

DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

United States Earthquakes, 1948

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CONTENTS

	Page
Introduction.....	1
Earthquake information services.....	1
Modified Mercalli Intensity Scale of 1931.....	3
Epicenter maps.....	3
Teleseismic results.....	5
Magnitude-intensity correlation.....	5
Strong-motion results.....	5
Earthquake history.....	5
Noninstrumental results.....	5
Earthquake activity in the various States.....	6
Earthquake activity outside the United States.....	6
Northeastern region.....	6
Eastern region.....	7
Central region.....	7
Western mountain region.....	7
California and western Nevada.....	11
Washington and Oregon.....	25
Alaska.....	26
Hawaiian Islands.....	27
Panama Canal Zone.....	27
Puerto Rico.....	28
Miscellaneous activities.....	28
Geodetic work of seismological interest.....	28
Tidal disturbances of seismic origin.....	28
Seismological observatory results.....	28
Table 1.—Principal earthquakes of the world from January through December 1948.....	29
Strong-motion seismograph results.....	30
Table 2.—List of shocks recorded and records obtained on strong-motion seismographs in 1948.....	31
Table 3.—Summary of outstanding instrumental and noninstrumental data.....	32
Table 4.—Composite of strong-motion instrumental data for 1948.....	33
Tilt observations.....	49
Corrections to previous publications.....	49

ILLUSTRATIONS

	Page
Figure 1.—Destructive and near destructive earthquakes in the United States through 1948.....	2
Figure 2.—Earthquake epicenters, 1948.....	4
Figure 3.—Area affected by the earthquake of March 11.....	8
Figure 4.—Areas affected by the earthquakes of February 10, March 1 and 28, and April 16 and 27.....	13
Figure 5.—Areas affected by the earthquakes of December 4, 29, and 31.....	18
Figure 6.—Tracings of accelerograph records obtained at Ferndale on March 27 and at Hollister on March 28 and April 18.....	35
Figure 7.—Tracings of accelerograph records obtained at Lima, Peru, on May 28; at Bishop on June 7, and at Ferndale (accelerograph and displacement meter) on August 18.....	37
Figure 8.—Tracings of accelerograph records obtained at Hoover Dam Intake Tower and 1215 Gallery on November 2.....	39
Figure 9.—Tracings of accelerograph records obtained at San Jose, Costa Rica, on November 18.....	41
Figure 10.—Tracings of accelerograph records obtained at Hoover Dam Oil House on November 2, and at Colton (accelerograph and displacement meter) on December 4.....	43
Figure 11.—Tracings of accelerograph records obtained at Hollywood Storage Company basement, penthouse, and P. E. Lot on December 4, and at Long Beach on December 4.....	44
Figure 12.—Tracings of displacement meter records obtained at Los Angeles Subway Terminal and Pasadena on December 4, and of accelerograph record obtained at Pasadena on December 4.....	45
Figure 13.—Tracings of accelerograph records obtained at Los Angeles Chamber of Commerce basement and 11th floor, at Los Angeles Edison Building basement, and at Los Angeles Subway Terminal sub-basement on December 4.....	46
Figure 14.—Tracings of accelerograph records obtained at Los Angeles Subway Terminal 13th floor, at San Diego, and at Vernon on December 4; at Hollister on December 31, and at San Francisco Southern Pacific Building 14th floor on December 31.....	47

UNITED STATES EARTHQUAKES, 1948

INTRODUCTION

This publication is a summary of earthquake activity in the United States and regions under its jurisdiction for the calendar year 1948. The sources of noninstrumental information used in the compilation include the United States Weather Bureau, whose observers prepare periodic reports on local seismic activity; telegraphic information collected by Science Service, Washington, D. C.; Bulletins of the Seismological Society of America; special reports of the Jesuit Seismological Association and the Northeastern Seismological Association; the Hawaiian Volcano Letter; newspaper clippings; and reports from interested individuals. Instrumental data used in locating earthquakes are obtained from the network of Coast and Geodetic Survey stations listed on page 00 and from other cooperating seismological stations in the United States and throughout the world.

The Coast and Geodetic Survey endeavors to coordinate efforts in collecting all types of earthquake information with the special object of correlating instrumental earthquake locations with noninstrumental reports received from the epicentral areas. This is done by local organizations making intensive regional investigations in California and elsewhere, and, when necessary, by the Coast and Geodetic Survey. This information serves to adequately map the seismic areas of the country and promote public safety through a better understanding of earthquake phenomena. Since the success of the general information service depends largely on the cooperation of local officials and citizens, all are urged to fill out and return earthquake questionnaires.

Earthquake information services.—The Coast and Geodetic Survey maintains a Seismological Field Survey in San Francisco to collect earthquake information and make field investigations of strong shocks in the Pacific Coast and Western Mountain States. Details concerning damage, destruction, and other effects are enumerated in the quarterly Abstracts of Earthquake Reports for the Pacific Coast and the Western Mountain region. This report is available on request from the Director of the Coast and Geodetic Survey, Washington 25, D. C. Active cooperation in this work is received from the University of California Seismographic Station, Berkeley (Dr. Perry Byerly, in charge); and the Seismological Laboratory, Pasadena (Dr. Beno Gutenberg, Director); as well as State Collaborators in Seismology. The following Collaborators served as agents of the Coast and Geodetic Survey in their respective States in 1948:

Arizona.—Dr. Eldred D. Wilson, University of Arizona, Tucson.

Colorado.—Prof. C. A. Heiland, Heiland Research Corporation, Denver.

Idaho.—Prof. Vernon E. Scheid, University of Idaho, Moscow.

Montana.—Prof. Stephen W. Nile, Montana School of Mines, Butte.

Nevada.—Prof. Vincent P. Gianella, University of Nevada, Reno.

New Mexico.—Prof. Stuart A. Northrop, University of New Mexico, Albuquerque.

Oregon.—Dean E. L. Packard, Oregon State College, Corvallis.

Utah.—Prof. J. Stewart Williams, Utah State Agricultural College, Logan.

Washington.—Dr. Harold E. Culver, Washington State College, Pullman.

Wyoming.—Prof. Horace D. Thomas, University of Wyoming, Laramie.

Among the commercial agencies on the west coast rendering valuable services are telephone, power, oil, railroad, and especially insurance companies. Certain concerns interested in the manufacture of earthquake-resistant building materials are also active together with various organizations of structural engineers and architects.

In other parts of the country the Jesuit Seismological Association with central office at St. Louis University collects information in the central Mississippi Valley area (Rev. Dr. James B. Macelwane, S. J., Dean of the Institute of Technology). The Northeastern Seismological Association with headquarters at Weston College, Weston, Mass. (Rev. Daniel J. Linehan, S. J., in charge) undertakes similar work in the northeastern States.

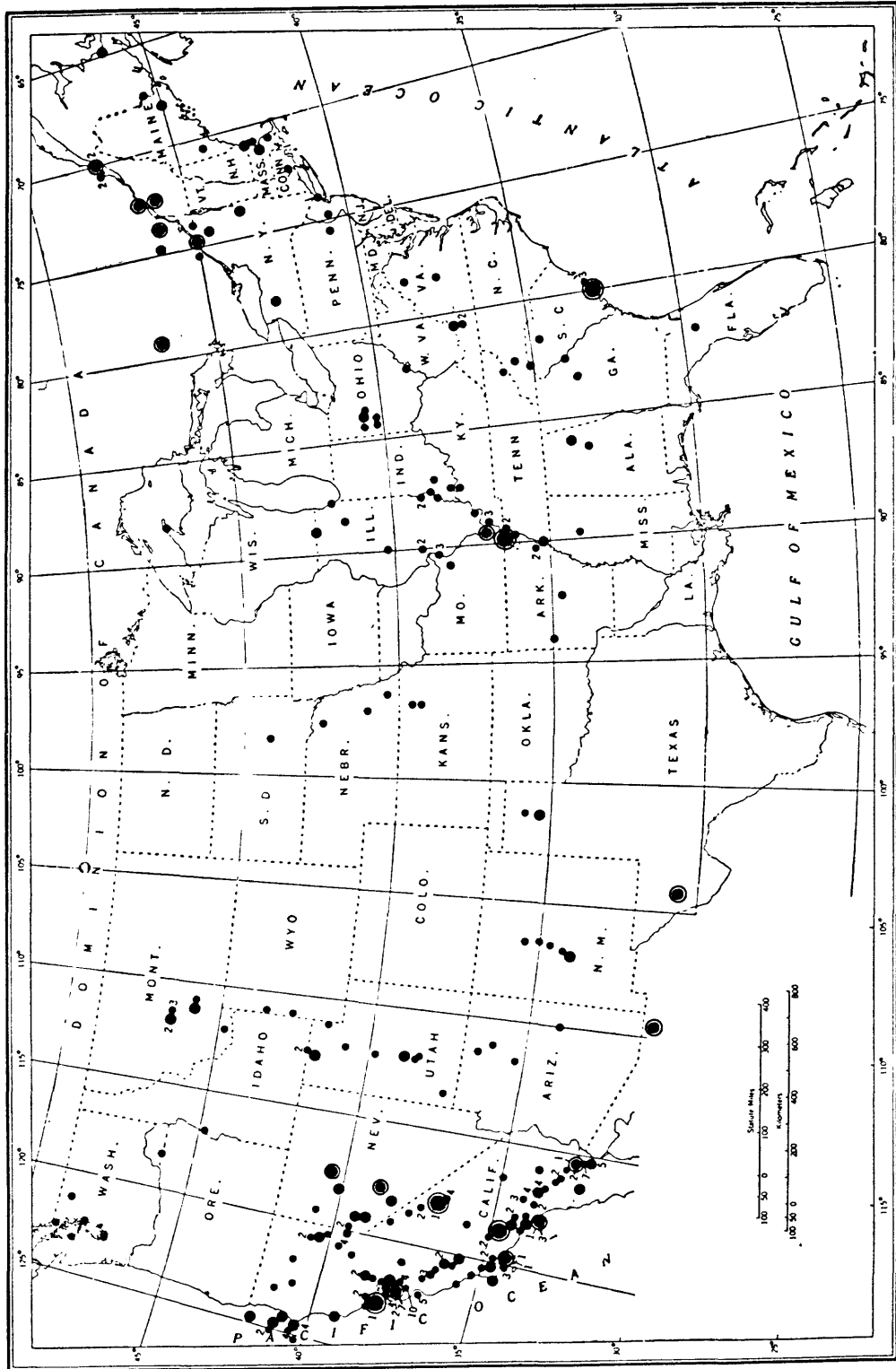


FIGURE 1.—Destructive and near destructive earthquakes in the United States through 1948.

Modified Mercalli Intensity Scale of 1931.—All intensities used by the Coast and Geodetic Survey refer to the Modified Mercalli Intensity Scale of 1931.¹ The abridged version of this scale is given here with equivalent intensities according to the Rossi-Forel scale.

MODIFIED MERCALLI INTENSITY SCALE OF 1931

(ABRIDGED)

- I. Not felt except by a very few under especially favorable circumstances. (I Rossi-Forel scale.)
- II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. (I to II Rossi-Forel scale.)
- III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing of truck. Duration estimated (III Rossi-Forel scale.)
- IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably. (IV to V Rossi-Forel scale.)
- V. Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (V to VI Rossi-Forel scale.)
- VI. Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. (VI to VII Rossi-Forel scale.)
- VII. Everybody runs outdoors. Damage **negligible** in buildings of good design and construction; **slight** to moderate in well-built ordinary structures; **considerable** in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motorcars. (VIII—Rossi-Forel scale.)
- VIII. Damage **slight** in specially designed structures; **considerable** in ordinary substantial buildings with partial collapse; **great** in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motorcars disturbed. (VIII + to IX — Rossi-Forel scale.)
- IX. Damage **considerable** in specially designed structures; well-designed frame structures thrown out of plumb; **great** in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (IX + Rossi-Forel scale.)
- X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. (X Rossi-Forel scale.)
- XI. Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipe lines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
- XII. Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into air.

Epicenter maps.—Figure 1 is designed to show the existence of destructive and near destructive earthquakes in the United States through 1948. The smallest dot indicates the shock was strong enough to overthrow chimneys or affect an area of more than 25,000 square miles (intensity VII to VIII); the largest solid dot may be associated with damage ranging from several thousand dollars to one hundred thousand dollars, or to shocks usually perceptible over more than 150,000 square miles (intensity VIII to IX); the smaller encircled dots represent damage ranging from approximately one hundred thousand to one million dollars, or an affected area greater than 500,000 square miles (intensity IX to X); the larger encircled dots represent damage of a million dollars or more, or an affected area usually greater than 1,000,000 square miles (intensity X to XII).

Figure 2 shows earthquake distribution in the United States during 1948. In a few cases where instrumental control is not satisfactory or where results of investigations are inadequate, the plotted epicenters should be considered as showing the existence of the earthquake rather than the precise location.

¹ Modified Mercalli Intensity Scale of 1931. Harry O. Wood and Frank Neumann, Bulletin of the Seismological Society of America, Vol. 21, No. 4, December 1931.

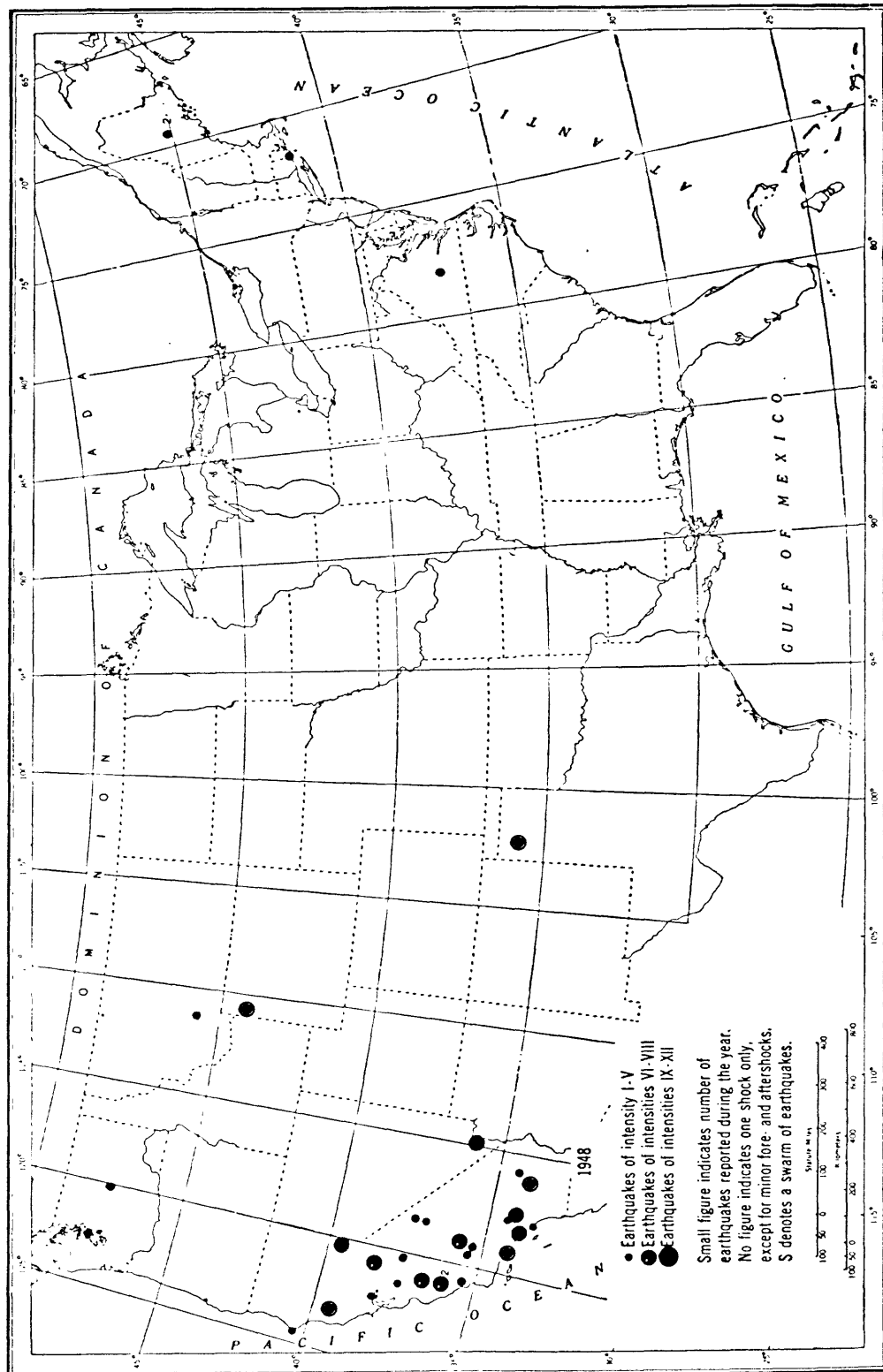


Figure 2.—Earthquake epicenters, 1948.

In figures 1 and 2, those earthquakes occurring in the California area are plotted when felt reports are received from several places. Earthquakes reported as feeble are not plotted on the epicenter map of the United States, nor are minor aftershocks plotted for heavy earthquakes in California or any other region. The number after a dot indicates the number of shocks which have occurred at or near the location shown. Bulletins of the University of California Seismographic Station, Berkeley, and the Seismological Laboratory, Pasadena, should be consulted for further details regarding epicenters and often for data on additional shocks.

The selection of isoseismal or "felt area" maps (figs. 3, 4, and 5) is governed largely by the size of the area affected, the minimum radius generally being of the order of 50 miles. In the case of sharp localized shocks this means that some earthquakes of intensity VI (mostly in California) will not be shown on such maps whereas others of intensity IV and V (largely in the eastern and central areas) will be shown.

Teleseismic results.—On page 00 is a list of Survey and cooperating teleseismic stations for which the Survey publishes results. Immediate epicenter determinations are made usually within three days through the cooperation of Science Service, the Jesuit Seismological Association, and many foreign and domestic stations. The results are furnished by mail to cooperators to assist in further analyses of their seismograms and to aid in seismological investigations. Teleseismic data and results are published in the quarterly Seismological Bulletin available from the Director of the Coast and Geodetic Survey, Washington, D. C.

Magnitude-intensity correlation.—Magnitude is given according to the Richter-Gutenberg scale and is now used extensively as a measure of the energy of an earthquake. An explanation of this scale is given in the Bulletin of the Seismological Society of America, Vol. 32, No. 3, 1942. This scale, derived from an empirical formula based on instrumental results, should be distinguished from the intensity scale which is a measure of the effects on animate and inanimate objects, including damage to buildings. The following comparison is given between the magnitude and intensity designations for normal depth earthquakes in southern California.

Magnitude.....	2.2	3	4	5	6	7	8	8½
M-M Intensity..	1.5	2.8	4.5	6.2	7.8	9.5	11.2	12.0

Strong-motion results.—The maintenance of a network of strong-motion seismographs and analysis of the records of destructive earthquake motions thus obtained are functions of the Bureau in connection with a broad cooperative program of research being carried out on the Pacific Coast with a number of local organizations and institutions interested in the engineering aspects of the earthquake problem. The details of this program are described in S. P. 201, Earthquake Investigations in California, 1934-35.

The preliminary analyses of strong-motion records are published in the Quarterly Engineering Seismology Bulletin, formerly Quarterly Progress Report on Strong-motion Earthquake Work, which is available upon request from the Director of the Coast and Geodetic Survey, Washington, D. C. The revised analyses are given in table 4.

Earthquake history.—A history of the more important shocks of the country appears in Serial 609, Earthquake History of the United States. Part I covers continental United States and Alaska, exclusive of California and western Nevada; Part II covers the stronger earthquakes of California and western Nevada. The first part was revised in 1947 and the latter in 1941.

A history of minor activity is covered largely in a series of references listed in Serial 609, in recent reports of the Coast and Geodetic Survey, and in the Bulletin of the Seismological Society of America, Vol. 29, No. 1, January 1939. The last two references give detailed information for all California earthquakes. The last one contains all information appearing in early catalogs published by the Smithsonian Institution.

NONINSTRUMENTAL RESULTS

NOTE.—The following symbols are used to indicate authority for origin times, instrumental times, or reported epicenters.

P—reported by the Seismological Laboratory of the California Institute of Technology at Pasadena.

B—reported by the Seismographic Station of the University of California at Berkeley.

BC—reported by the Boulder City office of the Coast and Geodetic Survey.

W—reported by the Washington Office of the Coast and Geodetic Survey.

An asterisk (*) indicates instrumental origin time of the earthquake when coordinates of the epicenter are given. Otherwise, instrumental times shown with asterisks are those of first motions.

When more than one degree of intensity is reported from a town, the town is listed under the highest intensity reported. More details will be found in the quarterly Abstracts of Earthquake Reports for the Pacific Coast and the Western Mountain region.

EARTHQUAKE ACTIVITY IN THE VARIOUS STATES

Arizona: January 23, 25; August 8; and December 3.

California: (shocks of intensity VI and above only) January 13; February 10, 19; March 1, 28; April 16, 27; June 18; July 25; September 28; and December 4, 27, 29, and 31.

Colorado: March 11 and October 2.

Connecticut: June 4.

Florida: November 8.

Iowa: April 20.

Kansas: March 11 and April 2 (2).

Maine: January 7 (2) and November 21 and 28.

Montana: January 4, 5, 9, 24; February 12; March 8 (2), 25; April 8; May 15; July 19, August 2 (2), 12; September 27; October 19; November 21 (3), and December 2 and 16.

Nebraska: April 7.

Nevada: January 8, 31; February 3, 20, 29; March 24, 28; April 27; May 2, 3 (2), 7, 8 (2), 9 (2), 14, 16, 22; June 9; July 6 (2), 19; August 31; September 5; October 24, 25; November 2 (4), 4, 5, 8, 12, 13, 21; and December 12, 27 (3), and 29.

New Jersey: July 7 and August 3.

New Mexico: March 11.

Oklahoma: March 11.

Oregon: February 29, March 21, and December 20.

Rhode Island: May 14.

Tennessee: February 9.

Texas: March 11.

Utah: November 4.

Virginia: January 4 (3) and March 26.

Washington: January 12; February 13; August 3, 6, 28; September 24; and October 25.

Wyoming: February 23; July 19; August 27; September 24; and November 9 and 10.

EARTHQUAKE ACTIVITY OUTSIDE THE UNITED STATES

Alaska: January 29; February 11, 14, 27; May 2, 29; June 20, 25; July 15, 27; August 1, 16, 19, 29; September 3; October 8; November 20; and December 5.

Hawaii: January 3, 8, 10, 15, 25; February 1, 20; March 9, 19 (2); April 6, 24 (2); May 24; June 1, 19, 25, 26, 28 (2); July 12, 17, 24, 30; August 3, 8; September 5, 7, 13; and December 9.

Panama Canal Zone: July 28.

Puerto Rico: April 21 and December 7.

NORTHEASTERN REGION

(75TH MERIDIAN OR EASTERN STANDARD TIME)

January 7: 15:47 and 16:20. Dover-Foxcroft area, Me. First shock of 30 seconds duration rocked Dexter, Dover-Foxcroft, Guilford, Brownville Junction, Milo, Katahdin Iron Works, Williamsburg, Sebec, Sangerville, and Schoodic Lake. Homes shook in Dexter and Milo. Windows and the whole front of a house were shaken at Schoodic Lake. Mild shocks were reported from Sebec and at Brownville Village one shock was reported as "like snow falling from the roof." The tremors were recorded on the Boston College seismograph at Weston, Mass.

May 14: 21:23. Westerly, R. I. Felt by most of populace as tremble with gradually increasing rumble climaxed by sound like explosion. Buildings trembled, dishes rattled, and windows shook slightly. The felt area included New London to west (18 miles), north to Hope Valley (12 miles), east to Narragansett (22 miles), and south to Watch Hill Coast Guard station (5 miles). The tremor was recorded by the Harvard seismograph.

June 4: 04:00. Westbrook, Conn. Observer awakened by moderately loud sounds and trembling of the earth. No other effects.

November 21: 10:41. Eastport, Me. Very abrupt shock with panting sound. Pictures moved on walls and freshly plastered ceiling of home in Lubec (4 miles to east) fell.

November 28: 04:57. Dover-Foxcroft, Maine. Three shocks, the first of marked intensity lasting about half a minute with direction from northwest to southeast. Felt especially heavy at South Dover where many persons were awakened, homes shook, and windows rattled. Several reported hearing a heavy rumble. Milo residents and a few Guilford residents were awakened, and at Dexter the quake was experienced as slight. A second shock of much lesser intensity but strong enough to shake buildings was felt at 06:00 the following day.

The initial tremor was recorded on the Boston College seismograph at Weston, Mass.

EASTERN REGION

(75TH MERIDIAN OR EASTERN STANDARD TIME)

January 4: 21:45, 22:20, and 23:00. Buckingham County, Va. Second tremor was most severe and was accompanied by loud roar. A fourth shock was felt at 01:00 the following day.

At Dillwyn nearly everybody felt the tremors, bumping motion, west to east, accompanied by thunderous sound. One wall lamp was displaced, one brick wall cracked, houses creaked, and loose objects rattled. An old wood two-story, well-constructed building in Buckingham rocked and disturbed objects were observed by several.

Reports of the shock were received from persons living in an area extending along Highway 15 from Farmville north about 50 miles. Cumberland and Prince Edward residents also were aware of the disturbances. A telephone operator in Palmyra reported switches dropping from the board and the whole board out temporarily during the second tremor. At Breemo Bluff several pitchers setting on a mantle were noticed vibrating and nearly everyone in New Canton felt the shocks.

February 9: 19:00. Campbell County, Tenn. Light tremor accompanied by a roar and a rumbling felt in Lafollette and as far south of the town as 12 miles. The St. Louis seismograph recorded the tremor.

March 26: 18:48. Charlottesville, Va. Very light shock felt by Weather Bureau observer at Leander McCormick observatory.

July 7: 02:15. Potsdam, N. J. Slight earthquake shook houses and rattled windows for one minute.

August 3: 14:04:40.* Atlantic City, N. J. Slight tremor felt. Newspaper and city offices were kept busy answering queries about the shock. The slight rumble was recorded on the Fordham University seismograph.

November 8: 12:44. Captiva, Fla. Sudden jar caused doors and windows to rattle. Accompanied by a sound like distant heavy explosion.

CENTRAL REGION

(90TH MERIDIAN OR CENTRAL STANDARD TIME)

April 2: 21:00 to 22:00. Wichita, Kan. Six tremors felt in Beechwood area about 5 miles east of Wichita. Walls of homes in Federal housing project (good construction, wood) trembled. Ripples and mild shaking of water noticed in goldfish bowls.

