GEOLOGICAL SURVEY CIRCULAR 717-D

Seismic Engineering Program Report, October–December 1975

Prepared on behalf of the
National Science Foundation

Seismic Engineering Program Report, October–December 1975

GEOLOGICAL SURVEY CIRCULAR 717–D

Prepared on behalf of the
National Science Foundation

1976

United States Department of the Interior

THOMAS S. KLEPPE, *Secretary*

Geological Survey

V. E. McKelvey, *Director*

Free on application to Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, VA 22202

PREFACE

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

This report contains a list of the accelerograph records recovered during the third quarter of 1975, a preliminary report on the Hawaiian earthquake of November 29, 1975, and an abstract of a report on the US-USSR strong-motion program. Future issues will contain similar information with all listed data as current as practicable.

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

SEISMIC ENGINEERING PROGRAM REPORT, OCTOBER - DECEMBER 1975

ACCELEROGRAPH RECORDS JULY - DECEMBER 1975

By R. P. Maley and B. L. Silverstein

Seventy-four accelerograph records were obtained from the strong-motion network during the second half of 1975. Forty of these records were related to the Oroville earthquake of August 1, 1975, thirteen from the main shock and the remainder almost entirely from aftershocks. Table 1 presents a summary of the earthquake records including date, location, and magnitude of the event, location of recording stations, S-wave minus trigger times, maximum accelerations (when greater than 0.05 g for ground stations and 0.10 g for instruments located on structures), and the duration for which acceleration peaks exceeded 0.10 g. Aftershock records from the Oroville earthquake recorded by permanently installed accelerographs are presented in table 2. Results from numerous Oroville aftershocks recorded by temporary accelergraphs installed by the California Division of Mines and Geology and California Institute of Technology are not shown in table 2. The data from these latter records will be presented in future reports by those organizations as well as the U.S. Geological Survey.

The distribution of accelerographs in California is now so widespread that relatively close-in records are obtained from nearly any earthquake greater than magnitude 4.5 that occurs in the State. For instance, during the third quarter of 1975, 19 records with peak accelerations ranging from 0.08 g to 0.29 g were obtained from 3 magnitude 4.8 to 4.9 earthquakes. The widespread distribution of accelerographs in California in recent years is primarily the result of the implementation of the State of California Strong-Motion Instrumentation Program, in which the first priority was given to the installation of accelerographs in all areas in which magnitude 6 or greater earthquakes can be expected. This program is now in its second phase, in which emphasis will be placed on the instrumentation of structures, chiefly dams and buildings.

Preliminary reports were published in the previous program report (U.S. Geological Survey Circular 717-C) for two earthquakes listed in table 1, the magnitude 5.7 Oroville earthquake of August 1 and the magnitude 4.8 central California earthquake of August 2.

PRELIMINARY REPORT ON THE HAWAIIAN EARTHQUAKE OF NOVEMBER 29, 1975

by C. Rojahn and B. J. Morrill

In the early morning hours of November 29, 1975 a series of strongly felt earthquakes occurred beneath the island of Hawaii (population 64,000), largest of the Hawaiian Islands. Initial analysis and interpretation of both local seismograph and teleseismic data (W.J. Person, National Earthquake Information Service, oral commun., 12/17/75) indicate that two large earthquakes, a magnitude 5.7 event at 0335 local time (lat 19° 21.15'N long 155° 03.53'W) and a magnitude 7.2 event at 0447 local time (lat 19° 20.06'N, long 155° 01.45'W), occurred 5 km beneath the sparsely populated southeastern coastline approximately 45 km south of Hilo.

Four accelerographs and four seismoscopes were located on the island at the time of the earthquakes (fig. 1). Three accelerographs located at Hilo, Punaluu, and Honokaa were triggered, whereas the fourth, located in Kailua, was not triggered although it was found to be in good operating condition. Apparently, vertical motions at Kailua were below the nominal 0.01g threshold trigger level. Copies of the accelerograph records are shown in figures 2 and 3. Maximum accelerations, .05g threshold durations (time summation of record portions in which the envelope of the acceleration trace was greater or equal to 0.05g), total record lengths, accelerograph locations,

epicentral distances, and other statistics are listed in table 3. As indicated in that table, a maximum acceleration of 0.22g (N16W) was recorded at the University of Hawaii in Hilo (43 km to the north of the epicenter) during the second and larger event. A 0.05g threshold duration of 13.7 seconds was measured for the same component (total record length = 76 seconds).

Records obtained from each of the seismoscopes located at two sites in Hilo, at the Namakani Pio Campground and at Kailua are shown in figure 4. Descriptions of the instruments and data, including relative displacement response spectrum values, S_d, are listed in table 4. As indicated in that table, the maximum relative displacement, S_d=3.4 cm, was recorded in Hilo, 43 km from the epicenter with lesser values recorded 45, 31 and 108 km from the epicenter.

The larger event generated a tsunami that caused at least one death, injury to 28 persons, and significant structural and nonstructural damage. This event was most probably also responsible for the slight to moderate structural and nonstructural damage sustained in the epicentral area and in Hilo from strong ground shaking. Most of the several dozen structures (mostly 1-story wood-frame corrugated-metal-roof dwellings) located within the sparsely populated epicentral area suffered little or no structural damage. In Hilo, the closest urban center to the epicenter (45 km to the north), damage was more prevalent, but less severe (based on comparative personal observations by one of the authors) than that sustained in the April 26, 1973 Hawaii earthquake (magnitude 6.2) whose epicenter was located approximately 16 km north of Hilo.

Outside of the immediate epicentral area (10 to 30 km from the epicenter) the authors observed only scattered evidence of strong ground shaking. At Pahoa (pop. 1000), 20 km northeast of the M_s=7.2 epicenter, and in the vicinity of Kilauea Volcano, 29 km northwest of that epicenter (both areas contain mostly wood-frame metal-roof buildings), damage was minimal, a fallen unreinforced masonry chimney at the Kilauea Military Camp Cafeteria being the most serious observed damage. Near Cape Kumukahi, 29 km northeast of the M_s=7.2 epicenter, stacks of lava rocks were intact, and in Lava Tree State Park, 21 km northeast of the epicenter, lava trees were not damaged.

