

# UNITED STATES EARTHQUAKES 1945

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SERIAL No. 699

U. S. DEPARTMENT OF COMMERCE

U. S. COAST AND GEODETIC SURVEY - WASHINGTON

U. S. DEPARTMENT OF COMMERCE

W. A. HARRIMAN, Secretary

COAST AND GEODETIC SURVEY

Leo Otis Colbert, Director

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Serial No. 699

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## 1945

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# UNITED STATES EARTHQUAKES, 1945

## INTRODUCTION

This publication is a summary of earthquake activity in the United States and the regions under its jurisdiction for the calendar year 1945. A history of the more important shocks of the country appears in Serial 609, *Earthquake History of the United States: Part I.—Continental United States (Exclusive of California and Western Nevada)* and *Alaska*, Revised (1947) edition; and *Part II.—Stronger Earthquakes of California and Western Nevada*, Revised (1941) edition.

The history of minor activity is covered largely in a series of references listed in Serial 609, in recent reports of the United States Coast and Geodetic Survey, and in a bulletin of the Seismological Society of America.<sup>1</sup> The last two references give very detailed information for all California earthquakes. The last one contains all of the information appearing in the early catalogs published by the Smithsonian Institution.

Earthquakes of volcanic origin in the Hawaiian Islands are not included. Complete reports are published by local seismological institutions. Earthquakes adjacent to the United States and felt within its borders are described only in a general way when detailed descriptions are published elsewhere.

*Cooperation of investigators solicited.*—In order that these publications may be as complete as possible in the more important details of earthquakes and in references, it is desired that investigators cooperate to the fullest extent, as such cooperation will be to the mutual advantage of everyone concerned. The Survey is willing to furnish investigators all information at its disposal, consisting principally of seismographic records and postcard questionnaires obtained in many instances through special canvassing of affected areas. In return it is requested that advance notices be furnished of results obtained so that abstracts and references may be inserted in these reports. An advance notice of a planned investigation might save considerable overlapping of effort and would give wider publicity to the work of the investigator.

*Earthquake information services.*—The Coast and Geodetic Survey maintains a field party in San Francisco, the Seismological Field Survey, which in addition to other duties collects earthquake information in the Pacific Coast and Western Mountain States. In this work the Seismological Station of the University of California, Berkeley (Dr. Perry Byerly in charge), and the Seismological Laboratory of the California Institute of Technology, at Pasadena, Dr. Beno Gutenberg in charge, cooperate actively. 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.

Outside of California the following Collaborators in Seismology served as agents of the Coast and Geodetic Survey in collecting earthquake information in their respective States in 1945.

*Arizona*.—Dean G. M. Butler, University of Arizona, Tucson.

*Colorado*.—Prof. C. A. Heiland, Colorado School of Mines, Golden.

*Idaho*.—Dean A. W. Fahrenwald, University of Idaho, Moscow.

*Montana*.—Dr. Francis A. Thomson, 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 Agricultural College, Corvallis.

*Utah*.—Prof. J. Stewart Williams, University of Utah, Salt Lake City.

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

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

In other parts of the country the Jesuit Seismological Association was active in cooperative projects. The central office of the association at St. Louis University (Rev. Dr. J. B. Macelwane, S. J., in charge) collected information in the central Mississippi

<sup>1</sup>Descriptive Catalog of Earthquakes of the Pacific Coast of the United States, 1769 to 1928. S. D. Townley and M. W. Allen, Bulletin of the Seismological Society of America, Vol. 29, No. 1, January 1939.

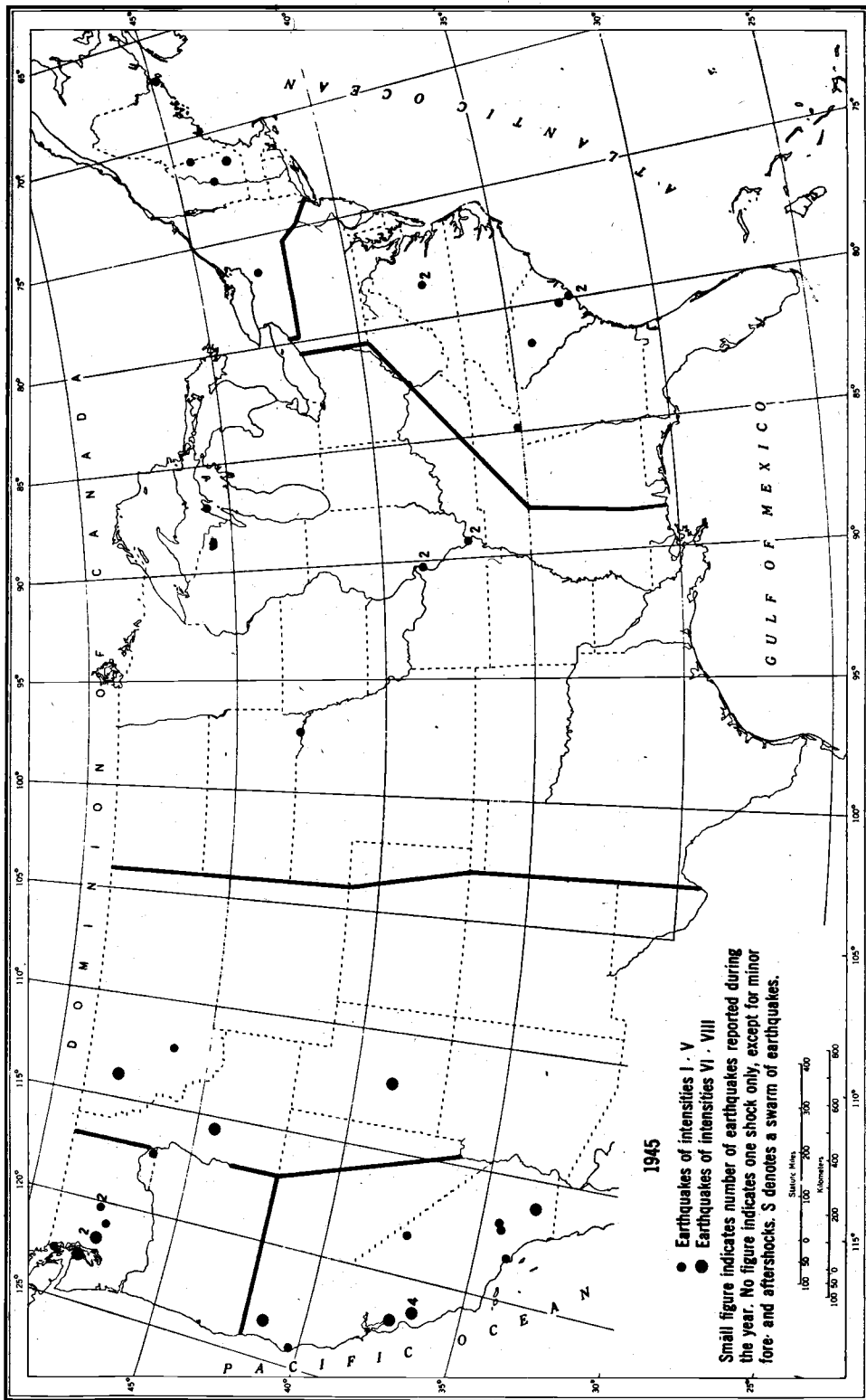


Figure 2.—Earthquake epicenters, 1945.

River valley area, and the Seismological Station at Weston College, Massachusetts (Rev. Daniel Linehan, S. J., in charge) undertook similar work in the Northeastern States under the auspices of the Northeastern Seismological Association and in close collaboration with the Harvard Seismological Observatory.

Other sources of information used in compiling this report included: (1) the United States Weather Bureau, whose observers prepare periodic reports on local seismic activity; (2) telegraphic information collected by Science Service, Washington; (3) bulletins of the Seismological Society of America; (4) bulletins of the Northeastern Seismological Association; (5) special bulletins of the Jesuit Seismological Association; (6) Earthquake Notes; (7) reports of the Hawaiian Volcano Observatory; and (8) reports from many interested individuals.

*Notes on the regional earthquake lists.*—The destructive features of all shocks are enumerated in the abstracts, but otherwise the descriptive matter is reduced to a minimum. The original reports are open for inspection by anyone interested in unpublished details. More detailed descriptions of earthquakes on the west coast will be found in the mimeographed reports available at the office of the Supervisor, Western District, in San Francisco.

Beginning with the 1931 number of this series, Serial 553, the Coast and Geodetic Survey has used and will continue to use the modified Mercalli intensity scale of 1931, in place of the Rossi-Forel scale, to designate the intensity of earthquake activity. All intensity numbers therefore refer to the modified Mercalli scale unless otherwise designated. The reasons for this change are set forth in an article entitled "Modified Mercalli Intensity Scale of 1931," by Harry O. Wood and Frank Neumann, in the December 1931 number of the Bulletin of the Seismological Society of America, Vol. 21, No. 4. This article contains the original unabridged scale and also an abridged scale. The latter is given here, together 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 motor cars 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 motor cars 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 motor cars. (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. Disturbs persons driving motor cars. (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.

In the case of California, earthquakes reported as feeble are not plotted on the epicenter map of the United States, nor are minor after-shocks plotted for heavy earthquakes in California or any other region. The reader should bear in mind that the information service in California has been developed to a point not approached in any other section of the country. When the coordinates of epicenters are given, the sources of information are stated also when the epicenters are determined by other organizations such as the Seismological Station of the University of California or the Seismological Laboratory of the California Institute of Technology. The bulletins of these institutions should be consulted for further details and often for data on additional shocks.

Within the United States the same regional arrangement has been followed as in Serial 609 previously mentioned.

*Special quarterly report.*—Attention is invited to a special quarterly report issued by the Seismological Field Survey, with headquarters at San Francisco, entitled "Abstracts of Earthquake Reports for the Pacific Coast and the Western Mountain Region." The reports are in mimeographed form and tabulate in unabridged style all information of value contained in noninstrumental reports collected in the region indicated.

*Epicenter maps.*—Figures 1 and 2 are designed to show earthquake distribution in the United States at a glance but the reader is cautioned in accepting all epicenter locations as correct. In a few cases, especially offshore epicenters and others in uninhabited areas, where instrumental control is not satisfactory or where results of investigations are overdue, the plotted epicenters may be in error. The maps must therefore be accepted as showing, in some cases, the existence of epicenters rather than their precise locations. The text of the publication should be consulted to appraise any individual case. This same condition prevails also, to some extent, in the case of isoseismal maps. In figure 2 the relative intensity of a shock is indicated by the size of the dot.

*Teleseismic results.*—On page 20 is a list of Survey and cooperating teleseismic stations for which the Survey publishes results. Immediate epicenter determinations are frequently made through the cooperation of Science Service, the Jesuit Seismological Association, the Coast and Geodetic Survey, and individual stations. The results are furnished by mail to cooperators.

*Strong-motion results.*—The introductory remarks in the chapter on this subject explain in detail the purpose of the work, which is primarily to furnish engineers exact information concerning ground movements in the central regions of strong earthquakes. The instrumental equipment is essentially different in type from teleseismic equipment although the principles involved are the same. Strong-motion instruments are installed mostly in the urban areas of California, and operate only when actuated by the movements of a strong earthquake.

The interpretation of strong-motion results is one of the duties assigned to the Survey in connection with a broad cooperative program of seismological research being carried out on the Pacific coast between the Survey and a number of local organizations and institutions interested in the engineering aspects of the earthquake problem. The details of this program are fully described in the Survey's Special Publication No. 201, Earthquake Investigations in California, 1934-35, which is obtainable from the Superintendent of Documents, Washington 25, D. C., for 35 cents.

Preliminary reports on strong-motion results are issued in quarterly mimeographed bulletins and sometimes in special mimeographed reports. They appear in revised form in this publication.

## NONINSTRUMENTAL RESULTS

NOTE.—The following symbols are used to indicate authority for the data shown.

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

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

BC—epicenter reported by the Boulder City office of the Lake Mead Seismological Survey.

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

An asterisk (\*) indicates instrumental time. Time is indicated as continuous from 0 to 24 hours, beginning and ending at midnight.

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 which may be obtained from the Washington Office of the U. S. Coast and Geodetic Survey.

## EARTH QUAKE ACTIVITY IN THE VARIOUS STATES

**California:** January 7, 10, April 1, 19, May 2, 17, 19, August 15, 27. Other minor shocks are not listed here.

**Colorado:** April 29.

**Florida:** December 22.

**Idaho:** February 13, July 9, 19.

**Illinois:** September 23, November 13.

**Maine:** July 15, August 27.

**Michigan:** May 18.

**Missouri:** March 27, May 21.

**Montana:** June 1, September 23. Other minor shocks are not listed here.

**Nevada:** Eighteen minor shocks.

**New Hampshire:** March 22, December 28.

**New York:** April 15.

**South Carolina:** January 30, May 18, June 5, July 26.

**South Dakota:** November 10.

**Tennessee:** June 13.

**Utah:** March 28, November 17.

**Vermont:** August 5.

**Virginia:** October 10, 12, 29.

**Washington:** January 3, 27, February 27, March 2, April 29, 30, May 1 (2), 3, September 22, November 11, 23.

**Wyoming:** April 21, 23 (4), 24 (6), June 23.

**Alaska:** January 16, 21, February 8, 10, March 5, April 11, June 3, September 17, October 10, 15, November 16, 17, December 1.

**Hawaii:** January 24, March 4, May 19, July 13, August 9, September 19.

## NORTHEASTERN REGION

(60TH MERIDIAN OR EASTERN WAR TIME)

**March 22:** 04:04. Concord, N. H. Light shock awakened some. Two shocks 4 or 5 seconds apart were noted at the city airport.

**April 15:** 09:15, 10:20, and 11:30. Auburn, Camillus, Marcellus, and South Syracuse, N. Y. Light shocks felt. No damage. All towns reported rumbling noises.

**July 15:** 06:45. Vicinity of Eastport, Maine. Loud rumbling like extreme heavy thunder or explosion. Buildings swayed. Movement felt strongly in granite building where heavy iron plates in basement rattled. Also felt at Calais, Machias, Pembroke, and Woodland. Water main reported broken at Calais.

**August 5:** 13:20 to 14:30. Woodstock, Vt. Three light shocks reported.

**August 27:** 21:37. Eastport, Maine. Light shock reported.

**December 28:** 06:23. North Conway, N. H. Local shock. One observer stated it seemed like someone in the cellar swung a sledgehammer against the floor under his feet.

## EASTERN REGION

(60TH MERIDIAN OR EASTERN WAR TIME)

**January 30:** 16:20. Summerville, S. C. Felt by many. Rattled doors and windows. No damage.

**May 18:** 08:20 and 08:40. Charleston, S. C. (three miles southwest of). Sharp bump felt by several. Possibility of blast investigated.

**June 5:** 08:10. Wappoo Heights, S. C. Light shock felt by several. Bumping motion.

**June 13:** 22:25. Cleveland, Tenn. A distinct tremor felt strongly in area between Cleveland, Tenn., and Blue Ridge, Ga. Intensity V in Cleveland. Many were alarmed and ran to streets. No damage.

## INTENSITY IV:

Athens and Chattanooga.

## INTENSITY I TO III:

Bradley, Copperhill, and Ocoee.



## INTENSITY I TO III IN GEORGIA:

Blue Ridge.

**July 26: 06:32.3.\*** Epicenter 34.3° north, 81.4° west, W. Thirty miles northwest of Columbia, S. C. No damage. Many reported rumbling noise preceding the earthquake. About 25,000 square miles affected.

## INTENSITY IV:

Abbeville, Anderson, Bamberg, Camden, Charleston, Chester, Columbia, and Greenville.

## INTENSITY IV IN NORTH CAROLINA:

Ashville and Charlottesville.

## INTENSITY I TO III:

Aiken, Lancaster, Langley, Orangeburg, North, Spartanburg, Summerville, and Sumpter.

## INTENSITY I TO III IN GEORGIA:

Augusta and Macon.

## INTENSITY I TO III IN TENNESSEE:

Knoxville.

**October 10: 15:43.** New Canton, Va. Felt by many and was accompanied by roaring. Also felt at Arvonja, Brems Bluff, Buckingham, Dillwyn, and Fork Union.

**October 12: 15:00.** Dillwyn, Va. Stove pipes and buildings shook. General alarm. Sounds approached from southeasterly direction.

**October 29: 21:29.** Dillwyn and New Canton, Va. Underground rumblings heard and a number of people awakened at Dillwyn. Ten to twelve seconds duration estimated at New Canton.

**December 22: 11:25.** Miami Beach and Hollywood, Fla. Press reports stated a slight shock was felt in these places and a weak shock was recorded on the seismograph at Spring Hill College near Mobile, Alabama.

## CENTRAL REGION

(75TH MERIDIAN OR CENTRAL WAR TIME)

**March 27: 20:46.** St. Louis, Mo. Light shock felt.

**May 18: 09:26.** Escanaba, Mich. Light shock felt by several including the local weather official. All reports came from people located on the middle floors of the taller buildings.

**May 21: 02:51.** St. Louis, Mo. Light shock rattled dishes in and near the city.

**September 23: 01:22.** Cairo, Ill. Light shock awakened perhaps 5 percent of the population.

**November 10: 03:00.** Yankton, S. D. Slight shock felt. Rattled dishes. Felt in Bon Homme and Yankton counties and also in the border areas of counties to the north and west.

**November 13: 03:21.** Cairo, Ill. Shock generally noted in Illinois and also at Perryville, Mo.

## WESTERN MOUNTAIN REGION

(90TH MERIDIAN OR MOUNTAIN WAR TIME)

**January 12: 12:48:30.\*** Epicenter about three miles northwest of Boulder City, BC. Fairly sharp shock felt by many. Rattled windows, doors, and water pipes.

**January 15: 06:10.** Helena, Mont. One weak tremor, lasting 2 seconds.

**January 20: 12:18.** Helena, Mont. Double tremor, lasting 2 seconds.

**January 23: 05:01.** Helena, Mont. Light shock, lasting 1 second.

**January 30: 08:00.\*** Epicenter in lake basin 3 miles northwest of Boulder Dam, BC. Felt by several.

**February 2: 06:03.** Helena, Mont. Shock with weak to moderate vibrations, lasting 4 seconds.

**February 7: 09:23:05.3.\*** Epicenter 4 to 5 miles southeast of Boulder City, BC. Felt by several in community. Rattled windows and doors.

**February 13: 21:01:15.1.\*** Tentative epicenter 44.7° north, 115.4° west, W. Near Clayton, Idaho. This earthquake was felt over a large portion of Idaho, extreme eastern portions of Washington and Oregon, and the southwestern region of Montana. See map, page 7. Affected area covered approximately 60,000 square miles.

## INTENSITY VI:

*Clayton.*—Motion rapid, lasting 30 seconds. Felt by all in community. Frightened few. Houses creaked and small objects overturned.

*Idaho City.*—Motion rapid. Felt by many in home and outdoors by some. Broke dishes. Damage slight.

*Weiser.*—Felt by many. Walls creaked. Hanging objects swung northeast. Cracked plaster.

## INTENSITY V:

Atlanta, Big Creek, Boise, Cottonwood, Cuprum, Dixie, Ellis, Mackay, Shoup, Stanley, Tendoy, Warren, White Bird, Wildhorse, and Yellow Pine.

## INTENSITY IV:

Calder, Cambridge, Cascade, Challis, Clearwater, Council, Crouch, Donnelly, Elk River, Grangeville, Hailey, Lowman, Lucile, McCall, Mesa, Midvale, Nezperce, North Fork, Orogrande, Orofino, Patterson, Pollock, Riggins, Saint Maries, Salmon, Stibnite, and Sunbeam.

## INTENSITY IV IN MONTANA:

Armstead, Deer Lodge, Stevensville, and Virginia City.

## INTENSITY IV IN OREGON:

Homestead, Nyssa, Robinette, and Vale.

## INTENSITY I TO III:

Caldwell, Gibbonsville, May, Moscow, Obsidian (7 miles south of), Payette, Priest River, Tamarack, and Wallace.

## INTENSITY I TO III IN MONTANA:

Conner, Dillon, Hamilton, Kalispell, Reichle, and Wisdom.

## INTENSITY I TO III IN OREGON:

Adrian.

