GEOLOGICAL SURVEY CIRCULAR 736–D

Seismic Engineering Program Report, October–December 1976

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

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United States Department of the Interior

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V. E. McKelvey, *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 accelerograph records recovered from the National Strong-Motion Network during the period October 1 through December 31, 1976. A preliminary report on the Calipatria, California earthquake swarm of November 4, and a report on the Russian accelerogram from the May 17, 1976 Gazli, U.S.S.R. earthquake are presented, along with abstracts of recent reports, notes on strong-motion information sources, and the availability of digitized data. The information presented in table 1 was recovered (although not necessarily recorded) during the past quarter. This procedure will be continued in future issues in order that the dissemination of strong-motion data may be as expeditious and current as practicable.

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Seismic Engineering Program Report
October–December 1976

RECENT STRONG-MOTION RECORDS

By R. L. Porcella

Twenty-six accelerograph records were recovered from the national strong-motion network during the fourth quarter of 1976. This figure brings the total number of records recovered in 1976 to 61, only 28 percent of the yearly average for the period 1972-1975 inclusive. The network is administered by the U.S. Geological Survey for the National Science Foundation in cooperation with other Federal, State, and local agencies and consists of more than 850 accelerographs located in 36 states, Puerto Rico, and Central and South America.

The Calipatria earthquake swarm of November 3-8, 1976 produced 18 strong-motion records from 7 accelerograph sites in the Imperial Valley area (see the following preliminary report).

Two interesting records were obtained at El Centro stations 5 and 6 from a 3.9 (M_L) event at 1031 GMT on April 14, 1976. The epicenter was located 5 km north of station 6, 3 km north of station 5, and within 10 km of 5 additional accelerograph sites (fig. 1). All of these instruments are equipped with vertical starters, yet only the accelerographs and stations 5 and 6 operated during this event. The record from station 6 shows a peak acceleration of 0.14 g and an S-trigger (S-t) interval of 2.20 sec (fig. 2). The record from station 5 shows a peak acceleration of 0.07 g and an S-t interval of 2.25 sec. The latter accelerogram contains two additional events recorded at 06:55:06 and 06:55:18 GMT on April 14 and displays S-t and S-P intervals of 2.20 and 2.50 sec, respectively. Maximum acceleration is approximately 0.04 g.

A magnitude 3.8 event in the Imperial Valley on April 26, 1976 triggered accelerographs at Calipatria and Salton Sea Wildlife Refuge (fig. 1). Maximum accelerations at these stations were 0.07 g and 0.08 g, respectively (fig. 2).

Additionally, minor records were recovered at the Panama Canal Zone and three southern California stations during this past quarter (table 1).

PRELIMINARY REPORT ON THE CALIPATRIA, CALIFORNIA, EARTHQUAKE SWARM: NOVEMBER, 1976

By R. L. Porcella and J. D. Nielson

A swarm of more than 400 earthquakes occurred near Calipatria in the Imperial Valley of California between November 3 and 8, 1976 (Gary Fuis, oral commun., November 9, 1976). Seven events, which were assigned magnitudes of 4 or greater, occurred on November 4 between 0548 and 1413 GMT (table 2). The epicenters for all of the shocks in this series have been assigned a location at 33.08° N. and 115.60° W., approximately 10 km southwest of Calipatria and 4 km north of Westmoreland (fig. 1). A depth of 5-6 km is assumed. The largest event registered 4.9 (M_L) and occurred at 0241:37.8 local time on November 4. Damage reports included several accounts of fallen stock from grocery shelves and a cracked storefront window in Calipatria. No major damage or injuries were reported (Imperial Valley Press, v. 76, no. 165, November 4, 1976; Calipatria Police and Fire Dept., oral commun., November, 6, 1976).

A total of 18 strong-motion records were recovered from 7 accelerograph stations located within 32 km of the epicenter. These instruments are owned and jointly maintained by the U.S. Geological Survey (USGS), the California Division of Mines and Geology (CDMG), and the Earthquake Engineering Research Laboratory of the California Institute of Technology

(CIT). This cooperative effort includes the development of a specialized strong-motion network in the Imperial Valley to fulfill such specific research needs as source-mechanism and ground-motion attenuation studies. The network presently consists of 24 accelerograph stations including a six-story building instrumented with a nine-channel CRA-1 remote recording system. Twenty of these stations contain accelerographs that record a WWVB absolute time code (GMT) on the accelerogram, and 22 stations contain instruments equipped with VS-1 vertical starters capable of triggering the accelerograph within a few tenths of a second of first P-wave arrivals. These capabilities, together with the relatively dense instrumental coverage in this region of recurring small- to moderate-size events, provide an ideal situation in which those data necessary to implement the preceding studies can be accumulated.

A maximum acceleration of 0.11 g was recorded by an accelerograph located at Brawley airport 12 km from the epicenter. Five of seven accelerographs that operated during this swarm are equipped with WWVB radio receivers and vertical triggers. Consequently, 14 accelerograms were recovered with identifiable events, and 12 of these records display S-trigger (S-t) or S-P intervals of 2.60-3.10 sec. Although some of the WWVB time codes are incomplete, significant portions were recorded to make possible positive identification of the events. The significant accelerograms are reproduced in figure 3.

Part of the nine-channel accelerogram from the six-story Imperial County Services Building at 940 Main Street in El Centro and a schematic of the strong-motion instrumentation scheme are shown in figures 4 and 5. Although the accelerations are small in amplitude, the accelerogram is included because it is the first such record recovered from a building instrumented by the CDMG in accordance with recently developed building instrumentation criteria. Instrumentation in this reinforced concrete frame and shear-wall building consists of a triaxial package of accelerometers at ground level, three single-axis horizontal accelerometers at the second floor level, and three single-axis horizontal accelerometers at the roof level. The recorder is located at the ground level and is equipped with a VS-1 vertical starter. An HS-1 horizontal starter is located at the roof level. The instrument triggered three times during the November swarm, and the records show maximum accelerations in the range 0.01-0.02 g.

One instrument at Calipatria recorded eight events in less than 44 minutes before it ran out of film. Five of these records show S-t intervals in the range 2.60-2.70 sec, and three records display S-P intervals of 2.80 sec. These records indicate that the instrument attained full operation within 0.2 sec of the first ground motion greater than the triggering threshold (table 3). In table 4, an obvious exception to this apparent early triggering capability is indicated by the accelerogram from Superstition Mountain. This station is located on Mesozoic granitic rock at an epicentral distance of about 25 km. The sharp S-wave arrival and 0.06 g peak acceleration would indicate a relatively low attenuation of the P-wave along this source-station path (Dielman, and others, 1975). The trigger time, however, is clearly late with respect to the S-wave arrival time and the inferred source-station travel path geometries of this site.

Of particular interest in table 4 are the S-wave arrival times at Brawley, Niland, Parachute Test, and Superstition Mountain. These four accelerograms are from the largest event (magnitude 4.9) of November 4. Although the epicentral distance for Superstition Mountain is approximately 40 percent greater than that for Parachute Test, the recorded S-wave arrivals at both stations occurred at nearly the same time. The velocity structure for this region is not well defined (Biehler, and others, 1964), but the inferred basement depth of 4 km at Parachute Test precludes this early S-wave arrival and must therefore be increased to 6 km to resolve these differences. The S-wave arrival at Niland is approximately 0.5 sec earlier than at Brawley, yet the epicentral distance for Niland is about 50 percent greater than it is for Brawley. Only a combination of adjustments in the assumed

velocity structure at Niland and the location of the epicenter can reasonably explain these inconsistencies. The S-P and S-t intervals at Calipatria, Brawley, and Parachute Test, however, significantly limit any changes in the epicenter location.

At present, records are digitized and further processed on a routine basis only if the peak acceleration exceeds 0.10 g. This minimum acceleration level is based primarily on the current capability of USGS to process strong-motion records and may vary with both the degree of seismic activity and number of personnel available at any given time. The records from the Calipatria swarm are not scheduled for further processing at this time. These accelerograms do, however, provide significant seismological data useful in magnitude and epicenter determinations, wave propagation, and source-mechanism studies of the Imperial Valley region.

References:

Biehler, S., Kovach, R. L., and Allen, C. R., 1964, Geophysical framework of northern end of Gulf of California structural province: Am. Assoc. Petroleum Geologists Memo 3, p. 126-143.

