C. 818-A

GEOLOGICAL SURVEY CIRCULAR 818-A

Seismic Engineering Program Report

January - April 1979

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

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United States Department of the Interior
CECIL D. ANDRUS, *Secretary*

Geological Survey
H. William Menard, *Director*

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PREFACE

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

This issue contains a summary of the accelerograms recovered from the U.S. Geological Survey's (USGS) National Strong-Motion Network during the period January 1 through April 30, 1979. A report on strong-motion instrumentation in the Imperial Valley, California, is presented along with summaries of recent reports, notes on strong-motion information sources and the availability of digitized data, and additional information pertinent to the USGS and other strong-motion programs. The data summary presented in table 1 includes those accelerograms recovered (although not necessarily recorded) during the period January through April 1979; this procedure will be continued in future issues so that the dissemination of strong-motion information may be as expeditious and current as practicable.

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Menlo Park, California 94025

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Seismic Engineering Program Report
January - April 1979

RECENT STRONG-MOTION RECORDS

by R. L. Porcella

A magnitude 7.7 (M_S) earthquake occurred on February 28, 1979 (1127 local time) approximately 75 km north of Icy Bay, Alaska. The hypocenter was located at a depth of about 15 km (± 10) in the vicinity of the St. Elias Mountains in southeastern Alaska (Lahr and others, 1979), which is a highly faulted and tectonically very complex region. Strong-motion accelerograph records were recovered at the U.S. Geological Survey's Icy Bay station, Shell Oil Company's Munday Creek station, and Lamont-Doherty Geological Observatory's Yakutat station; maximum recorded ground accelerations and the corresponding epicentral distances were 0.16 g (73 km) at Icy Bay, 0.06 g (92 km) at Munday Creek, and 0.09 g (161 km) at Yakutat (table 1). These stations are part of an informal Alaska strong-motion network operated by the U.S. Geological Survey, Lamont-Doherty Geological Observatory, the University of Alaska, and Shell Oil Company (see fig. 1); additional accelerographs within this network that did not trigger include Cape Yakataga, Kayak Island, and Cordova at epicentral distances of 79 km, 200 km, and 214 km, respectively. The Icy Bay and Yakutat accelerograms (fig. 2 and 3), and the Munday Creek records have been digitized; information about their corrected accelerations, velocities, and displacements and velocity response spectra is available from the U.S Geological Survey.*

The magnitude 4.6 (M_L) southern California earthquake of January 1, 1979 (1614 local time) was located in Santa Monica Bay at a depth of about 6 km; slight damage (MMI VI) was reported in Canoga Park, Sherman Oaks, Woodland Hills, Los Angeles, and El Segundo (Waverly Person, oral commun., June 20, 1979). Twenty-three accelerograms were recovered at strong-motion stations in the Los Angeles and San Fernando Valley areas; eight of these contain peak accelerations greater than five percent g (table 1). The peak horizontal ground acceleration (0.09 g) was recorded at the Topanga Fire Station at an epicentral distance of about 20 km. Additional records were recovered at 11 accelerograph sites maintained by the State of California Strong-Motion Program and located from Ventura south to Santa Catalina Island and east to Irvine (Rich McJunkin, oral commun. March 21, 1979).

Other earthquakes that produced accelerograph records recovered during this reporting period include those near the southern coast of Hawaii; east of Seattle, Washington; north of Lake Tahoe, California; and five events in the San Bernardino-San Jacinto mountains region of southern California (table 1). Event information listed in table 1 was taken primarily from the Preliminary Determination of Epicenters, published by the U.S. Geological Survey.

A total of 44 accelerograms was recovered from the U.S. Geological Survey's Strong-Motion Network during the period January through April, 1979; this national network is supported by the National Science Foundation and was made possible through the cooperation of both private industry and educational institutions as well as numerous Federal, State, and local agencies and organizations. The major objective of this program is to record both strong ground motion and the response of various types of engineered structures during potentially damaging earthquakes and to disseminate these data to the international community involved in earthquake engineering research and design.

Reference: Lahr, J., Plafker, G., Stephens, C., Fogleman, K., and Blackford, M., 1979, Interim report on the St. Elias, Alaska earthquake of 28 February 1979: U.S. Geological Survey Open-File Report 79-670, 35 p.

*The Munday Creek records were made available to the USGS by the Shell Oil Company on an "as is" basis. In making them available as a part of the data obtained from the February 28 event, the USGS is satisfied that the accuracy of the data is comparable to that obtained at other stations.

