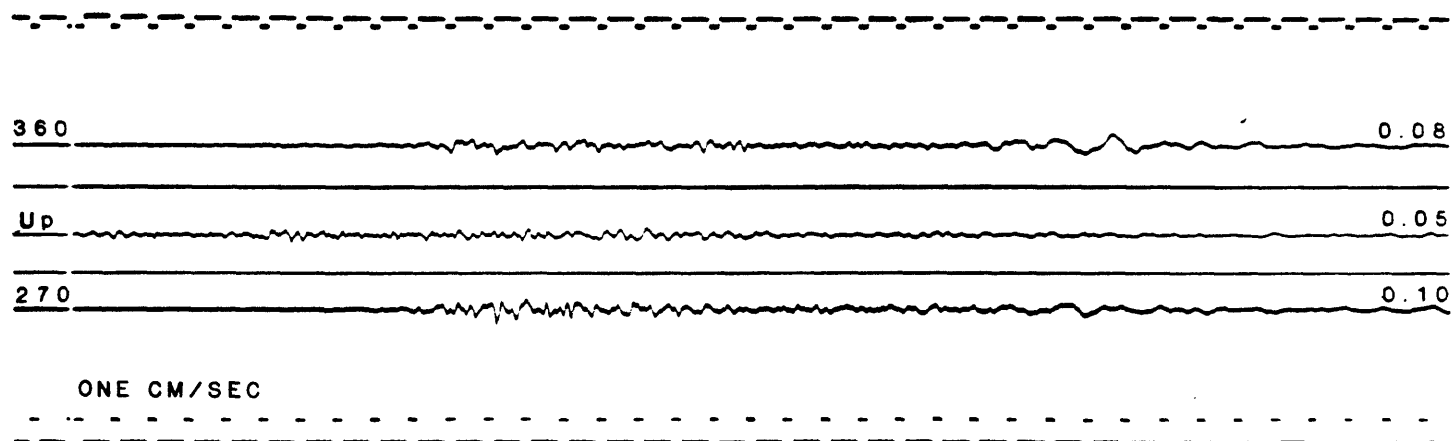
LONG BEACH VA HOSPITAL



6th Floor

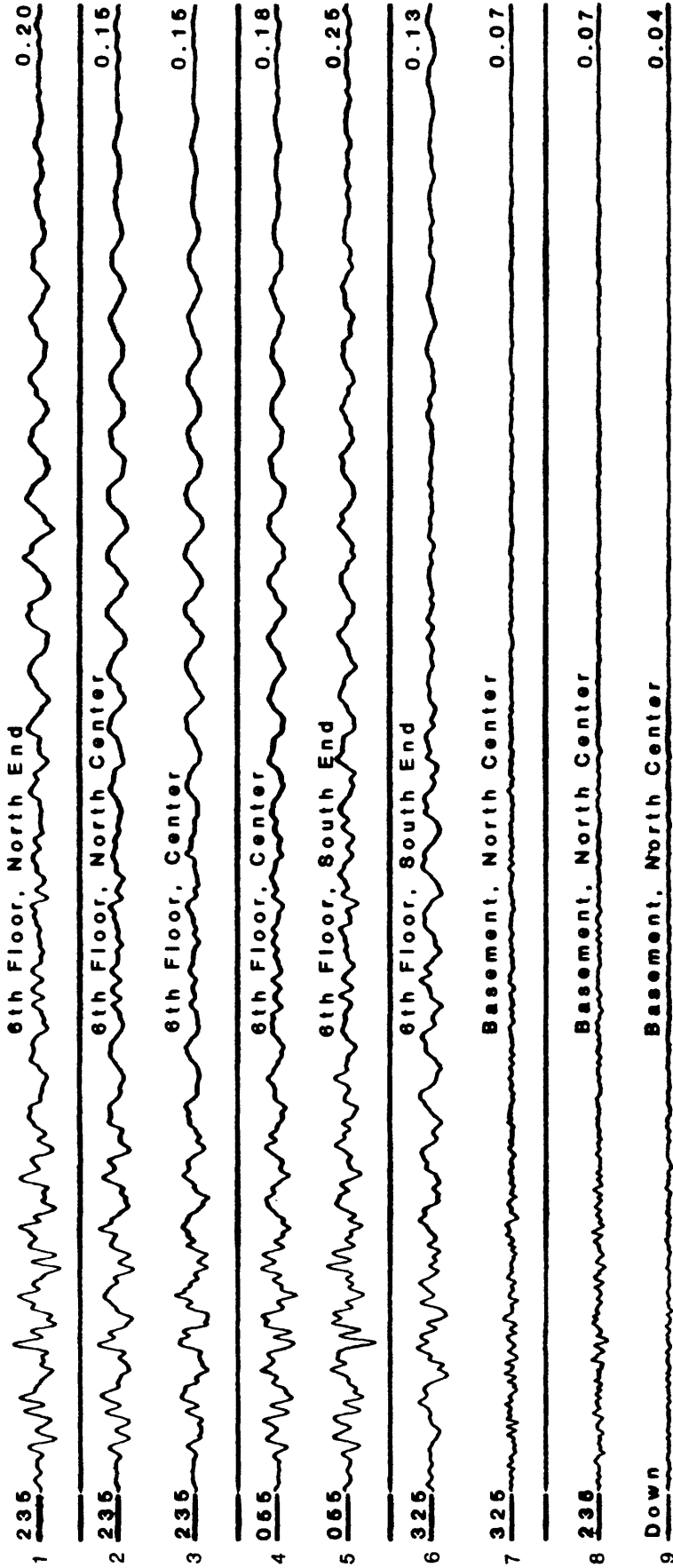


Basement



LOS ANGELES, WADSWORTH VA HOSPITAL

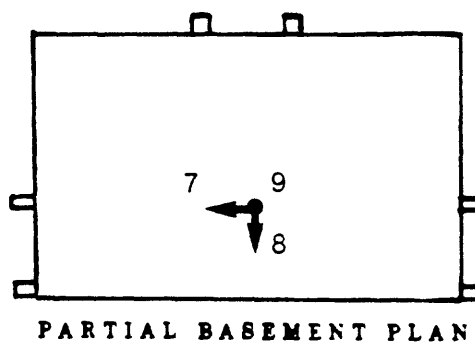
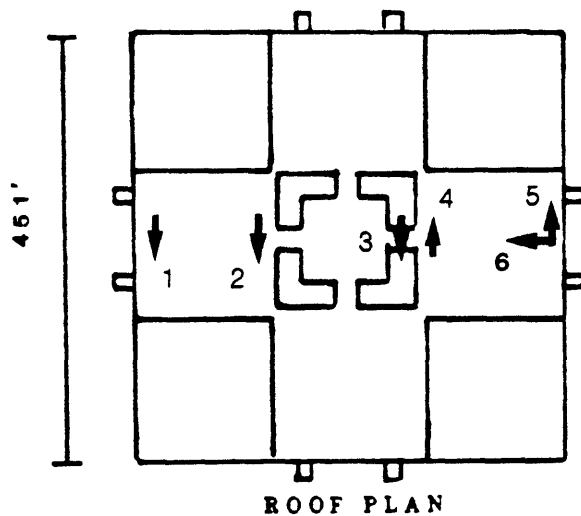
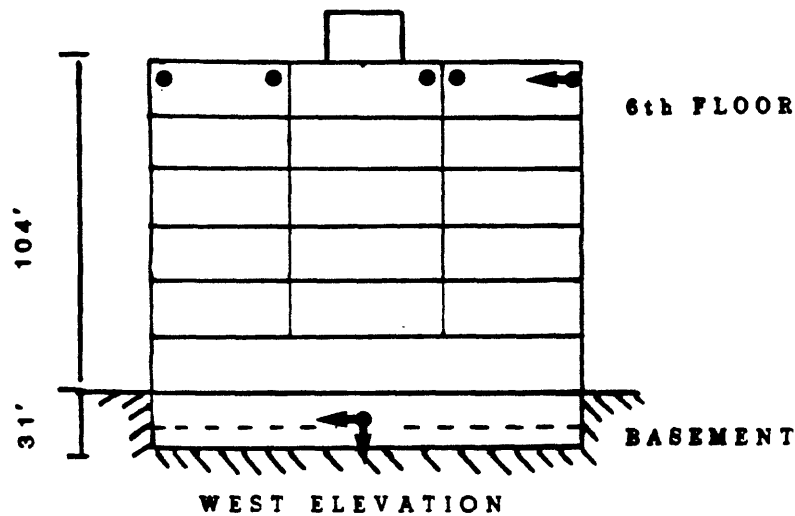
Structure Array



ONE CM/SEC

VETERANS ADMINISTRATION HOSPITAL
LOS ANGELES (WADSWORTH) , CALIFORNIA

STRONG-MOTION INSTRUMENTATION



STRUCTURE

Rectangular base

cross-shaped towers (5 stories)