Within the city of Hilo the effects of strong ground shaking included: plate glass windows broken in many of the old downtown wood-frame shops; items fell from shelves in some stores; furniture moved or overturned; a few older homes reportedly collapsed or partially collapsed (owners' reports to Civil Defense Office, unverified by authors); and several engineered structures suffered slight to moderate structural and nonstructural damage.

Preliminary damage statistics compiled by the Hilo Civil Defense Office are listed in table 5. The $4,147,973 total is current to December 18, 1975 and includes damages caused both by the tsunami and by the strong ground shaking.

ABSTRACT OF A RECENT REPORT

Rojahn, C., and Negmatullaev, S.K., Joint US-USSR strong-motion network, Tadzhik SSR; presented at the Annual Fall Meeting of the American Geophysical Union meeting in San Francisco, Calif., December 1975.

A network of 18 optical-mechanical, triaxial accelerographs and 1 remote-recording nine-channel, accelerograph system is being installed in the Tadzhik, SSR, one of the most highly active seismic areas in the USSR. The nine-channel system is installed in a multistory building in Dushanbe; the remaining instruments are being installed in a variety of sites including dams, buildings, and ground stations.

AVAILABILITY OF DIGITIZED DATA

The February 9, 1971 San Fernando earthquake strong-motion records and most of the significant records 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), NOAA in the following forms:

CALIFORNIA INSTITUTE OF TECHNOLOGY:
* Volume I form of data (uncorrected) is available on four magnetic tapes at a total cost of $400.

* Volume II form of data (corrected) is available for 329 records on three magnetic tapes at a total cost of $300. Data are available on seven-track, 800 BPI formatted tape in BCD; a few other formats are available including nine-track 1600 BPI.
*Inquiries should be addressed to:

Earthquake Engineering Research Lab
California Institue of Technology
MailMail Code 104-44
Pasadena, CA 91125

(213) 795-6841, ext 1232

ENVIRONMENTAL DATA SERVICE:
8 Volume I form of data (uncorrected) is available in punched card form (about 2000 cards each) for $20 per event and on magnetic tape (seven- or nine-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-
Terestrial Data Center
EDS/NOAA Code 62
Boulder, CO 80302

(303) 499-1000, ext 6472

Strong-motion records obtained since the San Fernando earthquake are being processed by the USGS. The availability of such data will be announced in subsequent Program Reports.

Table 1 - *Summary of accelerograph records: July - December 1975*

Event	Station location		S-t time[1] (sec)	Comp	Max accl[2] (g)	Duration[3] (sec)
	Name	Coord				
19 July 1975 0600 MST Helena, Montana 47.0N, 111.9W Magnitude 3.5	A small-amplitude record was obtained at Fort Harrison					
24 July 1975 2341 Local Time Cold Bay, Alaska 54.5N, 160.0W Magnitude 5.7	A small-amplitude record was obtained at Cold Bay.					
1 August 1975 1220 PST Oroville, Calif. 39.44N, 121.53W Magnitude 5.7	Chico	39.70N 121.72W	-	S33W Down S57E	.08 .03 .06	
	Marysville	39.15N 121.58W	-	S85W Down S05E	.07 .04 .06	
	Oroville Dam crest	39.54N 121.48W	-	N46E Down N44W	.12 .13 .09	1.6 0.3 -
	Oroville Seismo- graph Station	39.55N 121.50W	-	N53W Up N37E	.10 .12 .11	1 peak 1 peak 1 peak
	A small-amplitude record, presumed to be a foreshock, preceded the main record at the Oroville Dam, crest station.					
	Small-amplitude records were also obtained from stations at Almanor, Black Butte Dam, Garnier Ranch, Martis Creek Dam, Peripheral Canal, Rancho Seco, Stempede Dam, and Sutter Buttes in California and at Reno, Nevada.					
	See table 2 for a list of aftershock records from the Oroville earthquake.					
1 August 1965 1614 PST So California 33.54N, 116.58W Magnitude 4.8	Palm Springs	33.83N 116.51W	4.3	South Down East	.04 .04 .05	
	Puerta LaCruz	33.32N 116.68W	-	N20W Down S70W	.08 .07 .06	
	Sage	33.58N 116.93W	2.1	S14E Down N76E	.06 .04 .06	
	Small-amplitude records were also obtained at Indio, Hemet Fire Station and Borrego Springs.					

See footnotes at the end of the table.

Table 1 - *Summary of accelerograph records: July - December 1975* - Continued

Event	Station location		S-t time[1] (sec)	Comp	Max accl[2] (g)	Duration[3] (sec)
	Name	Coord				
2 August 1975 2235 PST Cntl California 36.46N, 120.33W Magnitude 4.8	Pleasant Valley Pumping Plant Basement	36.31N 120.25W	-	N44W Down S46W	.08 .02 .05	
	Pleasant Valley Pumping Plant Ground Level	36.31N 120.25W	-	N44W Down S46W	.08 .02 .05	
	Pleasant Valley Pumping Plant Roof	36.31N 120.25W	-	N45E Down N45W	.13 .04 .16	1.2 - 2 peaks
	Pleasant Valley Switchyard	36.31N 120.25W	-	N45E Down N45W	.08 .03 .13	- - 1 peak
2 Aug -19 Aug No California Loc and Mag unknown	Mariposa	37.53N 119.99W		S49W Down S41E	.08 .03 .06	
16 August 1975 1724 PST No California 37.53N, 118.74W Magnitude 3.7	A small-amplitude record was obtained at Convict Creek.					
13 September 1975 1420 PST Cntl California 36.00N, 120.56W Magnitude 4.9	Cholame-Shandon Array Station No 5	35.70N 120.33W	-	N51E Down N39W	.03 .02 .07	
	Cholame-Shandon Array Station No 8	35.67N 120.36W	-	N51E Down N39W	.02 .02 .05	
	Parkfield	35.90N 120.43W	2.6	North Down West	.07 .03 .06	
	Parkfield Grade	35.98N 120.48W	2.0	S67W Down S23E	.14 .04 .08	1.2 - -
	Vinyard Canyon	35.92N 120.53W	1.3	N64W Down S26W	.29 .20 .21	1.7 - 1.2
	Small-amplitude records were also obtained from Bitterwater Valley, Gold Hill, Greenfield, and San Antonio Reservoir.					

