

# **UNITED STATES EARTHQUAKES 1941**

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**SERIAL No. 655**

**U. S. DEPARTMENT OF COMMERCE  
COAST AND GEODETIC SURVEY - WASHINGTON**

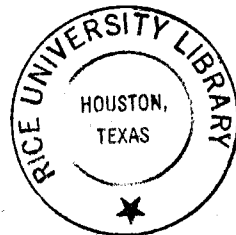
**U. S. DEPARTMENT OF COMMERCE**

JESSE H. JONES, Secretary

**COAST AND GEODETIC SURVEY**

Leo Otis Colbert, Director

Serial No. 655



**UNITED STATES EARTHQUAKES**

**1941**

By

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Principal Mathematician



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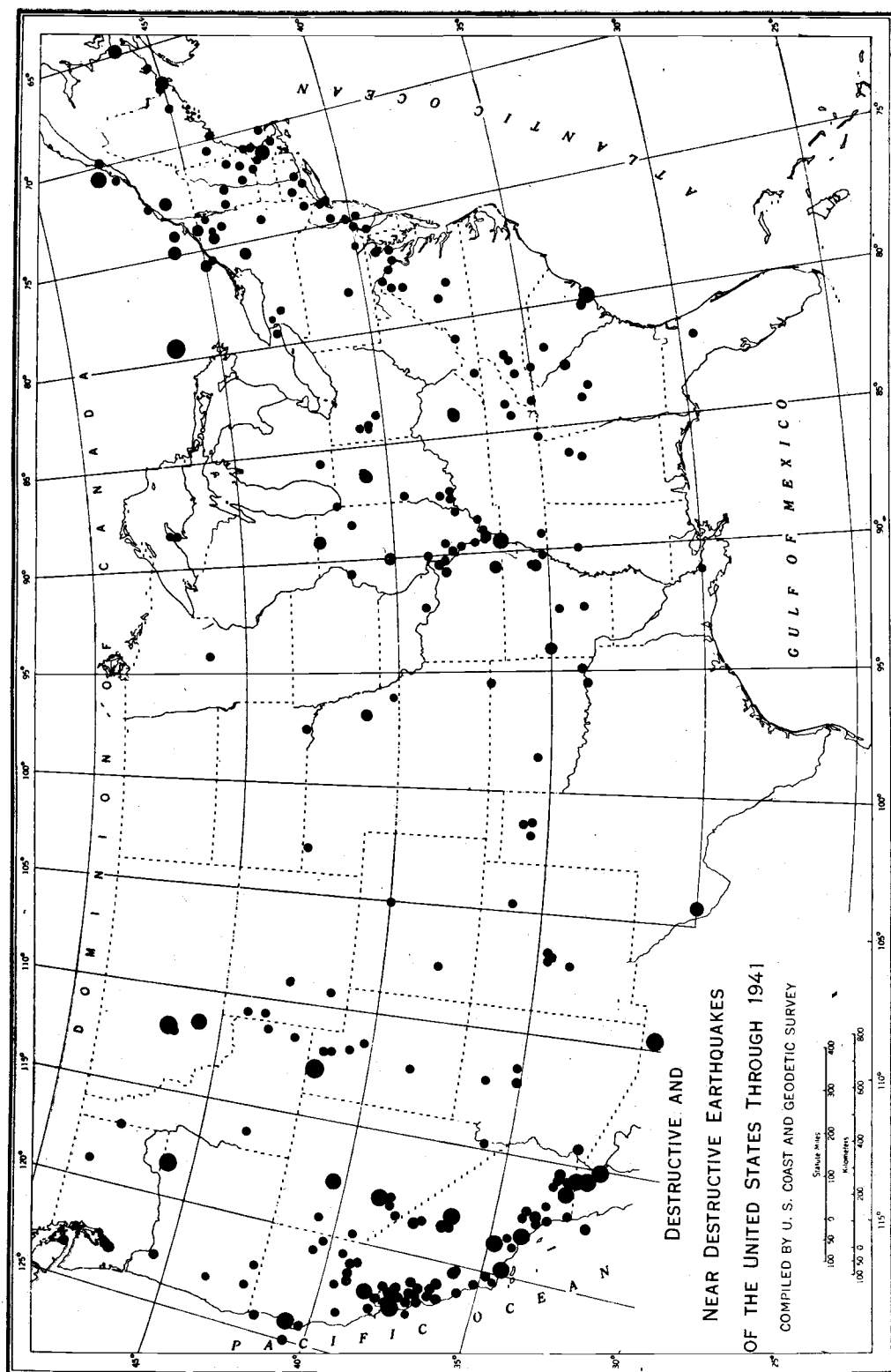
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# UNITED STATES EARTHQUAKES, 1941

## INTRODUCTION

This publication is a summary of earthquake activity in the United States and the regions under its jurisdiction for the calendar year 1941. A history of the more important shocks of the country appears in Serial 609 of the Survey, "Earthquake History of the United States: Part I.—Continental United States (Exclusive of California and Western Nevada) and Alaska," 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 recent 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 and Philippine Islands are not included, and only the stronger shocks are included in the case of the Philippine Islands. 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, 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 1941:

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

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

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

*Montana.*—Dr. Francis A. Thomson, Montana School of Mines, Butte.

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

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

*Utah.*—Prof. Hyrum Schneider, 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

<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.

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 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) press dispatches published by Georgetown University Seismological Station; (8) reports of the Hawaiian Volcano Observatory; (9) reports of the Weather Bureau of the Philippine Islands; and (10) 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 San Francisco Field Station of the Survey.

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 new 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 the air.

An asterisk (\*) indicates that the time is taken from an instrumental report and is reliable. In other instances quite large deviations are frequently reported.

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 when the epicenters are determined by other organizations such as the Seismological Station of the University of California under the direction of Prof. Perry Byerly or the Seismological Laboratory of the California Institute of Technology, at Pasadena. The bulletins of these institutions should be consulted for further details and often for data on additional shocks.

Time is indicated as continuous from 0 to 24 hours, beginning and ending at midnight. Local standard time is used.

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 to 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 and "affected area" maps. In figure 2 the relative intensity of a shock is indicated by the size of the dot.

*Teleseismic results.*—On page 25 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 and the results broadcast without delay to Europe and points in the Pacific. Postal card reports are also issued.

*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, 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

### EARTHQUAKE ACTIVITY IN THE VARIOUS STATES

**Arizona:** Light shocks on March 21 and 27.

**Arkansas:** Light shock on October 8, also felt in Tennessee.

**California:** In northern California the most important shock was that of October 3. In the San Francisco Bay region moderate shocks occurred on April 14, May 27, and September 17. In southern California the Torrance-Gardena earthquake of November 14, intensity VIII, was the outstanding shock of the year in the United States. The Santa Barbara shock of June 30 also reached intensity VIII. Other important shocks occurred on September 21 and October 21. Strong shocks occurred in the Owens Valley area on September 14 and December 20.