Dielman, R. J., Hanks, T. C., and Trifunac, M. C., 1975, An array of strong-motion accelerographs in Bear Valley, California: Seismol. Soc. America Bull. v., 65, p. 1-12.

STRONG-MOTION RECORD FROM THE MAY 17, 1976 GAZLI, U.S.S.R. EARTHQUAKE

On May 17, 1976 a large destructive earthquake occurred in the Kyzlkum desert of Uzbek, S.S.R. near the small settlement of Gazli, which is located approximately 90 km northwest of the ancient city of Bukhara. On the basis of data from a local seismic network installed after a magnitude 7.0 (M_S) event that occurred on April 8, 1976, the Institute of Physics of the Earth in Moscow has assigned a magnitude of 7.3 (M_{LH}) and a depth of 30 km to the May 17 earthquake (N. V. Shebalin, written commun., Nov. 10, 1976). On the basis of data from 300 worldwide stations, the National Earthquake Information Service of the U.S. Geological Survey has located the May 17 earthquake at lat 40.37 N., long 63.46 E. with a fixed depth of 10 km (J. S. Derr, oral commun., Nov. 10, 1976.)

The strong-motion record shown in figure 6 was recorded during the May 17 event, approximately 10 km from its epicenter, on the basis of preliminary data (N. V. Shebalin, oral commun., Nov. 10, 1976). It was recorded on a Soviet-built SSRZ three-component strong-motion accelerograph (table 5) installed in a temporary seismic station located in an unpopulated, undeveloped area of the desert approximately 30 km from Gazli. The station was established after the April 8 event to record possible further earthquake activity in the epicentral area.

On the basis of a direct scaling from figure 6, peak accelerations for the N-S, vertical, and E-W components are estimated to be 0.6 g, 1.3 g, and 0.8 g, respectively. The total length of the record is approximately 14 sec; the record was terminated when the film supply ran out. The durations for which the peaks of acceleration exceed 0.1 g are 10.5 sec for the N-S component, 13.6 sec for the vertical component, and 10.7 sec for the E-W component. Comparable durations for 0.5 g level motion are 3.8 sec, 6.1 sec, and 4.7 sec for the N-S, vertical, and E-W components, respectively.

The following preliminary information on the May 17 earthquake and strong-motion instrument site has also been provided (N. V. Shebalin and V. Shtejnberg, written commun., Nov. 10, 1976). The mechanism is strike slip with a small dip-slip component. The strong-motion instrument site rests on approximately 1420 m of sandy clay underlain by igneous rock. The maximum intensity of shaking in Gazli, located approximately 27 km from the epicenter, is estimated to be Intensity IX on the MSK-64 scale (equivalent to a MM Intensity of IX).

Because of the potential importance of the record, Shebalin and Shtejnberg have been asked to provide additional data and reports describing the earthquake mechanism, aftershock locations, location and extent of faulting, regional and site geology, instrument characteristics, instrument housing and location, and inten-

sity estimates. A copy of the original record, uncorrected and corrected digitized data, and calculated Fourier and response spectra have also been requested. This information will be made available to all interested parties as soon as it is received.

The record and support data were provided by N. V. Shebalin and V. Shtejnberg of the Institute of Physics of the Earth in Moscow and S. H. Negmatullaev of the Tadzhik Institute of Seismic Resistant Construction and Seismology in Dushanbe. The exchange of information with the Soviets has been made possible through the 1972 U.S.-U.S.S.R. Joint Agreement for Cooperation in the Field of Environmental Protection.

Reference: Shishkevish, C., 1975, Soviet strong-motion and vibration-and-blast seismographs: Defense Advanced Research Projects Agency Report No. R-1652 ARPA, Santa Monica, Calif., p. 56-59.

ABSTRACTS OF RECENT REPORTS

THE EFFECT OF SOIL-STRUCTURE INTERACTION ON THE READING OF SEISMOMETERS

By G. N. Bycroft

The rocking and translation of typical free field installations located on soft soils can significantly magnify the high-frequency components of ground motion. Further, bases or foundations that cover a significant part of horizontally incident wave motion can attenuate that motion. Down-hole instruments do not appear to be significantly affected by soil-structure interaction in practical cases. These results have been obtained using elastic half-space theory.

Reference: In press, Bulletin of the Seismological Society of America.

STRONG-MOTION ACCELEROGRAMS OF THE OROVILLE AFTERSHOCKS

By T. C. Hanks, A. G. Brady, and J. B. Fletcher

In the 90 days following the Oroville, California, earthquake (Aug. 1, 1975; M_L=5.7) 313 strong-motion accelerograms were obtained for 86 aftershocks with M_L as large as 5.2 and as small as 1.8. From this set we have chosen 123 records of 14 earthquakes ($2.8 \leq M_L \leq 5.2$) for digitization by a lazer-scanning device. The digitization of these records is so precise that transverse play of the advancing film with approximately 10 μ amplitude at the sprocket-hole frequency can be resolved. Several data-processing problems have been discovered in the processing of these small-amplitude, short-duration, high-frequency earthquakes. This set of data is a remarkable resource for earthquake mechanism information. Ten strong-motion accelerograms of the aftershock of 0350 Aug 6 (M_L=4.7) suggest that this earthquake was accompanied by a stress drop of approximately a kilobar; peak horizontal accelerations, velocities, and displacements were in the range 0.2-0.7 g, 3-20 cm/sec, and 0.3-2 cm, respectively.

Reference: In press, 1977 Meeting of Seismol. Soc. America, Sacramento, Calif., April 5-7, 1977.

NOTES ON STRONG-MOTION INFORMATION SOURCES

OROVILLE, CALIFORNIA, EARTHQUAKE 1 AUGUST 1975

California Division of Mines and Geology Special Report 124

This publication consists of 21 papers on the earthquake that struck the Oroville, California area on August 1, 1975. The papers are subdivided into four categories: governmental response and news coverage; geology and geologic investigations; earthquake damage; and seismology. The

fourth section (seismology) contains eight papers, including analyses of seismic intensity distribution data, strong-motion instrument data, and some results of aftershock studies. Spatial and temporal distributions of the aftershocks are presented both in tabular and graphical form.

This report is available through CDMG Publication Sales, P.O. Box 2980, Sacramento, Calif. 95812 ($3.50 plus tax).

ANNUAL REPORT ON STRONG-MOTION EARTHQUAKE RECORDS IN JAPANESE PORTS, SUPPLEMENTARY (1963-1975, Vertical Component).

Technical Note of the Port and Harbour Research Institute, Ministry of Transport, Japan. Number 250, December 1976.

Eiichi Kurata, Susumu Iai, and Hajime Tsuchida

Publication of this series of annual reports on strong-motion earthquake records in Japanese ports was begun in 1963. This volume contains digitized data of vertical ground accelerations from 28 records generated between 1963 and 1975. Vertical component response and Fourier spectra corresponding to previously published horizontal ground acceleration data are presented. Minimum peak horizontal and vertical accelerations for the records are 50 to 20 gals, respectively. The format of the data and the procedures used in record digitization for this report are virtually the same as those used for the previous annual reports.

Published by the Port and Harbour Research Institute, Nagase, Yokosuka, Japan.

U. S. EARTHQUAKES, 1974

Published jointly by U.S. Department of Commerce, National Oceanic and Atmospheric Administration and U.S. Department of the Department of the Interior, Geological Survey.

Edited by Jerry L. Coffman and Carl W. Stover, Boulder, Colorado, 1976, 125 pages.

This publication summarizes earthquake activity in the United States and nearby territories for the calendar year 1974. It includes brief descriptions of all earthquakes reported by residents of the United States, Puerto Rico, Virgin Islands, and the Panama Canal Zone. Each description generally contains date, time of occurrence, location, magnitude, felt area, and damage details. Included in this publication is a list of all pertinent data for instrumentally located earthquakes and related phenomena in the United States. The report presents sections on geodetic work of seismological interest, tidal disturbances of seismic origin, fluctuations in well-water levels with corresponding earthquakes, and principal earthquakes of of the world for 1974. Also presented is a list of all accelerograph records from the U.S. Geological Survey's strong-motion instrumentation network in 1974.

This report is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402.

