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GEOLOGICAL SURVEY CIRCULAR 717-A



Seismic Engineering
Program Report,
January–March 1975

Prepared on behalf of the National Science Foundation

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National Science Foundation*

United States Department of the Interior

ROGERS C. B. MORTON, Secretary



Geological Survey

V. E. McKelvey, Director

PREFACE

The Seismic Engineering Branch (SEB) of the U.S. Geological Survey is pleased to issue this second "Seismic Engineering Program Report," an informal document designed to keep the ever-growing community of strong-motion data users apprised of the activities and findings of this office. When published by SEB's predecessor, the Seismological Field Survey of the National Oceanic and Atmospheric Administration, this report was known as the "Quarterly Engineering Seismology Bulletin."

This particular report contains a listing of 1974 accelerograph records, two articles by SEB staff members—one on the Latin American and Caribbean strong-motion programs, the other on recent developments in strong-motion instrumentation—and other notes and announcements which might be of interest to the reader. Future issues will contain similar information with all listed data as current as practicable.

Christopher Rojahn
Data Management,
Seismic Engineering Branch

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Seismic Engineering Program Report, January – March 1975

1974 ACCELEROGRAPH RECORDS

By R. P. MALEY, R. L. PORCELLA, and B. L. SILVERSTEIN

More than 130 accelerograph records were obtained during 1974 from the national strong-motion instrumentation network operated by the U.S. Geological Survey. The recordings were largely from California although several other states were represented including Alaska, Hawaii, and South Carolina. The South Carolina earthquake, magnitude 4.5, occurred an estimated 14 km from the accelerograph station located at Citadel College in Charleston. Most of the 30 Hawaiian shocks recorded were of volcanic origin occurring between November 30, 1974 and January 5, 1975, in association with a late December eruption near Kilauea. Several records were also obtained from earthquakes that occurred in Peru, Nicaragua, and near Panama.

The following paragraphs summarize the results of the more important earthquakes recorded:

Lima, Peru, 5 January, 30 October and 9 November 1974

Three large earthquakes were recorded in 1974 at Lima, Peru, accelerograph stations within 70 to 90 km of the epicenter. Two records were obtained from each shock, one from the standard instrument located at the Geophysical Institute and the second from a Kinometrics SMA-1 that was relocated after each event. The January 5 earthquake, magnitude 6.3, occurred 73 and 79 km from the recording stations where respective maximum accelerations were 0.16 and 0.11g. The November 9 shock, magnitude 7.2, was 90 km and 94 km from the accelerographs; peak accelerations were, respectively, 0.14 and 0.08g. The largest earthquake of the three, magnitude 7.6, was located 85 and 91 km from the recording stations; maximum accel-

erations registered were 0.24 and 0.18g. Accelerations at the Geophysical Institute exceeded 0.1g for a duration of 30 seconds and exhibited a relatively high frequency content, a phenomena observed in other earthquakes recorded at this site. C. F. Knudson and Virgilio Perez have prepared an analysis of the three October records for presentation at the annual meeting of the Seismological Society of America in March 1975 (Los Angeles, California).

Hollister, California, 28 November 1974

A magnitude 5 (USGS) earthquake occurred 10 km northwest of Hollister between the Calaveras and Sargent faults, apparently on an extension of the smaller southwest-trending Busch fault. Nine accelerographs were triggered within 80 km of the epicenter including three instruments located nearly equidistant from the earthquake at 10 km. These latter sites showed maximum accelerations of 0.17g at Hollister City Hall, 0.14g at Gilroy, and 0.12g at San Juan Bautista. This was the fourth time in 27 years that accelerations greater than 0.1g were recorded at Hollister and the second time in the past year that 0.1g had been exceeded at Gilroy. Several seismoscope records were obtained from the shock including those from a pair of instruments located on opposite sides of the San Andreas fault at San Juan Bautista where the largest amplitudes were polarized transverse to the direction of wave travel. Similar large directional responses have been observed on seismoscope records from numerous other moderate-sized earthquakes.

Table 1 provides a listing of 1974 earthquake records and the maximum accelerations scaled from those considered more significant. The earthquakes are listed in chronological order and include locality, geographic coordinates, magnitude, and maximum intensity when available.

This information has been gathered from "Preliminary Determination of Epicenters" and "Abstracts of Earthquake Reports for the United States," both published by the U.S. Geological Survey. The recording stations for each event are listed in alphabetical order with a brief description of the building in which the instrument is housed. Epicentral distances were calculated to show the relative proximity of the individual recording stations. Directions are given for the components where maximum accelerations are provided except for three stations in Peru where this information was not available. In this instance, the directions are simply listed in a manner relevant to the instrument housing, longitudinal and transverse for the two horizontal components and vertical for the third component. The accelerations listed for the August 14 earthquake at Kagel Canyon are probably too low since accidental fogging obscured the first part of the record. Note that many earthquake dates are followed by a (?) signifying that the records could not be definitely identified with this particular event.* Maximum accelerations are shown for those events where ground accelerations were more than 0.05g or amplitudes recorded in structures (other than at the basement or ground level) were more than 0.1g. These criteria were arbitrarily adopted to reduce the amount of insignificant data reported. Although the maximum recorded acceleration poorly defines the nature of motion at a site, it is the most easily and quickly obtained quantity. It should be pointed out that these measurements have no relationship to frequency or duration of shaking, and in fact, in many instances, the amplitudes recorded as maximum acceleration were observed as only one or two prominent peaks.

LATIN AMERICAN AND CARIBBEAN STRONG-MOTION PROGRAMS

By C. F. KNUDSON

The establishment of a satisfactory number of operational strong-motion stations in Latin

*Most accelerographs possess only an integral timer that supplies two pulses a second; thus it is difficult to accurately identify the source of many earthquakes, particularly smaller ones. In an effort to alleviate this problem, many of the instruments being added to the network by the California Division of Mines and Geology are equipped with WWVB radio receivers that supply a real time base to the record. Because the cost of adding these receivers to an accelerograph amounts to almost \$600 per unit, it is only done in special instances.