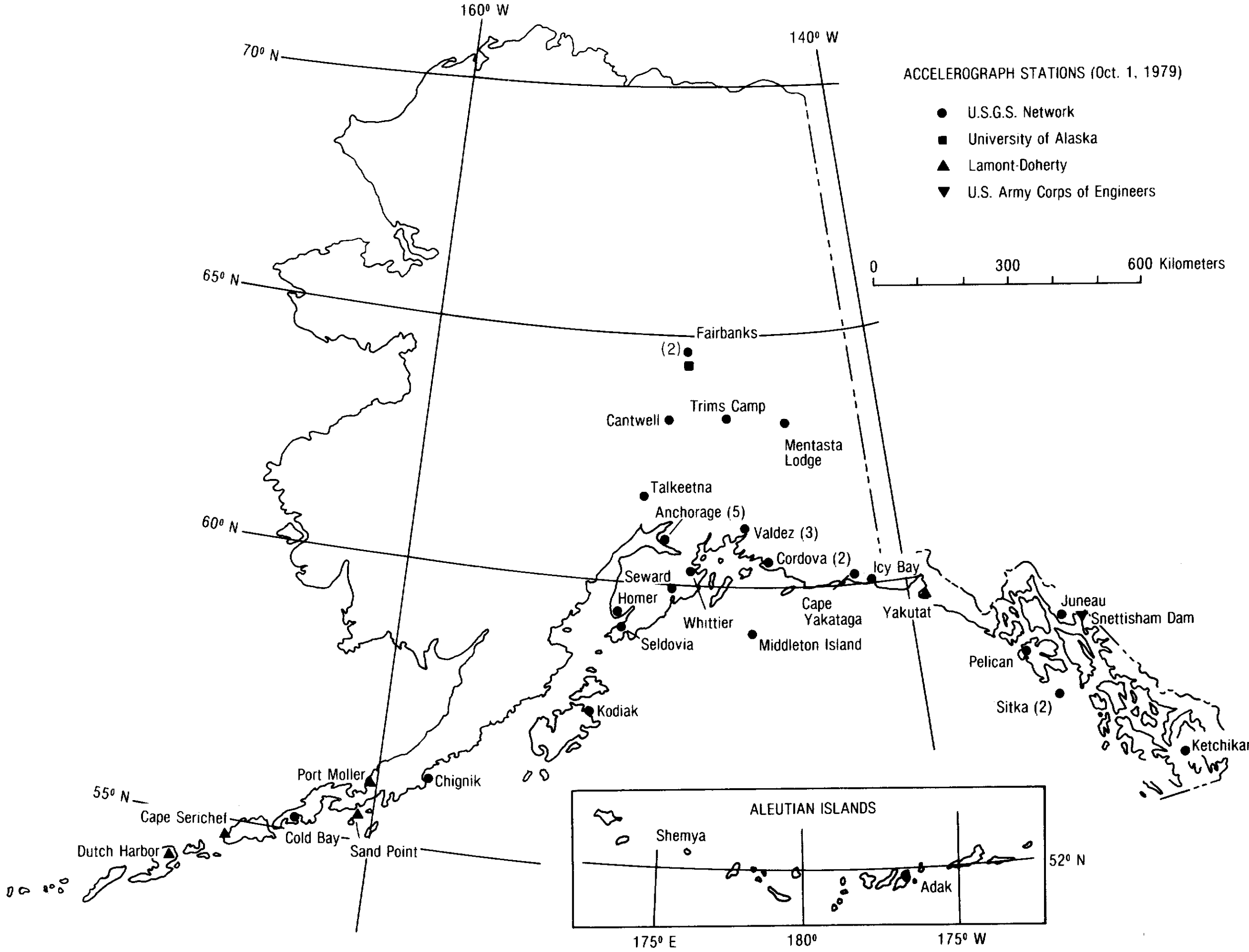

FIGURE 1. - ACCELEROGRAPH STATIONS IN ALASKA, NUMBERS IN PARENTHESIS ARE THE TOTAL ACCELEROGRAPH STATIONS AT THE INDICATED LOCALITY.

U.S. STRONG-MOTION NETWORK

Station No. 2728 59.51N, 139.63W

Yakatat, FAA-VOR Bldg.

SMA-1 No. 326 (LDGO) Ground level

EARTHQUAKE OF
28 February 1979, 1127 AST
28 February 1979, 2127 UTC

DIRECTION*	CONSTANTS**
L = 360°	Sens. = 1.90 cm/g Per. = .039 sec Damp. = 0.60 crit
V = Up	Sens. = 1.80 cm/g Per. = .038 sec Damp. = 0.60 crit
T = 270°	Sens. = 1.80 cm/g Per. = .038 sec Damp. = 0.60 crit

5 cm

Film Speed =
2 time marks/sec

** -Factory Data

*Azimuthal direction of case acceleration for upward trace deflection (opposite direction to pendulum motion - orientation questionable, need verification).

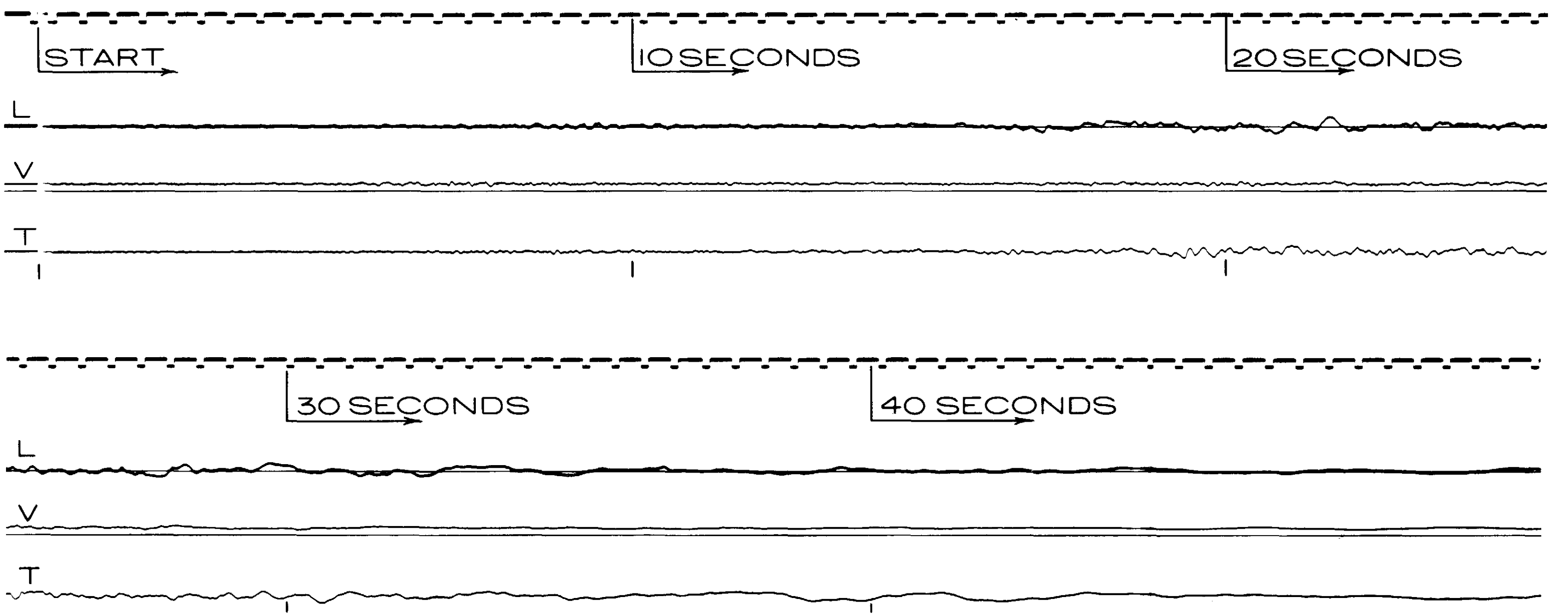

FIGURE 2. - ICY BAY ACCELEROGRAM FROM THE MAGNITUDE 7.7 ALASKA EARTHQUAKE OF FEBRUARY 28 (EPICENTRAL DISTANCE 73km).

U.S. STRONG-MOTION NETWORK

Station No. 2734 59.97N, 141.64W

Icy Bay, Gulf Timber Co.

SMA-1 No. 2248 (USGS) Ground level

EARTHQUAKE OF
28 February 1979, 1127 AST
28 February 1979, 2127 UTC

DIRECTION*	CONSTANTS	
L = 180°	Sens. = 1.65 cm/g Per. = .037 sec Damp. = 0.61 crit	
V = Up	Sens. = 1.77 cm/g Per. = .037 sec Damp. = 0.57 crit	
T = 090°	Sens. = 1.72 cm/g Per. = .038 sec Damp. = 0.61 crit	

5 cm

Film Speed =

2 time marks/sec

*Azimuthal direction of case acceleration for upward trace deflection (opposite direction to pendulum motion).