April 7: No time given. Broken Bow, Nebr. Very slight earth tremor reported felt.

April 20: 08:16:51.* Iowa City, Iowa. Apparently very local shock caused dishes to rattle in cupboards and caused windows to shake. The tremor was recorded on the seismograph of John Carroll University in Cleveland, Ohio.

WESTERN MOUNTAIN REGION

(105TH MERIDIAN OR MOUNTAIN STANDARD TIME)

January 4: 05:30. Kenwood (suburb of Helena), Mont. Light shock felt by several. Loud roar and slight vibration. Awakened few in community.

January 5: 04:26. Helena, Mont. Hard jolt felt by many; outdoors by some. Rapid vibration for 3 seconds.

January 8: 23:10:43.* BC. Boulder City, Nev. Motion rapid, lasted 2 to 3 seconds. Felt by several in home.

January 9: 11:27. Helena, Mont. Weak shock, lasted 2 seconds.

January 23: 19:57. Cocanino County, Ariz. Distinct shock of short duration heard along Colorado River in vicinity of Inner Canyon and Tuba City. Also felt at Cottonwood.

January 24: 14:50. Helena, Mont. Weak shock, lasted 2 seconds.

January 25: No time given. Inner Canyon, Ariz. Slight shock reported felt.

January 31: 23:49:03.* BC. Boulder City, Nev. Slight shock felt.

February 3: 04:25:49.* BC. Boulder City, Nev. Light shock felt by several in home, awakened few.

February 12: 02:54. Clarkston, Mont. Light shock felt by and awakened all in community. Rattled windows. Direction N.

February 20: 16:06:25.* BC. Boulder City, Nev. Slight shock felt by several in home. Also felt at Hoover Dam.

February 23: 19:39:00.* Epicenter 43.5° north, 111.0° west, W. Felt over an area of approximately 1,500 square miles in sparsely settled region of Wyoming. Maximum intensity VI. No damage but heavy objects shifted.

INTENSITY VI:

Jackson.—Felt by all in community. Rattled windows, doors, and dishes. "Dog lying on floor seemed very frightened." Trees and bushes shaken slightly. Buildings creaked. Rumbling sound heard at time of shock. Hanging plant swung.

Moran.—Felt by several in community. Rattled windows, shifted piano and bed.

Wilson.—Felt by all in community. Rattled dishes. Hanging objects swung, house frames creaked.

INTENSITY V: Elk, Gros Ventre River, and Red Rock Ranch on Crystal Creek (near Kelly).

INTENSITY IV: Gros Ventre River (13 miles east of Kelly), and Moose (Park Heights).

INTENSITY I TO III: Bondurant and Kelly (4 or 5 miles east and north).

Negative reports were received from 3 places.

February 29: 16:30:03.* BC. Boulder City, Nev. Slight shock felt by observer in home.

March 8: 03:40. Kenwood, Mont. Light shock felt by several in community. Rattled windows, walls creaked.

March 8: 07:30. Helena, Mont. Weak shock, lasted 1 second. Felt by several, rattled windows

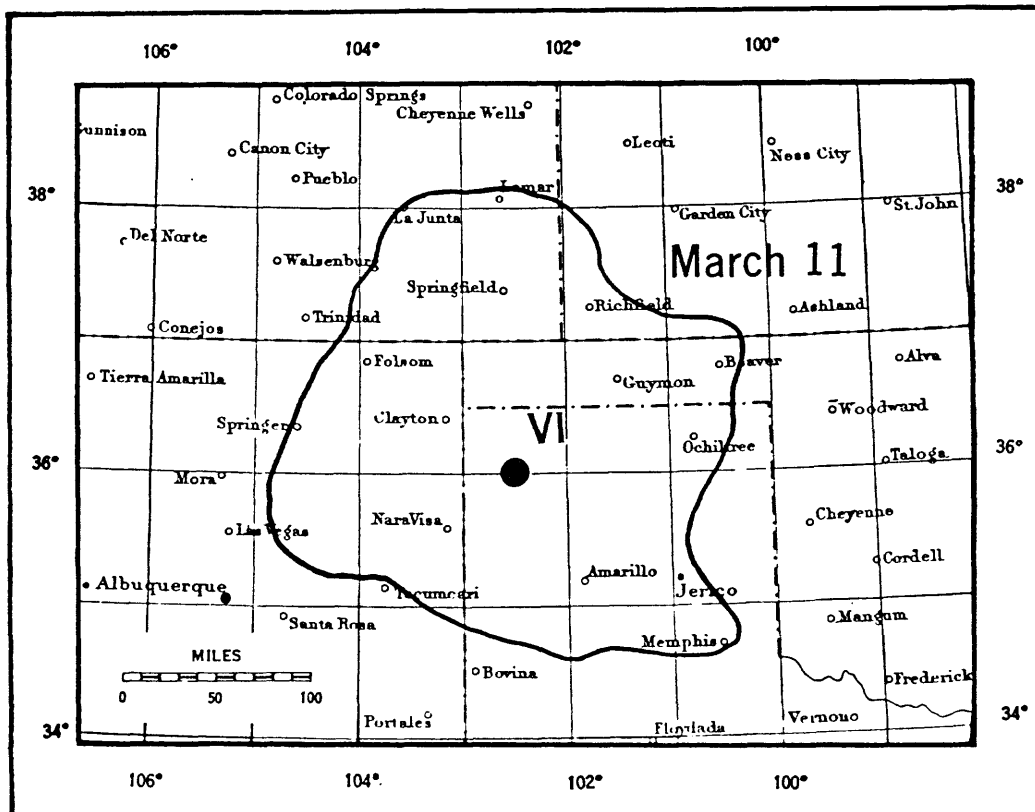


FIGURE 3.—Area affected by the earthquake of March 11.

March 11: 21:29:00.* Epicenter 36° north, 102½° west, W. Moderately strong, felt over an area of approximately 50,000 square miles of Colorado, Kansas, Oklahoma, New Mexico, and Texas. See map. Maximum intensity VI. Slight damage consisting mainly of cracked plaster.

INTENSITY VI IN NEW MEXICO:

Bell Ranch.—Sharp quick shock felt by several. Rattled windows, doors, and dishes. Cracked plaster.

Bueyeros.—Felt by several. Some cracked adobe walls. Houses creaked. Windows and dishes rattled. Rumbling sound heard.

Gladstone.—Felt by several in home. House creaked violently, frightened all. Followed by gradually receding roar. Rattled windows and dishes.

Ionc.—Felt by several, frightened few in community. Sixteen-inch stone wall cracked. Plaster cracked.

Logan.—Awakened many and frightened many in community. Walls creaked, windows and dishes rattled, plaster cracked. Vertical motion, then shaking from S-N. Small objects shifted.

Mount Dora.—Felt by several. Windows rattled and small objects shifted. "Very sharp tremor and a sound as of distant thunder."

Seneca.—Motion rapid, like an explosion. Felt by all awake in community. Frame houses creaked; windows, doors, and dishes rattled.

INTENSITY VI IN TEXAS:

Amarillo.—Damage minor despite cracked plaster. Shook floors and rattled heavy steel doors of Potter County jail. Swooshing sound like large truck passing a car heard at time of shock. Lamp shades moved

for about 3 seconds. The Daily News newsroom was flooded with calls, first pattern of calls followed E.-W. line across Amarillo in the 1600-1700 tier of blocks from Pierce Street west, then pattern of calls spread to all sections of town.

Amarillo (6 miles south of).—Bed rocked. Frightened dog ran from room barking loudly.

Channing.—Pictures rattled on walls and house shook noticeably for 30 seconds.

Dalhart.—Felt in all parts of town and rural areas. Many reported dull thud before shock. Railroad box cars shook, popcorn machine in theater swayed. Ice was shaken from pipes and open faucets began to flow. Hanging objects swung NE. One woman reported a bottle was shaken from a dresser.

Electric City.—Cracked building.

Panhandle.—Felt by several in community. Hanging objects swung, small objects shifted. Plaster cracked and fell. Damage slight.

Perico.—Awakened nearly all in community. Cracked plaster and walls. Rumbling sound heard by many before shock. Dogs barked. "House seemed to tilt east, then west, then a level quivering. Windows and dishes rattled.

Perryton.—Felt by and awakened many in community. Cracked walls, slight damage to wood. Rattled windows and doors. Sounded like an explosion.

INTENSITY VI IN OKLAHOMA:

Boise City.—Felt by many in community. Buildings creaked, loose objects rattled. Slight cracks in plastered walls of old buildings near openings. Faint rumbling sounds heard at beginning and during shock.

Felt.—Felt by all, awakened many.

Kenton.—Felt by many in community. Windows and doors rattled; houses shook. Stove pipe on top of house rattled. Sound like large truck coming to a stop. Slight plaster cracks.

Regnier.—Motion violent. Felt by and frightened all.

INTENSITY VI IN COLORADO:

Kim.—Frightened many. Shifted small objects.

Trinchera.—Felt by several in community. Windows, doors, and dishes rattled; hanging objects swung. Plaster cracked.

INTENSITY V IN NEW MEXICO: Albert, Chico, Clayton, Farley, Grenville, Nara Visa, Quay, Raton, Rosebud, and Sedan.

INTENSITY V IN TEXAS: Borger, Canyon, Conlen, Hereford, Kerrick, Plainview, Stratford, and Texline.

INTENSITY V IN COLORADO: Bronson, Lamar, Pritchett, Springfield, and Tobe.

INTENSITY V IN KANSAS: Eckhart and Larned.

INTENSITY IV IN NEW MEXICO: Cimarron, Claphorn, Des Moines, Folsom, Hayden, Jordan, Miami, Moses, Sabinoso, Shoemaker, Solono, Springer, Tucumcari, and Wagon Mound.

INTENSITY IV IN TEXAS: Channing, Claude, and Stinnett.

INTENSITY IV IN OKLAHOMA: Goodwell.

INTENSITY IV IN COLORADO: Granada, Hartman, La Junta, and Rocky Ford.

INTENSITY IV IN KANSAS: Satanta and Syracuse vicinity.

INTENSITY I TO III IN NEW MEXICO: Capulin, Obar, and Roy.

INTENSITY I TO III IN TEXAS: Dumas, Lipscomb, and Spearman.

INTENSITY I TO III IN OKLAHOMA: Guymon.

INTENSITY I TO III IN COLORADO: Uteyville.

INTENSITY I TO III IN KANSAS: Johnson and Rolla.

Negative reports were received from 33 places in New Mexico, 11 places in Texas, 6 places in Oklahoma, 14 places in Colorado, and 15 places in Kansas.

March 24: 03:03:55.* BC. Boulder City, Nev. Weak shock felt by observer in home.

March 25: 03:55. Helena, Mont. Weak shock reported by Weather Bureau.

April 8: 02:30. Ovando, Mont. Three tremors, intensity V, awakened and frightened many. Sounds like gun being fired and distant rumbling heard at time of second shock.

April 27: 23:07:01.* BC. Boulder City, Nev. Light shock felt by many in community. Windows rattled. Preceded by roaring sound.

May 2: 11:39:38.* BC. Boulder City, Nev. Weak shock felt.

May 3: 03:32:25.* BC. Boulder City, Nev. Light shock felt by observer in home, awakened one. Windows rattled.

May 3: 07:41:06.* BC. Boulder City, Nev. Light shock felt by many in community. Windows rattled. Sound like prolonged concussion from blasting. Typical local shock.

May 7: 01:18:49.* BC. Boulder City, Nev. Felt by several in community, awakened few. Noise heard.

May 8: 00:27:34.* BC. Boulder City, Nev. Light shock felt by observer in home, awakened few.

May 8: 17:23:59.* BC. Boulder City, Nev. Felt by observer in home; windows rattled, frame house creaked, and hanging objects swung.

May 9: 11:53:04.* BC. Boulder City, Nev. Fairly strong shock felt by all in community. Rattled windows and overhead lights. Fine cracks in plaster reported. Also felt by several in McKeeversville where trees and bushes were shaken slightly; windows, doors, and dishes rattled; and houses creaked.

May 9: 12:23:59*. BC. Boulder City, Nev. Weak shock felt by few.

May 14: 03:55:46.* BC. Boulder City, Nev. Slight shock felt.

May 15: 23:45. Montana. Intensity V earthquake felt by many at Clarkston, Trident, and Wickes. Windows and dishes rattled, houses creaked. Also felt by several at Three Forks as a preliminary quiver followed by wave-like motion. House creaked, windows rattled, and hanging objects swung NE.

Negative reports were received from 19 places.

May 16: 10:22:48.* BC. Boulder City, Nev. Weak shock felt by several.

May 22: 01:19:10.* BC. Boulder City, Nev. Very weak shock reported by one person.

June 9: 06:24:34.* BC. Hoover Dam, Nev. Weak shock felt by several.

July 6: 06:21. Boulder City, Nev. Light shock felt by several. Windows, doors, and dishes rattled; house creaked.

July 6: 06:25. Boulder City, Nev. Light shock felt by several. Windows and dishes rattled.

July 19: 15:18. Helena, Mont. Light shock felt by several at Weather Bureau. Direction vertical.

July 19: 17:00. Yellowstone National Park (east entrance), Wyo. Light shock felt by several. Rattled dishes, hanging objects swung. Shifted small objects on stove.

July 19: 23:42:56.* BC. Boulder City, Nev. Slight shock felt by a few.

August 2: 09:30 (about). Moiese, Mont. Slight shock felt by several.

August 2: 15:43. Moiese, Mont. Light shock felt by several, awakened one. Rumble heard. Recorded on seismograph at Butte, Mont.

August 8: 16:20. Grand Canyon National Park (Katching Lodge), Ariz. Light shock felt by several. Shifted small objects and furnishings. Sensation similar to powder charge shaking vicinity.

August 12: 21:29. Helena, Mont. Slight shock felt by several. Slight creaking of houses.

August 27: 14:00. Casper, Wyo. Slight trembling, rapid onset, felt by several. Buildings creaked and loose objects rattled.

August 31: 22:42:17.* BC. Boulder City, Nev. Light shock felt by many. Windows rattled.

September 5: 14:16:38.* BC. Boulder City, Nev. Light shock felt by several. Roaring noise heard.

September 24: 09:05. Rock Springs, Wyo. Fairly strong shock felt by several. Floors bobbed, dishes rattled, and furniture in office building was moved. Earlier shock reported at 07:00.

September 27: 14:51. Helena, Mont. Light shock felt by many in Weather Bureau office. Doors rattled slightly.

October 2: 21:30. Waldon, Colo. Light shock felt by several, awakened few. Rattled dishes. Plainly felt and heard by observer in home in Centennial. Also felt north of Holmes where roof suddenly flapped as though in strong wind, and at Jelm there was a roar and vibration, then house creaked.

October 19: 12:57:30.* Helena, Mont. Press reported earthquake strong enough to knock dishes off precarious ledges and to crack plaster in some houses. Occupants of Placer Hotel reported feeling a distinct sway and then an echoing rumble. Buildings creaked.

October 24: 15:06:37.* BC. Boulder City, Nev. Slight shock felt by a few. Roaring noise heard.

October 25: 08:56:29.* BC. Boulder City, Nev. Slight shock felt by a few.

November 2: 09:48:08.* BC. Epicenter 35°59' north, 114°47' west, Hoover Dam area of Nevada, W. Maximum intensity VI. Reports indicated the earthquake probably was not felt outside a 50-mile radius of Boulder City. No structural damage reported from any locality. Power transmission at Hoover Dam was interrupted for 1 minute and 15 seconds. Some of the little signal lights in control room rolled around on floor. Rocks were rolled out on the highway leading to the dam and from canyon walls both upstream and downstream from the dam; dust clouds from landslides were observed. Some minor cracking of plaster at Boulder City, small objects were displaced. One report of intensity III was received from Ludlow, Calif. (Pisgah substation), but reports from a questionnaire coverage of the California area were negative.

November 2: 10:58:34.* BC. Boulder City and Hoover Dam, Nev. Light shock felt by several. Rattled windows.

November 2: 11:15:23.* BC. Boulder City, Nev. Light shock felt by several. Windows rattled and walls creaked.

November 2: 16:47:25.* BC. Boulder City, Nev. Weak shock felt by several.

November 4: 05:08:55.* BC. Boulder City and Hoover Dam, Nev. Light shock felt by many. Windows, doors, and dishes rattled; house creaked.

November 4: 06:18. Manti, Utah. Light shock felt by all. Shifted small objects in some places, rattled loose objects. Buildings creaked. Bumping subterranean sounds heard at time of shock.

November 5: 16:32:38.* BC. Boulder City, Nev. Slight shock felt by a few.

November 8: 17:06:31.* BC. Boulder City and Hoover Dam, Nev. Slight shock felt by few.

November 9: 16:23. Old Faithful, Yellowstone National Park, Wyo. Slight shock felt by all at ranger station. Building creaked.

November 10: 00:47. Old Faithful, Yellowstone National Park, Wyo. Light shock felt by all at ranger station, awakened all in home.

November 21: 15:41. Helena, Mont. Sharp vibration felt by many at Weather Bureau. Rattled windows and doors, building creaked.

November 21: 15:43. Helena, Mont. Weak vibration felt by many at Weather Bureau. Windows and doors rattled, frame house creaked.

November 21: 16:03. Kenwood, Mont. Weak vibration, lasted 1 second.

November 21: 17:37:06.* BC. Boulder City, Nev. Slight shock felt by a few.

December 2: 15:15. Kenwood, Mont. Slight shock felt by several.

December 3: 11:45. Winslow, Ariz. Light shock, abrupt onset, felt by many. Loose objects rattled, building creaked. Subterranean sounds like an explosion at time of shock.

December 12: 13:44:55.* BC. Boulder City, Nev. Slight shock felt by a few.

December 16: 02:15. Helena, Mont. Light shock felt by several, awakened few. Buildings creaked.

CALIFORNIA AND WESTERN NEVADA

(120TH MERIDIAN OR PACIFIC STANDARD TIME)

January 2: 00:35. Fulton. Light shock reported.

January 3: 17:30:35.* Epicenter 35°50' north, 117°44' west, north of Inyokern, P. Felt at Sand Canyon Aqueduct station.

January 6: 18:30. Light shock felt at Sand Canyon Aqueduct station.

January 7: 08:32. Light shock felt at Sand Canyon Aqueduct station.

January 9: 08:26:47.* Epicenter 36°49' north, 121°19' west, B. Light shock 7 miles south of Hollister.

January 10: 21:37:38.* Epicenter 36°26' north, 121°29' west, B. Light shock felt in Hollister.

January 13: 20:57:01.* Epicenter 37°52' north, 121°42' west, B. Moderate earthquake felt in the San Joaquin Valley region over approximately 3,000 square miles. Maximum intensity VI. No damage except a few instances of cracked plaster.

INTENSITY VI:

Brentwood.—Short punch-like shock. Frightened many in community, some left theater. Trees and bushes shaken moderately. Definite rumbling preceded shock.

Byron.—Two shocks. Vases and small objects overturned; canned goods and knickknacks fell. Cracked plaster. Car suspended by chains from garage roof swung. Damage slight.

Stockton.—Sharp, short shock. Overturned small objects and shifted small furnishings. Broke a few dishes.

Waterman.—Frightened few in community, felt outdoors by some. Some plaster cracks.

INTENSITY V: Hollister, Holt, and Manteca.

INTENSITY IV: Bellota and Herdlyn (PG&E power stations), Isleton, Lathrop, Middle River, Oakland, Oakley, Placerville, Rio Vista, Tracy, Valley Home, and Walnut Grove.

INTENSITY I TO III: Antioch, Chinese Camp, Clements, Livermore, Lodi, Pittsburg, and Vernalis.

Negative reports were received from 81 places.

January 16: 01:45. Slight shock reported at Sand Canyon Aqueduct station. Awakened all in home. Walls creaked.

January 23: 01:30. Visalia. Slight shock felt by several in home, awakened few. Windows rattled.

January 28: 13:11 and 13:21. Fresno. Press reported 2 mild shocks felt in outskirts of city, mainly east section. Dishes and windows rattled; one picture fell from wall, others were displaced. Light fixtures swung slightly and venetian blinds vibrated.

January 29: 14:00. Camino. Slight shock felt by several in home. Windows and doors rattled.

January 29: 14:06. Fresno. Press reported mild earthquake which rattled dishes and shook venetian blinds. Blinds on north windows swung out from wall.

January 30: 14:15. Waterford. Light shock reported felt by several. Continuous rumble heard for several seconds. Windows, doors, and dishes rattled; package fell.

January 30: 18:54:54.* Epicenter 37°48' north, 121°57' west, B. Light shock felt by several in San Ramon. House creaked.

January 31: 15:42:12. Central Valley (near Redding). Slight shock reported by several in town. Direction from SE. Windows rattled and walls creaked.

February 3: 19:30. Miracle Hot Springs. Weak shock, lasted 2 seconds.

February 6: 05:14:13.* Epicenter 37°13' north, 117°54' west, east of Big Pine, P. Quite strong at Bishop, Laws, and Tinemaha Reservoir (Independence). Felt by many. Loose objects and dishes rattled, hanging objects swung, house creaked. Strong movement to SE, light to W.

February 9: 15:42:27.* Redding. Motion rapid. Felt by one at Government camp.

February 10: 03:15. Nevada State Highway No. 3 (about 9 miles east of Oasis, Calif.). Sudden jolt followed by slight rumbling. House creaked slightly.

February 10: 14:24:30.* Epicenter 33°43' north, 116°00' west, east of Coachella. Felt in Post Office in Coachella.

February 10: 19:29:28.* Epicenter 36.1° north, 118.8° west, B. Felt extensively in southern Sierra Nevadas and along east side of southern San Joaquin Valley over area of 18,000 square miles. See map. Maximum intensity VI.

INTENSITY VI:

Clavis.—Press reported the Temperance Colony School closed due to cracks which developed after the earthquake.

Dinuba.—High school gymnasium closed because of new series of cracks found under eaves and some trusses had shifted one-fourth inch. Building was previously damaged by earthquake on March 15, 1946.

Ducor.—Felt by many in home. Cracked plaster slightly. Damage slight.

Fresno.—California State Division of Architecture closed a one-story brick school nearby because of cracking of walls. Building was previously damaged by earthquake on March 15, 1946.

Kingsburg.—Felt by many in home. One store reported a crack in brick and plaster. Walls creaked. Damage slight.

Lindsay.—Plaster cracked and at least one window broke. One grandfather's clock reported stopped.

Miramonte.—Felt by all in home, felt outdoors by some. Windows and dishes rattled, hanging objects swung, pendulum clocks stopped. Trees and bushes shaken slightly. Some small slides of rocks on road cuts.

Springville.—Felt by all in community. Cracked plaster. Damage slight to concrete.

Three Rivers.—Two distinct shocks felt by all. Loud explosive noise heard. Windows, doors, and dishes rattled; house creaked.

Tipton.—Felt by several in home. Windows and dishes rattled, hanging objects swung. Cracked plaster slightly.

Woody.—Felt by all in home and community, awakened few. Creaking of buildings and rattling of loose objects heard by many. Rather loud noise similar to stampeding cattle at time of shock. Visible swaying of buildings and light fixtures.

INTENSITY V: Cottonwood Gates (Lone Pine), Miracle Hot Springs, Orange Cove, Posey, Sequoia National Park (Ash Mountain), and Woodlake.

INTENSITY IV: Academy, Alpaugh, Bakersfield, California Hot Springs, Cutler, Fresno, Friant, Jawbone Aqueduct Station, Kern River Powerhouse No. 3 (near Kernville), Le Grand, Lone Pine and vicinity, McFarland, Porterville, Prather, Reedley, South Haiwee (Coso Junction), Tulare, Visalia, and Yosemite National Park.

INTENSITY I TO III: Big Creek, Buttonwillow, Corcoran, El Nido, Keller, Kern River Powerhouse No. 1 (Kern Canyon near Bakersfield), Knowles, Oakdale, Olancho, Tinemaha Reservoir (Independence), Tule, Big Creek Powerhouse, Kern Canyon Powerhouse, and Piedra substation (PG&E).

Negative reports were received from 36 places.

February 14: 23:30. Los Angeles Aqueduct Intake (Independence). Light shock felt by and awakened all in home. Windows and dishes rattled, house creaked.

February 18: 05:38:50.* Epicenter 33°59' north, 117°33' west, near Mira Loma, P. Slight shock felt by several in Riverside.

February 19: 00:25:09.* Epicenter 41° north, 124.9° west, B. Off Cape Mendocino. Light shock with swaying motion felt by several in Eureka.

February 19: 11:36:42.* Epicenter 33°53' north, 118°05' west, southeast of Bellflower, P. Felt by many at Compton and Long Beach. Trees and bushes shaken slightly at latter place.

February 19: 17:11 and 17:21. El Centro. Slight shocks reported by press.

February 19: 20:21:24.* Epicenter 33°55' north, 118°13' west, near Lynwood, P. Limited felt area covering about 800 square miles of Los Angeles County. Maximum intensity VI. Centered apparently in downtown area and adjacent east-side territory.

INTENSITY VI:

Eagle Rock.—Felt by all. Shifted small objects and rattled windows.

La Crescenta.—Many awakened. Knickknacks fell; windows, doors, and dishes rattled.

Los Angeles.—Press reported shock was felt generally in downtown area. Many theater and dance hall patrons ran into lobbies, burglar alarms rang, many residents called police. City Hall swayed perceptibly, janitor on 24th floor felt elevator cage bump. Disturbed objects observed by many, table lamp jarred, lamp and chairs shifted. Rumbling subterranean sounds heard before shock.

Maywood.—Felt by many in home, by some outdoors. Hanging objects swung; windows, doors, and dishes rattled.

North Hollywood.—Felt by all. Slight damage due to cracked plaster. Walls creaked.

Santa Monica.—Press reported furniture was moved and pictures danced on walls.

INTENSITY V: Compton, Huntington Park, Long Beach, Lynwood, and San Gabriel.

INTENSITY IV: Alhambra, Burbank, East San Gabriel, Downey, Glendale, Hollywood, Inglewood (NE or airport 2½ miles), Montebello, Monterey Park (N section), Pasadena, Van Nuys, Walnut, Wilmar, and Whittier.

INTENSITY I TO III: Arcadia, Mount Wilson, and Palos Verdes Estates.
Negative reports were received from 31 places.

February 20: 20:19. Santa Rosa. Affected area was limited to Santa Rosa where one and possibly 2 quick bumps were felt by many. Buildings creaked, loose objects rattled, trees and bushes shaken slightly, and chandeliers and pictures swayed. Many residents phoned newspaper office and police department. Loud explosive sound heard by many at time of shock.