**Colorado:** Light shocks at one place on February 13, 21, and 27; one other on August 29.

**Illinois:** Light shock on October 21 felt in southern Illinois and Kentucky.

**Kentucky:** See Illinois.

**Maine:** Light shock on August 30.

**Mississippi:** Light shock on June 28.

**Missouri:** Light shock on October 26.

**Montana:** Light shocks on February 27, March 5, and September 28.

**Nevada:** Moderate shocks near Boulder Dam on March 22, September 3 and 5. In other parts of the State a moderate shock occurred on May 5 and October 14, and light ones occurred on January 27, July 17, and August 29.

**New Mexico:** Moderate shock on August 4.

**New Hampshire:** A light shock on January 20 was the 17th aftershock since the widespread December 20, 1940, earthquake.

**New York:** Five light shocks in 4 sections of the State on February 1, July 28, October 9 and 20, and December 12.

**North Carolina:** Light shock on May 10.

**Oklahoma:** Light shock on October 18.

**Oregon:** A strong shock on December 29; light shocks on February 16, July 6, October 19 and 31.

**South Dakota:** Moderate shock on May 25.

**Tennessee:** Light shocks in eastern part on March 4 and September 8; one moderate shock in the western part on November 16 and a light one on November 14. See Arkansas.

**Utah:** Light shock on June 20.

**Washington:** Moderately strong shock in central portion on April 7; weak and widely spread shocks on January 3, April 6 and 12, and July 29.

**Alaska:** One strong shock on the Kenai Peninsula area on July 29. Many minor shocks in the same area and in the Fairbanks region.

**Hawaiian Islands:** Moderately strong shock felt all over Island of Hawaii on September 25. Activity in minor shocks was normal.

**Philippine Islands:** No shock of outstanding importance. The strongest were near Manila on April 18, and in southern Luzon on November 6.

**Puerto Rico:** Several light shocks were felt on October 2 and 3.

**Panama Canal Zone:** A moderate shock was felt throughout Panama on March 9, and an off-shore shock, on the Pacific side, caused some damage in eastern Costa Rica and western Panama on December 5. Other activity was minor.

### NORTHEASTERN REGION

(75TH MERIDIAN OR EASTERN STANDARD TIME)

NOTE.—See bulletins of all seismographic stations in the region for additional information. "NESA" refers to Northeastern Seismological Association.

**January 20:** Night. Ossipee, N. H. Homes shaken within a 20-mile radius of Ossipee. Seventeenth shock felt since the earthquake of December 20.

**February 1:** 13:28. Canton, N. Y. Slight shock.

**July 28:** 19:24. Mt. Kisco and White Plains, N. Y. Felt, according to NESA bulletin.

**August 30:** 10:22. Houlton, Maine. Felt, according to NESA bulletin.

**October 9:** 17:07. Watertown, N. Y. Slight shock.

**October 20:** 16:29. Watertown, N. Y. Slight shock.

**December 12:** 18:30. Dannemora, N. Y. Slight shock.

### EASTERN REGION

(75TH MERIDIAN OR EASTERN STANDARD TIME)

**March 4:** 1:15. Knoxville, Tenn. Slight shock; loud rumbling noise.

**May 10:** 6:12. Asheville, N. C. Slight shock felt in northern and western parts of the city.

**September 8:** 4:45. Chattanooga, Tenn. Earthquake accompanied by a rumbling sound was felt over an area of about 100 square miles. Strong in the Lookout Mountain section.



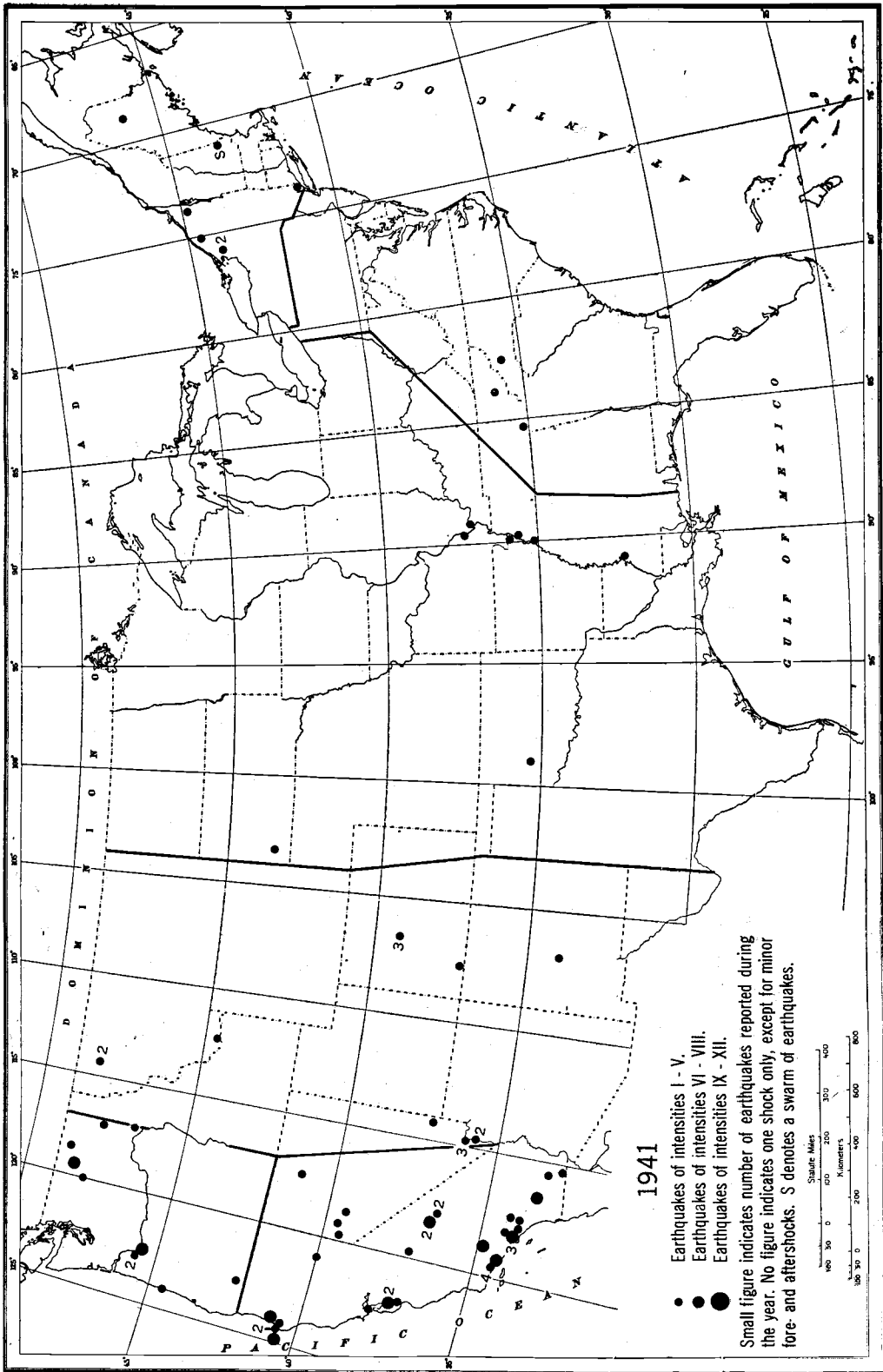


FIGURE 2.—Earthquake epicenters, 1941.