See footnotes at the end of the table.

Table 1 - *Summary of accelerograph records: July - December 1975* - Continued

Event	Station location		S-t time[1] (sec)	Comp	Max accl[2] (g)	Duration[3] (sec)
	Name	Coord				
14 November 1975	Ferndale	40.58N	-	Up	.03	-
0130 PST		124.26W		S44W	.18	0.5
No California				N46W	.09	-
40.57N, 124.45W	Cape Mendocino	40.35N		S60E	.10	0.1
Magnitude 5.1		124.35W	-	Down	.01	-
				N30E	.13	0.2
	Petrolia	40.32N		N75E	.10	1 peak
		124.29W	-	Down	.02	-
				N15W	.08	-
	Shelter Cove,	40.03N		S20E	.05	
	Station 2	124.06W	-	Down	.02	
				N70E	.07	
	A small-amplitude record was also obtained at Rockport.					
29 November 1975	Honokaa, Hawaii	20.07N		N15W	.04	
0335 HST		155.06W	-	Down	.02	
Island of Hawaii				S75W	.06	
19.35N, 155.06W	Hilo, Hawaii	19.70N		N74E	.05	-
Magnitude 5.7		155.08W	-	Down	.05	-
				N16W	.15	0.15
	A small-amplitude record was also obtained at Punaluu.					
29 November 1975	Honokaa, Hawaii	20.07N		N15W	.09	-
0447 HST		155.06W	-	Down	.04	-
Island of Hawaii				S75W	.11	0.3
19.33N, 155.02W	Hilo, Hawaii	19.70N		N74E	.11	1 peak
Magnitude 7.2		155.08W	-	Down	.10	1 peak
				N16W	.22	2.1
	Punaluu, Hawaii	19.16N		S37W	.12	1 peak
		155.52W	-	Down	.05	-
				N63E	.10	1 peak
	The duration of 2.1 sec for the N16W component of the Hilo record is for the first part of the record only.					

[1] S-wave minus trigger time.

[2] Unless otherwise noted, maximum acceleration recorded at ground or basement level. Data from the records are summarized only if the maximum acceleration is greater than 0.05 g at ground stations or greater than 0.10 g at upper floors of buildings.

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

Table 2 - *Summary of aftershock records from the Oroville earthquake*

Dates[1]	Station location		S-t time[2] (sec)	Comp	Max accl[3] (g)	Duration[4] (sec)
	Name	Coord				
1 Aug - 6 Aug	Oroville Seismo-	39.55N		N53W	.11	
	graph Station	121.50W	-	Up	.12	
				N37E	.12	
				N53W	.03	
			-	Up	.03	
				N37E	.05	
	Three small-amplitude records were obtained at the Oroville Seismograph Station and one at the Oroville Dam core block.					
5 Aug - 6 Aug	Oroville Dam,	39.55N		N46E	.09	
	core block	121.48W	-	Down	.05	
				N44W	.05	
6 Aug - 19 Aug	Oroville Dam	39.54N		N46E	.14	1 peak
	crest	121.48W	1.1	Down	.07	-
				N44W	.12	0.2
				N46E	.04	
			1.0	Down	.05	
				N44W	.08	
	Two small-amplitude records were obtained at the Oroville Dam crest, one at the Oroville Seismograph Station, and four at Chico.					
19 Aug - 5 Sep	Oroville Dam	39.54N		S44E[5]	.05	
	crest	121.48W	1.4	Down	.07	
				N46E	.11	1 peak
	Oroville Seismo-	39.55N		N53W	.04	
	graph Station	121.50W	-	Up	.06	
				N37E	.08	
	Two small-amplitude records were obtained at the Oroville Dam crest.					
5 Sep - 30 Sep	Oroville Dam	39.54N		S44E	.15	1 peak
	crest	121.48W	1.4	Down	.03	
				N46E	.04	
				S44E	.13	0.8
			1.1	Down	.10	1 peak
				N46E	.13	0.3
	Four small-amplitude records were obtained at the Oroville Dam crest.					

[1] Since most of the accelerographs at these stations do not have a real-time base, these records can only be categorized as having occurred during the time intervals shown.

[2] S-wave minus trigger time.

[3] Unless otherwise noted, maximum acceleration recorded at ground or basement level. Data from the records are summarized only if the maximum acceleration is greater than 0.05 g at ground stations or greater than 0.10 g at upper floors of buildings.

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

[5] The instrument at Oroville Dam was replaced with a newer instrument on 19 August 1975. This resulted in the change in component directions indicated.

Table 3 - *Accelerograph data, Hawaiian earthquakes of November 29, 1975*

Station location	Structure	Geology	Event	Epicentral distance (km)	Maximum accel (g)	Duration[1] .05g lvl (sec)	Total[2] length (sec)
Hilo, Cloud Physics Lab, UOH	1-story building	Lava rock	M_s=5.7	42	.15	1.3	18
			M_s=7.2	43	.22	13.7	76
Punaluu, Resort Serv Building	Small, 1-story building	Beach sand, lava rock	M_s=5.7	52	.03	0	26
			M_s=7.2	56	.14	10.8	84
Kailua, Fire Sta	1-story building	Lava rock	M_s=5.7	104	**[3]	**[3]	**[3]
			M_s=7.2	108	**[3]	**[3]	**[3]
Honokaa, Cntrl Serv Building	1-story building	Red ash & soil	M_s=5.7	99	.06	1.0	18
			M_s=7.2	95	.11	7.3	45

[1] $\Sigma t_{(a_e=.05g)}$ where t= time, a_e= maximum acceleration envelope.

