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Strong-Motion Program Report, January–December 1985

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Strong-Motion Program Report, January–December 1985

U.S. GEOLOGICAL SURVEY CIRCULAR 1027

DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

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PREFACE

This Program Report contains preliminary information on the nature and availability of strong-motion data recorded by the U.S. Geological Survey (USGS). The Strong-Motion Program is operated by the USGS in cooperation with numerous Federal, State, and local agencies and private organizations. Major objectives of this program are to record both strong ground motion and the response of various types of engineered structures during earthquakes, and to disseminate this information and data to the international earthquake-engineering research and design community.

This volume contains a summary of the accelerograms recovered from the USGS National Strong-Motion Instrumentation Network during 1985, summaries of recent strong-motion publications, notes on the availability of digitized data, and general information related to the USGS and other strong-motion programs. The data summary in table 1 contains information on all USGS accelerograms recovered (though not necessarily recorded) during 1985; event data are taken from "Preliminary Determination of Epicenters," published by the USGS.

Ronald L. Porcella, Editor
U.S. Geological Survey, MS 977
345 Middlefield Rd.
Menlo Park, California 94025

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1985 ACCELEROGRAPH RECORDS

By J. C. Switzer

During January–December 1985, 135 accelerograph records were recovered from the U.S. Geological Survey's (USGS) National Strong-Motion Instrumentation Network. This compares with a yearly average of 235 records for the period 1972 through 1984. Only two events in the U.S. larger than magnitude 5 were recorded; a magnitude 5.3 on January 24 in eastern California (one record), and a magnitude 5.4 on August 4 near Coalinga, California (seven records). A magnitude 4.8 earthquake on October 2 in southern California triggered 13 instruments at 9 stations; a peak horizontal ground acceleration of 0.09 *g* was recorded at the toe of Lake Mathews Dam.

Twenty-seven accelerograms were recovered from stations in Hawaii during 1985, recorded primarily during a magnitude 4.8 event on February 22 and during numerous small unidentified earthquakes that occurred throughout the year.

Other significant numbers of accelerograms were recorded at stations near Bear Valley and Coalinga in central California during small (magnitude 3–5) earthquakes.

SUMMARIES OF SOME 1985 STRONG-MOTION PUBLICATIONS[1]

Report on Recommended List of Structures for Seismic Instrumentation in San Bernardino County, California

By G. Brady, M. Celebi, C. Rojahn, W. Iwan, G. Hart, G. Pardoen, L. Schoelkopf R. Haskell, K. Topping, E. Safak, *and* R. Maley

The main objective of any instrumentation program for structural systems is to improve the understanding of the behavior and potential for damage of structures under seismic loading. The acquisition of structural response data during earthquakes is essential to confirm and further develop methodologies for analysis and design of earthquake resistant structural systems. This objective can best be realized by selectively instrumenting structural systems to acquire strong ground-motion data and the responses of structural systems to the strong ground motion.

To enhance the effort in structure instrumentation the USGS recently established an advisory committees program. The advisory committees are regional committees composed of professionals from universities, state, federal, and local government agencies, and private companies. The advisory committees are located in seismically active regions and are requested to develop recommended lists of structures for possible instrumentation. The first of these committees was formed in the San Francisco Bay region.

The USGS-San Bernardino Advisory Committee on Instrumentation of Structures was formed with the following objectives:

- develop a list of structures in San Bernardino County within the objectives of the USGS structure program,
- develop instrumentation priorities for the list of structures,
- coordinate the effort on instrumentation of structures with other programs and organizations,
- communicate to the public and private sectors the importance of building instrumentation programs,
- extend the program to other regions as practicable,
- optimize instrument maintenance in a coordinated way, and
- provide guidance by the development of methodologies related to instrumentation of structures.

This report documents the development of a list of structures recommended to the USGS for instrumentation. Every effort has been made to incorporate the input of local government officials, who have provided the majority of the data.

Reference: U.S. Geological Survey Open-File Report 85-583, 15 p.

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[1]Inclusion of strong-motion summaries is intended as a service to our readers and does not imply endorsement of these reports by the U.S. Geological Survey.

Manuscript approved for publication February 2, 1989.

Preliminary Report of Investigations of the Central Chile Earthquake of March 3, 1985

Edited by S.T. Algermissen

The March 3, 1985, earthquake is the largest earthquake to strike central Chile since 1906. Preliminary reports of the wide distribution of the damage soon made it apparent that the earthquake was very significant as a geophysical event and that the scientific and engineering study of this major shock would be of great value in improving our understanding of plate margin earthquakes, the characteristics of strong ground motion, building damage, and geologic effects such as soil liquefaction and landsliding. Accordingly, the decision was made to send a U.S. Geological Survey team and instrumentation to Chile with the following objectives: (1) aid Chilean seismologists in locating the many aftershocks of the main shocks by providing portable seismographs to supplement the Chilean seismograph network; (2) provide some additional strong-motion seismographs; (3) conduct a study of ground response, and its relation to geological factors and to observed Modified Mercalli intensity; and (4) investigate the geological and engineering (damage) consequences of the earthquake.

The U.S. Geological Survey team made a reconnaissance investigation of the damage and occupied 12 sites with the GEOS digital seismographs. Over 55 earthquakes were recorded at two or more sites during the study; 12 were recorded at four or more sites and six were recorded at six sites. Preliminary results of the field studies are outlined in this report to show the general nature of the engineering and geological studies of the earthquake and the scope of the site response investigations.

Reference: U.S. Geological Survey Open-File Report 85-542, 180 p.

