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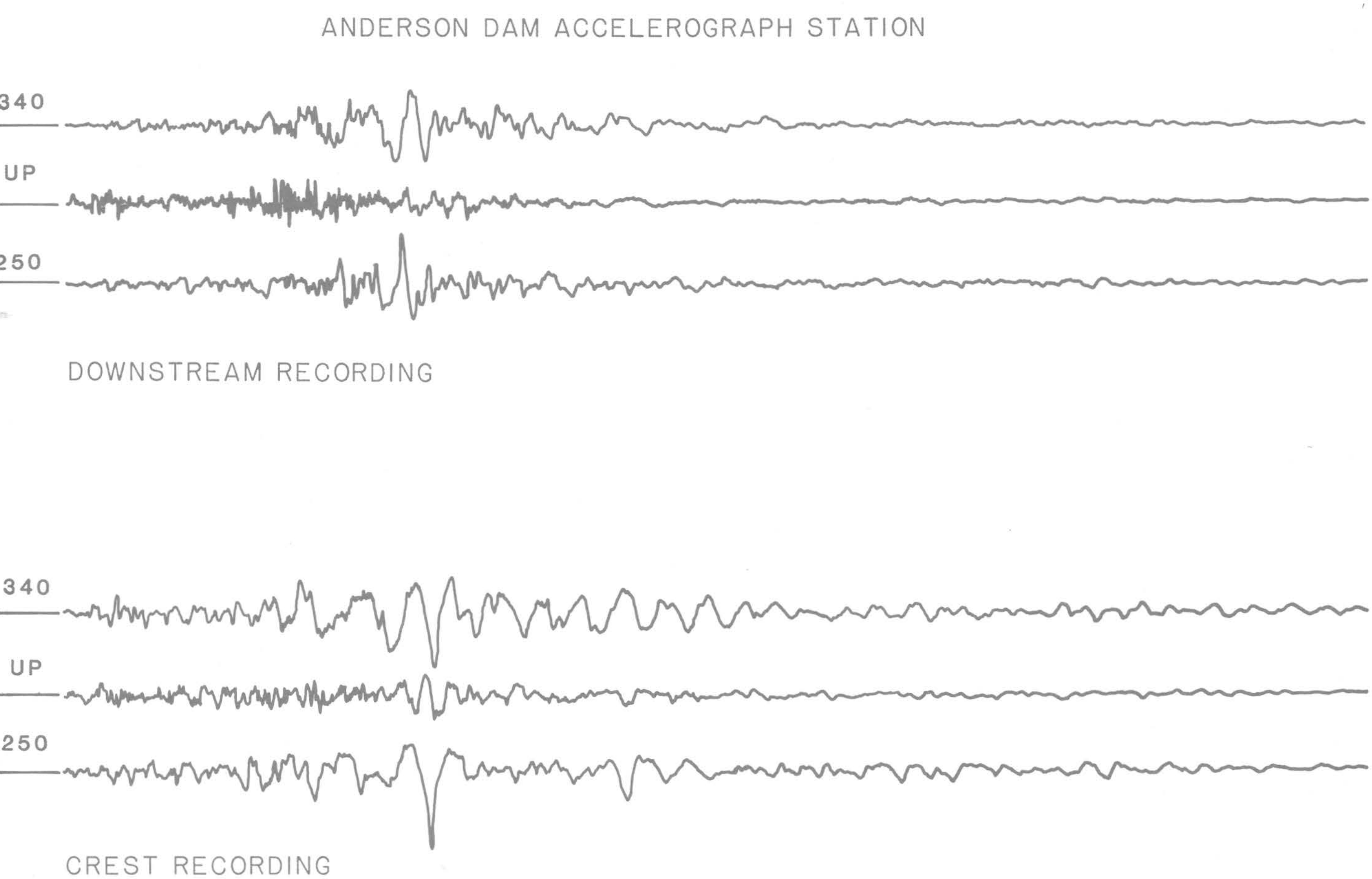
STRONG-MOTION PROGRAM REPORT, JANUARY-DECEMBER 1984



MAGNITUDE 6.2 MORGAN HILL, CALIFORNIA, EARTHQUAKE OF APRIL 24

U.S. GEOLOGICAL SURVEY CIRCULAR 992

STRONG-MOTION PROGRAM REPORT, JANUARY-DECEMBER 1984

U.S. GEOLOGICAL SURVEY CIRCULAR 992

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Department of the Interior

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U.S. Geological Survey

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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 Network during 1984, a report on the 1984 Morgan Hill, Calif., earthquake, 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 1984; event data are taken from "Preliminary Determination of Epicenters," published by the USGS.

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1984 ACCELEROGRAPH RECORDS

By J. C. Switzer

The U.S. Geological Survey's National Strong-Motion Network produced 164 records during the period January 1 through December 31, 1984. At least 43 of these records are from the main shock of the magnitude 6.1 (M_L) Morgan Hill earthquake of April 24, which was felt throughout central California (see the following report). A maximum horizontal ground acceleration of 0.40 g was recorded at the Anderson Dam downstream station. The Hollister Differential Array produced four digital records in addition to the film record (see table 1).

On November 23 a swarm of earthquakes occurred in the Mammoth Lakes area. A magnitude 6.1 (M_L) earthquake at 1808 G.m.t. produced a peak horizontal acceleration of 0.11 g at the McGee Creek strong-motion station and a magnitude 5.5 (M_L) earthquake at 1912 G.m.t. produced a maximum acceleration of 0.12 g at this station. During the period November 23-29, 141 channels of data were recorded; 117 of these are from the McGee Creek station.

Additional strong-motion records were recovered from USGS accelerograph stations located in North Dakota, Idaho, California, Alaska, and Hawaii during this reporting period (table 1).

STRONG-MOTION RESULTS FROM THE MAIN SHOCK OF THE APRIL 24, 1984, MORGAN HILL EARTHQUAKE

By G. Brady, R. Porcella, N. Bycroft, E. Etheredge, P. Mork, B. Silverstein, and A. Shakal

[This report is taken from the Morgan Hill, California, earthquake of April 24, 1984 (A Preliminary Report), U.S. Geological Survey Open-File Report 84-498A, p. 18-26.]

The permanent accelerograph networks of both the U.S. Geological Survey (USGS) and the California Division of Mines and Geology (CDMG) have provided an important set of strong-motion records from the main shock of the Morgan Hill earthquake. Altogether, about 75 stations were triggered at the two networks, at epicentral distances ranging from about 4 km (Hall's Valley, a CDMG-maintained station) to more than 100 km. The USGS network includes instruments owned by the California Department of Transportation, the California Department of Water Resources, the U.S. Bureau of Reclamation (USBR), and other organizations.

Figure 1 shows the locations of accelerograph stations in both networks at the time of the April 24, 1984, main shock. Triangles indicate the station