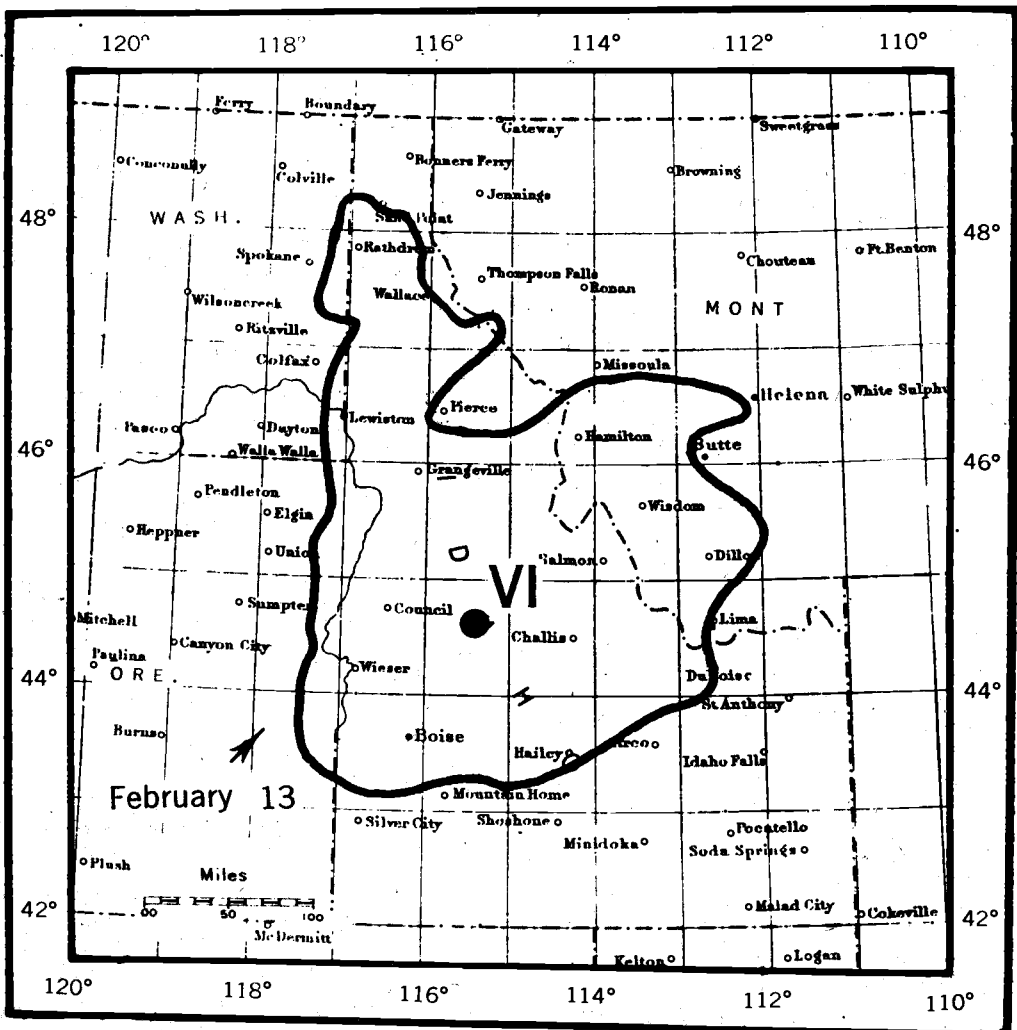


FIGURE 3.—Area affected by the earthquake of February 13, 1945.

## INTENSITY I TO III IN WASHINGTON:

Asotin Lamont (7 miles southwest of), Palouse, Pullman, and Spokane.

Negative reports were received from 18 places in Idaho, 10 places in Montana, 11 places in Oregon, and 16 places in Washington.

February 14: 18:49. Helena, Mont. Weak shock, lasting 2 seconds.

February 16: 15:05:32.\* Epicenter  $3\frac{1}{2}$  miles east of Boulder Dam, BC. Shock of short duration.

February 16: 15:28:32.\* Tentative epicenter 2 miles east of Boulder Dam, BC. Shock of short duration.

February 16: 16:10:09.\* Epicenter 3 miles southeast of Boulder Dam, BC. Shock of short duration.

February 16: 22:04:14.\* Epicenter 3 miles west of Boulder Dam, BC. Shock of short duration.

February 20: 18:15. Absarokee, Mont. (Press), "Tremors of medium intensity shook the mining area 30 miles west of this southern Montana community today. No damage or injuries reported. Felt at the Lower Mouatt Mine, the Upper Mouatt Mine, the Denbow Mine, and in the vicinity of Gardiner."

February 23: 15:13.\* Probable epicenter 1 or 2 miles south of Boulder Dam, BC. Felt by few. Rattled windows.

March 1: 09:50, 10:03, and 11:36. Helena, Mont. Weak shocks of 1-second duration.

March 2: 11:43, 20:37, 20:38, and 20:43. Helena, Mont. First, weak, lasting 1 second; second, strong jolting vibration, lasting 2 seconds; third, moderate jolting vibration, lasting 1 second; and fourth, weak, lasting 2 seconds.

March 3: 02:45, 03:05, 03:10, and 03:14. Helena, Mont. Earth tremors of strong intensity accompanied by roaring and rumbling. City was awakened. House timbers creaked and dishes rattled.

March 4: 07:19 and 18:19. Helena, Mont. First, light vibration, lasting 1 second; second, light jolting vibration, lasting 1 second.

March 5: 12:10, 18:45, and 18:57. Helena, Mont. All weak, lasting 1 second.

March 6: 10:54. Helena, Mont. Weak shock, lasting 1 second.

March 15: 11:47. Helena, Mont. Moderate vibration, lasting 2 seconds.

March 18: 02:58, 03:00, 03:02, 06:46, 06:47, 06:48, 06:49, 06:52, 07:01, 07:29, 07:42, and 07:45. Helena, Mont. All shocks were weak with the exception of those occurring at 06:46, 06:52, 07:01, and 07:42 which were moderate jolting vibrations, lasting 2 to 3 seconds.

March 26: 23:13. Helena, Mont. Moderate jolting vibration, lasting 2 seconds.

March 28: 04:40. Nephi, Utah. Motion rapid, lasting 2 seconds. Awakened several. Rattled windows.

April 1: 02:15 and 02:40. Helena, Mont. First, moderate; second, weak.

April 3: 23:45. Helena, Mont. Vibration felt.

April 4: 01:01, 09:45, and 12:41. Helena, Mont. Moderate shocks.

April 5: 03:25, 03:31, 03:45, 04:10, 05:05, 06:25, 12:04, and 18:25. Helena, Mont. Shock at 03:25 was strong jolt, lasting 4 seconds; others were moderate to weak in intensity and lasted from 1 to 2 seconds.

April 8: 18:23. Helena, Mont. Weak shock, lasting 1 second.

April 9: 17:24. Helena, Mont. Weak shock, lasting 1 second.

April 10: 18:10, 19:40, 19:45, 19:55, and 20:40. Helena, Mont. All shocks were weak with the exception of the one at 19:40 which rattled dishes and windows throughout the city and frightened many.

April 11: 07:29 and 11:01. Helena, Mont. Weak shocks, lasting 1 second.

April 13: 00:50, between 00:00 and 01:00, and 06:30. Helena, Mont. First moderate, lasting 2 seconds; others weak, lasting 1 second.

April 14: 07:54. Helena, Mont. Moderate shock, lasting 1 second.

April 15: 12:58. Helena, Mont. Light shock, lasting 1 second.

April 16: 12:20 and 13:10. Helena, Mont. Two weak shocks, lasting 1 second.

April 17: 01:14, and between 22:00 and 23:00. Helena, Mont. First, moderate, lasting 1 second; second, light, lasting 1 second.

April 19: 19:25. Helena, Mont. Light shock, lasting 1 second.

April 20: 04:45 and 22:14. Helena, Mont. Light shocks, lasting 1 second.

April 21: 07:28. Helena, Mont. Weak shock, lasting 1 second.

April 21: 18:32. Yellowstone Park, Wyo. (Canyon and Yellowstone Lake). Felt by several, by some outdoors. Houses creaked. Trees and bushes shaken slightly. Overturned vases and small objects. No damage to buildings.

April 23: 11:31. Yellowstone Park, Wyo. (Lake Station, Lake Hotel). Motion rapid, lasting a few seconds. Felt by observer in lake area. Houses creaked. Overturned vases and small objects.

April 23: 14:24, 14:58, and 15:13. Yellowstone Park, Wyo., (Yellowstone Lake). Motion rapid, lasting 2 seconds. Felt by two. Houses creaked. Overturned small objects. Dull sounds preceded each shock.

April 24: 09:20. Yellowstone Park, Wyo. Motion rapid, lasting about 2 seconds. Felt by few. Rattled windows. Overturned vases and small objects. Aftershocks occurred at 14:46, 15:37, 15:53, 16:16, and 22:25. All were preceded by a moaning sound.

**April 29:** 11:08 and 11:32. Silverton, Colo. First shock was a heavy muffled noise like the sound of a few boxes of powder exploding, and was accompanied by a distinct up-and-down movement under foot which shook houses and buildings. Some people ran into the streets in alarm. At Tacoma there was a bumping up-and-down motion with rapid onset. Windows rattled. Moderately loud thunderous subterranean sounds were heard.

**April 29:** 14:16:17.\* See Washington and Oregon.

**May 6:** 11:43. Helena, Mont. Moderate shock, lasting 2 seconds.

**May 9:** 17:16, 20:16, and 22:04. Helena, Mont. Weak to moderate shocks, lasting 1 second.

**May 11:** 19:33, 19:36, 19:40, and 20:16. Helena, Mont. All weak shocks, lasting 1 second.

**June 1:** 10:54.8\* Epicenter 46.6° north, 112.0° west, W. Helena, Mont. Felt over approximately 6,000 square miles in southwestern Montana. Maximum intensity V.

The following information is abstracted from a report of a field investigation made by personnel from the office of Dr. Francis A. Thomson, Collaborator in Seismology for the State of Montana. "The earthquake was generally conceded to be the strongest experienced since December 28, 1940. No damage was reported except for a few bricks from old chimneys and from unrepaired brick veneer remaining from 1935. Many of those interviewed reported hearing a rumbling preceding the earthquake, but the noise was not apparent to all. Dishes and windows rattled. There does not appear to have been significant difference between intensities in the bedrock parts of town and the alluvium-filled valley. As usual, the severity reported from a 50-mile radius around Helena varied with the character of the building in which the reporter experienced the tremor."

#### INTENSITY IV:

Austin, Belt, Big Prairie Ranger Station, Boulder, Butte, Stockett, Townsend, Trident. Wicks, and Wolf Creek.

#### INTENSITY I TO III:

Anaconda, Deer Lodge, Divide, Francis, Missoula, Norris, Three Forks, and Virginia City.

Negative reports were received from thirty places.

**June 1:** 11:19, 11:27, 11:40, 12:07, 12:32, 12:35, 12:41, 13:25, and 14:26. Helena, Mont. With the exception of a strong shock at 12:07, these shocks were all weak, lasting about 1 second.

**June 2:** 16:36 and 16:39. Helena, Mont. Weak shocks, lasting 1 second.

**June 3:** 15:46 and 16:05. Helena, Mont. First shock moderate; second shock weak, each lasting about 2 seconds.

**June 5:** 09:12 and 18:52. Helena, Mont. Weak shocks, lasting about 1 second.

**June 6:** 15:00. Helena, Mont. Moderate shock, lasting about 2 seconds.

**June 10:** 16:47:17 and 17:25. Helena, Mont. Weak shocks, lasting about 1 second.

**June 11:** 12:45 and 22:02. Helena, Mont. Weak shocks, lasting about 1 second.

**June 13:** 03:10 and 13:15. Helena, Mont. Weak shocks, lasting 1 second.

**June 15:** 15:23. Helena, Mont. Moderate shock, lasting 3 seconds.

**June 23:** 08:00. La Barge, Wyo. (30 miles west of). Motion rapid, lasting about 2 seconds. Felt by several in camp buildings.

**June 24:** 04:35. Helena, Mont. Weak shock, lasting 1 second.

**June 26:** 10:05 and 11:28. Helena, Mont. Moderate shocks, lasting about 2 seconds.

**July 4:** 03:12. Helena, Mont. Strong shock, lasting 3 seconds.

**July 6:** 17:01. Helena, Mont. Strong shock, lasting 2 seconds.

**July 9:** 23:21. Bayview, Idaho. Motion slow, lasting 6 seconds. Felt by several at lake on dock. Beds rattled and hanging objects swung. Water agitated. Loud rumble heard.

**July 14:** 14:12. Helena, Mont. Slight shock, lasting 2 seconds.

**July 15:** 15:19. Helena, Mont. Slight shock, lasting 2 seconds.

**July 19:** 18:30. Boise National Forest, Idaho. One severe and abrupt bump felt by several.

**July 26:** 10:11. Helena, Mont. Slight shock, lasting 1 second.

**July 27:** 12:50. Helena, Mont. Slight shock, lasting 2 seconds.

**July 27:** 03:31.\* Boulder City, Nev. Light shock. Felt by several.

**July 27:** 16:14. Helena, Mont. Slight shock, lasting 2 seconds.

**July 30:** 22:48.\* Boulder City, Nev. Light shock felt by many. No damage.

**August 10:** 10:57. Helena, Mont. Slight shock, lasting 2 seconds.

**August 22:** 17:57. Helena, Mont. Slight shock, lasting 1 second.

**August 23:** 21:35. Helena, Mont. Slight shock, lasting 2 seconds.

**August 25:** 03:57. Helena, Mont. Slight shock, lasting 1 second.

**August 25:** 05:50. Helena, Mont. Slight shock, lasting 1 second.

**September 18:** 15:39. Beowave, Nev. Felt by many. Rattled windows. Houses creaked. Hanging objects swung northeast.

**September 23:** 03:58.8.\* Epicenter 48.0° north, 114.2° west, W. West side of Flathead Lake about 20 miles north of Polson, Mont. Felt over an area of approximately 36,000 square miles. See map.

**INTENSITY, VI:**

**Elmo.**—Motion slow, lasting 30 seconds. Awakened all in community and frightened many. Overturned vases, cracked chimneys, and broke windows. Damage slight.

*Polson.*—Very severe shock. Awakened all. Very heavy sound resembling thunder heard. No damage except one broken window.

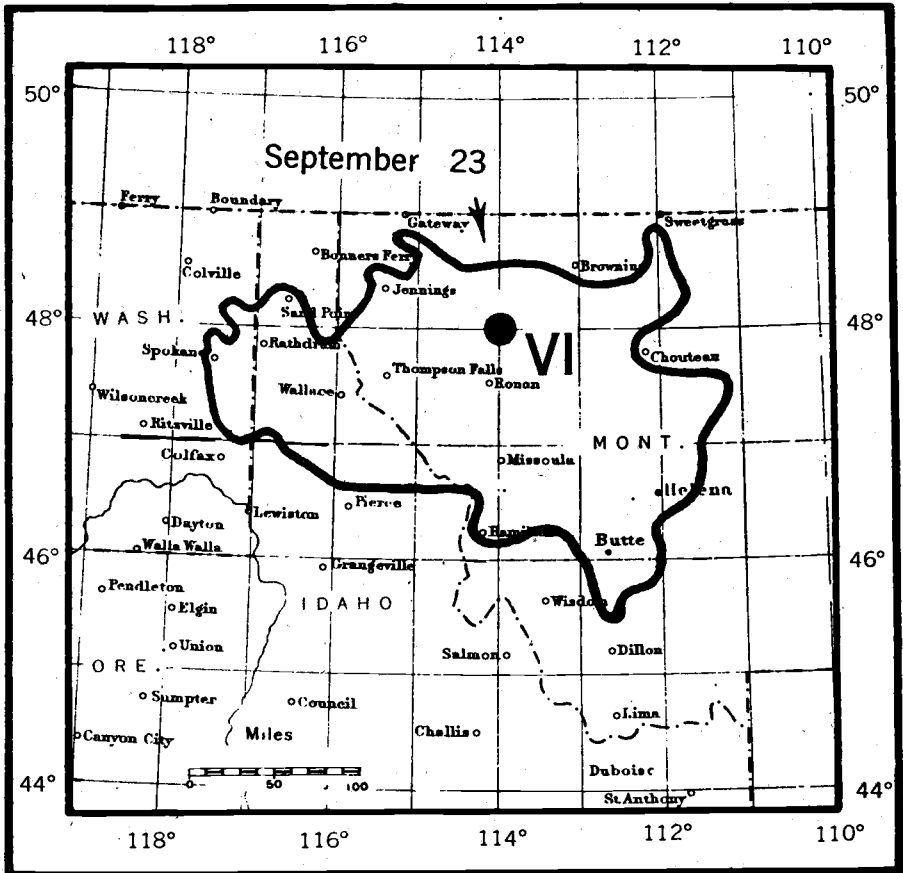


FIGURE 4.—Area affected by the earthquake of September 23, 1945.

### INTENSITY VI IN IDAHO:

*Mullan.*—Motion rapid, lasting about 2 minutes. Awakened many in community. Rattled windows and dishes. Shifted small objects. Cracked wallpaper. Accompanied by faint rumbling or rushing sound.

**INTENSITY V:**

Dixon, Flathead Lake, Kila, Missoula, Niarada, Olney, Ovando, Paradise, Ravalli, and Whitepine.

### INTENSITY V IN IDAHO:

**Avery.**

**INTENSITY IV:**

Anaconda, Alberton, Bearmouth, Boulder, Canyon Creek, Cascade, Charlo, Clinton, Columbia Falls, Conrad, Craig, Dayton (1 mile northeast of), Drummond, Eureka, Frenchtown, Glacier Park, Great Falls,

Hamilton, Helena, Heron, Huson, Kalispell, Kevin, Libby, Lincoln, Lolo, Lonepine, Lozeau, Marion, Melrose, Missoula, Pablo, Plains, Rexford, Ronan, Round Butte, Saltese, Somers, Stevensville, St. Ignatius, Trout Creek, Whitefish, Whitehall, Winston, and Yakt.

#### INTENSITY IV IN IDAHO:

Bungalo Ranger Station, Calder, Sandypoint, and Wallace.

#### INTENSITY I TO III:

Arlce, Augusta, Belton, Coram, Reichle, Shelby, Thompson Falls, and Wolf Creek.

#### INTENSITY I TO III IN WASHINGTON:

Coulee Dam, Deer Park, Greenacres, Newport, Oakdale, Spangle, and Spokane.

Negative reports were received from 28 places in Montana, 8 places in Idaho, and 16 places in Washington.

September 28: 17:10. Helena, Mont. Weak shock, lasting 1 second.

October 2: 12:10. Helena, Mont. Moderate shock, lasting 1 second.

October 27: 01:17\* and 01:18.\* Boulder City, Nev. Light shock rattled windows and doors. Awakened many. Hanging objects swung during the first shock.

November 7: 14:25.\* Boulder City and Boulder Power Plant, Nev. Felt by many. Rattled windows.

November 16: 02:49.\* Boulder City, Nev. Weak shock.

November 17: 18:15. South-central Utah.

#### INTENSITY VI:

Glenwood.—Motion slow, lasting 20 seconds. Frightened many. Cracked plaster and chimneys. Damage slight.

Richfield.—Motion slow, lasting 20 seconds. Frightened many. Cracked plaster and chimneys. Pictures fell. Distinct rumble heard prior to shock.

#### INTENSITY IV:

Monroe.

November 28: 01:51. Boulder City, Nev. slight Shock.

November 28: 07:38 and 07:44. Helena, Mont. One moderate and one weak shock. No damage.

November 28: 14:39. Butte, Mont. Motion rapid, momentary duration. Rattled windows.

December 1: 20:10.\* Boulder City, Nev. Felt by many. Rattled windows.

December 6: 06:20. Helena, Mont. Light shock, lasting 1 second.

December 17: 19:13.\* Boulder City, Nev. Slight shock felt.

### CALIFORNIA AND WESTERN NEVADA

(105TH MERIDIAN OR PACIFIC WAR TIME)

NOTE.—All places are in California unless otherwise stated. The bulletin of the Seismological Society of America is referred to as the SSA Bulletin.

January 7: 15:26.\* San Benito County, P. Felt over an area of approximately 13,000 square miles in west-central California. Maximum intensity VI. Outer limits of the felt area included San Rafael, southeasterly through La Grange to Yosemite National Park, southwesterly to San Ardo, thence along the coast from Big Sur to San Francisco. Strong motion records were obtained from the two accelerographs at San Jose and from the Weed instrument at Hollister.

#### INTENSITY VI:

Hollister.—Quite severe swaying of buildings and trees. Cracked plaster and chimneys. Displaced goods on store shelves. Pendulum clocks stopped. Frightened many.

Paicines.—Motion rapid, lasting 10 seconds. Frightened many. Overturned cans. Books and pictures fell.