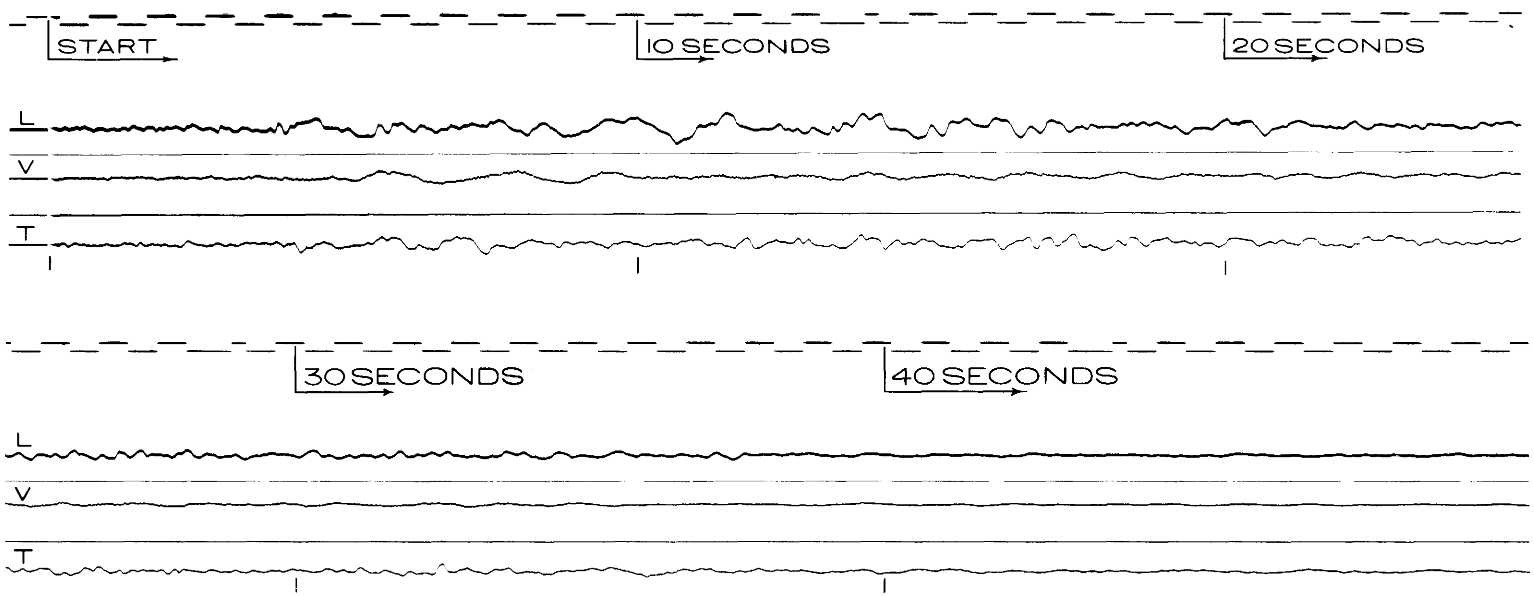

FIGURE 3. - YAKUTAT ACCELEROGRAM FROM THE MAGNITUDE 7.7 ALASKA EARTHQUAKE OF FEBRUARY 28 (EPICENTRAL DISTANCE 161km).

STRONG-MOTION INSTRUMENTATION IN THE IMPERIAL VALLEY, CALIFORNIA

by

R. L. Porcella and R. B. Matthiesen

From a paper to be presented at the Mexico-California Symposium, The Human Settlements on the San Andreas Fault:
Instituto Technologico Regional de Tijuana
September 4 - 8, 1979, Tijuana, Mexico

INTRODUCTION

The 1929 World Engineering Congress in Tokyo, Japan, has been cited as possibly the major impetus for the beginnings of earthquake engineering investigations in the western United States (Cloud, 1964). The discussions at this conference convinced many American engineers of the urgent need for the United States to move ahead rapidly in the investigation of the engineering aspects of seismology, including the development of instrumentation suitable for recording ground motions of a potentially damaging level. In 1931, the U.S. Congress allocated funds and designated responsibility to the Coast and Geodetic Survey for implementing an engineering seismology program.

The installation of strong-motion seismographs began in July 1932, and just eight months later the disastrous Long Beach earthquake triggered accelerographs at three southern California stations. These first records not only provided useful information about damaging earthquake motion, but also helped to justify the program and furnished an additional impetus for expanding the instrumentation effort. Within two years, 51 strong-motion seismographs had been installed, including one in El Centro on Commercial Avenue.

In recent years, the Imperial Valley of California has been one of the seismically most active regions in the continental United States. Despite the scarcity of records from the early part of this century, no less than 13 shocks of MMI VIII or above have been attributed to the Imperial Valley region between 1906 and 1934 (Ulrich, 1941). On May 18, 1940, a magnitude 7.1 earthquake was responsible for heavy damage throughout the Imperial Valley and was followed by a swarm of more than 30 recorded shocks during the eight succeeding days. The main shock triggered the strong-motion instrument in El Centro and those as far away as San Diego, San Bernardino, and Los Angeles. The 1940 El Centro accelerogram is still used worldwide in earthquake engineering design studies as a representative ground motion from a strong local earthquake.

IMPERIAL VALLEY NETWORK

Background

The Imperial Valley is situated within the central region of the Gulf of California physiographic province and is part of a broad, deep, and very complex structural trough filled with Cenozoic deposits derived from the nearby Colorado River and the surrounding mountain ranges (Dibblee, 1954). Although fault-associated uplift has occurred along the margins of this linear trough, the regional geologic setting suggests that this depression is not a simple graben (Biehler and others, 1964; Sharp, 1972).

The seismicity of this region has been widely investigated and has been characterized by both earthquake swarms as well as mainshock-aftershock activity. Although the nature of this latter activity grades imperceptibly into swarm-type activity, both theoretical and empirical investigations suggest that the type and complexity of earthquake sequences may be most closely related to the tectonic complexity of the region (Richter, 1958). This observation is in good agreement with recent studies of the tectonics of this region (for example, Sharp, 1972; Henyey and Bischoff, 1973; and Johnson and Hadley, 1976) and emphasizes the difficulty inherent in making definitive hazard evaluations for the Imperial Valley region. Nonetheless, numerous empirical studies have been made that attempt to define recurrence intervals for earthquakes in various magnitude ranges.

For the Imperial Valley region ($15{,}102\ km^2$), 786 earthquakes (greater than magnitude 3.5) from 1932 to 1971 were used as the basic data set to compute recurrence intervals of eight months for a magnitude 5-5 1/2 event, and 6.7 years for a magnitude 6-6 1/2 event (Hileman and others, 1973). Similarly, earthquake intensity data from 1870-1970 were used by Matthiesen (1978) in order to establish "projected histories" of possible strong-motion recording and to provide some insight into the return of data that could be expected from strong-motion networks in various locations throughout the United States. A projected history for the Imperial Valley indicates that a significant concentration of seismic activity throughout the second half of the study period could have provided a fairly consistent rate of strong-motion recording and suggests that this is a region where further development of the existing network is warranted.