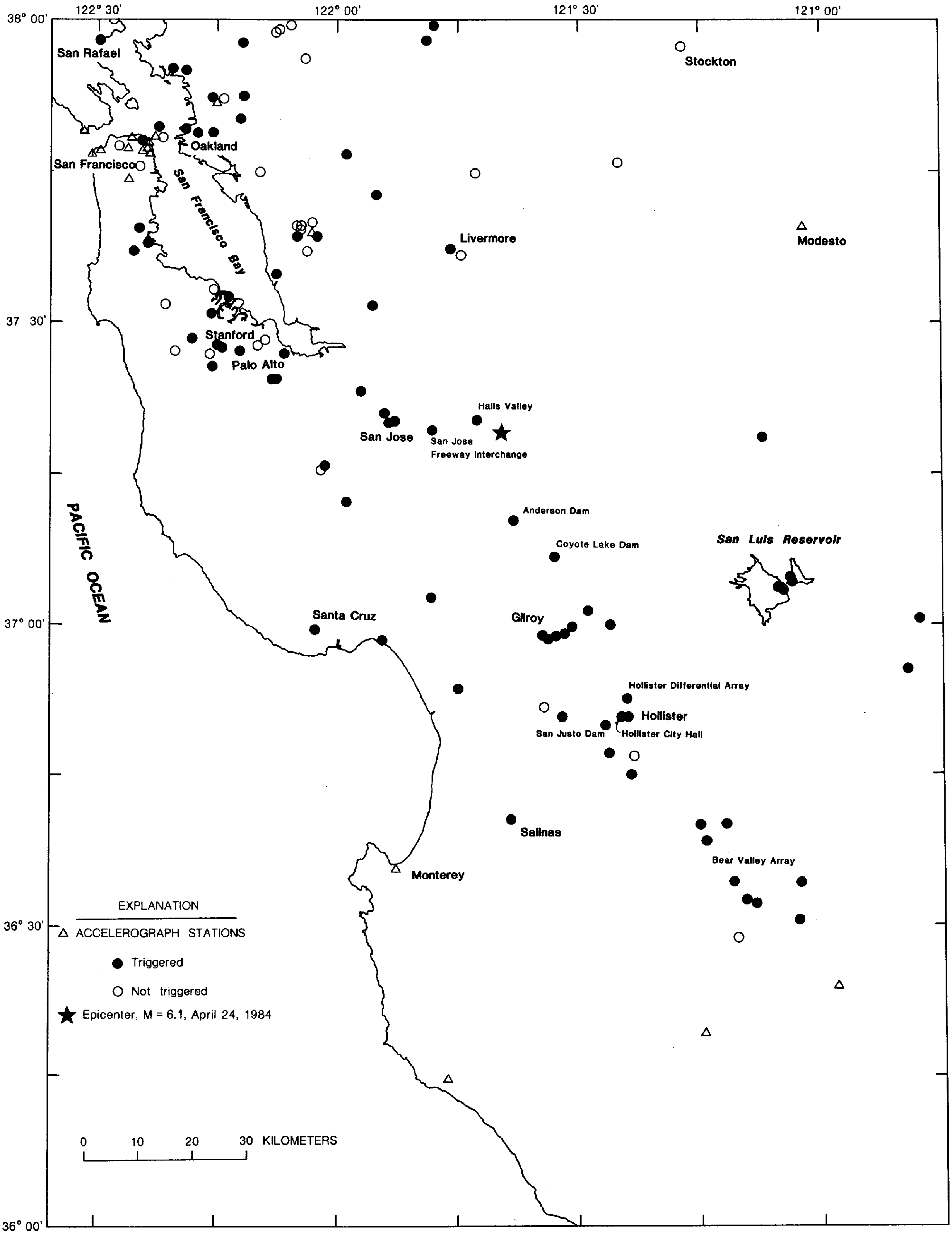

Figure 1.--Locations of accelerograph stations during the April 24 Morgan Hill earthquake main shock.

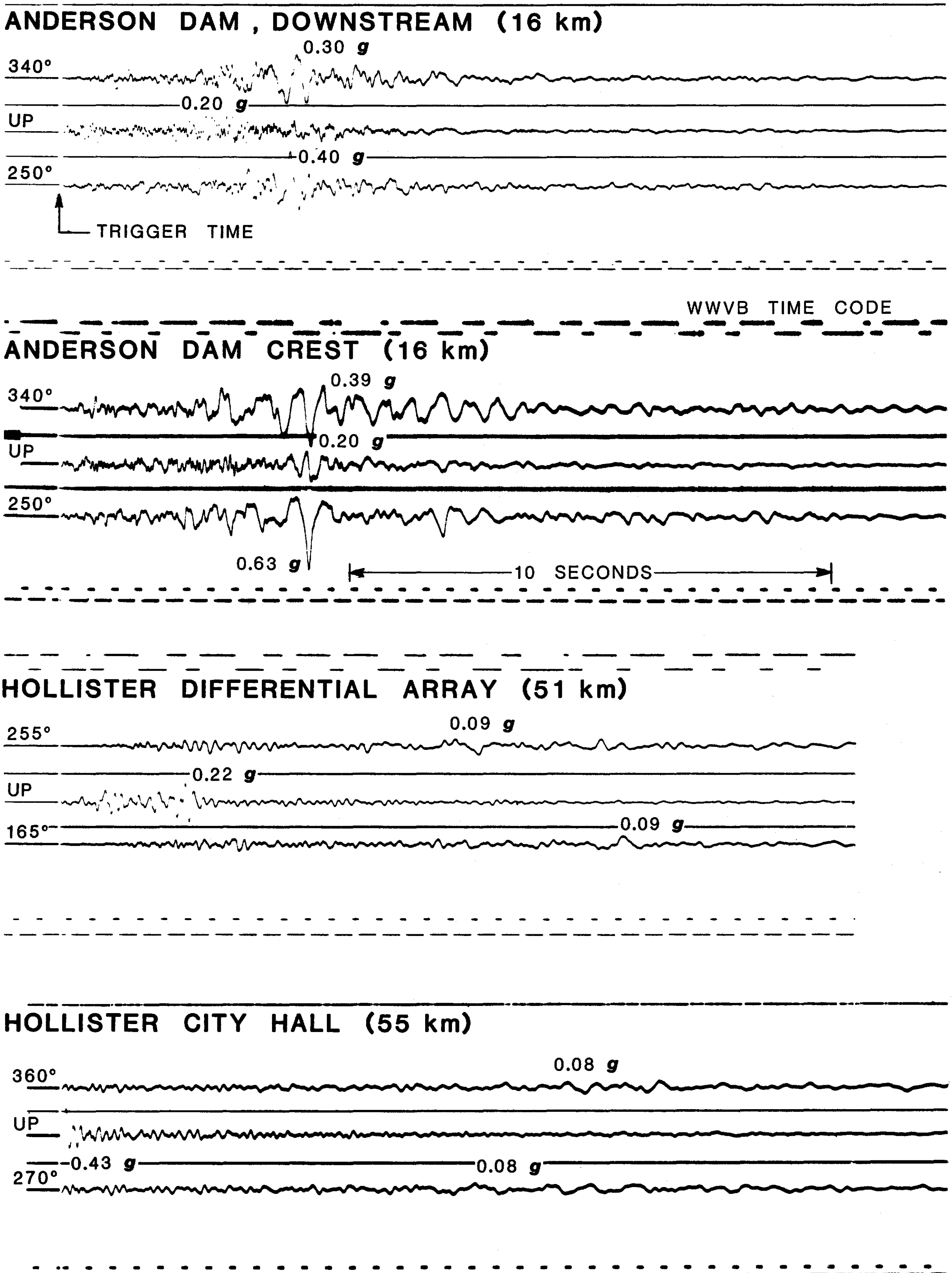

Figure 2.--Strong-motion records from the April 24 Morgan Hill earthquake main shock.