[2] Includes final trigger-stop interval (normally 7-10 seconds).

[3] Instrument not triggered.

Table 4 - *Seismoscope data, Hawaiian earthquakes of November 29, 1975*

Station location	Structure	Geology	Distance to epcntr (km)	Direction to epcntr	Max Relative displac, S_d[1] (cm)
Hilo, Univ of Hawaii	1-story building	Lava rock	43	S08E	3.4
Hilo, Lyman Residence	1-story building	Volcanic ash	45	S09E	3.1
Namakani Pio Camp Ground	1-story building	Lava & ash	31	S71E	1.5
Kailua Rec Center	1-story building	Beach sand, lava rock	108	S70E	0.4

[1] Maximum relative displacement, $S_d = \frac{gT^2}{4\pi^2} \max\sqrt{n/10}$

where T = period of seismoscope (0.75 seconds assumed)
n = percent critical damping (function of maximum record displacement)
Φ_{max}= trace amplitude sensitivity (normally 5.5 cm/rad).

Table 5 - *Civil Defense dollar damage estimates*[1]

Public sector		
State		
Highway Division		$ 20,000
Harbors Division		141,2000
General Services Dept		
Schools		142,800
Other State Buildings		114,300
		$418,300
County		
Water Supply		$ 31,000
Public Works		597,000
Parks & Recreation		160,000
		$788,000
Federal		
National Parks		$844,000
		$2,050,300
Private sector		
Homes: Punaluu		$177,625
Other areas		298,852
Boats		243,800
Buisness firms		1,355,396
Hawaii Electric Co		10,000
Telephone Co		5,000
Gas Co		1,500
Churches		1,000
Others		4,500
		$2,097,673
	Total	$4,147,973

[1] Oral communication, S. Kim, Acting Civil Defense Administrator Hilo, Hawaii (12/18/75).

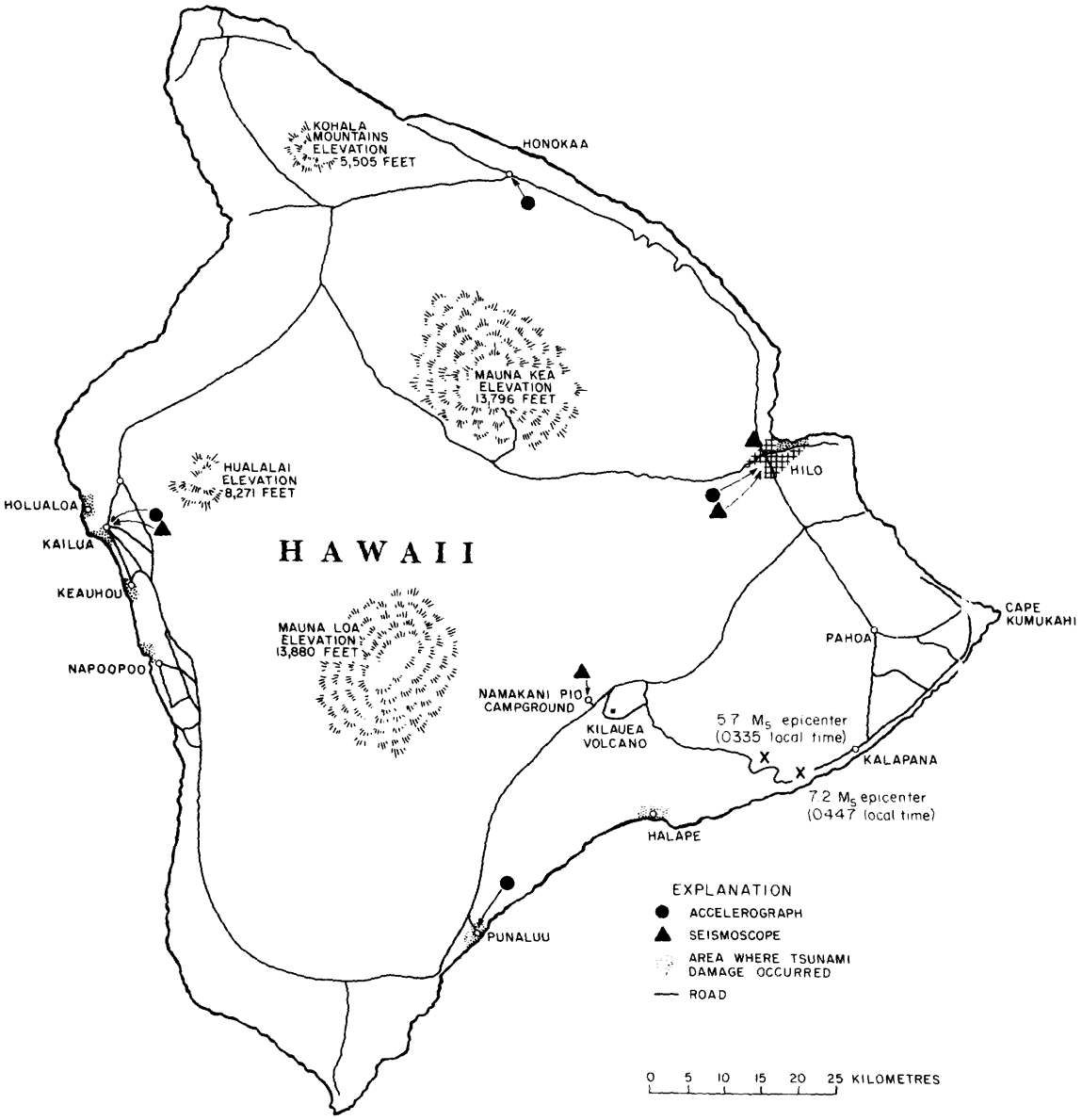

Figure 1.- Map of the island of Hawaii showing accelerograph, seismoscope, November 29, 1975 earthquake epicenter, and observed tsunami damage locations.