San Benito.—Motion rapid, lasting 1 minute. Felt by all. Shifted small objects. Knickknacks fell.

#### INTENSITY V:

Carmel, Los Banos, Monterey, Moss Landing, and Snelling.

#### INTENSITY IV:

Ahwahee, Ben Lomond, Big Sur, Chualar Canyon, Cupertino, El Nido, Firebaugh, Gilroy, Greenfield, Idria, Irvington, King City, La Grange, Los Gatos, Livingston, Mendota, Merced, Newman, Pacific Grove, Salinas, San Ardo, San Francisco, San Gregorio, San Jose, San Juan Bautista, San Lucas, San Martin, Santa Cruz, and Soledad.

#### INTENSITY I TO III:

Davenport, La Honda, Le Grand, Livermore, Mount Hamilton, Oakland, San Rafael, Saratoga, Seaside, Tranquillity, and Yosemite National Park.

Negative reports were received from 48 places.

**January 7: 17:24.** Hollister. Slight shock felt by several.

**January 7: 19:30.** Hollister. Slight shock.

**January 8: 03:22.** Hollister. Felt by several. Awakened many in community. Recorded at Tinemaha.]

**January 10: 11:34.** Upper Mattole. Felt over an area of about 400 square miles along the coastal region of northern California, from Fields Landing south to Briceland. Maximum intensity V.

A strong motion record was obtained on the accelerograph in Ferndale.

#### INTENSITY IV:

Briceland, Carlotta, Ettersburg, Ferndale, Fields Landing, Fortuna, Petrolia, and Scotia.

Negative reports were received from 4 places.

**January 18: 22:10:44.6.\*** Epicenter  $33^{\circ}56.5'$  north,  $118^{\circ}19.5'$  west, P. Inglewood Fault, 2 miles southeast of Inglewood. Felt over a very small area in southern California. Maximum intensity V reported from Los Angeles where small objects were shifted and windows rattled.

#### INTENSITY IV:

Beverly Hills, Culver City, Inglewood, and Long Beach.

Negative reports were received from 11 places.

**January 24: 05:00.** Sierra City. Felt by several. Awakened many in community. Recorded at Tinemaha.

**January 25: 21:23:56.\*** Epicenter  $34^{\circ}12'$  north,  $117^{\circ}09'$  west, P. Near Lake Arrowhead. Intensity V. Buildings creaked. Rumbling subterranean sounds heard before and during shock. Felt slightly at Riverside.

**January 30: 02:38:57.\*** Epicenter about  $33^{\circ}13'$  north,  $116^{\circ}17'$  west, P. West-central section of Borego Valley. Felt by many. Rattled windows. Moderately loud rumbling subterranean sounds heard before and after shock. Pendulum clock with pendulum swinging north-south stopped.

**January 30: 21:48:35\* and 21:53:28.\*** Epicenter about  $35^{\circ}19'$  north,  $117^{\circ}55'$  west, P. Near Cantil. Motion rapid, lasting a few seconds. Felt by several in community. Rattled windows slightly. Table lamps wobbled. Second shock was stronger. Sounds preceded each shock.

**February 5: 07:43:42.\*** Epicenter about  $33^{\circ}57'$  north,  $118^{\circ}21'$  west, P. Inglewood. Felt by many in community. Frightened few. Rattled windows. Also felt in southeastern and southwestern portions of Los Angeles.

**February 6: 15:56:11.\*** Epicenter  $33^{\circ}57'$  north,  $118^{\circ}21'$  west, P. Inglewood. Felt by many in home and community. No damage other than shattered dishes or slight cracks in house walls. The shock was also felt at Beverly Hills, Compton, Culver City, El Segundo, and Manhattan Beach.

Negative reports were received from 22 places.

**February 7: 02:11:47.\*** Epicenter  $33^{\circ}57'$  north,  $118^{\circ}21'$  west, P. Inglewood. Slight earth shocks along Inglewood Fault line. Felt in Southgate, Inglewood, Hawthorne, Palms, and Los Angeles areas.

**February 17: 13:09:36.\*** Epicenter  $33^{\circ}41'$  north,  $117^{\circ}56'$  west, P. Near Costa Mesa. Felt slightly at Balboa.

**February 19: 16:25.** Meyers. Light shock, lasting 2 seconds. Felt by several. Walls creaked.

**February 22: 11:58.** Gabbs, Nev. Shock felt like truck running into brick wall. Felt all over mine area on rock and in town on alluvium.

**February 23: 04:59:41.\*** Epicenter  $33^{\circ}45'$  north,  $116^{\circ}49'$  west, P. San Jacinto Fault, near Hemet. Sharp jolt preceded by noise. Houses creaked. Many awakened.

**March 14: 16:30.** Watsonville. "A sharp earthquake was felt at 4:30 p.m., P.W.T., on March 14, at Watsonville. It was felt by most residents of the area. No damage was reported." (SSA Bulletin, April 1945.)

**March 20: 14:55:07.\*** Epicenter about  $34^{\circ}15'$  north,  $116^{\circ}10'$  west, P. Mojave Desert, northwest of Twentynine Palms. Felt slightly at Anza, Idyllwild, Ludlow, San Diego, and Twentynine Palms.

Negative reports were received from 29 places.

**March 27: 11:41:52.\*** Epicenter  $34^{\circ}12'$  north,  $116^{\circ}54'$  west, P. Near Big Bear Lake. Felt by all at Pawnskin. Buildings creaked and rattled.

**April 1: 16:43:42.\*** Epicenter about  $34^{\circ}00'$  north,  $120^{\circ}01'$  west, P. Santa Rosa Island. Felt over an area of approximately 1,000 square miles along coastal area of southern California, from Santa Maria south through Santa Barbara and Ventura, to Simi. Maximum intensity IV.

A strong motion record was obtained on the accelerograph in Santa Barbara.

#### INTENSITY IV:

Carpinteria, Gaviota, Los Alamos, Santa Barbara, Santa Maria, Santa Inez, Summerland, and Ventura.

#### INTENSITY I TO III:

Fillmore, Los Olivos, and Simi.

Negative reports were received from 15 places.

**April 6: 08:46:45.\*** Epicenter about  $34^{\circ}00'$  north,  $116^{\circ}46'$  west, P. San Andreas Fault, near Cabazon. Felt by many in Idyllwild. Rattled windows and doors. Trees and bushes shaken slightly.

**April 17: 21:58:02.\*** Epicenter 34°26' north, 116°59' west, P. Lucerne Valley. Intensity V at Fawnskin. Felt by all. Houses creaked. Felt slightly at San Bernardino.

**April 19: 22:36:09.6.\*** Paradise, BC. Felt over an area of approximately 500 square miles in north-central California, from Hamilton City, northeast to Storrie, and thence southwest to Las Plumas. Maximum intensity VI.

#### INTENSITY VI:

*Paradise.*—Many awakened. Water pipes broken. No serious damage.

#### INTENSITY IV:

Las Plumas, Storrie, and northeast section of Butte county.

#### INTENSITY I TO III:

Northeast section of Glenn county.

Negative reports were received from 12 places.

**April 24: 14:23:14.\*** Probable epicenter near Crumbaugh Lake, BC. Felt by many in Mineral.

**May 1: 23:30.** San Jose. "At 11:30 p.m., P.W.T., a shock was felt in some sections of San Jose and Santa Clara." (SSA Bulletin, July 1945.)

**May 2: 12:47.9.\*** Epicenter 41.3° north, 122.5° west, P. Near Scott Mountain. Felt over an area of about 3,500 square miles in northwestern California. Maximum intensity VI.

Strong motion records were obtained on the accelerograph and displacement meter in Eureka.

#### INTENSITY VI:

*Etna.*—Felt by many. Cracked plaster.

*Burnt Ranch.*—First shock very slight, lasting 1 second; second shock quite heavy, lasting 2 seconds. Rattled windows and stopped clocks. Shook things out of cupboards and off dressers.

#### INTENSITY V:

Callahan, Clear Creek, Eureka, Hyampom, Salyer, Weaverville, and Weitchpec.

#### INTENSITY IV:

Bayles, Cecilville, Dunsmuir, Fort Jones, Gazelle, Hornbrook, Lewiston, McCloud, Miranda, Orleans, Redding, Somes Bar, Trinity Center, Weed, and Yreka.

#### INTENSITY I TO III:

Happy Camp and Round Mountain.

Negative reports were received from 14 places.

**May 8: 11:08:46.\*** Epicenter about 37°30' north, 118°34' west, P. Northern Owens Valley. Intensity V in Owens River Gorge, about 20 miles from Bishop. Felt by all. Rattled windows and shifted small objects.

**May 17: 02:45.** Kern County. Felt by two. Damage slight.

**May 17: 08:06.\*** Hollister, BC. Felt over an area of approximately 6,000 square miles. Maximum intensity VI. Considerable damage was done to glassware, drug supplies, liquors, and grocery store merchandise. Slight cracking and fall of plaster reported; several windows broken.

Strong motion records were obtained from the Weed instrument at Hollister; from two accelerographs and one displacement meter in the Southern Pacific Building in San Francisco; and from three Weed instruments in the Shell Building in San Francisco.

#### INTENSITY VI:

*Hollister.*—Disturbed objects observed by many. Visible swaying of buildings and trees. Slight damage to buildings. Cracked plaster and brick chimneys. Pictures and light fixtures swung. Moderately loud subterranean sounds heard during shock.

#### INTENSITY V:

Carmel, Gilroy, San Jose, and Tres Pinos.

#### INTENSITY IV:

Aromas, Big Sur, Chualar, Cupertino, Boulder Creek, Daly City, El Nido, Gonzales, Gustine, Hayward, Irvington, King City, La Honda, Lonoak, Los Banos, Los Gatos, Merced, Morgan Hill, Moss Landing, Mount Hermon, Pacific Grove, Redwood City, Robles del Rio, San Gregorio, San Juan Bautista, San Lucas, Soledad, Sunnyvale, and Watsonville.

#### INTENSITY I TO III:

Castroville, Davenport, Greenfield, Holy City, Newman, Salinas, San Ardo, San Francisco, Soquel, and Stockton.

Negative reports were received from 35 places.

**May 18: 11:10.** Friant. Shock felt by two. Buildings rattled and creaked.

**May 19: 08:07.\*** Epicenter 40.6° north, 126.4° west, W. Off northern California coast. Felt over an area of approximately 1,500 square miles extending through most of the coastal towns from Crescent City south to Fort Bragg and Willits. A maximum intensity of V was reported from Upper Mattole, where small objects were reported to have shifted.



Strong motion records were obtained on the instruments located at Ferndale and Eureka.

#### INTENSITY IV:

Arcata, Blue Lake, Carlotta, Eureka, Ferndale, Fields Landing, Klamath, Orick, Piercy, and Scotia.

#### INTENSITY I TO III:

Briceland, Fort Bragg, Kneeland, Smith River, and Willits.

Negative reports were received from 17 places.

**June 14: 15:57.9.\*** Epicenter about  $36.9^{\circ}$  north,  $120.9^{\circ}$  west, P. South of Los Banos. Felt by many in Hollister. Rattled loose objects. Hanging objects swung.

**June 21: 14:58.** Hollister. "An earthquake of moderate intensity was felt in Hollister at 2:58 p.m., P.W.T. No damage was reported." (SSA Bulletin, October 1945.)

**July 7: 16:55.\*** Central section of El Dorado County. Four shocks felt at about 3-second intervals. Buildings creaked. Faint subterranean sounds heard by several before shocks.

**July 9: 13:25.** Watsonville. Slight shock.

**July 11: 05:55.** Watsonville. Sharp shock awakened hundreds of Pajaro Valley residents. Also felt slightly at Big Sur.

**July 11: 09:13.\*** Epicenter  $35^{\circ}40'$  north,  $121^{\circ}15'$  west, P. Near San Simeon. Felt slightly at Cambria.

**July 21: 12:19.** Berkeley. "A slight earthquake was felt by residents of the Berkeley-Albany-Richmond area at 12:19 a.m., P.W.T. (SSA Bulletin, October 1945.)

**July 24: 17:08:11.\*** Epicenter  $34^{\circ}54'$  north,  $118^{\circ}57'$  west, P. Near Tejon Pass. Felt slightly at Salt Creek Canyon.

**July 27: 18:33.8.\*** Epicenter  $34.7^{\circ}$  north,  $120.1^{\circ}$  west, P. East of Santa Maria. Felt by many in Los Alamos. Houses creaked. Loud bumping sound heard.

**August 1: 10:55.** Banning. "An earthquake with a 'waving' motion was felt in Banning at 10:55 a.m., P.W.T. It was strong enough to swing hanging lamps, pictures, and other loose articles." (SSA Bulletin, October 1945.)

**August 3: 01:41.** Long Beach. Motion rapid. Felt by observer in home. Walls creaked.

**August 4: 09:31.** Near Bakersfield. Motion rapid, lasting 1 second. Windows rattled.

**August 15: 10:56:24.\*** Epicenter  $33^{\circ}13'$  north,  $116^{\circ}08'$  west, P. San Jacinto Fault zone, near Borego Valley. Felt over an area of approximately 15,000 square miles. Maximum intensity VI. Reports from an intensive questionnaire coverage and field investigation indicate there was no structural damage.

Strong motion records were obtained from the instruments at El Centro and San Diego, from three accelerographs in the Hollywood Storage Company, and from two accelerographs and one displacement meter in the Subway Terminal Building in Los Angeles.

#### INTENSITY VI:

*Borego Valley.*—Felt by all; frightened few. Rattled windows, doors, and dishes. Hanging objects swung. Trees and bushes shaken strongly.

*Fall Brook.*—Felt by many; few alarmed. Cracked plaster slightly.

*Mecca.*—Felt by all in community; frightened few. Hanging objects swung. Trees and bushes shaken moderately. Overturned small objects.

*Fullerton.*—Felt by many. Disturbed objects observed by many. Some damage to cables and power lines.

*San Jacinto.*—Felt by all in community; frightened few. Rattled windows, doors, and dishes. Houses creaked. Trees and bushes shaken moderately. Cracked plaster.

#### INTENSITY V:

Brawley, Coachella, Dulzura, El Centro, Holtville, Imperial, Lake Arrowhead, Palm Springs, and San Diego.

#### INTENSITY IV:

Artesia, Baker, Calipatria, Campo, Del Mar, Descanso, Escondido, Fawnskin, Indio, Jacumba, Jamul, Lakeside, Pala, Palomar Mountain, Plaster City, Perris, San Juan Capistrano, Santa Ysabel, Thermal, Thousand Palms, Twentynine Palms, Victorville, Westminster, and Wildomar.

#### INTENSITY I TO III:

Adelanto, Anza, Beaumont, Cabazon, Corona, Covina, Desert Center, El Toro, Hynes, Laguna Beach, La Habra, Los Angeles, Mount Laguna, Newport Beach, Niland, Oceanside, Palmdale, Riverside, and Santa Ana.

Negative reports were received from 43 places.

**August 24: 13:27.** Lone Pine. "An earthquake 'distinctly rough' in character set windows rattling at 1:27 p.m., P.W.T. No damage was reported throughout Inyo and Mono counties, but mine officials in upper Pine Creek said that it was accompanied by a roar that 'drowned out' blasting going on in the canyon." (SSA Bulletin, October 1945).

**August 27: 02:13.\*** San Jose. Felt over an area of approximately 13,000 square miles. Maximum intensity VI.

Strong motion records were obtained from the two accelerographs at the Bank of America Building in San Jose.

## INTENSITY VI:

*Mount Hamilton.*—Awakened all. Walls creaked. Pendulum clocks stopped. Overturned small objects.

*San Jose.*—Awakened all. Cracked plaster. One chimney was reported shaken loose.

## INTENSITY V:

Alma, Alviso, Boulder Creek, Hollister, San Francisco, and San Martin.

## INTENSITY IV:

Albany, Agnew, Belmont, Ben Lomond, Berkeley, Big Sur, Burlingame, Carmel, Castroville, Crows Landing, Cupertino, Daly City, Danville, Davenport, Decoto, Felton, Gilroy, Gustine, Holy City, Huntington Lake, Irvington, Lafayette, Livingston, Los Altos, Los Gatos, Madrone, Millbrae, Mill Valley, Modesto, Montara, Monterey, Moss Landing, Mountain View, Mount Eden, Newark, Niles, Novato, Oakdale, Pacific Grove, Palo Alto, Patterson, Petaluma, Pinole, Pleasanton, Redwood City, Richmond, Rockaway Beach, Ross, San Bruno, San Carlos, San Gregorio, St. Helena, San Juan Bautista, San Leandro, San Rafael, Santa Cruz, Sharp Park, Soquel, South San Francisco, Stinson Beach, Sunol, Sunnyvale, Vallejo, and Waterford.

## INTENSITY I TO III:

Bolinas, Hayward, Kentfield, Livermore, Lodi, Manteca, Moss Beach, Pinecrest, Salinas, South Dos Palos, Stockton, Walnut Creek, and Yosemite Valley.

Negative reports were received from 45 places.

**August 28:** 20:30 and 20:45. Mineral. Felt by several in home and community. Rattled dishes. Hanging objects swung.

**August 29:** 19:30. Grass Valley. "At 7:30 p.m., P.W.T., a light earthquake was felt in Grass Valley and Nevada City." (SSA Bulletin, October 1945.)

**September 7:** 04:34:20.\* Epicenter 35°50' north, 120°42' west, P. Near Bradley. Felt sharply at Cambria, Parkfield, Paso Robles, and San Miguel. No damage.

**September 7:** 08:34:24.\* Epicenter 33°58' north, 116°48' west, P. San Andreas Fault zone, north of Banning. Felt with intensity IV at Beaumont, Cabazon, Hemet, and Romoland. Slightly felt at Riverside.

A strong motion record was obtained from the Weed instrument in San Bernardino.

**September 8:** 03:20 and 03:30. Summit Lake Camp Ground (Lassen Volcanic National Park). Felt by several campers.

**September 17:** 16:22. Dunlap. Felt by two. Rattled windows and doors. Houses creaked.

**September 26:** 10:20. Near Hollister. Felt by observer in home. Rattled windows and doors. Houses creaked.

**September 28:** 11:25. San Diego. Felt by many. Rattled windows and doors. Houses creaked.

**September 29:** 21:30. Guernsey Camp (Lassen Volcanic National Park). Felt in house trailer.

**October 1:** 09:30. Fairfield. Felt by several in community.

**October 15:** 21:11.\* Mineral. Felt by several. Accompanied by rumbling noise.

**October 18:** 21:07.\* Mineral. Felt by several. Rattled windows.

**October 25:** 08:45.\* Mineral. Felt by several in community. Walls creaked. Recorded on seismograph at Boulder City along with several minor disturbances.

**October 31:** 12:41:52.\* Epicenter 34°20' north, 117°07' west, P. Northeast of Lake Arrowhead. Felt by many in Fawnskin. Houses creaked.

**November 3:** 07:50:20.\* Epicenter 36.7° north, 121.1° west, P. Southeast of Tres Pinos. Felt quite strongly near Hollister and near Soledad. Rattled windows and doors. Buildings creaked. Thunderous and prolonged subterranean sounds heard by many.

**November 4:** 18:42:27.\* Epicenter 33°57' north, 117°18' west, P. Southeast of Riverside. Felt by observer. Rattled windows slightly.

**November 8:** 03:19:27.\* Epicenter 33°57' north, 117°18' west, P. Southeast of Riverside. Two slight shocks felt by many. Rattled windows. Slight rumbling heard.

**November 8:** 12:07.\* Madrone. Felt by many. Rattled windows and doors. Knickknacks fell. Damage slight. Recorded on seismograph at Boulder City.

## INTENSITY IV:

Pescadero, San Martin, Soquel, and South San Francisco.

## INTENSITY I TO III:

San Francisco and San Jose.

Negative reports were received from 9 places.

**November 12:** 17:13.\* Pleasanton. Sharp shock rattled windows and buildings. Felt in Livermore and less perceptibly in Hayward.

**November 14:** 06:43:30.\* Epicenter 35°24' north, 118°55' west, P. East of Bakersfield. Felt slightly at Bakersfield, and in Kern Canyon. Rattled windows and caused lighting fixtures to swing.

**November 21:** 15:00 (about). Santa Rosa. "An 'apparent light earthquake' shock" was felt by local

residents a few minutes after 3 o'clock, P.S.T. Buildings quivered and chandeliers rocked, but there was no damage." (SSA Bulletin, January 1946.)