America and the Caribbean has met with only moderate success in the past 30 years. Limited funds and the even more critical shortage of personnel have contributed to the failure to develop a reliable and continuing maintenance program once the stations have been established. Furthermore, the expansion of many programs has been hampered by the fact that often a destructive earthquake must occur before enough funds become available for the institutions interested in earthquake engineering to develop new strong-motion stations.

Presently, the following countries have one or more operational strong-motion instruments: Mexico, Guatemala, El Salvador, Nicaragua, Costa Rica, Panama, Colombia, Ecuador, Peru, Chile, Argentina, Venezuela, Trinidad, Barbados, Jamaica, and Puerto Rico (U.S.A.). Ten accelerographs are also scheduled for installation on the French islands of Martinique and Guadeloupe. The number of strong-motion instruments in each of the Latin American and Caribbean countries known to be operational (as of December 1974) is shown in figure 1.

The historical development of each country's strong-motion program is briefly outlined below. The strong-motion records known to have been generated in that particular country are mentioned in each discussion.

MEXICO

Prior to the May 1962 Mexican earthquakes, there were three Japanese SMAC accelerographs in Mexico, all of which were operated by the Institute of Engineering at the National Autonomous University of Mexico. By January 1, 1970, 25 additional AR-240 accelerographs had been added, and since then, 5 RFT-250 and 23 SMA-1 accelerographs have been installed.

In its present form, the Mexican network extends from Mexicali at the U.S. border to Las Angostura Dam near the Guatemala border and contains more than 55 accelerographs. In addition, a strong-motion telemetry network, installed in cooperation with UNESCO, telemeters data to Mexico City from surrounding areas as far away as 114 km.

The first significant strong-motion records obtained in Mexico were generated by the earthquakes of May 11 and 19, 1962. Other significant records of destructive earthquakes include those



FIGURE 1.—Map showing the number of strong-motion instruments currently operational in each of the Latin American and Caribbean countries.

from the January 30, 1973, August 28, 1973, and October 6, 1974 events.

The Seismic Engineering Branch (formerly the Seismological Field Survey) has in the past provided assistance to the Institute of Engineering in digitizing records produced by these past earthquakes.

GUATEMALA

The first accelerograph for Guatemala, a standard Coast and Geodetic Survey (C&GS) accelerograph was installed at the Observatorio Nacional in Guatemala City in 1947. The instrument has been maintained by personnel of the Observatorio Nacional. In addition, the Centro de Investigaciones de Ingeniería of the Ciudad Universitaria at Guatemala purchased one RFT-250 and three seismoscopes in the late 1960's and have installed them at the university.

Earthquake records from events occurring in June 1947, July 1948, September 1949, December 1949, October 1950, July 1952, August 1953, and February 1973 have been obtained from the C&GS accelerograph. None of these records has been significant as the largest recorded acceleration was 0.036g in October 1950. No record has, as yet, been obtained from the RFT-250 at the university.

EL SALVADOR

The first strong-motion instrument, a standard C&GS instrument, was installed at the observatory in San Salvador in 1964. After the May 1965 El Salvador earthquake, 3 AR-240's and 25 seismoscopes were purchased. The AR-240's were installed at the new Airport Terminal Building, Ministerio de Educación Building, and the Instituto de Vivienda Urbana Building. The 25 seismoscopes, whose sites were selected on the basis of local geology, are located within the city of San Salvador and vicinity.

Numerous records of small felt earthquakes have been recorded on the instruments in San Salvador. All of these records have been relatively insignificant with very few recording as much as 0.05g.

NICARAGUA

Installation of the Nicaraguan network was begun by the Dirección General de Cartografía (a national government agency) after the purchase of instruments by the Banco Central de Nicaragua and the Universidad Nacional Autónoma de Nicaragua in 1966 and by the Esso Refinery in

1967 and 1968. At the time of the December 1972 Managua earthquake there were 4 AR-240 accelerographs and 19 seismoscopes located in and near Managua. Eighteen SMA-1 accelerographs and 14 seismoscopes were purchased in 1974 for the newly established Centro de Investigaciones Sísmicas Nicaragua. Three of the new SMA-1 accelerographs were installed in November 1974, with the remaining installations scheduled for completion in 1975. New locations to be instrumented include: Jinotepe, Chinandega, Leon, Masaya, Granada, Juigalpa, and Rivas as well as Managua.

The most important record obtained in Nicaragua was the Esso Refinery strong-motion accelerogram of December 23, 1972. Other records obtained from accelerographs in Managua were from the following events: October 15, 1967; January 4, 1968; January 18, 1968; January 2, 1972; January 5, 1972; January 30, 1973; March 31, 1973; and March 5, 1974.

COSTA RICA

The first accelerograph, a C&GS instrument, was installed at the University in San Jose during 1947. This instrument was maintained for 5 years by the university and then later by the Servicio Meteorológico y Sismológico. From 1953 to 1965 the instrument was inoperative. The instrument was put into operational order in 1965 and maintained by the Servicio Meteorológico until 1968 when the Department of Geology of the university took charge of the strong-motion instruments, which then included an AR-240 at Caja de Seguro and an AR-240 at the Hospital México. Alcoa purchased two SMA-1's that have been reported installed at San Isidro and Cahuita. The Instituto Costarricense de Electricidad has one SMA-1 at the Arenal Dam site. Two other SMA-1's were purchased for the Instituto de Seguro, but as of late October 1974 they had not been installed.