DATA REPORTS AND AVAILABILITY OF DIGITIZED DATA

The strong-motion records from the February 9, 1971 San Fernando earthquake and most of the significant records prior to that event have been digitized by the California Institute of Technology (CIT). 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.

The digitization and analysis of the significant records subsequent to the San Fernando earthquake have been carried out by the USGS. A report containing digitized data and spectra for the significant records collected in 1971 has been released as open-file report 76-609, available upon request, and a tape containing all the numerical data is available from the Environmental Data Service (see below).

Future reports in this series will include an up-to-date collection of records from Lima, Peru. Estimates of the publication dates of these future

reports are as follows:

Records from Peru:	March 1977
Records from 1972:	April 1977
Records from 1973:	June 1977
Records from 1974:	September 1977
Records from 1975:	November 1977

Table 6 presents a list of the records to be contained in each of these data reports.

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

CIT Volume I data (uncorrected) on cards: EDS

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CIT Volume I data on tape: EDS and NISEE
CIT Volume II data (corrected) and Volume III data (response spectra) on tape: NISEE
SEB 1971 data (complete): EDS and NISEE

Inquiries should be addressed to:

1. EDS/NOAA
   National Geophysical and Solar-Terrestrial Data Center
   Mail Code D-62
   Boulder, CO 80302

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

3. Seismic Engineering Branch, USGS
   345 Middlefield Rd., Mail Stop 78
   Menlo Park, CA 94025

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Table 1 - *Summary of accelerograph records: October - December 1976*

Event	Station (owner)[1]	Station coord	S-t time[2] (sec)	Comp	Max accl[3] (g)	Duration[4] (sec)
14 April 1976 0655:06 GMT Imperial Valley 32.88N, 115.53W Magnitude 3.7	El Centro station 5 2801 James Rd (CIT)	32.85 N 115.46 W	2.20		**	
14 April 1976 0655:18 GMT Imperial Valley 32.88N, 115.53W Magnitude unknown	El Centro station 5 2801 James Rd (CIT)	32.85 N 115.46 W	2.50*		**	
14 April 1976 1031 GMT Imperial Valley 32.88N, 115.48W Magnitude 3.9	El Centro station 5 2801 James Rd (CIT)	32.85 N 115.46 W	2.25	N50E Down N40W	0.07 - 0.06	- - -
	El Centro station 6 551 Huston Rd (CDMG)	32.84 N 115.49 W	2.20	N50E Down N40W	0.14 0.05 0.09	(1-peak) - -
26 April 1976 0646 GMT Imperial Valley 33.13N, 115.66W Magnitude 3.8	Calipatria Fire station (CIT)	33.13 N 115.52 W	2.65	S45E Down N45E	0.07 0.03 0.05	- - -
	Salton Sea Wildlife refuge (CIT)	33.18 N 115.62 W	2.05	S45E Down N45E	0.07 0.05 0.08	- - -
11 July 1976 1655 GMT Panama 7.6N, 77.9W Magnitude 6.9	Panama Canal Zone Admin bldg (USGS)	8.96 N 79.55 W	-		**	
11 July 1976 2042 GMT Panama 7.6N, 77.9W Magnitude 7.1	Panama Canal Zone Admin bldg (USGS)	8.96 N 79.55 W	-		**	
18 August 1976 1015 GMT So California Epicenter and Magnitude unknown	Lone Pine Canyon (CIT)	34.32 N 117.57 W	-		**	

See footnotes at end of table

Table 1 - *Summary of accelerograph records: October - December 1976* - Continued

Event	Station (owner)[1]	Station coord	S-t time[2] (sec)	Comp	Max accl[3] (g)	Duration[4] (sec)
17 October 1976 0538 GMT So California 34.29N, 118.24W Magnitude 4.0	Newhall fire station (CDMG)	34.39 N 118.53 W	-		**	
	Lake Hughes Station 4 (CIT)	34.66 N 118.46 W	-		**	
4 November 1976 0548:24 GMT Imperial Valley 33.08N, 115.60W Magnitude 4.2	Calipatria Fire station (CIT)	33.13 N 115.52 W	2.60	S45E Down N45E	0.04 0.02 0.06	- - -
4 November 1976 0548:59 GMT Imperial Valley 33.08N, 115.60W Magnitude unknown	Calipatria Fire station (CIT)	33.13 N 115.52 W	2.80*	S45E Down N45E	0.05 0.03 0.07	- - -
4 November 1976 0621 GMT Imperial Valley 33.08N, 115.60W Magnitude unknown	Calipatria Fire station (CIT)	33.13 N 115.52 W	2.65	S45E Down N45E	0.04 0.02 0.05	- - -
	Note: Five additional shocks of the November 4 earthquake swarm were recorded at Calipatria before the instrument ran out of film. Max accl less than 0.05 g.					
4 November 1976 1041 GMT Imperial Valley 33.08N, 115.60W Magnitude 4.9	Brawley airport Transformer bldg (CIT)	32.99 N 115.51 W	2.90	S45E Down N45E	0.11 0.04 0.08	(1-peak) - -
	Niland fire station (CDMG)	33.24 N 115.51 W	3.10	West Down South	0.08 0.07 0.07	- - -
	Superstition Mtn Camera site (CIT)	32.96 N 115.84 W	0.90	N45W Down S45W	0.06 0.02 0.03	- - -
	Imperial Valley Parachute test facility (CIT)	32.93 N 115.70 W	2.90		**	
	El Centro station 9 (USGS)	32.79 N 115.55 W	-		**	
	Imperial County bldg 940 Main St (CDMG)	32.79 N 115.56 W	-		**	
	Note: Two additional records obtained from a nine-channel CR-1 recorder at Imperial County bldg. Max accl less than 0.05 g.					

See footnotes at end of table

Table 1 - *Summary of accelerograph records: October - December 1976* - Continued

Event	Station (owner)[1]	Station coord	S-t time[2] (sec)	Comp	Max accl[3] (g)	Duration[4] (sec)
4 November 1976 1413 GMT Imperial Valley 33.08N, 115.60W Magnitude 4.4	Niland fire station (CDMG)	33.24 N 115.51 W	3.00		**	
	Imperial Valley Parachute test facility (CIT)	32.93 N 115.70 W	-		**	

[1] CDMG - California Division of Mines and Geology.
CIT - California Institute of Technology.
USGS - U.S. Geological Survey.

[2] S-wave minus trigger time.
* denotes S-P interval, that is, the earthquake occurred at the end of a previous record.

[3] 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.

[4] Duration for which peaks of acceleration exceed 0.10 g.

Table 2: *Events of magnitude 4-plus from the Calipatria earthquake swarm of November 4, 1976*

Event	Time (GMT)	Magnitude
1	05:48	4.2
2	06:36	4.1
3	07:56	4.2
4	10:41	4.9
5	11:49	4.1
6	13:31	4.2
7	14:13	4.4

Table 3: *Events recorded at Calipatria on November 4, 1976*

[The epicentral distances at Calipatria are about 15 km for all of the above events. The station is situated on approximately 0.2 km of Quaternary alluvium and lacustrine deposits underlain by 5.6 km of Tertiary sedimentary rocks. Station elevation is 175 ft (53.3 m) below sea level.]

Record	Trigger time (GMT)	S-trigger interval (sec)	Max accl (g)	Magnitude
1	0548:23.80	2.60	.06	4.2
2	0548:29.20	2.80*	†	††
3	0548:58.90	2.80*	.07	††
4	0551:03.10	2.65	†	††
5	0551:39.00	2.80*	†	††
6	0621:03.10	2.70	.05	††
7	0627:38.30	2.70	.04	††
8	0631:54.40	2.65	†	††

* Denotes S-P interval, that is, the earthquake occurred within the instrumental run-time of a previous event.

† Maximum acceleration less than .04 g.

†† Magnitude unknown (less than 4.0).

Table 4: *Strong-motion stations that recorded the 10:41 event (mag 4.9) and the 14:12 event (mag 4.4) of November 4, 1976*

Station	Trigger time (GMT)	S-wave arrival (GMT)	S-trigger interval (sec)	Epicentral distance (km)	Max accl (g)
Niland	1041:41.50	1041:44.60	3.10	18.7	.08
Brawley	1041:42.20	1041:45.15	2.95	12.2	.11
Parachute Test	1041:44.10	1041:47.05	2.85	17.3	††
Superstition Mtn.	1041:46.10	1041:47.00	0.90	24.6	.06
Imperial County Services Bldg.	1041*	1041	†	32.0	††
El Centro #9	1041*	1041	†	31.8	††
Niland	1412:53.80	1412:56.80	3.00	18.7	††
Parachute Test Facility	1412:58.30	-	-	17.3	††

* No radio time; correlation with magnitude 4.9 event is assumed.