February 21: 17:09:02.* Epicenter $36^{\circ}36'$ north, $121^{\circ}39'$ west, B. Felt by several near Hollister and at San Martin. Walls creaked and hanging objects swung.

February 21: 23:30 (about). Walnut. Motion sudden, like an explosion, lasted 1 second. Awakened few in community.

February 22: 07:05. San Francisco. Slight shock felt by observer in home. Direction vertical.

February 23: 19:03:39.* Epicenter $33^{\circ}59'$ north, $117^{\circ}32'$ west, near Mira Loma, P. Felt by several in Riverside. Very slight bump.

February 24: 00:15:10.* Epicenter $32^{\circ}30'$ north, $118^{\circ}33'$ west, south of San Clemente Island, P. Light shock reported felt with intensity IV in Alberhill, Avalon, Hawthorne, Lakeside, Norwalk, San Diego, and San Pedro. Windows, doors, and dishes rattled; hanging objects swung. Houses creaked slightly. Also felt slightly in Etiwanda.

Negative reports were received from 56 places.

February 26: 22:21:31.* Epicenter $32^{\circ}11'$ north, $118^{\circ}54'$ west, south of San Clemente Island, P. Felt at Lakeside by a few and in San Diego by several.

March 1: 00:12:13.* Epicenter $34^{\circ}10'$ north, $117^{\circ}32'$ west, about 15 miles northwest of San Bernardino. Sharp shock in southern California, centering near Cajon Pass. Affected area covered about 4,000 square miles, the greatest force being felt in San Bernardino Valley 40-60 miles east of Los Angeles. See map.

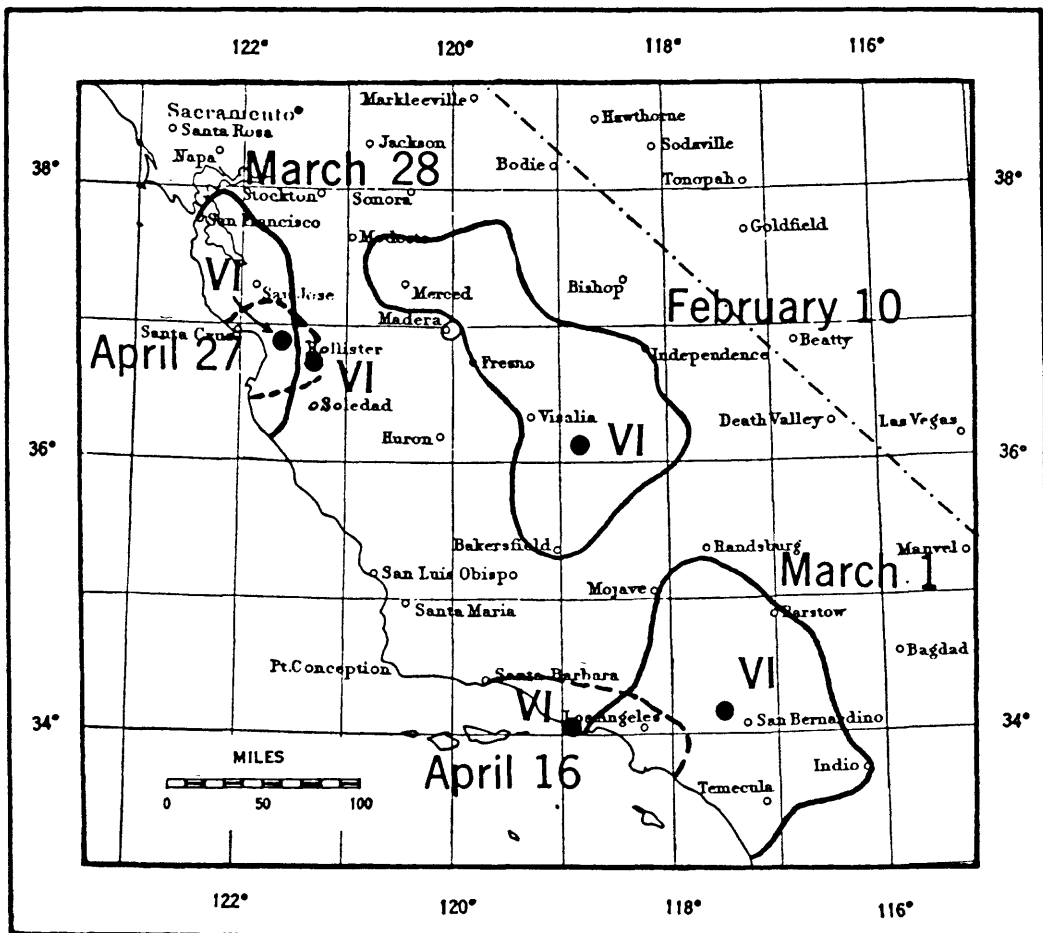


FIGURE 4.—Areas affected by the earthquakes of February 10, March 1 and 28, and April 16 and 27.

INTENSITY VI:

Arlington.—Two shocks, first motion rapid, second slow. Felt by many and awakened all. Windows, doors, and dishes rattled; house creaked.

Burbank.—One report of cracked plaster and walls.

Devore.—Concrete floor of ranch cabin cracked. A few dishes were broken and more would have been if shelves and hangers had not been specially arranged to safeguard against earthquakes.

Huntington Park.—Felt by many. Windows rattled, hanging objects swung, knickknacks fell. Damage slight.

Mira Loma.—Awakened many. Damage slight.

Mount Wilson.—Awakened many, felt outdoors by some. Windows, doors, and dishes rattled; trees and bushes shaken strongly.

Pasadena.—Chunks of plaster fell from interior walls of historic library building in Memorial Park. Electric lights were reported momentarily extinguished by the quake in many areas.

Riverside.—Felt by many and frightened many. Windows rattled.

San Bernardino.—Felt by all. Awakened and frightened many.

Temecula.—Felt by and awakened all.

Valermo.—Felt by and awakened all. Frightened few.

Walnut.—Felt by many, awakened many. Windows, doors, and dishes rattled. Hanging objects swung, trees and bushes shaken moderately. Overturned vases and small objects.

Wrightwood.—Felt by all. Direct up-and-down motion, like a jerk. Overturned small objects. Windows and dishes rattled, house creaked. Accompanied by a rumble before and after shock.

INTENSITY V: Altadena, Alta Loma, Artesia, Barstow, Brea, Cajon, Claremont, Compton, Del Mar, El Toro, Etiwanda, Fontana, Hesperia, Highland, Hinkley, Idyllwild, Lake Arrowhead, Llano, Long Beach, Lucerne Valley, North Hollywood, Pearblossom, Perris, Pomona Valley (all sections), Romoland, Santa Ana, Venice, White Water, and Wildomar.

INTENSITY IV: Alberhill, Acton, Adelanto, Arcadia, Balboa, Beverly Hills, Cantil, Charter Oak, Chino and Alhambra, Cornell, Corona, Covina, Fallbrook, Fullerton, Gilman Hot Springs, Glendale, Glendora, Helendale, Hemet, Huntington Beach, Laguna Beach, Lake Hughes, Lancaster, Los Angeles, Mojave, Murro, Newberry, Redondo Beach, San Juan Capistrano, San Marino, Seal Beach, Sierra Madre, Spadra, Stanton, Sunnymead, Whittier, Yermo, and Yucaipa.

INTENSITY I TO III: Anza, Beaumont, Cabazon, Calimesa, Culver City, Indio, Inglewood, and San Pedro.

Negative reports were received from 33 places.

March 3: 11:32:52.* Epicenter $33^{\circ}41'$ north, $117^{\circ}57'$ west, near Huntington Beach, P. Felt by many, outdoors by some, in Westminster. Hanging objects swung and houses creaked. Windows, doors, and dishes rattled.

March 7: 23:01. Sand Canyon Aqueduct station. Felt by several. Walls creaked and windows rattled.

March 15: 16:45. Riverside. Felt by observer in home. Rattled windows.

March 15: 18:46:51.* Epicenter $33^{\circ}55'$ north, $117^{\circ}19'$ west, near Riverside, P. Felt by several in Riverside. Rattled windows.

March 15: 22:04:26.* Epicenter $33^{\circ}55'$ north, $117^{\circ}19'$ west, near Riverside, P. Light shock awakened few in Riverside. Motion abrupt.

March 22: 01:13:28.* Epicenter $37^{\circ}49'$ north, $121^{\circ}39'$ west, B. Felt by many and awakened few in San Ramon. Houses creaked.

March 24: 07:20. White Water. Light shock felt by one. Rattled windows, doors, and dishes; hanging objects swung.

March 26: 20:27. Sand Canyon Aqueduct station. Slight shock rattled windows.

March 27: 13:09:36.* Epicenter 40.3° north, 124.8° west, B. Felt in Ferndale and to south. Walls creaked and hanging objects swung. Windows, doors, and dishes rattled slightly in Benbow. At Miranda, observer reported Easter cards standing on radio fell to floor toward north.

March 28: 10:26:20.* Epicenter 39.0° north, 119.9° west, B. Rocking motion felt by few in Reno, Nevada.

March 28: 14:36,* 14:38:03,* and 14:47.* Epicenter $36^{\circ}51'$ north, $121^{\circ}34'$ west, B. Three light shocks, the last reportedly the strongest, felt over an area of 4,100 square miles. See map. Top-floor apartment house tenants in San Francisco were alarmed when dishes rattled and chandeliers trembled. San Jose residents reported dishes were rattled and windows shaken.

INTENSITY VI:

Monterey.—Motion rapid, felt in home. Hanging objects swung. Trees and bushes shaken moderately.

Morgan Hill.—Felt by all, frightened many. Walls creaked, loose objects rattled. Chandelier swayed slightly E-W.

Salinas.—Felt by all, few alarmed.

INTENSITY V: Daly City, Montara, Hollister, and Santa Cruz.

INTENSITY IV: Ben Lomond, Big Sur, Chualar Canyon, Hayward, Lafayette, Newark, Salinas, San Jose, San Francisco, San Martin, and Watsonville.

INTENSITY I TO III: Pescadero, Pinole, and Pleasanton.

Negative reports were received from 35 places.

March 28: 18:40. Hollister. Felt by several in homes near town. Windows rattled and house creaked.

April 2: 23:05. Eureka. Press reported houses jarred slightly. Loose objects rattled and buildings creaked.

April 4: 07:45. Chualar Canyon. Slight shock felt in country.

April 5: 02:28:46.* Epicenter 33°37' north, 117°24' west, near Elsinore, P. Felt by and awakened many in Elsinore where windows and doors rattled. Awakened many in Wildomar where houses creaked and windows and dishes rattled.

April 5: 07:29:51.* Epicenter 38.0° north, 122.0° east, B. Numerous residents of Martinez reported dishes falling, chandeliers swaying, and severe house creaking. (BSSA, July 1948)

April 8: 09:57 (about). Redondo Beach. Felt by observer in home. Doors rattled slightly.

April 8: Some time in p. m. Dunlap. Bumping motion felt by two. House rattled.

April 12: 03:34. Sand Canyon Aqueduct station. Slight shock felt by several.

April 16: 14:26:24.* Epicenter 34°01' north, 118°58' west, southeast of Point Mugu, P. Felt near the coast, southeasterly to Long Beach, and inland about 25 miles, over an area of about 1,400 square miles. See map. Minor damage such as a few broken windows and some cracked plaster reported from Oxnard. Maximum intensity VI.

INTENSITY VI:

Oxnard.—Water movement in jugs and containers. Plaster cracked slightly. Scores of people left buildings. Dishes broke and lamps knocked over. Two windows broke in Naydock School and plaster fell from ceiling.

Somis.—Felt by all, frightened many in community. Overturned canned goods, hanging objects swung NE. Trees and bushes shaken strongly.

INTENSITY V: Camarillo, Cornell, Huntington Park, Los Angeles, Moorpark, Venice, and Ventura.

INTENSITY IV: Canoga Park, Carpinteria, Chatsworth, Compton, El Segundo, Fillmore, Hermosa Beach, Long Beach, Port Hueneme, Santa Barbara, Santa Monica, Santa Susana, San Pedro, Simi, and Van Nuys.

INTENSITY I TO III: Burbank, Downey, El Monte, Fullerton, La Habra, Lomita, Monterey Park, Newhall, North Hollywood, Northridge, Norwalk, Ojai, Pasadena, Palos Verdes Estates, San Dimas, Torrance, Universal City, and Vernon.

Negative reports were received from 50 places.

April 16: 17:23:42.* Epicenter 34°01' north, 118°58' west, near Point Mugu, P. Very slightly felt at Port Hueneme.

April 17: 00:33. Lomita. One jolt felt by observer in home.

April 17: 12:55. Independence. Slight shock felt by observer in trailer.

April 18: 13:25:10.* Epicenter 38°10' north, 122°32' west, B. Press reported sharp earthquake in San Francisco Bay area, felt principally in Richmond and Sunset districts and in Marin and Contra Costa counties. Felt at Fairfax, Kentfield, Petaluma, San Anselmo, San Francisco, San Rafael, and Vallejo.

April 20: 15:32. Pit River Powerhouse and Camp (Shasta County). Light shock felt by all in home.

April 20: No time given. Los Angeles (central section). Swaying motion felt by observer. Table lamp swayed.

April 22: 11:37 (a. m. or p. m. not stated). Fairfax. Very slight shock felt.

April 27: 12:22:25.* Epicenter 36°46' north, 121°16' west, B. Strongest of series reported on this date. Eight smaller shocks also reported felt. See map.

INTENSITY VI:

Hollister.—Cracked plaster. Hanging objects swung. Trees and bushes shaken strongly. Houses creaked and loose objects rattled.

Also reported felt at Big Sur, Chualar, Morgan Hill, Ben Lomond, and Salinas with lesser intensities.

April 27: 23:30 (about). Hollister. Awakened many. Overturned small objects E.-W. Rattled windows, house creaked.

April 29: 13:44:59.* Epicenter 33°59' north, 116°46' west, north of White Water, P. Felt by many in White Water. Hanging objects swung, windows and dishes rattled, house creaked.

May 3: 18:34:15.* Epicenter 37°51' north, 122°13' west, B. Felt by several in Oakland where loose objects rattled and house creaked. Felt by one in Berkeley.

May 9: 03:10.* P. Los Alamos. Felt by all, awakened many. Rattled windows, doors, and dishes.

May 9: 04:45. Hollister, 7 miles south of. Felt by observer in home, felt outdoors by some. Windows, doors, and dishes rattled; house creaked.

May 11: 02:45. Hollister, 7 miles south of. Rather sharp motion felt by many, frightened few in home. Rattled windows, doors, and dishes; shifted small objects. House creaked.

May 22: 01:39:53.* Epicenter 36°47' north, 121°24' west, B. Slight shock felt 7 miles south of Hollister.

May 24: 02:38:20.* Epicenter 33°55' north, 118°01' west, off Newport Beach, P. At Huntington Beach dishes rattled, small objects on dresser shifted, bottles overturned, and some clocks stopped. Also reported felt at Anaheim, Long Beach, Newport Beach, Santa Ana, and Westminster.

May 25: 14:20. Keller. Slight shock felt by observer. Pen on desk and desk shook.

May 31: 11:09:23.* Epicenter 35°30' north, 118°30' west, near Bodfish, P. Slight shock rattled windows and shook trees and bushes in Weldon.

June 7: 07:05:22.* Epicenter 37°12' north, 118°42' west, west of Big Pine, P. Intensity V at Bishop where two shocks were felt by many. Buildings creaked, disturbed objects observed by several. Theodolite and beacon tower swayed N.-S. Hanging lights in telephone building swayed. Felt by many over valley covering 10 square miles around Bishop.

June 9: 23:25. Bishop. Light shock rattled loose objects. Building creaked. At Laws windows and dishes rattled, hanging objects swung, and trees and bushes were shaken strongly.

June 10: 23:28:11.* Epicenter 36.6° north, 121.2° west, B. Three distinct shocks felt in Palace Hotel in San Francisco. Rattled windows, doors, and pipes within walls. Opened drawers slightly; hanging objects swung.

June 16: 16:53:47.* Epicenter 36°07' north, 117°52' west, near Haiwee, P. Nine shocks felt at Haiwee, about 40 smaller shocks recorded on seismograph. Coso Junction observer reported creaking buildings and moderately loud and thunderous subterranean sounds.

June 17: 11:00. Newbury Park. Slight shock felt by several, felt outdoors by observer.

June 18: 02:35:00.* Epicenter 39°04' north, 123°17' west, B. Felt in portions of Mendocino, Lake, and Sonoma counties, over an area of about 600 square miles. Cracked plaster and some chimneys. Maximum intensity VI.

INTENSITY VI:

Lakeport.—Felt by all and awakened all. Overturned vases, cracked plaster, rattled windows and dishes.

Talmage.—Felt by and frightened many. Cracked plaster. Knickknacks and plaster fell. Small objects overturned. Damage slight.

Ukiah.—Felt by and frightened many. Overturned vases and small objects. Cracked chimneys. Shifted small objects and furnishings.

INTENSITY V: Calpella, Clearlake Oaks, Finley, Potter Valley, Redwood Valley, and Upper Lake.

INTENSITY IV: Boonville, Cloverdale, Kelseyville, Philo, Witter Springs, and Yorkville.

Negative reports were received from 23 places.

June 18: 21:40. Lakeport. Slight shock felt by many.

June 20: 12:34:38.* Epicenter 36°57' north, 121°40' west, B. Light shock rattled windows, doors, and dishes in Watsonville.

June 20: 17:50. Riverside. Light shock rattled windows strongly. Felt by several in home.

June 23: 19:51. Slight shock reported felt strongest in Petrolia. Felt by many in Ferndale where walls creaked. At Scotia windows rattled and houses creaked.

July 1: 04:08. Death Valley National Monument (west-central section). Light shock felt by two. Faint rattling subterranean sounds heard at time of shock. Vibrations noticed on small pool. Dishes rattled.

July 5: 02:14. Manzanita Lake (Lassen Volcanic National Park). Light shock felt by and awakened many. Rattled windows, doors, and knickknacks. Dismantled both components of crude Bosch-type seismograph.

July 7: 17:15. Lakeport. Two minor jolts felt by several in home.

July 7: 18:36:23.* Epicenter 37°49' north, 122°34' west, B. Light shock felt by many in San Francisco where few were alarmed, room seemed to sway N-S, and windows and dishes rattled. Felt slightly in Berkeley and Ross.

July 13: 03:02:48.* Redding (Shasta seismograph station). Light shock felt by and awakened many. Reports indicated greatest movement near Whitmore. Walls creaked, windows and dishes rattled.

July 14: 21:32:49.* Epicenter 35°45' north, 117°55' west, near Walker Pass, P. Light shock felt by all in Weldon. Hanging objects swung, trees and bushes shaken slightly. Windows rattled and house creaked.

July 17: 17:03:48.* Epicenter 34°04' north, 117°49' west, near San Dimas, P. Press reported the shock felt from Covina to Riverside. Pendulum clock stopped, dishes broke, and trees shook moderately in Walnut. Felt with lesser intensity at Brea, Chino, Claremont, Elsinore, Hemet, Perris, Pomona, Riverside, Romoland, and Silverado.

July 20: 00:11:41.* Epicenter 37°27' north, 121°49' west, B. Slight shock rattled windows and dishes in San Jose and Milpitas, intensity VI. Also felt at Coyote, Gilroy, and San Jose, intensity V.

INTENSITY IV: Agnew, Aptos, Boulder Creek, Holy City, Mission San Jose, Niles, San Francisco, San Rafael, and Saratoga.

INTENSITY I TO III: Alvarado and Alviso.

Negative reports were received from 38 places.

July 21: 13:29:17.* Epicenter 37°53' north, 122°16' west, B. Light shock felt in Berkeley. Sound like explosion heard before house shook.

July 25: 21:29:26.* Epicenter 34°16' north, 117°14' west, near Lake Arrowhead, P. San Bernardino press reported a short, sharp jolt felt in north end of city. Felt in downtown area but not as severely. Other southland points did not report a tremor. One report of plaster and concrete floor of porch cracking.

July 26: 04:04. Weldon. Light shock awakened all in home. Rattled windows, doors, and dishes; house creaked.

July 26: 09:50:00.* Epicenter 35°34' north, 118°05' west, south of Walker Pass, P. Felt by all, frightened few in Weldon. Small objects shifted, trees and bushes shaken moderately. Violent rumble-like explosion. Also felt at Bodfish, Cantil, Haiwee Power Plant (Coso Junction), Johnsondale, Kern Canyon, Kernville River Powerhouse No. 3 (about 6 miles from Kernville), Kernville, Mount Owen, Miracle Hot Springs, Mojave, Muroc, Onyx, and Randsburg.

Negative reports were received from 28 places.

August 5: 20:22:57.* Epicenter 37°27' north, 118°35' west, west of Bishop, P. Intensity IV at Bishop and in the Sequoia National Park at Hospital Rock and Buck Rock Lookout where buildings creaked and loose objects rattled. Also felt at Atwell Ranger station.

August 9: 23:02:47.* Epicenter 37°51' north, 121°52' west, B. San Ramon. Felt in home, awakened few, rattled doors.

August 18: 11:11:57.* Epicenter 40.5° north, 124.7° west, B. Light shock felt by many in Eureka. Buildings creaked and loose objects rattled. Door to barometer case facing east was opened. Very slight swaying of buildings and trees. In Ferndale, Fields Landing, and Loleta hanging objects swung; windows, doors, and dishes rattled. Felt with lesser intensities at Alton, Arcata, Carlotta, Cape Mendocino, Honeydew, Kneeland, Korbek, Orick, Petrolia, Punta Gorda, Scotia, Spyrock, and Trinidad.

Negative reports were received from 27 places.

August 19: 02:54. Eureka and Scotia. Light shock awakened many. Loose objects rattled and house creaked.

August 25: 22:55. Bishop. Slight shock felt by several in east section. Building swayed and creaked; curtains swayed as though in wind; and surface sounds were heard by observer.

August 28: 05:31:59.* Epicenter 34°02' north, 117°31' west, near Mira Loma, P. Slight shock reported at Riverside.

September 1: 13:27:47.* Epicenter 38°20' north, 122°35' west, B. Santa Rosa press reported sofa and chairs shook and chairs on rollers moved noticeably. One report of noise like an explosion, then windows rattled and curtains swung out. Northeast section residents reported disturbed objects observed and hanging objects swung. Also reported felt in Cotati.

September 3: 15:42:26.* Epicenter 34°20' north, 119°32' west, P. Santa Barbara. Slight shock felt.

September 7: 20:28:13.* Epicenter 40°15' north, 124°16' west, B. Eureka. Slight shock felt.

September 11: 04:17:39.* Epicenter 36°43' north, 119°20' west, east of Sanger, P. Felt in Miramonte and Pinchurst where many were awakened. Hanging objects swung, vases overturned, knickknacks fell, and dishes rattled.

September 28: 06:30. Weldon. Slight shock felt by several. Trees and bushes shaken slightly.

September 28: 20:06:48.* Epicenter $35^{\circ}30'$ north, $118^{\circ}58'$ west, northeast of Bakersfield, P. Press reported two shocks felt at Porterville, the second being heavier. Felt as far north as the Blue Ridge Lookout in Sequoia National Forest. Local U. S. Forest Service headquarters reported the shock as strongest they had ever felt in the mountains. The lookout on Tobias Peak reported a windbreak shaken loose and house settled so that doors could not be closed. Needles Peak lookout also reported the shock as severe.

INTENSITY V: Bakersfield, Bodfish, Maricopa Flats, Miracle Hot Springs, Porterville, Visalia, and Weldon.

INTENSITY IV: California Hot Springs, Ducor, Johnsondale, Kernville Powerhouse No. 3 (6 miles from Kernville), McFarland, Miramonte, Springville, and Woody.

INTENSITY I TO III: Buttonwillow and Tupman.

Negative reports were received from 33 places.

October 9: 08:00 (about). Slight shock felt at Lone Pine, and in tin garage in Kelles, 16 miles distant.

October 10: 03:21:08.* Epicenter 36.9° north, 121.8° west, B. Watsonville and Moss Landing. Slight shock felt.

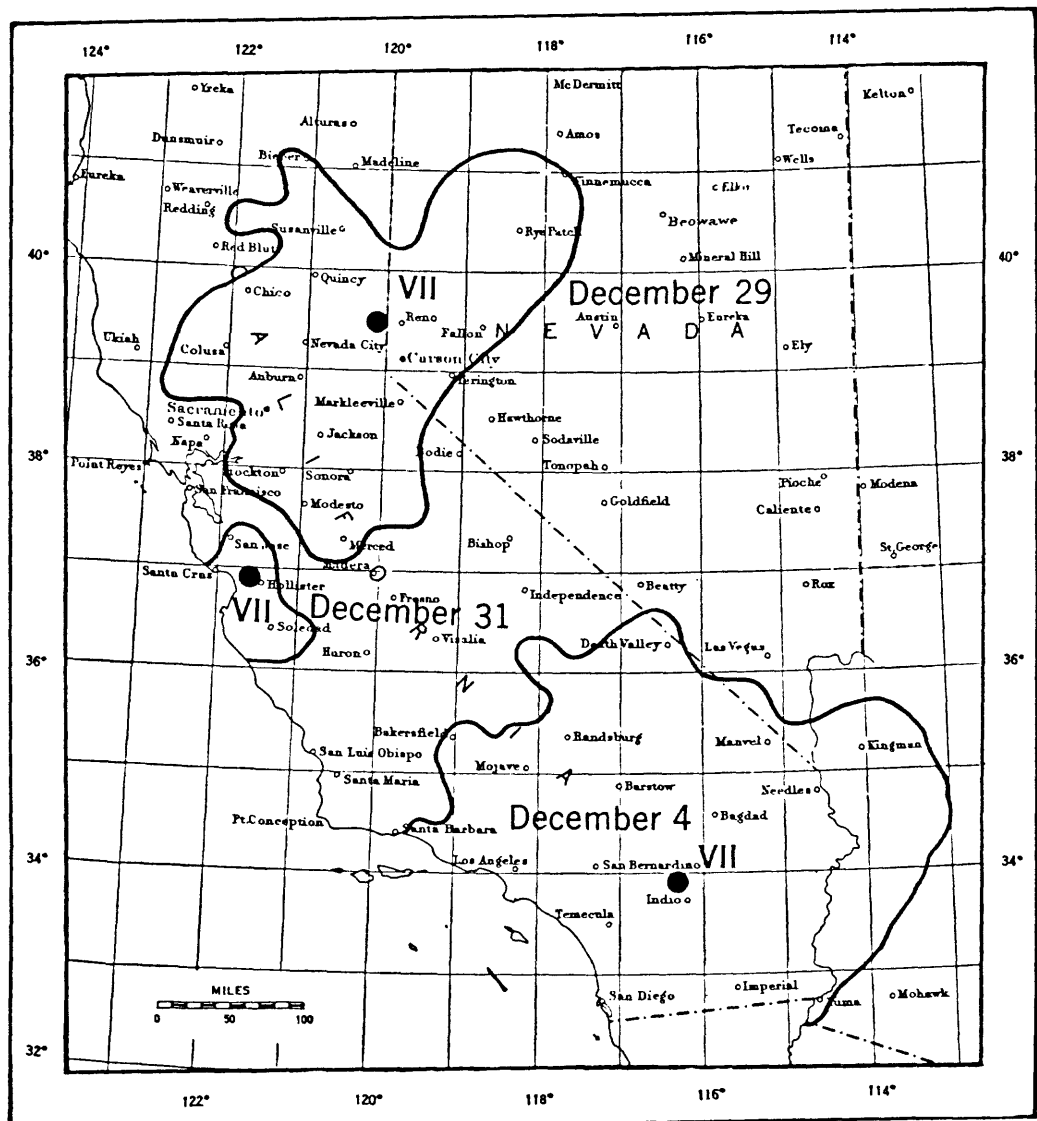


FIGURE 5.—Areas affected by the earthquakes of December 4, 29, and 31.