Records have been obtained from earthquakes occurring on the following dates: December 1947, September 1948, November 1948, October 1950, June 1951, December 1952, January 1953, October 1967, and August 1970. The records have not been very significant with the largest accelerations recorded being 0.055g for the October 5, 1950 event and 0.098g for the December 30, 1952 event.

As a result of meetings held in October 1974 at San Jose, Costa Rica, a commission was formed to draft a law for the establishment of an Institute of

Volcanology and Seismology for Costa Rica. The creation of this new institute will provide an expanded network of strong-motion stations and continuous and reliable maintenance of the present instruments as well as future instruments planned for installation in Costa Rica.

PANAMA

In 1934, the first accelerograph, an early model C&GS instrument, was installed in Panama at Balboa Heights (Canal Zone) Administration Building. The instrument was removed in 1965. In 1967, two strong-motion instruments were installed at Panama City and Balboa Heights as part of the seismic effects program for the Inter-oceanic Canal Studies. In December 1970 these instruments were turned over to the Instituto Geofísico in Bogotá, Colombia. A year later, a new SMA-1 was sent to Panama by the Seismological Field Survey. It was installed during January 1973 at the Balboa Heights Administration Building.

Records have been obtained from the Panama accelerographs on the following dates: July 17, 1934; May 6, 1936; March 17, 1945; January 6, 1951; and July 13, 1974. All records have been relatively insignificant with the maximum acceleration recorded being 0.060g for the May 6, 1936 event.

COLOMBIA

The first accelerograph for Colombia, a standard C&GS instrument, was installed at Bogotá in May 1945 in the seismograph vault at the Instituto Geofísico de Los Andes Colombianos where it remains. In December 1970, the AEC Atlantic-Pacific Inter-oceanic Canal Study Commission turned over to the Instituto Geofísico the 10 standard C&GS instruments used for the Inter-oceanic Canal Studies from 1967 to 1970. Those instruments are now installed in locations in Medellín, Cali, Manizales, and Bogotá.

Prior to 1972 no significant records had been obtained. Since then, 13 records have been obtained from 7 earthquakes: November 22, 1972; April 3, 1973; April 24, 1973; July 8, 1973; August 30, 1973; July 13, 1974; and August 24, 1974. The records were obtained from accelerographs located at Bogotá, Medellín, and Cali. The distance of the instruments from the epicenters varied from 155 km to 335 km, the magnitudes from 5.0 Richter to 6.4. Accelerations scaled were all less than 0.02g.

ECUADOR

Ecuador has only one strong-motion instrument, a standard C&GS accelerograph that was installed at the Observatorio Astronómica de Quito in 1945. Ing. Alejandro Segovia, a member of a seismic engineering group in Ecuador, has tried to promote the installation of more strong-motion instruments but has met with little success to date.

Only four records have been obtained from the Quito accelerograph. These records were generated by earthquakes on August 29, 1946; December 15, 1946; August 5, 1949; and February 9, 1967. The maximum acceleration recorded was 0.014g on August 5, 1949.

PERU

At the time of the May 31, 1970 Peruvian earthquake, there was only one strong-motion instrument, a standard C&GS accelerograph, in Peru. It was originally installed in 1944 and is located in the center of Lima. Six SMA-1's were purchased by the Instituto Geofísico and sent to Peru in February 1972 and another five were sent in October 1973. Five of the SMA-1's are being installed at Chira-Piura Dam in northern Peru. One SMA-1 was installed at Chorrillos but was stolen in 1974. The others have been installed at stations in Arequipa, Chimbote, Las Gavalavia, and Lima.

Between January 1946 and October 1959, the following earthquakes were recorded on the Lima C&GS accelerograph: January 23, 1946; November 1, 1947; May 23, 1948; March 4, 1949; March 6, 1949; May 17, 1949; January 31, 1951; August 9, 1951; July 19, 1952; February 15, 1953; August 29, 1954; September 20, 1954; February 9, 1955; September 9, 1956; September 29, 1956; January 24, 1957; February 18, 1957; April 23, 1958; and October 13, 1959. The maximum recorded acceleration for all 19 events was 0.07g on January 31, 1951. Since October 13, 1959, six records with accelerations exceeding that maximum of 0.07g have been recorded on the C&GS instrument on October 17, 1966; May 31, 1970; November 29, 1971; January 5, 1974; October 3, 1974; and November 9, 1974. The January, October, and November 1974 earthquakes were also recorded in Lima on a new SMA-1 accelerograph.

CHILE

The first accelerograph in Chile, a standard

C&GS instrument, was installed at Santiago in the University Engineering Building during March 1944. In the late 1950's a Japanese SMAC instrument was installed at the same location. In 1967, the University of California began a cooperative research program with the University of Chile. The instrumentation phase of this program called for the establishment of a strong-motion network of 57 accelerographs. The instruments were designed at the university and modeled after the standard C&GS instrument. As of April 30, 1974, 27 instruments had been installed with the following cities having operational instruments: Copiapó, Concepción, Chillan, Illapel, Iquique, La Ligua, Rancagua, Rapel, Santiago, Tocopilla, Taltal, Temuco, Osorno, Puerto Montt, Vallenar, Valdivia, and Valparaiso. As of May 1974, 10 more instruments were ready for installation, but it is now doubtful whether a network of 57 instruments will ever be attained.

Seven records from the standard C&GS instrument at Santiago were recorded on the following dates: June 8, 1945; June 24, 1945; September 13, 1945; April 29, 1952; September 4, 1953; July 9, 1971; and October 5, 1973. The largest recorded acceleration, 0.131g, occurred on September 13, 1945.

ARGENTINA

In 1972, Argentina had a network of six Japanese strong-motion instruments along with five strong-motion accelerographs and 50 seismoscopes made by the Polimnia Instrument Co. of San Juan, Argentina. The strong-motion instruments were installed at San Juan, Mendoza, La Fioja, Catamarca, and JuJuy. Installation of additional strong-motion instruments is continuing. Imula Dam near San Juan will be instrumented, as will a large earthfill dam in southern Argentina (both dams are presently under construction). Ing. Juan Carmona, Universidad Nacional de Cuyo and CONCAR (Consejo Nacional de Construcciones Argentina) have been responsible for the development of the present Argentina network of strong-motion instruments.