Core: steel frame

Wings: steel braced towers

Foundation: R C piles



ACCELEROMETER DIRECTIONS

- INTO PLANE OF PLAN/ELEVATION
- ← AS SHOWN

LOS ANGELES, WADSWORTH VA HOSPITAL

North Ground Site



325 0.07

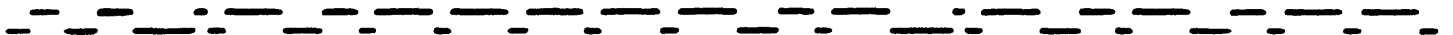
Up 0.03

235 0.08

ONE CM/SEC



South Ground Site



325 0.07

Up 0.04

235 0.09

ONE CM/SEC



LOS ANGELES, BRENTWOOD VA HOSPITAL



285 0.04

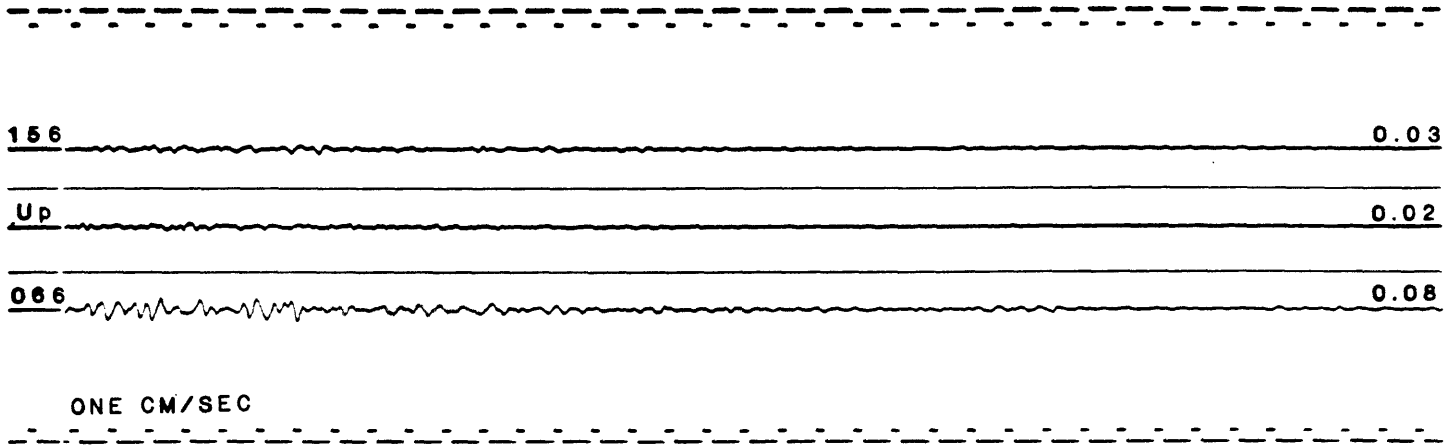
Up 0.03

195 0.05

ONE CM/SEC

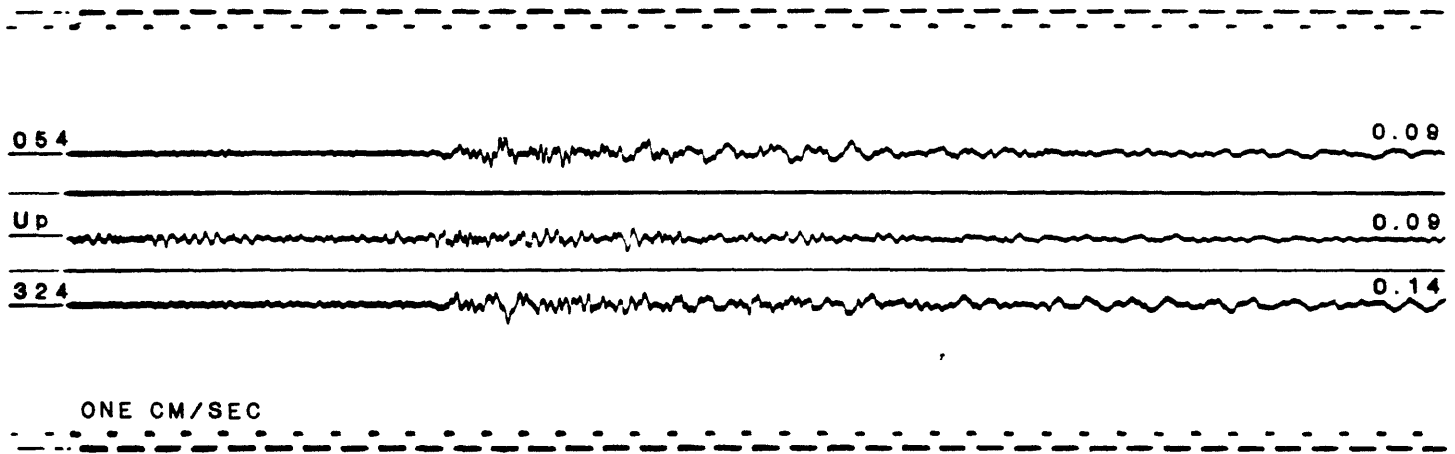


SEPULVEDA CANYON

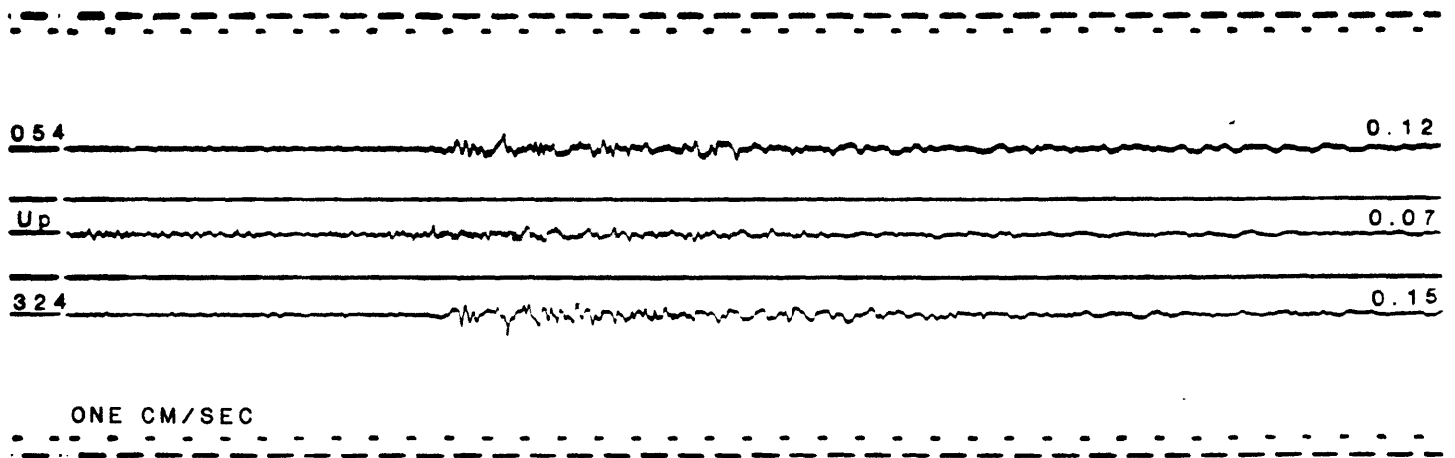


SEPULVEDA DAM

Crest

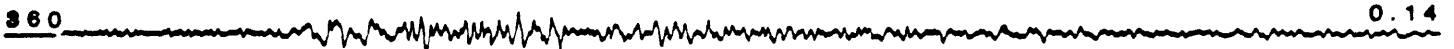
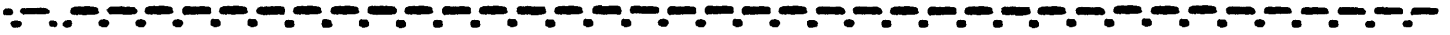


Downstream

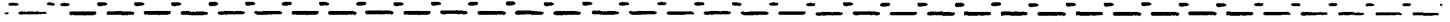


SAN ANTONIO DAM

Crest



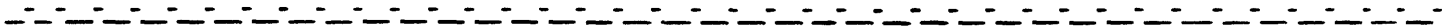
ONE SM/SEC



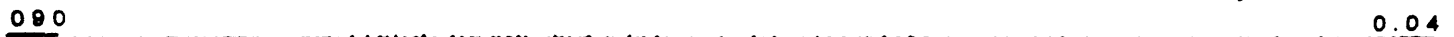
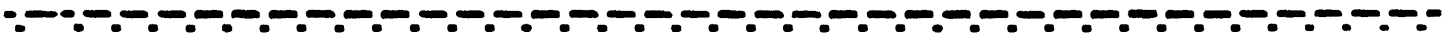
Downstream