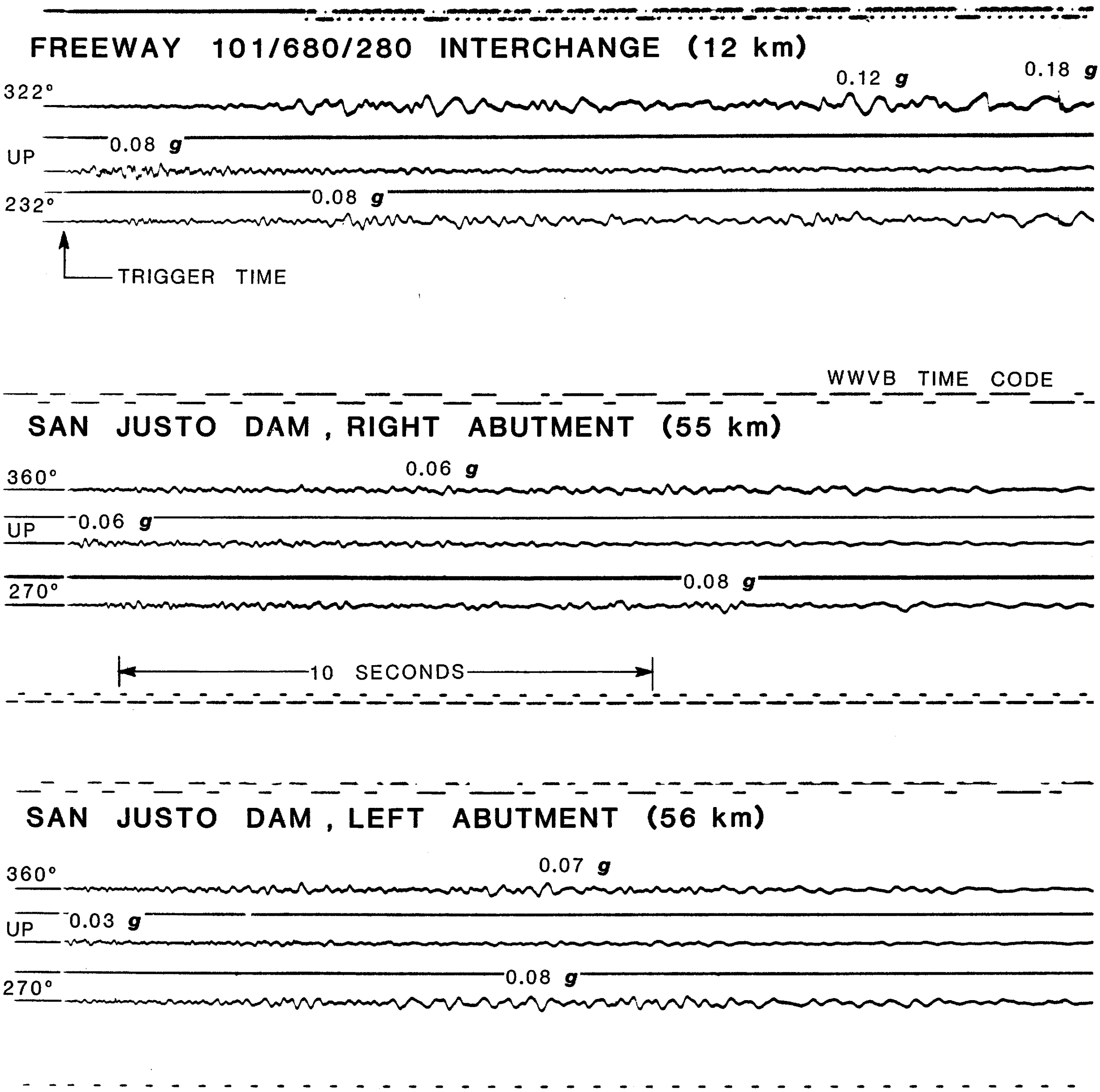

Figure 2.--Continued.

had not been visited when the figure was prepared. Table 1 summarizes the data for the USGS-maintained stations, including the USBR and others. A comparable list for CDMG-maintained stations is provided in Shakal and others 1984. The maximum acceleration for each component (scaled from the original records) is listed, together with the duration in seconds for which the acceleration reached amplitudes greater than 0.1 g. Copies of USGS film records from Anderson Dam, Hollister Differential Array and City Hall Annex, San Jose Interchange, and San Justo Damsite are shown in figure 2.

Table 1 contains information on both 70-mm film records and digital records (Kinemetrics' DSA-1). The entry "Hollister Differential Array" refers to a film recorder included within the Hollister Digital Differential Array. The array provided four digital records in addition to the listed film recording. Also, a set of digital records was obtained from various locations on a span of the San Jose Freeway Interchange (US-101, I-680, I-280). The details entered in table 1 for this station are from the film recorder, located within the bridge box girder, but close to the abutment. The Palo Alto Veteran's Administration Hospital has two digital recorders located in separate buildings.

Digitizing and processing of film records has been carried out for the following stations: Anderson Dam (crest and downstream), Hollister Differential Array, Hollister City Hall Annex, San Justo Damsite (right and left abutments), and the San Jose Freeway Interchange.

Record processing, including corrected ground motions from the digital records at the Hollister Differential Array, are included in Open-File Report 84-498B, volume II. The stations within the array are arranged along the two lines of a V; four stations along a 2,000 ft line, and two more along a 1,000 ft line at 33° to the first. The array is located at Hollister Airport, 4 km north of Hollister City Hall. At the present time, only stations 1, 3, 4, and 5 have been processed. Malfunctions on the other two records may limit their usefulness. All record processing for this report has been carried out in accordance with the descriptions in Converse (1984).

References:

Shakal, A. F., Sherburne, R. W., and Parke, D. L., 1984, CDMG strong-motion records from the Morgan Hill, California, earthquake of 24 April 1984: California Division of Mines and Geology, OSMS Report 84-7, 101 p.

Converse, A. M., 1984, AGRAM: A series of computer programs for processing digitized strong-motion accelerograms, version 2.0: U.S. Geological Survey Open-File Report 84-525, 98 p.

Any use of tradenames is for descriptive purposes only and does not constitute endorsement by the USGS.

SUMMARIES OF

1984 STRONG-MOTION PUBLICATIONS

[The following selected summaries have been abstracted from various sources, including B. A. Gessner, in press, Bibliography for topical studies of engineering seismology and geology: U.S. Geological Survey Open-File Report. Inclusion of these summaries is intended as a service to our readers and does not constitute an endorsement of these reports by the U.S. Geological Survey.]

Proceedings, Eighth World Conference on Earthquake Engineering

The world conferences on earthquake engineering, which are held every four years under the sponsorship of the International Association of Earthquake Engineering (IAEE), had their beginning with the World Conference on Earthquake Engineering held in Berkeley, California, in 1956, to commemorate the 50th anniversary of the 1906 San Francisco earthquake. At the Second World Conference on Earthquake Engineering in Tokyo-Kyoto, Japan, in 1960, the IAEE was officially formed, and the precedent was set to hold the world conferences on earthquake engineering every four years under its sponsorship.

Interest in the world conferences has steadily increased as evidenced by the growth in the size of the conference proceedings and the number of participating countries. The 1956 Berkeley Conference proceedings consist of a single volume containing 40 papers from 12 countries. In contrast, these Eighth World Conference proceedings consist of seven volumes containing approximately 850 papers from 43 countries. The scope of the conferences has also broadened as reflected by the following topic areas covered in these proceedings:

- o Seismic risk and hazard.
- o Ground motion and seismicity.
- o Soil stability, soil-structure interaction, and foundations.
- o Experimental methods and tests of structures and components.
- o Design of structures and structural components.
- o Special structures and critical facilities.
- o Response of structures.
- o Repair, strengthening, and retrofit of structures.
- o Urban design, socioeconomic issues, and public policy.
- o Lifelines--utility and transportation systems.
- o Non-structural systems and building contents.
- o Development and enforcement of seismic codes and standards.

There are more than 850 technical papers included in 7 hardbound volumes, with a total of 6,995 pages. These Proceedings are available from the Earthquake Engineering Research Institute, host organization for the Conference (see section "Data Sources"). The cost is $210 (U.S. dollars), which includes postage and handling, although EERI has had special sales.

Reference: Proceedings, Eighth World Conference on Earthquake Engineering, July 21-28, 1984, San Francisco, Calif., U.S.A.: Prentice-Hall, Inc., Englewood Cliffs, N.J.

AGRAM: A Series of Computer Programs for Processing Digitized Strong-Motion Accelerograms, Version 2.0

By A. Converse

This report describes the computer programs that are used by the U.S. Geological Survey for processing digitized strong-motion accelerograms. The report is primarily a user's guide for members of the USGS, but it will also inform organizations outside the USGS about the programs that have generated the data described in the strong-motion data reports published by the USGS.

The programs process strong-motion accelerograms that have been digitized by the automatic trace-following laser equipment at IOM/TOWILL Corporation. The contents of a tape written at the IOM/TOWILL digitizing facility are processed at the National Strong-Motion Data Center at the USGS offices in Menlo Park, California. First, the IOMTAP program is used to read the tape and translate its contents. Next, BUTTER rejoins separately digitized frames of an accelerogram into one continuous record. SCALE scales the data to represent time and acceleration rather than digitizer units. HIFRIC interpolates the data, applies an instrument correction, and filters high frequencies from the data. CORAVD integrates acceleration to obtain velocity and displacement and optionally performs a linear baseline correction or filters out long-period content. The FASPLT, PHASE3, and RSPECT programs perform spectral analyses of the CORAVD results.

The programs are still in the development process; many of the non-standard options they provide have yet to be evaluated and many other features intended for the programs have yet to be implemented. Many of the anticipated future modifications are mentioned in the report. With continued support and further development, however, the programs will evolve into a comprehensive series of relatively transportable FORTRAN77 computer programs available to any investigator who requires strong-motion data-processing software.

The FORTRAN code for all the AGRAM programs except the PHASE3 and RSPECT response spectra programs (they too may be available in the future) is available on magnetic tape. To acquire information about the most recent version of the code, telephone April Converse at the USGS offices in Menlo Park, California, (415) 323-8111, extension 2881, or mail a request to:

April Converse (AGRAM)
U.S. Geological Survey
Mail Stop 977
345 Middlefield Road
Menlo Park, CA 94025

This is version 2.0 of the report. The programs and report will continue to change as their development progresses. This version of the report will become outdated, just as the last version did, as the capabilities of the programs continue to expand.