October 12: 09:59:29.* Weldon. Slight shock felt by several. Rattled windows and doors.

October 12: 16:23. St. Helena. Light shock shook trees and bushes strongly.

October 13: 16:57:22.* Epicenter 35°50' north, 118°28' west, P. Kern River Powerhouse No. 3 reported a slight shock felt by many.

October 16: 21:21:47.* Epicenter 37°43' north, 122°32' west, B. Light shock felt by many in Daly City. Accompanied by sound like distant explosion. Felt by several in San Francisco.

October 26: 19:05. Los Alamos. Felt by few. Windows rattled and house creaked. Building quivered for several seconds.

October 28: 19:04:59.* Epicenter 34.1° north, 120.4° west, P. Arlight and Point Arguello Light Station. Light shock felt by and frightened all. Rattled vases, walls creaked. Small objects shifted. "Seemed to shake hardest at beginning and end."

November 10: 17:29. Light shock felt by several in El Portal, Exchequer Dam (Merced Falls), Mariposa, and Midpines. Hanging objects swung, windows rattled, small objects shifted, and trees and bushes shaken slightly.

INTENSITY IV: Ben Hur, Big Oak Flat, Cathay, Coulterville, Incline, Mount Bullion, Planada, Tuolumne, and Yosemite National Park.

INTENSITY I TO III: Bagby, Le Grand, Snelling, and White Rock (20 miles east of Le Grand).

Negative reports were received from 9 places.

November 12: 04:47. Reno, Nev. Brief jolt felt by several.

November 13: 04:54. Reno, Nev. Two sharp, short jolts felt by many.

November 14: Between 02:00 and 03:00. Chico. Observer awakened from sound sleep by trembling of bed.

December 1: 12:15:50. San Diego. Very light shock noticed by two in home.

December 4: 15:43:17.* Epicenter 33°53' north, 116°20' west, near Desert Hot Springs, P. Felt over an area of 65,000 square miles exclusive of Mexico. See map. Epicenter in foothills of Little San Bernardino Mountains, a desert range trending northwesterly about 45 miles long and 7 to 9 miles wide, bordering the Coachella Valley on the northeast. Elevations range from 3,000 to 5,000 feet above sea level as compared to 500 to 600 feet on the valley floor. Geologically the range is described as largely an ancient complex of igneous and metamorphic rocks. Near the epicentral location, the main San Andreas Fault, a branch known as the Mission Creek Fault and the Pinto Mountains Fault join at a nearly common junction. The upper Coachella Valley from Thousand Palms to White Water reported the highest intensities. This area is the most densely populated section adjacent to the epicenter. In the foothills of the Little San Bernardino Mountains the intensity was equal or greater but little information is available due to the region being sparsely settled.

INTENSITY VII:

Cabazon.—Felt by all, some alarmed. Cracked plaster and walls; fall of knickknacks and plaster. Three-quarter inch water pipe about 10 inches in ground sprung leaks. Damage slight to brick and masonry. Packaged groceries fell from shelves, most fell to east. Ceiling lights swayed. Many disturbed objects.

Desert Hot Springs.—Practically all adobe buildings showed cracks. Some small pipes in ground broken. Many chimneys separated from buildings, many cracked.

El Pueblo Store.—Adobe structure located on alluvial fan at south limit of town. Parapet on roof moved out on north and south sides; cracks throughout building, generally passing through mortar and around blocks. Broken windows. Everything from shelves on floor; cases and heavy articles moved; great damage to bottled merchandise.

Woods residence.—North of town about one-half mile, on basement rock. North end of new house of reinforced concrete building blocks showed rafters pulled loose $\frac{1}{4}$ inch; south end of house (rocks cemented with mortar of lime and desert sand) showed great damage. South walls displaced 2 inches to south at top, cracks throughout to $\frac{1}{2}$ inch separation, fallen chimney, one south window broken, and some dishes broken. Slight slumping noted in fill outside house.

The Oasis.—Scattered cracks around concrete blocks, one plaster of paris statuette broken. Plate glass windows of grocery across street broken and merchandise rolled on floor. In adjacent drugstore everything on north wall shelves was shaken off, only 4 cups on south wall shelves were displaced (dishes were stacked to 1-1½ feet). Roof tile displaced in isolated cases.

Harry Bennett Ranch.—Nearest structure to epicenter. One-inch cracks between 8-inch hollow concrete blocks. Blocks fell off at top of building, many others loosened enough to require removal and rebuilding. Some ceiling beams loosened. Small section of roof parapet damaged. Concrete floor slab between rooms opened $\frac{1}{2}$ inch. Water spilled from swimming pool in E-W direction.

Newly-constructed school.—Reflecting devices of Silvrav lamps suspended on 3 wires bent up $\frac{3}{4}$ inch at bottom were displaced so that they hung vertically from north wire hangers and had jumped out of the loops on the southeast and southwest sides.

Estharr Ranch.—Very well-constructed flat-roofed home and stable, cement floors. Parapet at corner of house shaken off, flashing next to roof pulled loose. Cracks to $\frac{1}{2}$ inch at joints in floor and subsequent pounding. Everything in house except heavy and low center of gravity articles overturned. Swimming pool filled to 9 foot depth at deep end was nearly emptied from splashing out of water. Water 20 feet higher in well and kept rising for some time. Large plate window set in caulking material was not broken but windows in bar were broken out.

Indio.—Hotel Waller, 3-story building with brick vertical columns and steel horizontal reinforcing. Hollow tile walls with concrete tie on top of each floor. Quite bad plaster cracks mostly vertical on second floor and without pattern on first floor. No damage on third floor. Plasterboard wall in Coffee Shop buckled. A 3-foot square area at floor line, next to an outside column, broke outward into room.

Hotel Indio.—2-story brick building, L-Shaped, and recently decorated. Damage to new work was extensive. Several N.-S. plasterboard walls had large bulges. Dishes broken, several plate-glass windows broken, numerous plaster cracks, and liquor bottles overturned and broken.

Indio Hills.—General landsliding, rocks on level ground were shifted 1 to 2 inches to west. Large and small rocks on slopes were overturned and rolled. Few cracks noted, $\frac{1}{4}$ inch separation and 25 to 40 feet long with no general trend in direction. Soil very loose in places following shock.

Joshua Tree.—Stocks in store thrown to floor, a dozen water pipes broken. Cracks in plaster, windows, walls, chimneys, and ground. Books, pictures, and plaster fell. Dishes broken.

Kiel Ranch.—Very well-built reinforced concrete block house with cement floor. Cracks on all sides of house, chiefly on E.-W. sides, displayed shear pattern. Tile shaken off roof. Heavy refrigerator moved $\frac{1}{2}$ inch to east, gas stove moved northwest about 1 inch, N.-S. sliding doors on wardrobe were shaken open, beds and dressers moved out from walls from 1 to 2 inches, and pictures were shaken off walls. Heavy clock remained on mantle of fireplace as did several smaller articles. Cracks in ground around house.

Mecca.—Earth slides and interruption in electric service on local line at Coachella. To the east, in mountains, pieces of cliffs fell off causing dust to rise. Observer reported highway rippled. Visible swaying of buildings and trees.

Morongo Valley.—Buckskin Club (8 miles east of Morongo Lodge). Adobe structure. East-wall wall cracked, 3 by 6-inch rafter split. Considerable damage to china, stacked furniture tumbled, chandeliers swung N.-S. People frightened, some saw waves in floor.

Palm Springs.—Center Building, a two-story ultra-modern building of steel and concrete with large patios. Two 9 by 12-foot plate glass windows broken, many plaster cracks both inside and outside, cracks seemingly followed steel in concrete.

Rexall drugstore.—One-story building. Large plaster crack in concrete block front, crack showing inside only about 8 feet above ground level. Glass not broken.

Plaza theater.—Rustic finish with open ceiling of 10 by 12-inch bolted beams, block walls. No damage to structure. Loose colored glass plates in bottoms of several chandeliers fell out injuring patrons. About 50 children in theater left hurriedly.

Hotel del Tahquitz.—Rather old two-story adobe structure reinforced by addition of a number of columns and beams duplicating the original design. Building has gone through several local earthquakes. Although a number of cracks developed and old ones were further widened, there appeared to be no structural damage.

Bullocks.—Modern two-story steel, concrete, and plaster structure. Outside damage was to plate glass windows where 4 panes 6 by 6 feet were shattered. Larger panes were not. Interior showed many small plaster cracks especially where one building material joined another as at baseboard and at partitions butting up against a wall. On the second floor 6 fluorescent hanging fixtures with decorative glass bottoms and slides broke or dropped their glass. No apparent structural damage.

Carnell property.—Solid concrete two-story structure with tile roof. Small cracks showed in walls and a number of tiles were loosened, quite a few dropping to street both to south and west. Small antique shop at rear of this building (one-story concrete block about 18-foot square with tile roof) lost its chimney. A number of objects fell from shelves in all directions.

Francis Stephens School.—A rambling one-story grammar school. Minor stucco cracks.

Twenty-nine Palms.—Bank, a one-story stucco frame building with 18-inch walls of steel and concrete showed hairline cracks around 10 by 6-foot vault where it is tied to building. Elsewhere a few windows were broken and objects were shaken from E.-W. shelves. Pavement cracked, visible swaying of buildings, trees, and telephone poles. Curio shop lost many glass and ceramic objects by breaking. Damage to glassware, slight damage to masonry and grocery store stocks (bottles and cans on shelves and in piles).

West of town a 66,000-gallon steel water tank 16 feet in diameter and 24 feet high with steel bottom resting on loose sand on a 200-foot hill, shifted about 1 inch north and the bottom buckled as if it had rocked. A split between the sides and bottom about 4 inches wide and several feet long occurred on the northwest side of the tank. Gullies several feet deep were cut into the hillside and across the approach road by the estimated 150 to 200 thousand gallons of lost water.

Thousand Palms.—Chimney on strong field stone building, one-story, twisted and tilted. Plaster cracked around plumbing installations and fell. Few windows and dishes broken, objects fell from shelves. Great clouds of dust arose from steep canyons in hills to north.

San Bernardino Mountains, north of Banning.—Press reported landslides and broken chunks in pavement on a road leading to the Morongo Indian Reservation.

San Bernardinos, about 11 miles northeast of Palm Springs.—At the aqueduct line in the San Bernardinos slumping of gravel sidings and cracks over gravel fills were noted. No rock movement apparent on side hills.

White Water Canyon.—Cliffs fell in canyon and horses stampeded.

Willis Palms (at Mission Creek Fault).—Cracks in ground, slumping of cliffs and river banks, rocks moved on 20° slopes and slightly displaced on level ground. Springs increased flow from trickle to small stream. Black mud was pumped from well 136 feet deep, alternately pumped clear to muddy afterwards. Temperature of well water changed from 90° to 92°. Tiny cracks noted in 4-inch reinforced concrete foundation setting of well casing. Dust obscured mountains, landslides in the hills.

Yucca Valley.—New 40 by 60-foot frame building with concrete block ends showed 4-inch breaks in tops of corner column. Considerable damage to grocery stocks. Dishes and windows broken.

INTENSITY VI:

Adelanto.—Pictures fell off narrow ledges. Plaster wall cracked. Light fixtures swung back and forth, N.-S. Sickening sensation felt by men and women. Pendulum clocks stopped.

Aguanga.—Pendulum clocks stopped, clocks faced E. Overturned vases and small objects. Rocks rolled. Groceries fell from shelves.

Alberhill.—Hanging objects swung N.-S. Small objects shifted.

Alta Loma.—Cracked plaster. Trees and bushes shaken moderately. Hanging objects swung.

Arlington.—Windows broken and a paint store messed up when stocks fell to floor.

Artesia.—Shifted small objects, overturned vases; knickknacks, books, pictures, and plaster fell. Hanging objects swung E.-W. Trees and bushes shaken moderately.

Balboa (Newport Beach).—Visible swaying of buildings and trees. Slight wall cracks (E.-W. and N.-S.) in some brick buildings. Cars and trucks rocked 4 to 6 inches. Hanging light fixtures swung E.-W. 6 to 8 inches.

Banning.—Small plaster cracks, a few bottles broken.

Beaumont.—Large cracks in old adobe church. Damage slight to masonry and concrete. Hanging objects swung N.-S. Plaster on walls cracked in a few buildings, mostly old cracks opened. Water in pan moved N.-S.

Bendel's Corner.—Cracked adobe walls. Road weaved.

Big Bear City.—Hanging objects swung NE. Windows and dishes broken. Trees and bushes shaken moderately, small objects overturned.

Blythe.—Cracked walls. Trees and bushes shaken moderately. Hanging doors swung NE.

Boron.—Some felt two shocks. Pictures moved, trees and bushes shaken.

Cathedral City.—Store windows in one-story wood-frame building broken. Groceries tumbled from shelves, books and pictures fell. Plaster cracked. Dust noted in hills.

Chubbuck.—Felt in store. Hanging objects swung. Plaster cracked. Slight damage.

Coachella.—House swayed, cups in kitchen swung N.-S. Opened one old crack in Coachella branch of the All American Canal. Trees and bushes shaken strongly. Overturned vases and small objects.

Colton.—Hanging objects swung NE. Pendulum clocks stopped. Fireplace tools swung N.-S. Disturbed objects observed by several.

El Segundo.—Felt by all in Post Office. Hanging objects swung NW-SE. Pendulum clocks stopped, clocks faced W. Trees and bushes shaken moderately.

Elsinore.—Press reported worst damage in high school where old pin-point crevices had considerably widened. New cracks were discovered in attic and wall in library was observed to have shifted.

Fall Brook.—Cracked plaster in a few places, shifted small objects. Hanging objects swung.

Fawnskin.—Hanging objects swung. Trees and bushes shaken strongly. Shifted small objects, overturned vases. Knickknacks fell.

Fullerton.—Few wall cracks on N.-S. sides. Lighting fixtures, wire cables, and doors swayed. Some store goods fell from shelves. Plaster on walls of older buildings cracked, mostly N.-S. walls in corners and ceiling, cracks E.-W.

Garnet.—Gas station attendant reported gasoline truck in driveway bounced. Three small window panes in a N.-S. wall were broken. Loose objects moved to E. and S. Dust in Little San Bernardino Mountains.

Hemet.—Press reported canned goods knocked from grocery shelves.

Highway 99 (west of Riverside).—Landslides on highway. Visible swaying of buildings, slight damage. Ornaments broken. Several walls cracked. Objects displaced E.-W., walls running N.-S.

Huntington Beach.—House felt like it was slowly pushed. Hanging objects swung. Pendulum clocks stopped, clocks faced SW. One clock started.

Huntington Park.—Hanging objects swung E.-W. Overturned vases and small objects. Knickknacks fell, dishes broke. Trees and bushes shaken strongly. Plaster cracked in some places.

Idyllwild.—Trees and bushes shaken strongly. Knickknacks fell. Damage slight. Several people observed rocks set in motion and knocked off cliffs. Sixty-foot pole at ranger station swayed in estimated 3-foot arc. Seventy linear inches of crack in brick chimney, E.-W. cracks dominated. Many items knocked off shelves running N.-S. in grocery store.

Indian Wells.—Plaster cracks.

Inglewood.—Hanging objects swung N.-S. Windows broke. Damage slight.

Jacumba.—Cracks in concrete opened slightly. Plaster cracked. Felt by all in general area. Trees and bushes shaken slightly.

Kelso.—Hanging objects swung. Pendulum clocks stopped. Walls cracked. Small objects shifted.

La Habra.—Overturned vases and small objects, hanging objects swung.

Lake Arrowhead.—Trees and bushes shaken strongly. Pendulum clocks stopped, hanging objects swung.

Los Angeles.—Edison Building. Numerous minor plaster cracks on various floors with exception of upper two floors. Cracks usually at junction between E. or W. outside walls and plastered partitions butting against them. Lighting fixtures swung with wide arc, some file drawers on upper floors in E.-W. position opened. Bridge between Edison Building and Annex Building immediately to west indicated considerable relative motion between the buildings.

Subway Terminal Building.—Minor cracking of plaster throughout building. One glass pane in cabinet broken.

Chamber of Commerce Building.—Few small plaster cracks especially around pipes through walls.

Binford Building.—Three-inch split in 5,800-gallon water tank located on top of 22-foot elevator shaft tower above 4-story building. Failure due to riveted joint at bottom of tank.

Federal Building.—Hanging objects swung SE. to NW. Cracked plaster. Slight damage.

Elsewhere crowds left theaters, windows and dishes broke, clocks stopped. Hanging objects on walls swung slightly, chandeliers swung a few inches.

Lucerne Valley.—Hanging objects swung NE. Overturned small objects. Plaster and walls cracked, knickknacks fell.

Maywood.—Trees and bushes shaken moderately. Hanging objects swung.

Mesa Grande.—Hanging objects swung, small objects shifted slightly, very few small objects overturned. Some knickknacks and books fell.

Midland.—Hanging objects swung, small objects and furnishings shifted.

Mojave.—Cracked plaster. Trees and bushes shaken moderately. Clocks facing west stopped. Chandeliers and curtains swayed.

Mountain Center.—Hanging objects swung. Trees and bushes shaken.

Newport Beach-Balboa area.—Heavy creaking of house. Hanging objects swung E.-W. Pendulum clocks stopped. Small objects overturned. Knickknacks and plaster fell. Windows cracked.

North Hollywood.—Cracks in cement. Damage slight. Hanging objects swung. Trees and bushes shaken strongly.

Nuevo.—Hanging objects swung. Knickknacks, books, and pictures fell.

Oasis (1 mile north of).—Rattled everything. Knocked cans off shelves.

Ontario.—Press reported windows broken in building of Ontario Daily Report.

Ornard.—Disturbed objects observed by many. Slight damage to buildings, walls cracked in concrete block construction. Lights, chains, and clothes swung. Some plaster cracked.

Palm City.—Emory School Building, old, constructed with hollow concrete block walls. New cracks appeared in walls and old ones were opened wider. Building was condemned for school use.

Palomar Mountain.—Sharp jolt, pause, then E.-W. swing. Hanging objects swung, pendulum clocks stopped, small objects shifted.

Pasadena.—Press reported local buildings rocked and new cracks in Hall of Justice. A few dishes toppled in one Altadena home. Several persons had sensation of dizziness.

Pasadena (central section).—Visible swaying of buildings, minor plaster cracks on ceiling and walls. Fluorescent fixtures swung 15° each side of center, N.-S.

Pasadena (California Institute of Technology).—Minor cracking of plaster in dormitory. Some motion noticed in flexible joints of buildings.

Perris.—Cracked plaster, shifted small objects and furnishings. Knickknacks fell. Trees and bushes shaken moderately.

Pine Valley.—Entire house creaked. Plaster cracked. Some small objects and furnishings shifted.

Plaster City.—Shifted small objects, overturned vases, cracked plaster. Knickknacks and plaster fell. Trees and bushes shaken moderately.

Ripley.—Shifted small objects from open shelves.

Riverside.—One woman fainted in department store. One burglar alarm was short-circuited and one fire alarm was set in motion. Wall of Safeway store at Third and Main Streets cracked, and one woman reported the top of her gas stove fell down. People streamed from the Public Library, more than half the theater patrons ran out exits.

San Bernardino (central section).—Felt by about 40 percent of population. Visible swaying of trees and flagpole. Windows cracked, lighting fixtures swayed. Damage slight to buildings. Northwest section residents reported visible swaying of buildings. Hanging objects swung N.-S., loose objects rattled.

San Diego.—Two 10-pound chunks of concrete cornice shaken from a Mission Beach amusement center. One watermain burst and several burglar alarms set off. Scattered reports of cracked plaster and paint. Pendulum clocks facing N. stopped. Canned goods fell from store shelves in grocery in west section of town. Hanging lights swayed, fans over meat counter swayed N.-S.

San Dimas.—Hanging objects swung E.-W. Pendulum clocks stopped. Trees and bushes shaken moderately. Few dishes broken. Cracked plaster slightly. Knickknacks fell.

San Jacinto.—Few cracks in plastered walls. Disturbed objects observed, electric wires were still swinging when observer went outside. Liquor bottles, canned goods piled high, and a few bottles on glass-topped showcase in drugstore fell. Moderate rumbling subterranean sounds heard by many at time of shock.

San Juan Capistrano.—Hanging objects swung, knickknacks fell, small objects overturned. Damage slight.

Santa Ana.—Hanging objects swung N.-E., house creaked. Few reports of fallen objects. Many frightened. Trees and bushes shaken strongly.

San Ysidro.—Cracked plaster slightly. Few frightened.

Seal Beach.—Cracked windows, hanging objects swung. Few frightened.

Temecula.—Long duration. Hanging objects swung NE. Cracked plaster and windows, cracked walls to some extent. Some dishes broken. Hanging baskets swung for 8 minutes after shock. Overturned vases and small objects. Trees shaken strongly.

Thermal.—Old plaster cracks opened. Groceries fell from shelves. Ten or twelve local telephone lines "wrapped up" causing interruption only on phones they served. Dust in the east.

U. S. Salton Sea Base.—Threw observer against desk NE.-SW., observer seated at desk. Telephone fell off wall. Phone line shaken.

Walnut.—Started with sharp shock followed by two others, second most severe. Hanging objects swung. Trees and bushes shaken strongly.

Warner Springs.—Hanging objects swung. Small objects shifted. Few frightened.

Westminster.—Cracked plaster, windows, and walls. Hanging objects swung. Trees and bushes shaken strongly.

Westwood.—Watermain on UCLA campus broke, was temporary installation partly at surface and partly in soft fill.

Wildomar.—Hanging objects swung, pendulum clocks facing E stopped. Plaster cracked, merchandise fell from shelves in grocery store. Chain hoist in garage swung in arc of about 18 inches.

Yucaipa.—Knickknacks fell, small objects shifted. Damage slight.

INTENSITY V: Acton, Alipine, Altadena, Amboy, Anza, Arvin, Avalon, Barstow, Brawley, Burbank, Camp Baldy, Campo, Cantil, Carpinteria, Compton, Corona, Covina, Culver City, Del Mar, Desert Center, Dulzura, El Monte, Essex, Etiwanda, Glendale, Hanford, Hayfield Pumping Plant (18 miles NW. of Desert Center), Helendale, Highland, Hinkley, Hipass, Holtville, Irvine, Julian, La Canada, Lakeside, Mount Laguna, Mentone (Mill Creek Powerhouse), Mount Wilson, Newberry, Paramount, Pearblossom, Pomona, Potrero, Poway, Ramona, Ranchita, Rice, San Gabriel, San Marcos, San Marino, San Pedro, Santa Fe Springs, Santa Ysabel, Saugus, Seven Oaks, Solromar, Tecopa, Tehachapi, Topanga, Trona, Valyermo, Van Nuys, Victorville, Vidal, Wheeler Ridge, Whittier, Winchester, Wrightwood, Yermo, and Yorba Linda.

INTENSITY V IN ARIZONA: Parker, Topock, and Wenden.

INTENSITY IV: Baker, Beverly Hills, Cadiz, Calimesa, Canoga Park, Cima, Coso Junction, Cross Roads, Death Valley, El Centro, Fenner, Fontana, Gorman, Imperial, Inyokern, Laguna Beach, La Jolla, Lake Hughes, Lancaster, Long Beach, Ludlow, Mentone, Miramonte, Montebello, Monterey Park, Muro, Needles, Niland, Oceanside, Olancho, Olive View, Palmdale, Palos Verdes Estates, Parker Dam, Port Hueneme, Rosamond, San Fernando Power Plant No. 3, San Fernando, Santa Monica, Torrance, Valley Center, and Ventura.

INTENSITY IV IN ARIZONA: Bouse, Hackberry, Oatman, Wikieup, Yucca, and Yuma.

INTENSITY I TO III: Alhambra, Antelope Patrol Station (Rosamond), Bakersfield, Cornell, Fillmore, Glamis, Haiwee Power House, Jacumba (Tunnel No. 5 Carriso Gorge), Monolith (PG&E Power Station) San Gabriel, Canyon, Santicoy (PG&E Power Station), and South Haiwee Reservoir (Coso Junction).

INTENSITY I TO III IN ARIZONA: Bagdad, Bullhead City, Chloride, and Kingman.

INTENSITY III IN NEVADA: Goodsprings.

Negative reports were received from 53 places in California, from 13 places in Arizona, and from 3 places in Nevada.

December 4: 19:55. Hyampom. Distinct shock felt by and awakened many.

December 5: 08:35 and 09:30. Hyampom. Distinct shocks, abrupt onset, felt by many.

December 5: 01:28, 04:25, 04:51, and 05:18. Palm Springs. Reported felt by Police Department. Heaviest tremor at 01:28.

December 5: 18:46. Cabazon. Felt by all. House creaked, hanging objects swung. Trees and bushes shaken moderately. Also reported felt in Palm Springs.

December 5: 18:51. Beaumont. Light shock rattled windows, doors, and dishes slightly. House creaked slightly.