ONE CM/SEC



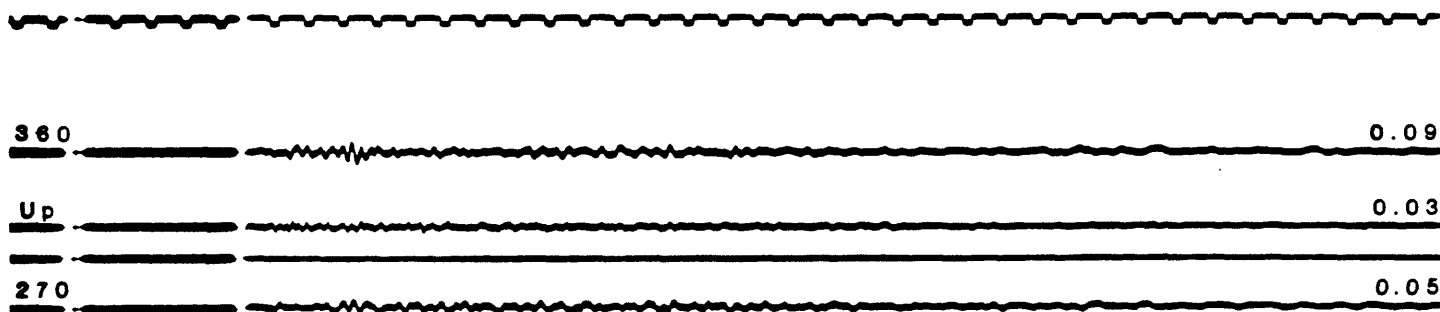
Right Abutment



ONE CM/SEC

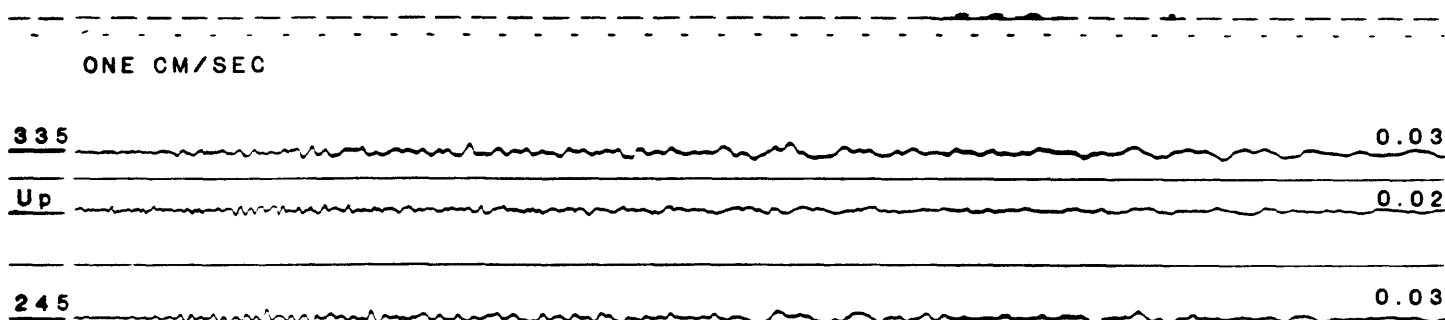


SANTA ANA, ORANGE COUNTY ENGINEERING BLDG



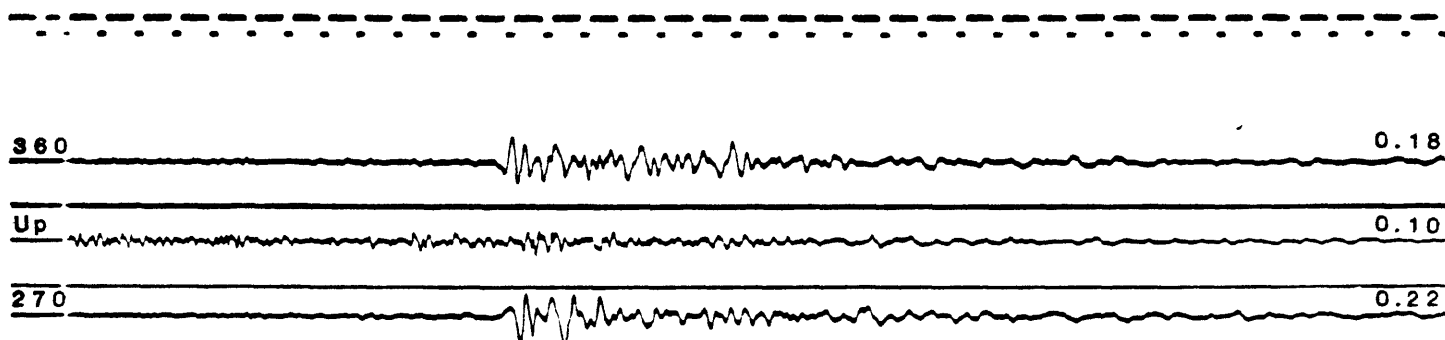
ONE CM/SEC

PALOS VERDES ESTATES, BASEMENT



ONE CM/SEC

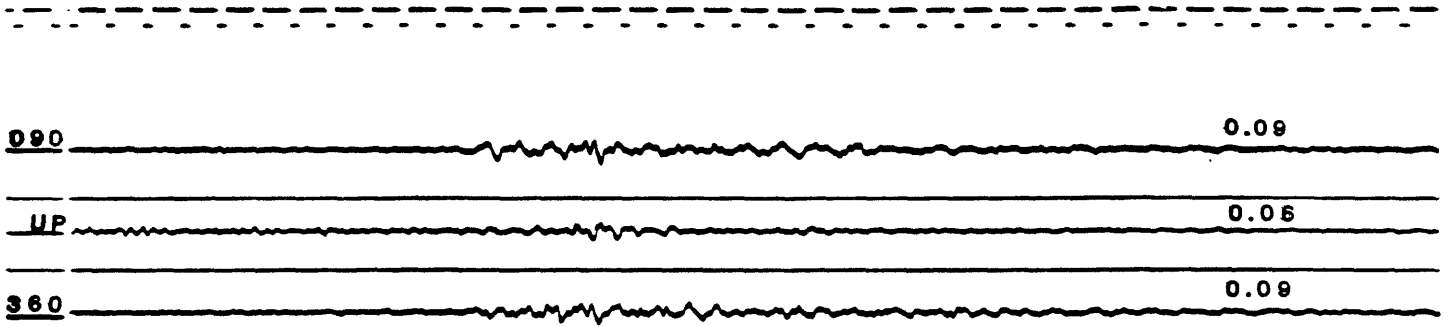
SEPULVEDA VA HOSPITAL



ONE CM/SEC

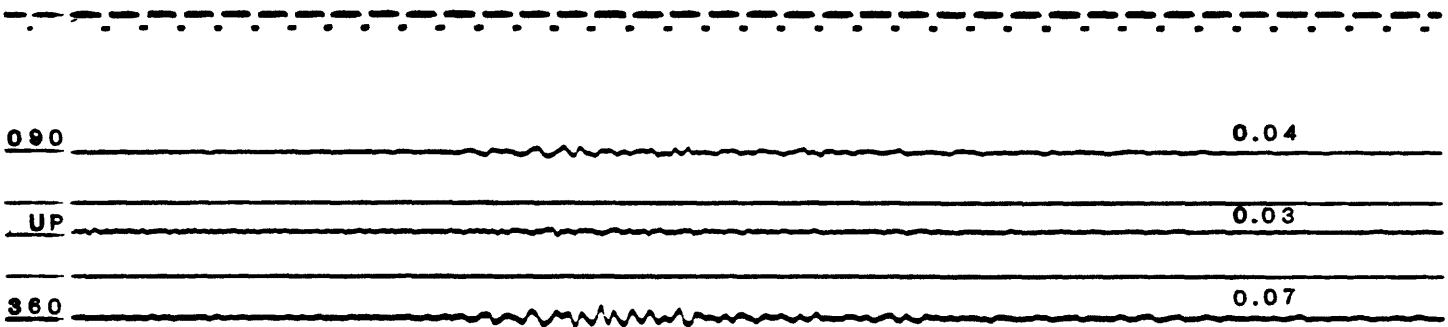
PRADO DAM

Crest



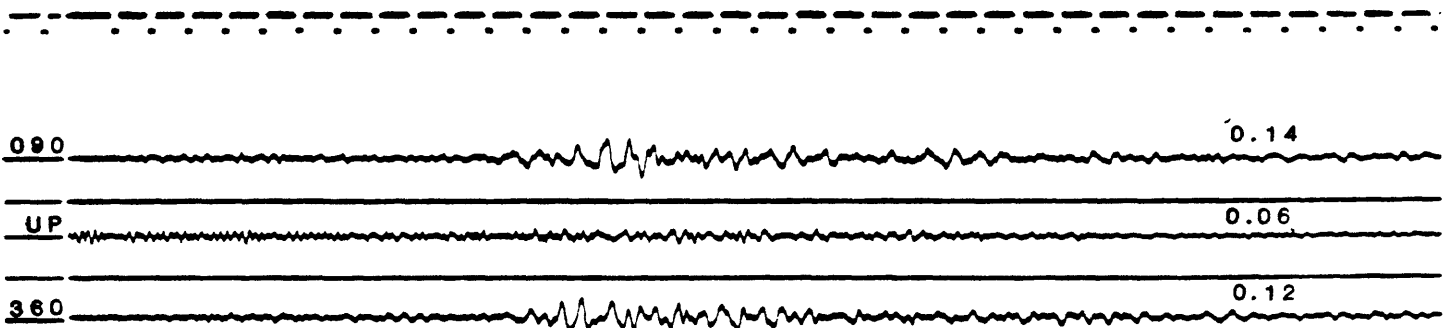
ONE CM/SEC

Left Abutment



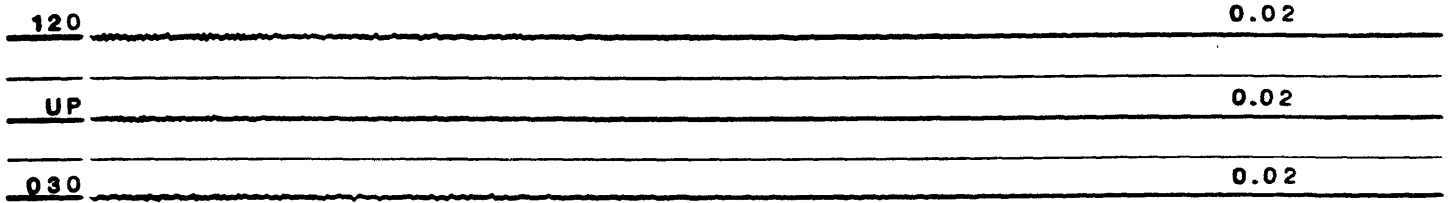
ONE CM/SEC

Downstream



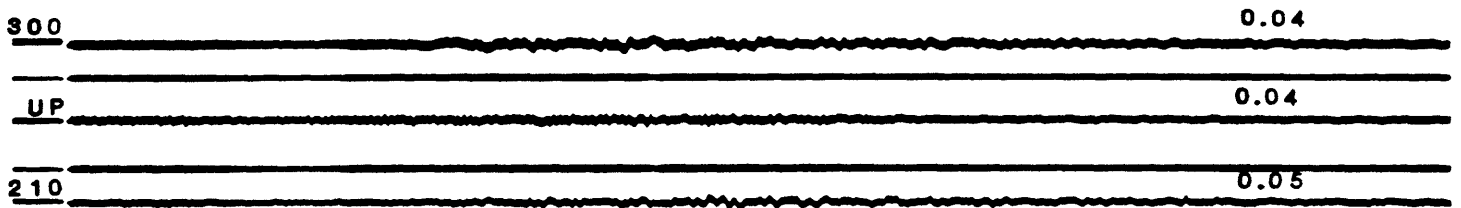
ONE CM/SEC

PARADISE SPRINGS CAMP



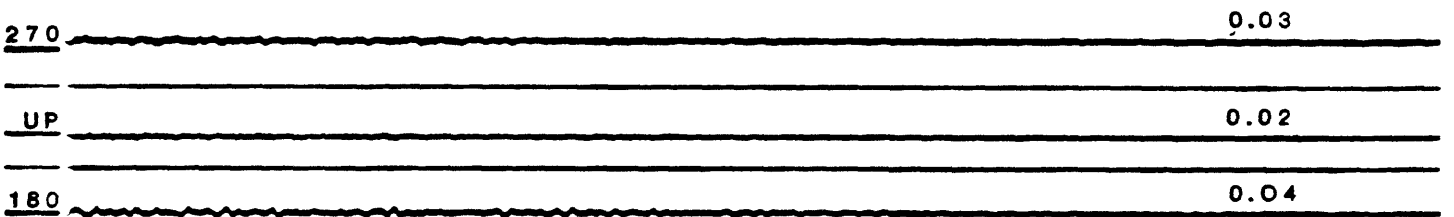
ONE CM/SEC

VALYERMO FOREST STATION



ONE CM/SEC

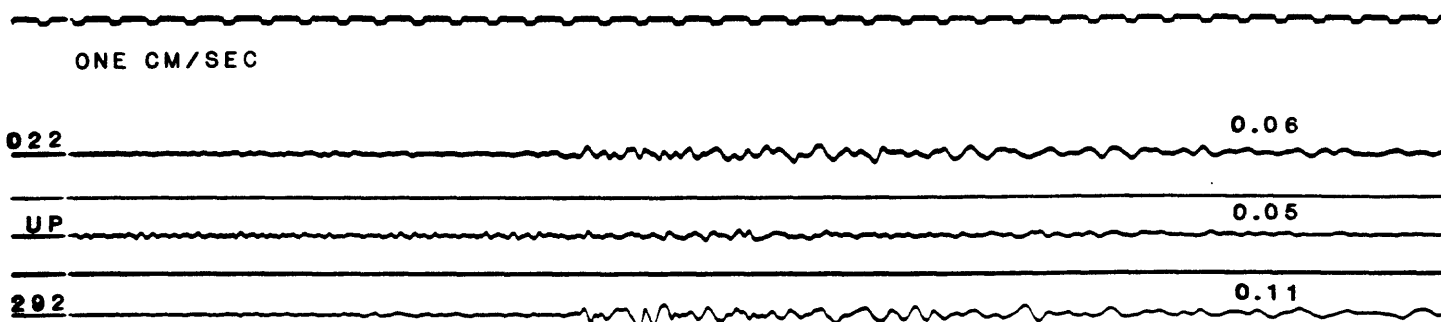
TOPANGA FIRE STATION



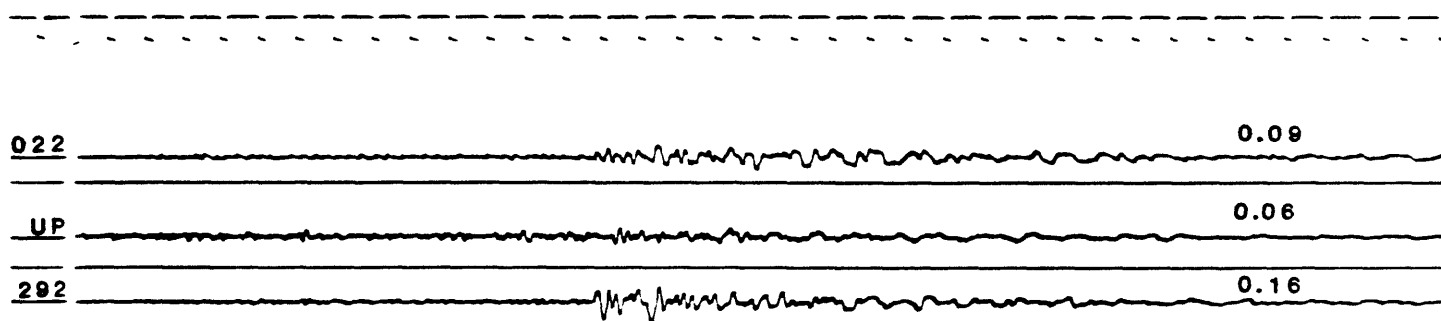
ONE CM/SEC

JENSEN FILTER PLANT