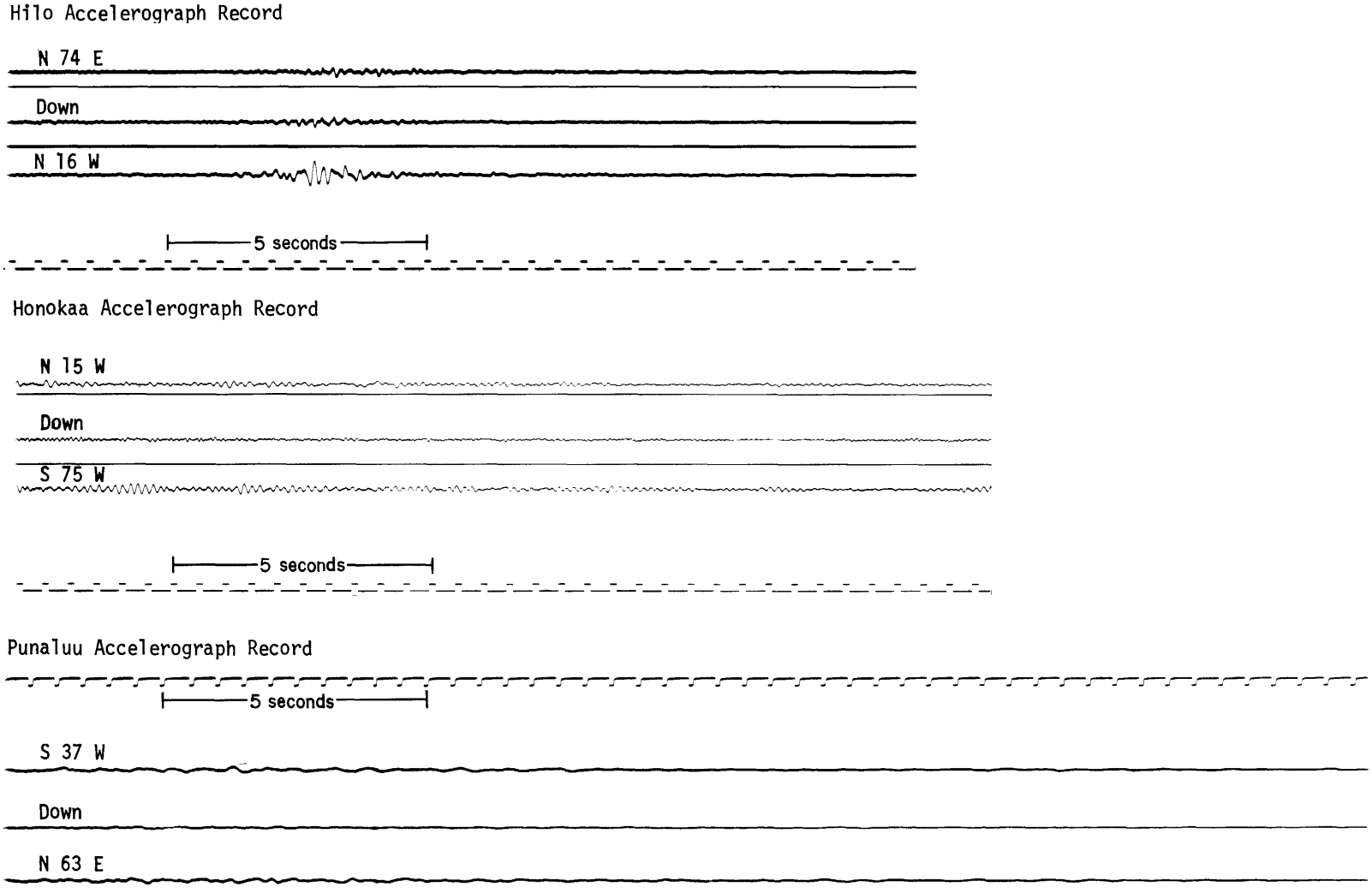

Figure 2.- Accelerograph records from the 0335 (local time) November 29, 1975 island of Hawaii earthquake (M_S = 5.7).