## CENTRAL REGION

(90TH MERIDIAN OR CENTRAL STANDARD TIME)

**May 25:** 0:25. Hot Springs, S. Dak. One wall reported cracked. Pictures and light fixtures swayed at Hot Springs, Rapid City, and Martin. Not felt at Longvalley, Belvidere, Oelrichs, and Cottonwood.

**June 28:** 12:30. Vicksburg, Miss. Slight shock.

**October 8:** 1:51.\* Blytheville, Ark., and Tiptonville, Tenn. Slight damage reported.

**October 18:** 1:48.\* Bessie and Clinton, Okla. Felt by 75 percent of population in Bessie; dishes rattled. Evidently not quite so strong at Clinton although the press reported cracks in the walls of one building; dishes and windows rattled. Not felt at 6 nearby towns canvassed by the U. S. Weather Bureau Office at Oklahoma City.

**October 21:** 10:53. Cairo, Ill., and Wickliffe, Ky. At Cairo furniture swayed and dishes rattled.

**October 26:** 22:00. Cape Girardeau, Mo. Felt by several.

**November 14:** 21:07. Memphis, Tenn. Slight shock felt by many.

**November 16:** 21:09. Western Tennessee. Intensity V at Covington where the shock was felt by all and cracks were reported in the courthouse. At Henning it was felt by many, an explosive noise preceding the trembling. Also felt at Memphis, Millington, Fraser, Ripley, Dyersburg, and Pleasant Hill.

## WESTERN MOUNTAIN REGION

(105TH MERIDIAN OR MOUNTAIN STANDARD TIME)

NOTE.—Only the more important shocks felt at Boulder Dam, and the more important aftershocks at Helena, Mont., are listed. The unabridged records are published in Abstracts of Earthquake Reports for the Pacific Coast and Western Mountain Region.

**February 13:** 3:30. Aspen, Colo. Felt down valley as far as Snowmass store. Windows rattled and some objects were visibly disturbed.

**February 21:** 14:22. Aspen, Colo. Felt by many.

**February 27:** Aspen, Colo. Felt.

**February 27:** 20:28. Monida, Mont. Felt by practically everyone. Windows shook and dishes rattled. Also felt at Lima. Recorded on seismographs at Butte, Mont., and Logan, Utah.

**March 5:** 22:10 and 22:55. Kalispell, Mont. Distinct shock felt in Flathead Valley. Also felt at Eagan, S. Dak.

**March 21:** (Evening). Willow Beach, Ariz. Felt by all. Small objects moved.

**March 22:** 4:08.\* Boulder City and power plant. Harder than the usual run of light shocks. Few awakened at Boulder City. Recorded on local seismographs.

**March 27:** 22:30. Willow Beach, Ariz. Felt by many; by some outdoors.

**May 5:** 20:12.\* Southeastern Nevada, near Caliente. Epicenter about 8 miles SSE of Joseco, Nev., according to Lake Mead Seismological Party. About 37.3° north, 114.3° west, according to Pasadena. Felt at Joseco and Caliente. At Joseco it was felt outdoors by some, but few were frightened.

**June 20:** 8.20.\* Logan, Utah. Intensity III shock felt and recorded on local seismograph. (Information obtained too late for insertion on map, Fig. 2.)

**August 4:** 0:40. Socorro, N. Mex. Many residents were awakened; a few left their homes. In one home plaster fell from walls. At McGaffey, 123 miles north of Socorro, hanging objects swung and a few residents were awakened.

**August 29:** 4:34. Bayfield, Colo. Felt from Bayfield up the Los Pinos River valley to the Vallecinto Dam 15 miles north of Bayfield. In Bayfield some dishes were knocked from a shelf and some furniture moved slightly. Horses were frightened.

**August 29:** 5:09. Winnemucca, Nev. Slight shock reported by several. Some objects disturbed. Also felt at McDermitt, 72 miles north of Winnemucca.

**September 3:** 14:25. \*Boulder City and power plant. Epicenter 4 miles east of Boulder Dam. Felt by many. Rumbling noise heard. Recorded locally on seismographs.

**September 5:** 6:11.\* Boulder City and power plant. Felt by many at both places. Recorded on local seismographs.

**September 28:** 2:00. Kalispell, Mont. Felt at Kalispell, Big Fork, Columbia Falls, Somers, Belton, and Whitefish. At Big Fork apples were shaken from trees and an entire family was awakened. At Kalispell it was felt by nearly everyone and many awakened. Hanging objects swung. A rumbling sound preceded the shock.

## CALIFORNIA AND WESTERN NEVADA

(120TH MERIDIAN OR PACIFIC STANDARD TIME)

NOTE.—All places are in California unless otherwise stated. "P" written after the location of an epicenter means that the location was reported by the Seismological Laboratory of the California Institute of Technology at Pasadena. "B" refers likewise to the Seismological Station of the University of California at Berkeley. The Berkeley data, however, are not available as this publication goes to press. More details will be found in Abstracts of Earthquake Reports for the Pacific Coast and Western Mountain Region. The Bulletin of the Seismological Society of America is referred to as the "SSA Bulletin".

When more than one degree of intensity is reported from a town, the town is listed under the highest intensity reported.

**January 9:** 2:29.\* Lower California. Epicenter about 31.7° north, 115.1° west, P. Felt in San Diego.

**January 19:** 22:14.\* Felt at Eureka, Blue Lake, Upper Mattole, and Ferndale.

**January 20:** 5:58.\* Near Buena Vista Lake. Epicenter about 35°20' north, 119°15' west, P. Felt at Buttonwillow and McKittrick.

**January 23:** 4:03.\* Humboldt Bay region. Felt over land area approximately 2,000 square miles. Maximum intensity V. A strong-motion record was obtained on the accelerograph at Ferndale.

#### INTENSITY V:

At Punta Gorda Light Station plaster was cracked and water spilled from indoor containers. Many or all were awakened at Dyerville, Eureka, Ferndale, Fields Landing, Miranda, Rio Dell, Shelter Cove, Shively, and Weott. At Ferndale hanging objects swung, and at Bridgeville trees and bushes shook slightly.

Also felt at Alder Point, Arcata, Blue Lake, Briceland, Cape Mendocino, Carlotta, Ettersburg, Forest Glen, Fortuna, Kneeland, Loleta, Rockport, Sawyers Bar, Scotia, and Westport.

Not felt at 24 other places canvassed.

**January 27:** 23:16. Fallon, Nev. Light shock accompanied by subterranean sounds. Two shocks recorded at Tinemaha, at 23:08 and at 1:23 on January 28.