**December 1:** 19:36:12.\* Epicenter 33°42' north, 118°28' west, P. Off Point Vicente. Felt slightly at Compton.

**December 2:** 20:29:22.\* Near Orinda. Ten-second shock felt by several. Slight plaster cracks. Thunderous subterranean sounds heard. Also felt at Berkeley, Oakland, and San Francisco.

**December 4:** 13:07.\* Near Mineral. Felt at Bucks Creek Powerhouse and Mineral. Rattled windows and doors. Recorded on seismograph at Boulder City, Nevada.

**December 13:** 19:17. Holy City. Felt by several in home. Houses creaked.

**December 19:** 08:10. Moss Beach. Two slight shocks, with interval of few seconds. Rattled doors slightly.

#### WASHINGTON AND OREGON

(105TH MERIDIAN OR PACIFIC WAR TIME)

**January 3:** 19:34:48.7.\* Entiat, Wash. Felt by all. Rattled dishes and doors.

**January 27:** 22:06:08.1\* Near Stanwood, Wash. Felt by many. Some plaster fell. Intensity IV at Granite Falls and Snohomish.

**February 13:** 20:02:9.1.\* See Western Mountain Region.

**February 27:** 04:00 (about). Entiat and Winthrop, Wash. Felt slightly.

**March 2:** 00:54:59.3\* Near Entiat, Wash. Motion rapid, lasting 4 seconds. Awakened many in community. Also felt at Chelan and Waterville.

**April 29:** 13:16:17.\* Epicenter about 47.4° north, 121.7° west, BC. Ten miles southeast of North Bend, Wash. This earthquake was felt over the greater portion of Washington, a small section of western Idaho, and in the vicinity of Portland, Ore. See map. Affected area covered approximately 50,000 square miles. Maximum intensity VII.

The shock was the most intense in this region since the quake of November 12, 1939. The 2-minute shaking was accompanied by a noise as of a muffled explosion. Although no damage was caused, the tre-

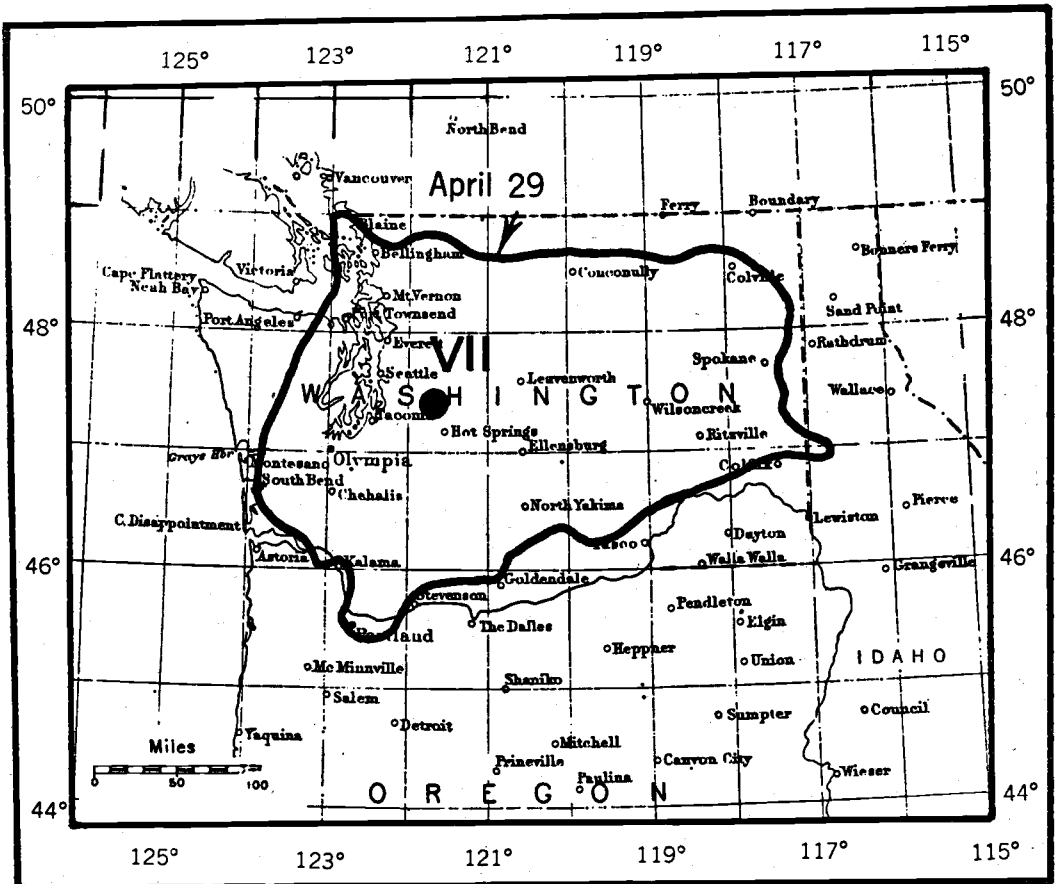


FIGURE 5.—Area affected by the earthquake of April 29, 1945.

mors were powerful enough to dislodge bricks from a dozen or more homes in the Cle Elum area. Only one minor casualty resulted; a boy at Roslyn was struck on the head by a falling brick.

Seismologists determined the shock originated in the Mount Si Fault, the old crack in the earth's crust that extends from North Bend almost due north along the west face of Mount Si to the town of Sultan. At the Mount Si Ranger Station, near North Bend, the earth buckled and heaved and tons of rock and earth cascaded down the 4,000 foot cliffs. Many local residents called the newspapers seeking information about the quake.

#### INTENSITY VII:

*North Bend.*—Felt by all in community. Trees and bushes shaken strongly. Cracked plaster and chimneys. Broke dishes, windows, and town water main. Damage was mostly to chimneys. Caused large rock slides on west face of Mount Si. Moderately loud to terrific muffled explosion-like sounds heard.

*Palmer.*—Felt by all. Trees and bushes shaken strongly. Cracked plaster and ground. Overturned vases and small objects. Damage slight.

*Stampede Pass.*—Buildings rocked back and forth. Slight damage as seams and joints spread in an east-west direction. Moderately loud, bumping and scraping subterranean sounds heard.

#### INTENSITY VI:

*Baldi.*—Felt by all. Rattled windows. Houses creaked. Spilled water from indoor containers in a northerly direction. Trees and bushes shaken moderately.

*Cedar Falls.*—Motion bumping, with abrupt onset. Felt by all. Small rock slides across Cedar River. Muffled subterranean sounds heard.

*Cle Elum.*—Felt by all in community. Frightened many. Cracked windows and chimneys. Hanging objects swung. Pendulum clocks stopped. Trees and bushes shaken moderately. Damage slight.

*Ellensburg.*—Felt by many in community. Rattled dishes and cracked plaster.

*Elma.*—Felt by several. Buildings creaked. Two north-south walls were cracked, cracks running south to north.

*Greenwater.*—Felt by several. Bumping subterranean sounds heard by several before shock. Damage to a few old brick chimneys. Pictures displaced on east-west walls. Pendulum clocks stopped.

*Hyak.*—Two shocks about 10 seconds apart. Felt by all in community. Slight visible swaying of buildings and trees. Articles fell from shelves.

*Index.*—Felt by many. Small landslides occurred. Bumping subterranean sounds heard by many before shock. Visible swaying of buildings and trees. Cracked plaster in a few instances.

*Leavenworth.*—Felt by all. Buildings creaked. Rumbling heard at time of shock. Visible swaying of buildings and trees. Slight damage to buildings. Some chimneys had top layers of bricks knocked to ground.

*Preston.*—Rapid undulating motion, abrupt onset, accompanied by loud rumbling noise. Felt by all. Overturned small objects. Spilled water from indoor containers. Trees and bushes shaken moderately.

*Skykomish.*—Felt by several. Buildings creaked. Moderately loud rumbling subterranean sounds heard before shock. Pictures displaced. Wires on electric light poles swayed vigorously up and down.

*Snoqualmie.*—Felt by many. Visible swaying of trees and light poles. Plastered ceilings cracked around edges; chimneys and crockery damaged. Display goods on shelves fell to floor. Roaring subterranean sounds heard by many before shock.

#### INTENSITY V:

Anacortes, Ardenvoir, Beverly, Coupeville, Chelan, Chewalah, Darrington, Entiat, Enumclaw, Everett, Gifford, Coulee Dam, Lakebay, Lake Cle Elum, Landsburg, Mount Vernon, Olga, Orondo, Orting, Packwood, Quilcene, Sultan, Scenic, Tacoma, Waterville, Winthrop, and Yakima.

#### INTENSITY IV:

Ariel, Bothell, Bremerton, Bumping Lake, Camano Island, Centralia, Cheney, Clear Lake, Concrete, Connell, Deer Park, Des Moines, Easton, Eastsound, Elbe, Ephrata, Gig Harbor, Hartline, Hoodsport, Holden, Issaquah, Kahlotus, Kelso, Kirkland, Klickitat, La Conner, Lake Wenatchee, Langley, Lopez Island, Lucerne, Mazama, Mineral, Monotor, Monroe, Mount Vernon, Naches, Nespelam, Odessa, Okanogan, Olympia, Omak, Paradise, Point Roberts, Port Gamble, Port Townsend, Poulsbo, Prosser, Puyallup, Rockport, Rosalia, Sedro-Wooley, Shelton, South Bend, Spanaway, Spokane, Stevens Pass, Tieton Ranger Station, Twisp, Wenatchee, Wellpinit, and Wilkeson.

#### INTENSITY IV IN OREGON:

Fossil and Portland.

#### INTENSITY I TO III:

Arlington, Bellingham, Camas, Conconully, Coulee City, Davenport, Evans, Glacier, Granite Falls, Lind (six miles north of), Newport, Othello, Roche Harbor, South Bend, Springdale, Wilson Creek, and Yacolt.

#### INTENSITY I TO III IN IDAHO:

Potlatch.

Negative reports were received from 59 places in Washington, and from 23 places in Oregon.

**April 30: 00:45:45.\*** Aftershock of preceding earthquake. Intensity VI at North Bend, Wash. Many were awakened, houses creaked, and vases overturned. Damage slight. Felt also at Enumclaw, Longmire, and Orting.

**May 1: 12:46:04.\*** Aftershock of April 29 earthquake. Felt over considerable area in west-central Washington. Maximum intensity V.

**INTENSITY V:**

Cle Elum, Stampede Pass, and Waterville.

**INTENSITY IV:**

Bumping Lake, Coulee Dam, Lake Wenatchee, Leavenworth, Longmire, Palmer, Sultan, and Wilkeson.

**May 1: 21:01:43.\*** Aftershock of April 29 earthquake. Felt at North Bend, Wash.

**May 3: 21:00 (about).** North Bend, Wash. Felt by three people.

**June 15: 15:25:02.\*** Epicenter probably in the Strait of Georgia near the international boundary. Intensity V at Point Roberts where trees and bushes were shaken strongly. Houses creaked and small objects were shifted. Intensity IV at Bellingham, Concrete, Friday Harbor, La Conner, Marietta, and Richardson.

Negative reports were received from 27 places.

**September 22: 19:40.** Walla Walla and College Place, Wash. Brief series of shocks with rapid onset. Felt strongly in Veterans Hospital section. Moderately loud rumbling similar to muffled explosion preceded shocks. Affected area extended as far as Blalock Lake.

**September 23: 02:57.8.\*** See Western Mountain Region.

**November 11: 21:05.** Epicenter probably near San Juan Island, Wash. Felt generally without damage at Chimacum, Coupeville, Double Bluff, and Port Townsend. Slight plaster cracks reported at Port Townsend.

Negative reports were received from 10 places.

**November 23: 16:30.** Packwood, Wash. Slight shock awakened many. Rattled windows, doors, and dishes. Hanging objects swung.

Negative reports were received from 5 places.

**ALASKA**

(105TH MERIDIAN TIME)

**January 16: 07:54.** Anchorage. Light shock felt by several.

**January 21: 04:04.** Slaters Camp, near Fairbanks. Sharp shock felt by many. Awakened many. Buildings creaked.

**February 8: 07:47.** Anchorage. Slight shock felt by several.

**February 10: 12:40.** Anchorage. Slight shock felt by several.

**March 5: 06:19.** Nome. Two slight shocks.

**April 11: 21:40.** Anchorage. Light tremor felt by a few people.

**June 3: 03:07.** Slaters Camp, near Fairbanks. Light tremor awakened a few people.

**September 17: 17:55.** Adak Island. Light shock accompanied by rumbling. No damage.

**October 10: 02:00.** Anchorage. Very light shock.

**October 15: 00:03 and 03:06.** Juneau. Two sharp shocks generally observed. No damage.

**November 16: 10:05.** Juneau. Two sharp shocks felt by many. Felt slightly at Skagway.

**November 17: 14:20.** Juneau. Light shock felt by several.

**December 1: 14:37.** Anchorage. Sharp bump felt by several.

**HAWAIIAN ISLANDS**

(HAWAIIAN STANDARD TIME)

**January 24: 10:38.** Ten to fifteen miles below east rim of Kilauea. Moderate shock widely felt over southeast half of island of Hawaii.

**March 4: 00:00.** Southwest rift of Mauna Loa. Moderate shock widely felt on island of Hawaii. Stopped clocks in South Kona.

**May 19: 01:48.** East slope of Mauna Loa. Felt generally on Hawaii and slightly on Oahu.

**July 13: 02:15.** Along Puna coast southwest of Kalapana. Widely felt in eastern half of island of Hawaii.

**August 9: 10:46.** East slope of Mauna Loa above Kapapala. Felt generally in southwest part of island of Hawaii.

**September 19: 05:33.** Between Mauna Loa and Mauna Kea. Felt over entire island of Hawaii.

**PUERTO RICO**

(60TH MERIDIAN TIME)

No earthquakes were reported in Puerto Rico during the year 1945.

**PANAMA CANAL ZONE**

(60TH MERIDIAN TIME)

**June 3: 09:05.6.\*** Epicenter near  $8.3^{\circ}$  north,  $82.6^{\circ}$  west, W. Generally felt in Chiriqui Province with minor damage at David and Puerto Armuelles. Felt by many in Canal Zone. Some were awakened.

**July 5: 08:03.** Santa Fe, Republic of Panama, about 105 miles west of Balboa Heights. Reports indicate the town was strongly shaken and that panic spread among the residents because of a tremendous roar that preceded the shock. No casualties. Also felt in Canal Zone.

**September 17: 00:15.** Pacific side of Canal Zone. Felt by many. No damage.

**December 1: 17:33.** Gatun. Slight shock felt by a few.

**MISCELLANEOUS ACTIVITIES****GEODETIC WORK OF SEISMOLOGICAL INTEREST**

In June 1945 the first-order network of leveling in and around Los Angeles, California, was releveled to detect possible earth movement, particularly in the vicinity of Terminal Island. The surveys extended from Santa Monica to San Juan Capistrano along the coast and inland from El Toro to Burbank through Alhambra, Brea, and Santa Ana. The total network comprised 476 miles of leveling, of which 256 miles were completed in 1945. This releveing has been adjusted and the results are available for distribution.

**TIDAL DISTURBANCES OF SEISMIC ORIGIN**

No seismic seawaves were recorded during the calendar year 1945.

## SEISMOLOGICAL OBSERVATORY RESULTS

The Coast and Geodetic Survey publishes the results of its teleseismic stations and cooperating stations quarterly in mimeographed form. In these reports 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. These reports will be furnished upon request made to the Director of the Coast and Geodetic Survey.

Instrumental results are published for the following observatories:

Balboa Heights, Canal Zone. (The Panama Canal)	Logan, Utah. (Utah State Agricultural College)
Bermuda. (Meteorological Station and International Union Geodesy and Geophysics.)	Montezuma, Chile. (Smithsonian Institution)
Boulder City, Nev. (Bureau of Reclamation, National Park Service)	New Kensington, Pa. (Private station)
Bozeman, Mont. (Montana State College)	Overton, Nev. (Bureau of Reclamation, National Park Service)
Burlington, Vt. (University of Vermont)	Philadelphia, Pa. (The Franklin Institute)
Butte, Mont. (Montana School of Mines)	Pierce Ferry, Nev. (Bureau of Reclamation, National Park Service)
Chicago, Ill. (University of Chicago and U. S. Weather Bureau)	Rapid City, S. D. (South Dakota State School of Mines)
College, Alaska. (University of Alaska)	Salt Lake City, Utah. (University of Utah)
Columbia, S. C. (University of South Carolina)	San Juan, P. R.
Grand Coulee, Wash. (Bureau of Reclamation, National Park Service)	Seattle, Wash. (University of Washington)
Honolulu, T. H. (University of Hawaii)	Shasta, Calif. (Bureau of Reclamation, National Park Service)
Huacayo, Peru. (Carnegie Institution of Washington)	Sitka, Alaska.
Lincoln, Nebr. (Nebraska Wesleyan University)	Tucson, Ariz.
	Ukiah, Calif. (International Latitude Observatory)

San Juan, Sitka, Tucson, and Ukiah are Coast and Geodetic Survey stations.

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

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

Boulder City, Grand Coulee, Overton, Pierce Ferry, and Shasta are cooperative stations of the Lake Mead Seismological Survey.

All readings were made or revised at the Washington Office except those for Balboa Heights and Bureau of Reclamation stations.

The provisional epicenter results for 1945 were not ready when this publication went to press. Those for the year 1944 are listed in table 1. Those for the stronger shocks of 1945 are listed in table 2.

Table 1.—Summary of instrumental epicenters for 1944.

NOTE.—The provisional epicenters in this table are primarily intended to cover earthquakes recorded in the United States. Some of them have been determined by the Coast and Geodetic Survey, and some have been taken from the reports of other organizations and stations. In many cases, as with Pasadena epicenters for instance, the original coordinates are known to the nearest minute but have been changed in this table to the nearest one-tenth degree. The epicenters reported by nearby stations are usually given preference. More detailed information will be found in the Seismological Bulletins (formerly Seismograph Reports) of the Coast and Geodetic Survey, and in the bulletins of other organizations and stations.

1944	Origin time G. C. T.	Region and focal depth	Coordinates of provisional epicenter	
			Latitude	Longitude
	<i>h. m.</i>			
Jan. 3.....	10 19.3	North of Gulf of Venezuela.....	13 N.	71 W.
Jan. 4.....	0 57.9	.....do.....	13 N.	71 W.
Jan. 5.....	10 59.1	.....do.....	13 N.	71 W.
Jan. 5.....	21 12.7	Sumatra, near southwest coast.....	3 S.	102 E.
Jan. 6.....	16 44.0	Peru, west coast.....	15 S.	76 W.
Jan. 7.....	2 49.3	Eastern New Guinea. Slightly deeper than 100 km.....	4.5 S.	143 E.
Jan. 10.....	20 09.9	Mexico, near southwest coast. Damage in State of Guerrero. Slight depth.....	17.4 N.	100.9 W.
Jan. 10.....	20 33.6	.....do.....	17.5 N.	100.5 W.
Jan. 12.....	15 02.6	California, off coast of Cape Mendocino.....	40.6 N.	125.1 W.