Evaluating Earthquake Hazards in the Los Angeles Region—An Earth-Science Perspective

Edited by J.I. Ziony

Potentially destructive earthquakes are inevitable in the Los Angeles region of California, but hazards prediction can provide a basis for reducing damage and loss. This volume identifies the principal geologically controlled earthquake hazards of the region (surface faulting, strong shaking, ground failure, and tsunamis), summarizes methods for characterizing their extent and severity, and suggests opportunities for their reduction.

Reference: U.S. Geological Survey Professional Paper 1360, 505 pages.

The Morgan Hill, California, Earthquake of April 24, 1984

Edited by Seena N. Hoose

The Morgan Hill earthquake, a moderate-size (M_L=6.2) event, was felt throughout central California on April 24, 1984. The epicenter of the earthquake was located near Halls Valley southwest of Mount Hamilton, and the event is presumed to have occurred on the Calaveras fault. Damage, however, was concentrated near the south end of the Anderson Reservoir and in the town of Morgan Hill. A preliminary assessment by the California Office of Emergency Services estimated damage to private property at $7.0 million and to local-government facilities at $0.5 million, for a total of $7.5 million in damage.

This report contains 19 chapters that include descriptions of the geologic, tectonic, and seismologic settings; postearthquake observations including seismologic, geologic, geodetic, and engineering; and earthquake implications and conclusions.

Reference: U.S. Geological Survey Bulletin 1639, 256 p.

The Morgan Hill Earthquake of April 24, 1984—Strong Motion Records

By A. Gerald Brady *and* Anthony F. Shakal

Seventy-two strong-motion accelerograph stations, mostly from within the permanent networks of the U.S. Geological Survey and the California Division of Mines and Geology, were triggered during the Morgan Hill earthquake, April 24, 1984. Among the more interesting records are the high acceleration recording (1.29 *g*) from Coyote Lake dam, those from the Gilroy array spanning the region between the San Andreas and Calaveras faults, the record from Hall's Valley (epicentral distance 4 km), and records from buildings, a bridge, and a dam within 20 km of the epicenter. Digitized data from 16 stations are available on tape.

Reference: Earthquake Spectra, v. 1, no. 3, May 1985

Integrated Instrumentation Plan for Assessing the Seismic Response of Structures—A Review of the Current USGS Program

By Mehmet Celebi, Erdal Safak, A. Gerald Brady, Richard Maley, *and* Vahid Sotoudeh

There are two main approaches to evaluating seismic behavior and performance of structural systems. One requires a laboratory in which subsystems, components, or (if the facility is large enough) prototypes or large-scale models of complete systems are tested under static, quasistatic, or dynamic loading.

The second approach is to use the natural laboratory of the Earth, by observing and studying damage to structures from earthquakes. By determining why specific designs lack earthquake resistance and then by using extensive laboratory testing of modified designs, significant progress in improved designs can be achieved.

For such design studies a natural laboratory would be a seismically prone area that offers a variety of structural systems; in optimum test areas, strong ground motions as well as moderate-level motions would be experienced frequently. Integral to the "natural laboratory" approach is the advance instrumentation of selected structures so that their responses can be recorded during future earthquakes. Thus it is essential that integrated arrays of instrumentation be planned and installed to assess thoroughly the relation of ground motion that starts at a source and is transmitted through various soils to a substructure and finally to a superstructure. The direction for seismologists and engineers working together is clear: to develop integrated networks which measure the seismic source, the transmittal of ground motion, and the structural response processes.

This report is intended to consider issues that are related to instrumentation—strong-motion arrays, free-field instrumentation near structures, and structural instrumentation schemes. Ultimately the data obtained should reveal the complete phenomena of motion originating at a source and response of a structure at a particular site.

Reference: U.S. Geological Survey Circular 947, 38 p.

A General Earthquake-Observation System (GEOS)

By R.D. Borcherdt, J.B. Fletcher, E.G. Jensen, G.L. Maxwell, J.R. VanSchaack, R.E. Warrick, E. Cranswick, M.J.S. Johnston, *and* R. McClearn

Microprocessor technology has permitted the development of a General Earthquake-Observation System (GEOS) useful for most seismic applications. Central-processing-unit control, via robust software, of system functions that are isolated on hardware modules permits field adaptability of the system to a wide variety of active and passive seismic experiments and straightforward modification for incorporation of improvements in technology. Various laboratory tests and numerous deployments of a set of the systems in the field have confirmed design goals, including wide linear dynamic range, broad bandwidth, selectable sensor-type, selectable channels, selectable record mode, large data capacity, selectable time standard, automatic self-calibration, simple field operation, full capability to adapt the system in the field to a wide variety of experiments, low power, portability, and modest costs. The systems have been deployed for 15 experiments, including: studies of near-source strong motion; high-frequency microearthquakes; crustal structure; down-hole wave propagation; teleseismicity; and earth-tidal strains. Data sets recorded on the GEOS illustrate the importance of broad bandwidth, high resolution, and wide linear dynamic range for future earthquake studies. System design goals for a microcomputer-controlled system with modular software and hardware components as implemented on the GEOS are presented.

Reference: Bulletin of the Seismological Society of America, v. 75, no. 6, p. 1783–1825.

AVAILABILITY OF STRONG-MOTION DATA

U.S. Geological Survey Data

Information about strong-motion accelerograph records that have been acquired and archived by the U.S. Geological Survey can be obtained by mailing a request to: BES&G Data Project; U.S. Geological Survey, MS 977; 345 Middlefield Road; Menlo Park, CA 94025

You may decide on either of two less efficient courses of action: visiting the USGS in Menlo Park (275 Middlefield Rd., Building 8), or telephoning specific personnel.