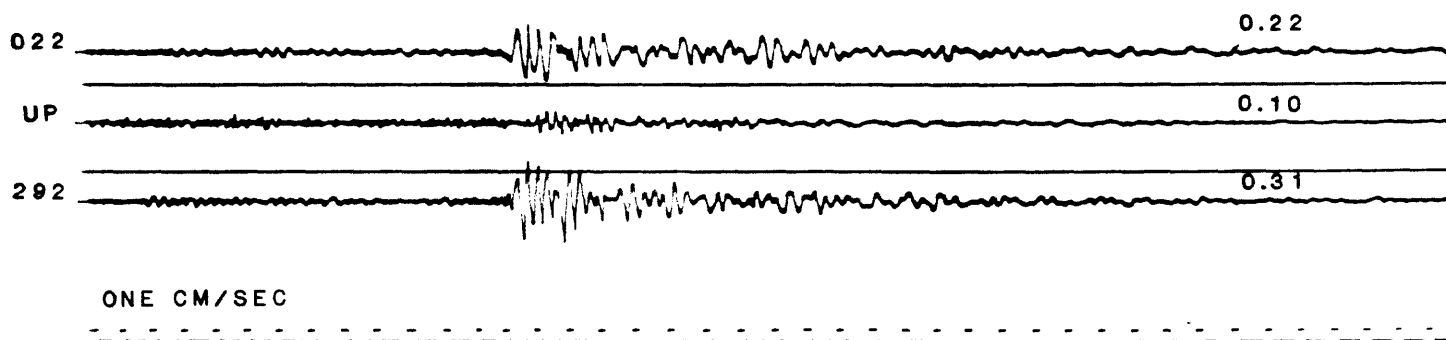
Admin. Bldg



Generator Room



Reservoir Roof



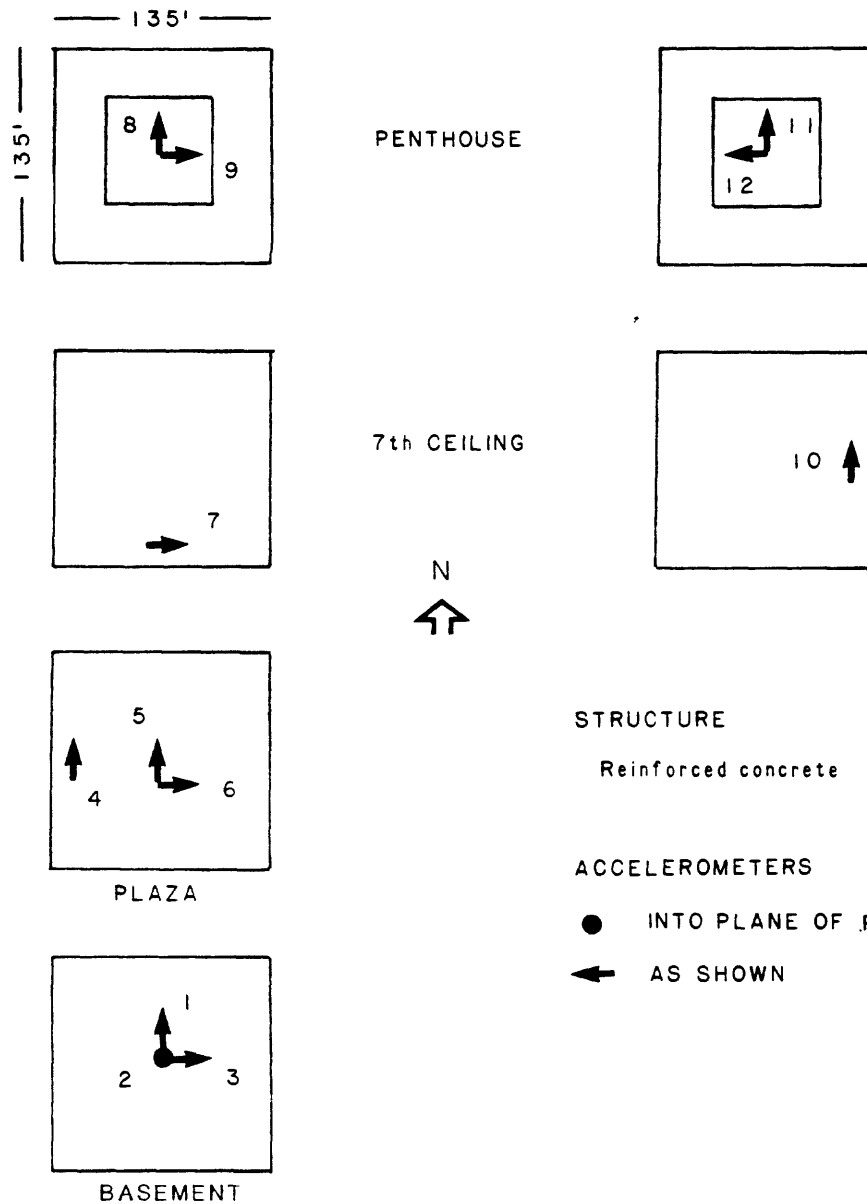
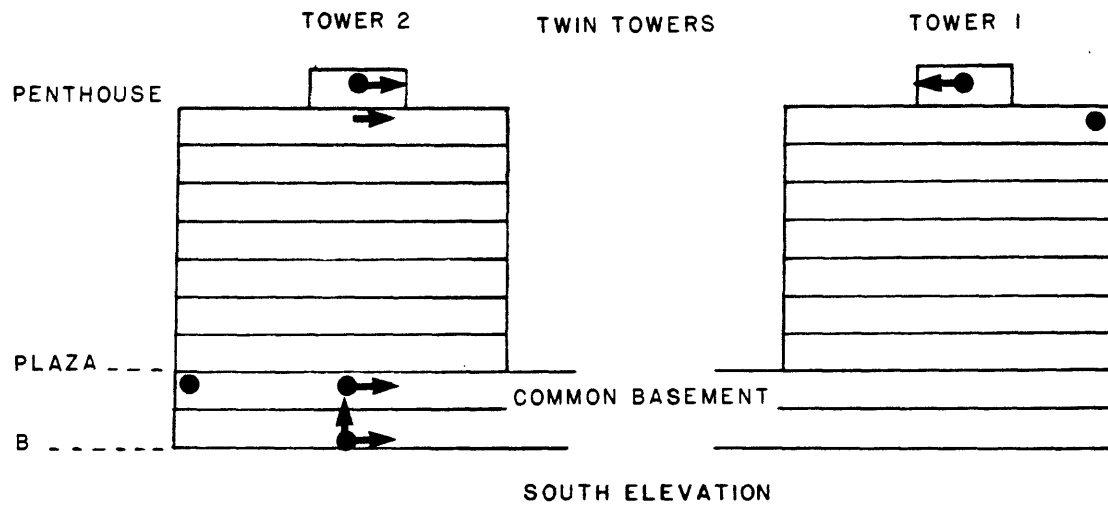
NEWPORT BEACH, 840 NEWPORT CENTER DRIVE

Structure Array

1	<u>360</u>	TOWER 2, LEVEL 1 (GARAGE), Center	0.06
2	<u>Up</u>	TOWER 2, LEVEL 1 (GARAGE), Center	0.02
3	<u>000</u>	TOWER 2, LEVEL 1 (GARAGE), Center	0.03
4	<u>360</u>	TOWER 2, LEVEL 2 (PLAZA), West End	0.08
5	<u>360</u>	TOWER 2, LEVEL 2 (PLAZA), Center	0.10
6	<u>000</u>	TOWER 3, LEVEL 2 (PLAZA), Center	0.06
7	<u>000</u>	TOWER 2, LEVEL 9 (ROOF), South End	0.04
8	<u>360</u>	TOWER 2, LEVEL 10 (PENTHOUSE) Center	0.04
9	<u>000</u>	TOWER 2, LEVEL 10 (PENTHOUSE) Center	0.08
10	<u>360</u>	TOWER 1, LEVEL 9 (ROOF), East End	0.04
11	<u>270</u>	TOWER 1, LEVEL 10 (PENTHOUSE) Center	0.04
12	<u>360</u>	TOWER 1, LEVEL 10 (PENTHOUSE) Center	0.06