Table 1.—Summary of instrumental epicenters for 1945—Continued

1944	Origin time G. C. T.	Region and focal depth	Coordinates of provisional epicenter	
			Latitude	Longitude
	<i>h. m.</i>			
Jan. 15.	5 46.1	Mid-Atlantic Ocean.	18 N.	47 W.
Jan. 15.	23 49.5	Argentina, near San Juan. 8,000 killed and \$100,000,000 property and industrial damage. Slight depth.	31.5 S.	68.5 W.
Jan. 16.	2 25.5	California, off coast of Cape Mendocino.	40.6 N.	124.8 W.
Jan. 16.	14 27.7	Nicaragua, off west coast.	11 N.	89 W.
Jan. 20.	2 59.2	Samoa Islands region.	15 S.	174.5 W.
Jan. 29.	2 25.0	Southwestern Alaska. Felt.	63 N.	156.5 W.
Feb. 1.	3 22.5	Turkey, near Gerede. Destructive. 1,000 killed.	41.0 N.	33.0 E.
Feb. 1.	5 16.2	Near Hokkaido, Japan.	41.5 N.	143 E.
Feb. 3.	11 25.3	Colombia. Felt.	6 N.	72 W.
Feb. 3.	12 15.2	Northwestern Canada. Felt.	59.6 N.	135.9 W.
Feb. 3.	14 10.2	Colombia. Felt.	6.5 N.	72 W.
Feb. 4.	15 41.4	California.	33.0 N.	116.0 W.
Feb. 5.	6 13.7	do.	33.0 N.	116.0 W.
Feb. 5.	17 20.0	Near southern Formosa.	23 N.	121 E.
Feb. 5.	20 02.3	Loyalty Islands region.	20.5 S.	168.5 E.
Feb. 6.	3 50.5	Venezuela, near northeast coast.	10 N.	62 W.
Feb. 6.	18 40.8	British Guiana.	6 N.	59 W.
Feb. 15.	5 39.5	North Atlantic Ocean.	51 N.	32 W.
Feb. 15.	15 56.0	South of Puerto Rico.	17 N.	67 W.
Feb. 18.	15 32.0	Gulf of California.	30.5 N.	114.2 W.
Feb. 19.	11 35.9	West of Iceland.	63 N.	25 W.
Feb. 21.	11 28.7	Mexico, off Colima coast.	18.3 N.	105.3 W.
Feb. 23.	12 25.1	Lower Aleutian Islands region.	52.5 N.	179 W.
Feb. 25.	6 51.0	California.	35.1 N.	116.6 W.
Feb. 25.	7 32.6	Alaska, Katzebue Sound.	67 N.	165 W.
Feb. 26.	22 23.6	Alaska, Prince William Sound.	61 N.	147 W.
Feb. 27.	20 14.5	Lower California.	29.2 N.	114.1 W.
Feb. 28.	17 44.1	Alaska, near Fairbanks.	63 N.	147 W.
Feb. 29.	3 41.9	Southeastern Peru. Depth approximately 200 km.	14.3 S.	70.7 W.
Feb. 29.	16 28.1	Indian Ocean.	1.5 N.	77 E.
Mar. 1.	17 16.1	Mindanao, off east coast. Depth approximately 200 km.	8 N.	127 E.
Mar. 6.	14 03.4	Oregon, off coast.	45 N.	129 W.
Mar. 6.	20 09.1	do.	44.7 N.	129.0 W.
Mar. 6.	21 05.9	do.	44.7 N.	129.0 W.
Mar. 6.	22 51.2	do.	45 N.	129 W.
Mar. 6.	23 16.5	do.	45 N.	129 W.
Mar. 7.	6 09.3	do.	44.7 N.	129.0 W.
Mar. 7.	6 45.1	do.	45 N.	129 W.
Mar. 7.	8 21.5	do.	45 N.	129 W.
Mar. 8.	7 54.8	Nevada.	37.6 N.	114.1 W.
Mar. 9.	8 41.9	California.	33.9 N.	115.7 W.
Mar. 9.	16 21.3	Oregon, off coast.	45 N.	129 W.
Mar. 9.	22 03.7	Eastern Turkistan.	44 N.	83 E.
Mar. 9.	22 13.0	do.	44 N.	83 E.
Mar. 10.	1 38.8	Peru, off southwest coast.	16.5 S.	76 W.
Mar. 10.	6 40.0	Hokkaido, Japan, near south coast.	42.5 N.	143.5 E.
Mar. 20.	9 31.0	Southwestern Utah.	37.2 N.	114.0 W.
Mar. 21.	22 09.9	Hokkaido, Japan, near south coast.	42 N.	143 E.
Mar. 22.	0 43.2	Floris Sea. Depth approximately 200 km.	8 S.	124 E.
Mar. 22.	8 09.7	California.	34.0 N.	116.5 W.
Mar. 24.	17 01.9	Costa Rica, near west coast.	9 N.	83.5 E.
Mar. 31.	22 51.9	West of New Guinea.	5.5 S.	136.5 W.
Apr. 1.	9 22.2	South Pacific Ocean.	54.5 S.	129 W.
Apr. 2.	4 40.0	Gulf of California.	27 N.	111 W.
Apr. 3.	17 50.8	Southwest of Tonga Islands.	23 S.	179 W.
Apr. 5.	4 40.6	Northwestern Turkey. Felt.	40.5 N.	31 E.
Apr. 7.	13 32.9	Nicaragua, north of Lake Nicaragua. Depth approximately 100 km.	12.4 N.	85.7 W.
Apr. 12.	15 32.2	California, off coast. Felt.	34.3 N.	119.5 W.
Apr. 13.	6 42.0	Gulf of California.	29 N.	113 W.
Apr. 19.	22 32.0	Pacific Ocean, west of Easter Island.	29 S.	116 W.
Apr. 21.	15 01.4	Colombia, off west coast.	4 N.	84 W.
Apr. 23.	10 57.7	Tonga Islands region. Depth approximately 375 km.	22 S.	177.5 W.
Apr. 26.	1 54.3	North of Netherlands New Guinea. Slight depth.	1 S.	135 E.
Apr. 27.	14 38.2	do.	0.5 S.	134.5 E.
Apr. 27.	19 05.2	do.	0.5 S.	134.5 E.
Apr. 28.	5 50.4	Panama, off south coast.	8 N.	83 W.
May 5.	13 45.6	California.	34.0 N.	116.4 W.
May 6.	13 47.2	do.	34.0 N.	116.4 W.
May 7.	0 13.7	Mid-Atlantic Ocean.	22.5 N.	45.0 W.
May 7.	15 10.1	Northwest of Kodiak Island.	58 N.	153.5 W.
May 9.	14 29.9	Colombia. Felt. Depth approximately 100 km.	3 N.	74.5 W.
May 14.	8 51.6	South of Fiji Islands. Depth approximately 600 km.	23 S.	179.5 E.
May 15.	19 18.1	New Guinea, near north coast.	4 S.	143.5 E.
May 18.	19 54.9	South Pacific Ocean.	48 S.	112 W.
May 19.	0 19.3	East Indies, near New Ireland.	2.7 S.	153.3 E.
May 21.	4 41.9	South America, off northeast coast.	9 N.	43 W.
May 21.	17 07.1	Dominican Republic, near north coast.	19.5 N.	71 W.
May 23.	10 38.5	South of Aleutian Islands.	51.2 N.	170.6 W.
May 24.	1 30.4	Dominican Republic, near north coast.	19.5 N.	71 W.
May 25.	1 08.5	South of Fiji Islands. Slightly deeper than 600 km.	22 S.	179 W.
May 25.	12 58.1	East Indies, near New Ireland.	2.5 S.	152.0 E.
May 29.	2 43.3	South of Panama.	5.2 N.	82.4 W.
June 3.	7 12.2	West Indies, north of Leeward Islands.	20 N.	63 W.
June 3.	15 46.4	Peru, off northwest coast. Slight depth.	8 S.	80 W.



Table 1.—Summary of instrumental epicenter for 1945—Continued

1944	Origin time G. C. T.	Region and focal depth	Coordinates of provisional epicenter	
			Latitude	Longitude
	<i>h. m.</i>		<i>° ' "</i>	<i>° ' "</i>
June 6 . . . . .	3 44.2	Near New Britain . . . . .	5 S.	152 E.
June 6 . . . . .	23 20.0	Peru, off southwest coast . . . . .	15.5 S.	76.5 W.
June 7 . . . . .	6 28.9	South-central Haiti . . . . .	18.5 N.	72 W.
June 7 . . . . .	21 10.9	California. Felt . . . . .	34.2 N.	117.5 W.
June 8 . . . . .	2 38.3	Near border of Peru and Brazil. Slightly deeper than 600 km. . . . .	9.5 S.	73.5 W.
June 9 . . . . .	20 35.0	East of New Guinea . . . . .	4 S.	150 E.
June 10 . . . . .	11 11.8	California. Felt . . . . .	34.0 N.	116.8 W.
June 10 . . . . .	11 15.5	do. . . . .	34.0 N.	116.8 W.
June 11 . . . . .	19 18.9	Ecuador, off west coast . . . . .	0.8 N.	85.8 W.
June 12 . . . . .	10 45.6	California. Felt . . . . .	34.0 N.	116.7 W.
June 12 . . . . .	11 16.6	do. . . . .	34.0 N.	116.7 W.
June 12 . . . . .	11 39.1	California. Felt . . . . .	34.0 N.	116.7 W.
June 12 . . . . .	11 48.8	do. . . . .	34.0 N.	116.7 W.
June 12 . . . . .	13 45.4	California. Felt . . . . .	34.0 N.	116.7 W.
June 12 . . . . .	20 22.9	California. Felt . . . . .	34.0 N.	116.7 W.
June 13 . . . . .	8 27.5	California. Felt . . . . .	34.7 N.	120.5 W.
June 13 . . . . .	8 46.7	do. . . . .	34.7 N.	120.5 W.
June 13 . . . . .	9 55.1	Aleutian Islands region. . . . .	51 N.	171 W.
June 13 . . . . .	11 07.4	California. Felt . . . . .	34.7 N.	120.5 W.
June 13 . . . . .	17 30.2	California. Felt . . . . .	34.0 N.	116.7 W.
June 14 . . . . .	0 04.6	do. . . . .	34.0 N.	116.7 W.
June 14 . . . . .	1 21.7	do. . . . .	34.0 N.	116.7 W.
June 14 . . . . .	9 46.5	do. . . . .	34.0 N.	116.7 W.
June 15 . . . . .	20 44.4	do. . . . .	34.0 N.	116.7 W.
June 16 . . . . .	21 51.6	Mexico, near Colima coast . . . . .	19.0 N.	105.2 W.
June 17 . . . . .	23 41.0	California. Felt . . . . .	34.0 N.	116.7 W.
June 18 . . . . .	22 12.3	Gulf of California . . . . .	26 N.	110 W.
June 19 . . . . .	0 03.5	California. Felt . . . . .	33.9 N.	118.2 W.
June 19 . . . . .	3 06.1	do. . . . .	33.9 N.	118.2 W.
June 21 . . . . .	10 58.3	Loyalty Islands region. Slight depth. . . . .	21.5 S.	169.5 E.
June 23 . . . . .	21 28.7	California. Felt . . . . .	34.0 N.	116.7 W.
June 25 . . . . .	1 08.3	Guatemala, off west coast . . . . .	14.5 N.	93 W.
June 25 . . . . .	4 16.3	Western Turkey . . . . .	39 N.	29 E.
June 25 . . . . .	8 06.9	East of Amelia Island . . . . .	52 N.	173 W.
June 25 . . . . .	14 17.4	Loyalty Islands region. . . . .	21.5 S.	170 E.
June 25 . . . . .	17 42.2	Mid-Atlantic Ocean . . . . .	0.4 S.	24.1 W.
June 28 . . . . .	5 31.8	Guatemala, off west coast . . . . .	14.5 N.	93 W.
June 28 . . . . .	6 55.3	California. Felt . . . . .	34.0 N.	116.8 W.
June 28 . . . . .	7 58.9	Guatemala, off west coast . . . . .	14.8 N.	92.7 W.
June 29 . . . . .	11 29.8	Peru, off west coast . . . . .	11 S.	79 W.
July 1 . . . . .	10 54.0	California. Felt . . . . .	34.0 N.	116.7 W.
July 2 . . . . .	22 12.4	Guatemala, near west coast . . . . .	14.5 N.	93 W.
July 3 . . . . .	5 38.4	California. Felt . . . . .	35.3 N.	117.9 W.
July 10 . . . . .	13 24.9	Samoa Islands region. Depth approximately 150 km. . . . .	14 S.	176 W.
July 10 . . . . .	15 47.8	Kermadec Islands region. Depth slightly less than 100 km. . . . .	31 S.	178 W.
July 12 . . . . .	19 30.4	Idaho. Felt . . . . .	44.7 N.	115.2 W.
July 13 . . . . .	0 14.3	South of Fiji Islands . . . . .	22 S.	170 E.
July 13 . . . . .	19 50.8	Mexico, near south coast . . . . .	16 N.	97 W.
July 16 . . . . .	10 19.1	South of Tonga Islands. Depth approximately 450 km. . . . .	22 S.	175 W.
July 19 . . . . .	10 21.4	Honshu, Japan, off east coast . . . . .	35 N.	143 E.
July 20 . . . . .	7 26.4	Alaska, Cook Inlet . . . . .	59.5 N.	152.5 W.
July 21 . . . . .	12 25.0	Oregon, off coast . . . . .	42.5 N.	127 W.
July 22 . . . . .	2 02.9	California. Felt . . . . .	33.5 N.	116.8 W.
July 22 . . . . .	11 28.6	Southern Mexico. Felt . . . . .	16.5 N.	95 W.
July 23 . . . . .	12 45.2	California. Felt . . . . .	33.2 N.	116.1 W.
July 23 . . . . .	16 13.5	Northern Argentina. Depth approximately 250 km. . . . .	24 S.	66 W.
July 26 . . . . .	9 11.9	California. Felt . . . . .	34.0 N.	116.4 W.
July 26 . . . . .	22 59.9	California. Felt . . . . .	33.8 N.	118.2 W.
July 27 . . . . .	0 04.4	Unimak Island, off southwest coast. Depth approximately 70 km. . . . .	54 N.	165 W.
July 27 . . . . .	8 18.6	Bay of Bengal, near Andaman Islands . . . . .	12 N.	93 E.
Aug. 2 . . . . .	12 29.2	Costa Rica, near west coast . . . . .	9.5 N.	84 W.
Aug. 4 . . . . .	22 46.9	California. Felt . . . . .	33.0 N.	116.0 W.
Aug. 5 . . . . .	1 24.1	Peru, off west coast . . . . .	13.5 S.	93 W.
Aug. 5 . . . . .	13 06.9	Nicaragua, off west coast . . . . .	12.5 N.	87.5 W.
Aug. 7 . . . . .	1 18.9	Nevada . . . . .	39.5 N.	120.0 W.
Aug. 7 . . . . .	3 25.3	Peru, off south coast . . . . .	17.5 S.	73.5 W.
Aug. 7 . . . . .	18 47.3	Mexico, off south coast . . . . .	16 N.	97.5 W.
Aug. 7 . . . . .	23 38.2	Peru, off south coast . . . . .	18 S.	74 W.
Aug. 9 . . . . .	4 15.4	Puerto Rico, off northwest coast. Felt . . . . .	19.0 N.	67.2 W.
Aug. 9 . . . . .	14 01.1	California. Felt . . . . .	35.9 N.	117.8 W.
Aug. 10 . . . . .	1 52.9	British Columbia, off southwest coast . . . . .	51.0 N.	130.7 W.
Aug. 10 . . . . .	11 31.5	Southern Mexico . . . . .	16.5 N.	96 W.
Aug. 10 . . . . .	15 27.2	Peru, near west coast . . . . .	12 S.	77 W.
Aug. 12 . . . . .	21 21.3	California. Felt . . . . .	35.9 N.	117.8 W.
Aug. 13 . . . . .	6 27.9	do. . . . .	35.9 N.	117.8 W.
Aug. 13 . . . . .	8 22.3	British Columbia, off southwest coast . . . . .	50.5 N.	132 W.
Aug. 14 . . . . .	11 07.5	North of Kodiak Island. Depth approximately 100 km. . . . .	58.5 N.	153 W.
Aug. 15 . . . . .	11 47.6	Mariana Islands region. Depth approximately 100 km. . . . .	13 N.	143.5 E.
Aug. 17 . . . . .	2 52.7	California. Felt . . . . .	34.3 N.	117.1 W.
Aug. 18 . . . . .	10 33.4	Northern Honshu, Japan. Depth approximately 200 km. . . . .	38 N.	140 E.
Aug. 18 . . . . .	19 22.5	Chile, off north coast . . . . .	21.5 S.	71 W.
Aug. 21 . . . . .	20 14.6	Mid-Atlantic Ocean . . . . .	3 N.	31 W.
Aug. 22 . . . . .	18 22.5	California. Felt . . . . .	34.0 N.	116.7 W.
Aug. 24 . . . . .	23 37.8	Mexico, off south coast. Depth approximately 100 km. . . . .	15.5 N.	93 W.
Aug. 25 . . . . .	7 30.4	California. Felt . . . . .	34.0 N.	116.7 W.

Table 1.—Summary of instrumental epicenters for 1945—Continued

1944	Origin time G. C. T.	Region and focal depth	Coordinates of provisional epicenter	
			Latitude	Longitude
Aug. 25.	<i>h. m.</i> 12 27.1	Tonga Islands region. Depth approximately 250 km.	18 S.	176 W.
Aug. 30.	1 14.2	New Hebrides Islands region.	17 S.	168.5 E.
Aug. 30.	4 00.8	Peru, off west coast. Depth approximately 100 km.	14.5 S.	78 W.
Sept. 3.	1 36.7	California	34.2 N.	116.4 W.
Sept. 3.	19 11.5	South Pacific Ocean, near Dougherty Island.	56 S.	123 W.
Sept. 3.	21 29.6	Colombia	3 N.	71.5 W.
Sept. 3.	22 58.6	Northeastern Chile. Depth approximately 100 km.	22.5 S.	68 W.
Sept. 4.	12 55.5	California	33.3 N.	116.1 W.
Sept. 5.	4 38.7	St. Lawrence Valley. Approximately \$2,000,000 property damage at Cornwall, Ontario and Massena, New York.	44.9 N.	74.3 W.
Sept. 5.	8 51.2	Aftershock of preceding quake.	44.9 N.	74.3 W.
Sept. 5.	15 30.0	Tonga Islands region.	18 S.	167 W.
Sept. 6.	5 52.4	Loyalty Islands region.	22 S.	172 E.
Sept. 9.	4 12.3	Western Colorado. Felt.	39 N.	107.5 W.
Sept. 9.	17 32.7	Aleutian Islands region.	51 N.	179 E.
Sept. 9.	23 24.8	Aftershock of St. Lawrence Valley quake of Sept. 5.	44.9 N.	74.3 W.
Sept. 11.	9 45.4	Molucca Islands region. Slight depth.	1 N.	127 E.
Sept. 14.	2 02.3	California. Felt.	37.5 N.	118.7 W.
Sept. 15.	19 20.1	Ecuador.	0.5 S.	79 W.
Sept. 16.	22 44.7	California, off northwest coast.	42.5 N.	127 W.
Sept. 18.	19 45.2	California.	34.0 N.	115.8 W.
Sept. 19.	13 06.0	Fore shock of Kamchatka quake of Sept. 23.	54 N.	161 E.
Sept. 20.	14 12.3	California.	34.0 N.	116.7 W.
Sept. 20.	16 39.5	do.	33.8 N.	117.7 W.
Sept. 23.	12 13.3	Kamchatka, off southeast coast. Slight depth.	53.8 N.	161.2 E.
Sept. 23.	16 01.3	Kermadec Islands region.	30 S.	177 W.
Sept. 24.	10 55.8	Aftershock of Kamchatka quake of Sept. 23.	54 N.	161 E.
Sept. 24.	15 13.7	California.	33.4 N.	116.2 W.
Sept. 25.	16 15.7	Aftershock of Kamchatka quake of Sept. 23.	54 N.	161 E.
Sept. 27.	16 25.1	U. S. S. R., 250 miles southeast of Tashkent	39 N.	73 E.
Sept. 29.	19 08.2	Aleutian Islands region.	52 N.	171 W.
Oct. 2.	17 22.1	Guatemala. Depth slightly less than 200 km.	14.5 N.	90.1 W.
Oct. 2.	20 29.9	Hokkaido, Japan. Depth approximately 100 km.	44 N.	143 E.
Oct. 3.	2 27.7	Northwestern Wyoming. Felt.	44.2 N.	109.2 W.
Oct. 5.	15 21.4	Colombia, near west coast.	4.5 S.	78 W.
Oct. 5.	16 57.0	Solomon Islands region. Felt.	5 S.	154 E.
Oct. 5.	17 28.4	Southeast of Loyalty Islands. Depth approximately 100 km.	22 S.	172 E.
Oct. 6.	2 34.6	Western Turkey. Destructive in Ayvalik and Burhaniz regions	39 N.	27 E.
Oct. 11.	9 45.2	South of Samoa. Depth approximately 100 km.	16 S.	172 W.
Oct. 12.	15 27.2	California.	34.0 N.	115.8 W.
Oct. 17.	18 37.0	Western China, north of Trans-Himalaya Mountains	34 N.	84 E.
Oct. 20.	1 13.1	Nevada.	38.5 N.	118.3 W.
Oct. 23.	23 40.1	Ecuador, near west coast.	0.5 N.	80.0 W.
Oct. 24.	0 27.7	Aftershock of preceding quake.	0.5 N.	80 W.
Oct. 24.	7 53.3	California.	34.1 N.	116.4 W.
Oct. 26.	22 54.2	do.	33.3 N.	116.2 W.
Oct. 26.	6 25.4	Lower California.	31.0 N.	116.0 W.
Oct. 27.	6 32.8	do.	31.0 N.	116.0 W.
Oct. 27.	12 27.0	do.	31.0 N.	116.0 W.
Oct. 28.	4 01.5	do.	31.0 N.	116.0 W.
Oct. 28.	18 30.3	California. Felt.	34.0 N.	116.7 W.
Oct. 29.	0 11.5	Aftershock of Western China quake of Oct. 17.	34 N.	84 E.
Oct. 29.	7 14.1	California.	34.1 N.	118.5 W.
Oct. 30.	5 34.1	Atlantic Ocean.	11 N.	43.5 W.
Nov. 4.	8 12.0	California.	36.3 N.	120.1 W.
Nov. 4.	15 19.1	do.	33.0 N.	116.0 W.
Nov. 8.	20 30.1	Southwestern Utah	38.8 N.	112.9 W.
Nov. 10.	13 16.7	South of Alaskan Peninsula.	55.7 N.	156.4 W.
Nov. 13.	19 23.5	South of Fiji Islands. Depth approximately 600 km.	21 S.	177 E.
Nov. 14.	0 30.4	South of Easter Islands.	33 S.	115 W.
Nov. 14.	20 47.0	Mindanao, off southeast coast.	4.5 N.	128.2 E.
Nov. 16.	12 10.9	Queen Charlotte Islands region.	11.5 S.	165.5 E.
Nov. 17.	22 10.3	Aftershock of preceding quake.	11.5 S.	165.5 E.
Nov. 18.	7 53.2	East of Easter Islands.	28 S.	113.5 W.
Nov. 19.	5 55.9	California.	32.7 N.	115.8 W.
Nov. 21.	10 02.3	Tierra del Fuego, off southeast coast.	56 S.	62 W.
Nov. 22.	5 25.6	California.	32.7 N.	115.8 W.
Nov. 24.	4 49.1	New Hebrides Islands region. Depth approximately 200 km.	19 S.	169 E.
Nov. 26.	17 57.6	California.	32.7 N.	115.8 W.
Nov. 27.	23 35.7	Nevada.	37.5 N.	117.1 W.
Nov. 28.	16 10.6	Gulf of California.	26 N.	111 W.
Nov. 29.	18 51.4	Aftershock of New Hebrides Islands quake of Nov. 24.	19 S.	169 E.
Nov. 30.	1 45.8	Southwest of Tonga Islands. Depth approximately 200 km.	25 S.	178 W.
Nov. 30.	18 53.2	California.	34.7 N.	120.4 W.
Dec. 1.	4 00.4	West of Tonga Islands. Depth approximately 600 km.	21 S.	178.5 W.
Dec. 1.	14 31.8	California.	32.6 N.	115.8 W.
Dec. 3.	20 59.7	do.	32.7 N.	115.8 W.
Dec. 4.	20 34.6	Mariana Islands region. Felt. Slight depth.	15 N.	146 E.
Dec. 5.	0 51.1	Chile. Depth approximately 100 km.	32 S.	70.5 W.
Dec. 5.	14 25.6	Kermadec Islands region.	27.5 S.	177.5 W.
Dec. 5.	14 41.4	Mexico, off west coast.	25 N.	109 W.
Dec. 5.	17 09.3	do.	25 N.	109 W.
Dec. 7.	4 35.7	Honshu, Japan, off south coast. Destructive in Japan. Accompanied by seismic sea-waves.	33 N.	137 E.
Dec. 8.	1 10.7	Tonga Islands region.	20.5 S.	174 W.
Dec. 8.	7 17.1	Loyalty Islands region. Depth approximately 100 km.	21.5 S.	169 E.