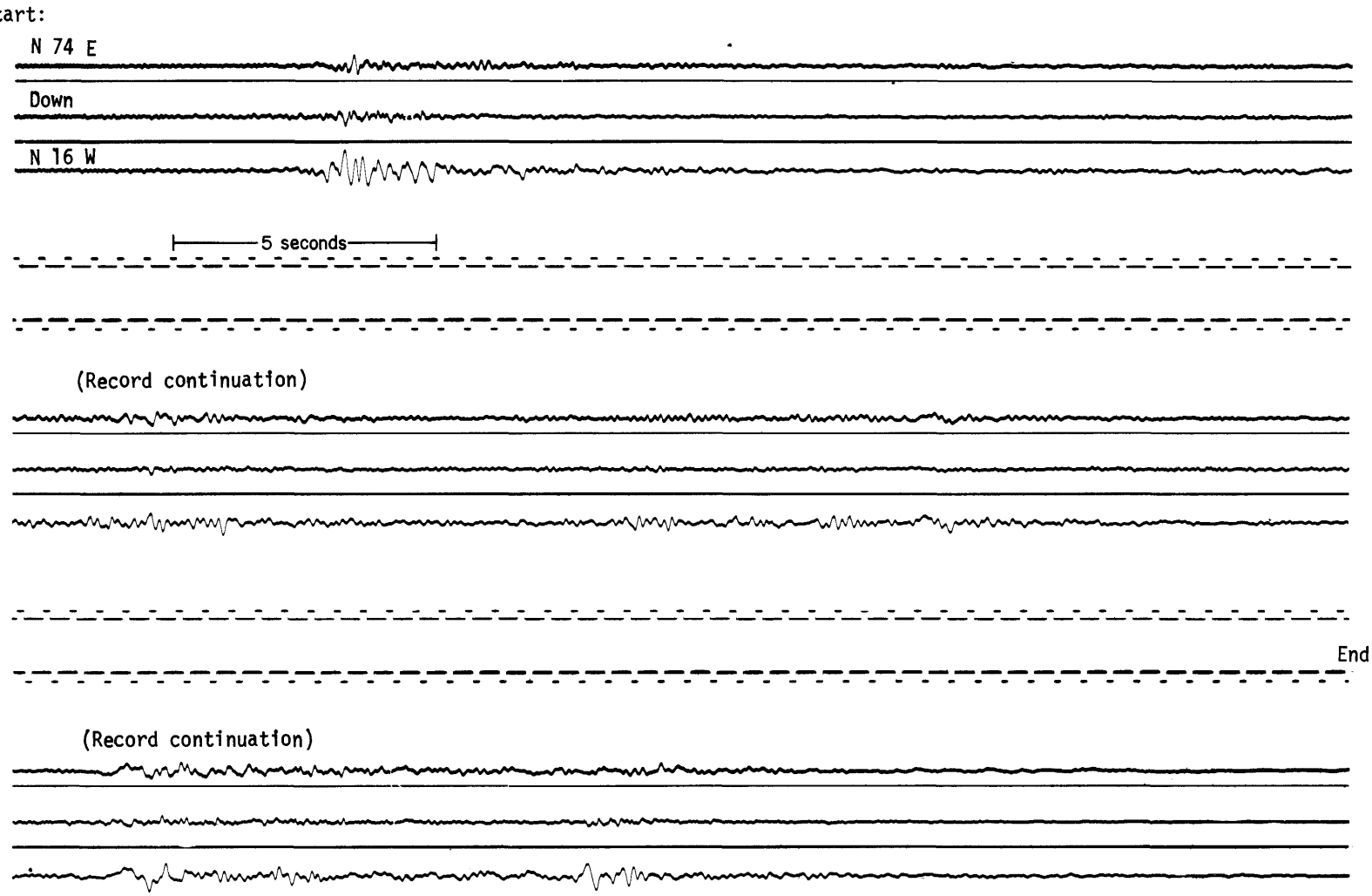

Figure 3a.- Hilo accelerograph record of the 0447 (local time) November 29, 1975 island of Hawaii earthquake (M_S = 7.2).

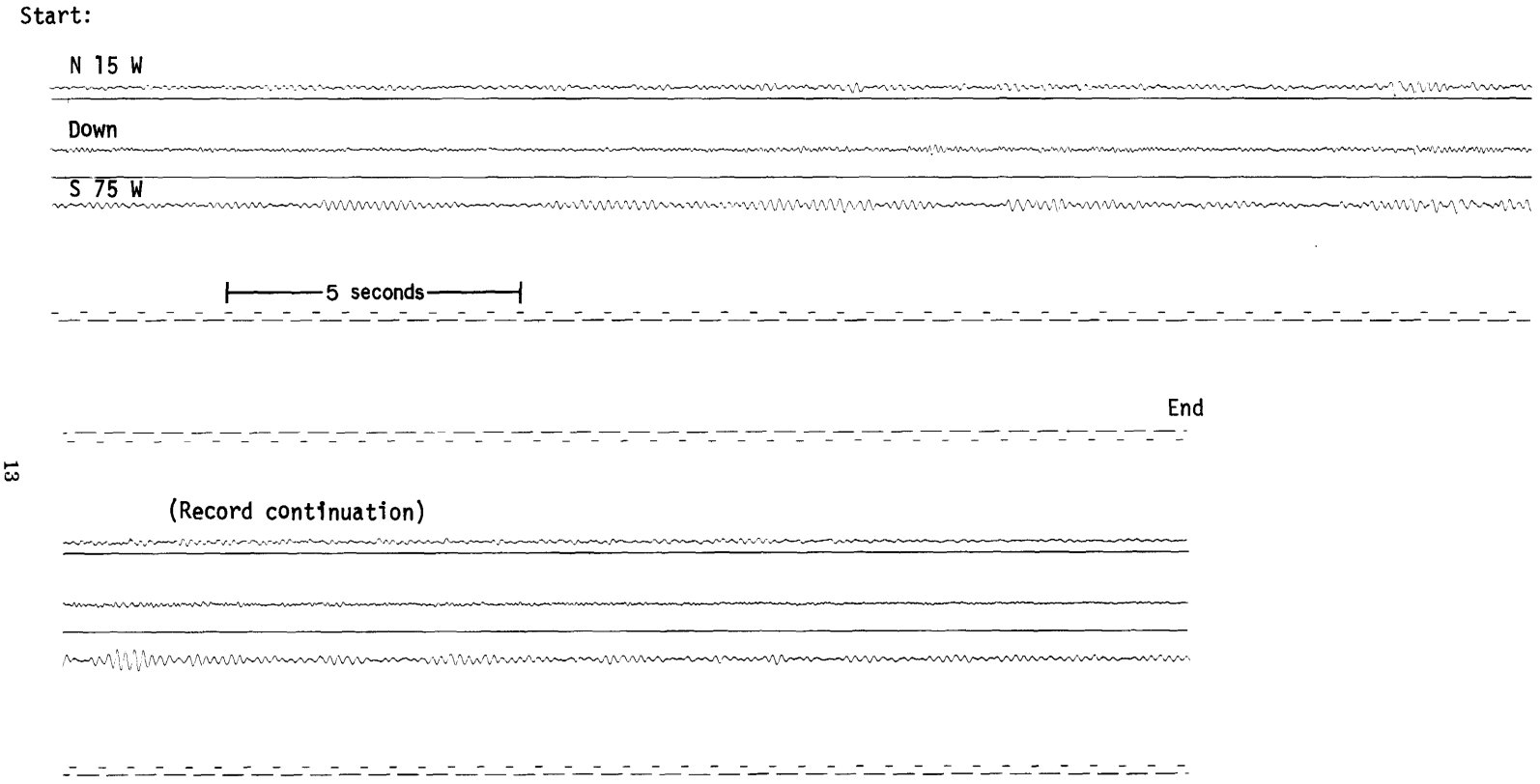

Figure 3b.- Honokaa accelerograph record of the 0447 (local time) November 29, 1975 island of Hawaii earthquake (M_S = 7.2).