Recently the Instituto Nacional de Prevencion Sismica (INPRES) replaced the CONCAR organization. The Instituto expected to spend \$80,000 during 1974 on seismic instruments for its new offices, laboratories, and other seismic stations and is contemplating purchase of 10 SMA-1's for installation elsewhere in Argentina.

Accelerograph and seismoscope records have

been obtained for the Argentina events of August 17, 1962 and November 10, 1966, and the recent earthquake in 1973.

VENEZUELA

Only one strong-motion instrument, a standard C&GS instrument, was located in Venezuela at the time of the July 1967 Caracas earthquake. It was obtained by Dr. Fiedler from Panama in January 1966. Unfortunately, it failed to operate at the time of the July earthquake owing to battery failure (16-year-old automobile battery). After the 1967 earthquake, 25 additional strong-motion instruments were installed in Venezuela. The strong-motion network now includes the standard C&GS instrument, 2 Japanese SMAC's, 1 New Zealand type MO-2, 2 AR-240's, 15 RFT-250's, and 5 SMA-1's. The instruments are maintained by the Cagigal Observatorio, National Cartografia, Comición Presidencial Para El Estudio Del Sismo, and Shell Oil Company. They have been installed at locations in Merida, El Tocuyo, Lagunillas, El Tuy, Cumana, and Caracas.

A few small-amplitude accelerograph records have been obtained from earthquakes of September 20, 1968; September 16, 1969; and July 27, 1972. The largest recorded acceleration from these records was 0.047g. Recently a new organization, the Fundación Venezolana de Investigaciones Sísmicas (FUNVESIS) has been formed in Venezuela. It has a staff of six people, including an executive secretary and three engineers, and is planning to substantially expand the network of accelerographs in 1975 and 1976.

TRINIDAD, BARBADOS, AND JAMAICA

The Seismic Research Unit of the West Indies completed installation of its network of six accelerographs in Trinidad in May 1974. Four SMA-1's have been installed at stations in Port of Spain with two others at San Fernando.

During 1974, the Seismic Research Unit also installed a network of six SMA-1 accelerographs on the island of Barbados. One SMA-1 has been installed at the University, three at a multiple installation in the new Cable Wireless Building at Bridgetown, and two others at separate locations in Bridgetown.

As of June 1974, one accelerograph, an SMA-1, has been installed in Jamaica. A network of five SMA-1's has been planned with installations at Kingston and Montego Bay.

GUADELOUPE AND MARTINIQUE

The French plan to install a network of strong-motion instruments on both Martinique and Guadeloupe. Ten SMA-1's that were scheduled for installation on Guadeloupe had been purchased and delivered prior to the October 8, 1974 Caribbean earthquake but had not been installed in time to record the event. Instruments are planned for installation on Martinique in the near future.

PUERTO RICO

A SMA-1 accelerograph was installed at the Veterans Administration Hospital in San Juan, Puerto Rico, in June 1973. In addition, through the efforts of Engineer Jose Capacete and the Puerto Rico del Colegio de Ingenieros, four other SMA-1's have been installed on the island. Two were installed in a new 17-story government building, the Mindlas Building, a third was installed in the basement garage of the Capacete and Martin Associates Building, and the fourth in a small firehouse at the Isla Grande Airport.

No earthquakes have yet been recorded on any of the five accelerographs now installed in Puerto Rico.

RECENT DEVELOPMENTS IN REMOTE TRANSDUCER INSTRUMENTATION FOR STRONG-MOTION ACCELERATION RECORDING

By B. J. MORRILL

The Seismic Engineering Branch (SEB) has been striving for some time to overcome the inadequacies of traditional mechanical-optical accelerographs in comprehensive arrays where it is necessary to install transducers in small or inaccessible locations, such as on specific members of a building's frame, imbedded within earth dams, or at downhole sites. In order to satisfy these diverse instrumentation requirements, SEB has written specifications for remote sensor systems to record strong-motion data at a central location and has begun to encourage the development and use of such systems. As a result of these efforts, four remote sensor acceleration recorders have been produced: the Nimbus TMA-100, Teledyne-Geotech RRA-100, Kinematics CR-1, and Terra Technology DCA-300.* Preliminary laboratory

evaluations have been conducted on each of these instrument types, and evaluations under field conditions are underway.

The Nimbus TMA-100 Dynamic Recording System is a six-channel, 89-mm film recording oscillograph with modular plug-in electronic elements. Numerous standard options are available for transducer sensitivities, signal conditioning, film speed, and timing. The conditioning features can provide specified filtering, dual sensitivities, automatic sensitivity selection, and a digital data delay that allows recording of the initial part of the earthquake normally missed on strong-motion records. The sensitivities of both the accelerometers and orthogonal triggers may be calibrated in the field. The instrument is available in a weathertight portable case and a rack-mounted drawer.

The Teledyne-Geotech RRA-100 Remote Recording Accelerograph is a three-channel, 70-mm film recording system utilizing force-balance accelerometers and a separate orthogonal omni-trigger. Sensitivity options are available for full-scale recording at $\frac{1}{4}$, $\frac{1}{2}$ and $1g$. The instrument is available in a portable weathertight case.

The Kinematics CR-1 Central Recording Accelerograph records up to 12 data channels on 7-inch-wide film. The weathertight case, recorder, and recorder drive are basically the same design as the now familiar SMA-1 optical-mechanical accelerograph. The force-balance accelerometers are modified SMA-1 accelerometers with variable capacitance transducers added to sense pendulum location and to provide a servo-signal to the torquer. Other parts of the output provide damping through a differentiating filter and signal. The instrument employs a vertical trigger that can be accurately calibrated in the field.