Individual projects involved in the Branch of ES&G Data Project:

- National Strong-Motion Instrumentation Network (NSMIN): instruments, stations, maintenance and records (Dick Maley, 415–329–5670, Ed Etheredge, x5667);
- NSMIN: digitized data (Gerald Brady, x5664);
- NSMIN: data dissemination on disc (Linda Seekins, x5661);
- Data management for portable digital event-recording seismographs (Charles Mueller, x5646).

Much of the information that is available from NSMIN is stored in a database that was at one time available by telephone to anyone outside the USGS. The database, formerly named SMIRS, is no longer directly available to outside users due to personnel and funding limitations, but the information is still kept on one of the USGS in-house computers in a newer database named ESM. External inquiries are preferably handled by mail now.

Researchers may still browse through the database themselves if they wish, but they must visit the USGS offices in Menlo Park to do so. Prospective visitors may wish to review the ESM database User's Guide, which is available on request, beforehand. The guide illustrates the kinds of requests that can be made and the kinds of information that are available in the database.

California Division of Mines and Geology Data

Processed strong-motion data from selected earthquakes are available from the California Division of Mines and Geology (CDMG). These data have been prepared by the interim CDMG strong-motion data-processing system. This system is composed of a series of programs that have been developed by the California Institute of Technology, the USGS, and the CDMG, with special emphasis on the handling of long-duration film records from multiple-channel central recording instruments.

The data are grouped by phase: I, uncorrected accelerations; II, corrected accelerations, velocities, and displacements; and III, response spectra.

Each phase contains three-channel subgroups arranged by station. At present, data from the following earthquakes, among others, have been processed:

- Santa Barbara earthquake of August 13, 1978
- Imperial Valley earthquake of October 15, 1979
- Westmorland earthquake of April 26, 1981
- Coalinga earthquake of May 2, 1983
- Morgan Hill earthquake of April 24, 1984

The data are available on standard nine-track tapes, along with a microfiche copy of the tape contents. Interested parties should contact the CDMG Office of Strong-Motion Studies (OSMS) (see section below entitled "Data Sources").

The policy of CDMG is to make all strong-motion record data promptly available to the public in a manner consistent with good data management. Requests for copies of records, personal access to record or data files, and copies of data files should be made to the chief, OSMS (address 8 in section below entitled "Data Sources"), and should specify the identity and medium of materials to be provided or reviewed. Desired access or delivery dates should be specific. When a request for copies of materials or personal access to files is received, the OSMS staff will provide the requested material or will set up an appointment time for a personal review of files; the requestor will be notified immediately of any significant delay or other problems that prevent meeting his or her request. Charges for copying or other processing of materials will be based on the actual cost of producing and delivering the items, and the OSMS will retain control of the original and master copies of all items.

Foreign Data

Because of the long history of close cooperation between the U.S. and the Central and South American strong-motion programs, many of the data from those programs are available from the same sources as the U.S. data. Information about strong-motion data from the Western Hemisphere will be included in the ESM database 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 Strong-Motion Program Report series, and through informal arrangements, copies of the data and records are available.

Worldwide 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, National Geophysical Data Center (NGDC), and U.S. National Oceanic and Atmospheric Administration (NOAA). Foreign countries contributing to the strong-motion database include Australia, Italy, Japan, New Zealand, Romania, the U.S.S.R., and Yugoslavia. The USGS 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 list of most records has been published in World Data Center A Report SE–6, "Catalog of Seismograms and Strong-Motion Records." This catalog can be ordered from the NGDC (NOAA) for $3.00 (see section below entitled "Data Sources").

The most significant strong-motion records recorded in the United States and Latin America between 1931 and 1971 have been copied on seven reels of 35-mm film (12X reduction) and on 70-mm film chips (approx. 8X reduction). The film chips are available for $1.50 per chip; longer records are continued on additional chips. The 35-mm film copies can be purchased for $30 per reel, and the complete set of reels for $180; there is a minimum charge of $10 per order. Check with the NGDC for current prices before placing your order.

Australia, Japan, and the U.S. have supplied magnetic tapes of digitized data from stations located in the western Pacific Ocean (Japan, Papua New Guinea, and New Britain). A series of 400 U.S. strong-motion records (1933–71) that were digitized by the California Institute of Technology are now available on six magnetic tapes. The USGS is digitizing post-1971 records from its network; they have generated 15 tapes of strong-motion records recorded from 1967 to 1981 in the United States, Chile, Nicaragua, El Salvador, and Mexico.

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

Recent acquisitions include a magnetic tape of strong-motion records triggered by a swarm of earthquakes that occurred in 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. Other data include records obtained from California earthquakes near Santa Barbara in August 1978, Gilroy in August 1979, El Centro in October 1979, Livermore in January 1980, Westmorland in April 1981, Coalinga in 1983, and Morgan Hill in April 1984.

A table listing all the digitized strong-motion records available on magnetic tape may be obtained free of charge from NOAA. These records may be purchased either in punched-card format (including all three instrument components) or in tape format.

Address inquiries to NOAA (see next section).