† Instrument equipped with horizontal starter; S-t is insignificant.

†† Maximum acceleration less than .04 g.

Table 5 - *Standard instrument characteristics for the SSRZ triaxial accelerograph with electromagnetic damping*

[The actual instrument characteristics of the accelerograph that recorded the May 17 event have not yet been obtained from the USSR.]

Natural frequency of pendulum accelerometers	20 Hz
Frequency range of flat response	0 to 15 Hz
Damping factor	0.6 critical damping
Trace sensitivity	15 mm/g
Film speed	10 mm/sec
Film length	3.5 m
Trigger level	0.3 to 0.5 cm/sec or 10 cm/sec^2
Dimensions	45 X 30 X 28.5 cm
Weight	22 kg (without power supply)

Table 6 - *Records being processed for data reports*

Date of event	Station location	Maximum accl (g)†
	Lima, Peru	
November 29, 1971	Geophysical Institute	0.08
January 5, 1974	Zarate Station	.16
	Geophysical Institute	.11
October 3, 1974	Dr. Huaco residence	.18
	Geophysical Institute	.21
November 9, 1974	La Molina Station	.14
	1972	
January 3, 1972	Managua, Nicaragua; Esso Refinery	0.15
January 5, 1972	Managua, Nicaragua; Esso Refinery	.22
	Managua, Nicaragua; National University	.12
March 4, 1972	Bear Valley, Calif.; Melendy Ranch barn	.15
March 22, 1972	Bear Valley, Calif.; Melendy Ranch barn	.16
July 30, 1972	Sitka, Alaska; Magnetic Observatory	.11
August 27, 1972	Beverly Hills, Calif.; 8383 Wilshire*	.15
	Beverly Hills, Calif.; 9100 Wilshire*	.12
	Los Angeles, Calif.; 6300 Wilshire*	.10
	Los Angeles, Calif.; 6420 Wilshire*	.15
September 4, 1972	Bear Valley, Calif.; CDF Fire Station	.18
	Bear Valley, Calif.; Melendy Ranch barn	.48
	Bear Valley, Calif.; Stone Canyon East	.18
December 23, 1972	Managua, Nicaragua; Esso Refinery	.39
Aftershock B	Managua, Nicaragua; Esso Refinery	.17
Aftershock C	Managua, Nicaragua; Esso Refinery	.32
	1973	
February 21, 1973	Port Hueneme, Calif.; U.S. Naval Laboratory	0.13
March 31, 1973	Managua, Nicaragua; National University	.60
April 26, 1973	Kilauea, Hawaii; Namakani Paio Campground	.17
August 8, 1973	Ferndale, Calif.; Old City Hall	.14
September 16, 1973	Berryessa, Calif.; CDF Fire Station	.18
	1974	
January 31, 1974	Gilroy, Calif.; Gavilan College, Bldg. 10	0.16
February 11, 1974	Los Angeles, Calif.; 420 S. Grand*	.10
	Los Angeles, Calif.; 525 S. Flower, No. Tower*	.13
	Los Angeles, Calif.; 700 W. 7th*	.18
	Los Angeles, Calif.; 533 S. Fremont*	.25
August 14, 1974	Pacoima Dam, abutment	.12
	Vasquez Rocks Park, Calif.	.10
November 28, 1974	Hollister, Calif.; City Hall	.17
	San Juan Bautista, Calif.; 24 Polk St.	.12
	Gilroy, Calif.; Gavilan College Bldg. 10	.14
December 6, 1974	Imperial, Calif.; Imperial Valley College Adm. Bldg.	.11

See footnotes at end of table.

Table 6 - *Records being processed for data reports* - Continued

Date of event	Station location	Maximum accl (g)†
	1975	
January 11, 1975	Petrolia, Calif.; General Store	0.10
	Cape Mendocino, Calif.; Petrolia	.19
January 23, 1975	Imperial, Calif.; Imperial Valley College Adm. Bldg.	.11
March 6, 1975	Bear Valley, Calif.; Melendy Ranch East	.18
May 6, 1975	Shelter Cove, Calif.; Station 2 Power Plant Yard	.18
June 7, 1975	Ferndale, Calif.; Old City Hall	.19
	Cape Mendocino, Calif.; Petrolia	.22
	Petrolia, Calif.; General Store	.19
	Shelter Cove, Calif.; Station 2 Power Plant Yard	.10
June 19, 1975	El Centro Array, Calif.; Station 6, 551 Huston	.10
June 20, 1975	El Centro Array, Calif.; Station 6, 551 Huston	.13
	Holtville, Calif.	.15
August 1, 1975	Oroville Dam, Calif.; Crest	.13
	Oroville Dam, Calif.; Seismograph station	.11
August 2, 1975	Pleasant Valley Pumping Plant, Calif.	.08
	Pleasant Valley, Calif.; Switchyard	.13
September 13, 1975	Parkfield Grade, Calif.; Jack Varian Ranch	.14
	Vineyard Canyon, Calif.	.18
November 14, 1975	Ferndale, Calif.; Old City Hall	.18
	Cape Mendocino, Calif.; Petrolia	.13
	Petrolia, Calif.; General Store	.10
November 29, 1975 0335 (local time)	Hilo, Hawaii; UH Cloud Physics Lab.	.15
November 29, 1975 0447 (local time)	Honokaa, Hawaii; Central Service Bldg.	.11

† Maximum acceleration at ground or basement level.
* The records from the upper levels of these buildings are being digitized.