ONE CM/SEC

NEWPORT BEACH
800 NEWPORT CENTER DRIVE
STRONG-MOTION INSTRUMENTATION



STRUCTURE

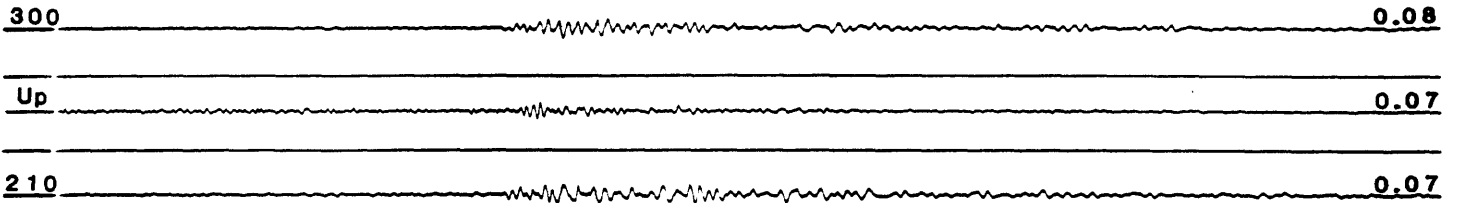
Reinforced concrete

ACCELEROMETERS

● INTO PLANE OF PLAN/ELEVATION

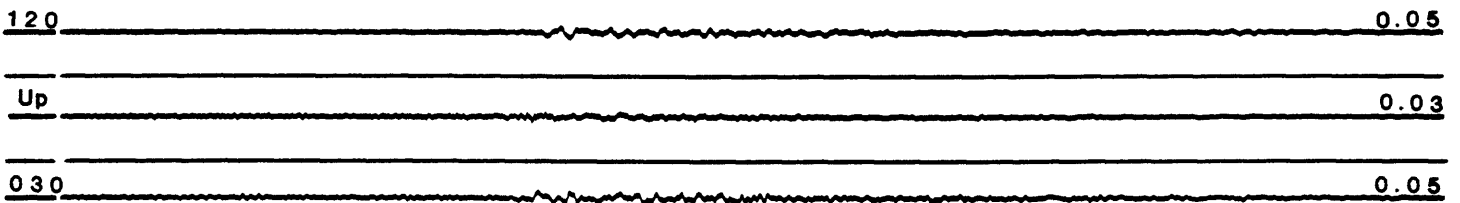
← AS SHOWN

LITTLEROCK POST OFFICE



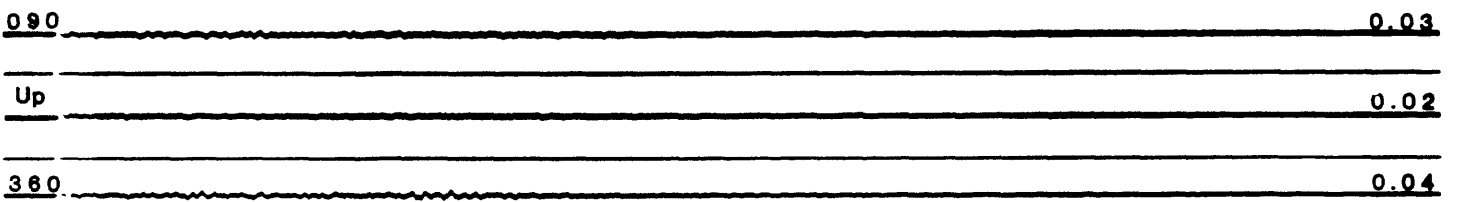
ONE CM/SEC

LONE PINE CANYON



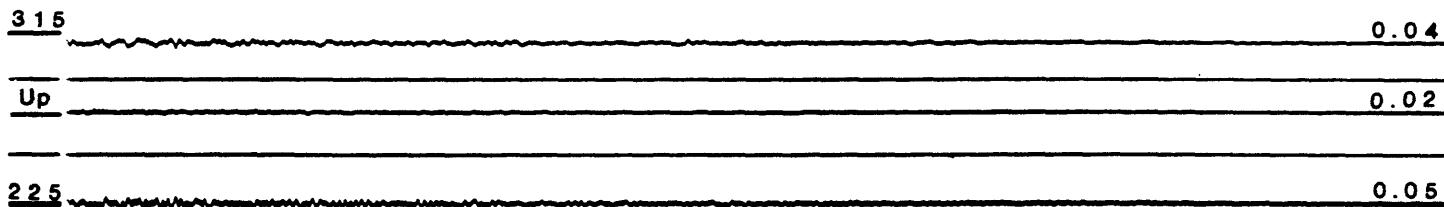
ONE CM/SEC

MALIBU CANYON, MONTE NIDO FIRE STATION



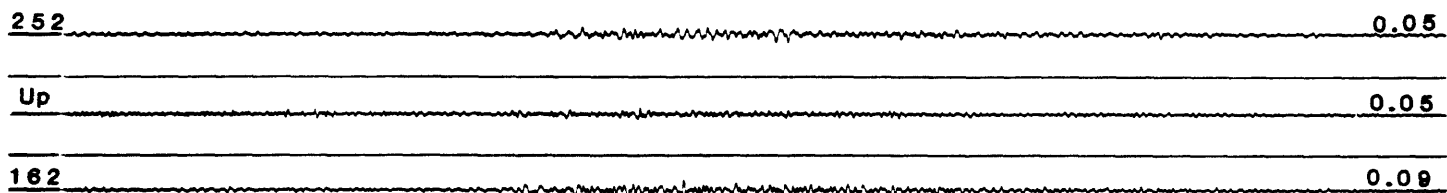
ONE CM/SEC

LYTLE CREEK RESIDENCE



ONE CM/SEC

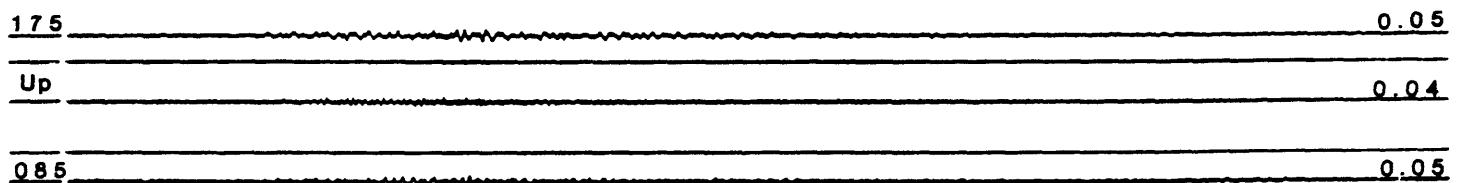
MATHEWS DAM, DIKE TOE



ONE CM/SEC

SANTA ANA RIVER BRIDGE

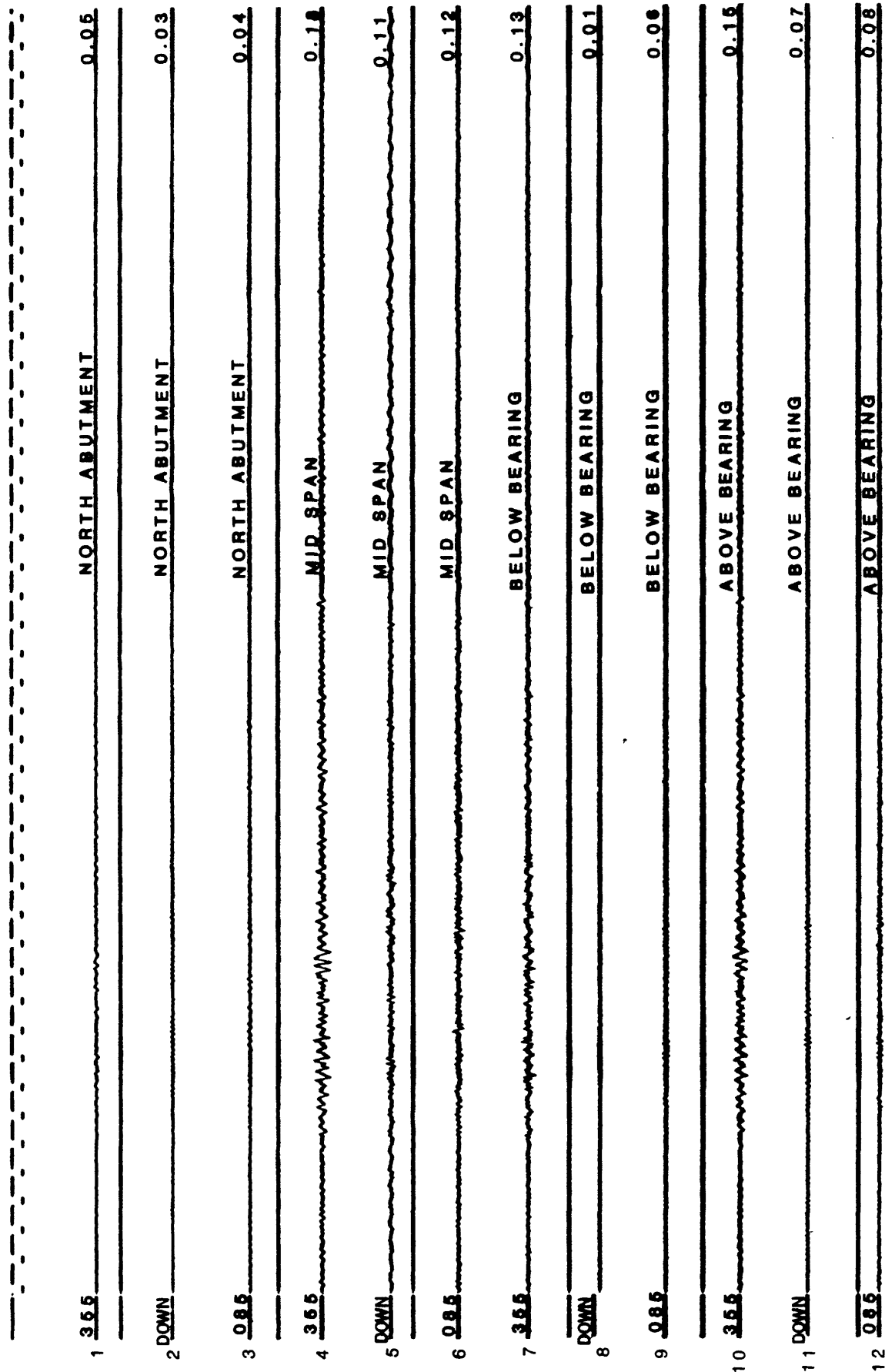
North Abutment Recorder Bldg



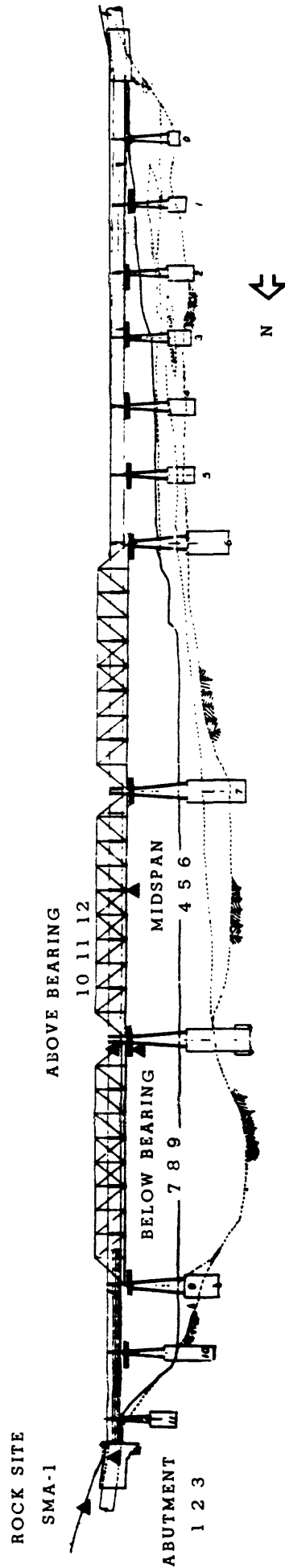
ONE CM/SEC

SANTA ANA RIVER BRIDGE

Structure Array



ONE CM/SEC



SANTA ANA RIVER BRIDGE
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

STRONG-MOTION INSTRUMENTATION

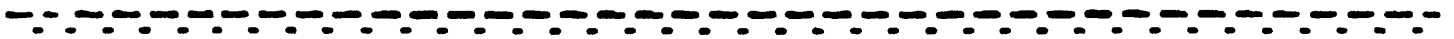
STRUCTURE

Three 180' long steel trusses
(instrumented section)