**January 29:** 17:35.\* Near Whittier. Epicenter  $33^{\circ}58'$  north,  $118^{\circ}03'$  west, P. Felt generally in the Los Angeles basin. Felt strongest at Alhambra, Burbank, Los Angeles, Norwalk, and San Gabriel. Some plaster was shaken down and a few dishes were broken. There were several cases of water spilling from indoor containers.

Also felt at Altadena, Compton, El Monte, Gardena, Huntington Park, Keystone, Pasadena, Pico, Riverside, Santa Monica, and Whittier. At Point Fermin the tip of the point slid another 4.5 feet toward the ocean.

Not felt at Balboa and Fontana.

**February 5:** 5:33.\* Near head of Gulf of California. Epicenter about  $31.7^{\circ}$  north,  $115.1^{\circ}$  west, P. Felt at San Diego. Not felt at Riverside.

**February 8:** 7:59.\* Near Santa Barbara. Epicenter about  $34^{\circ}33'$  north,  $119^{\circ}41'$  west, Felt at Santa Barbara.

**February 9:** 1:45.\* Off coast near Eureka. Epicenter about  $40.9^{\circ}$  north,  $125.4^{\circ}$  west. Felt over a land area of approximately 17,000 square miles in California and southern Oregon as shown on map. Maximum intensity VI. Cracked plaster was reported in some instances, but there was no structural damage. The earthquake occurred during a heavy rain and wind storm. Strong-motion records were obtained from the instruments at Ferndale and Eureka.

#### INTENSITY VI:

*Arcata.*—All awakened and many frightened. Vase overturned and broken.

*Eureka.*—Small objects overturned.

*Ferndale.*—Everyone awakened, many frightened. Small objects overturned and knickknacks fell.

*Punta Gorda Light Station.*—Slight damage from cracked plaster.

*Shelter Cove.*—Everyone ran from home of observer. Several places along the bluff slid in.

#### INTENSITY V:

*Bridgeville.*—Many awakened and frightened.

*Carlotta.*—Many awakened.

*Crescent City.*—Many awakened. Clocks stopped.

*Fields Landing.*—Many awakened and frightened. Small objects and furnishings moved.

*Forest Glen.*—All awakened. Liquid spilled from containers.

*Fort Seward.*—Many awakened. Trees and bushes shaken strongly.

*Fortuna.*—Many awakened.

*Garberville.*—Many awakened.

*Klamath.*—Many awakened.

*Loleta.*—Many awakened. Water spilled from indoor containers. Hanging objects swung.

*Orick.*—Many awakened. Light fixtures swung. Trees and bushes shaken slightly.

*Orleans.*—Many awakened. Hanging objects swung. Small objects and furnishings moved.

*Scotia.*—Many awakened.

*South Fork.*—All awakened.

*Trinidad.*—Many awakened. Hanging objects and doors swung.

*Upper Mattole.*—All awakened.

*Weott.*—Many awakened. Small objects moved. Trees and bushes shook slightly.

*Willow Creek.*—Many awakened.

#### INTENSITY V IN OREGON:

*Grants Pass.*—Many awakened. Wooden bowls moved. Floor in hotel visibly shaken.

*Port Orford.*—Many awakened.

#### INTENSITY IV:

Alderpoint, Benbow, Blue Lake, Briceland, Cape Mendocino, Ettersburg, Harris, Honeydew, Hoopa, Hyampom, Island Mountain, Mendocino, Miranda, Mount Shasta City, Petaluma, Point Arena, Rockport, San Francisco, Smith River, Yager, Zenia.

#### INTENSITY IV IN OREGON:

Agness, Brookings, Glendale, Medford, O'Brien and Cave Junction.

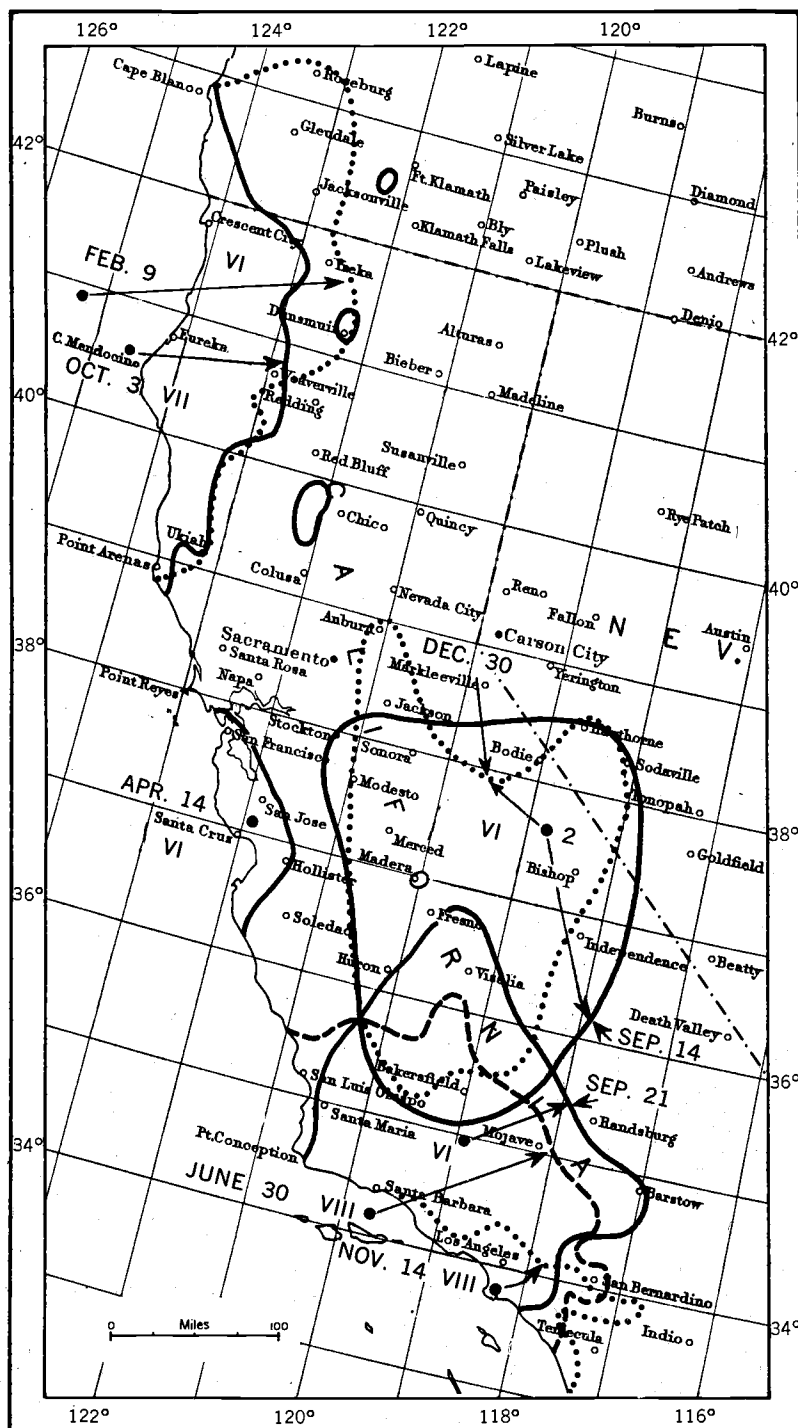


FIGURE 3.—Areas affected by the more important earthquakes of California and western Nevada in 1941.