Reference: U.S. Geological Survey Open-File Report 84-525, 98 p.

Report on Recommended List of Structures for Seismic Instrumentation in the San Francisco Bay Region

By M. Celebi, C. Arnold, V. Bertero, R. Borcherdt, G. Brady, J. Fedock, J. Gates, R. Maley, C. Mortgat, C. Rojahn, E. Safak, H. Shah, and E. Zacker

The moderate-sized Imperial Valley earthquake of October 15, 1979, represents a significant milestone in seismic engineering, in the sense that the shaking-induced failure of a modern engineered structure was accurately documented for the first time. Should a major earthquake recur along the San Andreas fault in either central or southern California, several typical structures could be expected to yield data of similar significance. However, very few non-typical structures are presently instrumented in the United States; should such an event occur, the opportunity to collect valuable information on many major engineered structures of substantial societal significance would be lost and would probably not recur for 50-100 years. Considering the significance of this issue for densely urbanized areas such as San Francisco and Los Angeles, an advisory committee was convened under the chairmanship of Dr. Celebi to develop a set of recommendations regarding the instrumentation of non-typical structures in the San Francisco Bay Region.

Reference: U.S. Geological Survey Open-File Report 84-488, 32 p.

National Planning Considerations for the Acquisition of Strong Ground-Motion Data

By R. Borcherdt, J. Anderson, C. Crouse, N. Donovan, T. McEvilly, and T. Shakal

Progress has been achieved on the long-term goal of developing an expanded network of strong-motion instrumentation to record adequately the next major earthquake. In spite of outstanding contributions by the National and California strong-motion instrumentation programs, this goal has not yet been reached, and its achievement within the next decade does not seem possible without a substantial increase in resources. Maintenance of the past level of progress with prospects of decreasing budgets and rising costs becomes a formidable challenge not only for the strong-motion instrumentation programs, but for all of the earthquake engineering and scientific communities.

The late Dr. R. B. Matthiesen, perceiving this challenge with the same keen insight with which he made innumerable and lasting contributions to the field of earthquake engineering, vigorously encouraged the development of a formalized framework for planning purposes. His contributions at the first meeting of the authors are clearly evident in the outline and scope of this document, as are his leading contributions to strong-motion programs throughout the United States.

Preliminary versions of this document were stimulated by efforts of the California Strong Ground-Motion/Instrumentation Subcommittee advisory to the California Strong Motion Instrumentation Committee (SMIC) of which the authors are members. SMIC, as an advisory committee of the California Seismic Safety Commission for the California Strong-Motion Instrumentation Program, sponsored the initial meetings.

The document represents a concerted effort by each of the authors who willingly prepared material and assumed responsibility for individual sections: seismological data needs; engineering data needs; lessons learned from the one-dimensional El Centro differential array; design considerations for dense arrays and instrumentation innovations; design considerations for downhole arrays; data management considerations; concepts pertinent to the framework for site selection; and additional sections.

Reference: Earthquake Engineering Research Institute Special Publication 84-08, 57 p.

Strong Ground Motion Simulation and Earthquake Engineering Applications A Technological Assessment

R. Scholl and J. King, editors

This report contains the proceedings of the Workshop on Strong Ground Motion Simulation and Engineering Applications conducted by the Earthquake Engineering Research Institute (EERI), with the support of Electric Power Research Institute, the National Science Foundation, the U.S. Nuclear Regulatory Commission, and the U.S. Geological Survey. The workshop was held April 30 - May 3, 1984, at the Jesuit Retreat House in Los Altos, California. The objective of the workshop was to review the state of knowledge of the strong ground motion simulation vis-a-vis engineering needs, and then to identify specific needs for strong-motion data acquisition and research in strong-motion modeling. The workshop consisted of six sessions of presentations, two sessions for working-group meetings, and a summary session.

A general conclusion of the workshop was that geologists, seismologists, and engineers must work together to develop ground-motion time histories for engineering design, and that the workshop was a step in this direction. Another conclusion of the workshop was that there is a great need for strong-motion data recorded close-in to a major earthquake (magnitude 7.5 or greater) by instruments located within structures, in the freefield near structures, and along soil-structure interfaces.

This report contains 31 papers that were presented at the workshop, including technical evaluations of research needs, and conclusions and recommendations.

Reference: Earthquake Engineering Research Institute Publication 85-02.

In-Situ Measurements of Seismic Velocity at 16 Locations in the Los Angeles, Caslifornia, Region

By T. Fumal, J. Gibbs, and E. Roth

Studies conducted in the San Francisco Bay region have shown that average shear-wave velocity can be related to quantitative estimates of ground motion such as amplification from nuclear explosions and earthquake intensity. Furthermore, when certain physical properties of the geologic materials such as texture, hardness, and fracture spacing are described during geologic mapping, a method can be used to predict shear-wave velocity from descriptions of geologic units. By measuring shear-wave velocities in representative geologic units, regional maps depicting the earthquake hazard can be compiled.

These studies are undertaken in the Los Angeles Basin and Oxnard-Ventura, California, areas. To date, shear and compressional waves have been measured in boreholes at 84 locations. Three previous reports summarized geologic and seismic data for sites 1-68; this report presents data for sites 69-84. At each location seismic travel times are measured in drill holes, normally at 2.5-m intervals to a depth of 30 m. Geologic logs are compiled from drill cuttings, undisturbed samples, and penetrometer samples. The data provide a detailed comparison of geologic and seismic characteristics and parameters for quantitatively estimating strong earthquake ground motions at each of the sites.

Reference: U.S. Geological Survey Open-File Report 84-681, 109 p.

Geotechnical Investigations at Strong-Motion Stations in the Imperial Valley, California

By R. Porcella

In the early 1970's the USGS began a program accumulating geotechnical and seismic data to be used in developing methods for estimating specific ground-response characteristics during strong local earthquakes. Recent site studies in the Los Angeles and San Francisco Bay regions indicate significant correlations exist between shear-wave velocity and various physical properties of the near-surface materials; these studies further suggest that these correlations can be used to define seismically distinct map units. The selection of specific locations for investigations has been based on sites where ground-motion data were recorded during earthquakes and, to a lesser extent, nuclear explosions, the availability of detailed geologic maps, and the distribution of intensity data from selected earthquakes.

This study involved investigations at most of the Imperial Valley, California, accelerograph stations, and was carried out because of the unique strong-motion data set recorded during the magnitude 6.5 earthquake of October 15, 1979. The project included the following investigations: (1) electronic cone-penetrometer soundings at nine stations; (2) drilling, sampling, and logging of 22 borings to depths of from about 30 to 244 m; (3) downhole P- and S-wave velocity surveys at 22 stations; (4) high-amplitude resonant column tests of undisturbed samples from several stations; and (5) numerous gamma, S-P, and resistivity logs and caliper and temperature measurements at selected stations. This study is one part of an ongoing USGS program to compile geotechnical data at selected locations in various regions and to use these data to make detailed comparisons of the geologic and seismic characteristics that will provide a means for quantitatively estimating strong ground motion at a given site and facilitate the development of seismic zonation techniques applicable to other regions.

This report focuses on results of the electronic cone-penetration tests and, in particular, the downhole velocity surveys. Results of other investigations undertaken as part of this project are discussed briefly and a reference regarding the availability of additional information or a report is given.

Reference: U.S. Geological Survey Open-File Report 84-562, 174 p.

Strong-Motion Data Recorded near Coalinga, California (May 2, 1983), and Processed Data from May 2 and May 9, 1983 (U.S. National Strong-Motion Network)

By R. Maley, E. Etheredge, D. Johnson, J. Switzer, P. Mork, and G. Brady

The $\underline{M}_L$ 6.7 Coalinga, California, earthquake on May 2, 1983, 2342 G.m.t., triggered 37 strong-motion accelerographs operated as part of the U.S. National Strong-Motion Network by the USGS. The two closest records were obtained at an epicentral distance of 9.2 km, from the Pleasant Valley Pumping Plant, a facility of the U.S. Bureau of Reclamation. The $\underline{M}_L$ 5.2 aftershock on May 9, 1983, 0249 G.m.t., triggered 12 USGS instruments, including four at the pumping plant and eight at aftershock stations, at epicentral distances ranging from 1.7 to 11.1 km. Copies of the records and computer plots showing corrected accelerations and response spectra from preliminary processing of the two main-shock records and 11 aftershock records are included in this report. Peak horizontal accelerations reached 0.54 $\underline{g}$ ($\underline{M}$ 6.7, $\underline{R}$ = 9.2 km) and 0.56 $\underline{g}$ ($\underline{M}$ 5.2, $\underline{R}$ = 1.7 km).

