C. 818-B

GEOLOGICAL SURVEY CIRCULAR 818-B

Seismic Engineering Program Report

May-August 1979

Prepared on behalf of the
National Science Foundation
Grant CA-114

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1980

United States Department of the Interior

CECIL D. ANDRUS, *Secretary*

Geological Survey

H. William Menard, *Director*

Free on application to Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, VA 22202

PREFACE

This Seismic Engineering Program Report is an informal document primarily intended to keep the ever-growing community of strong-motion data users apprised of the availability of data recovered by the Seismic Engineering Branch of the U.S. Geological Survey. The Seismic Engineering Program of strong-motion instrumentation is supported by the National Science Foundation (Grant CA-114) in cooperation with numerous Federal, State, and local agencies and organizations.

This issue contains a summary of the accelerograms recovered from the U.S. Geological Survey's (USGS) National Strong-Motion Network during the period May 1 through August 31, 1979. A report on the Gilroy (Coyote Lake) earthquake of August 6, 1979, is presented along with summaries of recent reports, notes on strong-motion information sources and the availability of digitized data, and additional information pertinent to the USGS and other strong-motion programs. The data summary presented in table 1 includes those accelerograms recovered (although not necessarily recorded) during the period May through August, 1979; this procedure will be continued in future issues so that the dissemination of strong-motion information may be as expeditious and current as practicable.

Ronald L. Porcella, Editor
U.S. Geological Survey, MS 78
Menlo Park, California 94025

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ILLUSTRATIONS

Seismic Engineering Program Report May—August 1979

RECENT STRONG-MOTION RECORDS

by R. L. Porcella

Approximately 140 accelerograph records were recovered from the U.S. Geological Survey's Strong-Motion Network during the period May 1 through August 31, 1979 (see table 1). The magnitude 5.7 Gilroy (Coyote Lake), California earthquake of August 6 produced 55 strong-motion records, including five that were recorded at stations within 16 km of the epicenter; these stations (the Gilroy array) extend from a rock site across an alluvial valley to another rock site. Information and data on these records and an additional 41 accelerograph records recovered by the California Division of Mines and Geology's Office of Strong-Motion Studies are presented in the following report.

Eleven accelerograms were obtained at seven strong-motion stations on the Island of Hawaii during this reporting period; four of these records contain peak ground accelerations greater than 0.10 *g* (table 1). The Hawaii strong-motion network has produced almost 100 records since the magnitude 7.2 earthquake of November 1975 and presently contains 18 accelerograph and three seismoscope stations on the islands of Oahu, Molokai, Maui, and Hawaii (fig. 1). Although many of the records from this network contain accelerations of small amplitude and short duration, a dominant frequency apparent in several of the analog records suggests that the subsurface conditions are markedly dissimilar not only from those at most sites in the western U.S., but also among the various sites within the Hawaii network. Although the former dissimilarities were anticipated (Furumoto and others, 1972) and in fact provided a major impetus to the establishment of the network, the latter dissimilarities have greatly complicated efforts related to the routine analysis and predictability of site response (see fig. 2, for example). However, if detailed site investigations (including geophysical and geologic studies) are made at all stations in the Hawaii network, this data base may provide valuable information for use in studies of soil-structure interaction and wave-propagation in the Hawaiian islands.

The strong-motion station at Monticello Dam in north-central South Carolina produced four accelerograph records during this reporting period; the accelerograph is located on an abutment of the dam and recorded a maximum acceleration of 0.05 *g*. The dam and reservoir are part of the Virgil C. Summer nuclear power facility operated by the South Carolina Electric and Gas Company and are located about 4 km northwest of Jenkinsville, S.C. The station was established by the U.S. Geological Survey in February 1978 as a result of an abrupt increase in seismic activity that accompanied filling of the reservoir (Porcella, 1978). Approximately 30 accelerograms have been recorded at this site; a magnitude 2.7 event on August 27, 1978 produced a 0.253 *g* peak horizontal ground acceleration with a strong duration (greater than 0.1 *g*) of about 0.06 s at approximately 25 Hz. This record contains the largest known recorded acceleration from an earthquake in central or eastern North America.

Additional records recovered from the National Network during May - August 1979 were recorded at stations located in Alaska, southern California, and the San Francisco Bay region (see table 1).

References:

Furumoto, A. S., Nielsen, N. N., and Phillips, W. R., 1972, A study of past earthquakes, isoseismic zones of intensity, and recommended zones for structural design for Hawaii: Engineering Bulletin PACE 72033, Center for Engineering Research, University of Hawaii, 53 p.

International Conference of Building Officials, 1976, Uniform building code: Whittier, California, InternationalConference of Building Officials, 728 p.

Porcella, R. L., 1978, Recent strong-motion records, in Seismic Engineering Program Report, May - August 1978: Geological Survey Circular 785-B, p. 1, table 1.

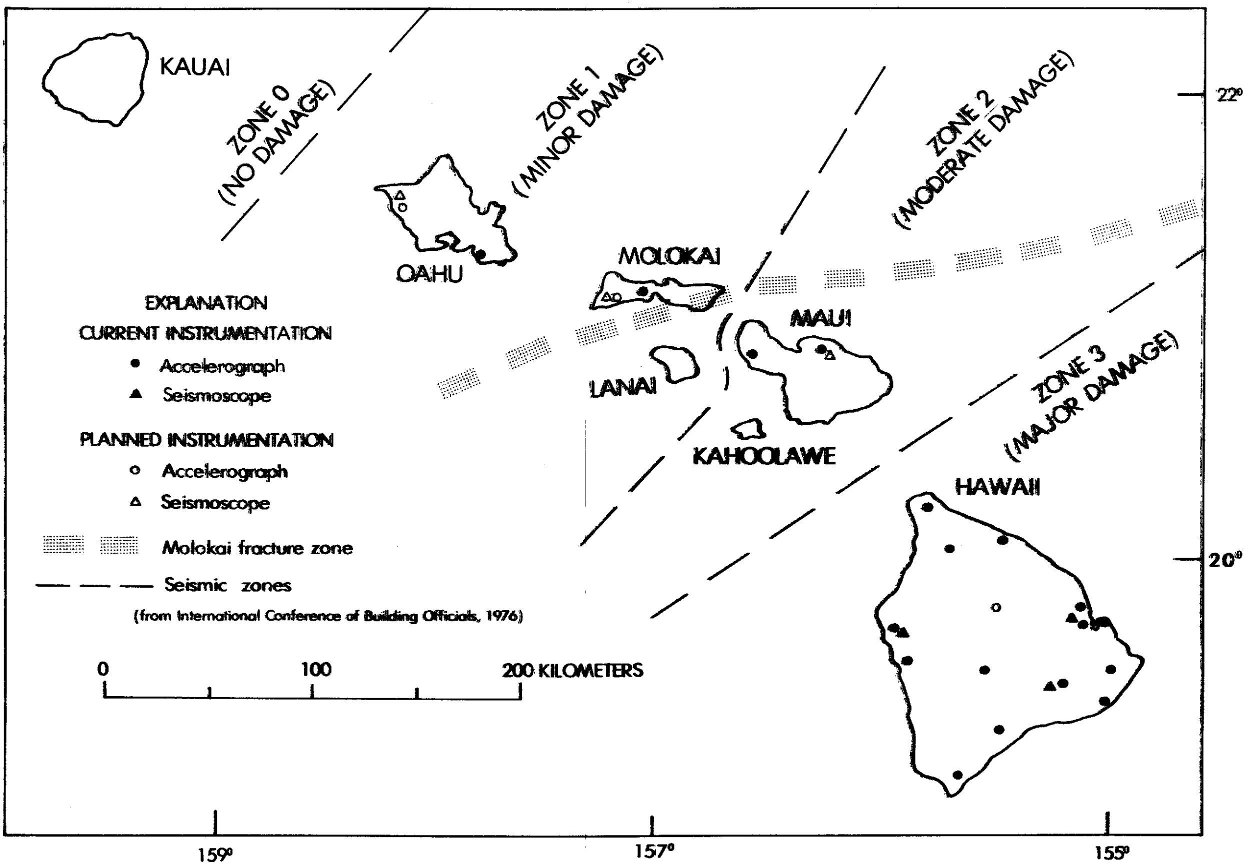

Figure 1. - U.S. Geological Survey strong-motion network in Hawaii.