DATA SOURCES

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

1. NOAA, National Geophysical Data Center (D622)
   Code E/GC11
   325 Broadway St.
   Boulder, CO 80303
   (303) 497–6764

2. National Technical Information Service
   5285 Port Royal Rd.
   U.S. Dept. of Commerce
   Springfield, VA 22161
   (703) 487–4560

3. National Information Service for Earthquake Engineering (NISEE)
   Library, UC Berkeley
   1301 S. 46th St.
   Richmond, CA 94804
   (415) 231–9401

4. National Strong-Motion Program
   U.S. Geological Survey
   345 Middlefield Rd., MS 977
   Menlo Park, CA 94025
   (415) 329–5675 or 329–5672

5. Branch of Distribution
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6. Earthquake Engineering Research Institute
   6431 Fairmont Ave., Suite 7
   El Cerrito, CA 94530
   (415) 525–3668

7. EERC (SUNY)
   State University, New York
   Buffalo, NY 14260

8. Office of Strong-Motion Studies
   California Division of Mines and Geology
   630 Bercut Drive
   Sacramento, CA 95814
   (916) 322–3105

Table 1. Summary of U.S. accelerograph records recovered during 1985

[Station owners: ACOE, U.S. Army Corps of Engineers; CDOT, California Department of Transportation; MANC, Municipality of Anchorage; MWD, Metropolitan Water District of Southern California; USBR, U.S. Bureau of Reclamation; USGS, U.S. Geological Survey; VA, Veterans Administration. Instrument trigger time in seconds after the minute (or the following minute) listed in event column. S-minus trigger denotes *S*-wave-arrival-minus-trigger-time (*S–t*) or *S*-wave-minus-*P*-wave-arrival time (*S–P*, in parentheses) interval. Direction is that of instrument case acceleration for upward trace deflection on accelerogram; horizontal components are listed as azimuth, and vertical components as "up" or "down." Maximum amplitude is peak acceleration recorded at ground level on one vertical and two horizontal (orthogonal) components unless otherwise noted. Duration is interval between first and last peaks of acceleration greater than 0.10 *g*]

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
2 January 1985 0524:58.2 G.m.t. Southern Calif. 34.050N, 116.530W Magnitude 3.8 M_L	Morongo Valley Fire Station (USGS)	34.048°N 116.577°W	02.1	0.6		([1])	
	North Palm Springs Post Office (USGS)	33.924°N 116.543°W	01.4	2.4		([1])	
	Whitewater Trout Farm (USGS)	33.989°N 116.655°W	03.7	([2])		([1])	
3 January 1985 1122:27.6 G.m.t. Central Calif. 36.170N, 120.273W Magnitude 3.7 M_L	Coalinga Oil City (USGS)	36.229°N 120.360°W	30.0	1.8	360°	.05	—
					Up	.01	
					270°	.06	—
6 January 1985 1833:25.8 G.m.t. Central Calif. 36.592N, 121.243W Magnitude 3.4 M_L	Bear Valley Station 1 Fire Station (USGS)	36.573°N 121.184°W	29.3	([2])		([1])	
14 January 1985 2117 G.m.t. Central Calif. Epicenter and magnitude unknown	Pleasant Valley Pump Plant (USBR)	36.308°N 120.249°W					
	Switchyard		17.1	0.5	135°	.05	—
					Up	.01	—
					045°	.04	—
19 January 1985 0030:15.0 G.m.t. Southern Calif. 33.990N, 116.400W Magnitude 3.9 M_L	Fun Valley Reservoir Ground Site (USGS)	33.925°N 116.389°W	18.3	([2])		([1])	
	North Palm Springs Post Office (USGS)	33.924°N 116.543°W	18.6	2.3		([1])	
6 December 1983– 21 January 1985 Hawaii Epicenters and magnitudes unknown	Kailua-Kona, Hawaii Fire Station (USGS)	19.649°N 155.996°W	([3])	([2])		([1])	

Table 1. Summary of U.S. accelerograph records recovered during 1985—*Continued*

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
6 December 1983– 21 January 1985 Hawaii, Epicenters and magnitudes unknown— *Continued*	Pahala, Hawaii Kau Hospital (USGS)	19.20° N 155.47° W	([3])	([2])		([1])	
	Waimea, Hawaii Fire Station (USGS)	20.026°N 155.664°W	([3])	([2])	155° Up 065°	.06 .04 .02	— — —
	Note: Four additional records[1] recovered at Waimea Fire Station.						
24 January 1985 1127:21.7 G.m.t. Eastern Calif. 38.140N, 118.838W Magnitude 5.3 M_L	Terminus Dam Auxiliary Dam (ACOE) Center crest	36.404°N 119.001°W	([3])	([2])		([1])	
31 January 1985 0928:49.4 G.m.t. Central Calif. 36.894N, 121.330W Magnitude 2.9 M_L	Hollister Diff. Array, analog (USGS)	36.888°N 121.413°W	52.0	0.5		([1])	
5 November 1984– 2 February 1985 Central Calif. Epicenter and magnitude unknown	Coalinga Burnett Company (USGS)	36.138°N 120.357°W	([3])	([2])		([1])	
15 February 1985 2326:26.5 G.m.t. Southern Calif. 33.980N, 116.400W Magnitude 4.0 M_L	Fun Valley Reservoir Ground Site (USGS)	33.925°N 116.389°W	29.4	([2])	135° Up 045°	.06 .02 .05	— — —
22 February 1985 0548:29.3 G.m.t. Hawaii 19.329N, 155.211W Magnitude 4.8 M_L	Hawaii National Park Volcano Observatory (USGS)	19.423°N 155.291°W	33.3[4]	([2])		([1])	
	Hilo, Hawaii U.S. Fish & Wildlife (USGS)	19.731°N 155.100°W	48.7[4]	([2])		([1])	
	Kealakekua, Hawaii Kona Hospital (USGS)	19.523°N 155.879°W	52.7[4]	([2])	346° Up 256°	.07 .02 .05	— — —
	Mauna Kea, Hawaii State Park (USGS)	19.752°N 155.530°W	41.1[4]	6.9		([1])	
	Pahala, Hawaii Kau Hospital (USGS)	19.20°N 155.47°W	41.1[4]	([2])	188° Up 098°	.04 .02 .06	— — —