December 10: 02:59. Palm Springs and White Water. Windows, doors, and dishes rattled at both places. Pendulum clock stopped in White Water.

December 10: 12:43. Twentynine Palms. Visible swaying of building, plaster reported cracked, loose objects rattled. Felt with lesser intensities at Cabazon, Idyllwild, Palm Springs, and White Water.

December 11: 08:12 and 10:15. Very lightly felt at Cabazon; two shocks felt by several in White Water. Windows rattled and walls creaked.

December 15: 08:42. Indio (U. S. Date Garden). Felt by several, buildings creaked. Observer noticed disturbed objects.

December 15: 17:56. Lucerne Valley. Light shock felt by many in home. Windows rattled and hanging objects swung.

December 18: 15:45:17.* Epicenter 34°57' north, 116°57' west, near Barstow, P. Rattled windows, doors, and dishes in Hinkley. Rattled windows slightly in Helendale; very slight creaking of walls in Victorville.

December 19: 20:42:46.* Epicenter 35.8° north, 121.5° west, off coast near Piedras Blancas Point, P. Very lightly felt by several at San Simeon.

December 27: 04:45. Virginia City, Nev. Light shock rattled windows and shook trees slightly. Hanging objects swung. Felt by many in Oroville where walls creaked, windows rattled, and lights swung. Also felt lightly by several in Tahoe Pines.

December 27: 18:25:42.* and 21:26:08.* Strongest of several foreshocks of the Verdi, Nev., earthquake of December 29. Shock at 21:06:08* is reported to have been the strongest of the series. Felt with greatest intensity at Emigrant Gap (Lake Spaulding) where there was visible swaying of buildings and trees, floor lamps, Christmas trees, pictures on walls, and doors. Distant roaring subterranean sounds heard at time of shock.

INTENSITY V: Bijou, Georgetown, Placerville, Tahoe, and Trowbridge.

INTENSITY V IN NEVADA: Crystal Bay, Reno, and Verdi.

INTENSITY IV: Baxter, Colfax, Foresthill, Fuller Lake, Long Barn, Pollock Pines, Truckee, Vinton, and Westpoint.

INTENSITY IV IN NEVADA: Steamboat and Wellington.

INTENSITY I TO III: Kings Beach, Norden, and Sierraville.

INTENSITY I TO III IN NEVADA: Sparks.

Negative reports were received from 10 places in California and 14 places in Nevada.

December 28: 04:53:41.* Epicenter 33°29' north, 116°42' west, near Palomar, P. Felt by several in Borego Valley, at Oak Grove Ranger Station (Aguanga), La Mesa, and San Diego.

December 29: 04:53:27.* Epicenter 39°33' north, 120°05' west, near Verdi, Nev., B. Maximum intensity VII at Verdi and Reno. Affected an area of about 40,000 square miles with epicenter apparently in the Verdi Fault immediately west of the town of Verdi. See map. The damage was confined mostly to a narrow strip along the California-Nevada border between Chilcoot and Floriston, Calif., and easterly through Verdi, Nev., to Reno along the Truckee River. Verdi, which lies at the sharp bend of the Truckee River, was hardest hit.

INTENSITY VII:

Chilcoot.—Rubble veneer broken loose from SW. corner of home. Plaster cracks in most buildings. Goods thrown off shelves in all directions.

Verdi.—No building escaped damage of some sort, damage mostly to older buildings where time had destroyed what little lateral force resistance they might have had. Half the west wall of the old general store, a brick and concrete landmark in the center of town, collapsed in a roar. Plaster in homes was cracked, chimneys were thrown down or twisted out of line, hot water heaters and electric stoves were wrenched from their foundations. All windows were broken out of the Sierra Pacific Power Company's Verdi substation. Dishes, canned goods, vases, and other movable objects crashed to floors in dozens of homes. Brick parapet walls of the school house fell, a chimney was cracked and twisted, and plaster was broken off wood lath in the interior. Mortar holding the rubble wall together could be easily crumbled between the fingers, parapet walls at the schoolhouse were not anchored, and mortar between bricks lacked strength, chimneys were slender and not reinforced. Damage at the powerhouse was an exception, damage was probably due to excess shear as the stiffening effect of walls was minimized by large window areas.

Reno.—Dozens of minor landslides on Route 40 to Sacramento. Twisting and fall of chimneys. Concrete floors cracked, plaster in new house cracked, cracks running N.-S. Damage considerable to brick and concrete. Dishes knocked off cupboards in many houses. Trucks and cars on highway felt shock. Telephone communication in Truckee River Canyon was cut off by a loosened boulder which crashed down a hill into a utility pole carrying 40 lines.

INTENSITY VI:

Baxter.—Awakened many. Windows, doors, and dishes rattled; house creaked. Hanging objects swung and pendulum clocks stopped. Small objects shifted.

Bijou.—Awakened many, frightened few. Rattled windows. House creaked.

Floriston.—Cracked plaster, walls, and chimneys. Twisted chimneys. Knickknacks, pictures and plaster fell; dishes broke. Damage considerable to brick. Hanging objects swung; furnishings shifted, vases and small objects overturned.

Isleton.—Felt by all, frightened few. Hanging objects swung E.-W. Windows, doors, and dishes rattled.

Kings Beach.—Hanging objects swung. Trees and bushes shaken moderately, small objects shifted, vases overturned. Knickknacks and books fell. House creaked.

Loyalton.—Awakened all. Hanging objects swung NE. Small objects shifted, vases overturned, knickknacks fell. House creaked. Tremors felt for some days after this one.

Meeks Bay.—Awakened many. Two windows broke, slight plaster cracks. Stones shifted. Slight damage.

Sierraville.—Felt by and awakened all. Hanging objects and doors swung. Trees and bushes shaken strongly. Small objects and furnishings shifted. Knickknacks fell. Houses creaked.

Sloughhouse.—Awakened many. Rattled windows, walls creaked. Hanging objects swung NE. Books fell.

Tahoe.—Felt by and awakened all. Hanging objects swung NE. Pendulum clocks facing NE stopped. Trees and bushes shaken moderately. Plaster cracked, dishes broke, knickknacks fell. Damage slight to masonry.

Truckee.—Strong tremor of about 3 minutes' duration. Manual clocks stopped, some cupboard doors opened and dishes cascaded to floor.

Vinton.—Plaster cracked in Robinson's store. Goods in SW. corner of store were thrown to floor. In other parts of store even light unstable objects were not affected.

INTENSITY VI IN NEVADA:

Camp Richardson.—Awakened all.

Carson City.—Motel guests fled from their beds. Some cracked walls. Pendulum clock stopped, pendulum swings E.-W. in 10-inch arc.

Dobbins.—Awakened all.

Garden Valley.—Awakened all.

Long Valley.—Trembling all day. Frame house creaked and settled 2 inches. Hanging objects swung N.-S. Small objects shifted. Damage slight to wood.

Norden.—Awakened all.

Sparks.—Felt by and awakened all in home. Hanging objects swung. Pendulum clocks facing NE. stopped. Small ornaments on shelves shifted. Some cracked plaster.

INTENSITY V: Blue Canon Airport, Butte City, Camp Richardson, Coleville, Colfax, Colusa, Dixon, Dobbins, Downieville, Galt, Garden Valley, Gridley, Jackson, Knights Landing, Las Plumas, Lodi, Marysville, Nevada City, Norden, Placerville, Quincy, Sacramento, Sheridan, Sonora, Stanislaus, Stockton, Susanville, Willows, and Woodland.

INTENSITY V IN NEVADA: Fernley, Lovelock, Minden, Nixon, Stewart, Wadsworth, and Yerington.

INTENSITY IV: Arbuckle, Browns Valley, Camp Connell, Chico, Dunigan, Elk Grove, El Portal, Emigrant Gap, Escolon, Feather Falls, Foresthill, Fresno, Grizzley Flats, Knights Ferry, Long Barn, Markleeville, Mother, Merced, Milford, Mitchell Mill, Modesto, Oakdale, Paradise, Pittsburg, Pittville, Planada, Pollock Pines, Portola, Roseville, Salt Springs Powerhouse (near Jackson), San Andreas, Sierra City, Snelling, Stevinson, Strawberry Valley, Tahoe City, Tahoe Valley, Thornton, Tiger Creek Powerhouse (23 miles east of Jackson), Truckee, Tuolumme, Turlock, Wendel, Westpoint, Whitmore, Yolo, and Yosemite National Park.

INTENSITY IV IN NEVADA: Gerlach, Glenbrook, Jungo, Oreana, Silver City, Smith, Stillwater, Wabuska, and Winnemucca.

INTENSITY I TO III: Belden, Big Bend Powerhouse, Bucks Creek Powerhouse, Chinese Camp, Deer Creek, Doyle, Drum Powerhouse, Electra Powerhouse, Las Plumas, Maxwell, Oakland, Oakley, Oroville, Rumsey, San Francisco, Sanger, Santa Rosa, and Woodfords.

Negative reports were received from 43 places in California and from 8 places in Nevada.

December 29: 22:00. Markleeville. Light shock felt by several in community.

December 31: 06:35:46.* Epicenter 35°40' north, 121°24' west, near San Simeon, B. Felt by many. Canned goods shaken from store shelves in San Simeon. No damage reported from any locality.

INTENSITY V: Cayucos, Creston, Moss Landing, Piedras Blancas Light Station.

INTENSITY IV: Big Sur, Crows Landing, Cuyama, San Ardo, San Luis Obispo, San Miguel, and Santa Margarita.

INTENSITY I TO III: Fresno, Lompoc, Pacific Grove, and Pismo Beach.

Negative reports were received from 43 places.

December 31: 17:17:52.* Epicenter 36°54' north, 121°37' west, about 10 miles east of Watsonville, B. Affected area covered about 3,500 square miles of coastal region of central California extending from Oakland to Big Sur. See map. Maximum intensity VII. Damage was confined to a small area near the south bank of the Pajaro River just east of where the river is crossed by the Old Chittenden Road, very near where geologists believe the concealed Pajaro Fault crosses the river, and about 2 miles up river from the main San Andreas Fault.

Most extensive damage was near Chittenden where, for some distance, the highway runs roughly parallel to the Pajaro River, and between the highway and the bank of the river are six houses. These were shifted on their foundations, in most cases of the order of a few inches, and the direction in each case was northwesterly. Houses were of light frame construction standing on stilts or blocks, not securely anchored to their foundations. In these homes plaster cracked and dishes were thrown from shelves. Fireplace chimneys on two of the houses were broken off. A small landslide one-half mile east partially blocked the Old Chittenden Road.

INTENSITY VI:

Hollister.—Felt by all, frightened few. Disturbed objects observed by many. Visible swaying of buildings and trees. Many minor plaster cracks on E.-W. walls. Doors and hanging fixtures swung; pendulum clock stopped on E.-W. wall only.

Santa Cruz.—Felt by many. Buildings creaked, loose objects rattled. Disturbed objects observed by many. Slight damage to buildings. Slight movement of pictures on walls.

INTENSITY V: San Francisco.

INTENSITY IV: Big Sur, Boulder Creek, Holy City, King City, Los Gatos, Morgan Hill, Oakland, Pacific Grove, Salinas, San Jose, and San Martin.

INTENSITY I TO III: Bitterwater (Lonoak).

Negative reports were received from 23 places.

WASHINGTON AND OREGON

(120TH MERIDIAN OR PACIFIC STANDARD TIME)

January 12: 22:55. Lucerne and Waterville, Wash. Felt by many and awakened many in each community. House creaked and windows rattled. Also felt at Ardenvoir, Chelan, Chelan Falls, and Entiat.

Negative reports were received from nine places.

February 13: 13:00. Adna, Wash. Light earthquake rattled windows. Negative reports were received from nine places.

February 29: 22:30. Buxton, Oreg. Slight shock felt by few, awakened one. Windows rattled.

March 21: 21:30. Hildebrand (southeast section), Oreg. Trembling motion lasting about 3 minutes rattled loose objects. Disturbed objects observed by several. Buildings creaked.

August 3: 04:00. Snoqualmie Falls, Wash. Awakened many. Awakened few at Fall City and North Bend. At the latter place it was reported as like two successive heavy explosions. Negative reports were received from 14 places in Washington and from one place in Oregon.

August 6: 18:05. Chehalis, Wash. Slight shock. Negative reports were received from 13 places.

August 28: 14:25. Denison, Wash. Felt by several. Ground swayed and made persons feel queer when walking. Two miles northeast, dishes were shaken off cupboard. Felt by many in Deer Park where trees were shaken slightly, and in Spokane where windows and doors rattled and very slight surface sounds were heard. Also felt very lightly at Milan and Newport. Negative reports were received from seven places.

September 24: 14:35. Port Gamble, Wash. Severe shock sounding like blast shook large buildings. Rattled windows, frame creaked, hanging objects swung, books fell. Trees and bushes shaken moderately.

INTENSITY V: Everett and Langley.

INTENSITY IV: Bangor, Granite Falls, Port Ludlow, Possession, Quilcene, Seabold, Seattle, Snohomish, and Startup.

INTENSITY I TO III: Bothell, Port Townsend, Potlatch, and Shelton.

Negative reports were received from eight places.

October 25: 11:50. Chelan and Nespelem, Wash. Slight shock rattled dishes at Chelan and jarred house in Nespelem.

Negative reports were received from 13 places.

December 20: 08:17. Fossil and Klamath Falls, Oreg. Felt by few in former community where windows rattled and trees and bushes were shaken slightly. At the latter, felt by two in house, building creaked. Negative reports were received from 40 places.

ALASKA

(150TH MERIDIAN OR ALASKA STANDARD TIME)

January 29: 09:10. McGrath. Two shocks approximately 5 seconds apart, felt by several. Mirror on wall swung ENE.-WSW. Disturbed objects observed by several.

February 11: 05:43. Northway and Fairbanks. Light shock felt by many. Objects inside buildings were shaken but not displaced to any noticeable extent. Shock came on rapidly at Northway, building up during first 4-5 seconds and then gradually diminishing, lasting about 1 minute in all. A second quake was felt in Fairbanks at 07:00. Lights and other objects swayed during both shocks.

February 14: 12:10 and 12:15. Fairbanks. Two light shocks felt.

February 27: 17:59. Annette. Light shock felt by several. Gentle rocking motion, E.-W. caused light cords suspended from ceiling to swing slightly.

May 2: 17:55. Fairbanks. Light shock felt by several.

May 29: 08:58. Anchorage. Several successive shocks of about 30 seconds' duration felt by several. Disturbed objects noticed, light fixtures swayed, and windows and shades rattled. Persons standing experienced gentle rolling motion in SSW.-NNE. direction.

June 20: 21:47 and 21:55. Two light shocks recorded at College Magnetic Observatory and felt by all observatory personnel.

June 25: 17:00. Wales. Four slight shocks reported felt by four women walking on side of Cape Mountain approximately one-half mile southeast of village of Wales. Shocks were not noticed by anyone in village.

July 15: 13:11. Anchorage. Slight tremor in NE.-SW. direction felt by several persons at Weather Bureau office.

July 27: 22:05 and 22:18. Fairbanks. Two shocks felt by many. Cupboard doors opened and suspended lights swung. Disturbed objects noticed by several. Both shocks were recorded at the College Magnetic Observatory and were felt by all observatory personnel.

August 1: 10:22. Fairbanks. Light shock felt by several.

August 16: 19:26. Bethel and McGrath. Light shock felt by many at Bethel where pictures swung and native populus became perturbed. At the latter place the shock was felt by several and light fixtures swung.

August 19: 03:53. Anchorage and Cordova. Strongest at Anchorage where many felt the tremors. Lamp fixtures, furniture, and venetian blinds were observed to sway in NW.-SE. direction. At Cordova several reported feeling a light tremor. Disturbed objects were observed by several, fluorescent lights swung.

August 29: 16:07. Anchorage. Light shock felt by a few. Slight vibration of objects noticed.

September 3: 11:25. Anchorage. Felt by many in central section of town. Mirror and pictures swayed N. to S., and photographic equipment rattled about. Felt by a few in west section of town where lamp fixtures swung and small objects were disturbed.

October 8: 21:38. Anchorage. Brief series of tremors felt by several in southwest section of town. House plants noticed swaying NW. to SE.

November 20: 05:16. Anchorage. Felt by several in east section of town. Disturbed objects noticed. Chandeliers swung slightly.

December 5: 12:41. Anchorage. Felt all over town, rocking motion NW to SE, and faint rumbling sounds. Disturbed objects observed by several, chandeliers swayed NW.-SE.

UNITED STATES EARTHQUAKES, 1948

27

HAWAIIAN ISLANDS

(HAWAIIAN STANDARD TIME)

(NOTE.—Data on the following local disturbances were determined from seismograph stations operated on the Island of Hawaii by the Hawaiian Volcano Observatory of the U. S. Geological Survey. For additional seismicity of the region, see Hawaiian Volcano Observatory Letters Nos. 499, 500, 501, and 502.)

- January 3:** 06:04. Feeble. Felt locally. Origin under Mokuaweoweo.
- January 8:** 16:15. Slight. Felt locally. Origin on east slope of Mauna Loa.
- January 10:** 17:11. Slight. Felt locally. Origin on east slope of Mauna Loa.
- January 15:** 06:16. Slight. Felt locally and at Hilo. Origin on northeast slope of Mauna Loa.
- January 25:** 23:02. Slight. Felt from Naalehu to Hilo. Origin on northeast rift of Mauna Loa.
- February 1:** 11:58. Feeble. Felt at Naalehu. Origin on southwest slope of Mauna Loa.
- February 20:** 09:30. Slight. Felt locally. Origin on Kilauea.
- March 9:** 15:46. Slight. Felt from Hilo to Kona. Origin off coast north of Hualali.
- March 19:** 16:18. Moderate. E.-W. component seismograph dismantled. Felt from Hilo to Naalehu. Origin deep under Kilauea.
- March 19:** 23:09. Very feeble. Felt at Naalehu.
- April 6:** 00:25. Slight. Felt locally. Origin shallow under northern end of Kilauea Caldera.
- April 24:** 10:05. Slight. Felt locally and at Hilo. Origin on east slope of Mauna Loa.
- April 24:** 23:59. Feeble. Felt locally. Origin Mauna Loa.
- May 24:** 23:16. Slight. Felt locally. Origin on northeast rift of Mauna Loa.
- June 1:** 07:34. Feeble. Felt at Ainahou.
- June 19:** 17:06. Slight. Felt locally. Origin on east slope of Mauna Loa.
- June 25:** 13:05. Feeble. Felt locally. Origin Mauna Loa.
- June 26:** 01:42. Slight. Felt at Hilo. Origin under Oahu.
- June 28:** 01:38. Two sharp shocks felt on Island of Oahu. Awakened most sleepers and sent them scurrying to streets. No serious damage reported; six plate-glass windows broken, occasional shattered dishware, some cracked walls, and some fallen plaster.
- In Honolulu, heavy bookcases at the Bishop Museum overturned, preserved samples of marine life were knocked over, a 3½-foot statue moved about 6 inches in its case, and glass was broken. Picture frames were thrown to floor. Damage to buildings consisted of cracks in brick, concrete, and hollow tile cracked or sections moved up to 2 inches. Manoa housing pipes were broken in nearly every home and most houses were moved 2 or 3 inches off their foundations. Large cracks were made up the center stairwell for four floors in the pineapple pentagon building at Fort Shafter. Plaster was knocked loose and joists sprung in the Army headquarters building. A landslide occurred on the Kipapa Gulch road.
- Only a nominal number of the populace on the Island of Kauai noticed the tremors. No damage was reported but windows rattled. Also felt in Kaunakakai area of Molokai and at Hilo. All three components of the seismograph at the Honolulu Magnetic Observatory near Barber's Point, Oahu, were rendered inoperative.
- July 12:** 00:29. Very feeble. Felt at Naalehu.
- July 17:** 06:11. Very feeble. Felt at Naalehu.
- July 24:** 13:19. Feeble. Felt locally and at Hilo. Origin on Mauna Loa.
- July 30:** 02:28. Moderate. Awakened some sleepers. Origin east of Kilauea Caldera.
- August 3:** 03:04. Moderate. Felt locally and at Hilo. Origin on northeast rift of Mauna Loa.
- August 8:** 05:14. Very feeble. Felt locally. Origin on Mauna Loa.
- September 5:** 08:01. Feeble. Felt locally and at Hilo. Origin on northeast rift of Mauna Loa.
- September 7:** 11:05. Feeble. Felt locally. Origin on Mauna Loa.
- September 13:** 08:20. Moderate. Generally felt on east half of Island. Origin 20-25 miles deep, southeast of Mauna Kea.
- December 9:** 15:05. Feeble. Felt locally.

PANAMA CANAL ZONE

(SIXTIETH MERIDIAN TIME)

July 28: 09:22, 09:51, and 10:06. Strongest of a series of eleven earthquakes near Coiba Island and recorded on the seismograph at Balboa Heights. The shock at 09:22 was felt by a resident from Coco Solo; the shock at 10:06 was felt by employees in the office of the Section of Meteorology and Hydrology in Balboa Heights.

PUERTO RICO

(SIXTIETH MERIDIAN TIME)

April 21: 16:24:30,* 04:34, 05:00:58*, and 08:29:55.* First shock moderate, second and third light, and last moderate. All four shocks were felt throughout Island, and all four were located instrumentally some distance north of the Dominican Republic.

December 7: 05:12 to 05:20. San Juan. Slight tremors of short duration. Felt also at Romey Airfield, about 50 miles directly west of San Juan in extreme northwestern portion of Island. Also felt by many people in Caguas, Ponce, and Humacao.

MISCELLANEOUS ACTIVITIES

GEODETIC WORK OF SEISMOLOGICAL INTEREST

During the calendar year 1948, triangulation to be used in the study of horizontal earth movements was continued northward from Point Reyes and in the vicinity of Petaluma, Calif. A connection was made to Farallon Island. Traverse measurements were made in the vicinity of Maricopa.

The final values for the 1948 astronomical azimuths observed at Mt. Toro are available. The following table shows the astronomical azimuths observed during the four different surveys.

Astronomical azimuths referred to line Mt. Toro-Santa Ana.

1885.....	218°30'59.47"
1906.....	62.04"
1923.....	62.48"
1948.....	67.83"

These astronomical azimuths are independent of the triangulation insofar as observation and computation are concerned. It is planned to reobserve these astronomical azimuths every 10 years.

Leveling for a study of vertical changes in the earth's surface was accomplished in the following areas in 1948. A net of first-order lines was established in the vicinity of Delano, Calif. A net of first-order lines in the vicinity of San Jose, Calif., was releveled. Work on the establishment of a basic net of first-order lines in the Central Valley of California was continued. A small amount of releveled was also done in the vicinity of Maricopa on earthquake crossline No. 8.

TIDAL DISTURBANCES OF SEISMIC ORIGIN

An earthquake in the Tonga Islands area with epicenter at 21° south, 174° west, on September 8 at 1509 G. C. T., generated a seismic sea wave which was recorded on tide gages at Pago Pago, Samoa; and at Honolulu, Port Allen, and Waianae in the Hawaiian Islands. Although the recorded seismic sea wave was less than a foot in range, it showed up clearly on the tide gage records.

SEISMOLOGICAL OBSERVATORY RESULTS

The U. S. Coast and Geodetic Survey publishes the results of its teleseismic stations and cooperating stations in the quarterly Seismological Bulletin. All seismogram interpretations are tabulated together with epicenters based on the published data and instrumental results received from seismological stations in all parts of the world. Instrumental results are published for the following stations:

Balboa Heights, C. Z.	Lincoln, Nebr.
(The Panama Canal)	(Nebraska Wesleyan University)
Bermuda	Logan, Utah
(Meteorological Station and International	(Utah State Agricultural College)
Union Geodesy and Geophysics)	New Kensington, Pa.
Boulder City, Nev.	(Private station)
Bozeman, Mont.	Overton, Nev.
(Montana State College)	Philadelphia, Pa.
Burlington, Vt.	(The Franklin Institute)
(University of Vermont)	Pierce Ferry, Ariz.
Butte, Mont.	Rapid City, S. Dak.
(Montana School of Mines)	(South Dakota State School of Mines and
Chicago, Ill.	Technology)
(University of Chicago and U. S. Weather	Salt Lake City, Utah
Bureau)	(University of Utah)
College, Alaska	San Juan, P. R.
Columbia, S. C.	Seattle, Wash.
(University of South Carolina)	(University of Washington)
Honolulu, T. H.	Shasta, Calif.
Huancayo, Peru	Sitka, Alaska
(Peruvian Government)	Tucson, Ariz.
Hungry Horse, Mont.	Ukiah, Calif.
	(International Latitude Observatory)

Honolulu, San Juan, Sitka, Tucson, and Ukiah are U. S. Coast and Geodetic Survey magnetic and seismological observatory stations.

Boulder City, Hungry Horse, Overton, Pierce Ferry, and Shasta are cooperating stations of the Bureau of Reclamation. Overton and Pierce Ferry are operated by the National Park Service personnel.

Bermuda, Bozeman, Butte, Chicago, College, Columbia, Lincoln, Rapid City, and Salt Lake City are cooperating university stations.

Balboa Heights, Burlington, Huancayo, Logan, New Kensington, Philadelphia, and Seattle are independent stations.

All readings were made or revised at the Washington Office except those for Balboa Heights.

The station at Grand Coulee was discontinued December 14, 1948, and the Montezuma station ceased operation January 1, 1948.

SUMMARY OF INSTRUMENTAL EPICENTERS FOR 1946

The summary of instrumental epicenters for 1946 is not available for publication at this time. Because of the accumulated backlog it is intended to publish only the interpretations of the seismograms in the 1946 quarterly Seismological Bulletin and later determine the epicenters as time permits. The last Seismological Bulletin to be issued covers the fourth quarter of 1945.

Table 1.—Principal earthquakes of the world from January through December 1948

[NOTE.—This table lists (1) the strongest shocks of the period as revealed by seismographic records, particularly those of the Western Hemisphere stations; (2) important destructive and near destructive earthquakes; (3) earthquakes of unusual interest outside the two preceding categories; and (4) magnitudes as determined by Pasadena.]