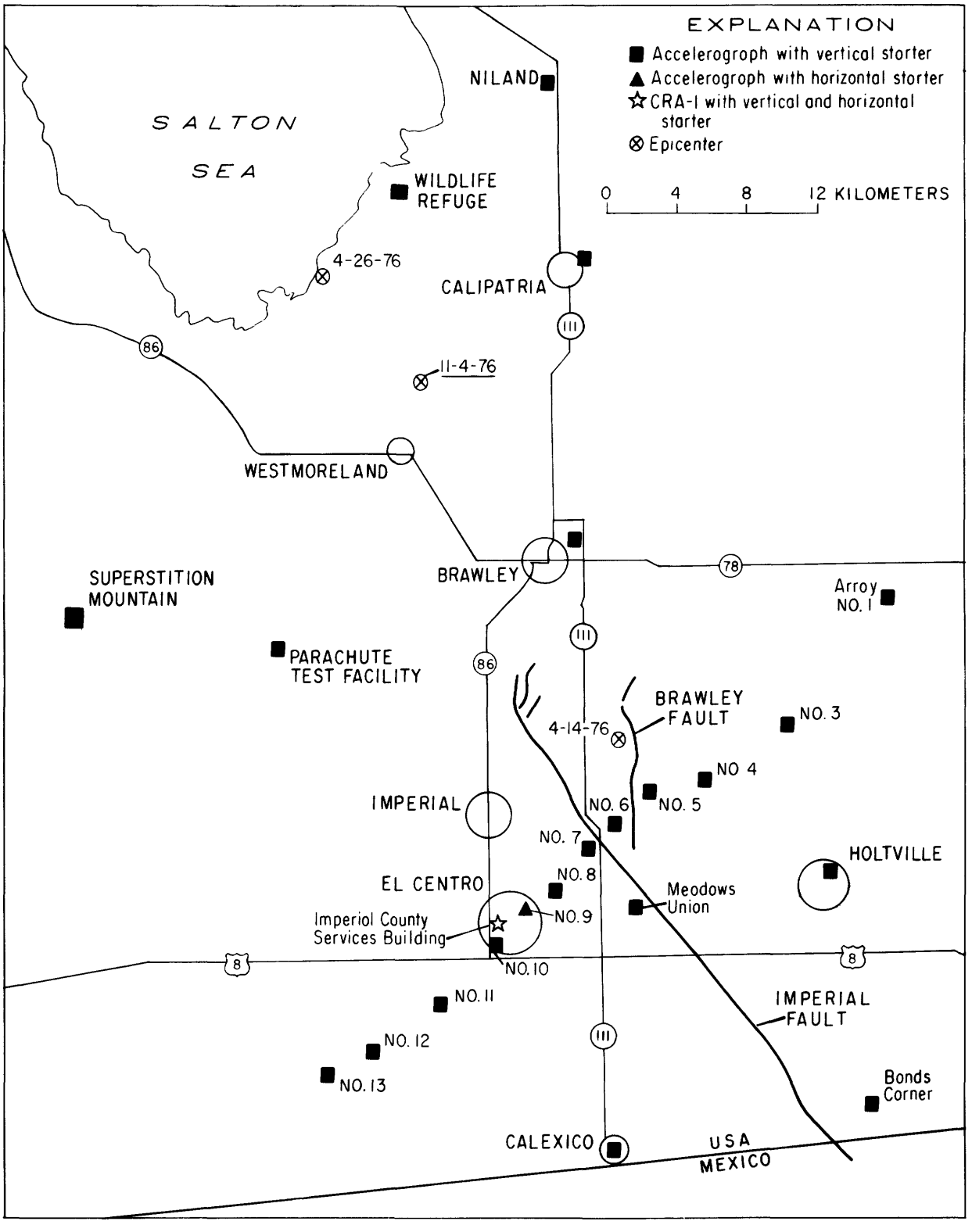

Figure 1.- Strong-motion stations in the Imperial Valley area.

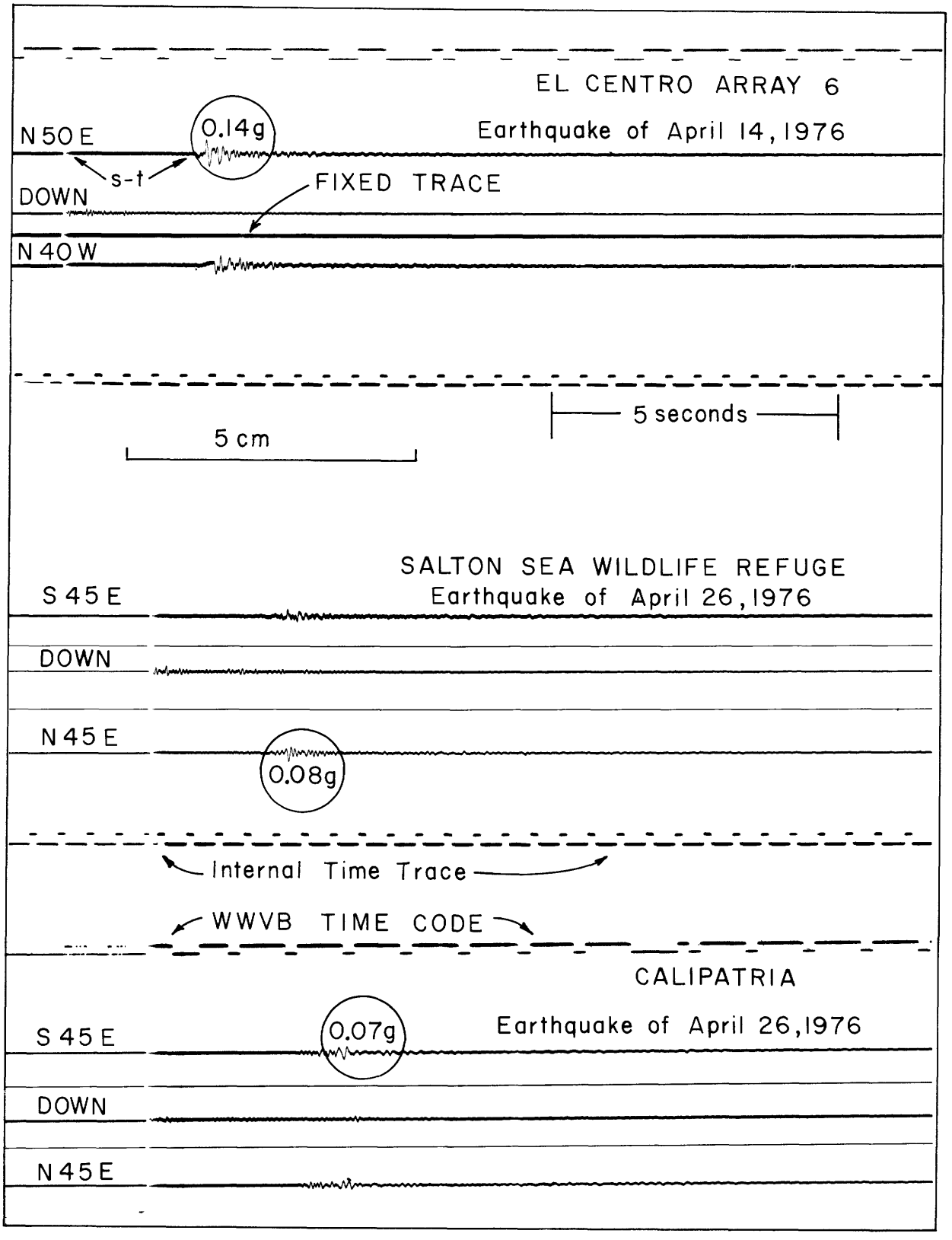

Figure 2.- Accelerograms from the Imperial Valley events of April 14 and 26, 1976.

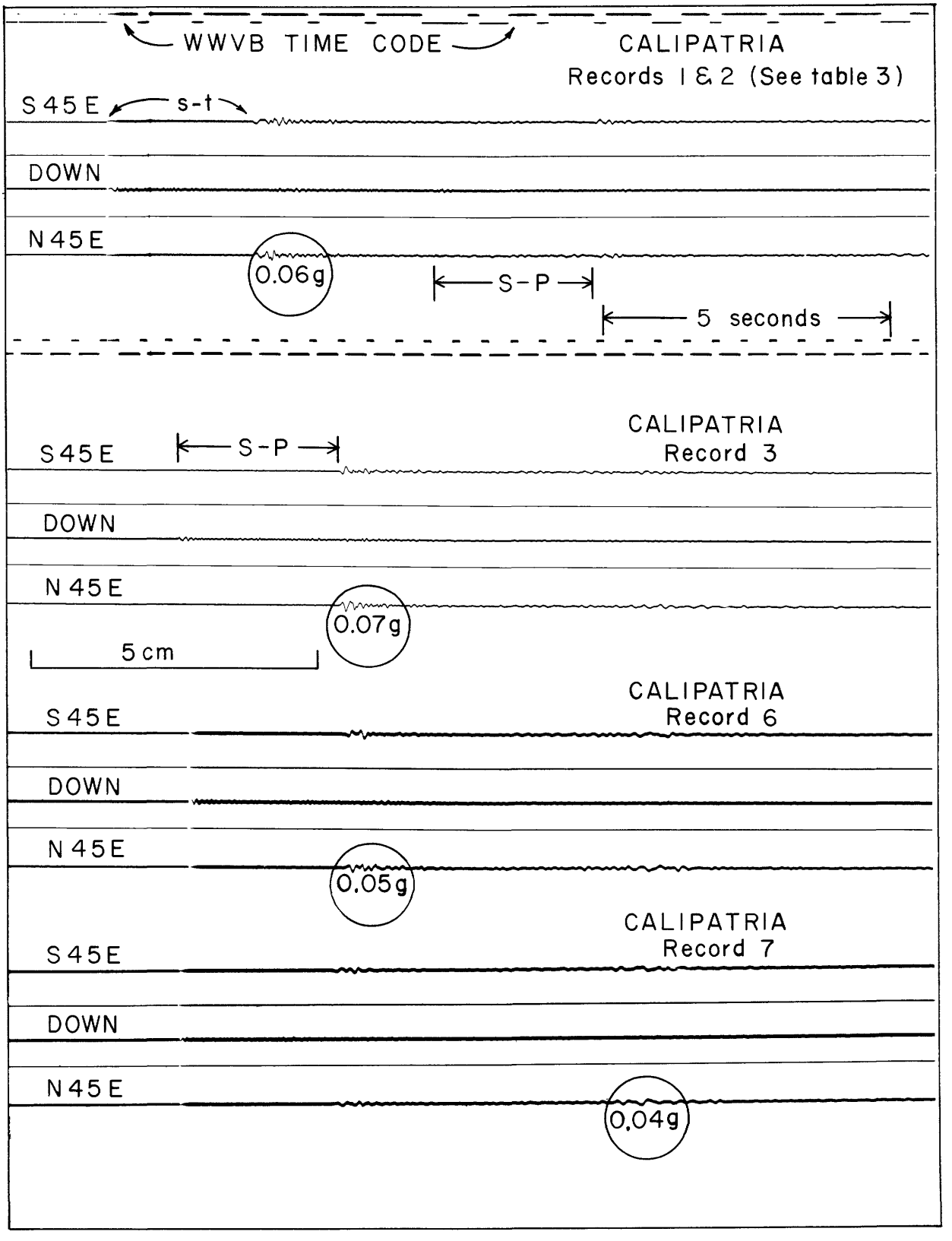

Figure 3.- Accelerograms from the Calipatria earthquake swarm, November 1976.