The Terra Technology DCA-300 records acceleration in a digital form on cassette tape. The instrument uses lightweight force-balance accelerometers with flexure suspensions and can provide a wide range of sensitivities. Signal conditioning options include a wide variety of sensitivities, filter bands, and 0.7 to 1.5 seconds pretriggering data storage. Triggering is provided by one or any number of the data-producing accelerometers and can be field adjusted and calibrated. Either rack-mount drawer or portable weathertight recorder electronics housing is available.

All four of the systems have been designed to

*Naming and describing these products does not constitute an endorsement by the U.S. Geological Survey of them or their manufacturers.

SEB specifications and provide operational modes and logic required for remote transducer strong-motion instrumentation.

NOTES ON RECORD CORRECTIONS AND THE AVAILABILITY OF STRONG-MOTION DATA

Additional accelerograph records obtained from earthquakes in 1974.—Table 2 lists two 1973 records from Valdez, Alaska, that were omitted from table 2 of the previous edition of the "Seismic Engineering Program Report" (Geological Survey Circular 713) because of the late date of recovery and difficulty in determining the exact date of the earthquake.

Corrections for 1971 San Fernando earthquake records.—Several of the 1971 San Fernando accelerograph records were originally labeled with erroneous component directions, and although these errors were subsequently corrected in Volume I, Part M, of "Strong-Motion Earthquake Accelerograms, Digitized and Plotted" (California Institute of Technology, Earthquake Engineering Research Laboratory, 1973), a number of record copies were distributed with improper data on the labels. Table 3 lists all known San Fernando records that initially contained direction errors. The corrected directions are shown in column 4 in a top to bottom order corresponding to the location of data traces on the individual records. Note that the revisions for some components are merely a 180° change to conform with the U.S. Geological Survey convention of correlating up motion on the record with the direction of pendulum deflection.

Two other records show incorrect location of the basement accelerographs. At both 3345 and 5900 Wilshire, the instruments are located one level above the lowest level of the building, not at the lowest level as previously reported.

Availability of digitized strong-motion data.—The February 9, 1971 San Fernando, California earthquake strong-motion records and most of the

significant records generated prior to that earthquake have been digitized by the California Institute of Technology (CIT). The digitized data are presently available through CIT and the Environmental Data Service (EDS) of the National Oceanic and Atmospheric Administration (NOAA) in the following forms:

CALIFORNIA INSTITUTE OF TECHNOLOGY:

Volume I form of data (uncorrected data) is available for approximately 400 records on four magnetic tapes at a total cost of \$400.

Volume II form of data (corrected data) is available for 329 records (approximately half from the San Fernando earthquake; 186 ground level) on three magnetic tapes at a total cost of \$300.

Data are available on 7-track 800 BPI formatted tape in BCD; a few other formats are available including 9-track 1600 BPI.

Inquiries should be addressed to:

Earthquake Engineering Research
Laboratory
California Institute of Technology
Mail Code 104-44
Pasadena, California 91125
(213) 795-6811, ext. 1232

ENVIRONMENTAL DATA SERVICE:

Volume I form of data (uncorrected data) is available in punched card form (about 2,000 cards each) for \$20 per event and on magnetic tape (7- or 9-track) for \$60 per tape. The complete file of approximately 400 records is available on six magnetic tapes for \$360.

Inquiries should be addressed to:

National Geophysical and Solar-
Terrestrial Data Center
Code 62
EDS/NOAA
Boulder, Colorado 80302
(303) 499-1000, ext. 6472.

TABLE 2.—Summary of additional accelerograph records obtained from earthquakes in 1973

[The initial 1973 summary was presented in Geological Survey Circular 713,
Seismic Engineering Program Report, October-December 1974]

Event	Station location	Station coordinates	Epicentral dist: km(mi)	Component	Maximum acceleration : g
Earthquake of 10 October 1973(?) Valdez, Alaska: 61.15N, 146.48W — Magnitude 3.9	Valdez, Alaska Valdez Dock Co. (Ground floor)	61.13N 146.36W	7 (4)	----	*
	Valdez, Alaska Harris Sand & Gravel (Ground floor)	61.13N 146.25W	13 (8)	----	*

*Maximum acceleration less than 0.05g.

(?) Some or all of the records could not be firmly identified with this earthquake.

Significant strong-motion records obtained since the San Fernando earthquake are being processed by SEB. SEB's digitization and data reduction capabilities are currently being improved and are not expected to be fully operational for at least several months. As soon as the systems are running smoothly, SEB will begin routinely digitizing and analyzing all significant ground-level records generated since February 9, 1971. The availability of such data will be announced in subsequent circulars.

Availability of film copies of strong-motion records.—70-mm film clips (approximately 8× reduction) of most of the United States and Latin

American records generated prior to February 9, 1971 (approximately 1,500 total) are available through EDS for \$.50 per record. A chronological file of all 1,500 records is also available on seven reels of 35-mm film (12× reduction) for \$12 per reel, \$70 complete set. Inquiries should be addressed to:

National Geophysical and Solar-Terrestrial
Data Center
Code 62
EDS/NOAA
Boulder, Colorado 80302
(303) 499-1000, ext. 6472.