Objectives

Initially, only one Standard accelerograph was installed in El Centro at the Commercial Avenue Station as a part of a program designed simply to gather strong-motion records from several regions in the western United States. In the early 1970's, several additional accelerograph stations were established in the Imperial Valley as a part of the development of a network along the San Jacinto fault, but it was not until 1975 that a cooperative effort was made by the California Institute of Technology (CIT), the California Division of Mines and Geology, and the U.S. Geological Survey to develop a specialized network of strong-motion instrumentation that would fulfill the specific research needs required by studies of source-mechanism, ground motion attenuation, and structure response.

An array of 13 accelerograph sites at 3- to 5-km spacings and transverse to the 1940 earthquake surface rupture was established for the purpose of obtaining information on the attenuation of ground motion with distance from the causative fault. The array crosses the Imperial fault (fig. 4) for a total length of about 45 km and contains accelerographs located both in buildings (school, hospital) and in small (approx. 2 m^3) fiberglass housings. Each instrument (a Kinemetrics model SMA-IT*) is equipped with a vertical starter to allow early triggering (usually within 0.2 s of the first P-wave arrival) and a WWVB radio receiver to record real time on the earthquake record.

Working with the Federal Highways Administration, the U.S. Geological Survey is presently installing a linear array of six triaxial accelerometers in order to record horizontally propagating surface waves, which will provide measurements of the differential motions of the ground surface. The array extends in a north-south direction for a total distance of 305 m, with accelerometers located at 0, 18, 55, 128, 214, and 305 m. The recorders and a SMA-IT accelerograph are located in a small concrete block structure 8 m south of the array. The accelerometer spacings are such that the distances between any two stations are similar both to the typical distances between bridge piers and to the half wavelengths of relevant shear wave motion (Noel Bycroft, oral commun., Mar. 20, 1979). Since the differential displacement (doubly integrated acceleration) between two accelerometers will be used as a measure of potential strain impressed on a bridge structure, the recorders must be perfectly synchronized; for this reason, six interconnected digital recorders (Terra Technology DCA-300) will be used with the six triaxial accelerometers (DSA-302-M). The primary objective of the array, then, is to obtain differential ground displacement data for use in the aseismic design of dams, pipelines, and particularly bridge structures.

The California Division of Mines and Geology, working with the State Department of Transportation and the U.S. Geological Survey, has instrumented the Meloland overpass at Interstate 8 in El Centro with a 26-channel remote-recording system (Kinemetrics model CRA-1). The instrumentation scheme includes strategically placed accelerometers designed to record strong-motion data for use in the evaluation of the structural response of the overpass during potentially damaging earthquakes. The major objective of this part of the Imperial Valley network is to record data such as modal response, damping characteristics, and generalized motions and displacements of a typical overpass structure and to develop a standardized procedure by which these data can be analyzed to produce the maximum amount of information (Chris Rojahn, oral commun., Mar. 28, 1979).

The six-story Imperial County Services Building in El Centro also has been instrumented under the California Strong-Motion Instrumentation Program (CSMIP); a 13-channel remote recording system (Kinemetrics CRA-1) was installed with accelerometers located at the ground, second and fourth floor, and roof levels (Rojahn and Ragsdale, 1978). The building is a reinforced concrete structure, rectangular in plan, designed to resist lateral forces in the transverse (N-S) direction by shear walls and in the longitudinal direction by frame action. Three ambient-vibration (velocity) measurements were made at the roof level of this building in June 1978; readings were taken at the east end, near the center, and at the west end of the building. The major objective of the CSMIP Building Instrumentation Program is to record the structural response of representative buildings during potentially damaging earthquakes and thus provide information that will lead to improved earthquake resistant design and ultimately protection of the public and reduced property losses in future earthquakes (Wootton and others, 1976).

*Any use of trade names in this report is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

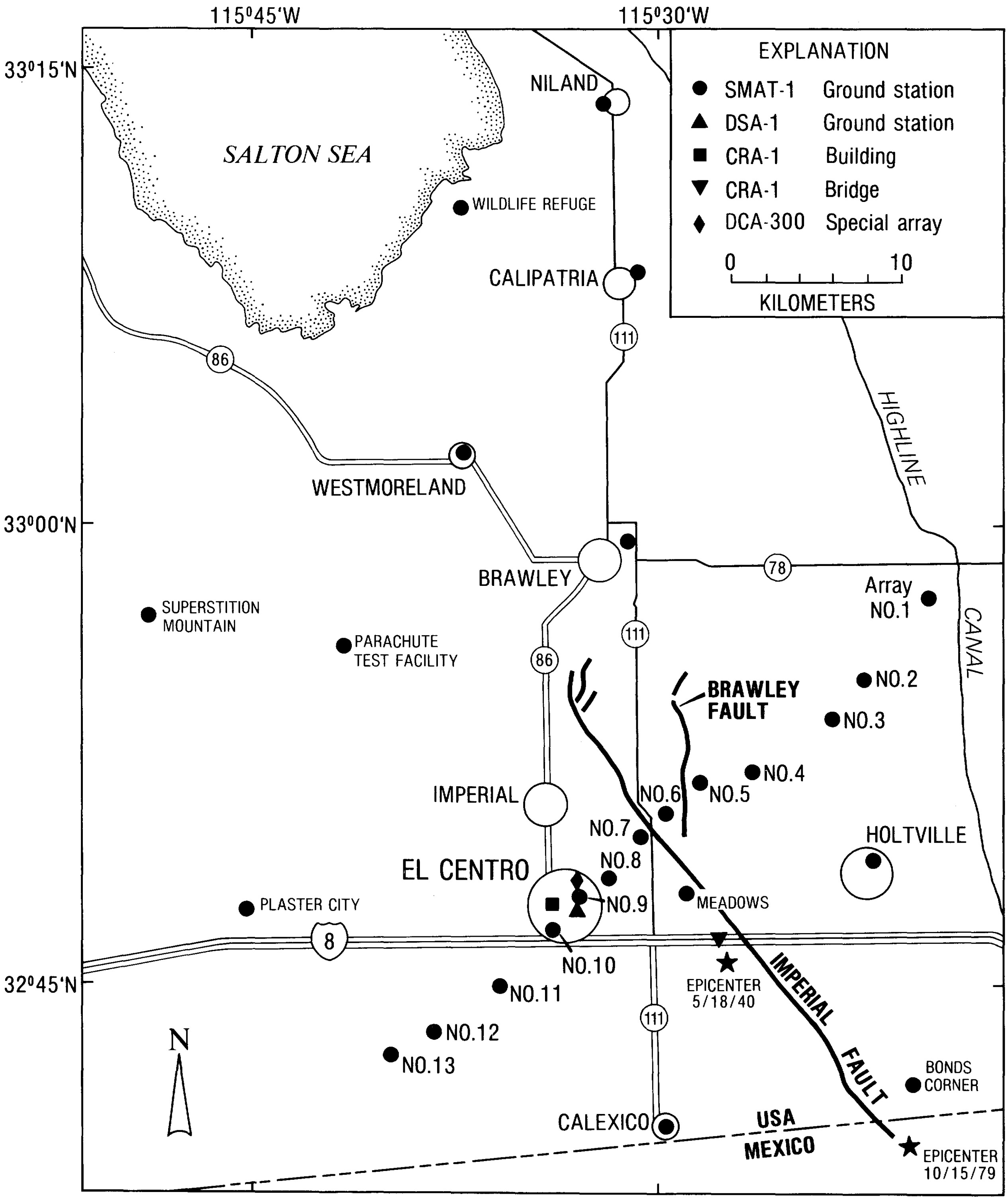

FIGURE 4. - STRONG-MOTION STATIONS IN THE IMPERIAL VALLEY, CALIFORNIA.