▲ TRIAXIAL SENSORS
— ELASTOMERIC BEARINGS

SANTA SUSANA

Ground Station



090 0.03

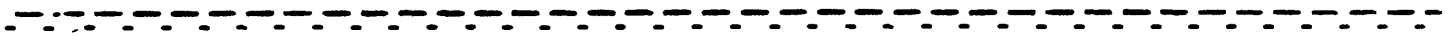
Up 0.01

360 0.03

ONE CM/SEC



Bldg 462, 1st Floor



090 0.02

Up 0.01

360 0.02

ONE CM/SEC



Bldg 462, 6th Floor



090 0.08

Up 0.04

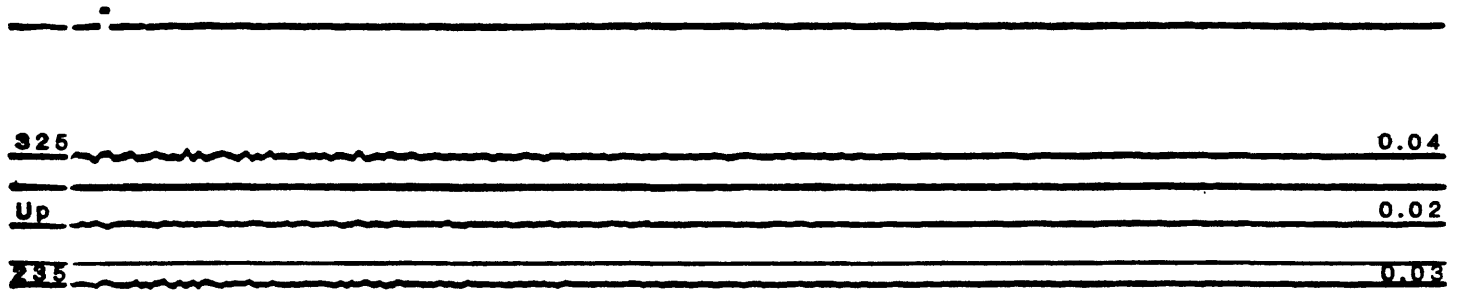
360 0.07

ONE CM/SEC



SANTA SUSANA

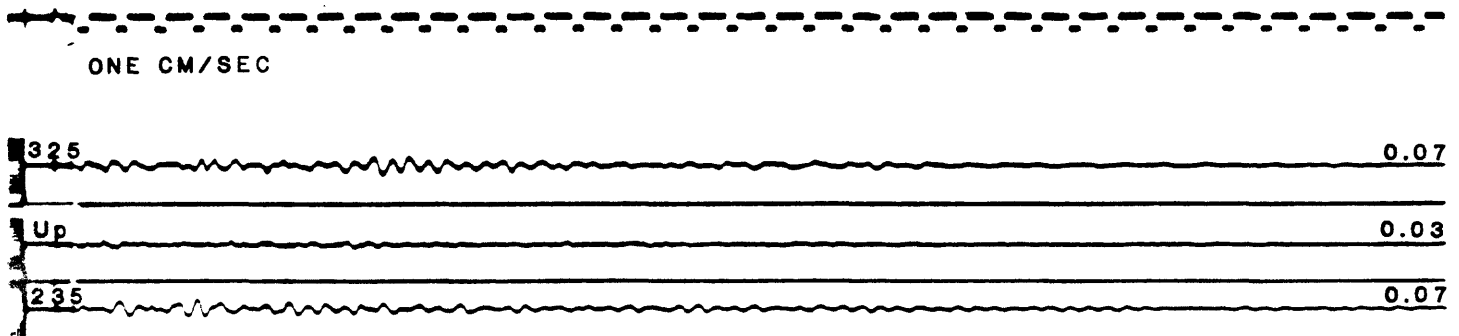
Bldg 026, Ground



ONE CM/SEC

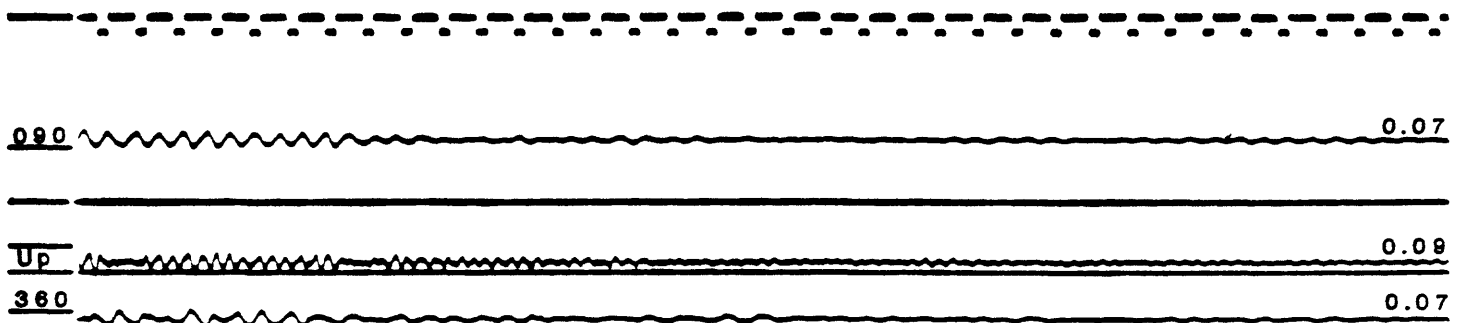


Bldg 356, 3rd Floor



ONE CM/SEC

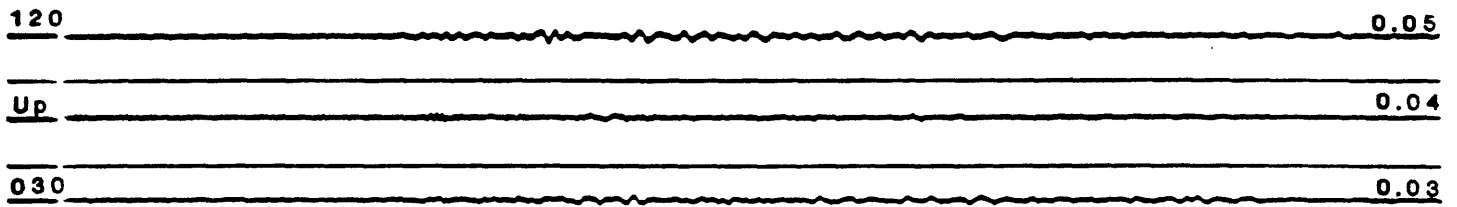
Bldg 463, Roof



ONE CM/SEC

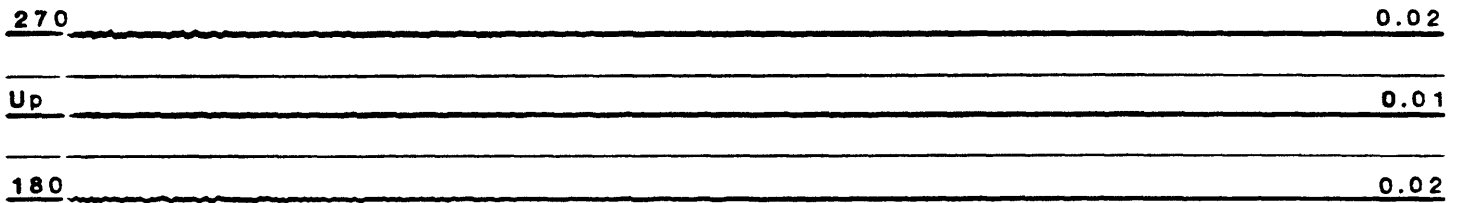


LEONA VALLEY FIRE STATION



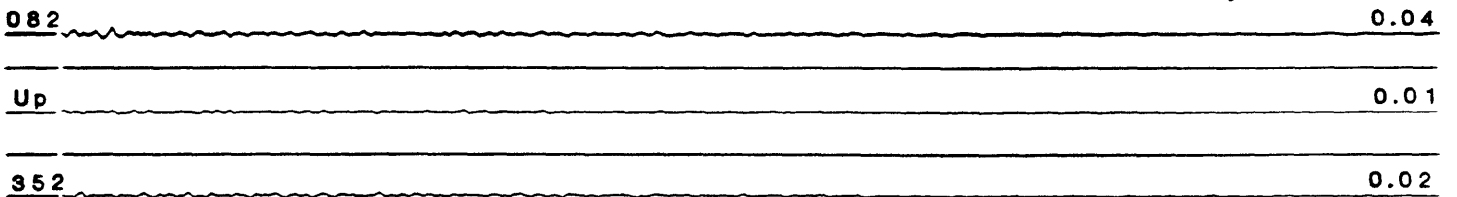
ONE CM/SEC

MALIBU, KILPATRICK SCHOOL



ONE CM/SEC

COLTON INTERCHANGE, VAULT



ONE CM/SEC

SAN BERNARDINO COUNTY GOVERNMENT CENTER

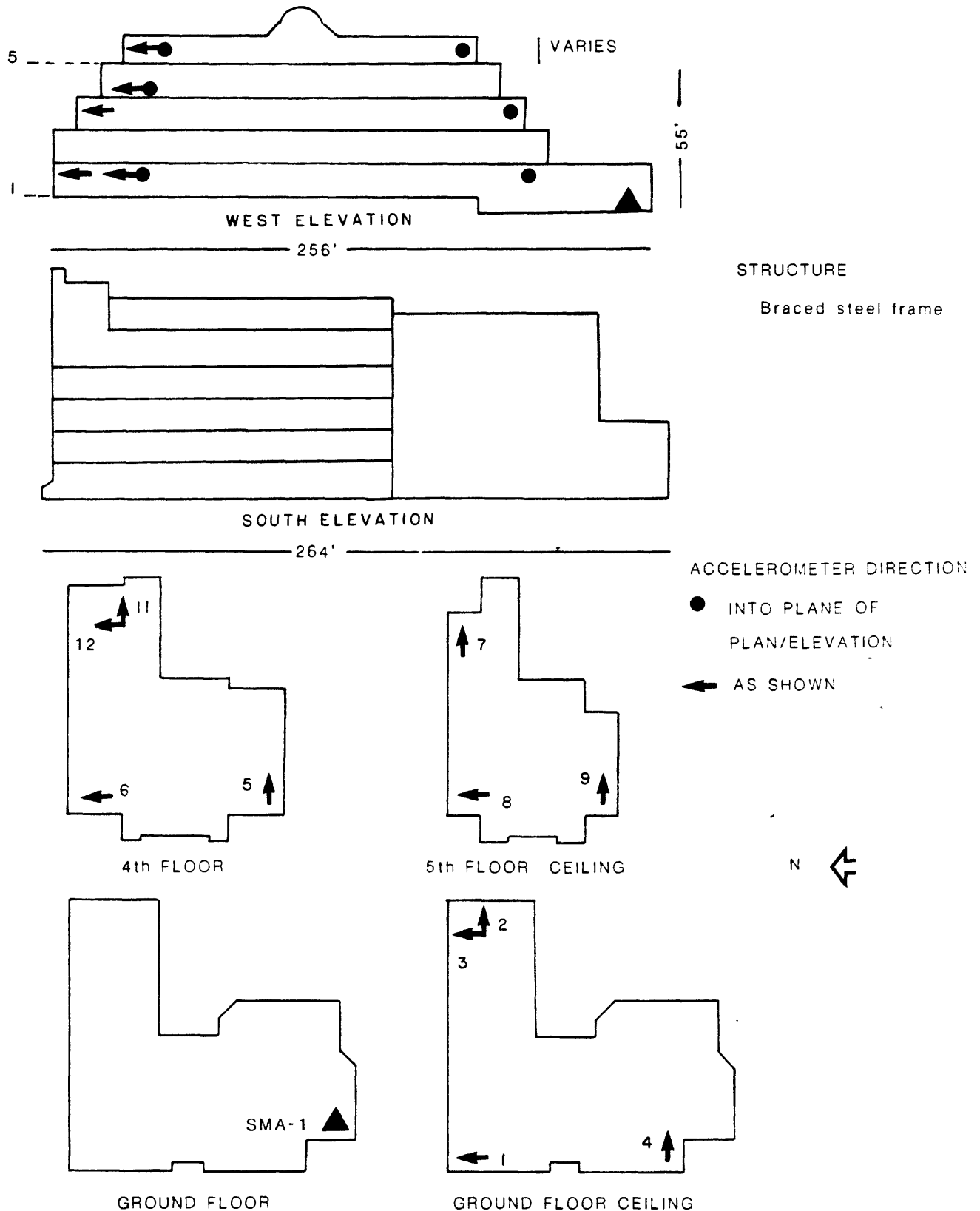
Structure Array

1	360	2nd Level, NW	0.04
2	090	2nd Level, NE	0.03
3	360	2nd Level, NE	0.04
4	090	2nd Level, SW	0.02
5	090	4th Level, SW	0.07
6	360	4th Level, NW	0.02
7	090	6th Level, (Roof) NE	0.05
8	360	6th Level, (Roof) NW	0.12
9	090	6th Level, (Roof) SW	0.05
10	(--)	Sensor Not Installed	(--)
11	090	4th Level, NE	0.02
12	360	4th Level, NE	0.07

ONE CM/SEC

SAN BERNARDINO
COUNTY GOVERNMENT CENTER

STRONG-MOTION INSTRUMENTATION



SAN BERNARDINO COUNTY GOVT CENTER

Ground Floor, SW



ONE CM/SEC



LOMA LINDA VA HOSPITAL

North Ground Site



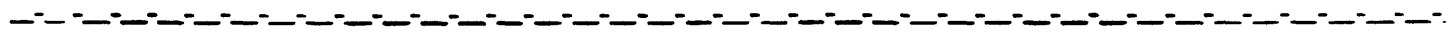
ONE CM/SEC



South Ground Site

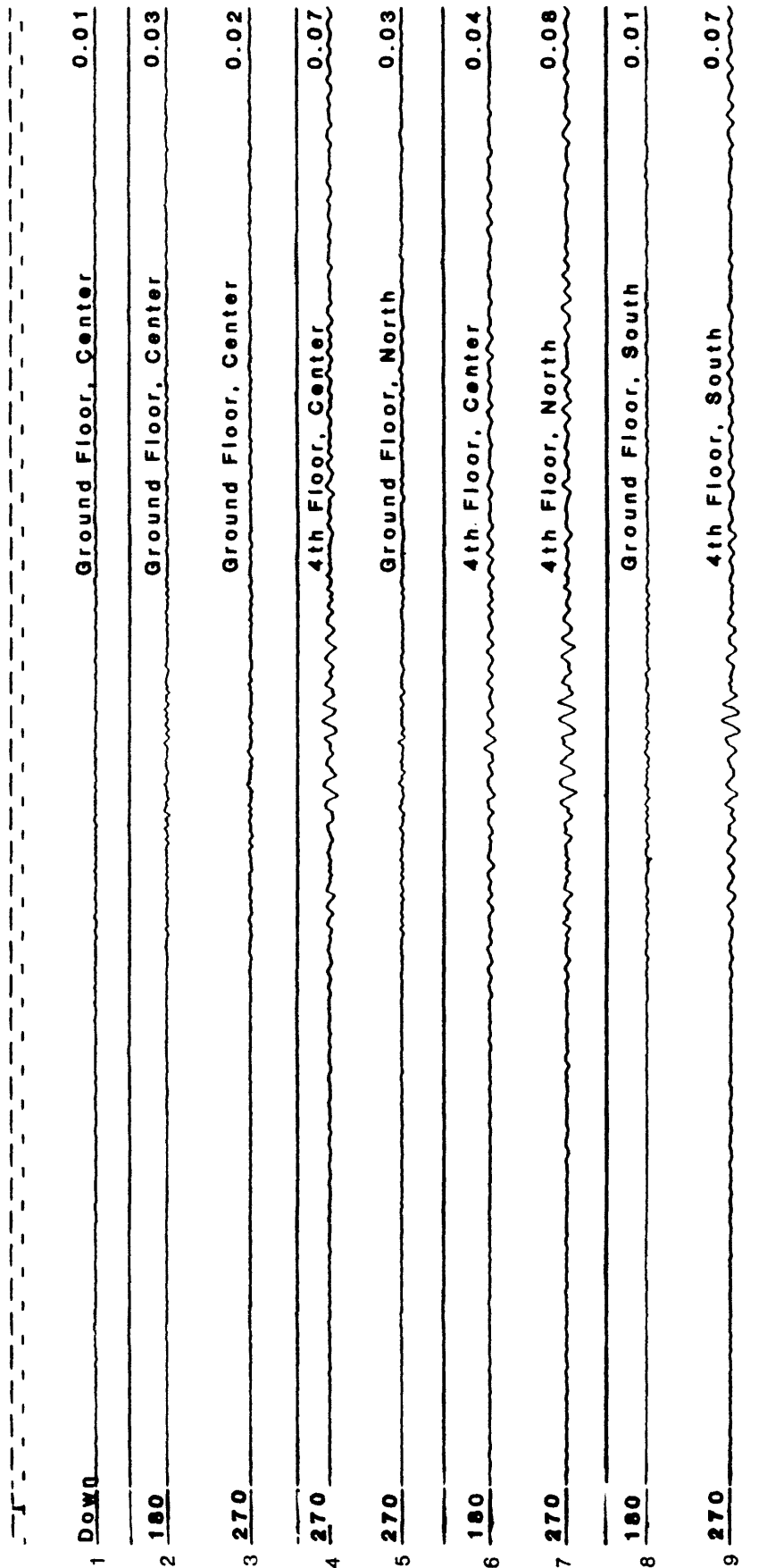


ONE CM/SEC



LOMA LINDA VA HOSPITAL

Building 1
Structure Array

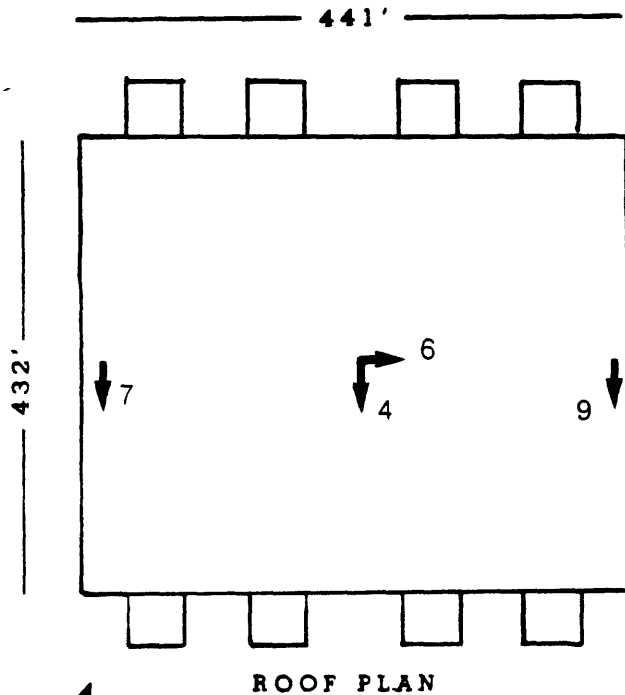
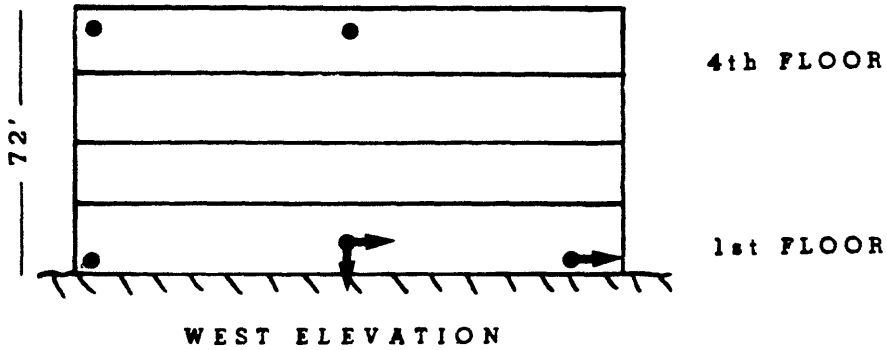