Table 1. Summary of U.S. accelerograph records recovered during 1985—*Continued*

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
24 February 1985 1430 G.m.t. Central Calif. Epicenter and magnitude unknown	Pleasant Valley Pump Plant (USBR)	36.308°N 120.249°W	26.4	1.6			
	Switchyard					([1])	
23 August 1979– 25 February 1985 Central Calif. Epicenter and magnitude unknown	San Francisco Eastman Kodak Bldg. (USGS)	37.81°N 122.42°W	([3])	([2])			
	Basement					([1])	
28 February 1985 0442:08.5 G.m.t. Southern Calif. 33.960N, 116.290W Magnitude 3.7 M_L	Fun Valley Reservoir Ground Site (USGS)	33.925°N 116.389°W	13.5	([2])		([1])	
27 September 1984– 20 March 1985 Central Calif. Epicenters and magnitudes unknown	Pine Flat Dam (ACOE)	36.83°N 119.33°W					
	Lower gallery		([3])	([2])		([1])	
	Upper gallery		([3])	([2])		([1])	
	Right abutment		([3])	([2])		([1])	
	Note: One each additional record[1] recovered at the lower gallery, upper gallery, and right abutment.						
27 March 1985 0833:44.9 G.m.t. Central Calif. 36.247N, 120.442W Magnitude 2.6 M_L	Coalinga Oil City (USGS)	36.229°N 120.360°W	48.1	([2])		([1])	
24 September 1984– 28 March 1985 Southern Calif. Epicenter and magnitude unknown	Bakersfield Harvey Auditorium (USGS)	35.37°N 119.02°W	([3])	3.1		([1])	
22 December 1984– 5 April 1985 Central Calif. Epicenter and magnitude unknown	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	([3])	1.6	310° Up 220°	.04 .01 .06	— — —
6 April 1985 1316:19.1 G.m.t. Central Calif. 36.578N, 121.133W Magnitude 3.3 M_L	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	21.2	1.7		([1])	

Table 1. Summary of U.S. accelerograph records recovered during 1985—*Continued*

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
6 April 1985 Central Calif. 36.578N, 121.133W Magnitude 3.3 M_L— *Continued*	Bear Valley Station 14 Upper Butts Ranch (USGS)	36.569°N 121.043°W	23.8	(2)		(1)	
9 April 1985 0323:24.7 G.m.t. Central Calif. 36.212N, 120.283W Magnitude 3.7 M_L	Coalinga Oil City (USGS)	36.229°N 120.360°W	29.6	(2)		(1)	
9 April 1985 1308 G.m.t. Central Calif. Epicenter and magnitude unknown	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	12.8	(2)		(1)	
24 June 1984– 23 April 1985 Southern Calif. Epicenters and magnitudes unknown	Rancho de Anza (USGS)	33.35° N 116.40°W	(3)	2.8		(1)	
	Note: One additional record[1] recovered at Rancho de Anza.						
7 November 1984– 9 May 1985 Central Calif. Epicenter and magnitude unknown	Diemer Filter Plant (MWD)	33.91° N 117.82°W	(3)	1.1			
	Basement					(1)	
	Reservoir roof					(1)	
11 May 1985 0859:23.8 G.m.t. Central Calif. 36.158N, 120.280W Magnitude 4.0 M_L	Coalinga Burnett Company (USGS)	36.138°N 120.357°W	26.8	2.3		(1)	
	Coalinga Oil City (USGS)	36.229°N 120.360°W	26.5	2.4	360° Up 270°	.10 .02 .10	1-peak — 1-peak
15 May 1985 2108 G.m.t. Hawaii, Epicenter and magnitude unknown	Hawaii National Park Volcano Observatory (USGS)	19.423°N 155.291°W	41.8[4]	(2)		(1)	
15 May 1985 2221 G.m.t. Hawaii, Epicenter and magnitude unknown	Hawaii National Park Volcano Observatory (USGS)	19.423°N 155.291°W	20.6[4]	(2)		(1)	
17 May 1985 1859 G.m.t. Hawaii Epicenter and magnitude unknown	Hawaii National Park Volcano Observatory (USGS)	19.423°N 155.291°W	29.8[4]	(2)		(1)	