Future Activities

Plans for future USGS efforts in the Imperial Valley include an expansion of the network into more of a grid-type array by the addition of perhaps 12-15 accelerographs and a redistribution of several of the array instruments. The locations of new stations would be based on the historic pattern of seismic activity, as well as on the location of epicenters of recent earthquakes (since 1973) recorded by the 22-station, CIT-USGS Imperial Valley seismographic network (for example, Hileman and others, 1973; Fuis and others, 1978).

Two SMA-1T accelerographs will be added to the El Centro Commercial Avenue station, one in the basement and one outside the building at ground level, perhaps 75-100 m away, where any effects of the building on the recorded motion would be minimal. Recent studies of the interaction of surficial deposits with man-made structures indicate that the presence of a massive building (such as the Commercial Avenue station) can alter the input ground motion to perhaps a greater degree than previously considered. It is anticipated that the installation of these two identical, interconnected accelerographs will provide the comparative data necessary for a better quantification of the differences in the spectral content of strong ground motion at "freefield" and at "building" sites, as well as additional information to be used in soil-structure interaction studies of the 1940 El Centro accelerogram.

STRONG-MOTION DATA

Since an accelerograph was first installed in El Centro in July 1932, more than 250 accelerograms have been recovered from the Imperial Valley region; nearly 200 of these records have been recovered since January 1975, and they contain accelerations as high as 30-50 percent g from moderate-size (magnitude 4-5) earthquakes (see table 2). It should be noted that all of the records in table 2 recorded prior to 1966 were recovered at the Commercial Avenue station, the only station in the Imperial Valley during that period. Thus, the increase in acceleration levels reported after 1966 is due to the increase in the number of stations in the area and the consequent overall decrease in the epicentral distances listed in table 2. Because of the extremely short durations of these high accelerations, the data are of minimal engineering significance; however, many of the records do contain useful seismologic information relevant to epicenter determinations, wave propagation, and source-mechanism studies of the Imperial Valley region (for example Porcella, 1978).

SUMMARY

The Imperial Valley strong-motion network operated by the U.S. Geological Survey is the result of the cooperative efforts of the California Institute of Technology, the California Division of Mines and Geology, the Federal Highways Administration, and the U.S. Geological Survey. Both the historical pattern of seismic activity and recent small- to moderate-size earthquakes have been used as a basis for planning the deployment of accelerographs in the Imperial Valley region. The network presently contains 28 accelerograph stations: an overpass on U.S. Interstate 8; the six-story Imperial County Services Building in El Centro; a 13-station array across and perpendicular to the Imperial fault; a six-component, 305-m specialized array for measuring differential ground motions; and an additional 12 "freefield" sites located from Niland south to Calexico, and from Superstition Mountain east to the Highline Canal. The major objective of this network is to accumulate data for use in studies of source mechanism, structural response, and ground motion attenuation in the Imperial Valley region.

Acknowledgement - The present Imperial Valley strong-motion network was made possible through the generous cooperation of many individuals, private organizations, and government agencies that granted permission to install and maintain instrumentation on their property. In particular, the logistical assistance and the complete cooperation of the Imperial Irrigation District and its Board of Directors in granting permission to operate strong-motion instrumentation at several locations on District property is hereby acknowledged.

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Table 2.- Selected accelerograms from the Imperial Valley strong-motion network

Event No.*	Date	Time (PST)	Magnitude	Peak accl.(g)	Epicentral dist. (km)	Data report reference*
4	12/30/34	0552	6.5	0.18	64	B024
10	04/12/38	0825	3.0	.04	11	T274
11	06/05/38	1842	5.0	.04	34	T275
12	06/06/38	0435	4.0	.01	69	T276
14	05/18/40	2037	7.1	.31	09	A001, T277-T285
19	10/21/42	0822	6.5	.06	46	T286
22	01/23/51	2317	5.6	.03	30	T287
28	06/13/53	2017	5.5	.04	12	T288
31	11/12/54	0427	6.3	.02	160	T289
--	06/13/55	2347	3.8	.06	20	**
34	12/16/55	2117	4.3	.03	24	T290
35	12/16/55	2142	3.9	.01	24	T291
36	12/16/55	2207	5.4	.08	24	T292
37	02/09/56	0633	6.8	.05	120	A011
38	02/09/56	0725	6.4	.01	125	A012
51	08/07/66	0936	6.3	.01	147	T293
55	04/08/68	1829	6.5	.12	69	A019
--	04/28/69	1521	5.9	.02	272	**
--	09/30/71	1446	5.1	.03	48	**
--	12/06/74	1413	4.8	.16	16	**
--	01/23/75	0902	4.7	.13	11	**
--	06/19/75	2148	4.2	.10	10	**
--	06/20/75	1415	4.1	.15	06	**
--	04/14/76	0231	3.9	.14	05	**
--	11/04/76	0241	4.9	.11	12	**
--	10/21/77	0524	4.2	.13	05	**
--	10/28/77	1324	3.9	.16	05	**
--	10/29/77	2130	4.0	.14	05	**
--	11/13/77	1611	3.9	.50	03	**
--	11/13/77	1805	4.2	.41	03	**
--	11/13/77	2130	3.3	.25	03	**
--	11/13/77	2136	4.1	.23	05	**

* Reference: Strong Motion Earthquake Accelerograms, Index Vol., Rept. No. EERL 76-02, Calif. Institute of Technology, Pasadena, Calif.

**Information about these accelerograms is available from the U.S. Geological Survey, Seismic Engineering Branch, Menlo Park, Calif.

Fuis, G. S., Johnson, C. E., and Jenkins, D. J., 1978, Preliminary catalog of earthquakes in northern Imperial Valley, California, October 1977 - December 1977: U.S. Geological Survey Open-File Report 78-673, 41 p.

Henyey, T. L. and Bischoff, J. L., 1973, Tectonic elements of the northern part of the Gulf of California: Geological Society of America Bulletin, v. 84, p. 315-330.

Hileman, J. A., Allen, C. R., and Nordquist, J. M., 1973, Seismicity of the southern California region 1 January 1932 to 31 December 1972: California Institute of Technology, Seismological Laboratory, p. 72-75.