1948	Origin time G. C. T.	Region	Coordinates of provisional epicenter		Remarks
			Latitude	Longitude	
Jan. 4	h m s	Tonga Islands.....	21° S.	178° W.	Depth about 600 km. Mag. 7.1.
6	17 23 28*	Western Oaxaca, Mexico.....	17° N.	98° W.	Depth about 80 km. Mag. 7.
24	17 46 39*	Philippine Islands, near southwest coast of Panay.....	11° N.	122° E.	72 killed, \$3½-million property damage; 2 killed by tidal wave in Iloilo Strait. Mag. 8.2.
27	11 58 56*	Tonga Islands.....	21° S.	177½° W.	Depth about 650 km.
28	03 47 20*	Molucca Passage.....	1½° N.	126½° E.	Depth about 80 km. Mag. 7.2.
Feb. 9	12 58 15*	South Aegean Sea.....	35½° N.	27½° E.	52 houses collapsed and 250 damaged in Carpathos, Dodecanese Island. Mag. 7.1.
9	14 54 22*	Celebes Islands.....	0°	122½° E.	Depth about 150 km. Mag. 7.2.
Mar. 1	01 12 23*	Molucca Islands.....	3° S.	127½° E.	Depth about 50 km. Mag. 7.5.
3	09 09 54*	Luzon, Philippine Islands, about 150 miles off northwest coast.....	19° N.	118½° E.	Mag. 7.2.
13	20 02 30*	Molucca Passage.....	1° N.	126½° E.	Depth about 60 km. Mag. 7.1.
Apr. 17	16 11 28*	Honshu, Japan, off southern coast.....	33° N.	136° E.	Mag. 7.3.
21	20 22 02*	Dominican Republic, near northeast coast.....	19¼° N.	69¼° W.	Felt in Puerto Rico. Mag. 7.3.
May 11	08 55 42*	Northern Chile, Province of Tacna.....	17½° S.	70° W.	4 killed and 50 injured. Slight property damage in Arequipa, Moquegua, and Tacna. Depth about 70 km. Mag. 7.1.
14	22 31 43*	Aleutian Islands.....	54½° N.	161° W.	Mag. 7.5.
25	07 11 21*	Sikiang Province, China.....	30° N.	100° E.	1,000 killed and severe property damage in Lihua. Mag. 7.3.
28	05 36 16*	Peru, near southwest coast.....	13° S.	76½° W.	Slight property damage at Canate. Depth about 60 km. Mag. 6¾-7.
June 28	07 13 29*	Honshu, Japan, near Fukui.....	36° N.	136° E.	3,238 dead and 7,250 injured. Extensive property damage in Fukui. Depth about 50 km.
29	10 28 37*	Samoa Islands region.....	16° S.	172½° W.	Depth about 60 km. Mag. 7.0.
30	12 21 09*	Greece, off southern coast.....	38½° N.	20° E.	6 killed and 8 injured. Property damage on Leukas and Greece mainland.
July 20	11 02 17*	Peru, near southwest coast.....	17½° S.	74½° W.	Slight damage at Caraveli and Chuquibamba. Depth about 70 km. Mag. 7.1.
Aug. 25	06 09 20*	Argentina, Salta Province.....	25° S.	64½° W.	5 killed and several injured in Salta. Depth about 50 km. Mag. 7.1.
Sept. 8	15 09 10*	Tonga Islands.....	21° S.	174° W.	Mag. 7.8.
10	13 48 33*	Kurile Islands.....	43½° N.	148° E.	Depth about 40 km. Mag. 7.1.
Oct. 5	20 12 06*	Near Turkeman, Iran border.....	37½° N.	58° E.	200 killed and 6,000 injured. Extensive property damage in Ashkhabad, Turkeman; and Meshed, Iran.
Nov. 19	01 04 24*	Costa Rica.....	9¾° N.	84° W.	Depth about 80 km. Mag. 7.0.
Dec. 4	00 22 47*	Mexico, off western coast.....	21½° N.	106½° W.	4 killed, 21 injured, and extensive property damage on Maria Madre Island. Mag. 7.
15	19 11 26*	Bonin Islands.....	22° N.	143° E.	Depth about 250 km. Mag. 7.

STRONG-MOTION SEISMOGRAPH RESULTS

INTRODUCTION

During 1932, the Coast and Geodetic Survey inaugurated a program of recording strong ground movements in the seismically active regions of the country to obtain basic data needed in the design of earthquake-resistant structures. Notes pertinent to this program will be found in the preceding issues of the United States Earthquakes series and in S. P. 201, Earthquake Investigations in California, 1934-35. The latter is much broader in scope than the former, and contains data on structural and ground vibrations with detailed descriptions of the various activities which comprise the seismological program as a whole. Additional descriptive material on strong-motion instruments and vibration meters will be found in S. P. 206, Selection, Installation, and Operation of Seismographs.

Interpretation of records.—The following analyses are based on the assumption of simple harmonic motion. This refers especially to the computation of displacement from accelerograph records. As most accelerograph records are of irregular character, and the character of the longer period waves is often obscured by the superposition of shorter period waves of relatively large amplitude, the estimates of displacement must be considered only rough approximations.

For the more important records, those involving destructive ground motions, the use of integration methods in computing velocity and displacement curves has become established practice. The accelerograms of the Lake Mead earthquake of November 2 are of sufficient amplitude for analysis by integration which will be accomplished as soon as possible. An outline of the double integration process is published in the Bulletin of the Seismological Society of America, Vol. 33, No. 1, January 1943, subsequently reprinted by the Coast and Geodetic Survey as S. P. 250, The Determination of True Ground Motion from Seismograph Records.

Following the listing of strong-motion records obtained during 1948 is table 3 which gives the earthquake locations, the distance and azimuth to the epicenter, and the maximum values of acceleration and displacement for each station.

Table 4 is a composite of strong-motion seismogram interpretations. In 1948 there were several records of weaker shocks and those recorded at distant stations on which the traces were too indefinite or on which there were no discernible motions. These records have been omitted from the table. The instruments at the Hollywood Storage Company, Los Angeles Chamber of Commerce, San Francisco Southern Pacific Building, and San Jose Bank of America are wired to start simultaneously.

In June 1948, the program of substituting unifilar suspensions in all accelerometers in place of the pivoted spindle type was completed for all instruments operating in the United States.

Units and instrumental constants.—Quantitative results are expressed in c. g. s. units; centimeters or millimeters for displacement; and centimeters per second per second for acceleration. It is sometimes desirable to express acceleration in terms of the acceleration of gravity, indicated by "g" which is equal to 980 cm/sec.² For practical purposes it is only necessary to point off three decimal places to convert cm/sec.² to "g."

Most of the instruments have been adjusted so that each will register the maximum acceleration to be expected on the particular type of geological formation beneath the instrument. The following expectable earthquake accelerations were used in determining the accelerograph sensitivities: (a) rock foundation, 25 percent of gravity, (b) conglomerate foundations, 40 percent of gravity, (c) alluvium, 70 percent of gravity, and (d) top floors of tall buildings, 100 to 200 percent of gravity. The four sensitivities may be roughly listed as 26, 19.5, 13, and 6.5 mm. per 0.1 g, respectively.

Sensitivity of the seismographs is expressed as the deflection of the trace, or light spot, in centimeters, for a constant acceleration of 100 cm/sec.² This means that the seismometer pendulum is tilted sideways until the effective component of the earth's gravitational field is equal to 100 cm/sec.² or practically 0.1 g.

The following are constants which may be used in converting c. g. s. units to the customary English units:

1 cm.	= 0.3937 in. = 0.03281 ft.
1 cm/sec.	= 0.03281 ft/sec.
1 cm/sec. ²	= 0.03281 ft/sec. ²
1 cm.	= 10 mm.
0.1 g.	= 98 cm/sec. ² = 3.215 ft/sec. ²
1 (statute) mile	= 1.609 km.

Damping ratio of the pendulum is the ratio between successive amplitudes when the pendulum oscillates under the influence of the damping force alone.

Seismogram illustrations.—Reproductions of records in this publication are tracings of the original records and must not be accepted as genuine copies. The tabulated instrumental constants refer to the original records. The tracings are reduced approximately in the ratio of 1.8 to 1, so that the same scales do not apply. They are intended to show the nature of the data rather than furnish a means through which the reader can make his own measurements. Those who desire true copies for critical study should make request to the Director of the Coast and Geodetic Survey, Washington 25, D. C.

Acceleration scales are indicated on the tracings of acceleration curves by two dots, the distance between them representing the equivalent of 100 cm/sec.² when applied to the curves over which they appear. These dots provide a quick means for making auxiliary scales in cases where an investigator desires to make rough measurements on the published curves. The measurements of periods on records of this nature is dependent largely on the judgment of the person reading them and considerable latitude must be allowed in appraising their accuracy. The aim of such analyses is primarily to give a fair picture of the magnitudes of the various elements involved, and the figures tabulated should therefore not be used for important studies without first referring to the illustrations for some idea of the nature of the original records.

Table 2.—List of shocks recorded and records obtained on strong-motion seismographs in 1948

Date, region, and recording station	Records		
	Accelerograph	Displacement meter	Weed
Feb. 19: Southern California. Los Angeles Subway Terminal.....	2	1	
Mar. 27: Northern California. Ferndale.....	1	1	
Mar. 28: Northern California. Hollister.....	2		
San Francisco Southern Pacific Building.....	2	1	
Apr. 16: Southern California. Hollywood Storage Company.....	3		
Apr. 18: Northern California. Hollister.....	1		
May 28: Near coast of Peru. Lima.....	1		
June 7: Southern California. Bishop.....	1		
July 17: Near coast of Guatemala. Guatemala City.....	1		
July 18: Near coast of Guatemala. Guatemala City.....	1		
July 19: Near coast of Guatemala. Guatemala City.....	1		
July 20: Northern California. San Jose Bank of America.....	2		
Aug. 18: Northern California. Ferndale.....	1	1	
Eureka.....	1		
Sept. 16: Near coast of Costa Rica. San Jose.....	2		
Sept. 18: Near coast of Costa Rica. San Jose.....	1		
Nov. 2: Lake Mead. Hoover Dam.....	3		
Nov. 18: Near coast of Costa Rica. San Jose.....	2		
Dec. 4: Southern California. Colton.....	1	1	
Hollywood Storage Company.....	3		
Long Beach.....	1		
Los Angeles Chamber of Commerce.....	2		
Los Angeles Edison Building.....	1		
Los Angeles Subway Terminal.....	2	1	
Pasadena.....	1	1	1
San Bernardino.....			1
San Diego.....	1		
San Francisco Southern Pacific Building.....	2	1	
San Jose Bank of America.....	2		
Santa Ana.....			1
Vernon.....	1		
Westwood.....	1		
Dec. 29: Northern California. Sacramento.....			1
San Francisco Southern Pacific Building.....	2	1	
Dec. 31: Northern California. Hollister.....	1		
San Francisco Southern Pacific Building.....	2	1	
San Jose Bank of America.....	2		
Total.....	53	10	4

Table 3.—Summary of outstanding instrumental and noninstrumental data for 1948

[All instruments are accelerographs unless otherwise noted.]

Epicenter	Recording station and position ¹	Position of instrument	Intensity ²	Maximum acceleration	Computed maximum displacement
SOUTHERN CALIFORNIA EARTHQUAKE OF FEBRUARY 19					
33°55' N., 118°13' W., near Lynwood, VI*.	Los Angeles Sub. Term., 9 miles N, 350°-----	13th floor-- DM ³ -----	VI	cm. sec. ² 3 1	cm. 0.031 .05
NORTHERN CALIFORNIA EARTHQUAKE OF MARCH 27					
40.3° N., 124.8° W., V*....	Ferndale, 35 miles NE. 55° (fig. 6)-----	1st floor---- DM ³ -----	V	18 1	0.04 .03
NORTHERN CALIFORNIA EARTHQUAKE OF MARCH 28					
36°51' N., 121°34' W., VI*..	Hollister, 9 miles E. 90° (fig. 6)----- San Francisco, So. Pac. Bldg., 79 miles NW. 325°	Basement-- 14th floor-- Basement-- DM ³ -----	V IV	12 3 5 1	0.018 .064 .026 .02
SOUTHERN CALIFORNIA EARTHQUAKE OF APRIL 16					
34°01' N., 118°58' W., SE. of Point Mugu, VI*.	Hollywood Storage Co., 37 miles NE. 81°-----	Penthouse-- P. E. Lot-- Basement--	V	2 2 1	0.009 .002 .001
NORTHERN CALIFORNIA EARTHQUAKE OF APRIL 18					
38°10' N., 122°32' W., V*..	Hollister, 109 miles SE. 146° (fig. 6)-----	Basement--		25	0.015
EARTHQUAKE OF MAY 28 OFF COAST OF PERU					
12° S., 77° W.-----	Lima, 30 miles SE. 130° (fig. 7)-----	1st floor----		13	0.007
SOUTHERN CALIFORNIA EARTHQUAKE OF JUNE 7					
37°12' N., 118°42' W., west of Big Pine, V*.	Bishop, 20 miles NE. 55° (fig. 7)-----	1st floor----	V	25	0.011
GUATEMALA EARTHQUAKE OF JULY 17					
15° N., 91° W., near coast.	Guatemala, 45 miles SE. 135°-----	Basement--		3	0.016
GUATEMALA EARTHQUAKE OF JULY 18					
15° N., 91° W., near coast.	Guatemala, 45 miles SE. 135°-----	Basement--		1	0.005
GUATEMALA EARTHQUAKE OF JULY 19					
15° N., 91½° W., near coast.	Guatemala, 80 miles SE. 115°-----	Basement--		2	0.004
NORTHERN CALIFORNIA EARTHQUAKE OF JULY 20					
37°27' N., 121°49' W., north of San Jose.	San Jose, 8 miles SW. 204°-----	13 floor---- Basement--		1 1	0.005 .004
NORTHERN CALIFORNIA EARTHQUAKE OF AUGUST 18					
40.5° N., 124.7° W., off Cape Mendocino.	Ferndale, 25 miles NE. 75° (fig. 7)----- Eureka, 35 miles NE. 50°-----	1st floor---- DM ³ ----- Basement--	V ----- V	22 5 5	0.029 .20 .009
EARTHQUAKES OF SEPTEMBER 16 NEAR COAST OF COSTA RICA					
8° N., 84° W., off south-west coast.	San Jose, 125 miles N. 0°-----	Basement--		3	0.002
LAKE MEAD EARTHQUAKE OF NOVEMBER 2					
35°59' N., 114°47' W., VI*..	Hoover Dam, 4 miles NE. 50° (figs. 8, 10)-----	Intake tower Gallery----- Oil House--	IV	98 121 45	0.032 .080 .011

See footnotes at end of table, page 33.

Table 3.—Summary of outstanding instrumental and noninstrumental data for 1948.—Con.

Epicenter	Recording station and position ¹	Position of instrument	Intensity ²	Maximum acceleration	Computed maximum displacement
EARTHQUAKE OF NOVEMBER 18 NEAR COAST OF COSTA RICA					
8° N., 84° W., off south-west coast.	San Jose, 125 miles N. 0° (fig. 9).....	Basement.....	-----	27	0.147
SOUTHERN CALIFORNIA EARTHQUAKE OF DECEMBER 4					
33°53' N., 116°20' W., near Desert Hot Springs, VII*.	Colton, 58 miles NW., 282° (fig. 10).....	1st floor.....	VI	22	0.030
		DM ³	-----	13	.31
	Hollywood Storage Co., 115 miles NW. 278° (fig. 11)	Basement.....	VI	15	0.288
		Penthouse.....	-----	52	.36
		P. E. Lot.....	-----	11	.051
	Long Beach, 106 miles SW. 266° (fig. 11).....	Basement.....	IV	7	0.114
	Los Angeles C. of C., 110 miles NW. 276° (fig. 13)	do.....	VI	14	0.15
		11th floor.....	-----	30	1.491
	Los Angeles Edison Bldg., 110 miles NW. 276° (fig. 13).	Basement.....	VI	27	0.308
	Los Angeles Suh. Term., 110 miles NW. 276° (figs. 12, 13, 14).	do.....	VI	23	0.271
		13th floor.....	-----	51	.546
		DM ³	-----	16	.455
	Pasadena, 104 miles NW. 280° (fig. 12).....	Basement.....	VI	16	0.130
		Weed.....	-----	3	.01
		DM ³	-----	15	.34
	San Bernardino, 57 miles NW. 285°.....	1st floor.....	VI	80	0.02
	San Diego, 94 miles SW. 211° (fig. 14).....	Basement.....	VI	21	0.137
	San Francisco Southern Pacific Bldg., 430 miles NW. 310°	do.....	VI	7	0.086
	San Jose Bank of America, 387 miles NW. 309°				
	Santa Ana, 89 miles SW. 264°				
	Vernon, 107 miles NW. 275° (fig. 14).....				
	Westwood, 113 miles NW. 278°.....				
NORTHERN CALIFORNIA EARTHQUAKE OF DECEMBER 29					
39°33' N., 120°05' W., near Verdi, Nev. VII*.	San Francisco Southern Pacific Bldg., 175 miles SW. 235°.	14th floor.....	-----	11	0.437
	Sacramento, 100 miles SW. 230°.....	-----	-----	-----	-----
NORTHERN CALIFORNIA EARTHQUAKE OF DECEMBER 31					
36°46' N., 121°44' W.	San Jose Bank of America, 38 miles NW. 347° ..	Basement.....	IV	15	0.085
	Hollister, 19 miles NE. 76° (fig. 14).....		VI		
	San Francisco Southern Pacific Bldg., 77 miles NW. 332° (fig. 14)		V		

* Following intensity designation indicates maximum reported intensity of earthquake.

¹ Position of station in respect to epicenter.

² Reported intensity of earthquake at recording station.

³ All displacement meter readings should be assumed as recorded maximum displacement and computed maximum acceleration.

Table 4.—Composite of strong-motion instrumental data for 1948

[See the text preceding this table for additional details.]

SOUTHERN CALIFORNIA EARTHQUAKE OF FEBRUARY 19									
Station and component*	Instrument No.	T ₀	V	Sensitivity	ε	Earth-wave period	Maximum Acceleration	Maximum Displacement	Remarks
LA Sub. Term., 13th floor:		Sec.		Cm.		Sec.	Cm. sec. ¹	Cm.	
Vertical-up.....	V-190.....	0.046	123	0.66	9	-----	-----	-----	No visible motion.
SW. 218°.....	L-189.....	.046	126	.69	15	0.63	3	0.031	Very weak regular waves.
NW. 308°.....	T-188.....	.046	128	.70	11	-----	-----	-----	Very small motion.
Sub-basement:									
Vertical-up.....	V-211.....	.065	124	1.33	10	-----	-----	-----	No visible motion.
SE. 129°.....	L-210.....	.065	125	1.34	8	-----	-----	-----	Very small motion.
SW. 219°.....	T-209.....	.065	126	1.35	9	-----	-----	-----	Do.
RDM NE. 39°.....	-----	9.95	1	-----	10	5.45	1	.05	Long-period sinusoidal waves.
LDM SE. 129°.....	-----	10.35	1	-----	10	-----	-----	-----	Very small motion.

See footnotes at end of table, page 49.

Table 4.—Composite of strong-motion instrumental data for 1948.—Continued

Station and component*	Instru-ment No.	T ₀	V	Sensi-tivity	ε	Earth-wave period	Maxi-mum Acceleration	Maxi-mum Dis-placement	Remarks
NORTHERN CALIFORNIA EARTHQUAKE OF MARCH 27									
Ferndale, 1st floor: Vertical-up.....	V-126.....	0.098	70	1.70	9	0.22	4	0.005	Irregular waves at begin-ning.
SW 224°.....	L-124.....	.099	72	1.79	11	.30 .38	4 14	.009 .015	Irregular waves at begin-ning.
NW 314°.....	T-125.....	1.00	74	1.86	9	.25 .34 .15 .26 .51	7 4 18 11 6	.011 .012 .010 .019 .040	(1)
RDM SE. 134°.....	-----	10.0	1	-----	10	7.32	1	.03	Sinusoidal waves. Very small motion.
LDM SW. 224°.....	-----	9.9	1	-----	12	6.11 7.42 7.42	1 1 1	.02 .03 .01	Do.
NORTHERN CALIFORNIA EARTHQUAKE OF MARCH 28									
Hollister basement: Vertical-up.....	V-20.....	0.069	115	1.39	10	0.08 .14 .22	8 8 11	0.001 .003 .013	(2)
SW 181°.....	L-21.....	.068	112	1.33	11	.11 .14 .24 .38	6 10 12 4	.002 .005 .017 .014	Irregular waves. (2) Sharp wave.
NW. 271°.....	T-32.....	.070	113	1.40	11	.18 .28 .33	11 9 6	.009 .018 .016	Irregular waves.
Aftershock: Vertical-up.....	V-20.....	.069	115	1.39	10	.19 .21	4 3	.004 .003	Very small motion.
SW. 181°.....	L-21.....	.068	112	1.33	11	.22 .10 .20	8 8 4	.010 .002 .004	(2)
NW. 271°.....	T-32.....	.070	113	1.40	11	.16 .26 .43	12 9 4	.008 .016 .019	Sharp wave. Long-period irregular waves.
SF. So. Pac. Bldg., 14th floor: Vertical-up.....	V-184.....	.047	116	.63	11	.47	1	.006	Very small motion.
SW. 225°.....	L-183.....	.047	122	.66	9	.46 .50	2 2	.010 .013	Regular waves.
NW. 315°.....	T-182.....	.047	126	.67	10	.41 .92	3 3	.013 .064	Do.
Basement: Vertical-up.....	V-11.....	.101	76.3	1.93	6	.44	2	.010	Very small motion.
NW. 315°.....	L-24.....	.099	72.0	1.80	3	.45	5	.026	(2)
NE. 45°.....	T-6.....	.101	70.8	1.77	8	.47 .56	1 1	.006 .008	Irregular waves.
RDM NW. 319°.....	-----	10.0	1	-----	11	8.03	1	.02	Very small motion.
LDM NE. 49°.....	-----	9.6	1	-----	13	9.61	1	.02	Do.
SOUTHERN CALIFORNIA EARTHQUAKE OF APRIL 16									
Hollywood Storage Co., penthouse: Vertical-up.....	V-193.....	0.046	121	0.65	6	0.12	1	0.001	Very small motion.
S. 180°.....	L-192.....	.046	126	.68	12	.31	1	.002	Do.
W. 270°.....	T-191.....	.045	131	.67	20	.43	2	.009	Do.
P. E. Lot: Vertical-up.....	V-214.....	.065	123	1.34	10	-----	-----	-----	Irregular waves at begin-ning.
E. 90°.....	L-213.....	.066	124	1.35	9	.29	1	.002	Do.
S. 180°.....	T-212.....	.066	127	1.40	12	.17	2	.002	Do.
Basement: Vertical-up.....	V-217.....	.065	126	1.36	7	-----	-----	-----	Very small motion.
E. 90°.....	L-216.....	.067	121	1.37	7	-----	-----	-----	Irregular waves at begin-ning.
S. 180°.....	T-215.....	.065	125	1.32	10	.21 .20	1 1	.001 .001	Do.

See footnotes at end of table, page 49.

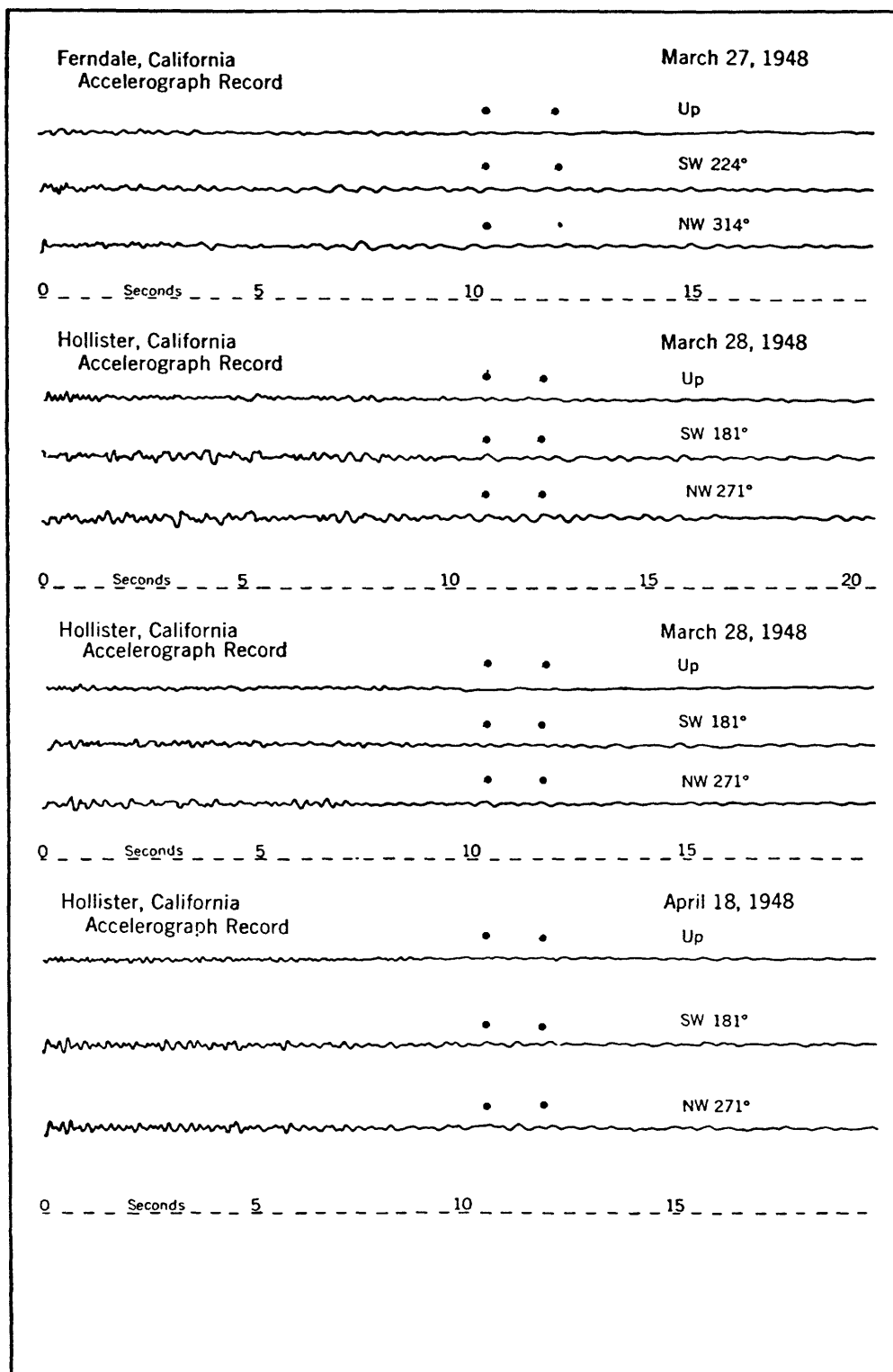


FIGURE 6.—Tracings of accelerograph records obtained at Ferndale on March 27 and at Hollister on March 28 and April 18.