STRONG-MOTION RECORDS FROM THE GILROY (COYOTE LAKE), CALIFORNIA EARTHQUAKE OF AUGUST 6, 1979

The following summary report has been abstracted primarily from Porcella, R. L., Matthiesen, R. B., McJunkin, R. D., and Ragsdale, J. T, 1979, Compilation of strong-motion records from the August 6, 1979 Coyote Lake earthquake: U.S. Geological Survey Open-File Report 79-385 and California Division of Mines and Geology Preliminary Report 25, 71 p.

A magnitude 5.7 (M_L) earthquake occurred at 10:05:23 local time on August 6, 1979 in the central California coastal region at a depth of about 6 km; the epicenter was located at 37.10°N and 121.50°W in the Calaveras fault zone near Coyote Lake, approximately 10 km north-northeast of Gilroy (fig. 3). This event was the largest to occur in the region since a magnitude 6.6 earthquake near the town of Coyote on July 1, 1911, and was reported felt from Santa Rosa south to the San Fernando Valley and east to Reno, Nevada. Some damage was reported in the Gilroy-Hollister area and included cracked plaster and stucco, broken windows, and fallen stock from store shelves.

The Gilroy (Coyote Lake) earthquake triggered all accelerographs within a radius of approximately 40 km of the epicenter; the most distant instrument triggered was located approximately 114 km from the epicenter. The locations of ground-motion instruments relative to the epicenter are shown in figure 4. The dots in this figure indicate instruments from which a record was obtained, and the circles indicate instruments that were operational at the time of the earthquake but did not trigger; stations that are not known to have been operational at the time of the earthquake are omitted from the figure.

Figure 3 shows the locations of close-in stations and their relation to the epicenter and fault zone. Two arrays of ground stations, the Gilroy and Bear Valley arrays, recorded the event. All stations in the Gilroy array are within 16 km of the epicenter and extend from a rock site across an alluvial valley to a rock site. Therefore, the Gilroy array characteristics provide data that are important in studies of source mechanism, wave propagation, near-field motions, and site effects. Refraction surveys and down-hole

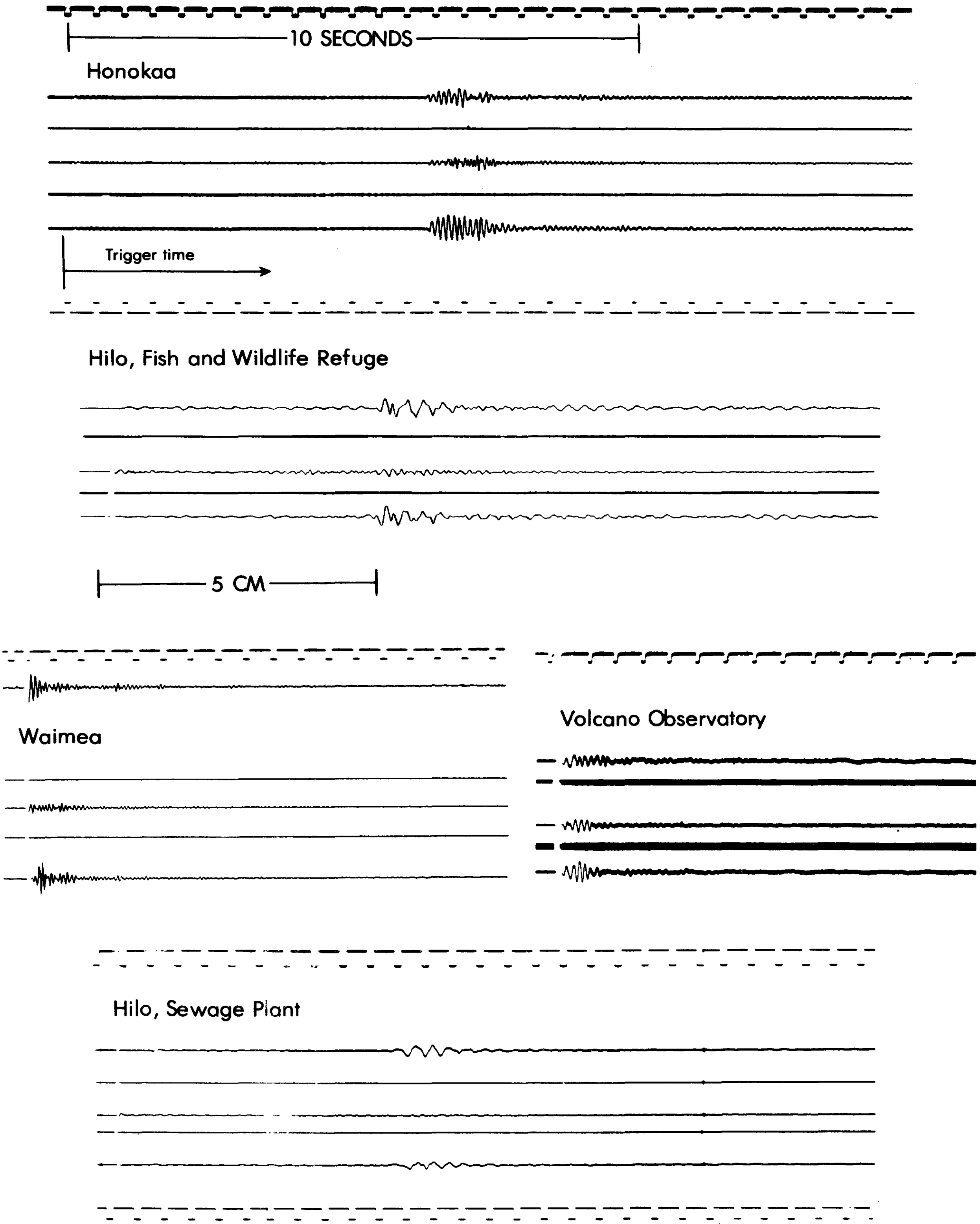

Figure 2. - Selection of accelerograms from the island of Hawaii; correlation of these records with the earthquake of March 6, 1979 is questionable. Top and bottom data traces on accelerogram show horizontal motion, middle trace shows vertical motion.

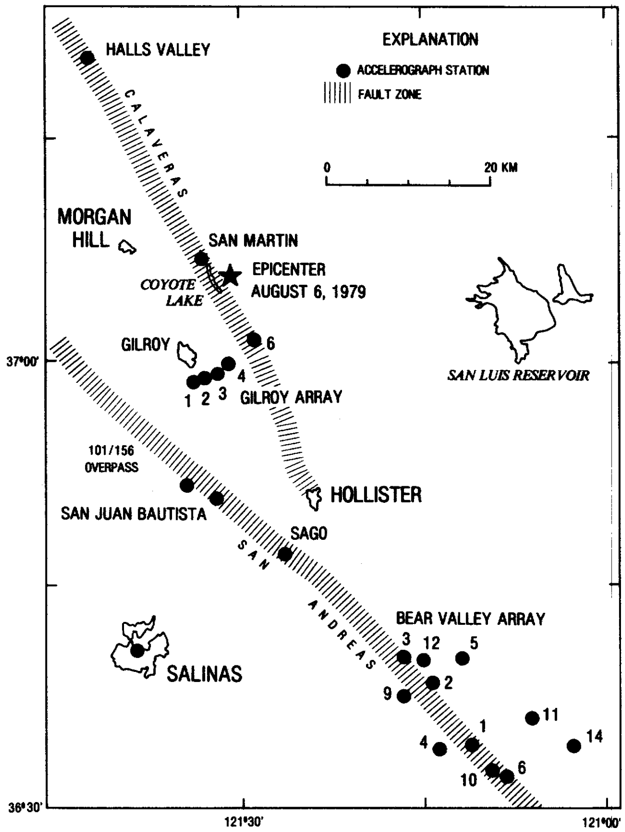

Figure 3. - Location of strong-motion arrays and close-in stations that recorded the Gilroy, California earthquake of August 6, 1979 (from Porcella and others, 1979).

shear-wave velocity studies are being conducted to determine the subsurface conditions at each of the Gilroy array stations. Stations in the Bear Valley array are located between 50 and 75 km from the epicenter and are within a relatively narrow azimuthal range; the stations are situated on both sides of the San Andreas fault on a variety of surficial materials. Data from this array exhibit a considerable range of peak accelerations and provide additional information for studies of propagation path and site effects. Full-scale reproductions of records from the Gilroy array are shown in figure 5. The data from instruments at ground level are summarized in table 1 (see event of 6 August 1979, 1705 UTC) and are presented in order of increasing epicentral distance.