Johnson, C. and Hadley, D., 1976, Tectonic implications of the Brawley earthquake swarm, Imperial Valley, California, January 1975: Seismological Society of America Bulletin, v. 66, p. 1133-1144.

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SUMMARIES OF RECENT REPORTS *

STRONG-MOTION RECORDS OF THE MILFORD SOUND EARTHQUAKE OF MAY 4, 1976

by S. B. Hodder, R. I. Skinner, R. T. Hefford, and P. M. Randal

The Milford Sound earthquake was recorded by three-component accelerographs at Milford Hotel, Wanaki, and Te Anau and by an acceleroscope at Haast. These strong-motion records are of particular interest because the intensities assessed for the region covered by the recorders were exceptionally low for an earthquake with a Richter magnitude of 7. The low values of maximum acceleration, from about 0.093 *g* recorded at Milford Hotel to about 0.033 *g* at Te Anau, together with the short durations of relatively severe shaking, were consistent with the reported low intensities. The digitization calibration and correction of the Milford Hotel accelerogram are described and the acceleration response spectra have been plotted.

Reference: Bulletin of the New Zealand National Society for Earthquake Engineering, v. 11, no. 3, September 1978.

CATALOG OF STRONG-MOTION ACCELEROGRAPH STATIONS AND RECORDS IN TAIWAN

by Hung-Chie Chiu and Wen-Shiang Liu

In 1971 a comprehensive earthquake observation and research program was started by the National Science Council, Republic of China. Installation of a strong-motion accelerograph network throughout the Taiwan area was one major item of the program. Since then, the number of instruments has steadily increased. At the end of 1978 42 accelerographs were operating in the country. A list of recording sites is included in this publication.

In the past few years, several tens of records were collected. However, most of these records contain accelerations barely above the trigger level (0.01 *g*) of these instruments. This situation was changed on April 14, 1976 when a magnitude 5.4 earthquake in southwestern Taiwan produced unusually high accelerations at some sites. In particular, several earthquakes with magnitude above 6.0 have occurred during 1978, resulting in a number of records of engineering interest. The purpose of this publication is to inform interested researchers and engineers of the existence of these records.

The records are arranged by individual earthquake, in chronological order. Information about the origin time, focal depth, and Richter magnitude of each earthquake is provided. In addition, the observed intensity values (Central Weather Bureau intensity scale), which are essentially the same as the JMA intensity scale, are also given for reference.

Reference: Institute of Earth Sciences, Academia Sinica, Taipei, Taiwan, Republic of China, December 1978, Volume 1.

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

ON THE DEVELOPMENT OF STRONG-MOTION INSTRUMENT NETWORKS IN THE UNITED STATES

by R. B. Matthiesen

To establish engineering design criteria and to evaluate earthquake hazards, studies of the spectral shape and spectral attenuation of strong ground motion and of regional differences in these characteristics are the most important topics for which additional strong-motion data are required. Evaluations of the inelastic response of structures and of the influence of soil-structure interaction on such response are the second most important types of strong-motion studies relative to engineering research and design applications. Studies of local site effects (amplification effects resulting from soft surficial layers, or differences in motion at nearby points on the ground surface) and of soil failure phenomena (liquefaction or landslides) are of less importance, but they are sufficiently important that special arrays should be placed in several regions where the potential for soil failure is recognized and where a sufficiently high rate of return of strong ground motions is likely.

A review of the strong-motion activity in each region of the country implies that special ground motion and structural response studies should be planned for the Cape Mendocino area, along the Hayward fault, in the Gilroy to Hollister area, in the Transverse Ranges, and in the Imperial Valley of California. Outside of California there are few regions in which research type studies of structural response can be justified on the basis of anticipated return of data, but additional development of networks to study ground motion may be justified in the Mississippi Valley and on the Island of Hawaii. Along the shore of the Gulf of Alaska and in the Aleutian Island arc are areas of considerable activity, but the logistical problems of maintaining instruments and the locations of the islands relative to the sources of major earthquakes impose additional constraints, which dictate that only a minimum network of instruments for ground motion studies be developed in this region. Western Nevada and the Puget Sound trough are regions in which major events have occurred in the recent past, but the uncertainty regarding the level of current activity precludes the development of more than a minimum network of ground stations in these regions. The Honey Lake and Long Valley areas in California and the Flat-head Lake area in Montana are areas in which a buildup of activity may be occurring. This activity must be monitored, and plans should be made to respond to any indication that a major event is likely to occur. The regions in which instruments should be installed to monitor critical structures, such as dams and nuclear power plants, clearly include many of the regions that are of relatively low priority for research-type studies. To supplement the network of permanently installed strong-motion instruments, other instruments should be maintained in a stand-by condition at several locations for rapid deployment to study ground motions from aftershocks.

The importance of adequate strong-motion data to the fields of geophysics, seismology, and earthquake engineering places some urgency on the development of the network, but the inherent long-term nature of the process of gathering strong-motion data places the burden on the present generation to plan wisely for future generations who will utilize the data in research, design, operations, and regulation.

Reference: U.S. Geological Survey Open-File Report 78-1024, October 1978,
91 p.

A PRELIMINARY STUDY OF THE SANTA BARBARA, CALIFORNIA, EARTHQUAKE OF AUGUST 13, 1978 AND ITS MAJOR AFTERSHOCKS

by W. H. K. Lee, C. E. Johnson, T. L. Henyey, and R. L. Yerkes

The M_L5.1 Santa Barbara earthquake of August 13, 1978 occurred at lat 34° 22.2'N, long 119° 43.0'W, 4 km south of Santa Barbara, Calif. at a depth of 12.5 km in the northeast Santa Barbara Channel, part of the Transverse Ranges geomorphic-structural province. This part of the province is characterized by seismically active, east-trending reverse faults and rates of coastal uplift that have averaged up to about 10 m/1000 years over the last 45,000 years.

No surface rupture was detected onshore. Subsurface rupture propagated northwest from the main shock toward Goleta, 15 km west of Santa Barbara, where a maximum acceleration of 0.44 g was measured at ground level and extensive minor damage occurred; only minor injuries were reported. A fairly well constrained fault-plane solution of the main shock and distribution of the aftershocks indicate that left reverse-oblique slip occurred on west-northwest-trending, north-dipping reverse faults; inadequate dip control precludes good correlation with any one of several mapped faults. Had the earthquake been larger and rupture propagated to the southeast or a greater distance to the northwest, it could have posed a hazard to oil-field operations. The fault-plane solution and aftershock pattern closely fit the model of regional deformation, and the solution closely resembles those of five previously mapped events located within a 15-km radius.

Reference: U.S. Geological Survey Circular 797, 1978, 11 p.

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

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

by Richard K. Miller and Stephen F. Felszeghy

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

Reference: University of California, Santa Barbara, Report UCSB-ME-78-2, December 1978, 133 p.