Table 4.—Composite of strong-motion instrumental data for 1948.—Continued

Station and component*	Instru-ment No.	T ₀	V	Sensi-tivity	ε	Earth-wave period	Maxi-mum Acceler-ation	Maxi-mum Dis-place-ment	Remarks
NORTHERN CALIFORNIA EARTHQUAKE OF APRIL 18									
Hollister, basement:									
Vertical-up.....	V-20.....	0.069	115	1.39	10	0.11	4	0.001	Irregular waves at begin-ning.
SW 181°.....	L-21.....	.068	112	1.33	11	.15 .13 .16 .21 .33	6 15 9 9 4	.003 .006 .006 .010 .010	(?) Irregular long-period waves. (?)
NW 271°.....	T-32.....	.070	113	1.40	11	.14 .17 .16 .39	25 16 9 4	.013 .011 .006 .015	Irregular long-period waves.
EARTHQUAKE OF MAY 28 NEAR COAST OF PERU									
Lima, 1st floor:									
Vertical-up.....	V-7.....	0.101	84	2.16	9	0.12 .13	4 7	0.001 .003	Sinusoidal waves.
NW. 278°.....	L-2.....	.099	85	2.09	7	.09 .07	3 12	.001 .001	Surface waves.
NE. 8°.....	T-17.....	.094	77	1.83	9	.10 .12 .18	2 13 9	.001 .004 .007	Do. Irregular waves.
SOUTHERN CALIFORNIA EARTHQUAKE OF JUNE 7									
Bishop, 1st floor:									
Vertical-up.....	V-23.....	0.099	108	2.70	10	0.12 .22	6 4	0.002 .005	Short-period wave super-posed.
E. 90°.....	L-36.....	.100	102	2.58	9	.25 .10 .23 .21 .23	2 25 11 5 2	.003 .006 .011 .006 .003	(?) Sinusoidal wave.
S. 180°.....	T-19.....	.102	104	2.74	10	.13 .12 .26 .38	24 9 5 1	.010 .003 .009 .004	(?) Irregular waves.
EARTHQUAKE OF JULY 17 NEAR COAST OF GUATEMALA									
Guatemala, base-ment:									
Vertical-up.....	V-138.....	0.100	80	2.02	10	0.43 .59	1 1	0.005 .009	Short-period waves super-posed.
SW. 194°.....	L-136.....	.101	81	2.12	7	.46 .39	3 2	.016 .007	Very small motion. Irregular wave.
NW. 284°.....	T-137.....	.097	80	1.90	6	.56 .51	2 1	.016 .007	
EARTHQUAKE OF JULY 18 NEAR COAST OF GUATEMALA									
Guatemala:									
Vertical-up.....	V-138.....	0.100	80	2.04	10	0.26 .30	1 1	0.002 .002	Very small motion. Do.
SW. 194°.....	L-136.....	.101	81	2.11	7	.30	1	.005	Do.
NW. 284°.....	T-137.....	.097	80	1.88	6	.43	1		
EARTHQUAKE OF JULY 19 NEAR COAST OF GUATEMALA									
Guatemala:									
Vertical-up.....	V-138.....	0.100	80	2.04	10	0.30 .30 .30	2 2 1	0.004 .004 .002	Very small motion.
SW. 194°.....	L-136.....	.101	81	2.11	7				
NW. 284°.....	T-137.....	.096	80	1.87	6				

See footnotes at end of table, page 49.

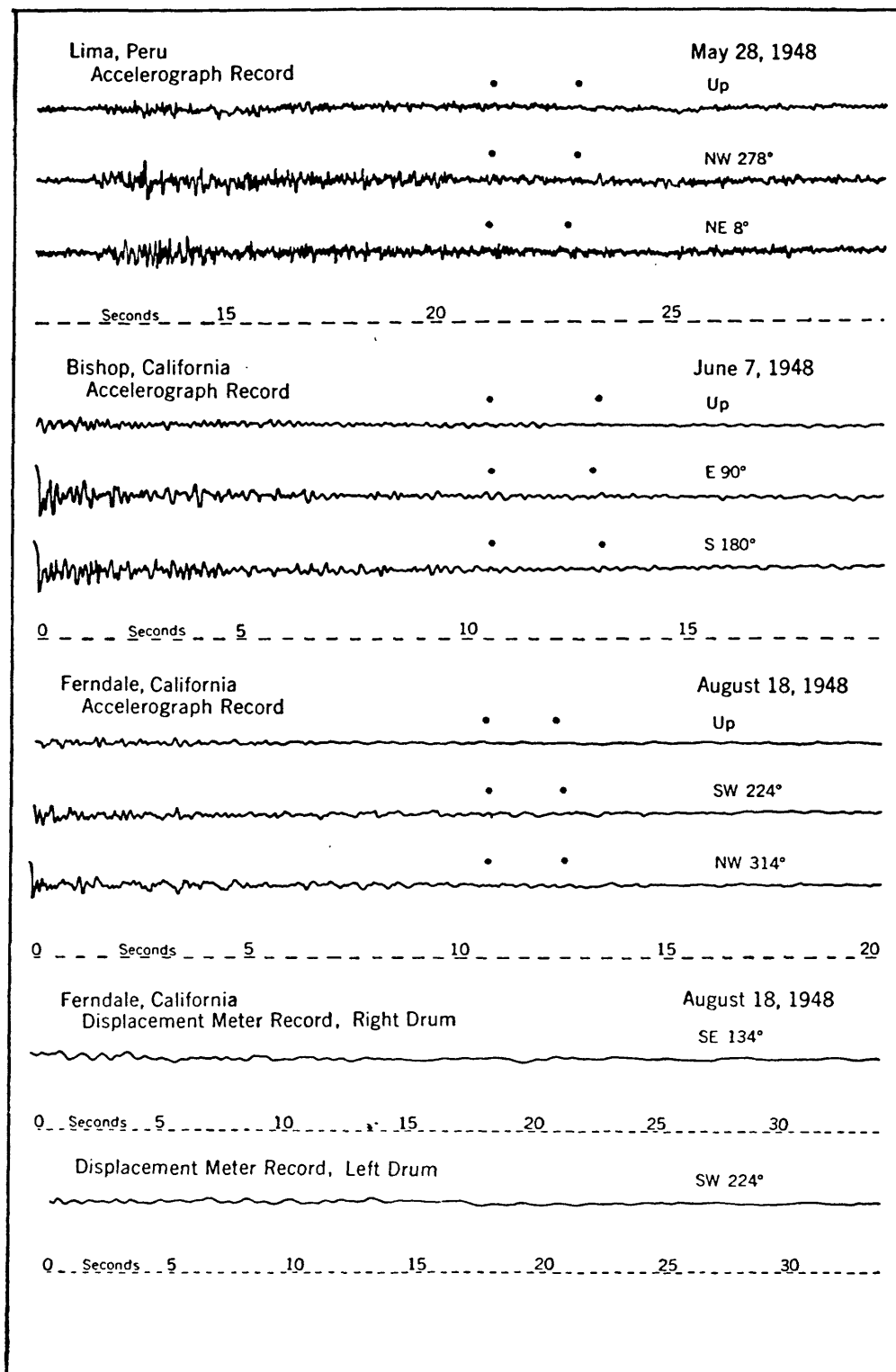


FIGURE 7.—Tracings of accelerograph records obtained at Lima, Peru, on May 28; at Bishop on June 7, and at Ferndale (accelerograph and displacement meter) on August 18.

Table 4.—Composite of strong-motion instrumental data for 1948.—Continued

Station and component*	Instru- ment No.	T ₀	V	Sensi- tivity	ε	Earth- wave period	Maxi- mum Acceler- ation	Maxi- mum Dis- place- ment	Remarks
NORTHERN CALIFORNIA EARTHQUAKE OF JULY 20									
San Jose, 13th floor:									
Vertical-up-----	V-175-----	0.046	117	0.64	8	0.16	1	0.001	Very small motion.
NE. 59°-----	L-174-----	.046	120	.64	8	.45	1	.005	Do.
SE. 149°-----	T-173-----	.047	118	.65	7	.52	1	.007	Do.
Basement:									
Vertical-up-----	V-202-----	.068	124	1.45	9	.18	1	.001	Very small motion.
NE. 59°-----	L-201-----	.067	123	1.38	10	.22	1	.001	Irregular waves.
SE. 149°-----	T-200-----	.067	122	1.40	9	.23	1	.001	
						.26	1	.002	Do.
						.41	1	.004	
NORTHERN CALIFORNIA EARTHQUAKE OF AUGUST 18									
Ferndale:									
Vertical-up-----	V-126-----	0.097	70	1.69	9	0.21	10	0.011	Irregular waves at begin- ning.
						.14	6	.003	
SW. 224°-----	L-124-----	.099	74	1.83	12	.15	6	.003	Sinusoidal wave.
						.11	12	.004	(?)
						.14	1	.001	
						.45	1	.005	Short-period waves super- posed.
NW. 314°-----	T-125-----	.100	73	1.84	10	.11	22	.007	(?)
						.15	11	.006	
						.38	8	.029	Short-period waves super- posed.
RDM SE. 134°-----		9.9	1		11	.38	2	.007	
						.66	1	.20	
LDM SW. 224°-----		10.0	1		12	1.06	4	.10	Irregular waves.
						.64	1	.07	
						.91	5	.10	
Eureka, basement:									
Vertical-up-----	V-29-----	.070	101	1.25	9	.08	3	.001	Weak sinusoidal waves.
NE. 79°-----	L-13-----	.068	105	1.23	11	.22	2	.002	
SE. 169°-----	T-8-----	.068	108	1.26	11	.22	5	.006	(?)
						.41	2	.009	
EARTHQUAKE OF SEPTEMBER 16 NEAR COAST OF COSTA RICA									
San Jose, basement:									
Vertical-up-----	V-135-----	0.099	78	1.92	10				Very small motion.
SE. 171°-----	L-133-----	.099	82	2.02	10	.15	1	0.001	
SW. 261°-----	T-134-----	.099	83	2.05	9	.25	1	.002	
EARTHQUAKE OF SEPTEMBER 16 NEAR COAST OF COSTA RICA									
San Jose:									
Vertical-up-----	V-135-----	0.099	78	1.92	10				Very small motion.
SE. 171°-----	L-133-----	.099	82	2.02	10	0.16	1	0.001	
SW. 261°-----	T-134-----	.099	83	2.05	9	.15	1	.001	
EARTHQUAKE OF SEPTEMBER 18 NEAR COAST OF COSTA RICA									
San Jose:									
Vertical-up-----	V-135-----	0.099	78	1.92	10	0.29	1	0.002	Short-period waves super- posed.
SE. 171°-----	L-133-----	.099	82	2.02	10	.18	3	.002	Sinusoidal wave.
SW. 261°-----	T-134-----	.099	83	2.05	9	.22	1	.001	
						.17	1	.001	Irregular wave.
						.16	1	.001	

See footnotes at end of table, page 49.

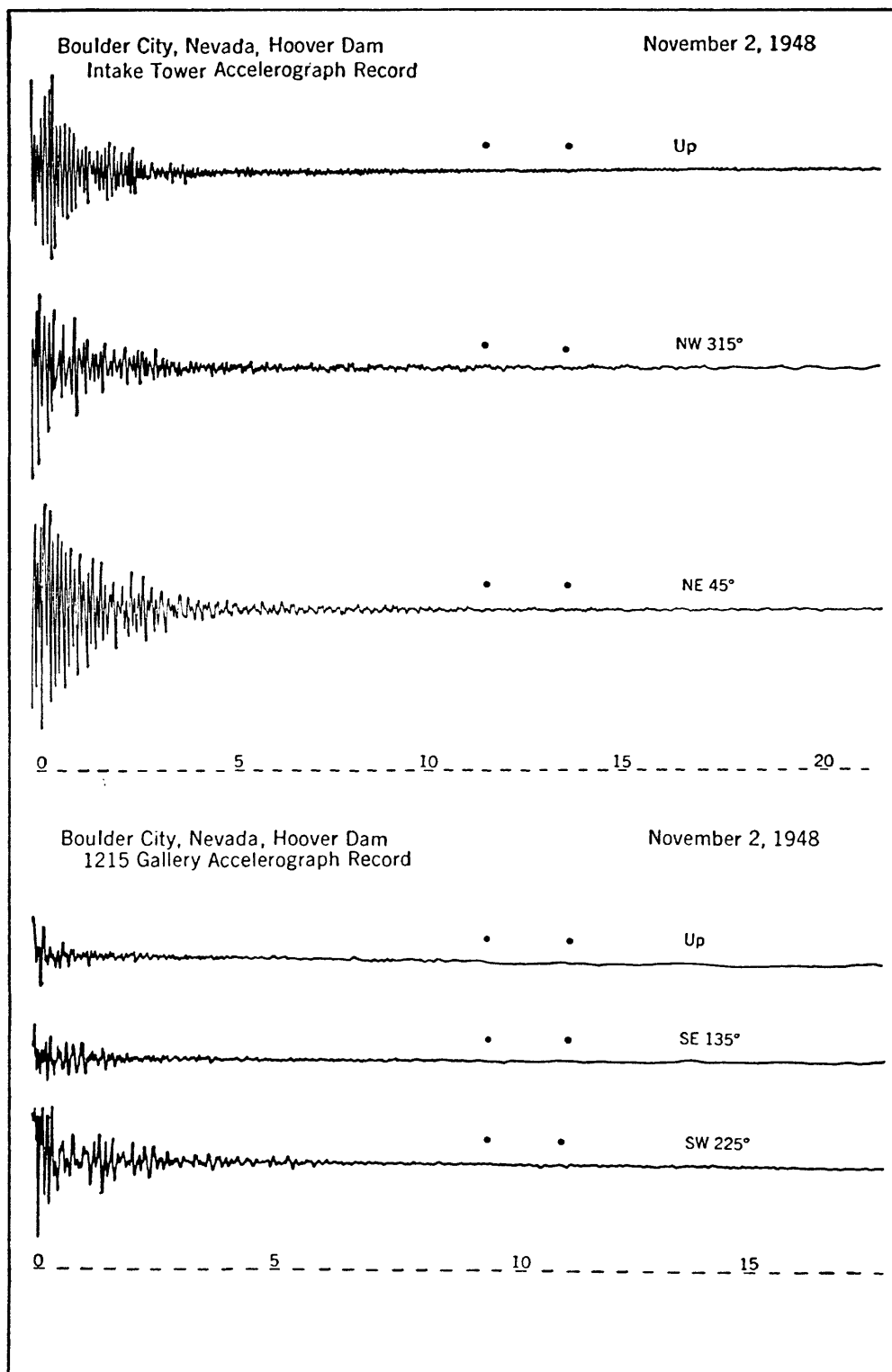


FIGURE 8.—Tracings of accelerograph records obtained at Hoover Dam Intake Tower and 1215 Gallery on November 2.

Table 4.—Composite of strong-motion instrumental data for 1948.—Continued

Station and component*	Instru- ment No.	T ₀	V	Sensi- tivity	ε	Earth- wave period	Maxi- mum Accel- eration	Maxi- mum Dis- place- ment	Remarks
LAKE MEAD EARTHQUAKE OF NOVEMBER 2									
Hoover Dam, in- take tower:									
Vertical-up-----	V-328-----	0.079	129	2.05	4	0.10	75	0.019	(*)
						.10	43	.011	
NW. 315°-----	L-329-----	.078	128	1.99	6	.10	24	.006	(*)
						.10	98	.025	
						.10	47	.012	
						.10	16	.004	
NE. 45°-----	T-330-----	.078	135	2.00	4	.92	2	.032	Irregular surface waves.
						.11	82	.025	(*)
						.11	80	.006	
						.24	14	.020	
						.93	1	.011	
1215 Gallery:									
Vertical-up-----	V-331-----	.081	123	2.02	14	.10	51	.013	(*)
						.15	26	.015	
SE. 135°-----	L-332-----	.079	127	2.00	12	.09	11	.002	Irregular waves.
						.10	47	.012	
						.16	20	.013	Short-period waves super-
									posed.
SW. 225°-----	T-333-----	.079	126	1.95	13	.18	1	.001	Irregular waves.
						.09	121	.025	(*)
						.12	68	.025	Sinusoidal waves.
						.4	20	.080	Irregular waves.
						.13	40	.017	
						.14	18	.009	Do.
Oil House:									
Vertical-up-----	V-334-----	.081	124	2.04	8	.08	45	.007	Strong impulsive wave.
NW. 315°-----	L-335-----	.081	124	2.04	5	.08	27	.004	Short-period waves super-
									posed.
NE. 45°-----	T-336-----	.081	123	2.05	3	.14	14	.007	Do.
						.10	45	.011	Do.
						.10	29	.007	(*)
EARTHQUAKE OF NOVEMBER 18 NEAR COAST OF COSTA RICA									
San Jose:									
Vertical-up-----	V-135-----	0.097	78	1.86	10	0.11	7	0.002	Sinusoidal waves.
						.13	10	.004	Irregular waves.
						.15	27	.015	Sinusoidal surface waves.
						.85	8	.147	Short-period waves super-
									posed on long-period
									surface waves.
Se 171°-----	L-133-----	.097	82	1.95	9.9	.12	4	.001	(*)
						.19	22	.020	Regular waves.
						.22	21	.025	
SW. 261°-----	T-134-----	.098	83	2.02	8.9	.13	12	.005	Sinusoidal waves.
						.19	19	.017	
						.20	24	.024	
						.78	6	.093	Short-period waves super-
									posed.
Aftershock:									
Vertical-up-----	V-135-----	.097	78	1.86	10	-----	-----	-----	Very small motion.
SE. 171°-----	L-133-----	.097	82	1.95	9.9	.17	1	.001	
SW. 261°-----	T-134-----	.098	83	2.02	8.9	.17	1	.001	
Aftershock:									
Vertical-up-----	V-135-----	.097	78	1.86	10	-----	-----	-----	Do.
SE. 171°-----	L-133-----	.097	82	1.95	9.9	.17	1	.001	
SW. 261°-----	T-134-----	.098	83	2.02	8.9	.15	1	.001	
Aftershock:									
Vertical-up-----	V-135-----	.097	78	1.86	10	-----	-----	-----	Do.
SE. 171°-----	L-133-----	.097	82	1.95	9.9	.19	1	.001	
SW. 261°-----	T-134-----	.098	83	2.02	8.9	.13	1	.001	
Aftershock:									
Vertical-up-----	V-135-----	.097	78	1.86	10	.27	2	.004	Sinusoidal waves.
						.21	2	.002	Irregular waves.
SE. 171°-----	L-133-----	.097	82	1.95	9.9	.21	4	.004	
						.23	13	.017	Single waves.
						.25	2	.003	
SW. 261°-----	T-134-----	.098	83	2.02	8.9	.17	3	.002	
						.22	9	.011	Single wave.
						.27	1	.002	

See footnotes at end of table, page 49.

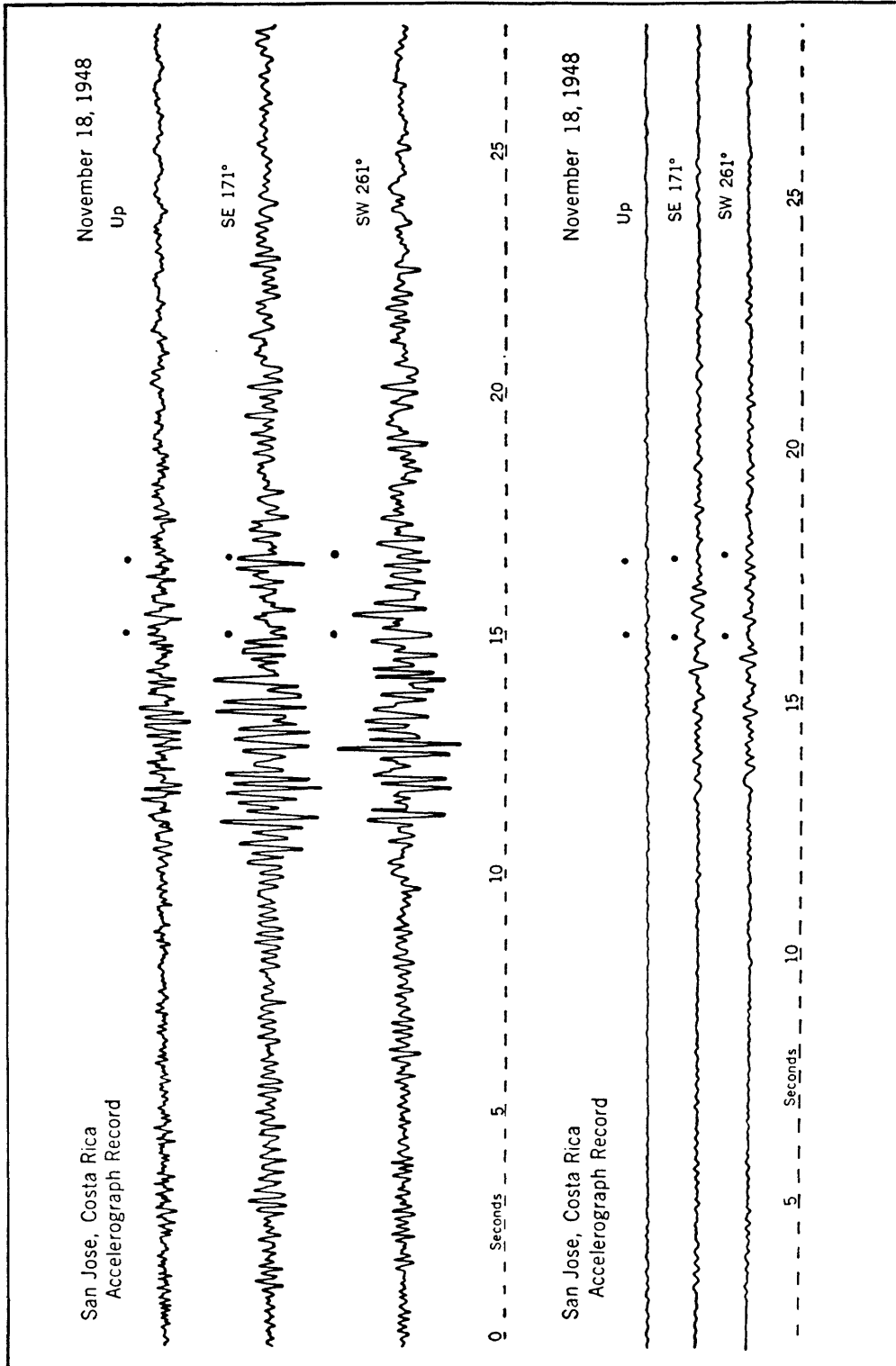


FIGURE 9.—Tracings of accelerograph records obtained at San Jose, Costa Rica, on November 18.

Table 4.—Composite of strong-motion instrumental data for 1948.—Continued

Station and component*	Instru-ment No.	T ₀	V	Sensi-tivity	ε	Earth-wave period	Maxi-mum Acceleration	Maxi-mum Dis-placement	Remarks
SOUTHERN CALIFORNIA EARTHQUAKE OF DECEMBER 4									
Colton, 1st floor:									
Vertical-up	V-253	0.065	111	1.18	12	0.11	13	0.004	Sinusoidal waves.
						.15	9	.005	
E. 90°	L-254	.067	126	1.42	10	.10	13	.003	Strong irregular wave.
						.17	16	.011	
						.20	15	.015	
S. 180°	T-255	.065	126	1.35	10	.28	15	.030	
						.18	18	.015	Sinusoidal waves.
						.17	22	.016	
						.30	13	.030	
RDM W. 270°		9.76	1		10	1.3	3	.13	Do.
						1.15	6	.21	
						3.6	1	.27	Strong phase near begin-
						1.7	4	.26	ning.
LDM N. 0°		9.84	1		12	1.0	13	.31	
						0.9	12	.24	
						2.3	2	.27	
						1.5	3	.18	
Hollywood Storage Co., penthouse:									
Vertical-up	V-193	.046	122	.65	8	.60	8	.073	Sinusoidal waves.
S. 180°	L-192	.047	126	.70	11	.65	22	.235	Do.
						.70	29	.360	
						.50	52	.333	
W. 270°	T-191	.046	131	.69	24	.45	13	.066	Sinusoidal waves.
						.60	36	.328	
						.60	29	.265	
P. E. Lot:									
Vertical-up	V-214	.065	123	1.32	10	.15	2	.001	
E. 90°	L-213	.066	123	1.34	9	.15	11	.006	Single wave.
						.12	4	.001	Superposed on long-period wave.
S. 180°	T-212	.066	126	1.39	11	.16	11	.007	Series of sinusoidal waves.
						.50	8	.051	
Basement:									
Vertical-up	V-217	.065	126	1.36	7	.55	2	.015	Irregular wave.
						.80	6	.097	Sinusoidal wave.
E. 90°	L-216	.067	120	1.35	7	.30	12	.028	Irregular wave.
						.90	14	.288	Do.
						.60	6	.055	
S. 180°	T-215	.064	125	1.31	10	.55	13	.100	Irregular wave.
						.30	15	.035	
Long Beach, base-ment:									
Vertical-up	V-265	.067	125	1.40	10	.15	4	.002	Very small motion.
N. 0°	L-266	.065	126	1.36	9	.23	4	.005	
						.80	7	.114	
E. 90°	T-267	.067	124	1.39	7	.22	7	.009	
LA C. of C., 11th floor:									
Vertical-up	V-187	.046	117	.63	13	.14	8	.004	Very small motion.
SW. 218°	L-186	.045	122	.64	15	.35	20	.062	
						1.40	30	1.491	Irregular waves.
						.40	25	.100	
NW. 308°	T-185	.045	126	.66	9	.28	14	.028	
						1.40	21	1.044	Irregular waves.
						.25	23	.037	Single wave.
						.40	17	.069	Do.
Basement:									
Vertical-up	V-205	.064	112	1.15	13	.35	4	.013	Very small motion.
NE. 36°	L-204	.064	128	1.34	14	.20	4	.004	
						.50	7	.044	
SE. 126°	T-203	.065	128	1.39	12	.65	14	.150	Irregular wave.
						.50	7	.044	
LA Edison Bldg., basement:									
Vertical-up	V-268	.066	118	1.31	9	.40	5	.020	
						.16	4	.003	Superposed on preceding wave.
						.30	4	.009	
SW. 218°	L-269	.067	120	1.35	8	.60	16	.146	
						.70	15	.156	
NW. 308°	T-270	.067	120	1.36	7	.67	27	.308	Irregular waves.