Ground-motion data from this event have been used to plot attenuation of peak acceleration with distance as shown in figure 6. The error in epicenter or fault trace location is about ± 1 km; some error is also associated with interpretation of the peak accelerations in terms of component directions. Upper and lower bounds are drawn to delineate the approximate range of variation in the data. Because these bounds indicate approximately a 10:1 difference in the level of acceleration at any given distance, interpretation of the data must be refined if a useful attenuation relation is to be derived.

All instrumented structures from which records were obtained were at sufficiently large distances that the recorded motions at these stations were small relative to those associated with damage; however, these records do provide important structural response data for the study of a freeway overpass, the torsional response of buildings, and deformation of diaphragms and walls.

SUMMARIES OF RECENT REPORTS*

ENGINEERING FEATURES OF THE SANTA BARBARA EARTHQUAKE OF AUGUST 13, 1978

A report on research supported by Earthquake Engineering Research Institute, National Science Foundation, and University of California.

by Richard K. Miller and Stephen F. Felszeghy

Although the Santa Barbara earthquake was only a moderate seismic event, several of its features were unusual and interesting from an engineering point of view. Included among these features are the geographical asymmetry of strong ground shaking, the large peak accelerations recorded by strong-motion instruments, and the differences in reported magnitudes for the event. This earthquake also provided a picture of the performance of modern California buildings in a moderate earthquake. Presented in this report are preliminary investigations of some of the more striking engineering features of the earthquake, details of the geologic features, strong-motion records, and effects of the earthquake on the various facilities in the area.

Copies of this report (UCSB-ME-78-2) may be obtained at a cost of $10.00 ($11.00 outside the U.S., $8.00 EERI members) from Earthquake Engineering Research Institute (address listed in Data Sources, this report).

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*Inclusion of strong-motion information sources is intended as a service to our readers and does not constitute endorsement of these reports by the U.S. Geological Survey.

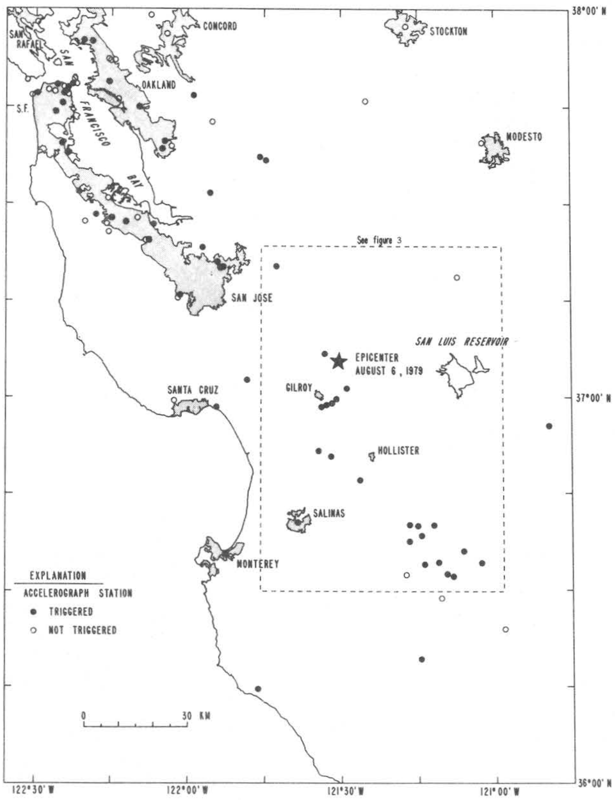


Figure 4. - Location of strong-motion stations in the region of the August 6, 1979 Gilroy, California earthquake (from Porcella and others, 1979).

RECENT AWARDS

(A quarterly report)

National Science Foundation
Division of Problem-Focused Research
Directorate for Engineering and Applied Science
Washington, DC 20550

This quarterly report is intended to keep researchers, research users, and policy makers informed of those projects supported by National Science Foundation Division of Problem-Focused Research (PFR). The goals of the Earthquake Hazards Mitigation (EHM) program, just one part of this Division, are to develop an understanding of earthquakes in relation to constructed facilities and to reduce casualties, damage, and social and economic disruption which are the result of earthquakes. The actions necessary to attain these goals are heavily dependent upon technical capabilities that require development through research.

Primary objectives of EHM-supported research are: to determine the nature of strong ground shaking during earthquakes; to develop analytical procedures to predict the spatial and temporal distribution of strong ground motion at different sites; to understand the dynamic behavior of soil and rock subjected to strong shaking; to determine the nature of the interaction of structures and their supporting soil during earthquakes; to determine the engineering aspects of reservoir-induced seismicity; to develop procedures for performing dynamic analyses of proposed or existing construction under earthquake loadings; to develop an understanding of materials and structural components subjected to damaging dynamic loads; to develop procedures for analysis and design of nonstructural and architectural systems for earthquake effects; and to study the influences of architecture and urban planning activities on the earthquake vulnerability of regions.

Questions about PFR program objectives, procedures for application, subscription to the quarterly report (which includes a current list of projects supported by the EHM program), or general information should be addressed to the Professional Assistant for PFR, Room 1134A, National Science Foundation, Washington, DC 20550.

FOUR DEFINITIONS OF STRONG-MOTION DURATION: THEIR PREDICTABILITY AND UTILITY FOR SEISMIC HAZARD ANALYSIS

by Robin K. McGuire and T. P. Barnhard

This report examines four proposed definitions of strong-motion duration in order to determine their utility in the context of seismic hazard analysis. The definitions examined are those proposed by Bolt, Aptikaev, Trifunac and Brady, and Vanmarcke and Lai. For a quantitative definition of duration to be useful for conventional seismic hazard studies, values of duration must first be predictable using only the earthquake magnitude, source-to-site distance, and a general description of soil conditions at the site, because these are the only available variables used in the current generation of seismic hazard maps. Second, the definition of duration, in addition to the peak-motion parameters, must be useful in determining the severity of seismic shaking. Peak-motion hazard analyses and maps have been, and will continue to be, made as a first step in seismic hazard evaluation; the additional time, effort, and expense of conducting seismic hazard analyses for strong-motion duration can be justified only if a measure of duration is used that provides significant additional information for estimating damage or designing structures.