Reference: U.S. Geological Survey Open-File Report 84-626, 255 p.

Coalinga, California, Earthquake of May 2, 1983

R. Scholl and J. Stratta, editors

On Monday, May 2, 1983, at 4:42 p.m., P.d.t., an earthquake struck the town of Coalinga in California's San Joaquin Valley. A large aftershock followed slightly more than 3 minutes later. Although the main earthquake was of only moderate magnitude (6.7 on the Richter scale), ground motion was clearly perceptible 200 miles to the north and south, in San Francisco and Los Angeles. Because news releases in the early evening of May 2 indicated that substantial damage had occurred in the town, the Earthquake Engineering Research Institute (EERI) began coordinating the investigation of various aspects of the earthquake effects.

In general, EERI investigates all aspects of significant earthquakes throughout the world, including geology, seismology, engineering (geotechnical, structural, civil, mechanical, and electrical), architecture, urban planning, and social sciences. For earthquakes in California, however, EERI has a cooperative agreement with the California Division of Mines and Geology (CDMG), which assumes investigative responsibility for aftershock studies, strong-motion seismology, geology, and geophysics. In conjunction with CDMG, EERI establishes a clearinghouse to coordinate the activities of various investigators after any significant earthquake in California.

On Tuesday evening, May 3, at 7:30, a clearinghouse meeting was held for all investigators in the area at the time. Informal presentations on various topics, such as geology, seismology, locations and types of damage, were made. The discussions Tuesday evening proved to be informative and further underscored the need for clearinghouses for earthquakes affecting urban areas.

Because of the relatively short distance to Coalinga from both San Francisco and Los Angeles, many phone calls were received from EERI members expressing interest in investigating various aspects of the effects of the earthquakes. Because of those expressions of interest, the preliminary knowledge of the Coalinga earthquake effects, and the information still needed on earthquake damage and effects, several investigation teams were dispatched to the area.

Other organizations aided substantially in facilitating a comprehensive investigation of the Coalinga earthquake, including the U.S. Geological Survey, the American Society of Civil Engineers, the Structural Engineers Association of California, and others. This volume is a compilation of the reports from those teams, involving more than eighty individuals, and includes such varied topics as seismological and geological aspects; strong-motion records; geotechnical engineering; building performance, including performance of nonstructural components, lifelines, and industrial facilities; fires; injuries and emergency response; and urban planning aspects.

Reference: Earthquake Engineering Research Institute Report No. 84-03, 304 p.

The Morgan Hill, California, Earthquake of April 24, 1984 (A Preliminary Report)

S. Hoose, Compiler

A moderate earthquake (M 6.2) occurred on April 24, 1984 (21:15:19.0 G.m.t), near Morgan Hill, California. The earthquake ruptured a 30-km segment of the Calaveras fault to the east of San Jose, California, and caused approximately $7.5 million in damage primarily in the community of Morgan Hill. The event ruptured a segment of the fault previously recognized as a likely candidate for such an event and generated seismic radiation fields of substantial amplitude (1.29 *g*), in the direction of unilateral rupture to the southeast.

A variety of seismological, geological, geodetic, and geotechnical studies were undertaken by the U.S. Geological Survey immediately after the main event. This report provides a preliminary summary of findings as of June 12, 1984.

This report is intended to facilitate and assist in more thorough studies of data collected for this event as well as suggest a format for future preliminary reports for similar events. Results presented herein are intended for presentation first as an Open-File Report in order to expedite publication, and subsequently as a Circular.

Reference: U.S. Geological Survey Open-File Report 84-498A and 84-498B, 148 p., 1 pl. and 118 p.

The 1984 Morgan Hill, California, Earthquake

J. Bennett and R. Sherburne, editors

The Morgan Hill earthquake (M_L 6.2) occurred at 1:15 p.m. (P.s.t.) on April 24, 1984, the consequence of sudden rupture along a 30-km segment of the historically active Calaveras fault. This moderate earthquake---

- o was the third damaging earthquake ($\underline{M} \geq 6$) to strike the San Francisco Bay region since 1979 and the largest event in the region since 1911.
- o caused damage estimated at about $8 million, but no loss of life or serious injury.
- o produced many significant records of ground and structural shaking, including an unprecedented 1.29 g horizontal ground acceleration.
- o produced no evidence of premonitory activity and little, if any, surface rupture.
- o evidenced directivity of earthquake energy release (focusing).

It was immediately apparent that subsequent studies of this earthquake would add significantly to our understanding of various earthquake related concerns. These include the response of modern structures to earthquake motion, the efficacy of building codes, the effects of local geology and topography on seismic motion, the extent to which the source rupture may focus energy, the pattern of seismicity in the region, and the adequacy of emergency response procedures.

In undertaking this publication, our intention was to encourage timely and formal documentation of the observations and conclusions of the principal investigators, information that, in some cases, might be generally unavailable or undocumented and lost to future investigators. Significant earthquakes are relatively infrequent and, generally, very costly learning experiences. It is essential that the knowledge gained and lessons learned be recorded and communicated.

The 24 papers compiled in this publication represent the efforts of some 56 investigators representing 21 organizations. Included among the authors are engineers, scientists, emergency-response officials, and others in government, the universities, utilities, and consulting firms. The papers are presented in four sections: earthquake damage, emergency response, geologic and geophysical investigations, and seismological investigations.

Reference: California Division of Mines and Geology Special Publication 68, 271 p.

AVAILABILITY OF STRONG-MOTION DATA

U.S. GEOLOGICAL SURVEY DATA

The TYMNET telephone link to the SMIRS database has been discontinued. SMIRS and the computer on which it resided was shut down on April 1, 1986. The SMIRS information will be transferred to a new database named ESM that will be installed on one of the USGS computers in Menlo Park. This database will not be accessible by telephone for the near future, so users outside the USGS must either mail their requests for database information to us or visit us. Mail your requests to:

Chuck Mueller (ESM inquiry)
US Geological Survey, Mailstop 977
345 Middlefield Road
Menlo Park, CA 94025
(415) 323-8111 Ext. 2989

ESM will be fully operational at this first level by July 1986.

A user's guide for the ESM database will be available in July. If you would like a copy, request one from the above address. Although you cannot access the ESM database yourself unless you visit our offices, the guide will let you know what sorts of requests can be made and what information is available. The ESM database will have a significantly different structure than the SMIRS database, and the ESM support software will permit a larger variety of queries than did the SMIRS software.

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 have been processed, among others:

Santa Barbara earthquake of August 13, 1978

Station	Channels
UCSB Goleta	3
UCSB North Hall	9
Freitas Building	9

Imperial Valley earthquake of October 15, 1979

Station	Channels
El Centro free-field	3
Imperial County Services Building	13

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 the 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 originals 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 SMIRS 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), U.S. National Oceanic and Atmospheric Administration (NOAA). 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 (x12 reduction) and on 70-mm film chips (approx. x8 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.