Table 1. Summary of U.S. accelerograph records recovered during 1985—*Continued*

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
17 May 1985 1902 G.m.t. Hawaii, Epicenter and magnitude unknown	Hawaii National Park Volcano Observatory (USGS)	19.423°N 155.291°W	28.4[4]	([2])		([1])	
17 May 1985 1903 G.m.t. Hawaii, Epicenter and magnitude unknown	Hawaii National Park Volcano Observatory (USGS)	19.423°N 155.291°W	10.9[4]	([2])		([1])	
17 May 1985 1905 G.m.t. Hawaii, Epicenter and magnitude unknown	Hawaii National Park Volcano Observatory (USGS)	19.423°N 155.291°W	52.4[4]	([2])		([1])	
29 November 1984– 18 May 1985 Eastern Calif. Epicenters and magnitudes unknown	McGee Creek, SMA (USGS)	37.550°N 118.811°W	([3])	0.6	180° Up 090°	.08 .04 .09	— — —
	Note: Three additional records[1] recovered at McGee Creek, SMA.						
	McGee Creek, CRA (USGS)	37.550°N 118.811°W	([3])	0.5			
	166 m downhole					([1])	
	35 m downhole					([1])	
	Surface				360° Up 270°	.08 .05 .09	— — —
	Note: Three additional records[1] recovered at McGee Creek, CRA. SMA is surface triaxial accelerograph; CRA consists of surface and downhole triaxial packages at indicated depths.						
	Long Valley Dam Lake Crowley (USGS)	37.588°N 118.705°W					
	Left abutment		([3])	([2])		([1])	
25 May 1985 1550:45.4 G.m.t. Southern Calif. 33.950N, 116.650W Magnitude 3.2 M_L	North Palm Springs Post Office (USGS)	33.924°N 116.543°W	48.6	([2])		([1])	
28 May 1985 1831:47.4 G.m.t. Eastern Calif. 37.550N, 118.850W Magnitude 3.8 M_L	McGee Creek, SMA (USGS)	37.550°N 118.811°W	([3])	([2])	180° Up 090°	.05 .02 .05	— — —

Table 1. Summary of U.S. accelerograph records recovered during 1985—*Continued*

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (*g*)	Duration (s)
28 May 1985 1831:47.4 G.m.t. Eastern Calif. 37.550N, 118.850W Magnitude 3.8 M_L– *Continued*	McGee Creek, CRA (USGS)	37.550°N 118.811°W	50.0	(2)			
	166 m downhole					(1)	
	35 m downhole					(1)	
	Surface				360° Up 270°	.05 .02 .06	— — —
15 April 1985– 7 June 1985 Southern Calif. Epicenter and magnitude unknown	Isabella Dam (ACOE)	35.645°N 118.480°W					
	Main dam Right crest		(3)	(2)		(1)	
	Auxiliary dam Right crest		(3)	(2)		(1)	
	Auxiliary dam Right abutment		(3)	(2)		(1)	
14 June 1985 1124:03.1 G.m.t. Central Calif. 36.162N, 120.268W Magnitude 3.2 M_L	Coalinga Burnett Company (USGS)	36.138°N 120.357°W	05.7	2.4		(1)	
22 December 1984– 26 June 1985 Central Calif. Epicenter and magnitude unknown	Bear Valley Station 6 James Ranch (USGS)	36.504°N 121.101°W	(3)	1.1		(1)	
27 June 1985 0438:55.4 G.m.t. Central Calif. 36.510N, 121.118W Magnitude 3.3 M_L	Bear Valley Station 6 James Ranch (USGS)	36.504°N 121.101°W	55.8	1.0	310° Up 220°	.15 .10 .15	0.1 1 peak 1 peak
	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	56.5	1.1		(1)	
30 June 1985 2112:24.0 G.m.t. Hawaii 19.371N, 155.299W Magnitude 4.3 M_L	Hawaii National Park Volcano Observatory (USGS)	19.423°N 155.291°W	30.7[4]	2.8		(1)	
31 July 1984– 2 July 1985 Alaska, Epicenter and magnitude unknown	Whittier, Alaska RR Dock Building (USGS)	60.778°N 148.692°W	(3)	(2)		(1)	

Table 1. Summary of U.S. accelerograph records recovered during 1985—*Continued*

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
4 July 1985 1305:56.9 G.m.t. Eastern Calif. 37.467N, 118.858W Magnitude 3.1 M_L	McGee Creek, SMA (USGS)	37.550°N 118.811°W	(3)	(2)		(1)	
	McGee Creek, CRA (USGS)	37.550°N 118.811°W	02.1	(2)			
	166 m downhole					(1)	
	35 m downhole					(1)	
	Surface					(1)	
7 July 1985 1200:37.4 G.m.t. Hawaii 19.168N, 155.596W Magnitude 4.2 M_L	Pahala, Hawaii Kau Hospital (USGS)	19.20°N 155.47°W	38.2[4]	(2)		(1)	
12 July 1985 0051 G.m.t. Central Calif. Epicenter and magnitude unknown	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	24.6	0.8		(1)	
24 July 1985 1545:44.2 G.m.t. Central Calif. 36.192N, 120.285W Magnitude 3.1 M_L	Coalinga Burnett Company (USGS)	36.138°N 120.357°W	49.0	0.9		(1)	
4 August 1985 1201:57.0 G.m.t. Central Calif. 36.130N, 120.127W Magnitude 5.4 M_L	Coalinga Burnett Company (USGS)	36.138°N 120.357°W	05.6	(2)	360° Up 270°	.05 .02 .06	— — —
	Coalinga Oil City (USGS)	36.229°N 120.360°W	10.4	(2)		(1)	
	Pleasant Valley Pump Plant (USBR)	36.308°N 120.249°W	06.9	(2)			
	Basement					(1)	
	Main floor					(1)	
	Roof					(1)	
	Switchyard					(1)	
	Terminus Dam Auxiliary Dam (ACOE)	36.404°N 119.001°W	(3)	(2)			
	Center crest					(1)	