Section II of this report describes the strong-motion data used in this study, the definitions of duration examined, and the definitions used quantitatively to measure the severity of shaking. Section III indicates dependences of peak-motion parameters on

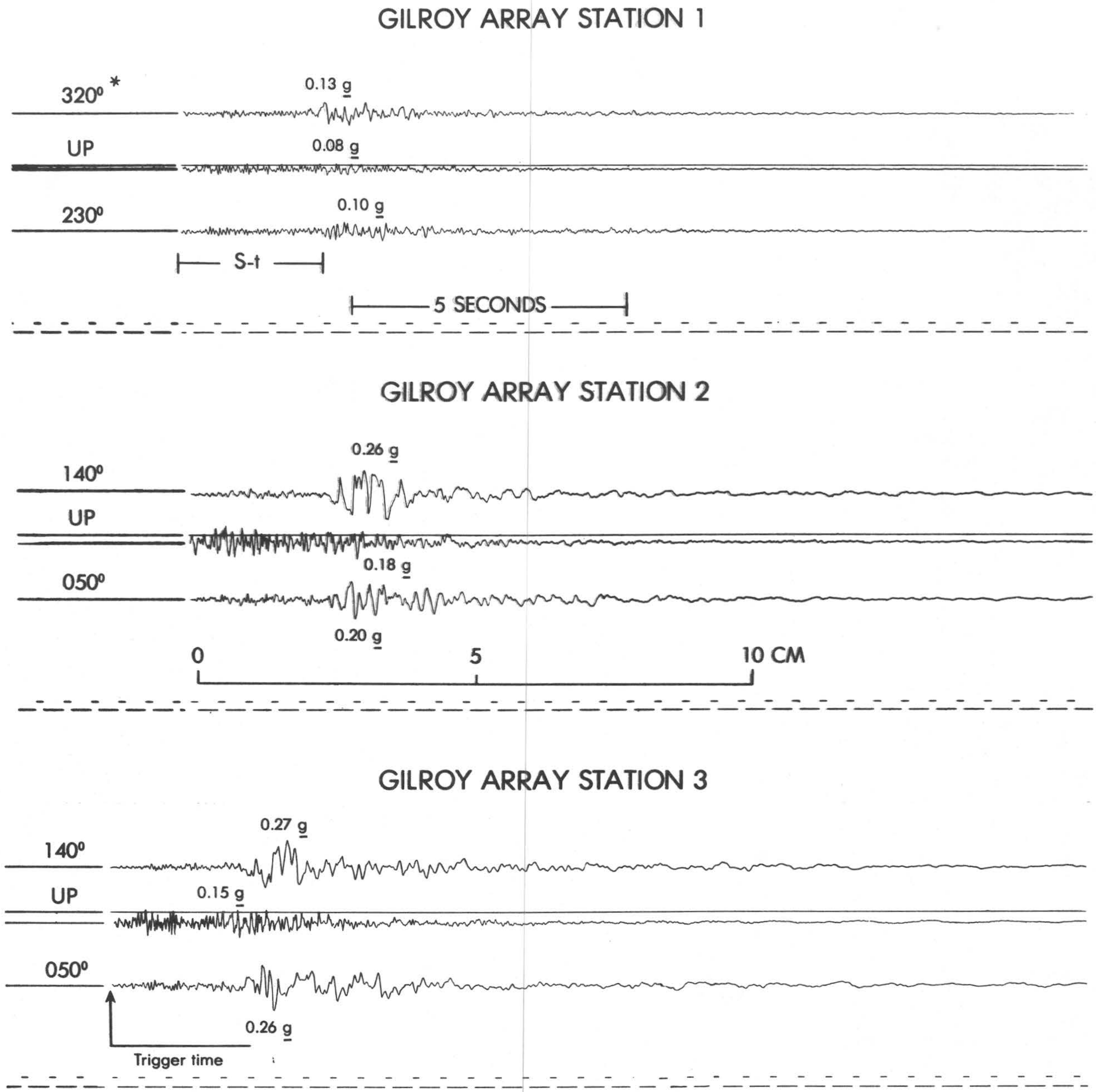
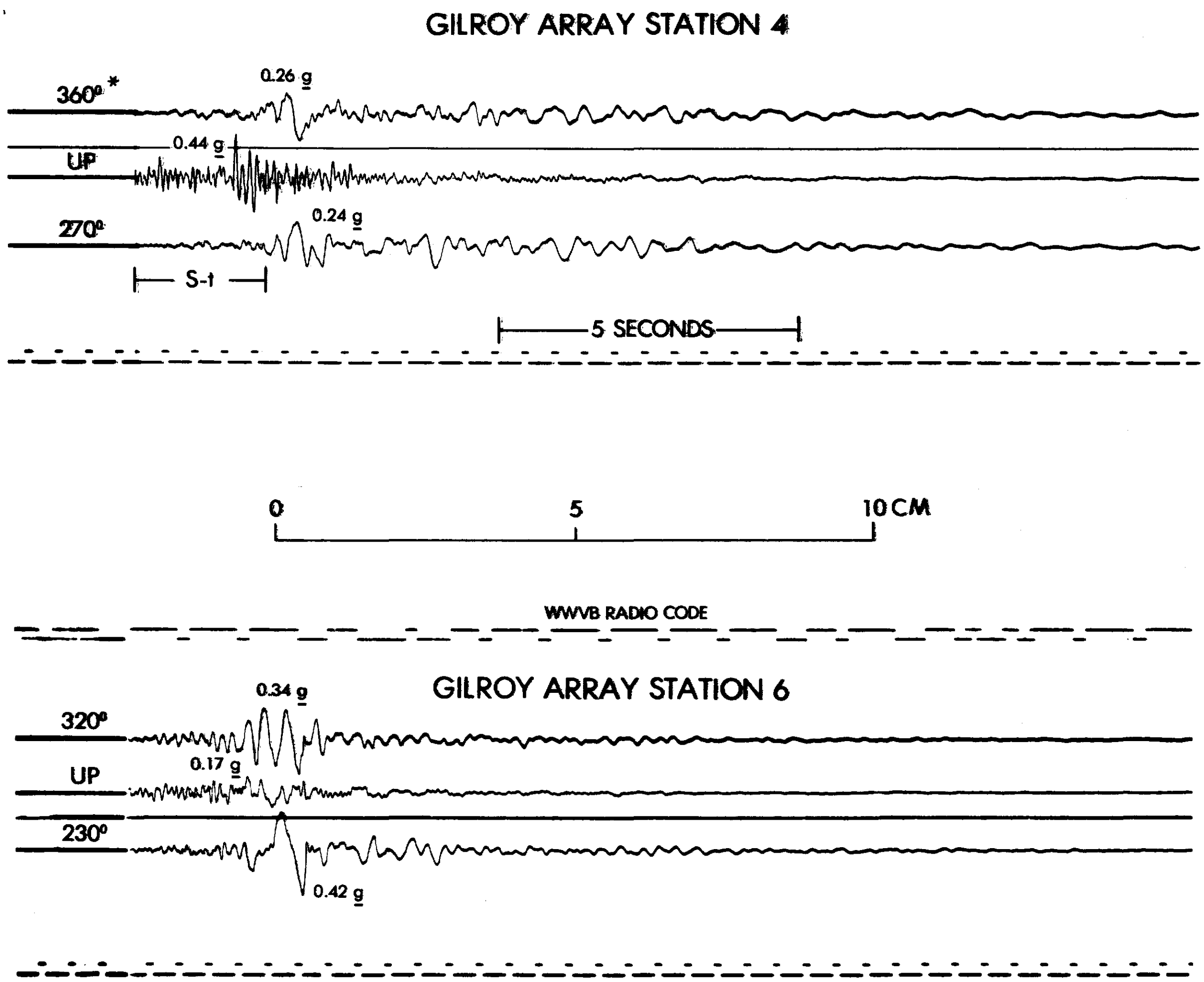


Figure 5. - Gilroy array accelerograms from the central California (Coyote Lake) earthquake of August 6, 1979.

earthquake magnitude, distance, site conditions, and component direction. These relations are included for completeness and to show that the data set is a "typical" one in the sense that typical peak-motion parameter relations are obtained. Attempts to predict duration for given magnitudes, distances, and soil conditions are reported in Section IV. Section V shows the accuracy with which Modified Mercalli (MM) intensity, one measure of shaking severity, can be predicted using peak-motion parameters and duration. In Section VI comparable results are reported using, as a measure of shaking severity, the hysteretic energy absorbed by a class of single-degree-of-freedom oscillators with bilinear force-deformation characteristics. Finally, discussion of these results and conclusions are presented in Section VII.

Reference: U.S. Geological Survey Open-File Report 79-1515, 115 p. Available from Open-File Services; address listed in Data Sources, this report.



* Azimuthal direction of case acceleration for upward trace deflection.

Figure 5. - Gilroy array accelerograms - continued.