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 (1933-71) 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 punched cards containing 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. Branch of Distribution (303) 236-7476
   Books and Open-File
   Reports Section
   U. S. Geological Survey
   Federal Center, Box 25425
   Denver, CO 80225

2. Earthquake Engineering (415) 525-3668
   Research Institute
   6431 Fairmont Ave., Suite 7
   El Cerrito, CA 94530

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

4. National Technical (703) 487-4650
   Information Service
   5285 Port Royal Rd.
   U.S. Dept. of Commerce
   Springfield, VA 22161

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

6. National Strong-Motion (415) 323-8111 ext. 2881
   Program
   U.S. Geological Survey
   345 Middlefield Rd., MS 977
   Menlo Park, CA 94025

Table 1.--*Summary of USGS accelerograph records recovered during 1984*

[Station owners: ACOE, U.S. Army Corps of Engineers; CDOT, California Department of Transportation; CDWR, California Department of Water Resources; CHY, City of Hayward; UCB, University of California at Berkeley; USBR, U.S. Bureau of Reclamation; USGS, U.S. Geological Survey; VA, U.S. 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 of 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 orthogonal horizontal 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)
3 January 1984 1051 G.m.t. Central Calif. Epicenter and magnitude unknown	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	5.3	(2)		(1)	
23 January 1984 0540:19.7 G.m.t. Central Calif. 36.373N, 121.907W Magnitude 5.4 ML	Bear Valley Station 6 James Ranch (USGS)	36.504°N 121.101°W	43.6	(2)		(1)	
	Bear Valley Station 14 Upper Butts Ranch (USGS)	36.569°N 121.043°W	45.9	(2)		(1)	
27 January 1984 0444:35.8 G.m.t. Central Calif. 36.277N, 120.400W Magnitude 3.7 ML	Coalinga Oil City (USGS)	36.229°N 120.360°W	37.1	1.6		(1)	
10 April 1983- 14 February 1984 North Dakota Epicenter and magnitude unknown	Garrison Dam (ACOE)	47.50° N 101.43° W	(2)	(2)			
	Crest					(1)	
19 February 1984 0943:10.8 G.m.t. Central Calif. 36.285N, 120.317W Magnitude 4.1 ML	Coalinga Burnett Company (USGS)	36.138°N 120.357°W	(2)	3.1		(1)	
	Coalinga Oil City (USGS)	36.229°N 120.360°W	12.4	2.0	360° Up 270°	.18 .05 .20	0.3 --- 0.1
20 February 1984 1617:25.5 G.m.t. Western Idaho 44.432N, 114.194W Magnitude 3.6 ML	Dickey, Idaho Hatch Ranch (USGS)	44.338°N 114.051°W	29	1.2		(1)	
23 February 1984 0959 G.m.t. Central Calif. Epicenter and magnitude unknown	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	31.3	.8		(1)	

Table 1.--*Summary of USGS accelerograph records recovered during 1984*--Continued

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
31 July 1983- 26 February 1984 Eastern Calif. Epicenter and magnitude unknown	Long Valley Dam Lake Crowley (USGS)	37.588°N 118.705°W	(2)	(2)			
	Left abutment					(1)	
29 February 1984 0207:31.7 G.m.t. Southern Calif. 33.140N, 116.070W Magnitude 4.3 ML	Ocotillo Wells Burro Bend Cafe (USGS)	33.140°N 116.130°W	33.7	1.4		(1)	
2 March 1984 0029:45.1 G.m.t. Western Idaho 44.350N, 114.186W Magnitude 4.3 ML	Dickey, Idaho Hatch Ranch (USGS)	44.338°N 114.051°W	48	(2)		(1)	
6 May 1983- 7 March 1984 Central Calif. Epicenter and magnitude unknown	Hollister Damler Residence (UCB)	36.81° N 121.41° W	(2)	2.6	118° Up 028°	.05 .02 .05	--- --- ---
26 March 1984 0758:39.7 G.m.t. Central Calif. 36.740N, 121.507W Magnitude 4.0 ML	San Justo Damsite (USBR)	36.827°N 121.445°W					
	Left abutment		44.9	(2)		(1)	
	Right abutment (Dike)		45.2	(2)		(1)	
27 March 1984 0336:35.6 G.m.t. Central Calif. 37.727N, 122.130W Magnitude 4.4 ML	Hayward City Hall (CHY)[3]	37.68° N 122.08° W	(2)	(2)			
	Basement					(1)	
	Ground floor					(1)	
	11th floor					(1)	
30 March 1984 1021 G.m.t. Hawaii Epicenter and magnitude unknown	Honokaa Fire Station (USGS)	20.080°N 155.465°W	30	(2)		(1)	
31 March 1984 0112:56.4 G.m.t. Western Idaho 44.326N, 114.144W Magnitude 3.3 ML	Dickey, Idaho Hatch Ranch (USGS)	44.338°N 114.051°W	59	(2)		(1)	

Table 1.--*Summary of USGS accelerograph records recovered during 1984*--Continued

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
8 April 1984 Time unknown Central Calif. Epicenter and magnitude unknown	Coalinga Oil City (USGS)	36.229°N 120.360°W	14.5	1.8		(1)	
10 April 1984 1812:11.5 G.m.t. Central Calif. 36.250N, 120.222W Magnitude 3.4 ML	Coalinga Oil City (USGS)	36.229°N 120.360°W	17	(2)		(1)	
18 April 1984 0115:09.4 G.m.t. Western Idaho 44.342N, 114.099W Magnitude 4.0 ML	Dickey, Idaho Hatch Ranch (USGS)	44.338°N 114.051°W	(2)	(2)		(1)	
23 April 1984 2142 G.m.t. Idaho Epicenter and magnitude unknown	Dickey, Idaho Smith Ranch (USGS)	44.134°N 113.901°W	2	1.2		(1)	
24 April 1984 0452:51.5 G.m.t. Central Calif. 36.163N, 120.287W Magnitude 4.0 ML	Coalinga Burnett Company (USGS)	36.138°N 120.357°W	54	2.3		(1)	
	Coalinga Oil City (USGS)	36.229°N 120.360°W	57	(2)		(1)	
24 April 1984 2115:19.0 G.m.t. Central Calif. 37.320N, 121.698W Magnitude 6.2 ML	Anderson Dam (USGS)						
	Crest	37.166°N 121.626°W	23	(2)	340° Up 250°	.39 .20 .63	8.7 3.3 7.8
	Downstream	37.165°N 121.631°W	(2)	(2)	340° Up 250°	.30 .20 .40	4.0 5.2 4.4
	Bear Valley Station 1 Fire Station (USGS)[3]	36.573°N 121.184°W	(2)	(2)		(1)	
	Bear Valley Station 2 Stone Canyon West (USGS)	36.636°N 121.234°W	36.1	(2)		(1)	
	Bear Valley Station 5 Callens Ranch (USGS)	36.673°N 121.195°W	35.3	(2)		(1)	

Table 1.--*Summary of USGS accelerograph records recovered during 1984*--Continued

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
24 April 1983 2115:19.0 G.m.t. -continued-	Bear Valley Station 6 James Ranch (USGS)	36.504°N 121.101°W	40.5	(2)		(1)	
	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	41.2	(2)		(1)	
	Bear Valley Station 12 Williams Ranch (USGS)	36.658°N 121.249°W	34.7	(2)	310° Up 220°	.06 .14 .04	--- 0.6 ---
	Bear Valley Station 14 Upper Butts Ranch (USGS)[3]	36.569°N 120.043°W	(2)	(2)		(1)	
	Dos Amigos Pumping Plant (CDWR)[3]	36.92° N 120.83° W	(2)	9.6			
	Level 1					(1)	
	Hollister City Hall Annex (USGS)	36.85° N 121.40° W	(2)	(2)			
	Basement				360° Up 270°	.08 .42 .08	--- 1.3 ---
	Hollister Differential Array (USGS)	36.888°N 121.413°W					
	Freefield		29.2	(2)	255° Up 165°	.09 .22 .09	--- 2.0 ---
	Station 1		(2)	(2)	255° Up 345°	.09 .21 .09	--- 2.1 ---
	Station 3		(2)	(2)	255° Up 345°	.08 .24 .08	--- 2.2 ---
	Station 4		(2)	(2)	255° Up 345°	.10 .28 .10	1 peak 2.1 1 peak
	Station 5		(2)	(2)	255° Up 345°	.08 .25 .10	--- 2.1 1 peak

Table 1.--*Summary of USGS accelerograph records recovered during 1984*--Continued

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
24 April 1984 2115:19.0 G.m.t. -continued-	Hollister Damler Residence (UCB)[3]	36.81° N 121.41° W	(2)	(2)	118°	.08	---
					Up	.08	---
					028°	.06	---
	Note: One additional record[1] recovered at Damler Residence.						
	Livermore VA Hospital Building 62 (VA)[3]	37.62° N 121.76° W	(2)	(2)			
	Basement					(1)	
	Roof					(1)	
	Palo Alto VA Hospital (VA)	37.40° N 122.14° W	(2)	(2)			
	Basement					(1)	
	Roof (7th level)					(1)	
	San Jose Interchange Freeways 101/680/280 (USGS/CDOT)	37.340°N 121.851°W	(2)	(2)	322°	.12	4-peaks
					Up	.08	---
					232°	.08	---
	San Justo Damsite (USBR)						
	Right abutment (dike)	36.827°N 121.445°W	31.0	(2)	360°	.06	---
					Up	.06	---
					270°	.08	---
	Left abutment	36.815°N 121.447°W	31.5	(2)	360°	.07	---
					Up	.03	---
					270°	.08	---
	San Francisco Transamerica Tower (USGS)[3]	37.80° N 122.40° W	(2)	(2)			
	Basement					(1)	
	24th floor					(1)	
	49th floor					(1)	
	58th level				261°	.10	1-peak
					Up	.04	---
					171°	.08	---
	San Francisco Standard Oil, SMA-1 (USGS)[3]	37.79° N 122.40° W	(2)	(2)			
	Basement					(1)	