## INTENSITY I TO III:

Blocksburg, Bolinas, Camp Grant (South Fork), Cummings, Fort Bragg, Laytonville, Longvale, Sawyers Bar, Weaverville, Willits, Yreka.

## INTENSITY I TO III IN OREGON:

Blaine, Gold Beach, Roseburg (Weather Bureau Office).

Not felt at 51 places canvassed in California and 23 in Oregon.

**February 10:** 22:44.\* Santa Barbara. Epicenter  $34^{\circ}16'$  north,  $119^{\circ}34'$  west, P. Felt in Santa Barbara. Police, fire department, and newspaper switchboards were jammed with hundreds of calls, according to the press.

**February 20:** 8:55.\* Near Saugus. Epicenter about  $34^{\circ}31'$  north,  $118^{\circ}33'$  west, P. Felt at Acton and Saugus. At Saugus liquids spilled from containers and trees and bushes shook slightly.

**February 21:** 2:43.\* Sierra Nevada, near Weldon. Epicenter  $35^{\circ}42'$  north,  $118^{\circ}22'$  west, P. Felt by many at Kernville. Few awakened.

**February 23:** 10:36.\* San Jacinto fault, Coahuila Valley. Epicenter about  $33^{\circ}30'$  north,  $116^{\circ}29'$  west, P. Felt at Indio, Mount Laguna, San Diego, Spring Valley, Thermal, and Warner Springs.

Not felt at 9 other places canvassed.

**February 26:** 5:09.\* Imperial Valley, near Niland. Epicenter about  $33.3^{\circ}$  north,  $115.5^{\circ}$  west, P. At Westmorland all were awakened and frightened. Small objects and furnishings moved and hanging objects swung. Clocks stopped. At Brawley and Calipatria many were awakened.

**February 26:** 6:02.\* Imperial Valley near Niland. Epicenter about  $33.3^{\circ}$  north,  $115.5^{\circ}$  west, P. Many awakened at Calipatria.

Not felt at Ogilby.

**February 28:** 12:14. Weott and Scotia. Trees and bushes shaken slightly at Weott.

**March 2:** 12:18.\* Los Angeles area. Epicenter about  $33^{\circ}59'$  north,  $118^{\circ}18'$  west, P. Felt in Wilshire District of Los Angeles.

Not felt at Maywood.

**March 5:** 23:18. San Leandro, Mills College, and Lake Merrit, slight shock. Recorded on the Berkeley seismographs.

**March 14:** 21:46.\* Lower California. Epicenter about  $28.1^{\circ}$  north,  $113.6^{\circ}$  west. Felt by few in San Diego.

**March 15:** 23:55. Benbow. Few awakened by light shock recorded on seismograph at Tinemaha.

**March 17:** 22:37. Imperial Valley. Many awakened in Brawley. Recorded on seismograph at Riverside.

**March 18:** 16:16. Hollister and Salinas. Windows rattled at Hollister.

**March 20:** 19:14.\* Santa Ana Mountains. Epicenter  $33^{\circ}41'$  north,  $117^{\circ}32'$  west, P. Felt in the Silverado Canyon.

**March 21, 22:** 19:12, 24:00, 4:00. Three shocks felt in the Silverado Canyon.

**March 25:** 15:44.\* San Bernardino Valley. Epicenter  $34^{\circ}13'$  north,  $117^{\circ}28'$  west, Lytle Creek region, P. At Alta Loma plaster cracked and small objects overturned. Also felt at San Bernardino, Cajon, Corona Ranger Station, Fontana, Llano, Lytle Creek Ranger Station, Riverside, and Victorville.

**March 27:** 2:45.\* Madera County. Epicenter  $37.2^{\circ}$  north,  $119.8^{\circ}$  west, P. At Raymond many awakened and small objects and furnishings moved. At Yosemite National Park many awakened and a roaring noise was heard by some. In Mariposa County residents were awakened by two shocks like an underground blast. Also felt at Knolls.

**March 27:** 17:35.\* Plaster City. Small objects and furnishings moved. Recorded on seismograph at Riverside.

**March 31:** 23:05.\* Sunol. Slight shock. Recorded definitely on seismographs at Tinemaha and Haiwee.

**April 5:** 4:41.\* Alpine County. At Woodfords the shock was felt by many, and loud sounds were heard. At Markleeville a clock stopped. A slight shock reported from Yosemite National Park one hour later was probably identical with this.

**April 9:** 9:08\* and 9:40.\* Probably Gulf of California. Epicenter about  $31^{\circ}$  north,  $114^{\circ}$  west, P. Felt by many in San Diego. Chandeliers swayed.

**April 10:** 17:20.\* Santa Ana Canyon. Epicenter  $33^{\circ}54'$  north,  $117^{\circ}35'$  west, Elsinore Fault zone, P. At Corona Ranger Station small objects moved and trees and bushes shook slightly. Also felt at Fontana, La Verne, Riverside, and San Bernardino.

**April 14:** 8:17.\* Lower San Francisco Bay and Monterey Bay regions. Felt over a land area of approximately 5,000 square miles as shown on map. Maximum intensity approximately VI.

## INTENSITY VI:

*Alma.*—All frightened. Trees and bushes shaken strongly.

*Aptos.*—Small objects moved, dishes and cans knocked off shelves.

*Capitola.*—Many frightened. Cans shaken from shelves in grocery store. Damage slight.

*Santa Cruz.*—Walls cracked slightly. Buildings and trees swayed visibly. Thunderous subterranean sounds were heard at time of shock.

*Soquel.*—Small objects overturned.

## INTENSITY V:

Small objects were moved in San Francisco, Saratoga, and Watsonville. At San Martin all were awakened.

## INTENSITY IV:

Almaden, Ben Lomond, Big Sur, Boulder Creek, Carmel, Colma, Davenport, Felton, Gilroy, Hollister, Holy City, Laurel, Los Gatos, Madrone, Moss Beach, Olympia, Spreckels.

## INTENSITY I TO III:

Brookdale, Coyote, Hayward, Marina, Monterey, Pacific Grove, Salinas, San Bruno, San Juan Bautista, Seaside, Sunnyvale.

Not felt at 57 places canvassed.

**April 18:** 17:46.\* Near Long Beach. Epicenter 33°48' north, 118°12' west, P. Felt at Compton, according to the press.

**April 24:** 10:46.\* Off Huntington Beach. Epicenter 33°37' north, 118°02' west, P. Felt at Huntington Beach.

**May 1:** 5:29.\* Northern California. Plumas and Butte Counties. Epicenter about 40° north, 121° west, P. Felt at Almanor, Caribou, De Sable, Lassen, and Stirling City; also Bucks and Prattville Powerhouses. At Caribou the shock was felt by many and rumbling sounds were heard at time of shock.