PRELIMINARY SUMMARY OF THE U.S. GEOLOGIC SURVEY STRONG–MOTION RECORDS FROM THE OCTOBER 15, 1979 IMPERIAL VALLEY EARTHQUAKE

by R. L. Porcella and R. B. Matthiesen

This report summarizes the data from near-in strong-motion accelerograph stations operated by the U.S. Geological Survey in the Imperial Valley of California at the time of the October 15, 1979 Imperial Valley earthquake. This report is intended to alert others as to the nature of the strong-motion data that are available from this event. In order to provide the information in a timely manner, the report has been limited to a summary of the data. A similar preliminary report of strong-motion data collected by the Office of Strong-Motion Studies of the California Division of Mines and Geology has also been issued (see note below).

Reference: U.S. Geological Survey Open-File Report 79-1654, October 1979, 41 p.

Note: For information about California Division of Mines and Geology stations that recorded this earthquake, see "Preliminary data--partial film records and file data--Imperial Valley earthquake of 15 October 1979", available from CDMG (address listed in Data Sources, this report).

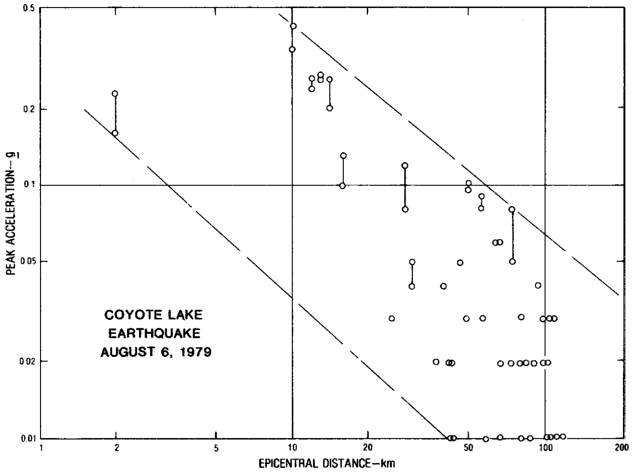


Figure 6. - Plot of attenuation for peak acceleration with increasing epicentral distance (from Porcella and others, 1979).

REPRESENTATION OF EARTHQUAKE GROUND MOTION: SCALED ACCELOROGRAMS AND EQUIVALENT RESPONSE SPECTRA

by Erik H. Vanmarcke

Alternative representations of earthquake ground motion for the purpose of seismic analysis and design are reviewed and critically examined, with emphasis on the relation between earthquake time histories and response spectra. The results of a study on the effects of scaling earthquake records on peak acceleration are presented. Errors attributable to scaling are evaluated in terms of the reponse for one-degree elastic and elasto-plastic systems and the equivalent number of cycles of uniform shear stress. The significance of duration and frequency content is assessed in this context. The pitfalls of the practice of using "standard" design response spectra are pointed out, and methodology is proposed for developing site-specific design response spectra based on appropriate accelerograms from past earthquakes.

Reference: Miscellaneous Paper S-73-1, Report 14 of a series, U.S. Army Engineer Waterways Experiment Staton, August 1979, 83 p.

Note: Request copies from Dr. Ellis Krinitzsky, U.S.A.E./W.E.S., Box 361, Vicksburg, Mississippi 39180.

STRONG-MOTION INFORMATION, DATA REPORTS, AND AVAILABILITY OF DIGITIZED DATA

U.S. Strong-Motion Network Data

A strong-motion information retrieval system (SMIRS) has been developed to provide up-to-date information about strong-motion records and the circumstances in which they were recorded. The system is accessible through a data terminal (30 cps, half duplex). The system is operational, but the information within it is incomplete and needs to be verified. A user's manual is available (Converse, 1978). To retrieve information, dial (415) 329-8600 and place the telephone handset into the terminal. When the carrier light comes on, press the "line-feed" key and wait for the computer to respond (two lines will be printed); type the following:

enter yourname SMIRS

Type the "enter" and "SMIRS" exactly as shown above, but replace yourname with your own name. The word "enter" is five lowercase characters followed by one space; your name is typed as one continuous character string and followed by one space; and "SMIRS" is five uppercase characters. Type the carriage-return key and then the line-feed key; then you will be given instructions.

The strong-motion records from the February 9, 1971 San Fernando, California earthquake and most of the significant records prior to that event have been digitized by the California Institute of Technology (CIT) (Hudson, 1976). Processing and analysis of the data have been presented in a series of reports containing (1) uncorrected digital data, (2) corrected accelerations, velocities, and displacements, (3) response spectra, and (4) Fourier amplitude spectra. All of these data reports are available through the National Technical Information Service (NTIS, see Data Sources, this report).

The digitization and analysis of the significant records subsequent to the San Fernando earthquake have been carried out by the U.S. Geological Survey (USGS). Processing and analysis of these data are presented in a series of USGS Open-File Reports. When published, these reports are available from the USGS, Open-File Services Section (see Data Sources, this report).

The digitization and analysis of the records collected by the State of California Strong-Motion Instrumentation Program are being handled by the Office of Strong-Motion Studies (OSMS), California Division of Mines and Geology. When completed, reports on these analyses will be available from OSMS (see Data Sources, this report).

The digitized data from the CIT digitization program are available from the Environmental Data and Information Service (EDIS) and the National Information Service for Earthquake Engineering at the University of California, Berkeley (NISEE) (see Data Sources, this report). The magnetic tape digital data from subsequent years will be available from EDIS and NISEE at approximately the same time as the data reports are published.

References:

Converse, April, 1978, Strong-motion information retrieval system user's manual: U.S. Geological Survey Open-File Report, 79-289, 51 p.

Hudson, D. E., 1976, Strong-motion earthquake accelerograms - index volume: California Institute of Technology, EERI report 76-02, 72 p.

FOREIGN STRONG-MOTION DATA

Because of the long history of close cooperation between the U.S. and the Central and South American strong-motion programs, much of the data from those programs are available from the same sources as the U.S. data (see below). Information about strong-motion data from the Western Hemisphere will be included in the Strong-Motion Information Retrieval System operated by the USGS.

The USGS does not attempt to obtain first-class copies of records from those foreign organizations that prepare data reports comparable to those prepared by the USGS. Abstracts of the data reports from such organizations are presented in this Seismic Engineering Program Report series, and through informal arrangements, copies of the data and records are made available.

EDIS/NOAA WORLDWIDE STRONG-MOTION DATA

A worldwide collection of strong-motion seismograms for dissemination to the scientific and engineering community is available from World Data Center A for Solid Earth Geophysics and the National Geophysical and Solar-Terrestrial Data Center (NGSDC). Countries contributing to the strong-motion database include Australia, Italy, Japan, New Zealand, Rumania, U.S.S.R., and Yugoslavia. The U.S. Geological Survey has furnished records from its network of cooperative strong-motion stations, including those in Central and South America.

Copies of strong-motion records are available on 35-mm film, on 70-mm film chips, as paper copies, and as digitized data on punched cards or magnetic tape. A listing of most records can be obtained from the World Data Center A publication "Catalog of Seismograms and Strong-Motion Records, Report SE-6". This catalog can be ordered from NGSDC (EDIS/NOAA) for $2.00 (see Data Sources, this report).

The most significant strong-motion records recorded in the United States and Latin America between 1931 and 1971 have been copied on eight reels of 35-mm film (12x reduction) and 70-mm film chips (approximately 8x reduction). The film chips are available for $.50 per chip; longer records are continued on additional chips. The 35-mm film copies can be purchased for $20 per reel, the complete set of reels for $130.

Full-size paper copies (12" x 36") are available for many of the events in the United States and Latin America at a cost of $1.50 per record. Other records are available as paper copies, but at a reduced scale.

Japan and Australia have supplied magnetic tapes of digitized data from stations located in the western Pacific Ocean (the Japanese Islands, New Guinea, and New Britain). A series of 400 U.S. strong-motion records (1933-1971) were digitized by the California Institute of Technology and are now available on six magnetic tapes. The U.S. Geological Survey is digitizing post-1971 records from its network; they have generated five tapes of strong-motion records recorded from 1967 to 1975 in the United States and Latin America (Chile, Nicaragua, San Salvador, and Mexico).