PROCESSED DATA FROM THE PARTIAL STRONG-MOTION RECORDS OF THE SANTA BARBARA EARTHQUAKE OF AUGUST 13, 1978

by L. D. Porter, J. T. Ragsdale, and R. D. McJunkin

On August 13, 1978 a moderate magnitude earthquake (M_L = 5.1, Calif. Institute of Technology) occurred in the ocean 6 km south of Santa Barbara, California. The earthquake had a focal depth of 12.5 km and was located at lat 34.37°N and long 119.72°W.

The Santa Barbara area has a moderate amount of instrumentation, which includes 27 accelerographs within 90 km of the epicenter. Eleven accelerographs were triggered by the August 13 main event; eight of these instruments belong to the California Division of Mines and Geology (CDMG), and one each to Southern California Edison Company, the U.S. Bureau of Reclamation, and the U.S. Geological Survey. Three CDMG stations in the Santa Barbara area produced records significant enough to require digitization by the State Program: (1) Santa Barbara-Freitas Building, (2) Santa Barbara-UCSB North Hall Building, and (3) Santa Barbara-UCSB Goleta. The subject of this report is the record analysis of approximately the first 10 s of earthquake-generated motion at these stations. Data presented in this report include uncorrected accelerations, corrected accelerations, velocities, and displacements, and response spectra.

Reference: California Division of Mines and Geology Preliminary Report 23, 1979, 93 p.

COMPILATION OF STRONG-MOTION RECORDS RECOVERED FROM THE BISHOP, CALIFORNIA EARTHQUAKE OF OCTOBER 4, 1978

by R. D. McJunkin

A moderate magnitude earthquake (M_L = 5.7, Berkeley seismographic station) occurred approximately 30 km northwest of Bishop, California, on October 4, 1978. The earthquake had a focal depth of 4.8 km and was located at lat 37.518°N and long 118.705°W.

The Bishop area is moderately instrumented by 11 accelerograph sites within 100 km of the epicenter; these instruments are owned and operated by the Office of Strong-Motion Studies, California Division of Mines and Geology. Five of the 11 accelerograph stations were triggered and produced records of the Bishop earthquake.

As an aid to the analysis of records, stations are listed alphabetically and in a north-south pattern. The relative positions of triggered stations with respect to the earthquake epicenter are listed by range and azimuth. The performance of the station network for the Bishop region is examined with respect to epicentral distance. The peak uncorrected ground accelerations (horizontal components) are listed along with their corresponding azimuths.

Reference: California Division of Mines and Geology, preliminary results, OSMS Report 78-7.1, November 1978, 29 p.

INTERIM REPORT ON THE ST. ELIAS, ALASKA EARTHQUAKE OF FEBRUARY 28, 1979

by J. C. Lahr, George Plafker, C. D. Stephens K. A. Fogleman, and M. E. Blackford

On February 28, 1979 an earthquake with surface wave magnitude (M_S) of 7.7 occurred beneath the Chugach and St. Elias Mountains of southern Alaska. This is a region of complex tectonics resulting from northwestward convergence between the Pacific and North American plates. A telemetered seismic network in southern Alaska has been operated by the USGS since 1971, and it was greatly expanded along the eastern Gulf of Alaska in September 1974. The current configuration of stations is shown. Technical details of the network are available in published earthquake catalogs; preliminary analysis of the data from this network covering the period from September 1, 1978 through March 10, 1979, as well as worldwide data for the main shock, is discussed in this paper.

Reference: U.S. Geological Survey Open-File Report 79-670, 1979, 35 p.

PRELIMINARY ANALYSIS OF STRONG-MOTION RECORDS OBTAINED AT ULCINJ, BAR, AND PETROVAC FROM THE APRIL 15, 1979 MONTE NEGRO, YUGOSLAVIA EARTHQUAKE

by Nove Naumovski, Dimitar Petrovski, Vidoje Zelenovic, Jakim Petrovski, and Trifun Paskalov

The April 15, 1979 Yugoslavia earthquake in the Monte Negro coastal region was recorded by more than 25 strong-motion instruments located throughout an area of approximately 50,000 km^2. All these instruments are part of the strong-motion instrument network in Yugoslavia that is maintained by the Institute of Earthquake Engineering and Engineering Seismology, Skopje.

For the purpose of preliminary analysis, only the strongest motion of three records from an area of about 60 km along the Adriatic coast was selected: Petrovac - "Olivia" Hotel, Ulcinj - "Olimpic" Hotel, and Bar - Town Assembly building. The choice of only three records for analysis was based primarily on the limited time available and the urgent need for definition of the main earthquake effect upon the structures located in the epicentral region. In this area, in addition to the old traditional stone masonry buildings, a number of modern structures were seriously damaged or destroyed.

Reference: Institute of Earthquake Engineering and Engineering Seismology, University "Kiril and Metodij", Skopje, Yugoslavia, Publication No. 64, April 1979.

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

U.S. STRONG-MOTION NETWORK DATA

A Strong-Motion Information Retrieval System (SMIRS) has been developed to provide up-to-date information about strong-motion records and the circumstances in which they were recorded. The system is accessible through a data terminal (30 cps, half duplex). The system is operational, but the information within it is incomplete and needs to be verified. A user's manual is available (Converse, 1978). To retrieve information dial (415) 329-8600. When the system comes on line, type: enter your name SMIRS, and you will be given instructions.

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

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

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

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

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

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

FOREIGN STRONG-MOTION DATA

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

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

EDIS/NOAA WORLDWIDE STRONG-MOTION DATA

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

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

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

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

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

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

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

A table listing all digitized strong-motion records available on magnetic tape may be obtained free of charge from EDIS/NOAA. Digitized strong-motion records may be purchased either in punched card format at $20 per record (including all three instrument components) or in tape format at $60 per tape.

Checks or money orders should be made payable to "Commerce/NOAA/NGSDC"; inquiries should be addressed to EDIS/NOAA (see address below). Phone:
(303) 499-1000, ext. 6744; FTS phone 323-6477.