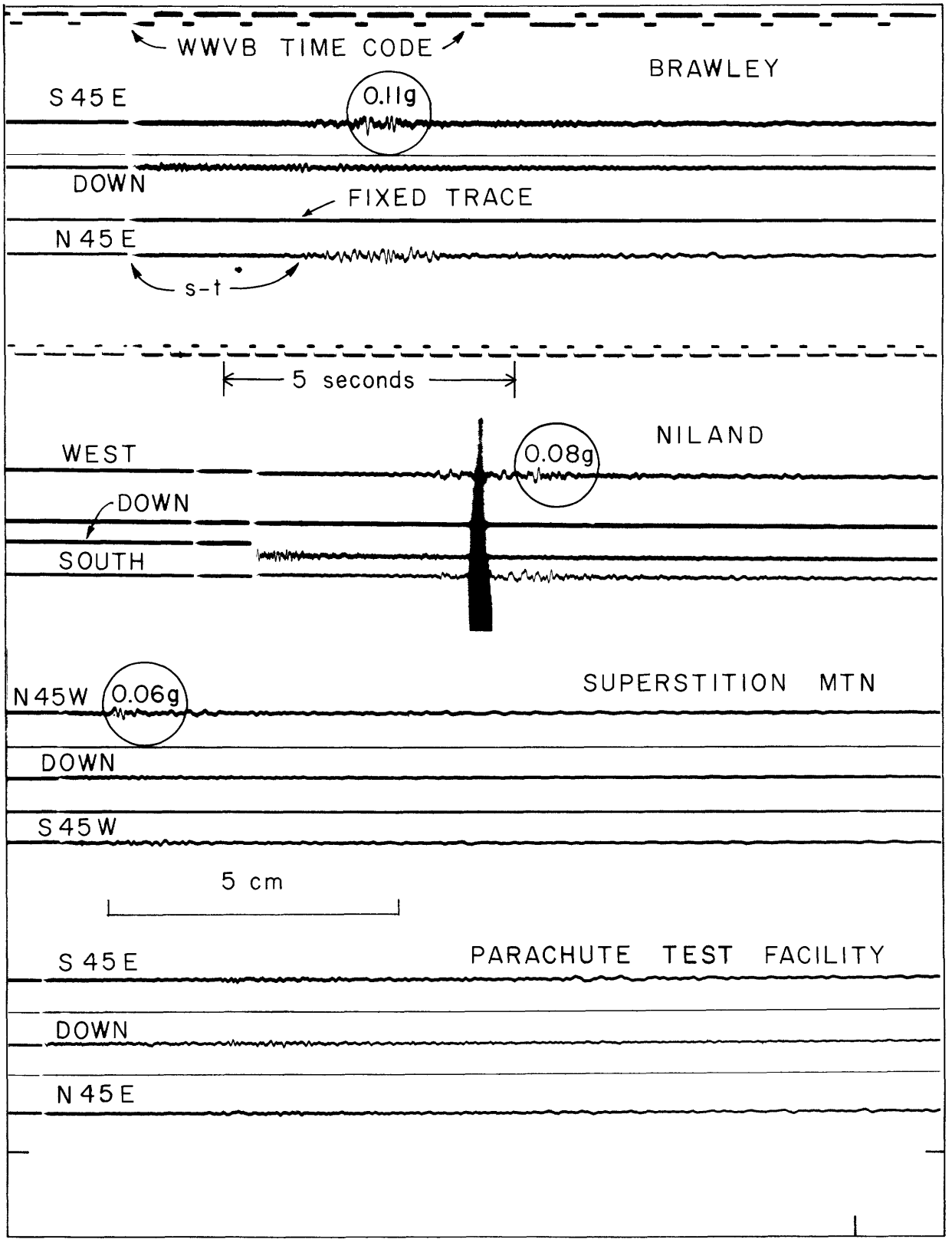

Figure 3.- Continued.

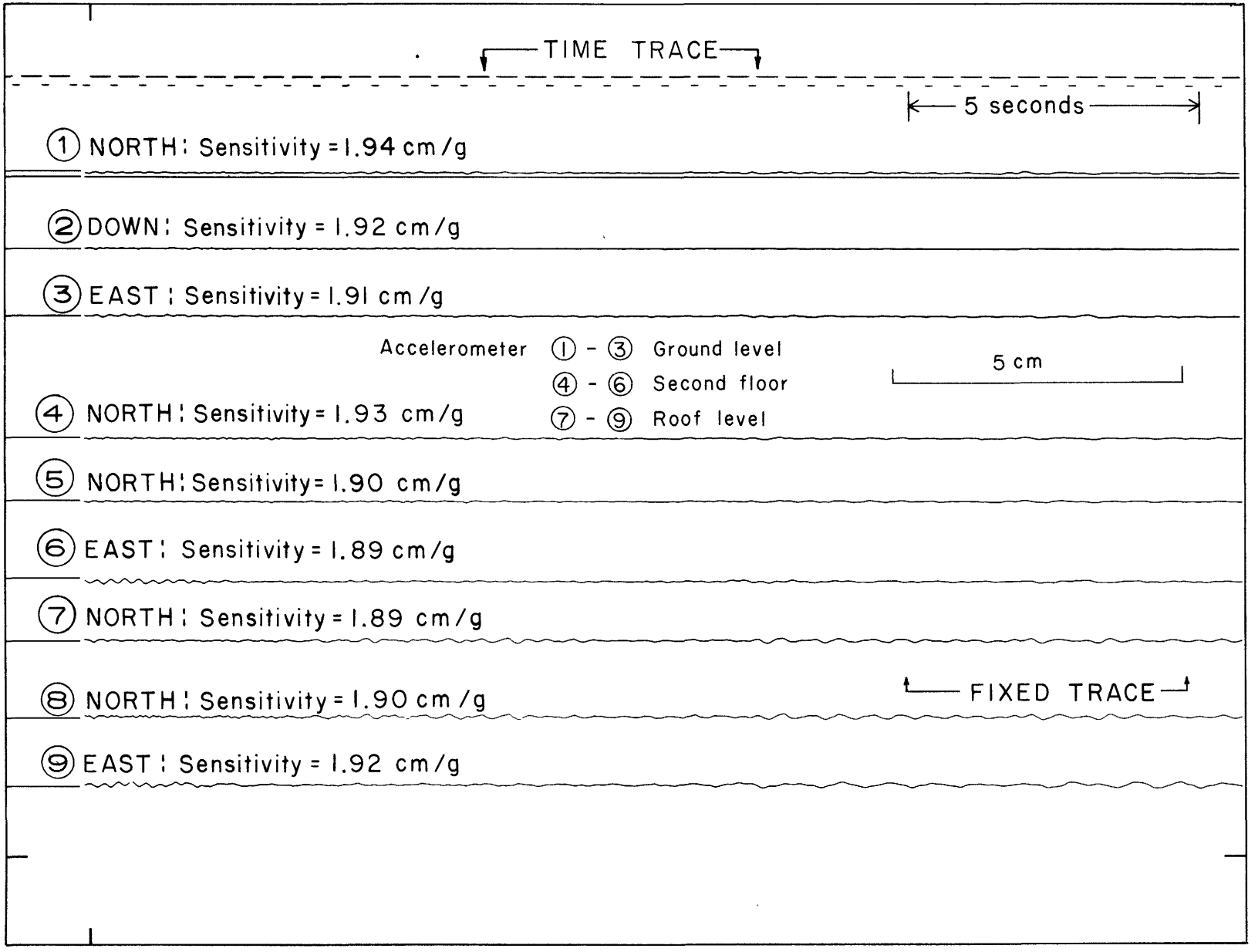

Figure 4.- Strong-motion record from the earthquake of November 4, 1976 - Imperial County Services Building, 940 Main Street, El Centro, California. See figure 5 for accelerometer locations.