**May 13:** 8:02.\* Off Cape Mendocino. Epicenter 40.3° north, 125.0° west. Felt along the coast at widely separated points and at 2 towns in Oregon. Maximum intensity V.

A record was obtained on the strong-motion seismograph at Ferndale. At Loleta many awakened. At Santa Cruz plaster was reported cracked. Hanging objects swung at Ferndale, Rio Dell, Rockport, and Willits. Also felt at Arcata, Ben Lomond, Blue Lake, Bolinas, Carlotta, Ettersburg, Eureka, Fort Bragg, Petrolia, Redwood City, San Francisco, Scotia, Shively, Trinidad, Ukiah, Upper Mattole, and Wildwood. Felt at DePoe Bay and Knappa in Oregon.

Not felt at 40 other places canvassed in California nor at 40 in Oregon.

**May 14:** 19:29 and 22:00. Coalinga. Hanging objects swung. Recorded indefinitely at Pasadena, Tinemaha, and Mt. Wilson.

**May 21:** 15:43. Probably Gulf of California. Epicenter 29°? north, 113°? west, P. Felt in San Diego.

**May 27:** 22:23.\* San Francisco and Monterey Bay regions. Felt over land area of approximately 4,500 square miles. Maximum intensity about VI. Plaster was reported cracked in one town.

## INTENSITY VI:

*San Martin.*—Many awakened and frightened. Plaster cracked, hanging objects swung. Damage slight.

## INTENSITY V:

Many were awakened at Boulder Creek, Niles, San Carlos, and Soquel. Small and hanging objects were disturbed at Kentfield, Los Gatos, Manor, San Carlos, and San Francisco.

## INTENSITY IV:

Almaden, Alvarado, Aptos, Ben Lomond, Berkeley, Bolinas, Burlingame, Campbell, Corte Madera, Davenport, El Granada, Gilroy, Half Moon Bay, Laurel, Los Altos, Madrone, Mill Valley, Milpitas, Morgan Hill, Newark, Olympia, Redwood City, Ross, San Gregorio, San Jose, San Juan Bautista, San Mateo, Santa Cruz, Sausalito, Sunnyvale.

## INTENSITY I TO III:

Alameda, Coyote, Montara, Moraga, Oakley, Pescadero, Pleasanton, Tiburon.

Not felt at 41 other places canvassed.

**June 2:** 17:20.\* Off Huntington Beach. Epicenter about 33°37' north, 118°02' west, P. Felt at Seal Beach.

**June 4:** 0:56.\* Near Santa Ana. Epicenter 33°45' north, 117°50' west, P. In Santa Ana many residents were awakened. At Newport Beach few were awakened and hanging objects swung. Also felt 3 miles south of Anaheim.

**June 4:** 5:47. Sierra Madre Mts. Epicenter about 34°17' north, 117°43' west, P. Felt outdoors by some and awakened a few at Valyermo Ranger Station.

**June 7:** 18:18.\* Near Independence. Epicenter 36°43' north, 118°10' west, P. Felt by many at Independence. Stove and furniture rattled.

**June 11:** 5:27. Lower Los Angeles County. Epicenter 33°47' north, 118°25' west. Felt at Redondo, Hermosa, and Manhattan Beaches, according to the press.

**June 25:** 9:15.\* Lower California. Epicenter about 32.5° north, 115.9° west, P. Felt at Calipatria and Carriso Gorge.

**June 30:** 23:51.\* Santa Barbara channel. Epicenter 34°20' north, 119°35' west, P. Maximum intensity VIII. Land area affected about 20,000 square miles as shown on the map. The intensity was in the lower bracket of VIII at Santa Barbara and Carpinteria and VII at Goleta and Ventura. The total damage was estimated around \$100,000, of which 25 percent was damage to drug and liquor stocks and 10 percent to plate glass. An article on the earthquake appears in the October 1941 issue of "Building Standards Monthly."

The outstanding features included a small slide which covered the railroad and reached the highway about twenty miles south of Santa Barbara on Highway 101; temporary suspension of telephone service between Santa Barbara, Carpinteria, Ventura, and San Luis Obispo; the toppling of 600,000 board feet of lumber standing on end, 2,000 stacked cases of lemons, and a number of bookcases; and the snapping off of many street lamps in Santa Barbara.

Strong-motion seismograph records were obtained at Santa Barbara, Hollywood, Los Angeles, Vernon, and Long Beach.

## INTENSITY VIII:

*Carpinteria*.—Damage was proportionately higher than in Santa Barbara. About 25 chimneys and a number of walls fell, and the cornice of 1 building was shaken off. Pictures and plaster fell, and dishes and windows were broken.

*Santa Barbara*.—Thirty glass-topped street lamps were snapped off. Bricks were dislodged from some buildings and several buildings were cracked, but none was seriously damaged. In several old school buildings some plaster cracked or fell, but there was no structural damage to any schools. One chimney toppled down. The loss due to shattering of plate-glass windows amounted to approximately \$10,000. Art and curio shops suffered from \$5,000 to \$10,000 loss. Practically every store in the 600 to 1,000 blocks of State Street suffered considerable inside damage.

Sidewalks buckled in a few places and there were 17 breaks in the larger water mains in addition to 18 service breaks. Power and gas were shut off in a few sections to check operations. In the County Law Building large book shelves toppled, and there were many instances of broken dishes, windows, and furniture. Liquids spilled from indoor and outdoor containers.

## INTENSITY VII:

*Goleta*.—All residents were awakened and a few frightened. Plaster, windows, walls, and chimneys were cracked. Knickknacks, books, and pictures fell, and there was some fall of plaster. Dishes, windows, and furniture were reported broken. Liquids spilled from indoor and outdoor containers. Trees and bushes were shaken strongly.

*Ventura*.—Some cracked walls and fall of plaster were reported. Windows and dishes were broken. There was considerable damage to glass goods in stores.

## INTENSITY VI:

*Fillmore*.—All were awakened and frightened. Clocks stopped.

*Kern*.—Dishes were broken and clocks stopped. According to the press, there was a flood of telephone calls to local law enforcement agencies. One sleeper reported he fell out of bed.

*Keystone*.—Many awakened and frightened. Plaster was cracked and liquids spilled from indoor containers. Damage slight.

*Los Alamos*.—Many awakened. Vases and small objects overturned. Damage slight. Many clocks stopped.

*Ojai*.—Some walls cracked very slightly. Trees and street lamps swayed visibly. A few small objects were overturned.

*Oxnard*.—Many were alarmed. Clocks stopped. No appreciable damage.

*Port Hueneme*.—Awakened all and frightened many. Plaster cracked. Trees and bushes shaken moderately.

*Santa Paula*.—All awakened. Vases overturned. Trees and bushes shook moderately.