DATA SOURCES

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

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

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

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

4. NISEE/Computer Applications
   Davis Hall, UC Berkeley
   Berkeley, CA 947205.

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

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

ERRATA

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

Table 1. - *Summary of accelerograms recovered during January - April, 1979*

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl[4] (g)	Duration[5] (s)
28 August 1978 - 17 January 1979 S. Hawaii Epicenters and magnitudes unknown	Pahala, Hawaii Kau Hospital (USGS)	19.20 N 155.47 W	1.4	155	0.08	-
				Up	.03	-
				065	.08	-
	Wahaula, Hawaii Visitor Center (USGS)	19.33 N 155.03 W	-		**	
	Note: Two additional records recovered at Pahala and one additional record recovered at Wahaula during this period; maximum acceleration less than 0.05 g.					
20 November 1978 0655 UTC S. California 34.15 N, 116.97 W Magnitude 4.1	Cherry Valley Johnson Res. (USGS)	33.98 N 116.99 W	*		**	
	Forest Falls Mill Creek Cyn. (USGS)	34.09 N 116.92 W	0.3	300	.11	0.1
				Up	.07	-
				210	.16	.1
	Mill Creek Forest Station (USGS)	34.08 N 117.05 W	2.3	315	.04	-
				Up	.02	-
				225	.05	-
	East Highlands Post Office (USGS)†	34.11 N 117.17 W	3.2		**	
31 December 1978 0323 UTC Seattle, Wash. 47.58 N, 121.85 W Magnitude 4.0	Mud Mt. Dam Enumclaw, Wash. Crest (ACOE)†	47.14 N 121.93 W	*		**	
1 January 1979 2314 UTC S. California 33.93 N, 118.70 W Magnitude 4.6	Topanga Fire Sta. Topanga, Calif. (USGS)	34.084 N 118.599 W	2.4	270	.07	-
				Up	.04	-
				180	.09	-
	Kilpatrick School Malibu, Calif. (USGS)	34.093 N 118.836 W	2.2	270	.06	-
				Up	.04	-
				180	.07	-
	Monte Nido Fire Sta. Malibu Cyn, Calif. (USGS)	34.08 N 118.69 W	2.1	090	.05	-
				Up	.05	-
				360	.06	-

See footnotes at end of table.

Table 1. - *Summary of accelerograms recovered during January - April 1979* - continued

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl[4] (g)	Duration[5] (s)
January 1979 2314 UTC -continued-	Century City Los Angeles, Calif. (USGS)	34.06 N 118.42 W	*		**	
	Liquid Metal Eng. Cntr. Canoga Park, Calif. (DOE)	34.23 N 118.71 W				
	Bldg. 462, ground level		*		**	
	Bldg. 462, 6th floor		*		**	
	Bldg. 463, roof level		*	090	0.02	-
				Up	.10	-
				360	.05	-
	Jensen Filter Plant Los Angeles, Calif. (MWD)	34.31 N 118.50 W				
	Gen. room, ground level		*		**	
	Residence, roof level		*		**	
	Admin. bldg., basement		*		**	
	Sepulveda Dam Los Angeles, Calif. (ACOE)	34.17 N 118.47 W				
	Crest station		*		**	
	Downstream station		*		**	
	Sepulveda Cyn. Control Facility (MWD)	34.10 N 118.48 W	3.3	156	.03	-
				Up	.02	-
				066	.06	-
	333 S. Hope St. Los Angeles, Calif. (CLA)	34.05 N 118.25 W	*			
	Basement				**	
	31st floor				**	
	55th floor				**	
	Brentwood VA Hosp. Ground level (VA)	34.06 N 118.46 W	3.6		**	
	Long Beach VA Hosp. Long Beach, Calif. (VA)†	33.78 N 118.12 W	*			
	Basement				**	
	6th floor				**	
	Note: Instrument at 11th floor malfunctioned.					
	Vernon, Calif. CMD Terminal (USGS)†	34.00 N 118.20 W	*		**	

See footnotes at end of table.

Table 1. - *Summary of accelerograms recovered during January - April, 1979* - continued

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl[4] (g)	Duration[5] (s)
1 January 1979 2314 UTC -continued-	201 Ocean Ave. Santa Monica, Calif. (OTA)	34.03 N 118.51 W	3.2			
	Basement			170	0.03	-
				Up	.02	-
				080	.05	-
	10th floor			170	.06	-
				Up	.03	-
				080	.12	0.3
	17th floor			170	.10	1-peak
				Up	.11	0.2
				080	.17	1.6
	Note: Data from station at 201 Ocean Ave. was obtained from a reproduction of records owned by Ocean Tower Apartments, Santa Monica, Calif.					
	Note: Additional accelerograph records were recovered at California Strong-Motion Instrumentation Program (CSMIP) sites; stations that were triggered include Santa Catalina, Culver City, Inglewood, University, of California at Los Angeles, Hollywood Storage, Century City, Long Beach (2), Irvine, Sherman Oaks, and Ventura (Rich McJunkin, (oral commun.).					
12 February 1979 0448 UTC S. California 33.45 N, 116.42 W Magnitude 4.4	Pinyon Flt. Observ. Underground vault (USGS)	33.61 N 116.46 W	*		**	
	Rancho De Anza Anza-Borrego Park (USGS)	33.35 N 116.40 W	1.8		**	
22 February 1979 1557 UTC N. California 40.01 N, 120.07 W Magnitude 5.2	Grizzly Valley Dam Abutment station (CDWR)†	39.88 N 120.48 W	*		**	
28 February 1979 2127 UTC S. Alaska 60.62 N, 141.51 W Magnitude 7.7	Yakutat, Alaska FAA-VOR Bldg. (LDGO)	59.51 N 139.63 W	*	360 Up 270	.09 .02 .06	- - -
	Icy Bay, Alaska Gulf Timber Co. (USGS)	59.97 N 141.64 W	*	180 Up 090	.16 .07 .11	16.5 - 1-peak
15 March 1979 2017 UTC S. California 34.30 N, 116.44 W Magnitude 5.0	Morongo Valley F.S. Morongo Valley, Calif. (USGS)†	34.05 N 116.58 W	4.4		**	

See footnotes at end of table.

Table 1. - *Summary of accelerograms recovered during January - April, 1979* - continued

Event	Station name (owner)[1]	Station coord.	S-t[2] (s)	Direction[3]	Max accl.[4] (g)	Duration[5] (s)
15 March 1979 2107 UTC S. California 34.32 N, 116.44 W Magnitude 5.2	Morongo Valley F.S. Morongo Valley, Calif. (USGS)†	34.05 N 116.58 W	4.7		**	
	White Water Trout Farm White Water Canyon (USGS)†	33.99 N 116.66 W	4.6		**	
	Fun Valley Reservoir 361 (USGS)†	33.93 N 116.39 W	*		**	
	North Palm Springs Post Office (USGS)†	33.92 N 116.54 W	5.0		**	
15 March 1979 2307 UTC S. California 34.33 N, 116.44 W Magnitude 5.0	Morongo Valley F.S. Morongo Valley, Calif. (USGS)†	34.05 N 116.58 W	*		**	
	Note: Additional records recovered at CSMIP sites include those from Joshua Tree, Palm Springs, Desert Hot Springs, Palm Desert, and San Bernardino (Rich McJunkin, oral commun.).					

[1] ACOE - U.S. Army Corps of Engineers
CDWR - California Dept. of Water Resources
CLA - City of Los Angeles
DOE - U.S. Department of Energy
LDGO - Lamont-Doherty Geological Observatory
MWD - Metropolitan Water District of Southern California
OTA - Ocean Tower Apartments, Santa Monica
USGS - U.S. Geological Survey
VA - Veterans Administration
† - WWVB time code is incomplete or nonexistent; correlation of accelerogram with event is questionable.

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

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

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

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

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