Table 1.—Summary of instrumental epicenters for 1945—Continued

1944	Origin time G. C. T.	Region and focal depth	Coordinates of provisional epicenter	
			Latitude	Longitude
	<i>h. m.</i>		<i>° ' "</i>	<i>° ' "</i>
Dec. 8. . . . .	9 20.8	Nevada. . . . .	38.4 N.	117.4 W.
Dec. 8. . . . .	12 59.5	Loyalty Islands region. Depth approximately 100 km. . . . .	21.5 S.	169 E.
Dec. 10. . . . .	5 11.5	Indian Ocean, 1,000 miles east of Madagascar . . . . .	23 S.	65 E.
Dec. 10. . . . .	16 25.1	New Hebrides Islands region. Depth slightly less than 100 km . . . . .	18.5 S.	168 E.
Dec. 12. . . . .	4 17.1	Aleutian Islands region . . . . .	52 N.	179.5 W.
Dec. 20. . . . .	20 45.1	Kermadec Islands region . . . . .	27.5 S.	177.5 W.
Dec. 21. . . . .	5 19.1	California, off north coast . . . . .	42 N.	125 W.
Dec. 21. . . . .	20 13.8	Kermadec Islands region . . . . .	27.5 S.	177.5 W.
Dec. 21. . . . .	22 27.7	do. . . . .	27.5 S.	177.5 W.
Dec. 22. . . . .	5 35.4	do. . . . .	27.5 S.	177.5 W.
Dec. 22. . . . .	22 32.1	Chile, near coast of Antofagasta Province. Depth approximately 200 km . . . . .	24 S.	70 W.
Dec. 23. . . . .	8 16.4	California . . . . .	36.4 N.	117.9 W.
Dec. 27. . . . .	15 25.7	New Britain. Depth approximately 100 km . . . . .	6 S.	150 E.
Dec. 28. . . . .	1 05.6	do. . . . .	6 S.	150 E.
Dec. 29. . . . .	22 55.9	Mexico, off south coast . . . . .	8 N.	104 W.
Dec. 29. . . . .	23 45.3	do. . . . .	8 N.	104 W.
Dec. 30. . . . .	22 03.1	Oregon, off coast . . . . .	43.7 N.	127.0 W.

Table 2.—Principal earthquakes of the world from January 1945 to December, 1945, inclusive.

This table lists (1) the strongest shocks of the period as revealed by seismographic records, particularly those of 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.

1945	Origin time G. C. T.	Region	Coordinates of provisional epicenter		Remarks, Depths, Principal Facts, Magnitudes
			Latitude	Longitude	
	<i>h. m.</i>		<i>° ' "</i>	<i>° ' "</i>	
Jan. 1. . . . .	1 20.7	Baffin Bay. . . . .	73 N.	69½ W.	7
Jan. 12. . . . .	18 38.5	Honshu, Japan, off southcentral coast. . . . .	34½ N.	138 E.	6.9
Feb. 10. . . . .	4 57.9	Hokkaido, Japan, off south coast. . . . .	41½ N.	142 E.	Depth slight. Felt in Honshu. Property damage. 7.3.
Feb. 14. . . . .	3 01.3	Idaho. . . . .	44.7 N.	115.4 W.	Felt in Idaho, Montana, Oregon, and Washington.
Mar. 17. . . . .	23 57.9	Colombia, off west coast. . . . .	6.7 N.	78.1 W.	Felt in Panama Canal Zone.
Mar. 20. . . . .		Turkey. . . . .			One dispatch reports 14 killed, another 300 killed, near Adana.
Apr. 15. . . . .	2 35.3	Kamchatka, off east coast. . . . .	57½ N.	164 E.	7
May 19. . . . .	15 07.0	California, off Cape Mendocino . . . . .	40.6 N.	126.4 W.	Felt in California. 6
June 3. . . . .	13 05.6	Panama, western Chiriqui Province. . . . .	8.6 N.	82.6 W.	Felt in Panama. 7.
June 22. . . . .	9 18.6	Hokkaido, Japan, off north-east coast. . . . .	44 N.	146 E.	Depth about 100 km. 7.0
June 24. . . . .	19 57.9	Chile, about 100 miles south of Santiago. . . . .	35 S.	71 W.	Do.
June 27. . . . .	13 08.3	Gulf of California. . . . .	26.7 N.	111.3 W.	Felt in Lower-California. 7.0
July 15. . . . .	5 35.1	Mariana Islands region. . . . .	17½ N.	146 E.	Depth about 100 km. 7.1
July 26. . . . .	10 32.3	South Carolina. . . . .	34.3 N.	81.4 W.	
Aug. 21. . . . .	16 29.6	Central Peru. . . . .	10½ S.	75½ W.	Depth about 100 km.
Sept. 13. . . . .	11 17.1	Chile, about 60 miles south of Santiago. . . . .	34.2 S.	70.8 W.	Do. 7.1
Sept. 28. . . . .	22 24.1	California, off north coast. . . . .	41.7 N.	126.9 W.	6
Oct. 9. . . . .	14 36.7	Hokkaido, Japan, off east coast . . . . .	44 N.	147½ E.	Depth about 100 km. 7.0
Oct. 25. . . . .	14 58.7	Kamchatka, off east coast. . . . .	57 N.	165 E.	
Nov. 3. . . . .	22 09.0	Alaska, off south coast. . . . .	59 N.	151 W.	
Nov. 8. . . . .	10 02.7	Greenland, near northeast coast . . . . .	81 N.	18 W.	
Nov. 16. . . . .	18 02.3	Alaska, about 100 miles west of Juneau. . . . .	58 N.	137 W.	
Nov. 26. . . . .	5 13.2	Southwest of Tonga Islands. . . . .	21 S.	180 W.	Depth about 600 km. 7.0
Nov. 27. . . . .	21 57.0	Iran, off southeast coast. . . . .	25 N.	60½ E.	Strong seismic seawaves. Destructive along Arabian Sea coast, especially at Ormara, Baluchistan, and Karachi, India. 4,000 persons reported killed. Considerable property damage. 8¼
Dec. 8. . . . .	1 04.1	South of New Britain. . . . .	6½ S.	151 E.	7.1
Dec. 28. . . . .	17 48.8	Do. . . . .	6½ S.	151 E.	7.8

## STRONG MOTION SEISMOGRAPH RESULTS

## INTRODUCTION

During the latter part of 1932, the Coast and Geodetic Survey inaugurated a program of recording strong ground movements in the seismically active regions of the country to obtain data needed in the design of earthquake-resisting structures. Notes pertinent to the development of this program will be found in the twelve preceding issues of this series, Serials 579, 593, 600, 610, 619, 629, 637, 647, 655, 662, 672, and 682, and in Special Publication 201, Earthquake Investigations in California, 1934-35. Material in the United States Earthquakes series is restricted to the analysis of strong motion seismograph records. Special Publication 201 is much broader of scope, containing data on structural and ground vibrations and detailed descriptions of the various activities which comprise the seismological program as a whole. The reader is also referred to Special Publication 206, Selection, Installation, and Operation of Seismographs, for descriptive material on strong motion instruments and vibration meters in addition to similar information on teleseismic instruments.

*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 superposing of shorter period waves of relatively large amplitude, the estimates of displacement must be considered as only approximate. One must refer to the illustrations of the curves themselves to evaluate the probable accuracy of the estimated displacements.

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 accuracy of such work, as well as an appraisal of instrumental performance, has been definitely established through accelerometer shaking table tests made at, and with the cooperation of, the Massachusetts Institute of Technology. (Bulletin of the Seismological Society of America, Vol. 33, No. 1, January 1943.) In the displacement results the errors of mensuration, computation, and adjustment can be kept within a range of 1 cm. Errors due to minute shiftings of the zero positions of the pendulums on pivot accelerometers increase this range of error to about 2 or 3 cm. In both cases the errors apply only to displacements of a slow drifting type, somewhat similar to waves of about 10 seconds period and over. But they represent motions that are necessarily associated with extremely small accelerations and are therefore of no significance in engineering studies.

None of the 1945 records was strong enough to require integration.

*Units Used.*—Quantitative results are expressed in c. g. s. units; centimeters or millimeters for displacement; centimeters per second for velocity; 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.<sup>2</sup> For practical purposes it is only necessary to point off three decimal places to convert cm/sec.<sup>2</sup> to "g."

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.<sup>2</sup> 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.<sup>2</sup>, 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. <sup>2</sup>		= 0.03281 ft/sec. <sup>2</sup>
1 cm.		= 10 mm.
0.1 g.		= 98 cm/sec. <sup>2</sup> = 3.215 ft/sec. <sup>2</sup>
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.

*Time used.*—Times given in connection with the strong motion seismograph results for 1945 are war time or one hour more than standard.

*Seismogram illustrations.*—Reproductions of seismograms are usually tracings of the original records and must not be accepted as genuine copies. 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 address the Director of the Coast and Geodetic Survey for further particulars.

The tabulated instrumental constants refer to the original records. The tracings in this publication are reduced so that the same scales do not apply. The reductions are approximately in the ratio of 1.80 to 1.

#### NOTES ON STRONG-MOTION SEISMOGRAPH RECORDS

The practice of attempting to describe the seismograms in detail in the text is believed to be rather superfluous because the outstanding periods are listed in tables, such as table 4 in this issue. The illustrations provide a far better picture of the records than can be obtained in any other way. The following notes will therefore contain only such information on the earthquakes and the records which may not be evident from table 4 or from the illustrations. For convenience certain fundamental information on the earthquakes will be repeated from the noninstrumental part of the publication.

It is well to repeat here that, as the measurement of periods on records of this nature is dependent largely on the judgment of the person reading them, 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.

Acceleration scales are indicated on the tracings of acceleration curves by two dots, the distance between them representing the equivalent of 100 cm/sec.<sup>2</sup> when applied to the curves over which they appear. A similar scheme is adopted for other types of curves. These dots provide a quick means for making auxiliary scales in cases where an investigator desires to make rough measurements on the published curves. They are especially necessary at this time in view of the instrumental changes begun in 1942.

The pendulum periods of a number of accelerographs in southern California have been reduced from 0.1 second to about 0.07 second. Also a number of the 6-inch and 12-inch recorders have been interchanged. Most of this work was done during 1942. The purpose was to arrange the instruments so that their recording capacities would more nearly equal the accelerations which might be expected at the various station sites. As a result of previous experience the following expectable earthquake accelerations were used in determining the adjustment and placement: (a) rock foundation 25 percent of gravity, (b) conglomerate foundations 40 percent of gravity, (c) alluvium 70 percent of gravity, (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 gravity respectively. In order to realize the desired recording capacities it was necessary to shift a number of accelerographs because of the greater recording range of the 12-inch drums as compared with the 6-inch.

In the notes following table 3 listing the strong-motion records obtained during 1945 the maximum values of acceleration and displacement are given for each station. Accelerations shown may have been recorded by any one of the three components. As will be seen in table 4 maximum recorded acceleration is not necessarily associated with the same ground period as the maximum computed displacement.

Table 3.—*List of shocks recorded and records obtained on strong motion seismographs in 1945*

Date, epicenter, and recording station	Records		
	Accelerograph	Displacement meter	Weed strong motion seismograph
Jan. 7: Northern California:			
San Jose . . . . .	2		1
Hollister . . . . .	1		
Jan. 10: Northern California: Ferndale . . . . .	1		
Mar. 17: Off Colombia, South America:			
Balboa Heights . . . . .	1		
Apr. 1: Southern California: Santa Barbara . . . . .	1		
May 2: Northern California: Eureka . . . . .	1	1	
May 17: Northern California:			
Hollister . . . . .			1
San Francisco Shell Building . . . . .		1	3
San Francisco Southern Pacific Building . . . . .	2		
May 19: Northern California:			
Ferndale . . . . .	1		
Eureka . . . . .	1	1	
June 1: Southwestern Montana: Helena . . . . .	1		
June 8: Chile, Santiago region: Santiago . . . . .	1		
June 24: Chile, Santiago region: Santiago . . . . .	1		
August 15: Southern California:			
El Centro . . . . .	1		
San Diego . . . . .	1		
Los Angeles Subway Terminal . . . . .	2	1	
Hollywood Storage Company . . . . .	3		
Aug. 27: Northern California: San Jose . . . . .	2		
Sept. 7: Southern California: San Bernardino . . . . .			1
Sept 13: Chile, Santiago region: Santiago . . . . .	1		
Total . . . . .	23	4	

## NORTHERN CALIFORNIA EARTHQUAKE OF JANUARY 7

Epicenter in the Hollister area. Maximum intensity VI at three places.

*San Jose Bank of America*.—Station about 48 miles NW  $320^\circ$  of epicenter. Intensity III in San Jose. Maximum acceleration 3 cm/sec.<sup>2</sup> and computed maximum displacement .102 cm. on thirteenth floor. Maximum acceleration 1 cm/sec.<sup>2</sup> and computed maximum displacement 0.002 cm. in basement.

*Hollister*.—Intensity VI in Hollister. Recorded maximum displacement 0.73 cm. and no available computed maximum acceleration.

## NORTHERN CALIFORNIA EARTHQUAKE OF JANUARY 10

Epicenter in the Upper Mattole area. Maximum intensity V.

*Ferndale*.—Station about 20 miles NW  $350^\circ$  of epicenter. Intensity IV in Ferndale. Maximum acceleration 8 cm/sec.<sup>2</sup> and computed maximum displacement 0.007 cm.

## EARTHQUAKE OF MARCH 17 OFF COLOMBIA, SOUTH AMERICA

Provisional epicenter off the coast of Colombia at  $6.7^\circ$  north,  $78.1^\circ$  west. Maximum intensity about IX at the epicenter.

*Balboa Heights*.—Station about 170 miles NW  $233^\circ$  of epicenter. Felt in Balboa Heights. Maximum acceleration 14 cm/sec.<sup>2</sup> and computed maximum displacement 0.050 cm.

## SOUTHERN CALIFORNIA EARTHQUAKE OF APRIL 1

Epicenter from local instrumental data,  $34^\circ 00'$  north,  $120^\circ 01'$  west, Santa Rosa Island. Maximum intensity IV reported at several places.

*Santa Barbara*.—Station 36 miles NE  $32^\circ$  of epicenter. Intensity IV in Santa Barbara. Maximum acceleration 6 cm/sec.<sup>2</sup> and computed maximum displacement 0.045 cm.

## NORTHERN CALIFORNIA EARTHQUAKE OF MAY 2

Epicenter from local instrumental data,  $41.3^\circ$  north,  $122.5^\circ$  west, near Scott Mountain. Maximum intensity VI at two places.

*Eureka*.—Station 50 miles SW  $256^\circ$  of epicenter. Intensity V at Eureka. Maximum acceleration 4 cm/sec.<sup>2</sup> and computed maximum displacement 0.003 cm. Maximum displacement 0.03 cm. recorded on displacement meter and computed maximum acceleration 0.7 cm/sec.<sup>2</sup>

## NORTHERN CALIFORNIA EARTHQUAKE OF MAY 17

Epicenter in the Hollister area. Maximum intensity VI at Hollister.

*Hollister*.—Maximum acceleration 55 cm/sec.<sup>2</sup> and computed maximum displacement 0.068 cm.

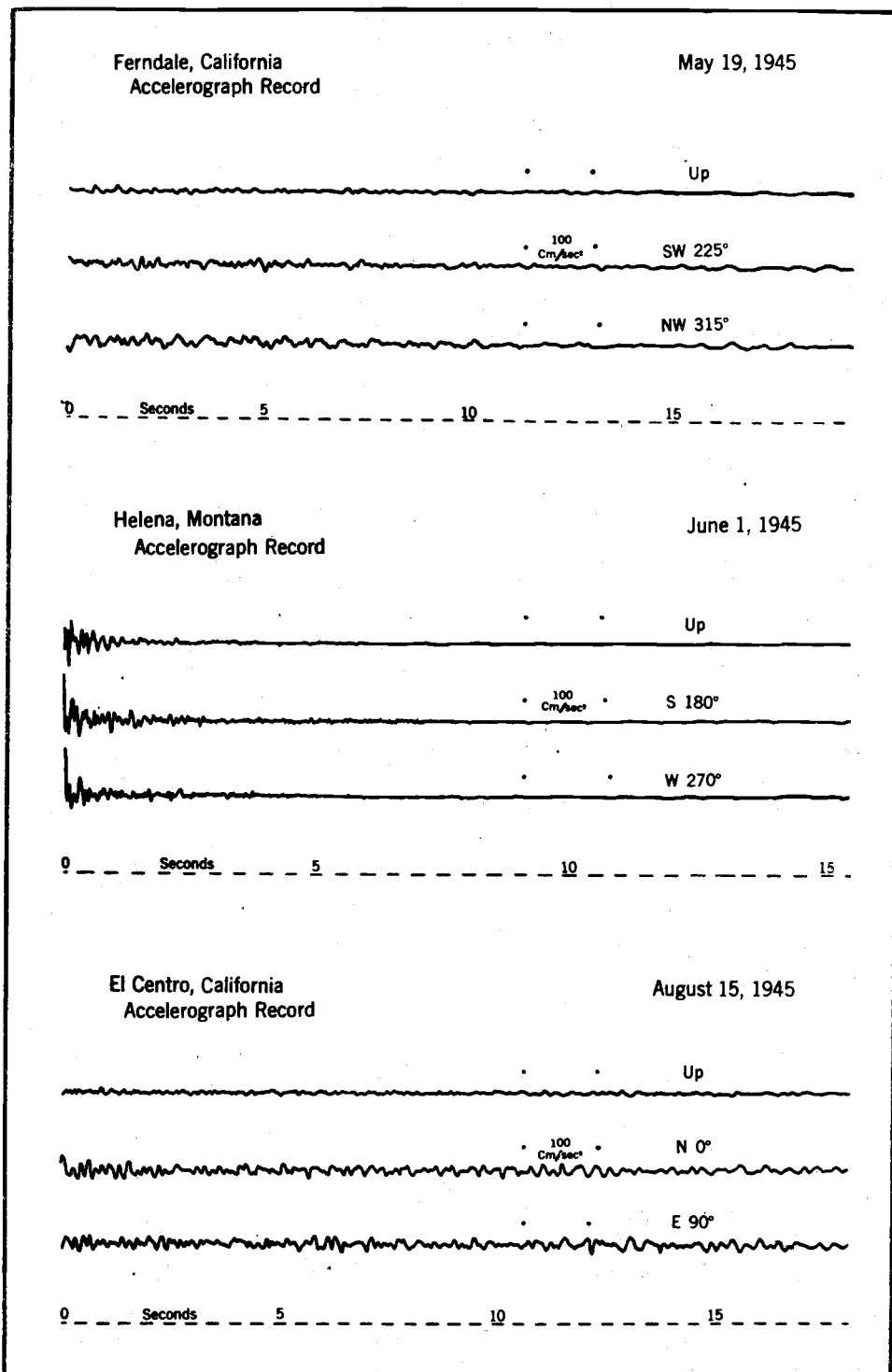


FIGURE 6.—Tracings of accelerograph records obtained at Ferndale on May 19, Helena, Montana, on June 1, and El Centro on August 15.