ONE CM/SEC

VETERANS ADMINISTRATION HOSPITAL

LOMA LINDA , CALIFORNIA

STRONG-MOTION INSTRUMENTATION

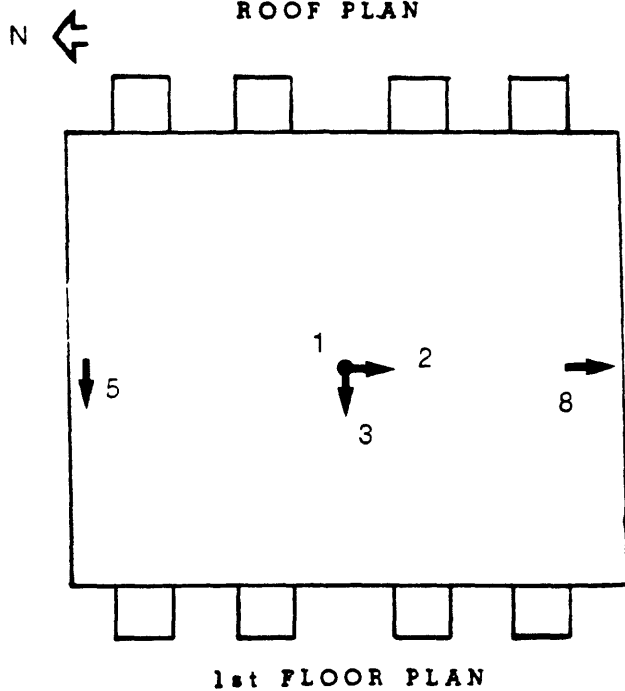


STRUCTURE

Rectangular

Moment resisting steel frame

Concrete shear walls in
both directions



ACCELEROMETER DIRECTIONS

● INTO PLANE OF PLAN/ELEVATION

← AS SHOWN

LOMA LINDA MEDICAL CENTER, BASEMENT

360 0.02
Up 0.01
270 0.02

ONE CM/SEC

RECHE CANYON

330 0.02
Up 0.02
240 0.02

ONE CM/SEC

PALMDALE FIRE STATION

120 0.03
Up 0.04
030 0.04

ONE CM/SEC

Table 1. MAIN-SHOCK DATA FROM USGS STRONG-MOTION STATIONS NEAR LOS ANGELES

[Station owners are Army Corps of Engineers (ACOE); Bechtel Power Corporation (BECH); Calif. Dept. of Transportation (CDOT); U.S. Dept. of Energy (DOE); JCG Finance Corp. of America (JCG); Los Angeles Metro. Water District (MWD); U.S. Geological Survey (USGS); and the Veterans Administration (VA). Epicentral distance is measured from station to epicenter at lat. 34.058 N., long. 118.077 W. Direction of acceleration is for upward trace deflection on accelerogram; vertical-component directions are listed as 'up' or 'down'.]

Map Index Number	Station Identification		Coordinates (Lat. °N, Long. °W)	Epicentral Distance (km)	Acceleration	
	USGS Number	Name (Owner)			Direction (degrees)	Maximum (g)
1	709	Garvey Reservoir	34.05	3	060	0.33
		Abutment Bldg.	118.11		Up	.38
		(MWD)			330	.47
2	289	Whittier Narrows Dam	34.03	4		
		(ACOE)	118.05			
		Crest			033	.31
					Up	.19
					303	.32
		Upstream			152	.31
3	482	Alhambra	34.09	8		
		900 S. Fremont	118.15			
		(USGS)				
		Basement			090	.30
					Up	.19
					360	.26
		6th Floor			090	.47
					Up	.18
					360	.37
		12th Floor			090	.28
					Up	.29
					360	.23
4	804	Whittier	33.977	10		
		7215 Bright Ave.	118.036			
		(USGS)				
		Basement			180	.40
					Up	.26
					090	.63
		5th Floor			180	.61
					Up	.34
					090	.60
		10th Floor			180	.41
					Up	.54
					090	.54

Table 1. MAIN-SHOCK DATA FROM USGS STRONG-MOTION STATIONS NEAR LOS ANGELES (continued)

Map Index Number	Station Identification		Coordinates (Lat. °N, Long. °W)	Epicentral Distance (km)	Acceleration	
	USGS Number	Name (Owner)			Direction (degrees)	Maximum (<u>g</u>)
5	5244	Los Angeles 4407 Jasper Street (USGS)	34.081 118.188	11	130 Up 040	.33* .13* .23*
6	5129	Los Angeles Bulk Mail Center (USGS)	33.99 118.16	11	010 Up 280	.34 .52 .46
7	288	Vernon 4814 Loma Vista Ave. (USGS)	34.00 118.20	13	007 Up 277	.29 .17 .22
8	634	Norwalk 12400 Imperial Hiway (USGS/BECH)	33.92 118.07	15		
		Basement			090 Up 360	.12 .07 .21
		4th Floor			090 Up 360	.17 .12 .33
		Roof			090 Up 360	.21 .18 .40
		North Ground Site	-- removed for repair.		---	---
		South Ground Site			090 Up 360	.10 .09 .29
9	5239	Norwalk 12440 Imperial Hiway (USGS/BECH)	33.92 118.07	15		
		Basement			090 Up 360	.11 .10 .21
		North Ground Site			090 Up 360	.13 .13 .24
		South Ground Site			090 Up 360	.09 .10 .21

*Partial record, film fogged for approx. the first 3 sec. after triggering.

Table 1. MAIN-SHOCK DATA FROM USGS STRONG-MOTION STATIONS NEAR LOS ANGELES (continued)

Station Identification				Epicentral Distance (km)	Acceleration		
Map Index Number	USGS Number	Name (Owner)	Coordinates (Lat. °N, Long. °W)		Direction (degrees)	Maximum (g)	
9	5239	Norwalk, 12440 Imperial Hiway (continued)					
		Structure Array 1:					
		Ch. 1- 7th Floor, Center			090	.18	
		Ch. 2- 5th Floor, Center			090	.15	
		Ch. 3- 2nd Floor, Center			090	.12	
		Ch. 4- 1st Floor, Center			090	.13	
		Ch. 5- Basement, East			360	.19	
		Ch. 6- 5th Floor, West-Center			360	.23	
		Ch. 7- Basement, Center			090	.05	
		Ch. 8- Basement, Center			Up	.11	
		Ch. 9- Basement, Center			360	.20	
		Ch. 10- 30 ft. Downhole, Bldg. Center			090	.05	
		Ch. 11- 30 ft. Downhole, Bldg. Center			Up	.10	
		Ch. 12- 30 ft. Downhole, Bldg. Center			360	.16	
		Structure Array 2:					
		Ch. 13- 7th Floor, East			360	.31	
		Ch. 14- 5th Floor, East			360	.14	
		Ch. 15- 2nd Floor, East			360	.17	
		Ch. 16- 1st Floor, East			360	.18	
		Ch. 17- 7th Floor, Center			360	.41	
		Ch. 18- 5th Floor, Center			360	.26*	
		Ch. 19- 2nd Floor, Center			360	.30	
		Ch. 20- 1st Floor, Center			360	.23	
		Ch. 21- 7th Floor, West			360	.27	
		Ch. 22- 5th Floor, West			360	.12	
		Ch. 23- 2nd Floor, West			360	.19	
		Ch. 24- 1st Floor, West			360	.22	
-10	872	Los Angeles 1111 Sunset Blvd. (MWD)	34.07 118.25	16			
		Basement			348 Up 258	.16 .07 .11	
		4th Floor			348 Up 258	.19 .09 .11	
		Roof			348 Up 258	.18 .22 .15	
11	5233	Los Angeles 1100 Wilshire (JCG/USGS)	34.052 118.263	17			
		Basement 3, NE			298 Up 208	.18 .07 .12	

*Ch. 18 failed after 2.5 sec.

Table 1.--MAIN-SHOCK DATA FROM USGS STRONG-MOTION STATIONS NEAR LOS ANGELES (continued)

Station Identification			Epicentral Distance (km)	Acceleration		
Map Index Number	USGS Number	Name (Owner)		Coordinates (Lat. °N, Long. °W)	Direction (degrees)	Maximum (g)
11	5233	L.A., 1100 Wilshire (continued)				
		Basement 3, SE			298 Up 208	.18 .07 .11
		Basement 4, NW			298 Up 208	.17 .08 .11
		Structure Array:				
		Ch. 1- 12th Floor, North			298	.13
		Ch. 2- 12th Floor, North			208	.24
		Ch. 3- 12th Floor, South			208	.10
		Ch. 4- 13th Floor, North			298	.14
		Ch. 5- 13th Floor, North			208	.26
		Ch. 6- 13th Floor, South			208	.12
		Ch. 7- 32nd Floor, North			298	.17
		Ch. 8- 32nd Floor, North			208	.19
		Ch. 9- 32nd Floor, South			208	.10
		Ch. 10- Ground Floor, North			298	.17
		Ch. 11- Ground Floor, North			208	.21
		Ch. 12- Ground Floor, South			208	.15
12	141	Los Angeles Griffith Park Observatory (USGS)	34.12 118.30	22	360 Up 270	.13 .06 .15
13	756	Morris Dam Abutment (MWD)	34.17 117.88	22	246 Up 156	.04 .04 .05
14	697	Orange County Reservoir Abutment (MWD)	33.935 117.883	23	096 Up 006	.23 .10 .21
15	951	Brea Dam (ACOE)	33.889 117.926	23		
		Crest			130 Up 040	.31 .14 .23
		Left Abutment			130 Up 040	.16 .09 .10
		Downstream			130 Up 040	.32 .09 .18

Table 1. MAIN-SHOCK DATA FROM USGS STRONG-MOTION STATIONS NEAR LOS ANGELES (continued)

Station Identification				Epicentral Distance (km)	Acceleration	
Map Index Number	USGS Number	Name (Owner)	Coordinates (Lat. °N, Long. °W)		Direction (degrees)	Maximum (g)
16	108	Carbon Canyon Dam (ACOE)	33.92 117.84	27		
		Crest			130 Up 040	.17 .13 .20
		Left Abutment			130 Up 040	.22 .07 .16
17	5164	Weymouth Filter Plant (MWD)	34.114 117.778	28		
		Bldg., Ground Level			017 Up 287	.10 .05 .06
		Water Tank, Top			017 Up 287	.15 .11 .13
18	698	Diemer Filter Plant (MWD)	33.91 117.82	29		
		Admin. Bldg. Basement			281 Up 191	.09 .04 .06
		Reservoir Roof			281 Up 191	.11 .17 .11
19	132	Long Beach, CSULB Humanities Bldg. Basement (USGS)	33.78 118.11	31	076 Up 346	.09 .05 .09
20	656	Live Oak Reservoir (MWD)	34.134 117.753	31		
		Abutment			180 Up 090	.04 .02 .03