Table 1.--*Summary of USGS accelerograph records recovered during 1984*--Continued

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
24 April 1984 2115:19.0 G.m.t. -continued-	San Francisco Standard Oil, CRA-1 (USGS)[3]	37.79°N 122.40°W	(2)	(2)			
	41st floor (NW end) channel (1)				045°	(1)	
	41st floor (center) channel (2)				225°	(1)	
	41st floor (center) channel (3)				135°	(1)	
	33rd floor (NW end) channel (4)				045°	(1)	
	33rd floor (center) channel (5)				225°	(1)	
	33rd floor (center) channel (6)				135°	(1)	
	24th floor (NW end) channel (7)				045°	(1)	
	24th floor (center) channel (8)				225°	(1)	
	24th floor (center) channel (9)				135°	(1)	
	1st basement (center) channel (10)				045°	(1)	
	1st basement (center) channel (11)				315°	(1)	
	Stanford University Quadrangle (USGS)[3]	37.429°N 122.169°W	(2)	(2)		(1)	
	Stanford University Survey Hill (USGS)	37.417°N 122.198°W	(2)	(2)		(1)	
	Stanford University Test Laboratory (USGS)	37.419°N 122.205°W	(2)	(2)		(1)	
26 April 1984 0042:26.6 G.m.t. Central Calif. 37.140N, 121.580W	Anderson Lake Cochrane Bridge (USGS)	37.152°N 121.583°W	(2)	(2)			
Magnitude 3.9 ML	Abutment				360° Up 270°	.05 .03 .05	--- --- ---

Table 1.--*Summary of USGS accelerograph records recovered during 1984*--Continued

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
26 April 1984	Anderson Lake	37.152°N	(2)	(2)			
0629:51.9 G.m.t.	Cochrane Bridge	121.583°W					
Central Calif.	(USGS)						
37.138N, 121.570W							
Magnitude 4.0 ML	Abutment				360°	.02	---
					Up	.03	---
					270°	.05	---
29 April 1984	Anderson Lake	37.152°N	(2)	(2)			
2358:20.2 G.m.t.	Cochrane Bridge	121.583°W					
Central Calif.	(USGS)						
37.142N, 121.572W							
Magnitude 3.2 ML	Abutment					(1)	
7 March 1984 -	Hollister	37.76° N	(2)	(2)		(1)	
8 May 1984	Vault	121.45° W					
Central Calif.	(UCB)						
Epicenter and							
magnitude unknown							
8 May 1984	Coalinga	36.138°N	16	2.2	360°	.06	---
1921:14.0 G.m.t.	Burnett Company	120.357°W			Up	.01	---
Central Calif.	(USGS)				270°	.05	---
36.168N, 120.297W							
Magnitude 4.1 ML	Coalinga	36.229°N	18.6	.2	360°	.12	0.2
	Oil City	120.360°W			Up	.03	---
	(USGS)				270°	.11	1-peak
17 May 1984	Anderson Lake	37.152°N	(2)	(2)			
0843:03.6 G.m.t.	Cochrane Bridge	121.583°W					
Central Calif.	(USGS)[3]						
37.298N, 121.688W							
Magnitude 3.6 ML	Abutment					(1)	
23 September 1983-	Talkeetna	62.30° N	(2)	10		(1)	
7 June 1984	FAA-VOR	150.10° W					
Alaska	(USGS)						
Epicenter and							
magnitude unknown	Note: One additional record[1] recovered at Talkeetna.						
1 February 1984-	Bradbury Dam	34.59° N					
19 June 1984	(USBR)	119.98° W					
Southern Calif.							
Epicenter and	Toe		(2)	1.9		(1)	
magnitude unknown							
	Crest		(2)	1.9		(1)	
24 June 1984	Dickey, Idaho	44.338°N	12	(2)		(1)	
1708 G.m.t.	Hatch Ranch	114.051°W					
Idaho	(USGS)						
Epicenter and							
magnitude unknown							

Table 1.--*Summary of USGS accelerograph records recovered during 1984*--Continued

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
7 July 1984 0725:05.2 G.m.t. Central Calif. 37.165N, 121.682W Magnitude 3.3 ML	Anderson Dam (USGS)	37.166°N 121.626°W	7.2	(2)			
	Crest					(1)	
13 August 1983- 19 July 1984 Alaska Epicenter and magnitude unknown	Cordova Airport FAA Flight Service (USGS)	60.48° N 145.40° W	(2)	(2)		(1)	
6 August 1984 0814:36.5 G.m.t. Southern Calif. 33.980N, 116.710W Magnitude 4.3 ML	Cabazon Post Office (USGS)	33.72° N 116.78° W	42	(2)		(1)	
	Morongo Valley Fire Station (USGS)	34.05° N 116.58° W	40.3	2.8		(1)	
	North Palm Springs Post Office (USGS)	33.92° N 116.54° W	40.6	3.2		(1)	
	Whitewater Canyon Trout Farm (USGS)	33.99° N 116.66° W	39.3	2.1	270° Up 180°	.03 .08 .03	--- --- ---
14 August 1984 0102:08.4 G.m.t. Southern Alaska 61.857N, 149.104W Magnitude 5.7 ML	Anchorage Arctic Road Ski Lodge (USGS)	61.013°N 148.015°W	22	7.3		(1)	
22 August 1984 0946:30.2 G.m.t. Western Idaho 44.467N, 114.008W Magnitude 5.8 ML	Dickey, Idaho Hatch Ranch (USGS)	44.338°N 114.051°W	34	1.3	360° Up 270°	.33 .19 .16	2.5 4-peaks 1.2
	Dickey, Idaho Smith Ranch (USGS)	44.134°N 113.901°W	42	(2)		(1)	
22 August 1984 1052:01.1 G.m.t. Western Idaho 44.48N, 114.20W Magnitude 4.0 ML	Dickey, Idaho Hatch Ranch (USGS)	44.338°N 114.051°W	5	1.3	360° Up 270°	.07 .02 .06	--- --- ---
23 August 1984 1321:53.0 G.m.t. Western Idaho 44.462N, 114.137W Magnitude 3.8 ML	Dickey, Idaho Hatch Ranch (USGS)	44.338°N 114.051°W	57	(2)		(1)	

Table 1.--*Summary of USGS accelerograph records recovered during 1984*--Continued

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
30 August 1984 2106:20.7 G.m.t. Western Idaho 44.455N, 114.154W Magnitude 3.9 ML	Dickey, Idaho Hatch Ranch (USGS)	44.338°N 114.051°W	25	(2)		(1)	
8 September 1984 0616:40.1 G.m.t. Western Idaho 44.439N, 114.154W Magnitude 5.0 MB	Dickey, Idaho Hatch Ranch (USGS)	44.338°N 114.051°W	43	1.8	360° Up 270°	.09 .03 .06	--- --- ---
8 September 1984 1356:37.7 G.m.t. Western Idaho 44.416N, 114.147W Magnitude 4.4 MB	Dickey, Idaho Hatch Ranch (USGS)	44.338°N 114.051°W	41	1.6		(1)	
31 May 1984- 11 September 1984 Alaska Epicenter and magnitude unknown	Anchorage USGS Building (USGS)	61.223°N 149.892°W	(2)	(2)			
	Basement					(1)	
18 September 1984 1509:58.0 G.m.t. Western Idaho 44.408N, 114.124W Magnitude 4.0 ML	Dickey, Idaho Hatch Ranch (USGS)	44.338°N 114.051°W	1	1.0		(1)	
19 September 1984 1533:22.6 G.m.t. Western Idaho 44.334N, 114.205W Magnitude 3.5 ML	Dickey, Idaho Hatch Ranch (USGS)	44.338°N 114.051°W	26	1.2		(1)	
5 October 1984 1616:30.0 G.m.t. Central Calif. 36.573N, 121.203W Magnitude 4.0 ML	Bear Valley Station 1 Fire Station (USGS)	36.573°N 121.184°W	33.3	(2)		(1)	
	Bear Valley Station 6 James Ranch (USGS)	36.504°N 121.101°W	32.9	2.1		(1)	
	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	32.2	1.5	310° Up 220°	.07 .01 .09	--- --- ---
	Bear Valley Station 14 Upper Butts Ranch (USGS)	36.569°N 121.043°W	33.6	2.5	310° Up 220°	.04 .04 .06	--- --- ---