TABLE 1.—Summary of accelerograph records obtained from earthquakes in 1974
[Unless otherwise noted, maximum acceleration recorded at ground or basement level]

<u>EVENT</u>	<u>STATION LOCATION</u>	<u>STATION COORDINATES</u>	<u>EPICENTRAL DIST: km(mi)</u>	<u>COMPONENT</u>	<u>MAX. ACCELERATION^a: g</u>
<u>Earthquake of 5 January 1974</u>	Lima, Peru	12.02S	73 (45)	Long.	.16
Lima, Peru:	Zarate Station	77.01W		Vert.	.09
12.30S, 76.40W - Magnitude 6.3				Transv.	.16
	Lima, Peru	12.07S	74 (46)	Up	.06
	Geophys. Institute	77.04W		N82W	.09
	(1-story bldg.)			N08E	.11
<u>Earthquake of 10 January 1974</u>	Gilroy, Calif.	36.97N	3.5 (2)	S67W	.05
Hollister, California:	Gavilan College,	121.57W		Down	.02
36.95N, 121.60W - Magnitude 4.2	Bldg. 10			S13E	.09
	(1-story bldg.)				
Note: A small amplitude record* was also obtained from Hollister City Hall (339 Fifth).					
<u>Earthquake of 12 January 1974 (?)</u>	Kilauea, Hawaii	19.43N	18 (11)	-	*
Mauna Loa area, Hawaii:	Camp Ground	155.30W			
19.34N, 155.16W - Magnitude 4.7	(1-story bldg.)				
<u>Earthquake of 31 January 1974 (?)</u>	Gilroy, Calif.	36.97N	19 (12)	S67W	.08
Gilroy, California:	Gavilan College,	121.57W		Down	.03
36.80N, 121.54W - Magnitude 3.5	Bldg. 10			S13E	.16
<u>Earthquake of 11 February 1974 (?)</u>	Los Angeles, Calif.	34.05N	6 (4)	N52W	<u>Bsmt</u> .03 <u>19th flr</u> .07 <u>39th flr</u> .03
Los Angeles, California:	445 Figueroa Street	118.26W		Down	.04 .04 .04
34.10N, 118.27W - Magnitude 3.4	(39-story bldg.)			S38W	.05 .02 .01

* Maximum acceleration less than .05g.

(?) Some or all of the records could not be firmly identified with this earthquake.
See descriptive introductory text.

TABLE 1.—Summary of accelerograph records obtained from earthquakes in 1974—Continued

<u>EVENT</u>	<u>STATION LOCATION</u>	<u>STATION COORDINATES</u>	<u>EPICENTRAL DIST: km(mi)</u>	<u>COMPONENT</u>	<u>MAX. ACCELERATION^a: g</u>		
<u>Earthquake of 11 February 1974</u> (Continued)	Los Angeles, Calif. 420 S. Grand (15-story bldg.)	34.05N 118.25W	6 (4)	S37W	<u>Bsmt</u> .10	<u>8th flr</u> .07	<u>15th flr</u> .05
				Down	.08	.07	.10
				S53E	.08	.07	.03
	Los Angeles, Calif. 525 S. Flower, North Tower (52-story bldg.)	34.05N 118.26W	6 (4)	S52E	<u>Bsmt</u> .13	<u>24th flr</u> .01	<u>52nd flr</u> .01
				Down	.09	.06	.03
				N38E	.10	.02	.01
	Los Angeles, Calif. 700 W. 7th (9-story bldg.)	34.05N 118.26W	6 (4)	N52W	<u>Bsmt</u> .12	<u>4th flr</u> .10	<u>Roof</u> .09
				Down	.11	.06	.04
				S38W	.18	.11	.18
	Los Angeles, Calif. 646 S. Olive (7-level garage)	34.05N 118.25W	6 (4)	S37W	<u>Bsmt</u> .07	<u>4th lvl</u> .09	<u>Roof</u> .12
				Down	.05	.06	.08
				S53E	.07	.05	.09
Note: Smaller amplitude records* that may or may not be from the 2/11/74 event were also obtained from the following Los Angeles stations: 525 S. Flower (South Tower), 750 Garland, 110 E. Ninth St., 800 W. Sixth St., 637 Wil- shire Blvd., 770 Wilshire Blvd., and 1200 Wilshire Blvd.							
<u>Earthquake of 5 March 1974</u> Managua, Nicaragua: 12.3N, 86.4W - Magnitude 5.8	Managua, Nicaragua National University (small 1-story bldg.)	12.11N 86.27W	-	E - W		.09	
				Down		.05	
				N - S		.09	

* Maximum acceleration less than .05g (upper stories less than .10g).

TABLE 1.—Summary of accelerograph records obtained from earthquakes in 1974—Continued

EVENT	STATION LOCATION	STATION COORDINATES	EPICENTRAL DIST: km(mi)	COMPONENT	MAX. ACCELERATION ^a : g
<u>Earthquake of 8 March 1974 (?)</u> San Fernando, California: 34.38N, 118.43W - Magnitude 4.7	Los Angeles, Calif. 13100 Balboa (2-story bldg.)	34.31N 118.50W	10 (6)	S25W Down S65E	.05 .03 .06
Note: Smaller amplitude records* were also obtained from Leona Valley (Ritter Ranch), Castaic Dam, Castaic (Old Ridge Route) and the following Los Angeles stations: 8244 Orion, 16111 Plummer (V.A. Hospital, Bldg. 40), 15107 Van Owen and UCLA (Reactor Lab).					
<u>Earthquake of 17 April 1974</u> Gilroy, California: 36.95N, 121.60W - Magnitude 3.2	Gilroy, Calif. Gavilan College, Bldg. 10 (1-story bldg.)	36.97N 121.57W	3.5 (2)	S67W Down S13E	.06 .02 .06
<u>Earthquake of 25 April 1974 (?)</u> Mauna Loa area, Hawaii: 19.31N, 155.22W - Magnitude 4.0	Kilauea, Hawaii Camp Ground (1-story bldg.)	19.43N 155.30W	16 (10)	-	*
<u>Earthquake of 5 May 1974 (?)</u> Mauna Loa area, Hawaii: 19.35N, 155.27W - Magnitude 4.4	Kilauea, Hawaii Camp Ground (1-story bldg.)	19.43N 155.30W	9 (6)	-	*
<u>Earthquake of 9 June 1974</u> China Lake, California: 35.53N, 117.45W - Magnitude 4.2	China Lake, Calif. Naval Weapons Ctr. (Concrete vault)	35.63N 117.59W	17 (10)	-	*
<u>Earthquake of 12 June 1974</u> Hollister, California: 36.74N, 121.39W - Magnitude 3.7	Hollister, Calif. Almaden Winery (1-story bldg.)	36.75N 121.38W	1.4 (1)	N45W Down S45W	.06 .02 .03

Note: Smaller amplitude records* were also obtained from the following two Hollister stations: Sago Central and Sago East.