*San Francisco Shell Building.*—Station about 85 miles NW 210° of epicenter. Maximum acceleration 4 cm/sec.<sup>2</sup> and computed maximum displacement 0.072 cm. on twenty-ninth floor. Maximum trace amplitude 0.24 cm. on twenty-first floor, and 0.07 cm. in sub-basement.

*San Francisco Southern Pacific Building.*—Station about 85 miles NW 210° of epicenter. Maximum acceleration 13 cm/sec.<sup>2</sup> and computed maximum displacement 0.075 cm. on fourteenth floor. Maximum acceleration 2 cm/sec.<sup>2</sup> and computed maximum displacement 0.009 cm. in basement. Maximum displacement 0.01 cm. recorded on displacement meter and computed maximum acceleration 4 cm/sec.<sup>2</sup>

#### NORTHERN CALIFORNIA EARTHQUAKE OF MAY 19

Epicenter from local instrumental data, 40.6° north, 126.4° west, off northern California coast. Maximum intensity V at one place.

*Ferndale.*—Figure 6. Station 105 miles NE 70° of epicenter. Intensity IV at Ferndale. Maximum acceleration 10 cm/sec.<sup>2</sup> and computed maximum displacement 0.076 cm.

*Eureka.*—Station about 115 miles NE 60° of epicenter. Intensity IV at Eureka. Maximum acceleration 2 cm/sec.<sup>2</sup> and computed maximum displacement 0.002 cm. Maximum displacement 0.50 cm. recorded on displacement meter and computed maximum acceleration 0.32 cm/sec.<sup>2</sup>

#### SOUTHWESTERN MONTANA EARTHQUAKE OF JUNE 1

Epicenter from local instrumental data, 46.6° north, 112.0° west, about 3 miles northwest of Helena. The location is the same as the destructive Helena earthquake of October 31, 1935. Maximum intensity V.

*Helena.*—Figure 6. Station about 3 miles SE 165° of epicenter. Intensity V at Helena. Maximum acceleration 35 cm/sec.<sup>2</sup> and computed maximum displacement 0.008 cm.

#### EARTHQUAKE OF JUNE 8 NEAR SANTIAGO, CHILE

Epicenter near Santiago, Chile. Maximum intensity unknown.

*Santiago.*—Weak record obtained. Maximum acceleration 16 cm/sec.<sup>2</sup> and computed maximum displacement 0.004 cm.

#### EARTHQUAKE OF JUNE 24 NEAR SANTIAGO, CHILE

Epicenter from instrumental data, 35° south, 71° west, about 105 miles south of Santiago. Maximum intensity unknown.

*Santiago.*—Maximum acceleration 6 cm/sec.<sup>2</sup> and computed maximum displacement 0.003 cm.

#### SOUTHERN CALIFORNIA EARTHQUAKE OF AUGUST 15

Epicenter from local instrumental data, 33°13' north, 116°08' west, in San Jacinto Fault near Borego Valley. Maximum intensity VI at a few places.

*El Centro.*—Figure 6. Station 42 miles SE 127° of epicenter. Intensity V at El Centro. Maximum acceleration 13 cm/sec.<sup>2</sup> and computed maximum displacement 0.013 cm.

*San Diego.*—Station 78 miles SW 217° of epicenter. Intensity V at San Diego. Maximum acceleration 5 cm/sec.<sup>2</sup> and computed maximum displacement 0.013 cm.

*Los Angeles Subway Terminal.*—Station 160 miles NW 297° of epicenter. Intensity III at Los Angeles. Maximum acceleration 3 cm/sec.<sup>2</sup> and computed maximum displacement 0.015 cm. on thirteenth floor. Maximum acceleration 1 cm/sec.<sup>2</sup> and computed maximum displacement 0.562 cm. in sub-basement. Maximum displacement 0.1 cm. recorded on displacement meter and computed maximum acceleration 1 cm/sec.<sup>2</sup>

*Hollywood Storage Company.*—Station 164 miles NW 298° of epicenter. Maximum acceleration 9 cm/sec.<sup>2</sup> and computed maximum displacement 0.062 cm. in penthouse. Maximum acceleration 1 cm/sec.<sup>2</sup> and computed maximum displacement 0.004 cm. in basement. Maximum acceleration 1 cm/sec.<sup>2</sup> and computed maximum displacement 0.005 cm. in P. E. lot.

#### NORTHERN CALIFORNIA EARTHQUAKE OF AUGUST 27

Epicenter in the San Jose area. Maximum intensity VI at one place.

*San Jose.*—Figure 7. Intensity IV at San Jose. Maximum acceleration 15 cm/sec.<sup>2</sup> and computed maximum displacement 0.55 cm. on thirteenth floor. Maximum acceleration 16 cm/sec.<sup>2</sup> and computed maximum displacement 0.019 cm. in basement.

#### SOUTHERN CALIFORNIA EARTHQUAKE OF SEPTEMBER 7

Epicenter from local instrumental data, 33°58' north, 116°48' west, in San Andreas Fault north of Cabazon. Maximum intensity IV at a few places.

*San Bernardino.*—Station 36 miles NW 285° of epicenter. The surface waves are scarcely perceptible.

#### EARTHQUAKE OF SEPTEMBER 13 NEAR SANTIAGO, CHILE

Epicenter from instrumental data, 34.2° south, 70.8° west, about 60 miles south of Santiago. Destructive. Maximum intensity unknown.

*Santiago.*—Figure 7. Maximum acceleration 131 cm/sec.<sup>2</sup> and computed maximum displacement 0.275 cm.



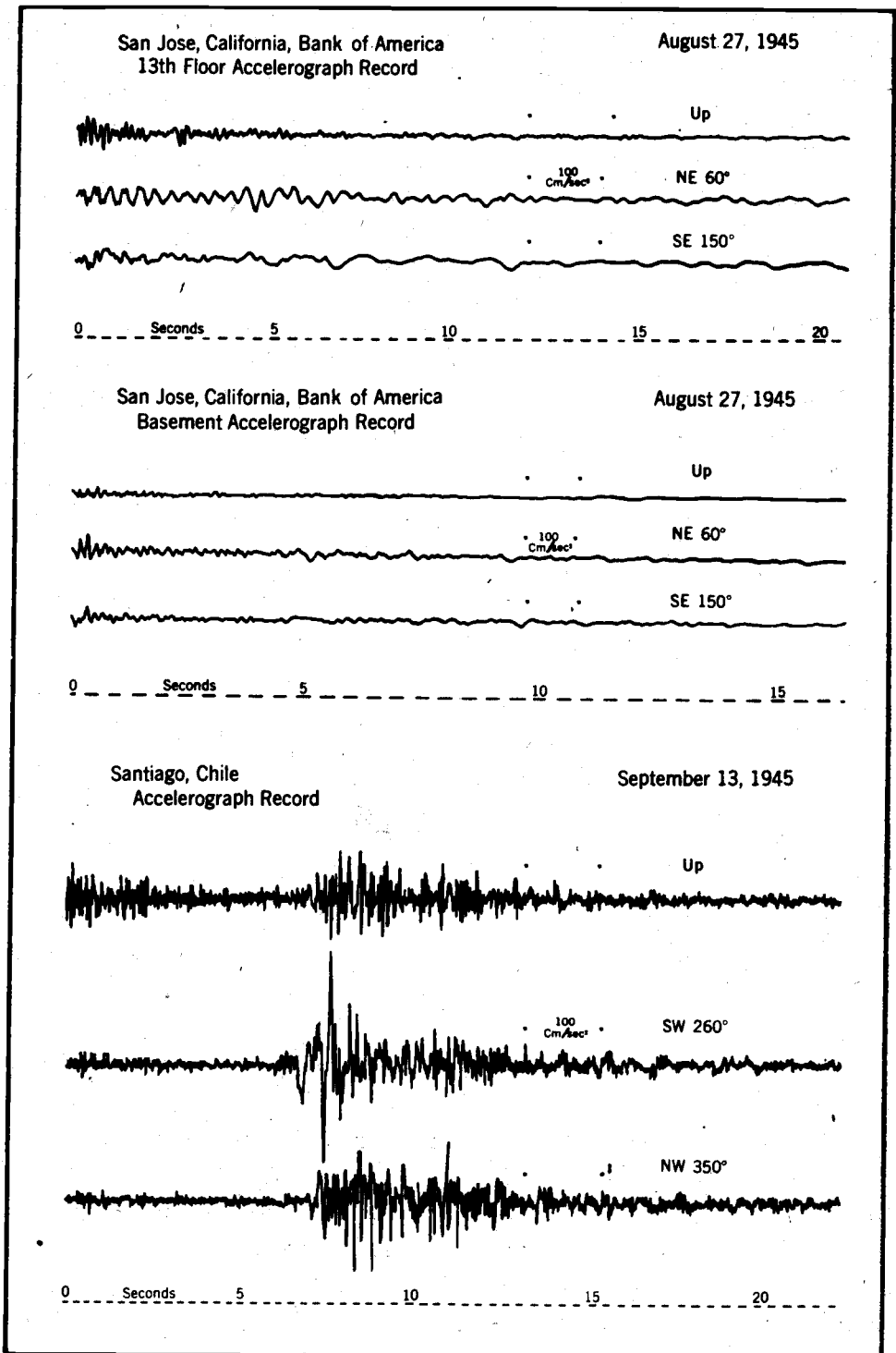


FIGURE 7.—Tracings of accelerograph records obtained at San Jose Bank of America, 13th floor and basement, on August 27, and Santiago, Chile, on September 13.

Table 4.—Summary of strong motion seismograph data for the year 1945

(See the text preceding this table for additional details. Simple harmonic motion is assumed when computing displacement from an accelerogram and when computing acceleration from a displacement-meter record.)

NORTHERN CALIFORNIA EARTHQUAKE OF JANUARY 7				
Station and component	Earth-wave period	Maximum acceleration	Maximum displacement	Remarks
	<i>Seconds</i>	<i>Cm/sec.<sup>2</sup></i>	<i>Cm.</i>	
San Jose Bank of America, 13th floor accelerograph:				
Vertical, up.....	0.19	3	0.003	Very weak.
	.28	1	.002	
NE: 60°.....	.87	3	.057	Weak long-period waves.
	1.18	3	.102	Short periods superposed.
SE: 150°.....	.52	2	.012	Weak irregular long periods.
	.51	3	.020	
basement accelerograph:				
Vertical, up.....				Too weak.
NE: 60°.....	.28	1	.002	Very weak.
SE: 150°.....	.36			Do.
Hollister Weed seismograph:				
NE: 45°.....			.69	Trace amplitude only.
NW: 315°.....			.73	Do.
NORTHERN CALIFORNIA EARTHQUAKE OF JANUARY 10				
Ferndale accelerograph:				
Vertical, up.....	0.31	3	0.007	Short periods superposed.
	.22	2	.002	
SW: 225°.....	.12	4	.001	Irregular periods.
	.18	5	.004	Do.
	.32	1	.003	
NW: 315°.....	.09	8	.002	Possibly preceded by stronger motion.
	.08	4	.001	
	.27	2	.004	Weak.
EARTHQUAKE OF MARCH 17 OFF COLOMBIA, SOUTH AMERICA				
Balboa Heights accelerograph:				
Vertical, up.....	0.18	1	0.001	Weak irregular motion.
	.18	1	.001	Do.
SE: 100°.....	.25	7	.001	Regular sinusoidal motion.
	.27	7	.013	Short periods superposed.
	.44	6	.030	Do.
	.27	6	.011	Sinusoidal wave.
SW: 190°.....	.38	14	.052	Irregular motion.
	.20	7	.007	Do.
	.46	3	.016	Short periods superposed. Weak motion.
SOUTHERN CALIFORNIA EARTHQUAKE OF APRIL 1				
Santa Barbara accelerograph:				
Vertical, up.....	0.52	3	0.021	Weak short-period waves superposed.
	.41	3	.013	Weak.
	.50	3	.019	Do.
NE: 45°.....	.32	6	.016	Possibly preceded by stronger motion.
	.57	3	.025	Short-period waves superposed.
	.47	4	.022	Regular waves.
	.43	3	.014	
SE: 135°.....	.18	3	.002	Weak irregular waves.
	.60	5	.045	
	.60	4	.036	
NORTHERN CALIFORNIA EARTHQUAKE OF MAY 2				
Eureka accelerograph:				
Vertical, up.....	0.17	2	0.001	Very weak record.
	.14	2	.001	
NE: 79°.....	.16	2	.001	Possibly preceded by stronger motion.
	.19	3	.002	
SE: 169°.....	.19	2	.002	Weak irregular motion.
	.15	2	.001	
	.17	4	.003	
Eureka, right displacement meter:				
SE: 169°.....	1.09	0.7	.02	Very weak motion.
	1.12	.3	.01	
Eureka, left displacement meter				
SW: 259°.....	1.63	.5	.03	Weak motion.
	1.34	.5	.02	
	1.17	.6	.02	

Table 4.—Summary of strong-motion seismograph data for the year 1945—Continued

NORTHERN CALIFORNIA EARTHQUAKE OF MAY 17				
Hollister Weed seismograph:				
NE: 45°	0.09	55	0.001	Strong sharp phases.
	.16	37	.024	Do.
	.18	28	.023	
	.18	7	.006	
NW: 315°	.21	38	.042	Strong sharp phases.
	.21	48	.023	Do.
	.23	51	.068	
	.30	26	.061	Sinusoidal waves.
San Francisco Shell Building, sub-basement Weed seismograph:				
N: 0°				Double trace amplitude 0.07 cm. Brief duration.
				Lost motion evident.
				Double trace amplitude 0.03 cm.
E: 90°				
21st floor Weed seismograph:				
E: 90°				Initial and maximum trace amplitude 0.23 cm. with reversal 0.11 cm. to new zero position. Brief and jerky.
				Initial and maximum trace amplitude 0.24 cm. with reversal 0.07 cm. to new zero position.
N: 0°				
29th floor Weed seismograph:				
E: 90°	.84	4	.072	Regular sinusoidal waves.
	.72	4	.054	
	.76	2	.036	Regular sinusoidal waves.
N: 0°	.76	2	.036	These periods are greater than all of the natural periods of the building except the fundamental which is 1.90 sec.
San Francisco Southern Pacific Building, basement accelerograph:				
Vertical, up	.41	2	.009	Very weak.
NW: 319°	.48	1	.006	Do.
NE: 49°	.46	1	.005	Do.
Right displacement meter:				
NW: 319°	.48	1.60	.01	
Left displacement meter:				
NE: 49°	.30	4.44	.01	
14th floor accelerograph:				
Vertical, up	.32	1	.003	Irregular motion.
	.42	2	.009	
	.37	1	.003	Weak waves.
SW: 229°	.42	7	.031	Possibly preceded by stronger motion.
	.46	4	.022	
	.81	2	.033	Weak short-period waves superposed.
NW: 319°	.48	13	.075	Possibly preceded by stronger motion.
	.51	10	.066	
	.52	6	.041	
	1.01	2	.051	Regular waves.
NORTHERN CALIFORNIA EARTHQUAKE OF MAY 19				
Ferndale accelerograph:				
Vertical, up	0.25	5	0.008	Irregular motion.
	.33	3	.008	Do.
	.20	3	.003	
	.32	1	.003	
SW: 225°	.43	6	.028	Short-period waves superposed.
	.15	6	.003	
	.25	9	.015	Regular waves.
	.32	3	.008	Do.
NW: 315°	.32	10	.028	Possibly preceded by stronger motion.
	.52	9	.062	Short-period waves superposed.
	.43	4	.019	Irregular waves.
	.61	8	.076	
Eureka accelerograph:				
Vertical, up				Extremely weak.
NE: 79°	.06	2	.001	Very weak.
	.24	1	.001	
SE: 169°	.29	1	.002	Weak irregular motion.
	.17	2	.001	
Eureka, right displacement meter:				
SE: 169°	1.94	0.11	.11	Regular motion.
	8.70	.32	.50	
Eureka, left displacement meter:				
SW: 259°	1.70	.20	.09	Regular motion.
	7.90	.24	.28	

Table 4.—Summary of strong-motion seismograph data for the year 1945—Continued

## SOUTHWESTERN MONTANA EARTHQUAKE OF JUNE 1

Helena accelerometer:				
Vertical, up.....	0.11	28	0.008	Strong phase.
	.13	11	.005	Regular waves.
	.11	4	.001	
S: 180°.....	.08	35	.006	Strong phase at beginning.
	.09	20	.004	
	.11	11	.003	Strong phase.
	.14	4	.002	Sinusoidal waves.
W: 270°.....	.06	29	.003	Possibly preceded by stronger motion.
	.14	16	.008	
	.10	3	.001	Irregular waves.
	.11	1	.001	

## EARTHQUAKE OF JUNE 8 NEAR SANTIAGO, CHILE

Santiago accelerometer:				
Vertical, up.....	0.13	10	0.004	Possibly preceded by stronger motion.
	.11	5	.002	Regular waves.
SW: 260°.....	.07	11	.001	
	.09	6	.001	
	.07	5	.001	Weak motion.
NW: 350°.....	.09	16	.003	Possibly preceded by stronger motion.
	.15	4	.002	
	.24	1	.001	Irregular motion.