*Summerland*.—All awakened and frightened. Vases and small objects overturned. Damage slight.

*Wheeler Springs*.—Many frightened. Mirror broken. Hanging objects swung.

## INTENSITY V:

Acton, Altadena, Arlight, Artesia, Arvin, Balboa, Betteravia, Buellton, Burbank, Camarillo, Canoga Park, Casmalia, Cayucos, Chatsworth, Compton, Concepcion, El Segundo, Gaviota, Glendale, Hermosa Beach, Inglewood, La Crescenta, Laguna Beach, Lancaster, Lomita, Lompoc, Long Beach, Los Angeles, Los Olivos, Maywood, McKittrick, Montalvo, Moorpark, Mt. Figueroa Lookout, Newbury Park, Newport, Nipomo, North Hollywood, Oceano, Orcutt, Pasadena, Pattiway, Piru, Sandberg, San Nicolas Island, San Pedro, Santa Ana, Santa Maria, Santa Monica, Santa Inez, Sierra Madre, Simi, Stanton, Sunland, Surf, Tehachapi, Upper Sespe Mts., Valyermo, Wheeler Ridge, Whittier.

At most of these places many residents were awakened and some frightened. In a small number of cases hanging objects swung and trees and bushes were shaken slightly. Los Angeles reported slight swaying of some buildings.

## INTENSITY IV:

Adelanto, Alhambra, Arroyo Grande, Avalon, Bakersfield, Bellflower, Brea, Buttonwillow, Caliente, Creston, El Toro, Fellows, Grapevine, Guadalupe, Hollywood, Huntington Beach, Huntington Park, La Canada, Lake Arrowhead, Littlerock, Manzanita Lookout, Maricopa, Mount Wilson, Moreno, Olive View, Ontario, Point Conception Light Station, San Dimas, San Juan Capistrano, Santa Susana, Saticoy, Seal Beach, Shafter, Shandon, South Gate, Taft, Topanga, Tupman, Van Nuys, Yorba Linda.

## INTENSITY I TO III:

Delano, Etiwanda, Llano, Mojave, Palmdale, Point Loma, Pozo, Pomona, Redlands, Riverside, Rosamond, San Bernardino, San Diego, Santa Margarita, Tipton, Tujunga, Wasco, Wrightwood. Not felt at 54 other places canvassed.

**July 1:** 15:54.\* Near Santa Barbara. Epicenter 34°20' north, 119°35' west, P. Felt at Fillmore, Gaviota, Los Alamos, and Santa Barbara. Felt by nearly everyone at Los Alamos.

**July 6:** 0:47.\* Ukiah. Felt by several. Awakened all at a point 15 miles northwest of Ukiah.

**July 12:** 8:18.\* Near Santa Barbara. Epicenter 34°20' north, 119°35' west, P. Felt rather strongly at Montrose, Saticoy, and Wheeler Springs. Also felt at Fillmore, Glendale, Los Angeles, and Saugus.

**July 17:** 19:54.\* Western Nevada. Epicenter about 40° north, 119° west, P. Felt at Wadsworth, Nev.

**July 22:** 10:52.\* Imperial Valley. Epicenter about 32°44' north, 115°27' west, P. Felt at Brawley, Westmorland, and Calipatria. At Brawley a few cracks appeared in walls of buildings in the business district.

**July 23:** 13:13.\* Marin County. Strongest at Kentfield where some residents ran from their homes and mirrors moved. At Novato a wall was reported cracked. Intensity IV at Ross, San Rafael, and Sausalito. Also felt at Ignacio, Olema, Petaluma, San Francisco, Berkeley, Richmond, Napa, and Vallejo.

**July 25:** 23:32.\* Los Angeles County. Epicenter about 33°37' north, 118°02' west, P. Felt near Huntington Beach.

**August 10:** 4:08.\* Los Angeles County. Epicenter about 34°01' north, 117°53' west, near Walnut, P. Felt at Claremont.

**August 17:** 3:14.\* Owens Valley. Epicenter about 36.5° north, 118.0° west, near Lone Pine, P. Many awakened at Keeler. At Lone Pine china was dislodged in several homes.

**August 25:** 20:31.\* Hollister. Slight shock recorded at Tinemaha.

**September 1:** 21:48. Pope Valley. A few awakened at St. Helena. Recorded at Tinemaha.

**September 7:** 19:12:45\* and 19:14:23.\* Near Santa Barbara. Epicenter 34°20' north, 119°35' west, P. Twin shocks of about the same magnitude were felt over a land area of approximately 1,500 square miles. Maximum intensity V was reported from Goleta and Santa Barbara. A strong-motion record was obtained on the accelerograph in Santa Barbara.

At Goleta small objects and furnishings moved and hanging objects swung. At Santa Barbara some dishes were reported broken, many residents were frightened, and trees and bushes were shaken slightly. Similar intensity was reported from Los Alamos and Summerland. Also felt at Buellton, Carpinteria, Los Olivos, Santa Inez, Ventura, and Lompoc. It was not felt at Maricopa and San Onofre.

**September 7:** 20:45.\* Near Santa Barbara. Epicenter 34°20' north, 119°35' west, P. Felt at Santa Barbara.

**September 8:** 19:23.\* Near Santa Barbara. Epicenter 34°20' north, 119°35' west, P. Felt at Santa Barbara.

**September 12:** 19:25.\* Near Riverside. Epicenter about 33°50' north, 117°20' west, the Gavilan district, P. Felt at Fawnskin (Big Bear Ranger Station).

**September 13:** 5:05. Off La Jolla. Felt by many at Point Loma. Hanging objects swung and subterranean sounds were heard. (Possibly same shock as one recorded on September 14 at 15:51.\* Epicenter about 32°53' north, 117°24' west, about 15 miles off La Jolla, P.)

**September 14:** 8:44,\* 8:55,\* 10:21,\* 10:39,\* 10:54.\* Owens Valley, near Rock Creek. Epicenter 37°34' north, 118°44' west, P. Maximum intensity VI-VII. Higher intensities probably occurred but were not reported because of sparseness of population. The magnitudes of the five shocks listed were respectively 6, 4.5, 5.5, 6, and 4, according to the Pasadena magnitude scale. Area affected, about 30,000 square miles, mostly in California. Rock slides in the mountains raised huge clouds and blocked roads and trails. Highway 395 was blocked at two points by large boulders, and an unoccupied cabin was destroyed. All residents of the Rock Creek and Mono Creek basins were frightened.

Because of confusion in the times of occurrence listed on many of the reports, the following abstracts will include information on all of the shocks. In "Abstracts of Earthquake Reports for the Pacific Coast and Western Mountain region" for this period the data are separated into 3 groups, those for the 8:43 shock and various others, the 10:21, and the 10:39 shocks.

Strong-motion records of the 8:43, 10:21, and 10:39 shocks were obtained at Bishop.

#### INTENSITY VI:

*Benton.*—All were frightened. Plaster and walls cracked, knickknacks, books, and pictures fell.