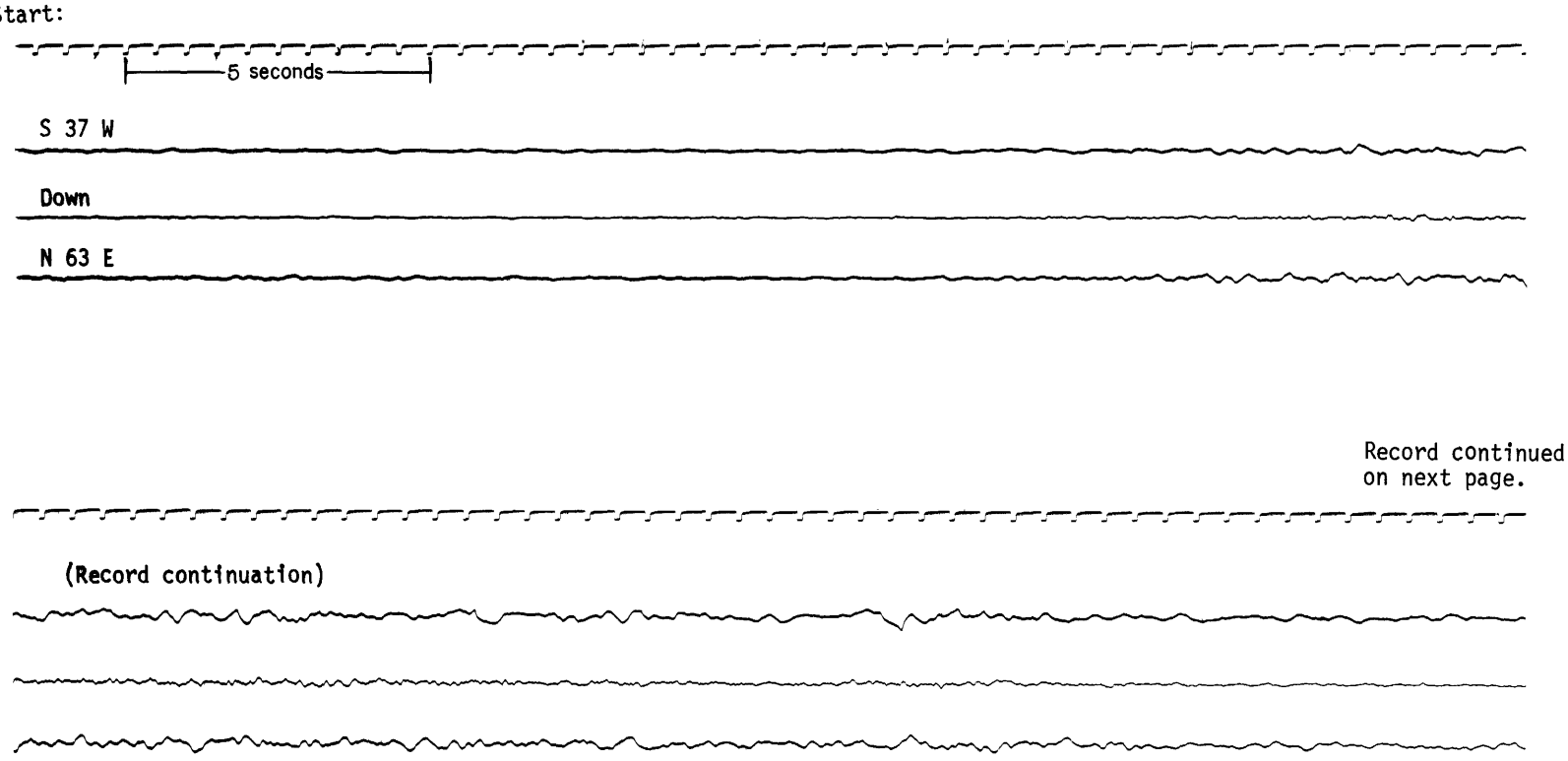

Figure 3c.- Punaluu accelerograph record of the 0447 (local time) November 29, 1975 island of Hawaii earthquake (M_S = 7.2).