* Maximum acceleration less than .05g (upper stories less than .10g).

(?) Some or all of the records could not be firmly identified with this earthquake.

See descriptive introductory text.

TABLE 1.—Summary of accelerograph records obtained from earthquakes in 1974—Continued

<u>EVENT</u>	<u>STATION LOCATION</u>	<u>STATION COORDINATES</u>	<u>EPICENTRAL DIST: km(mi)</u>	<u>COMPONENT</u>	<u>MAX. ACCELERATION^a: g</u>
<u>Earthquake of 15 June 1974</u> Hollister, California: 36.73N, 121.39W - Magnitude 3.0	Hollister, Calif. Almaden Winery (1-story bldg.)	36.75N 121.38W	2.5 (1.5)	-	*
<u>Earthquake of 19 June 1974 (?)</u> Mauna Loa area, Hawaii: 19.35N, 155.40W - Magnitude 5.1	Kilauea, Hawaii Camp Ground (1-story bldg.)	19.43N 155.30W	14 (9)	-	*
<u>Earthquake of 5 July 1974</u> Central California: 36.55N, 121.19W - Magnitude 3.1	Bear Valley, Calif. CDF Fire Station (1-story bldg.)	36.57N 121.18W	2.5 (1.5)	S50E Down N40E	.04 .02 .05
<u>Earthquake of 13 July 1974</u> Panama Canal Zone, Panama: 7.75N, 77.63W - Magnitude 7.3	Panama Canal Zone Canal Zone Adm. Bldg. (3-story bldg.)	8.96N 79.55W	250 (155)	-	*
<u>Earthquake of 14 August 1974</u> San Fernando, California: 34.43N, 118.37W	Pacoima Dam Abutment (Concrete dam)	34.34N 118.40W	10 (6)	N76W Down S14W	.06 .03 .12
	Kagel Canyon 12587 Dexter Park (1-story bldg.)	34.30N 118.38W	14 (9)	S20E Down N70E	.06** .02** .06**
	Vasquez Rocks Park (small, prefab bldg.)	34.49N 118.32W	8 (5)	North Down West	.10 .06 -

Note: Smaller amplitude records* were also obtained from the following Los Angeles stations: 13100 Balboa, 14123 Nordhoff, and 8244 Orion.

* Maximum acceleration less than .05g (upper stories less than .10g).

** Partial record.

TABLE 1.—Summary of accelerograph records obtained from earthquakes in 1974—Continued

<u>EVENT</u>	<u>STATION LOCATION</u>	<u>STATION COORDINATES</u>	<u>EPICENTRAL DIST: km(mi)</u>	<u>COMPONENT</u>	<u>MAX. ACCELERATION^a: g</u>
<u>Earthquake of 3 October 1974</u>	Lima, Peru	12.13S	91 (57)	Long.	.17
Lima, Peru:	Dr. Huaco Residence	76.97W		Vert.	.13
12.27S, 77.80W - Magnitude 7.6				Transv.	.18
	Lima, Peru	12.07S	85 (53)	Up	.13
	Geophys. Institute	77.04W		N82W	.24
	(1-story bldg.)			N08E	.21
<u>Earthquake of 7 October 1974</u>	Oxnard, Calif.	34.23N	27 (17)	-	*
Oxnard, California:	500 Esplanade	119.17W			
34.05N, 118.97W - Magnitude 4.0	(15-story bldg.)				
<u>Earthquake of 12 October 1974</u>	Hemet, Calif.	33.73N	9 (6)	N45E	.09
Hemet, California:	895 Stetson	116.98W		Down	.05
33.72N, 116.88W - Magnitude 3.5	(1-story bldg.)			N45W	.05
Note: Smaller amplitude records* were also obtained from Anza (Post Office), Indio (Coachella Citrus Groves), and Palm Springs (Airport).					
<u>Earthquake of 9 November 1974</u>	Lima, Peru	-	-	Long.	.11
Lima, Peru:	La Molina Station			Vert.	.05
12.50S, 77.79W - Magnitude 7.2				Transv.	.14
	Lima, Peru	12.07S	94 (59)	Up	.03
	Geophys. Institute	77.04W		N82W	.05
	(1-story bldg.)			N08E	.08
<u>Earthquake of 22 November 1974</u>	Charleston, S.C.	32.79N	14 (9)	East	.01
Charleston, South Carolina:	Citadel College	79.96W		Down	.01
32.91N, 80.02W - Magnitude 4.5	(small, 1-story bldg.)			North	.01
<u>Earthquake of 28 November 1974</u>	Bear Valley, Calif.	36.64N	37 (23)	S03E	.02
Hollister, California:	Stone Canyon East	121.24W		Down	.05
36.91N, 121.48W - Magnitude 5.0	(small, 1-story bldg.)			N87E	.03

* Maximum acceleration less than .05g (upper stories less than .10g).