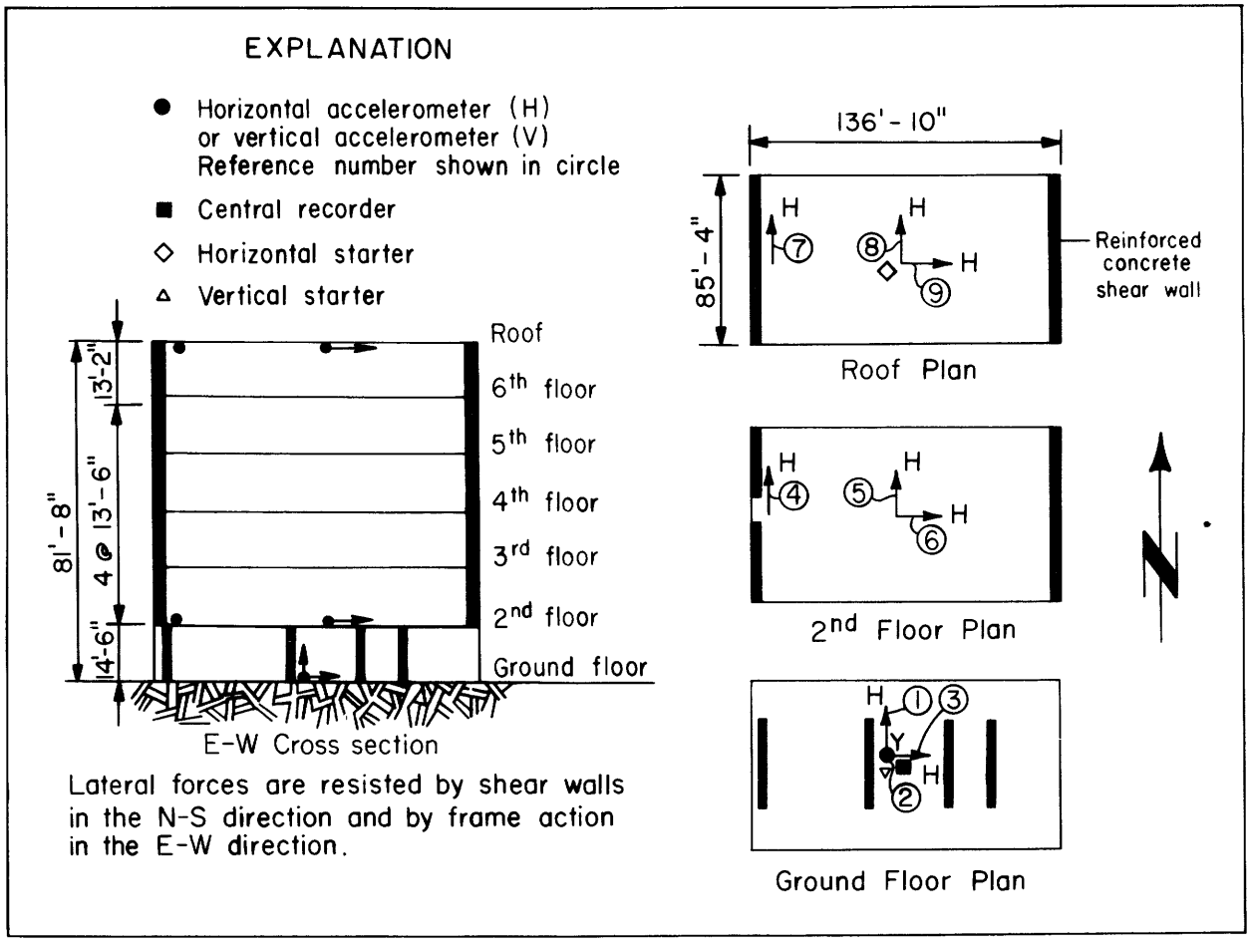

Figure 5.- Imperial County Services Building, 940 Main Street, El Centro, California. Schematic diagram showing locations of strong-motion instrumentation.

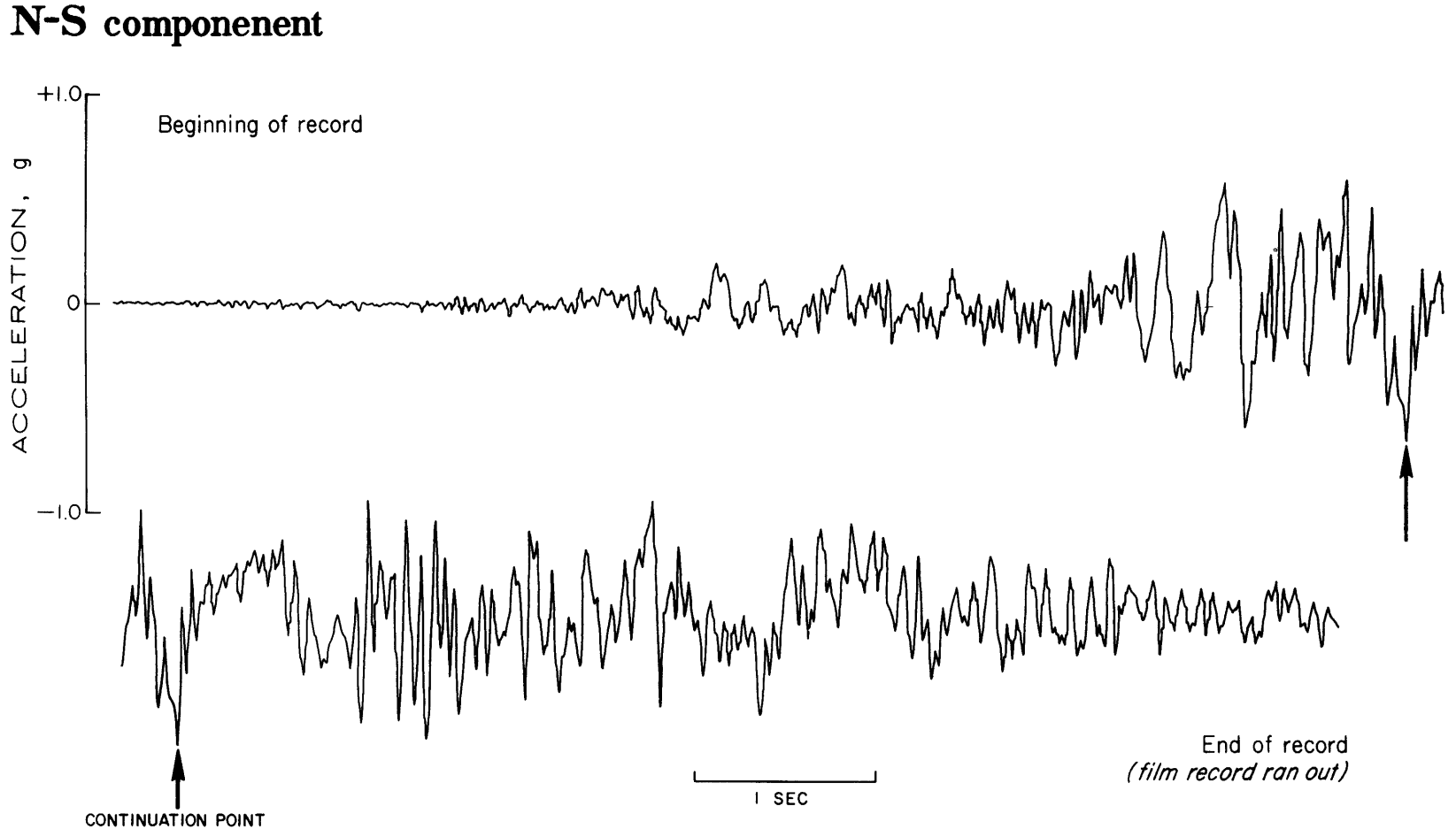

Figure 6a.- Plot of uncorrected digitized accelerogram from the May 17, 1976 Gazli, U.S.S.R. earthquake. N-S component, ground motion.