See footnotes at end of table, page 49.

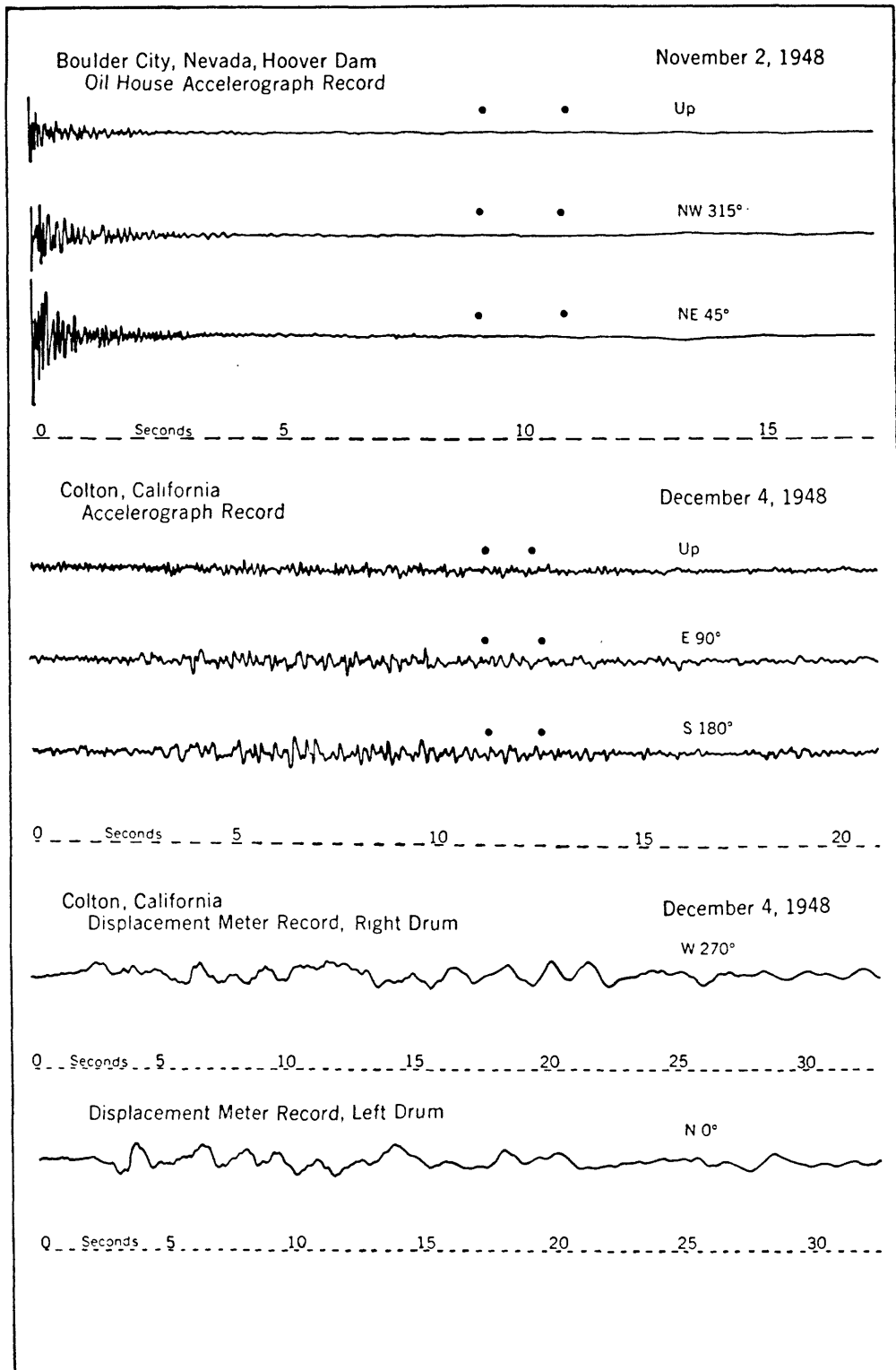


FIGURE 10.—Tracings of accelerograph records obtained at Hoover Dam Oil House on November 2, and at Colton (accelerograph and displacement meter) on December 4.

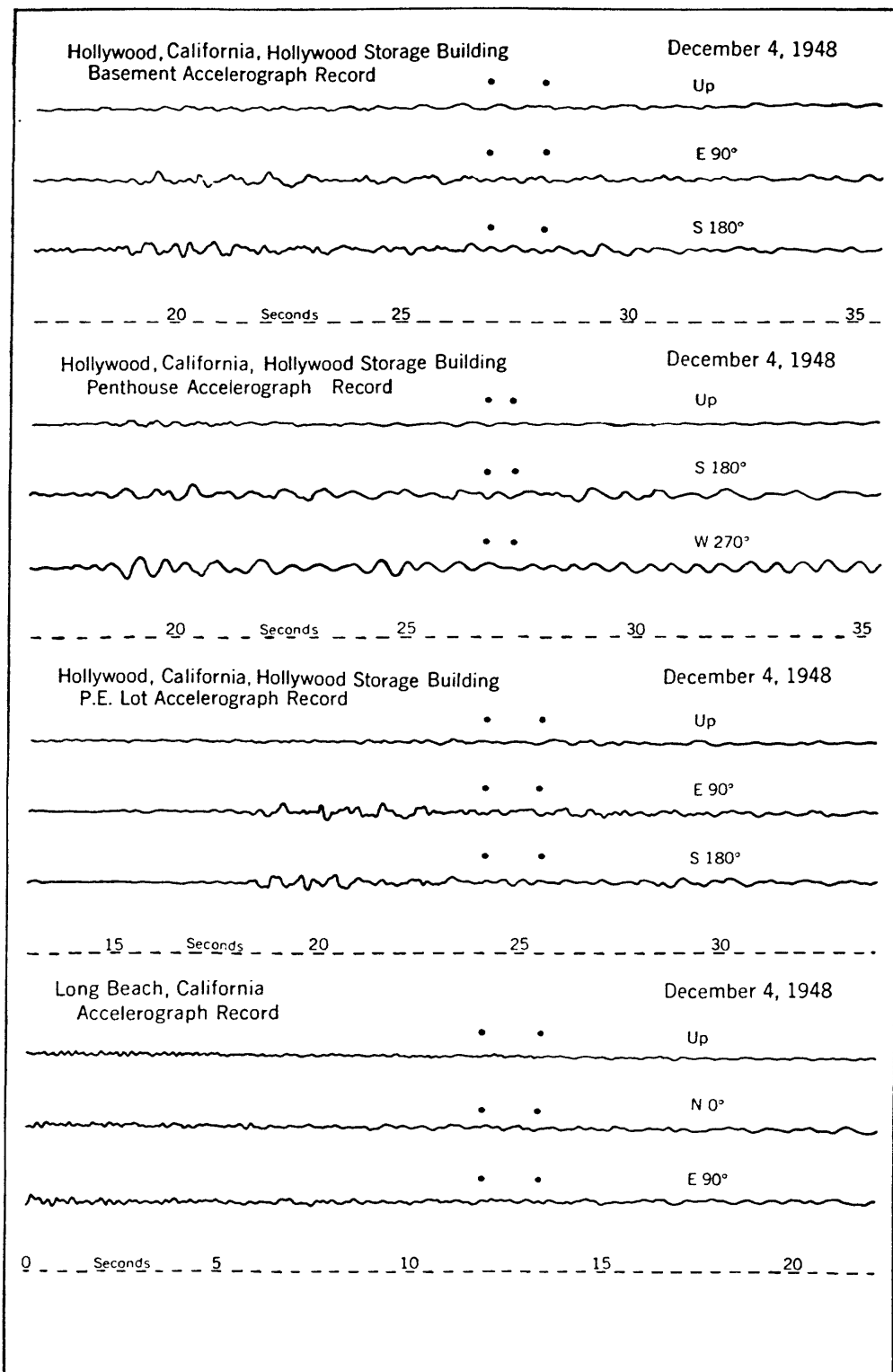


FIGURE 11.—Tracings of accelerograph records obtained at Hollywood Storage Company basement, penthouse, and P. E. Lot on December 4, and at Long Beach on December 4.

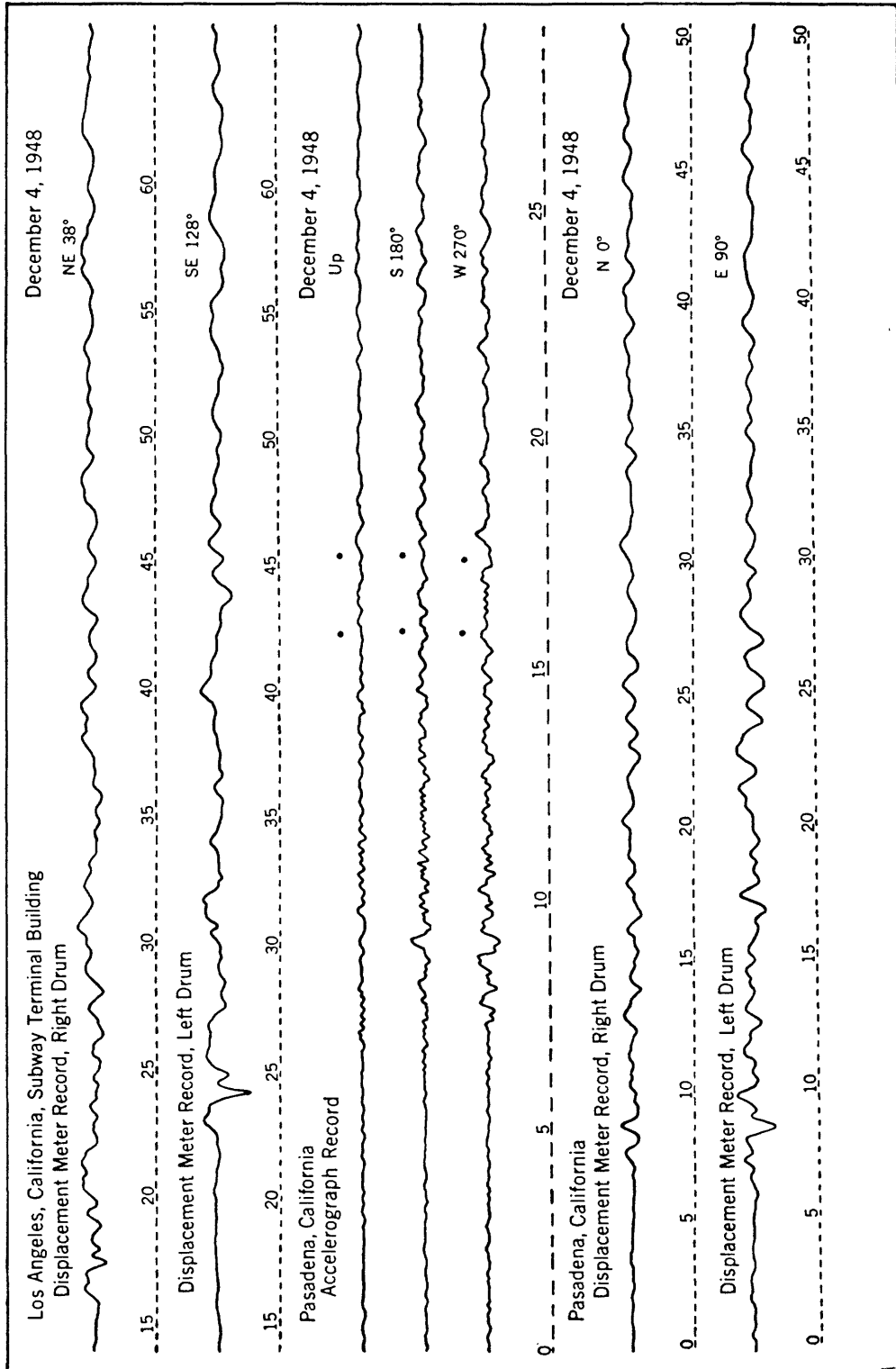


FIGURE 12.—Tracings of displacement meter records obtained at Los Angeles Subway Terminal and Pasadena on December 4, and of accelerograph record obtained at Pasadena on December 4.

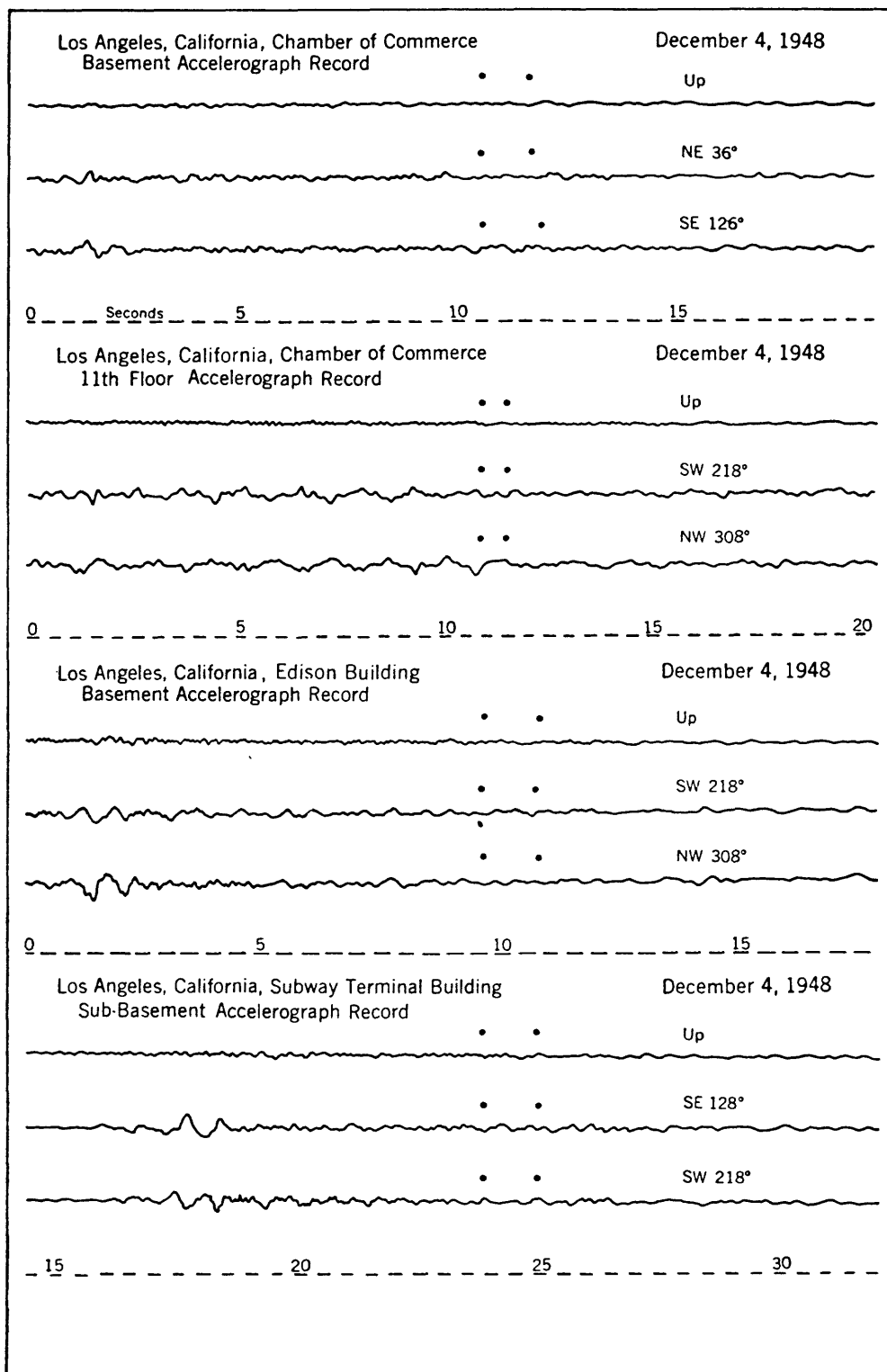


FIGURE 13.—Tracings of accelerograph records obtained at Los Angeles Chamber of Commerce basement and 11th floor, at Los Angeles Edison Building basement, and at Los Angeles Subway Terminal sub-basement on December 4.

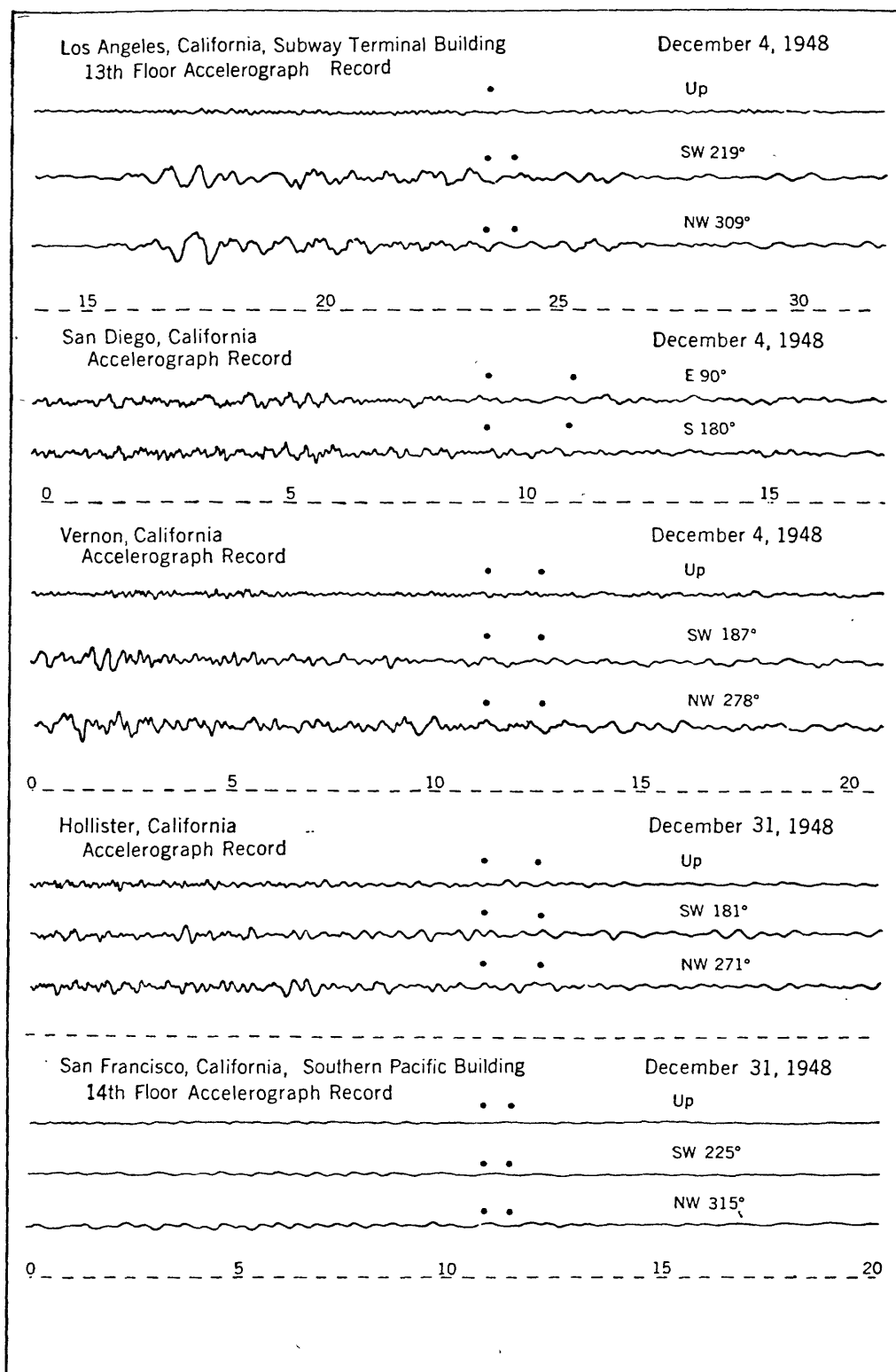


FIGURE 14.—Tracings of accelerograph records obtained at Los Angeles Subway Terminal, 13th floor, at San Diego, and at Vernon on December 4; at Hollister on December 31, and at San Francisco Southern Pacific Building, 14th floor, on December 31.

Table 4.—Composite of strong-motion instrumental data for 1948.—Continued

Station and component*	Instru- ment No.	T ₀	V	Sensi- tivity	ε	Earth- wave period	Maxi- mum Accel- eration	Maxi- mum Dis- place- ment	Remarks
SOUTHERN CALIFORNIA EARTHQUAKE OF DECEMBER 4—continued									
LA Sub. Term., 13th floor:									
Vertical-up	V-190	.046	123	.66	9				Very small motion.
SW. 219°	L-189	.046	126	.68	15	.65	40	.428	Irregular waves.
						.15	7	.004	
						.80	29	.473	
NW. 309°	T-188	.046	.28	.69	12	.65	51	.546	
						.40	23	.092	
Sub-basement:									
Vertical-up	V-211	.065	.24	1.33	10	.15	4	.002	Very small motion.
SE. 128°	L-210	.065	125	1.32	8	.68	23	.271	
						.40	5	.020	
SW. 218°	T-209	.064	125	1.31	10	.60	16	.146	Sinusoidal waves.
RDM NE. 38°		9.95	1		13	1.8	3	.254	
						2.4	1	.173	
						1.65	2	.136	
LDM SE. 128°		10.40	1		9	1.05	16	.455	
						.95	1	.245	
Pasadena, basement:									
Vertical-up	V-114	.101	75	1.96	11	.26	4	.007	
						.70	5	.062	
S. 180°	L-94	.099	77	1.93	9	.50	13	.083	
						.50	8	.051	
						.80	6	.097	
W. 270°	T-104	.099	73	1.81	10	.50	11	.070	
						.54	16	.124	
						.40	6	.024	
						.80	8	.130	
RDM N. 0°		9.71	1		9	.9	1	.18	
						1.7	2	.18	
						1.45	3	.17	
LDM E. 90°		9.67	1		8	1.20	7	.27	
						1.80	2	.20	
Weed:									
E. 90°		.204	7.0	.74	2	.8	1	.01	Very small motion.
						.4	3	.01	
N. 0°		.206	6.8	.73	3	.4	1	.01	
San Ber. Weed:									
NW. 315°		.173	6.4	.49	2	.10	40	.01	
						.2	20	.02	
						.1	80	.02	
						.3	9	.02	
SW. 225°		.167	6.4	.45	2	.2	10	.01	
						.2	10	.01	
						.4	3	.01	
San Diego, 1st floor:									
Vertical-up	V-322	.082	123	2.09	8	.15	4	.002	No visible motion. Very small motion. Short-period waves superposed.
E. 90°	L-323	.080	123	2.00	9	.47	8	.045	
						.10	3	.001	
						.40	9	.037	
						.45	6	.031	
S. 180°	T-324	.081	122	2.02	9	.13	5	.022	
						.30	7	.016	Very small motion.
						.45	10	.051	
						.30	5	.011	
Santa Ana, Weed, 1st floor:									
SE. 135°		.197	6.8	.67	3	.1	80	.02	Short period wave at start for 2 seconds on both components.
						.3	9	.02	
						.7	1	.01	
						.3	4	.01	Changes sharply to weak irregular waves.
NE. 45°		.197	7.0	.69	3	.1	80	.02	
Vernon, basement:									
Vertical-up	V-256	.065	124	1.34	7	.19	4	.004	Very small motion.
						.25	7	.011	
SW. 187°	L-257	.065	128	1.36	6	.42	14	.063	
						.36	18	.059	Sinusoidal waves.
						.24	11	.016	
						.30	11	.024	
NW. 277°	T-258	.065	129	1.38	7	.45	21	.108	Irregular wave. Superposed on long-period wave.
						.20	15	.015	
						.17	7	.005	
						.60	15	.137	
Westwood, base- ment:									
Vertical-up	V-262	.065	120	1.27	6	.20	2	.002	Very small motion.
						.20	3	.003	
S. 180°	L-263	.065	122	1.29	10	.40	6	.020	
W. 270°	T-264	.065	118	1.26	10	.70	7	.086	
						.40	7	.028	

See footnotes at end of table, page 49.

Table 4.—Composite of strong-motion instrumental data for 1948.—Continued

Station and component*	Instrument No.	T ₀	V	Sensitivity	ε	Earth-wave period	Maximum Acceleration	Maximum Displacement	Remarks
NORTHERN CALIFORNIA EARTHQUAKE OF DECEMBER 29									
SF So. Pac. Bldg., 14th floor:									
Vertical-up-----	V-184-----	0.047	117	0.65	14	-----	-----	-----	
SW. 225°-----	L-183-----	.047	122	.67	12	1.25	11	0.437	
NW. 315°-----	T-182-----	.045	126	.65	16	1.10	7	.211	
NORTHERN CALIFORNIA EARTHQUAKE OF DECEMBER 31									
Hollister, basement:									
Vertical-up-----	V-238-----	0.068	117	1.36	5	0.10	4	0.001	
						.20	7	.007	Irregular waves.
						.18	8	.006	Single sine wave.
						.28	8	.016	Irregular wave.
SW. 181°-----	L-239-----	.066	123	1.35	5	.40	11	.044	Irregular waves at beginning.
						.38	15	.055	Sinusoidal wave.
						.30	9	.021	
						.40	11	.044	
NW. 271°-----	T-240-----	.066	124	1.36	7	.22	9	.011	Single wave.
						.55	11	.085	Irregular waves.
						.40	15	.060	
						.40	8	.032	Sinusoidal waves.

* The directions given indicate the direction of pendulum displacement relative to instrument pier, which will displace the trace upward on the original seismogram. Directions for the horizontal components are given first by quadrant followed by specific directions expressed in degrees measured from north around by east.

† Approximate orientation, a temporary installation.

‡ Possibly preceded by stronger motion.

§ Possibly preceded by stronger motion at beginning.

¶ Sinusoidal waves with short-period waves superposed.

TILT OBSERVATIONS

Two tiltmeters at Berkeley and one at Long Beach were continued in operation in cooperation with the University of California and the Long Beach Engineering Department, respectively. The tiltmeter at Long Beach was reset in April 1948.

CORRECTION TO PREVIOUS EDITION

1947. Serial 730. In table 1, the epicenters listed from October 15, 02h through October 30, should read November, and those from November 15, 18 through November 31 should read October.

PUBLICATION NOTICES

To make immediately available the results of its various activities to those interested, the Coast and Geodetic Survey maintains mailing lists of persons and firms desiring to receive notice of the issuance of charts, Coast Pilots, maps, and other publications.

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