TABLE 1.—Summary of accelerograph records obtained from earthquakes in 1974—Continued

<u>EVENT</u>	<u>STATION LOCATION</u>	<u>STATION COORDINATES</u>	<u>EPICENTRAL DIST: km(mi)</u>	<u>COMPONENT</u>	<u>MAX. ACCELERATION^a: g</u>
<u>Earthquake of 28 November 1974</u> (Continued)	Hollister, Calif.	36.85N	10 (6)	Up	.07
	339 Fifth (City Hall)	121.40W		S01W	.10
	(1-story bldg.)			N89W	.17
	San Juan Bautista	36.86N	8 (5)	S45E	.12
	24 Polk Street	121.54W		Down	.05
	(1-story bldg.)			N45E	.05
	Gilroy, Calif.	36.97N	10 (6.5)	S67W	.14
	Gavilan College,	121.57W		Down	.03
	Bldg. 10			S23E	.10
	(1-story bldg.)				
Note: Smaller amplitude records* were also obtained from Capitola (405 Capitola Avenue), Castle Rock Geophysics Observatory, Corralitos (1473 Eureka Canyon Road), San Jose (8 S. First), and Santa Cruz (University of California Observatory).					
<u>Earthquake of 28 November 1974</u> Ferndale, California: 40.28N, 124.93W - Magnitude 4.2	Ferndale, Calif.	40.58N	66 (41)	-	*
	City Hall/Fire Stn.	124.26W			
	Brown Street				
	(2-story bldg.)				
<u>Earthquakes of 30 November 1974</u> <u>to 2 January 1975</u> Mauna Loa area, Hawaii: Magnitude Range 3.5 to 5.3	Punuluu, Hawaii				
			More than 15 shocks* were recorded before, during and after the December 28 volcanic eruption on the flank of Kilauea.		
<u>Earthquake of 6 December 1974</u> Calexico, California: 32.71N, 115.40W - Magnitude 4.8	El Centro, Calif.	32.80N	12 (7)	S52W	.07
	2059 Bowker	115.47W		Down	.01
	(1-story bldg.)			S38E	.07
	El Centro, Calif.	32.79N	17 (10)	N52E	-
	302 Commercial	115.55W		Down	.01
	(2-story bldg.)			N38W	.05

* Maximum acceleration less than .05g.

TABLE 1.—Summary of accelerograph records obtained from earthquakes in 1974—Continued

<u>EVENT</u>	<u>STATION LOCATION</u>	<u>STATION COORDINATES</u>	<u>EPICENTRAL DIST: km(mi)</u>	<u>COMPONENT</u>	<u>MAX. ACCELERATION^a: g</u>
<u>Earthquake of 6 December 1974</u> (Continued)	Imperial, Calif. Imperial Val. College Admin. Bldg. (1-story bldg.)	32.83N 115.50W	16 (10)	S52W Down N38E	.11 .03 .16
Note: A small amplitude record* was also obtained from El Centro Community Hospital (Imperial & Ross Streets).					
<u>Earthquake of 19 December 1974</u> 0436 PST San Gabriel, California: 34.08N, 118.08W - Magnitude 3.7	Monterey Pk., Calif. Garvey Reservoir (Earth dam)	34.05N 118.11W	4.5 (3)	S60W Down S30E	.04 .02 .06
<u>Earthquake of 19 December 1974</u> 0440 PST (aftershock) San Gabriel, California: 34.07N, 118.08W - Magnitude 3.4	Monterey Pk., Calif. Garvey Reservoir (Earth dam)	34.05N 118.11W	3.5 (2)	-	*
<u>Earthquake of 29 December 1974</u> Richmond, California: 37.92N, 122.29W - Magnitude 3.5	Oakland, Calif. 2730 Adeline Street (2-story bldg.)	37.82N 122.28W	11 (7)	-	*
<u>Earthquake of 31 December 1974</u> Hollister, California: 36.93N, 121.47W - Magnitude 4.0	Hollister, Calif. 339 Fifth (City Hall) (1-story bldg.) San Juan Bautista 24 Polk Street (1-story bldg.)	36.85N 121.40W 36.86N 121.54W	11 (7) 10 (6)	- -	* *

* Maximum acceleration less than .05g (upper stories less than .10g).

TABLE 3.—*Direction corrections for labels on San Fernando earthquake records*

<u>STATION</u>	<u>LOCATION OF DATA TRACE ON RECORD</u>	<u>ORIGINAL DIRECTION SHOWN</u>	<u>CORRECTED DIRECTION</u>
<u>Long Beach, Calif.</u>	Top - Accelerometer	Up	No change
200 W. Broadway	Carder Displ. Meter (CDM)	East	West
(Pub. Util. Bldg.)	Middle - Accelerometer	North	No change
	CDM	South	North
	Bottom - Accelerometer	East	No change
<u>Los Angeles, Calif.</u>	Top	S30W	N60W
750 Garland	Middle	Down	No change
(All 3 accelerographs)	Bottom	N60W	S30W
808 Olive	Top	S37W	N37W
(8th floor only)	Middle	Down	No change
	Bottom	S53E	N53W
611 W. Sixth	Top	N52W	N38E
(All 3 accelerographs)	Middle	Down	No change
	Bottom	N38E	N52W
UCLA	Top - Accelerometer	Up	No change
	CDM	West	South
	Middle - Accelerometer	South	West
	CDM	South	West
	Bottom - Accelerometer	East	North
3710 Wilshire	Top	West	South
(10th floor only)	Middle	Down	No change
	Bottom	South	East
<u>Pacoima Dam, Calif.</u>	Top	S74W	N76W
	Middle	Down	No change
	Bottom	S16E	S14W
<u>Pasadena, Calif.</u>	Top	South	West
CIT Seism. Lab.	Middle	Down	No change
	Bottom	East	South
<u>Port Hueneme, Calif.</u>	Top - Accelerometer	Up	No change
	CDM	West	South
	Middle - Accelerometer	South	West
	CDM	North	West
	Bottom - Accelerometer	West	North
<u>Palmdale, Calif.</u>	Top	S60E	S30W
38318 Ninth	Middle	Down	No change
(Fire Station)	Bottom	S30W	S60E