Vertical component

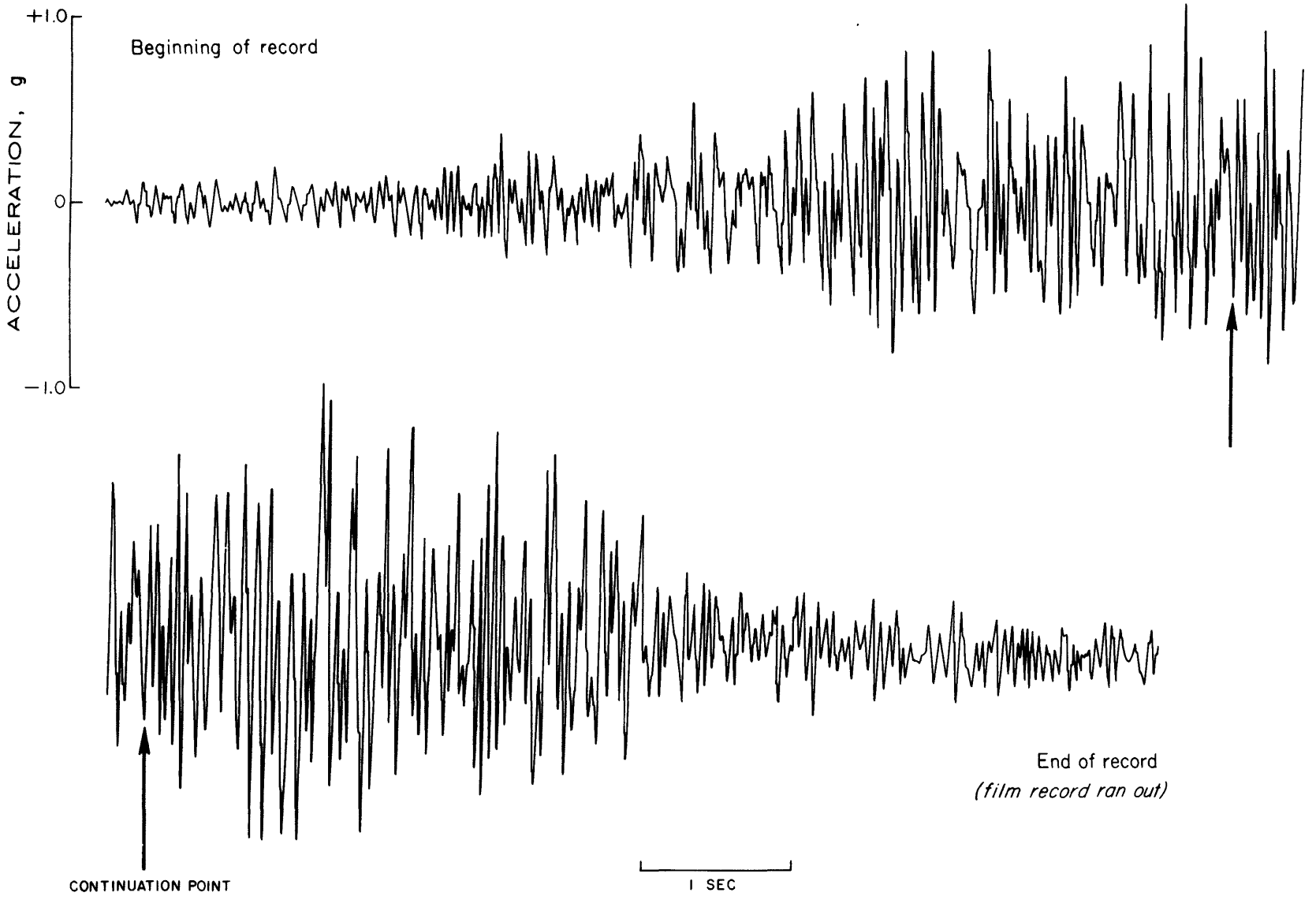

Figure 6b.- Plot of uncorrected digitized accelerogram from the May 17, 1976 Gazli, U.S.S.R. earthquake. Vertical component, ground motion.

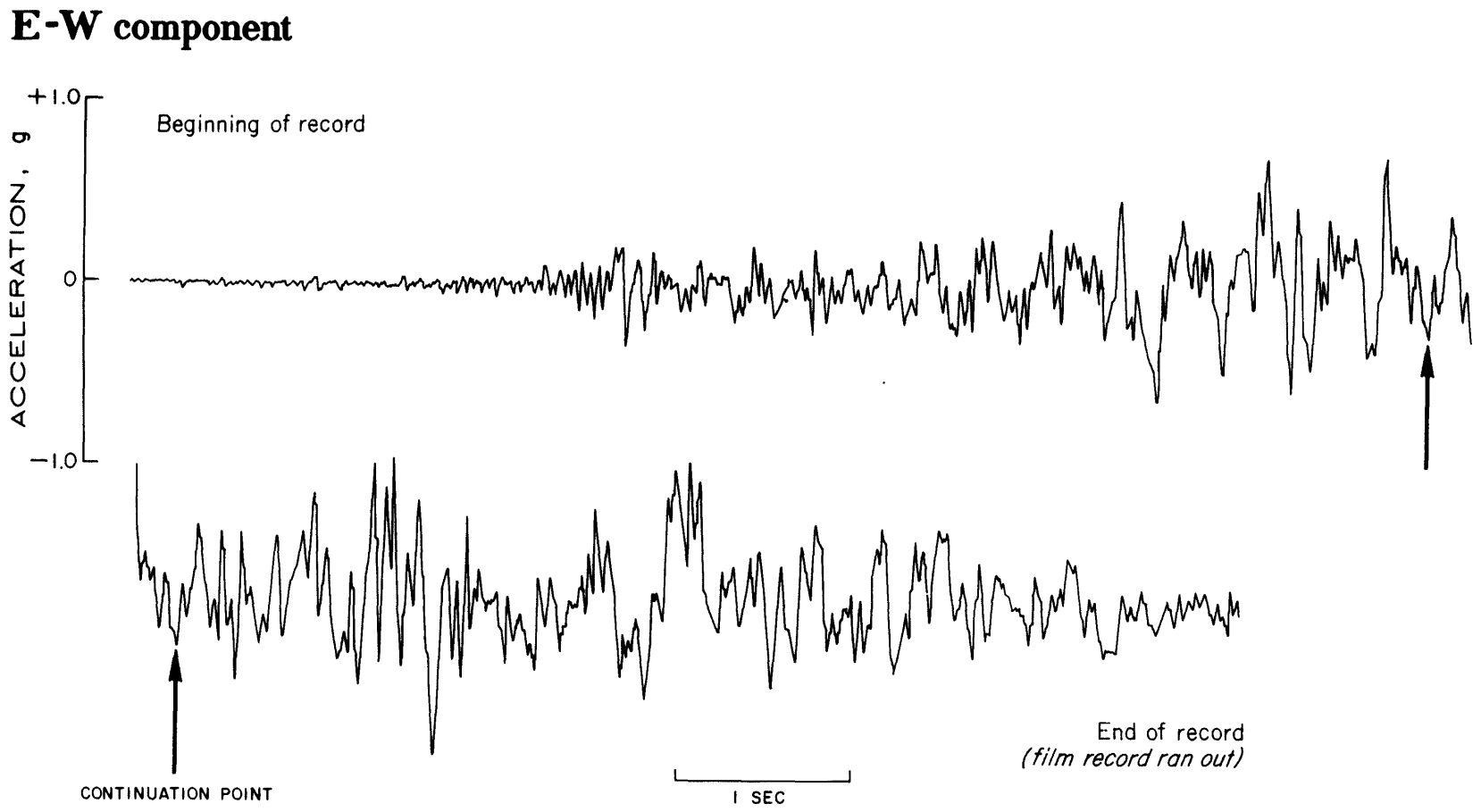

Figure 6c.- Plot of uncorrected digitized accelerogram from the May 17, 1976 Gazli, U.S.S.R. earthquake. E-W component, ground motion.