Table 1. Summary of U.S. accelerograph records recovered during 1985—*Continued*

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
6 November 1984– 14 August 1985 Central Calif. Epicenters and magnitudes unknown	Bear Valley Station 5 Callens Ranch (USGS)	36.673°N 121.195°W	([3])	([2])		([1])	
	Bear Valley Station 12 Williams Ranch (USGS)	36.658°N 121.249°W	([3])	([2])		([1])	
	Note: One additional record[1] recovered at Williams ranch.						
13 July 1985– 14 August 1985 Central Calif. Epicenters and magnitudes unknown	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	([3])	1.7		([1])	
	Note: One additional record[1] recovered at Webb Residence.						
29 August 1985 0455:04.7 G.m.t. Southern Calif. 32.870N, 115.500W Magnitude 3.2 M_L	El Centro Array #6 551 Huston Road (USGS)	32.839°N 115.487°W	07.3	2.6		([1])	
14 September 1985 0302:44.2 G.m.t. Central Calif. 36.266N, 120.255W Magnitude 2.8 M_L	Coalinga Burnett Company (USGS)	36.138°N 120.357°W	49.2	0.7		([1])	
7 September 1985– 22 September 1985 Central Calif. Epicenter and magnitude unknown	Bear Valley Station 6 James Ranch (USGS)	36.504°N 121.101°W	([3])	0.7		([1])	
30 September 1985 0945:39.7 G.m.t. Central Calif. 36.582N, 121.225W Magnitude 3.2 M_L	Bear Valley Station 1 Fire Station (USGS)	36.573°N 121.184°W	42.3	([2])		([1])	
	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	41.9	1.7	310° Up 220°	.05 .02 .06	— — —
2 October 1985 2344:12.4 G.m.t. Southern Calif. 34.030N, 117.250W Magnitude 4.8 M_L	Cherry Valley (USGS)	33.98°N 116.99°W	17.7	3.8		([1])	
	Colton I–10/15 Interchange (CDOT)	34.06°N 117.30°W	([3])	([2])			
	Bridge cell					([1])	
	Ground vault				082° Up 352°	.05 .01 .05	— — —

Table 1. Summary of U.S. accelerograph records recovered during 1985—*Continued*

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
2 October 1985 2344:12.4 G.m.t. Southern Calif. 34.030N, 117.250W Magnitude 4.8 M_L— *Continued*	Diemer Filter Plant (MWD)	33.91°N 117.82°W	([3])	0.8			
	Basement					([1])	
	Reservoir roof					([1])	
	Highland Fire Station (USGS)	34.136°N 117.213°W	16.0	2.2	315° Up 225°	.05 .02 .03	— — —
	Lake Mathews Dam (MWD)	33.852°N 117.451°W	([3])	([2])			
	Dike toe				252° Up 162°	.07 .03 .09	— — —
	Loma Linda University Medical Center (USGS)	34.05°N 117.26°W	([3])	2.1			
	Basement					([1])	
	Loma Linda VA Hospital (VA)	34.049°N 117.248°W	([3])	1.9			
	Structure Array:						
	Channel 1—1st floor center				Down	.01	—
	Channel 2—1st floor center				180°	.04	—
	Channel 3—1st floor center				270°	.02	—
	Channel 4—4th floor center				270°	.06	—
	Channel 5—1st floor north				270°	.03	—
	Channel 6—4th floor center				180°	.03	—
	Channel 7—4th floor north				270°	.05	—
	Channel 8—1st floor south				180°	.03	—
	Channel 9—4th floor south				270°	.05	—
	North free field	34.051°N 117.248°W	17.3	0.3	360° Up 270°	.07 .02 .05	— — —
	South free field	34.049°N 117.250°W	([3])	1.6	360° Up 270°	.06 .02 .05	— — —
	Mentone Fire Station (USGS)	34.067°N 117.117°W	([3])	0.5	315° Up 225°	.05 .02 .03	— — —
	Reche Canyon Olive Dell Ranch (USGS)	34.01°N 117.22°W	17.7	([2])		([1])	

Table 1. Summary of U.S. accelerograph records recovered during 1985—*Continued*

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (*g*)	Duration (s)
2 October 1985 2344:12.4 G.m.t. Southern Calif. 34.030N, 117.250W Magnitude 4.8 M_L— *Continued*	Sunnymead Egg Ranch (USGS)	33.95°N 117.15°W	19.1	([2])	315° Up 225° ([1])	.04 .02 .07	— — —
3 October 1985 1612 G.m.t. Hawaii Epicenter and magnitude unknown	Mauna Kea, Hawaii State Park (USGS)	19.752°N 155.530°W	38.3[4]	7.0		([1])	
28 October 1985 0425:52.3 G.m.t. Central Calif. 36.547N, 121.165W Magnitude 3.2 M_L	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	54.4	0.6		([1])	
	Bear Valley Station 6 James Ranch (USGS)	36.504°N 121.101°W	54.3	1.8		([1])	
31 October 1985 1955:03.7 G.m.t. Southern Calif. 34.460N, 117.880W Magnitude 3.7 M_L	Valyermo Forest Station (USGS)	34.44°N 117.85°W	05.9	1.0	300° Up 210°	.06 .04 .04	— — —
8 November 1985 2210 G.m.t. Central Calif. Epicenter and magnitude unknown	San Justo Damsite (USBR)	36.827°N 121.445°W	10.1	([2])			
	Right abutment (Dike)					([1])	
12 November 1985 0444 G.m.t. Central Calif. Epicenter and magnitude unknown	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	53.5	([2])		([1])	
16 January 1985– 24 November 1985 Hawaii, Epicenters and magnitudes unknown	Hawaii National Park Wahaula Maintenance Center (USGS)	19.329°N 155.031°W	([2])	([2])		([1])	
	Waiohinu, Hawaii Kau Baseyard (USGS)	19.070°N 155.615°W	([2])	1.8	065° Up 335°	.10 .06 .10	1-peak — 1-peak
	Hawaii National Park Observatory Warehouse (USGS)	19.434°N 155.264°W	([2])	([2])		([1])	
	Mauna Loa, Hawaii Weather Observatory (USGS)	19.539°N 155.580°W	([2])	5.8	030° Up 300°	.07 .02 .03	— — —