Table 1.--*Summary of USGS accelerograph records recovered during 1984*--Continued

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
22 October 1984 0406:31.4 G.m.t. Central Calif. 36.582N, 121.235W Magnitude 3.7 ML	Bear Valley Station 1 Fire Station (USGS)	36.573°N 121.184°W	33.3	1.2	310° Up 220°	.07 .02 .05	--- --- ---
	Bear Valley Station 6 James Ranch (USGS)	36.504°N 121.101°W	34.6	2.5		(1)	
	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	33.9	1.8	310° Up 220°	.07 .04 .09	--- --- ---
	Bear Valley Station 14 Upper Butts Ranch (USGS)	36.569°N 121.043°W	35.3	3.1		(1)	
4 November 1984 1120:19.7 G.m.t. Central Calif. 36.553N, 121.172W Magnitude 3.1 ML	Bear Valley Station 1 Fire Station (USGS)	36.573°N 121.184°W	20.7	.8	310° Up 220°	.04 .02 .05	--- --- ---
	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	20.9	1.1		(1)	
11 November 1984 0405 G.m.t. Central Calif. Epicenter and magnitude unknown	Bear Valley Station 10 Webb Residence (USGS)	36.532°N 121.143°W	21.9	.9	310° Up 220°	.05 .05 .06	--- --- ---
22 November 1984 2359:08.4 G.m.t. Central Calif. 36.563N, 121.198W Magnitude 3.2 ML	Bear Valley Station 10 Webb Residence (USGS)[3]	36.532°N 121.143°W	10.1	1.3		(1)	
23 November 1984 1808:25.3 G.m.t. Eastern Calif. 37.480N, 118.655W Magnitude 6.1 ML	Buchanan Dam (ACOE)	37.22° N 119.98° W	47.6	13.7			
	Left crest					(1)	
	Hidden Dam (ACOE)	37.112°N 119.883°W	.3	(2)			
	Left crest					(1)	
	McGee Creek (USGS)	37.550°N 118.811°W	30	2.9			
	166-m downhole					(1)	
	35-m downhole					(1)	
	Surface				360° Up 270°	.11 .09 .10	0.3 --- 0.2

Table 1.--*Summary of USGS accelerograph records recovered during 1984*--Continued

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
23 November 1984 1808:25.3 G.m.t. -continued-	Terminus Dam Main dam (ACOE)						
	Slope	36.417°N 119.003°W	(2)	(2)		(1)	
	Right crest	36.418°N 119.003°W	(2)	(2)		(1)	
	Upper tower	36.414°N 119.002°W	(2)	(2)		(1)	
23 November 1984 1809 G.m.t. Eastern Calif. Epicenter and magnitude unknown	McGee Creek (USGS)	37.550°N 118.811°W	4	(2.9)			
	166-m downhole					(1)	
	35-m downhole					(1)	
	Surface					(1)	
23 November 1984 1912:34.5 G.m.t. Eastern Calif. 37.435N, 118.641W Magnitude 5.5 ML	McGee Creek (USGS)	37.550°N 118.811°W	40.1	2.1			
	166-m downhole					(1)	
	35-m downhole					(1)	
	Surface				360° Up 270°	.12 .11 .09	0.6 0.4 ---
	Terminus Dam Main dam (ACOE)						
	Slope	36.417°N 119.003°W	(2)	(2)		(1)	
	Right crest	36.418°N 119.003°W	(2)	(2)		(1)	
	Upper tower	36.414°N 119.002°W	(2)	(2)		(1)	
23 November 1984 1927:59.2 G.m.t. Eastern Calif. 37.430N, 118.630W Magnitude 3.4 ML	McGee Creek (USGS)	37.550°N 118.811°W	5.8	(2)			
	166-m downhole					(1)	
	35-m downhole					(1)	
	Surface					(1)	

Table 1.--*Summary of USGS accelerograph records recovered during 1984*--Continued

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
24 November 1984 0921:17.7 G.m.t. Eastern Calif. 37.489N, 118.626W Magnitude 4.2 ML	McGee Creek (USGS)	37.550°N 118.811°W	24.5	(2)			
	166-m downhole					(1)	
	35-m downhole					(1)	
	Surface					(1)	
24 November 1984 1400:49.3 G.m.t. Eastern Calif. 37.531N, 118.861W Magnitude 3.3 ML	McGee Creek (USGS)	37.550°N 118.811°W	53.1	(2)			
	166-m downhole					(1)	
	35-m downhole					(1)	
	Surface					(1)	
24 November 1984 2025:33.2 G.m.t. Eastern Calif. 37.458N, 118.663W Magnitude 4.0 ML	McGee Creek (USGS)	37.550°N 118.811°W	39.7	(2)			
	166-m downhole					(1)	
	35-m downhole					(1)	
	Surface					(1)	
25 November 1984 2310:09.5 G.m.t. Eastern Calif. 37.450N, 118.620W Magnitude 4.8 ML	McGee Creek (USGS)	37.550°N 118.811°W	16.1	(2)			
	166-m downhole					(1)	
	35-m downhole					(1)	
	Surface					(1)	
26 November 1984 1621:47.0 G.m.t. Eastern Calif. 37.467N, 118.700W Magnitude 5.6 ML	McGee Creek (USGS)	37.550°N 118.811°W	50.7	2.3			
	166-m downhole					(1)	
	35-m downhole					(1)	
	Surface					(1)	
26 November 1984 1631:21.4 G.m.t. Eastern Calif. 37.445N, 118.702W Magnitude 4.5 ML	McGee Creek (USGS)	37.550°N 118.811°W	27.1	(2)			
	166-m downhole					(1)	
	35-m downhole					(1)	
	Surface					(1)	

Table 1.--*Summary of USGS accelerograph records recovered during 1984*--Continued

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
27 November 1984 0141:52.2 G.m.t. Eastern Calif. 37.459N, 118.680W Magnitude 4.4 ML	McGee Creek (USGS)	37.550°N 118.811°W	58.2	(2)			
	166-m downhole					(1)	
	35-m downhole					(1)	
	Surface					(1)	
26 February 1984- 28 November 1984 Eastern Calif. Epicenters and magnitudes unknown	Long Valley Dam Lake Crowley (USGS)	37.588°N 118.705°W					
	Left Abutment						
			(2)	(2)	275° Up 185°	.06 .06 .08	--- --- ---
			(2)	2.2	275° Up 185°	.03 .03 .06	--- --- ---
			(2)	(2)	275° Up 185°	.01 .06 .02	--- --- ---
	Note: Three additional records[1] recovered at Long Valley Dam, left abutment.						
29 November 1984 1042:28.0 G.m.t. Eastern Calif. 37.420N, 118.650W Magnitude 3.7 ML	McGee Creek (USGS)	37.550°N 118.811°W	35.3	(2)			
	166-m downhole					(1)	
	35-m downhole					(1)	
	Surface					(1)	
29 November 1984 1045:40.4 G.m.t. Eastern Calif. 37.420N, 118.650W Magnitude 3.5 ML	McGee Creek (USGS)	37.550°N 118.811°W	44.6	(2)			
	166-m downhole					(1)	
	35-m downhole					(1)	
	Surface					(1)	

Table 1.--*Summary of USGS accelerograph records recovered during 1984*--Continued

Earthquake	Station name (owner)	Station location	Trigger time	S-minus trigger (s)	Direction (az)	Maximum amplitude (g)	Duration (s)
21 December 1984 1239:04.4 G.m.t. Central Calif. 36.508N, 121.113W	Bear Valley Station 6 James Ranch (USGS)	36.504°N 121.101°W	6.1	1.4		(1)	
Magnitude 3.0 ML	Bear Valley Station 10 Webb Residence (USGS)[3]	36.532°N 121.143°W	6.1	.7		(1)	

[1]Less than 0.05 g at ground-level or less than 0.10 g at non-ground-level stations.

[2]Questionable or undeterminable.

[3]WWVB time code illegible, or instrument not equipped with a radio receiver; correlation of accelerogram with event may be questionable.

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