Table 1.--MAIN-SHOCK DATA FROM USGS STRONG-MOTION STATIONS NEAR LOS ANGELES (continued)

Station Identification			Coordinates (Lat. °N, Long. °W)	Epicentral Distance (km)	Acceleration	
Map Index Number	USGS Number	Name (Owner)			Direction (degrees)	Maximum (g)
20	656	Live Oak Reservoir (continued)				
		Structure Array:				
		Ch. 1- Center Crest			155	.07
		Ch. 2- Center Crest			Up	.04
		Ch. 3- Center Crest			245	.07
		Ch. 4- Left Crest			155	.09
		Ch. 5- Left Crest			245	.08
		Ch. 6- Left Slope			245	.04
		Ch. 7- Center Slope			155	.09
		Ch. 8- Center Slope			Up	.04
		Ch. 9- Center Slope			245	.06
		Ch. 10- Center Toe			155	.05
		Ch. 11- Center Toe			Up	.02
		Ch. 12- Center Toe			245	.03
21	5106	Long Beach VA Hospital (VA)	33.78 118.12	31		
		Basement			360 Up 270	.08 .05 .10
		6th Floor			360 Up 270	.17 .08 .11
		11th Floor			360 Up 270	.26 .11 .16
22	5243	Lawndale 15000 Aviation Blvd. (USGS)	33.895 118.377	33	360 Up 270	.06 .04 .06
23	5082	Los Angeles Wadsworth VA Hospital (VA/USGS)	34.050 118.452	35		
		Bldg. 500 Structure Array:				
		Ch. 1- 6th Floor, North End			235	.20
		Ch. 2- 6th Floor, North Center			235	.15
		Ch. 3- 6th Floor, Center			235	.15
		Ch. 4- 6th Floor, Center			055	.18
		Ch. 5- 6th Floor, South End			055	.25
		Ch. 6- 6th Floor, South End			325	.13
		Ch. 7- Basement, North Center			325	.07
		Ch. 8- Basement, North Center			235	.07
		Ch. 9- Basement, North Center			Down	.04
		North Ground Site			325 Up 235	.07 .03 .08

Table 1.--MAIN-SHOCK DATA FROM USGS STRONG-MOTION STATIONS NEAR LOS ANGELES (continued)

Map Index Number	Station Identification		Coordinates (Lat. °N, Long. °W)	Epicentral Distance (km)	Acceleration	
	USGS Number	Name (Owner)			Direction (degrees)	Maximum (g)
23	5082	L.A., Wadsworth VA Hospital (continued)				
		South Ground Site			325	.07
					Up	.04
					235	.09
24	638	Los Angeles, Brentwood VA Hospital, Ground level (VA)	34.058 118.457	35	285	.04
					Up	.03
					195	.05
25	757	Sepulveda Canyon Spillway Roof (MWD)	34.05 118.48	37	156	.03
					Up	.02
					066	.08
26	287	San Antonio Dam (ACOE)	34.166 117.680	38		
		Crest			090	.10
					Up	.06
					360	.14
		Right Abutment			090	.04
					Up	.05
					360	.04
		Downstream			090	.07
					Up	.04
					360	.05
27	949	Sepulveda Dam (ACOE)	34.17 118.47	38		
		Crest			054	.09
					Up	.09
					324	.14
		Downstream			054	.12
					Up	.07
					324	.15
28	710	Palos Verdes Reservoir Abutment (MWD)	33.774 118.321	39	253	.04
					Up	.03
					163	.04
29	281	Santa Ana, Orange County Engineering Bldg., Basement (USGS)	33.75 117.87	39	360	.09
					Up	.03
					270	.05
30	411	Palos Verdes Estates Basement (USGS)	33.801 118.387	40	335	.03
					Up	.02
					245	.03

Table 1.--MAIN-SHOCK DATA FROM USGS STRONG-MOTION STATIONS NEAR LOS ANGELES (continued)

Map Index Number	Station Identification		Coordinates (Lat. °N, Long. °W)	Epicentral Distance (km)	Acceleration	
	USGS Number	Name (Owner)			Direction (degrees)	Maximum (g)
31	637	Sepulveda VA Hospital	34.249	43	360	.18
		Ground level	118.475		Up	.10
		(VA)			270	.22
32	969	Prado Dam	33.89	44		
		(ACOE)	117.64			
		Crest			090	.09
					Up	.06
					360	.09
		Left Abutment			090	.04
					Up	.03
					360	.07
		Downstream			090	.14
					Up	.06
					360	.12
33	5032	Paradise Springs Camp	34.40	46	120	.02
		Ground Level	117.80		Up	.02
		(USGS)			030	.02
34	5031	Valyermo Forest Station	34.44	47	300	.04
		Ground Level	117.85		Up	.04
		(USGS)			210	.05
35	655	Jensen Filter Plant	34.309			
		(MWD)	118.499			
		Administration Bldg.			022	.06
					Up	.05
					292	.11
		Generator Room			022	.09
					Up	.06
					292	.16
		Reservoir Roof			022	.22
					Up	.10
					292	.31
36	5081	Topanga Fire Station	34.084	48	270	.03
		Ground Level	118.600		Up	.02
		(USGS)			180	.04
37	5030	Littlerock Post Office	34.521	52	300	.08
		Ground Level	117.991		Up	.07
		(USGS)			210	.07

Table 1.--MAIN-SHOCK DATA FROM USGS STRONG-MOTION STATIONS NEAR LOS ANGELES (continued)

Map Index Number	Station Identification		Coordinates (Lat. °N, Long. °W)	Epicentral Distance (km)	Acceleration	
	USGS Number	Name (Owner)			Direction (degrees)	Maximum (g)
38	5246	Newport Beach 840 Newport Center Drive (USGS)	33.618 117.878	52		
		Structure Array:				
		Ch. 1- Tower 2, Level 1 (Garage), Center			360	.06
		Ch. 2- Tower 2, Level 1 (Garage), Center			Up	.02
		Ch. 3- Tower 2, Level 1 (Garage), Center			090	.03
		Ch. 4- Tower 2, Level 2 (Plaza), West End			360	.08
		Ch. 5- Tower 2, Level 2 (Plaza), Center			360	.10
		Ch. 6- Tower 2, Level 2 (Plaza), Center			090	.06
		Ch. 7- Tower 2, Level 9 (Roof), South End			090	.04
		Ch. 8- Tower 2, Level 10 (Penthouse), Center			360	.04
		Ch. 9- Tower 2, Level 10 (Penthouse), Center			090	.08
		Ch. 10- Tower 1, Level 9 (Roof), East End			360	.04
		Ch. 11- Tower 1, Level 10 (Penthouse), Center			270	.04
		Ch. 12- Tower 1, Level 10 (Penthouse), Center			360	.06
39	5034	Lone Pine Canyon Ground Level (USGS)	34.32 117.57	55	120 Up 030	.05 .03 .05
40	5080	Malibu Canyon Monte Nido Fire Station (USGS)	34.08 118.69	56	090 Up 360	.03 .02 .04
41	262	Palmdale Fire Station Ground Level (USGS)	34.58 118.11	58	120 Up 030	.03 .04 .04
42	5035	Lytle Creek Mann Residence (USGS)	34.26 117.50	58	315 Up 225	.04 .02 .05
43	5235	Santa Ana River Bridge (MWD/USGS)	33.968 117.447	59		
		South Abutment			175	.05
		Recorder Building			Down 085	.04 .05
		Structure Array:				
		Ch. 1- North Abutment			355	.05
		Ch. 2- North Abutment			Down	.03
		Ch. 3- North Abutment			085	.04
		Ch. 4- Mid Span			355	.18
		Ch. 5- Mid Span			Down	.11
		Ch. 6- Mid Span			085	.12
		Ch. 7- Below Bearing			355	.13
		Ch. 8- Below Bearing			Down	.01
		Ch. 9- Below Bearing			085	.06
		Ch. 10- Above Bearing			355	.15
		Ch. 11- Above Bearing			Down	.07
		Ch. 12- Above Bearing			085	.08

Table 1.--MAIN-SHOCK DATA FROM USGS STRONG-MOTION STATIONS NEAR LOS ANGELES (continued)

Map Index Number	Station Identification		Coordinates (Lat. °N, Long. °W)	Epicentral Distance (km)	Acceleration	
	USGS Number	Name (Owner)			Direction (degrees)	Maximum (g)
44	5108	Santa Susana (DOE)	34.23 118.71	61		
		Ground Station			090 Up 360	.03 .01 .03
		Building 026, Ground			325 Up 235	.04 .02 .03
		Building 356, 3rd Floor			325 Up 235	.07 .03 .07
		Building 462: 1st Floor			090 Up 360	.02 .01 .02
		6th Floor			090 Up 360	.08 .04 .07
		Building 463, Roof			090 Up 360	.07 .09 .07
45	5036	Sycamore Forest Station Ground Level (USGS)	34.193 117.426	62	315 Up 225	Did not trigger
46	707	Mathews Dam Dike Toe (MWD)	33.852 117.451	62	252 Up 162	.05 .05 .09
47	5029	Leona Valley Fire Station Ground Level (USGS)	34.62 118.29	65	120 Up 030	.05 .04 .03
48	5079	Malibu Kilpatrick School (USGS)	34.093 118.836	70	270 Up 180	.02 .01 .02
49	754	Colton Interchange, I-10/I-215 Pier Base Vault (CDOT)	34.06 117.30	72	082 Up 352	.04 .01 .02

Table 1.--MAIN-SHOCK DATA FROM USGS STRONG-MOTION STATIONS NEAR LOS ANGELES (continued)

Station Identification				Epicentral Distance (km)	Acceleration	
Map Index Number	USGS Number	Name (Owner)	Coordinates (Lat. °N, Long. °W)		Direction (degrees)	Maximum (g)
50	5245	San Bernardino County Government Center (USGS)	34.106 117.287	73		
		Ground Floor, SW			090 Up 360	.02 .02 .03
		Structure Array:				
		Ch. 1- 2nd Floor Level, NW			360	.04
		Ch. 2- 2nd Floor Level, NE			090	.03
		Ch. 3- 2nd Floor Level, NE			360	.04
		Ch. 4- 2nd Floor Level, SW			090	.02
		Ch. 5- 4th Floor Level, SW			090	.07
		Ch. 6- 4th Floor Level, NW			360	.02
		Ch. 7- 6th Floor Level, (Roof) NE			090	.05
		Ch. 8- 6th Floor Level, (Roof) NW			360	.12
		Ch. 9- 6th Floor Level, (Roof) SW			090	.05
		Ch. 10- Sensor Not Installed			(--)	(--)
		Ch. 11- 4th Floor Level, NE			090	.02
		Ch. 12- 4th Floor Level, NE			360	.07
51	129	Loma Linda Medical Center Basement (USGS)	34.05 117.26	75	360 Up 270	.02 .01 .02
52	5229	Loma Linda VA Hospital (VA/USGS)	34.049 117.250	76		
		Building 1 Structure Array:				
		Ch. 1- Ground Floor, Center			Down	.01
		Ch. 2- Ground Floor, Center			180	.03
		Ch. 3- Ground Floor, Center			270	.02
		Ch. 4- 4th Floor, Center			270	.07
		Ch. 5- Ground Floor, North			270	.03
		Ch. 6- 4th Floor, Center			180	.04
		Ch. 7- 4th Floor, North			270	.08
		Ch. 8- Ground Floor, South			180	.01
		Ch. 9- 4th Floor, South			270	.07
		North Ground Site			360 Up 270	.04 .03 .04
		South Ground Site			360 Up 270	.04 .02 .02
53	5037	Reche Canyon Olive Dell Ranch (USGS)	34.01 117.22	79	330 Up 240	.02 .02 .02