Other digitized data include punched cards containing strong-motion records from the March 4, 1977 earthquake in Rumania (recorded in Bucharest); the Gazli earthquake of May 17, 1976, in Uzbek, USSR; and three earthquakes in the New Madrid seismic zone (located in midcontinental United States) in 1975 and 1976.

Recent acquisitions include a magnetic tape of strong-motion records triggered by a swarm of earthquakes that rocked northern Italy near the town of Friuli in 1976; these were compiled by the National Commission for Nuclear Energy and have been given to the Center for distribution.

DATA SOURCES

For reports or information regarding strong-motion records and data, address inquiries to the appropriate agency listed below:

1. Branch of Distribution
U.S. Geological Survey
1200 South Eads Street
Arlington, VA 22202

2. Earthquake Engineering Research Institute
2620 Telegraph Avenue
Berkeley, CA 94704

3. EDIS/NOAA
National Geophysical and Solar-
Terrestrial Data Center (D62)
Boulder, CO 80302

4. National Technical Information Service
U.S. Dept. of Commerce
Springfield, VA 22151

5. NISEE/Computer Applications
Davis Hall, UC Berkeley
Berkeley, CA 94720.

6. Office of Strong-Motion Studies
California Division of Mines and
Geology
2811 "O" Street
Sacramento, CA 95816

7. Open-file Services Section
Branch of Distribution
U.S. Geological Survey
Box 25425, Federal Center
Denver, CO 80225

8. Seismic Engineering Branch
U.S. Geological Survey
345 Middlefield Road--MS 78
Menlo Park, CA 94025.

ERRATA

Reference	Error	Correction
CIT; EERL S-M earthquake accelerograms, digitized & plotted data; vol II, III, IV; Part B; Record #037 (1966 Parkfield earthquake)	Temblor, Calif. No. 2 USGS Station No. 1097 35 45'07" N 120 15'52" W	Temblor, Calif. USGS Station No. 1438 35 42'36" N 120 10'12" W
same as above: vol I, II; Part C Record #041 (1971 San Fernando earthquake; Component direction- Pacoima Dam accelerogram)	L - S74W V - Down T - S16E	L - N76W V - Down T - S14W
USGS S-M Station No. 1250 Gilroy, Gavilan College (Component direction - all S-M records since Oct. 1972)	L - S67W V - Down T - S13E	L - S67W V - Down T - S23E
USGS S-M Station 2420 New Madrid, Missouri (Component direction- events of 6-13-75 and 3-24-76)	L - S19W V - Down T - S71E	L - West V - Down T - South
USGS S-M Station no. 181; Los Angeles, 640 Marengo, 1st floor (Component direction prior to 7-15-70)	L - N36W V - Down T - S54W	L - S54W V - Down T - S36E
NOTE: Since 7-15-70, the 1st floor (also 4th floor and roof) component directions are:		L - N36W V - Down T - S54W
USGS S-M Station No. 122; Glendale, California (Component direction - events of 4/8/68 and 2/9/71)	L - S70E V - Down T - S20W	L - S72E V - Down T - N18E
USGS S-M Station No. 125(828); Lake Hughes Array Station 1 (1A) Component direction:		
event 9/12/70	L - N21E V - Down T - N69W	L - S21W V - Down T - S69E
event 2/9/71	L - N21E V - Down T - S69E	L - S21W V - Down T - S69E

Table 1. - *Summary of accelerograms recovered during May - August 1979*

Event	Station name (owner) [1]	Station coord.	S-t [2] (s)	Direction [3]	Max accl [4] (g)	Duration [5] (s)
16 May 1978- 12 June 1979 Cent. Alaska Epicenters and magnitudes unknown	Talkeetna, Alaska FAA/VOR (USGS)	62.30 N 150.10 W	*		**	
	Fairbanks, Alaska Duckering Hall (USGS)	64.85 N 147.82 W	*		**	
	Fairbanks, Alaska College Observatory (USGS)	64.86 N 147.83 W	*	200°	0.05	-
				Up	.05	-
				110°	.03	-
	Note: One each additional records recovered at Talkeetna and at College Observatory; maximum acceleration less than 0.05 g.					
20 January 1979- 29 July 1979 S. Hawaii Epicenters and magnitudes unknown	Waimea, Hawaii Waimea School (USGS)	20.03 N 155.67 W	*		**	
			*	140°	.14	0.2
				Up	.06	-
				050°	.17	0.1
	Honokaa, Hawaii Fire Station (USGS)	20.081N 155.465W	6.4	030°	.09	1-peak
				Up	.08	-
				300°	.12	0.8
			*	030°	.05	-
				Up	.02	-
				300°	.04	-
			*	030°	.04	-
				Up	.04	-
				300°	.07	-
	Hilo, Hawaii Univ. of Hawaii (USGS)	19.707N 155.083W	4.4		**	
	Hilo, Hawaii Fish & Wildlife (USGS)	19.731N 155.096W	4.7	180°	.09	-
				Up	.04	-
				090°	.11	1-peak
	Hilo, Hawaii Sewage Plant (USGS)	19.734N 155.050W	4.9	156°	.06	-
				Up	.02	-
				066°	.03	-

See footnotes at end of table.

Table 1. - *Summary of accelerograms recovered during May - August 1979* - Continued

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl[4] (g)	Duration[5] (s)
	Hawaii Nat'l Park Volcano Observatory (USGS)	19.42 N 155.29 W	*	360°	0.06	-
				Up	.06	-
				270°	.11	1-peak
	Wahaula, Hawaii Visitor Center (USGS)	19.33 N 155.03 W	1.4		**	
	Note: The largest amplitude record for each station is questionably associated with the magnitude 4.7 event of March 6, 1979; this earthquake was located at 19.52°N and 155.27°W at a depth of 28 km.					
16 November 1978- 6 August 1979 Cental Calif. Epicenters and magnitudes unknown	Bear Valley Array Sta. 11, Wilkinson Ranch (USGS)	36.61 N 121.11 W	1.8		**	
			1.5	130°	.06	-
				Up	.02	
				040°	.05	-
13 February 1979 1921 UTC Central Calif. 36.56N, 121.16W Magnitude 3.5	Bear Valley Array Sta. 10, Webb Ranch (USGS)	36.53 N 121.14 W	*	**		
	Bear Valley Array Sta. 14, Butts Ranch (USGS)	36.57 N 121.04 W	*		**	
5 March 1979 0818 UTC Central Calif. Epicenter and magnitude unknown	Bear Valley Array Sta. 12, Williams Ranch (USGS)	36.66 N 121.25 W	2.3		**	
10 March 1979 0831 UTC Central Calif. Epicenter and magnitude unknown	Bear Valley Array Sta. 10, Webb Ranch (USGS)	36.53 N 121.14 W	*		**	

See footnotes at end of table.

Table 1. - *Summary of accelerograms recovered during May - August 1979* - Continued

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl[4] (g)	Duration[5] (s)
15 March 1979 2006 UTC Central Calif. 36.61N, 121.09W Magnitude 3.0	Bear Valley Array Sta. 14, Butts Ranch (USGS)	36.57 N 121.04 W	1.7	310° Up 220°	0.11 .04 .10	0.1 - 1-peak
16 March 1979 2000 UTC Central Calif. Epicenter and magnitude unknown	Bear Valley Array Sta. 9, Schrolls Ranch (USGS)	36.63 N 121.28 W	*		**	
21 March 1979 17 July 1979 N. California Epicenter and magnitude unknown	San Francisco 3333 25th St. (USGS)	37.75 N 122.42 W	-			
	Basement				**	
	Roof (9th)				**	
	San Francisco 3250 Van Ness Ave. (USGS)	37.81 N 122.42 W	-			
	Basement				**	
	4th floor				**	
21 March 1979- 6 August 1979 N. California Epicenter and magnitude unknown	San Francisco BART Tube (USGS)	37.80 N 122.38 W	-			
	Section 16				**	
	Section 19				**	
	San Francisco BART Vent Shaft (USGS)	37.80 N 122.39 W	-			
	Level -48 ft				**	
	Level + 9 ft				**	
	San Francisco 555 Pine Street (USGS)	37.79 N 122.40 W	-			
	Basement				**	
	8th floor & rack				**	
	16th floor & rack				**	
	Roof (18th)				**	

See footnotes at end of table.