Table 1. Summary of U.S. accelerograph records recovered during 1985—*Continued*

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (*g*)	Duration (s)
16 January 1985– 24 November 1985 Hawaii, Epicenters and magnitudes unknown—*Continued*	Mauna Loa, Hawaii Weather Observatory (USGS)—*Continued*	19.539°N 155.580°W	(2)	4.9	030°	.05	—
					Up	.01	—
					300°	.04	—
24 November 1985 1256:15.6 G.m.t. Central Calif. 36.360N, 120.210W Magnitude 2.8 M_L	Coalinga Oil City (USGS)	36.229°N 120.360°W	19.2	2.0		(1)	
	Bear Valley Station 1 Fire Station (USGS)	36.573°N 121.184°W	(3)	0.6		(1)	
	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	(3)	1.0		(1)	
14 August 1985– 28 November 1985 Central Calif. Epicenter and magnitude unknown	Bear Valley Station 12 Williams Ranch (USGS)	36.658°N 121.249°W	(3)	1.6	310°	.05	—
					Up	.03	—
					220°	.05	—
28 November 1985 1513:57.2 G.m.t. Central Calif. 36.562N, 121.060W Magnitude 4.5 M_L	Bear Valley Station 1 Fire Station (USGS)	36.573°N 121.184°W	03.4	(2)		(1)	
	Bear Valley Station 5 Callens Ranch (USGS)	36.673°N 121.195°W	04.9	(2)		(1)	
	Bear Valley Station 6 James Ranch (USGS)	36.504°N 121.101°W	00.0	2.3	310°	.06	—
					Up	.02	—
					220°	.05	—
	Bear Valley Station 7 Pinnacles (USGS)	36.483°N 121.180°W	00.5	2.0		(1)	
	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	00.1	1.9	310°	.09	—
					Up	.04	—
					220°	.12	1 peak
	Bear Valley Station 12 Williams Ranch (USGS)	36.658°N 121.249°W	02.5	4.2		(1)	
	Bear Valley Station 14 Upper Butts Ranch (USGS)	36.569°N 121.043°W	59.3	1.3	310°	.28	2.7
					Up	.11	0.4
					220°	.20	2.1

Table 1. Summary of U.S. accelerograph records recovered during 1985—*Continued*

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (*g*)	Duration (s)
5 December 1985 0628:36.9 G.m.t. Northern Calif. 40.600N, 124.500W Magnitude 3.2 M_L	Eel River Valley Array Centerville Beach (USGS)	40.563°N 124.348°W	42.8	(2)		(1)	
12 December 1985 1901:19.8 G.m.t. Hawaii 20.615N, 155.762W Magnitude 4.5 M_L	Honokaa, Hawaii Fire Station (USGS)	20.080°N 155.465°W	33.1[4]	(2)		(1)	
	Kapaau, Hawaii Kohala Police Station (USGS)	20.230°N 155.801°W	(2)	(2)	102° Up 012°	.05 .03 .06	— — —
12 December 1985 2118:39.3 G.m.t. Hawaii 19.516N, 155.908W Magnitude 4.0 M_L	Kealakekua, Hawaii Kona Hospital (USGS)	19.523°N 155.879°W	41.5[4]	1.1		(1)	
30 December 1985 1241:02.7 G.m.t. Southern Alaska 61.541N, 150.340W Magnitude 5.5 M_B	Anchorage Alaska Hospital (USGS)	61.21°N 149.82°W	(3)	7.1			
	1st floor					(1)	
	4th floor					(1)	
	7th floor					(1)	
	Anchorage, Alaska Pacific University (USGS)	61.189°N 149.801°W	(3)	7.7	360° Up 270°	.07 .01 .08	— — —
	Anchorage, Alaska Fire Station #1 (MANC)	61.174°N 149.973°W	(3)	7.7		(1)	
	Anchorage, Alaska Fire Station #3 (MANC)	61.214°N 149.824°W	(3)	(2)		(1)	
	Anchorage, Alaska Fire Station #4 (MANC)	61.182°N 149.848°W	(3)	8.0		(1)	
	Note: One additional record[1] recovered at Fire Station #4.						
	Anchorage, Alaska Fire Station #7 (MANC)	61.146°N 149.950°W	(3)	7.8		(1)	

Table 1. Summary of U.S. accelerograph records recovered during 1985—*Continued*

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (*g*)	Duration (s)
30 December 1985 1241:02.7 G.m.t. Southern Alaska 61.541N, 150.340W	Anchorage, Alaska Federal Building (USGS)	61.216°N 149.883°W	(3)	7.6		(1)	
Magnitude 5.5 M_B— *Continued*	Anchorage, Alaska Russian Jack Park (USGS)	61.209°N 149.783°W	24.7[4]	(2)		(1)	
31 December 1985 2334 G.m.t. Hawaii Epicenter and magnitude unknown	Hawaii National Park Volcano Observatory (USGS)	19.423°N 155.291°W	37.9[4]	(2)		(1)	

[1]Less than 0.05 *g* at ground-level or less than 0.10 *g* at non-ground-level stations.
[2]Questionable or indeterminable.
[3]WWVB time code illegible, or instrument not equipped with a radio receiver; correlation of accelerogram with event may be questionable or identity of event unknown.
[4]Internal clock time; accuracy is variable

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