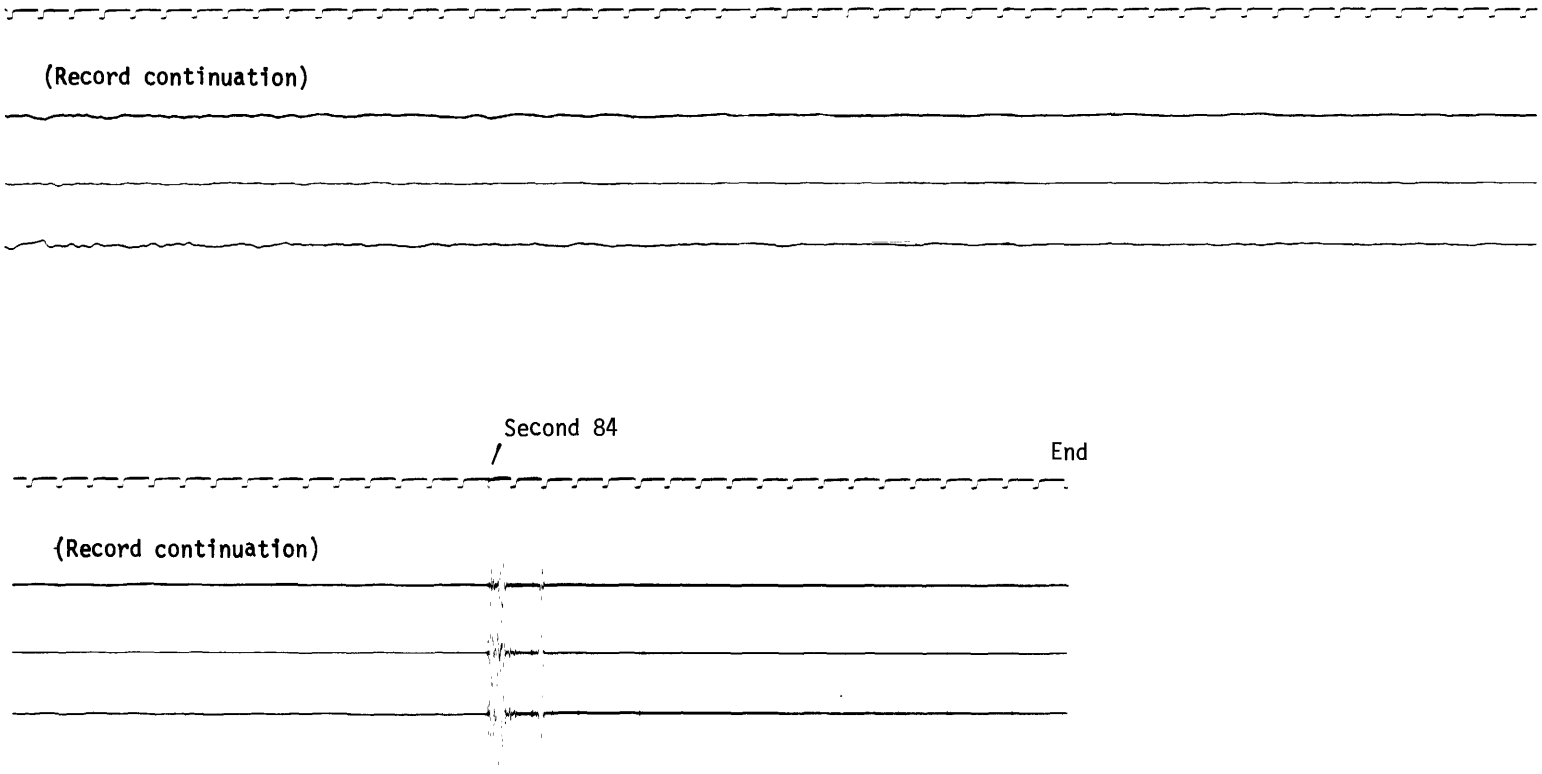

Figure 3c. (continued)- Note: Pulse at second 84 is postulated arrival time of tsunami at accelerograph site.

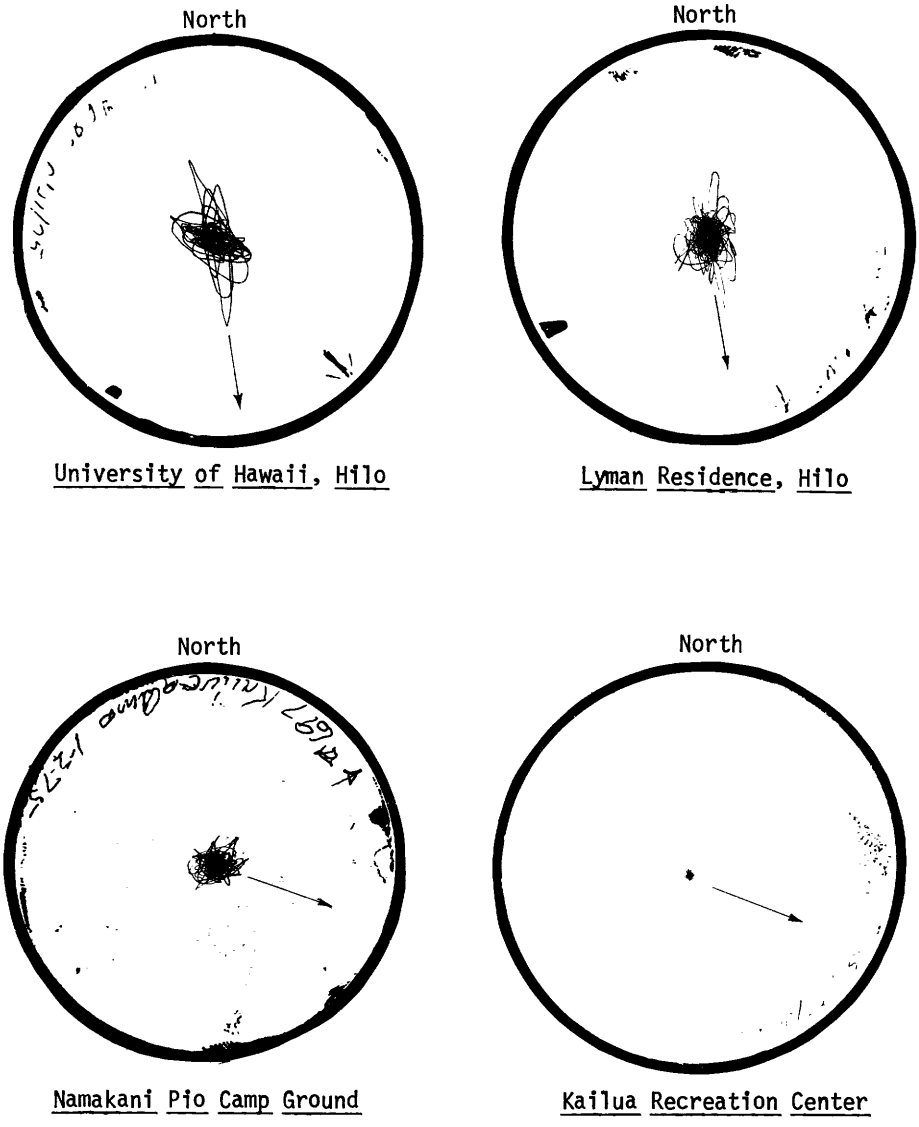

Figure 4.- Seismoscope records from the November 29, 1975 island of Hawaii earthquakes. Arrows point toward epicentral area.

☆GPO 690-340-1976