Table 1. - *Summary of accelerograms recovered during May - August 1979* - Continued

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl[4] (g)	Duration[5] (s)
15 March 1979 2006 UTC Central Calif. 36.61N, 121.09W Magnitude 3.0	Bear Valley Array Sta. 14, Butts Ranch (USGS)	36.57 N 121.04 W	1.7	310° Up 220°	0.11 .04 .10	0.1 - 1-peak
27 May 1979 1428 UTC Central Calif. 36.53N, 121.13W Magnitude 3.3	Bear Valley Array Sta. 6, James Ranch (USGS)	36.51 N 121.10 W	1.2	310° Up 220°	.07 .05 .10	- - 1-peak
	Bear Valley Array Sta. 10, Webb Ranch (USGS)	36.53 N 121.14 W	*	310° Up 220°	.08 .02 .10	- - 1-peak
27 May 1979 1628 UTC Central Calif. 36.53N, 121.13W Magnitude 3.2	Bear Valley Array Sta. 6, James Ranch (USGS)	36.51 N 121.10 W	1.1	310° Up 220°	.07 .03 .06	- - -
27 May 1979 1630 UTC Central Calif. Epicenter and magnitude unknown	Bear Valley Array Sta. 6, James Ranch (USGS)	36.51 N 121.10 W	1.1		**	
29 May 1979 2216 UTC Central Calif. Epicenter and magnitude unknown	Bear Valley Array Sta. 6, James Ranch (USGS)	36.51 N 121.10 W	1.1		**	
26 June 1979- 5 September 1979 N. California Epicenter and magnitude unknown	Rancho Seco Nuclear Power Plant (USGS)	38.34 N 121.11 W	-		**	

See footnotes at end of table.

Table 1. - *Summary of accelerograms recovered during May - August 1979* - Continued

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl[4] (g)	Duration[5] (s)
5 June 1979- 4 August 1979 South Carolina Epicenters and magnitudes unknown	Jenkinsville, S.C. Monticello Dam (USGS)	34.30 N 81.33 W	*			
	Shared abutment (Center crest)			180° Up 090°	0.05 .04 .05	- - -
	Note: Three additional records recovered at this station; maximum acceleration less than 0.05 g					
13 June 1979 0709 UTC Imperial Valley, Ca. 33.08N, 115.62W Magnitude 3.7	Calipatria, Calif. Fire Station (USGS)	33.13 N 115.52 W	3.0		**	
13 June 1979 1946 UTC Imperial Valley, Ca. 33.02N, 115.67W Magnitude 4.2	Brawley, Calif. Municipal Airport (USGS)	32.988N 115.509W	2.3		**	
	Calipatria, Calif. Fire Station (USGS)	33.13 N 115.52 W	3.0	315° Up 225°	.04 .04 .06	- - -
13 June 1979 2021 UTC Imperial Valley, Ca. 33.12N, 115.62W Magnitude 3.3	Calpatria, Calif. Fire Station (USGS)	33.13 N 115.52 W	3.0		**	
29 June 1979 0553 UTC Big Bear Lake, Ca. 34.25N, 116.90W Magnitude 4.6	Cherry Valley Johnson Residence (USGS)	33.98 N 116.99 W	*		**	
	Forest Falls Mill Creek Canyon (USGS)	34.09 N 116.92 W	2.6	300° Up 210°	.08 .07 .12	- - 1-peak
30 June 1979 0034 UTC Big Bear Lake, Ca. 34.24N, 116.90W Magnitude 4.8	Whitewater Trout Farm, Whitewater Canyon, (USGS)	33.99 N 116.66 W	4.2		**	
	North Palm Springs Post Office, (USGS)†	33.92 N 116.54 W	6.1		**	

See footnotes at end of table.

Table 1. - *Summary of accelerograms recovered during May - August 1979* - Continued

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl[4] (g)	Duration[5] (s)
30 June 1979 0034 UTC -continued	Cedar Springs Dam Toe Station, (CDWR)†	34.30 N 117.31 W	*		**	
	Cedar Springs Dam Crest Station, (CDWR)†	34.30 N 117.31 W	*	020° Up 290°	0.06 .04 .03	- -
	Perris Dam Crest Station, (CDWR)†	33.85 N 117.18 W	*		**	
30 June 1979 0703 UTC Big Bear Lake, Ca. 34.25N, 116.90W	Cedar Springs Dam Toe Station, (CDWR)†	34.30 N 117.31 W	*		**	
Magnitude 4.5	Cedar Springs Dam Crest Station, (CDWR)†	34.30 N 117.31 W	*		**	
9 July 1979 2120 UTC Central Calif. 36.55N, 121.18W	Bear Valley Array Sta. 1, Fire Station (USGS)	36.57 N 121.18 W	0.6	310° Up 220°	.05 .03 .05	- - -
Magnitude 3.0	Bear Valley Array Sta. 4, Bickmore Cyn. (USGS)	36.57 N 121.22 W	*		**	
	Bear Valley Array Sta. 5, Callens Ranch (USGS)	36.67 N 121.20 W	*		**	
	Bear Valley Array Sta. 10, Webb Residence, (USGS)	36.53 N 121.14 W	1.1		**	
17 July 1979- 6 August 1979 N. California	San Francisco 3333 25th St. (USGS)	37.75 N 122.42 W	-			
Epicenter and	Basement				**	
magnitude unknown	Roof (9th)				**	

See footnotes at end of table.

Table 1. - *Summary of accelerograms recovered during May - August 1979* - Continued

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl[4] (g)	Duration[5] (s)
	San Francisco	37.81 N	-			
	3250 Van Ness Ave.	122.42 W				
	(USGS)					
	Basement				**	
	4th floor				**	
	San Francisco	37.80 N	-			
	600 Montgomery St.	122.40 W				
	(USGS)					
	Basement (3rd)				**	
	24th floor				**	
	49th floor				**	
	Tower (58th)				**	
2 August 1979	Bear Valley Sta. 12	36.66 N	*		**	
2143 UTC	Williams Ranch	121.25 W				
Central Calif.	(USGS)					
36.79N, 121.57W						
Magnitude 3.7						
4 August 1979	Talkeetna, Alaska	63.30 N	*		**	
2012 UTC	FAA-VOR, (USGS) †	150.10 W				
Central Alaska						
62.45N, 149.72W						
Magnitude 4.4						
6 August 1979	San Martin	37.118N	1.3	250°	0.23	1.5
1705 UTC	Coyote Creek	121.550W		Up	.10	1-peak
Gilroy, Calif.	(CDMG)			160°	.16	2.8
37.10N, 121.50W						
Magnitude 5.9	Gilroy Array Sta. 6	37.026N	1.5	320°	.34	1.8
	San Ysidro F.F.	121.484W		Up	.17	1.5
	(USGS)			230°	.42	3.2
	Gilroy Array Sta. 4	37.000N	2.2	360°	.26	[illegible].8
	San Ysidro School	121.521W		Up	[illegible]	[illegible].4
	(USGS)			270°	[illegible]	6.1
	Gilroy Array Sta. 3	36.991N	2.6	140°	[illegible]	[illegible]0
	Sewage Plant	121.536W		Up	.15	[illegible].8
	(USGS)			050°	.26	[illegible].5
	Gilroy Array Sta. 2	36.982N	2.7	140°	.26	[illegible].4
	Mission Trails Motel	121.556W		Up	.18	3.1
	(USGS)			050°	.20	1.7

See footnotes at end of table.