## EARTHQUAKE OF JUNE 24 NEAR SANTIAGO, CHILE

Santiago accelerometer:				
Vertical, up.....	0.11	3	0.001	Weak irregular motion.
	.05	2	.001	Very weak.
SW: 260°.....	.10	6	.002	Weak irregular motion.
	.11	3	.001	Short periods superposed on longer periods.
NW: 350°.....	.20	3	.003	Weak.
	.11	2	.001	

## SOUTHERN CALIFORNIA EARTHQUAKE OF AUGUST 15

El Centro accelerometer:				
Vertical, up.....	0.14	4	0.002	Very irregular motion.
	.15	2	.001	
	.23	3	.004	Short periods superposed.
N: 0°.....	.15	13	.007	Possibly preceded by stronger motion.
	.17	12	.009	Regular waves.
	.27	7	.013	
	.23	7	.009	
E: 90°.....	.16	10	.007	Possibly preceded by stronger motion.
	.10	11	.003	
	.17	11	.008	Regular waves.
	.20	12	.012	
	.34	4	.012	
San Diego accelerometer:				
Vertical, up.....	.19	1	.001	Very weak.
	.29	1	.002	
E: 90°.....	.32	5	.013	Possibly preceded by stronger motion.
	.33	4	.011	Short periods superposed.
	.36	2	.007	
S: 180°.....	.13	3	.001	
	.32	2	.005	Sinusoidal waves.
	.36	1	.003	
Los Angeles Subway Terminal				
13th floor accelerometer:				
Vertical, up.....	.40	1	.004	Very weak.
SW: 219°.....	.60	1	.009	
	.67	1	.011	Sinusoidal waves.
NW: 309°.....	.22	1	.001	Weak irregular motion.
	.22	3	.004	
	.56	2	.015	Weak motion.
Sub-basement accelerometer:				
Vertical, up.....				Too weak.
SE: 129°.....				Do.
SW: 219°.....	4.9	1	.562	Very weak.
Right displacement meter:				
NE: 39°.....				Very long periodic and weak waves.
Left displacement meter:				
SE: 129°.....	5.6	1	.1	Very weak.
Hollywood Storage Company				
Penthouse accelerometer:				
Vertical, up.....	.40	2	.008	
	.52	2	.013	Sinusoidal weak motion.
S: 180°.....	.34	3	.009	Irregular waves.
	.65	3	.032	
W: 270°.....	.52	9	.062	Very irregular motion
	.45	5	.026	
	.50	2	.013	

Table 4.—Summary of strong-motion seismograph data for the year 1945—Continued

SOUTHERN CALIFORNIA EARTHQUAKE OF AUGUST 15.—Continued				
Basement accelerograph:				
Vertical, up.....	.41	1	.004	Very weak.
E: 90°.....	.42	1	.004	Do.
S: 180°.....	.41	1	.004	Do.
P. E. lot accelerograph:				
Vertical, up.....				Too weak.
E: 90°.....	.44	1	.005	Very weak.
S: 180°.....	.39	1	.004	Do.
NORTHERN CALIFORNIA EARTHQUAKE OF AUGUST 27				
San Jose Bank of America				
13th floor accelerograph:				
Vertical, up.....	0.17	15	0.001	Strong motion at beginning.
	.18	10	.008	Regular motion.
	.19	9	.008	
NE: 60°.....	.33	9	.025	Short-period waves superposed.
	.44	13	.064	
	1.89	6	.55	Very long waves.
SE: 150°.....	.29	7	.015	Very irregular motion.
	1.94	5	.048	Part of record lost.
Basement accelerograph:				
Vertical, up.....	.11	8	.002	Irregular waves.
	.13	4	.002	
	.13	1	.001	Weak irregular waves.
NE: 60°.....	.15	12	.007	Possibly preceded by stronger motion.
	.10	16	.004	
	.02	5	.001	Short-period waves superposed.
SE: 150°.....	.13	8	.003	Possibly preceded by stronger motion.
	.10	4	.001	Very irregular.
	.43	4	.019	
SOUTHERN CALIFORNIA EARTHQUAKE OF SEPTEMBER 7				
San Bernardino strong motion				
seismograph.....				Surface waves are scarcely perceptible.
EARTHQUAKE OF SEPTEMBER 13 NEAR SANTIAGO, CHILE				
Santiago accelerograph:				
Vertical, up.....	0.14	40	0.020	Strong phase. Possibly preceded by stronger motion.
	.10	28	.007	Strong irregular motion.
	.14	14	.007	
	.09	50	.010	Strong motion corresponding to S phase on a tele-
				seismic record.
	.08	53	.008	Sharp phases.
	.09	7	.001	Short periods superposed on 0.43 sec. waves.
SW: 260°.....	.14	15	.008	Weak irregular motion at beginning.
	.12	7	.003	
	.29	131	.275	Maximum acceleration for quake.
	.08	42	.007	Regular motion.
	.13	18	.007	Do.
	.05	13	.001	Short periods superposed on 0.75 sec. waves.
NW: 350°.....	.12	10	.004	Weak irregular motion.
	.25	37	.059	Strong irregular waves.
	.17	67	.049	Strong motion.
	.14	23	.011	
	.11	13	.004	Irregular motion.
	.07	8	.001	Short periods superposed on longer waves.

Table 5.—*Instrumental constants of strong motion seismographs in 1945*

Station and instrument	Orientation of instrument <sup>1</sup>	Pendulum period	Static magnification	Sensitivity <sup>2</sup>	Damping ratio	Instrument number
NORTHERN CALIFORNIA EARTHQUAKE OF JANUARY 7						
San Jose Bank of America 13th floor accelerograph No. 35.....	Up..... NE. 60°..... SE. 150°.....	Sec. 0.100 .097 .097	77 76 76	Cm. 1.96 1.81 1.81	10 12 9	V-107 L-87 T-97
Basement accelerograph No. 8.....	Up..... NE. 60°..... SE. 150°.....	.069 .068 .067	111 113 115	1.34 1.32 1.31	13 9 8	V-49 L-50 T-51
Hollister Weed seismograph No. 8.....	NE. 45°..... NW. 315°.....	.18 .18	10.1 10.1	0.93 0.86	3.6 5.1	..... .....
NORTHERN CALIFORNIA EARTHQUAKE OF JANUARY 10						
Ferndale accelerograph No. 28.....	Up..... SW. 225°..... NW. 315°.....	0.097 .098 .100	71 71 74	1.70 1.73 1.88	10 12 10	V-126 L-124 T-125
EARTHQUAKE OF MARCH 17 OFF COLOMBIA, SOUTH AMERICA						
Balboa Heights accelerograph No. 31.....	Up..... SE. 100°..... SW. 190°.....	0.098 .100 .100	..... ..... .....	2.82 2.88 2.96	8 8 10	V-73 L-74 T-75
SOUTHERN CALIFORNIA EARTHQUAKE OF APRIL 1						
Santa Barbara accelerograph No. 26.....	Up..... NE. 45°..... SE. 135°.....	0.101 .097 .099	78 78 77	2.02 1.87 1.91	8 9 11	V-55 L-56 T-57
NORTHERN CALIFORNIA EARTHQUAKE OF MAY 2						
Eureka accelerograph No. 30.....	Up..... NE. 79°..... SE. 169°.....	0.070 .069 .069	101 107 108	1.25 1.29 1.30	10 9 8	V-29 L-13 T-8
Eureka displacement meter No. 13.....	SE. 169°..... SW. 259°.....	10.0 9.9	1 1	..... .....	8 10	..... .....
NORTHERN CALIFORNIA EARTHQUAKE OF MAY 17						
Hollister Weed seismograph No. 8.....	NE. 45°..... NW. 315°.....	0.19 .18	10.1 10.1	0.93 0.86	3.1 5.0	..... .....
San Francisco Shell Building <sup>3</sup> Sub-basement Weed seismograph No. 2.....	N. 0°..... E. 90°.....	.184 .188	7.3 7.3	0.63 0.65	5.1 5.4	..... .....
21st floor Weed seismograph No. 6.....	E. 90°..... N. 0°.....	.18 .18	6.4 6.4	0.52 0.52	3.6 2.9	..... .....
29th floor Weed seismograph No. 4.....	E. 90°..... N. 0°.....	.18 .18	7.6 7.6	0.62 0.69	4.1 4.8	..... .....
San Francisco Southern Pacific Building <sup>3</sup> Basement accelerograph No. 27.....	Up..... NW. 319°..... NE. 49°.....	.068 .069 .069	115 118 111	1.35 1.42 1.34	13 10 9	V-110 L-90 T-100
Basement displacement meter No. 18.....	NW. 319°..... NE. 49°.....	9.9 9.9	1.0 1.0	..... .....	9.0 9.6	..... .....
14th floor accelerograph No. 34.....	Up..... SW. 229°..... NW. 319°.....	.101 .101 .101	83 80 78	2.13 2.07 2.01	9 12 10	V-108 L-88 T-98
NORTHERN CALIFORNIA EARTHQUAKE OF MAY 19						
Ferndale accelerograph No. 28.....	Up..... SW. 225°..... NW. 315°.....	0.097 .099 .100	72 71 74	1.71 1.76 1.89	9 11 9	V-126 L-124 T-125
Eureka accelerograph No. 30.....	Up..... NE. 79°..... SE. 169°.....	.070 .069 .069	101 107 108	1.25 1.29 1.30	10 9 8	V-29 L-13 T-8
Eureka displacement meter No. 13.....	SE. 169°..... SW. 259°.....	10.0 9.9	1 1	..... .....	8 10	..... .....

Table 5.—Instrumental constants of strong-motion seismographs in 1945—Continued

SOUTHWESTERN MONTANA EARTHQUAKE OF JUNE 1						
Helena accelerometer No. 48.....	Up.....	0.100	76	1.93	9	V-135
	S. 180°.....	.100	81	2.04	10	L-133
	W. 270°.....	.102	83	2.18	9	T-134
EARTHQUAKE OF JUNE 8 NEAR SANTIAGO, CHILE						
Santiago accelerometer No. 50.....	Up.....	0.097	80	1.90	10	V-151
	SW. 260°.....	.098	82	1.98	8	L-141
	NW. 350°.....	.100	81	2.04	9	T-150
EARTHQUAKE OF JUNE 24 NEAR SANTIAGO, CHILE						
Santiago accelerometer No. 50.....	Up.....	0.097	80	1.90	10	V-151
	SW. 260°.....	.098	82	1.98	8	L-141
	NW. 350°.....	.100	81	2.04	9	T-150
SOUTHERN CALIFORNIA EARTHQUAKE OF AUGUST 15						
El Centro accelerometer No. 4.....	Up.....	0.098	78	1.88	10	V-10
	N. 0°.....	.099	77	1.90	8	L-4
	E. 90°.....	.100	77	1.63	8	T-15
San Diego accelerometer No. 5.....	Up.....	.096	106	2.46	10	V-70
	E. 90°.....	.100	107	2.72	9	L-71
	S. 180°.....	.099	111	2.76	8	T-72
Los Angeles Subway Terminal <sup>1</sup> 13th floor accelerometer No. 39.....	Up.....	.101	83	2.14	10	V-112
	SW. 219°.....	.100	81	2.05	8.5	L-92
	NW. 309°.....	.100	79	2.01	10	T-102
Sub-basement accelerometer No. 3.....	Up.....	.69	116	1.40	8	V-58
	SE. 129°.....	.69	118	1.43	9	L-59
	SW. 219°.....	.70	120	1.48	10	T-60
Sub-basement displacement meter No. 13	NE. 39°.....	9.9	1.0	.....	9	.....
	SE. 129°.....	10.3	1.0	.....	10	.....
Hollywood Storage Company <sup>2</sup> Penthouse accelerometer No. 40.....	Up.....	.099	81	2.00	8	V-113
	S. 180°.....	.099	84	2.09	7	L-93
	W. 270°.....	.100	79	2.00	8	T-103
Basement accelerometer No. 22.....	Up.....	.068	105	1.22	8	V-25
	E. 90°.....	.069	111	1.33	8	L-3
	S. 180°.....	.070	110	1.37	6	T-18
P. E. lot accelerometer No. 1.....	Up.....	.070	108	1.34	8	V-66
	E. 90°.....	.070	108	1.34	6	L-64
	S. 180°.....	.070	111	1.38	8	T-65
NORTHERN CALIFORNIA EARTHQUAKE OF AUGUST 27						
San Jose Bank of America 13th floor accelerometer No. 35.....	Up.....	0.101	82	2.10	10	V-107
	NE. 60°.....	.098	76	1.86	11	L-87
	SE. 150°.....	.098	76	1.85	9	T-97
Basement accelerometer No. 8.....	Up.....	.070	111	1.36	10.6	V-49
	NE. 60°.....	.067	113	1.30	8.1	L-50
	SE. 150°.....	.067	115	1.31	4.7	T-51
SOUTHERN CALIFORNIA EARTHQUAKE OF SEPTEMBER 7						
San Bernardino Weed seismograph No. 10.	SE. 135°.....	0.19	10	.....	1.9	.....
	NE. 45°.....	.19	10	.....	1.6	.....
EARTHQUAKE OF SEPTEMBER 13 NEAR SANTIAGO, CHILE						
Santiago accelerometer No. 50.....	Up.....	0.097	80	1.90	.....	V-151
	SW. 260°.....	.097	82	1.98	9	L-141
	NW. 350°.....	.102	81	2.04	8	T-150

<sup>1</sup> 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.

<sup>2</sup> The sensitivity is the number of centimeters on the seismogram that corresponds to 100 cm/sec.<sup>2</sup> of acceleration. The deflection corresponding to 1/10 gravity may be obtained by multiplying the sensitivity tabulated by 0.98.

<sup>3</sup> Instruments at this station are wired to start simultaneously.

## TILT OBSERVATIONS

With the cooperation of the University of California, two tilt-meters were operated at Berkeley. The tilt-graph data obtained from these instruments during 1945 are shown in figure 8, inside back cover.

A third tilt-meter was operated at Long Beach, California, in cooperation with the Long Beach Harbor Department. The 1945 tilt-graph results from this station are shown in figure 9, inside back cover.

## CORRECTION TO PREVIOUS PUBLICATION

**1944, September 5:** Origin time of the destructive Cornwall, Ontario-Massena, New York earthquake should be 4h 38.7 m., G. C. T.

U. S. Earthquakes 1944, page 30, table 4; the date November 15 should read November 14.



## 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.

Should you desire to receive such notices, you may use the form given below, checking the list covering the subjects in which you are interested.

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DIRECTOR U. S. COAST AND GEODETIC SURVEY,

*Washington 25, D. C.*

Dear Sir: I desire that my name be placed on the mailing lists indicated by check below, to receive notification of the issuance of publications referring to the subjects indicated:

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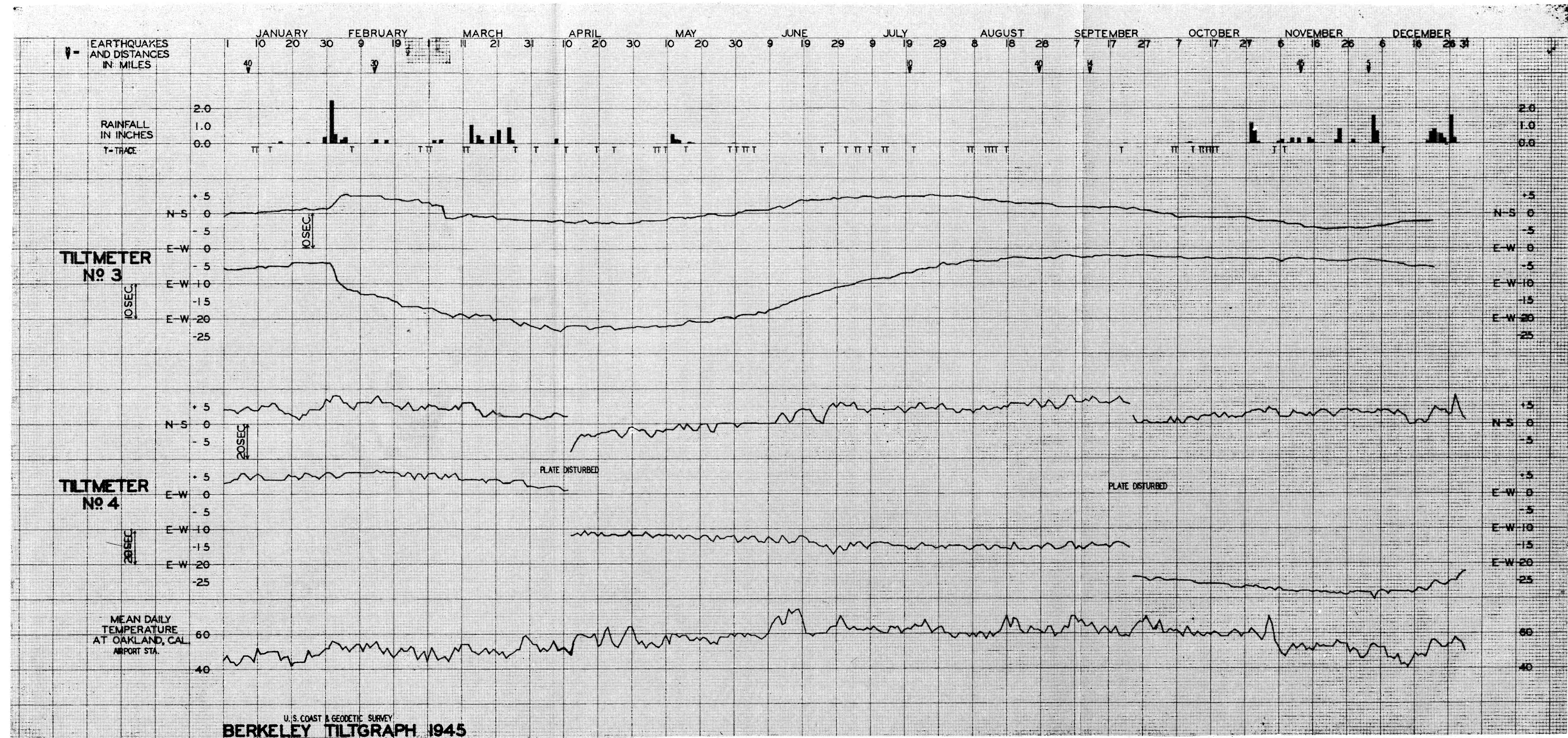


FIGURE 8.—Berkeley tilt-graph for 1945.



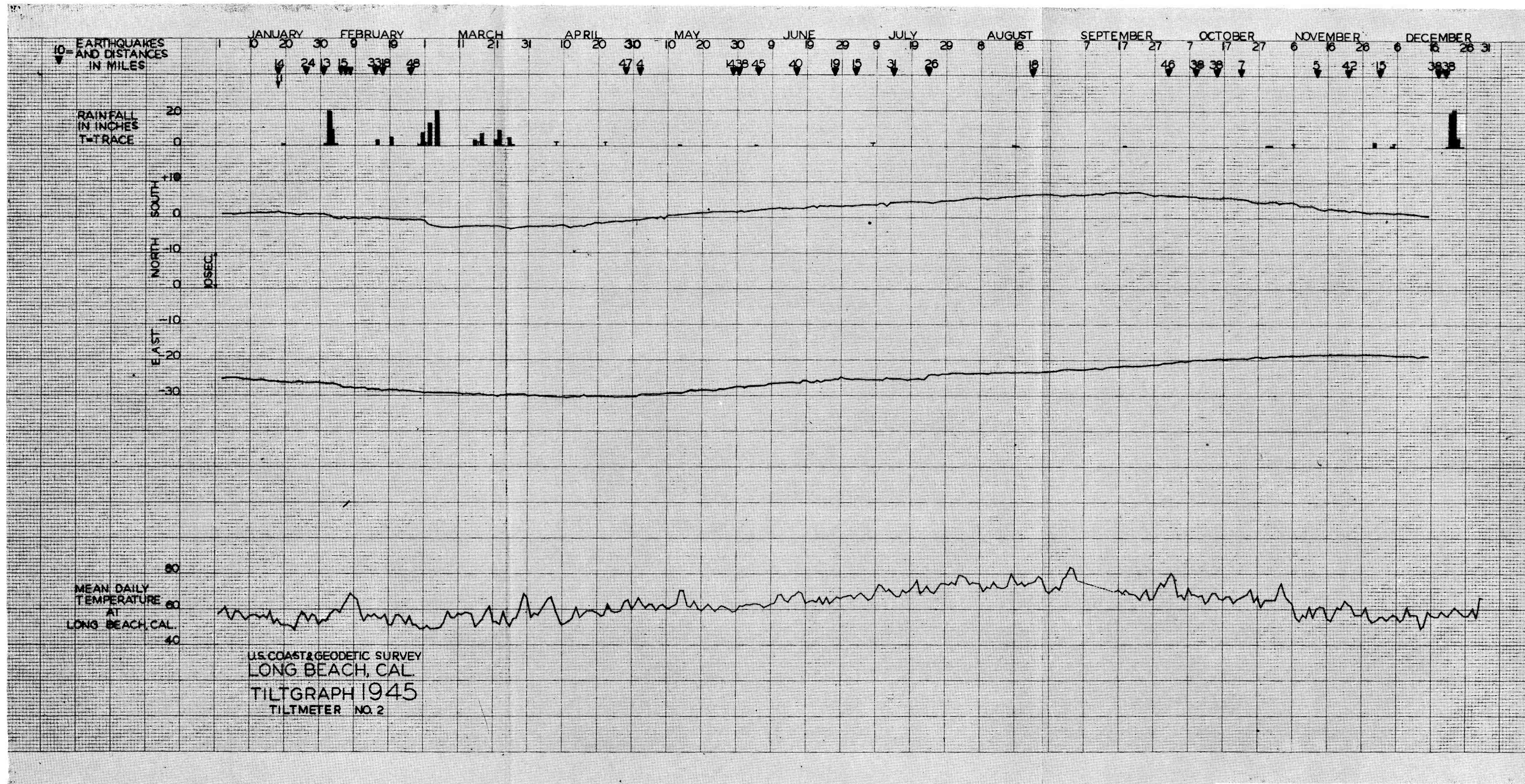


FIGURE 9.—Long Beach tilt-graph for 1945.