Table 1. - *Summary of accelerograms recovered during May - August 1979* - Continued

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl[4] (g)	Duration[5] (s)
6 August 1979 1705 UTC -continued	Gilroy Array Sta. 1 Gavilan College (USGS)	36.973N 121.572W	2.5	320° Up 230°	0.13 .08 .10	0.9 - 0.9
	Corralitos Eureka Canyon Rd. (CDMG)	37.05 N 121.80 W	*		**	
	San Juan Bautista 101/156 Overpass (CDMG)	36.86 N 121.58 W	3.5	293° Up 023°	.12 .06 .08	0.1 - -
	San Juan Bautista 24 Polk St. (CDMG)	36.86 N 121.54 W	4.3	303° Up 213°	.09 .12 .11	- 2.0 0.4
	Halls Valley Grant Ranch (CDMG)	37.34 N 121.71 W	*	240° Up 150°	.05 .03 .04	- - -
	SAGO Central Harris Ranch (USGS)	36.78 N 121.45 W	3		**	
	Capitola 405 Capitola Ave. (CDMG)	36.97 N 121.95 W	*		**	
	San Jose Great Western Bldg. (CDMG)	37.34 N 121.89 W	7		**	
	San Jose Town Park Towers (CDMG)	37.34 N 121.89 W	6		**	

See footnotes at end of table.

Table 1. - *Summary of accelerograms recovered during May - August 1979* - Continued

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl[4] (g)	Duration[5] (s)
6 August 1979 1705 UTC -continued	San Jose Santa Clara County Bldg. (CDMG)	37.35 N 121.90 W	*		**	
	Saratoga West Valley College (CDMG)	37.27 N 122.01 W	6		**	
	Agnews State Hospital (CDMG)	37.40 N 121.95 W	9		**	
	Salinas John and Work St. (CDMG)	36.67 N 121.64 W	7	250° Up 160°	0.10 .06 .10	1-peak - 1-peak
	Bear Valley Sta. 3 Almaden Guest House (USGS)	36.67 N 121.28 W	*		**	
	Bear Valley Sta. 12 Williams Ranch (USGS)	36.66 N 121.25 W	8	310° Up 220°	.09 .07 .08	- - -
	Bear Valley Sta. 5 Callens Ranch (USGS)	36.67 N 121.20 W	10		**	
	Fremont Mission San Jose (CDMG)	37.52 N 121.92 W	10		**	
	Bear Valley Sta. 9 Schrolls Ranch (USGS)	36.63 N 121.28 W	7		**	
	Bear Valley Sta. 2 Stone Canyon (USGS)	36.64 N 121.24 W	10		**	
	Del Valle Dam Toe Station (CDWR)	37.61 N 121.74 W	*		**	

See footnotes at end of table.

Table 1. - *Summary of accelerograms recovered during May - August 1979* - Continued

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl[4] (g)	Duration[5] (s)
6 August 1979 1705 UTC -continued	Palo Alto VA Hospital Bldg. 5 (USGS)	37.41 N 122.14 W	*		**	
	Palo Alto 1900 Embarcadero Rd. (CDMG)	37.45 N 122.12 W	9		**	
	Monterey City Hall Few Hall (USGS)	36.60 N 121.89 W	*		**	
	Dos Amigos Pumping Plant (CDWR)	36.92 N 120.83 W	6			
	Level 1			180° Up 090°	0.03 .02 .06	- - -
	Level 4			180° Up 090°	.03 .02 .06	- - -
	Bear Valley Sta. 4 Bickmore Canyon (USGS)	36.57 N 121.22 W	8		**	
	Bear Valley Sta. 11 Wilkinson Ranch (USGS)	36.61 N 121.11 W	8		**	
	Bear Valley Sta. 1 Fire Station (USGS)	36.57 N 121.18 W	6		**	
	Bear Valley Sta. 10 Webb Residence (USGS)	36.53 N 121.14 W	7		**	
	Bear Valley Sta. 14 Upper Butts Ranch (USGS)	36.57 N 121.04 W	11	310° Up 220°	.05 .02 .08	- - -

See footnotes at end of table.

Table 1. - *Summary of accelerograms recovered during May - August 1979* - Continued

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl[4] (g)	Duration[5] (s)
6 August 1979 1705 UTC -continued	Bear Valley Sta. 6 James Ranch (USGS)	36.51 N 121.10 W	*		**	
	APEEL Array Sta. 2E Hayward (USGS)	37.66 N 122.08 W	12		**	
	Hayward City Hall (USGS)	37.68 N 122.08 W	*		**	
	APEEL Array Sta. 7 Crystal Springs (USGS)	37.48 N 122.31 W	*		**	
	San Ramon Fire Station (CDMG)	37.78 N 121.98 W	13		**	
	Lower Crystal Springs Dam, Abutment (CDMG)	37.53 N 122.36 W	*		**	
	Oakland Calrus Bldg. (CDMG)	37.74 N 122.15 W	*		**	
	Greenfield 845 Oak St. (CDMG)	36.32 N 121.24 W	*		**	
	San Francisco International Airport (CDMG)	37.62 N 122.40 W	13		**	
	Big Sur State Park Maintenance Bldg. (CDMG)	36.25 N 121.78 W	*			
	South San Francisco Kaiser Medical Bldg. (CDMG)	37.66 N 122.43 W	17		**	

See footnotes at end of table.

Table 1. - *Summary of accelerograms recovered during May - August 1979* - Continued

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl[4] (g)	Duration[5] (s)
6 August 1979 1705 UTC -continued	Oakland Title Ins. & Trust (CDMG)	37.81 N 122.27 W	16		**	
	San Francisco Diamond Heights (CDMG)	37.74 N 122.43 W	*		**	
	San Francisco 3333 25th St. (USGS)	37.75 N 122.42 W	*		**	
	San Francisco 555 California St. (USGS)	37.79 N 122.40 W	*		**	
	San Francisco 600 Montgomery St. (USGS)	37.80 N 122.40 W	*		**	
	San Francisco 3250 Van Ness Ave. (USGS)	37.81 N 122.42 W	*		**	
	El Cerrito Capwell's Dept. Store (CDMG)	37.90 N 122.30 W	*		**	
	San Francisco VA Hospital (USGS)	37.78 N 122.50 W	*		**	
	Richmond Field Station (UCB)	37.92 N 122.33 W	*		**	

Note: This data summary for the Gilroy earthquake includes ground stations only; for structural response data, see Porcella and others, 1979.

See footnotes at end of table.

Table 1. - *Summary of accelerograms recovered during May - August 1979* - Continued

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl[4] (g)	Duration[5] (s)
6 August 1979 2233 UTC Gilroy, Calif. 37.00N, 121.48W Magnitude 4.4	Gilroy Array Sta. 6 San Ysidro F.F. (USGS)	37.026N 121.484W	1.2		**	
6 August 1979 2236 UTC Gilroy, Calif. 36.96N, 121.55W Magnitude 3.8	Gilroy Array Sta. 6 San Ysidro F.F. (USGS)	37.026 N 121.484 W	1.3		**	

Note: Unidentifiable aftershock records were obtained at Gilroy array stations 2 and 6; peak accelerations were 0.05 *g* and 0.06 *g*, respectively. Additional records that could not be identified were obtained at Gilroy array stations 2 (3 each) 3, and 4; peak accelerations were less than 0.05 *g*.

[1] CDMG - California Division of Mines and Geology
CDWR - California Department of Water Resources
UCB - University of California, Berkeley
USGS - U.S. Geological Survey
† WWVB time code is incomplete or nonexistent; correlation of accelerogram with event is questionable.

[2] S-wave minus trigger time.
* S-t time is questionable or cannot be determined.

[3] Azimuthal direction of case acceleration for upward trace deflection on accelerogram (opposite direction to pendulum motion).

[4] Unless otherwise noted, maximum acceleration recorded at ground or basement level.
** Denotes maximum acceleration is less than 0.05 *g* at ground stations or less than 0.10 *g* at upper floors of buildings

[5] Time duration between first and last peaks of acceleration greater than 0.1 *g*.

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