*Columbia.*—Small objects moved, and knickknacks fell.

*Coulterville (Trumbull Peak Lookout).*—Small objects moved, knickknacks fell.

*Doyles.*—Fireplace damaged.

*Groveland (Wood Ridge Lookout).*—Small objects moved, knickknacks fell.

*Groveland (Tuolumne Ranger Station).*—Small objects moved, knickknacks fell.

*Incline Ranger Station.*—Small objects moved, knickknacks fell.

*Incline Guard Station.*—Trees and bushes shaken moderately.

*North Fork.*—Small objects overturned.

*Oakhurst (Miami Ranger Station).*—Chimney and walk cracked.

*Pinedale.*—One adobe wall cracked, floor lamps moved.

*Pineridge Shaver Ranger Station.*—Walls and chimneys cracked; trees and bushes shaken strongly. All frightened.

*Tuolumne.*—Small objects moved, knickknacks fell.

*Yosemite Valley.*—Canned goods tumbled from shelves. Several chimneys damaged. Small objects were overturned, and a chandelier swung through a wide arc.

#### INTENSITY V:

*Ash Peak Lookout (Sequoia National Park).*—Wooden walls cracked; trees and bushes shaken moderately.

*Auberry, 10 miles north of.*—Felt by all. Hanging objects swung. Shock preceded by rumbling noise.

*Big Creek.*—Small objects and furnishings moved. Rumbling sounds heard during shock by many.

*Breckenridge Lookout.*—Small objects moved,



- Cathay Valley*.—Small objects and mirror moved. Bed shaken distinctly.  
*Delpiedra*.—Small objects and furnishings moved; trees and bushes shook moderately.  
*Dunlap*.—Small objects moved. Trees and bushes shook strongly.  
*El Portal*.—Small objects and furnishings moved; large rockery shaken.  
*Fresno*.—Tall buildings swayed slightly; furniture was displaced and chandelier swayed. Press reported some plaster cracked.  
*Friant*.—Disturbed objects observed by many; suspended rope swung moderately.  
*Jamestown*.—Plaster cracked.  
*Kaweah*.—Liquids spilled from containers; trees and bushes shook strongly. Many frightened. Rumbling noise.  
*Lakeshore (Kaiser Diggings)*.—Felt by all. Trees and bushes shook slightly.  
*Lakeshore (High Sierra Ranger Station)*.—Felt by all. Trees and bushes shook slightly.  
*Laws*.—Trees and bushes shook strongly. Clocks stopped.  
*Lone Pine*.—Small objects and furnishings moved.  
*Madera*.—Buildings swayed. Bumping subterranean sounds heard during one shock.  
*Mammoth Lakes*.—Several small slides of stones near Convict Lakes and along Rock Creek Road; slight damage to roads. Terrific rumble heard with many landslides on higher mountains.  
*Mammoth Lakes District (Crystal Crag)*.—Rocks fell from cliff. Part of mountain east of Twin Lakes slipped off. Many frightened at Tamarack Lodge.  
*Newman*.—Chandelier swung.  
*Oakhurst*.—Felt by all. Pictures swayed.  
*O'Neals*.—Small objects and furnishings moved.  
*Pineridge*.—Many frightened. Small objects moved up and down.  
*Pine Creek Canyon (about 15 miles west of Bishop)*.—Felt by all. Trees and bushes shaken moderately. One observer reported the following: "I was on my way to a mill in Pine Creek Canyon when the last and most severe shock occurred and happened to be immediately across the stream (Pine Creek) from a long swale heading on the very top of Mt. Tom and descending almost in a straight line to Pine Creek. \* \* \* I noticed the rocks hurtling down the mountain side, accompanied by a large cloud of dust. \* \* \* Many of the boulders weighed several tons and literally hundreds of them were in the air over a period of at least three or four minutes, possibly longer. \* \* \* Considerably rolling stock was found lodged in the road and in some instances had to be removed before traffic could be resumed."  
*Porterville*.—Plaster cracked in a few houses; hanging objects swung.  
*Raisin*.—Small objects and furnishings moved. Some frightened.  
*Reds Meadow Guard Station (Mammoth Lakes)*.—Rocks fell from sides of road, cut, and canyons. Dishes moved.  
*Reedley*.—Plaster cracked; damage slight.  
*Riverdale*.—Small objects moved.  
*Shaver Lake*.—Pine cones and limbs fell from trees. Rumbling sounds.  
*Sonora*.—Small objects moved. Trees and bushes shook moderately.

## INTENSITY V IN NEVADA:

- Dyer*.—Plaster cracked; damage slight.  
*Mount Montgomery*.—Small objects overturned; canned goods moved.

## INTENSITY IV:

Academy, Bakersfield, Benton, Big Meadow Guard Station (Pinehurst Ranger Station), Big Oak Flat, Bigpine (Powerhouse), Bishop, Bodfish, Bridgeport, Buttonwillow, Camp Mather, Cathay Valley, Choice Valley (Cholame), Clovis (7 miles northeast of), Coalinga, Coulterville, Corcoran, Cutler, Dardanelle, Deep Springs, Dos Palos, Ducor, Dunlap, El Portal, Exeter, Fresno and mountain area, Friant, Grizzly Flats, Hanford, Havilah, Hume Lake, Huntington Lake, Huron, Independence, Kaweah, Kerman, Kernville, Kettleman City, Lakeshore, LaGrange, Laton, Laws, Lemon Cove, Lindsay, Lone Pine, Lost Hills, Madera, Mammoth Lakes, McKittrick, Mendota, Mt. Baldy Look-out, Navalencia, Newman, North Fork, Oakdale, Oasis, Oilfields, O'Neals, Orange Cove, Pinehurst Ranger Station, Pineridge, Pond, Prather, Reedley, Riverdale, Sacramento, Sanger, Selma, Sequoia National Park, Snelling, Sonora, South Lake, Springville, Stratford, Squaw Valley, Three Rivers, Tipton, Tollhouse, Tranquillity, Usona, Visalia, Wawona, Woodlake, Yosemite Valley.

## INTENSITY IV IN NEVADA:

Hawthorne, Mina.

## INTENSITY I TO III:

Arvin, Bakersfield, Bear Valley, Buttonwillow, Copperopolis, Cutler, Ducor, Hollister, Ione, June Lake, Kerman, Laton, Leevining, LeGrand, Linden, Long Barn, Navalencia, O'Neals, Sacramento, Selma, Shafter, Stanislaus, Stockton, Stratford, Three Rivers, Tollhouse, Traver, Tulare, Ventucopa, Vernalis.

Not felt at 83 places canvassed in California and 8 places in Nevada.

**September 14: 13:16.\*** Owens Valley. Epicenter 37°34' north, 118°44' west, near Rock Creek, P. Felt at Big Creek.

**September 14: 17:37.\*** Near Santa Barbara. Epicenter 34°20' north, 119°35' west, P. Felt at Santa Barbara, Goleta, and Summerland. Maximum intensity at Santa Barbara; many frightened, trees and bushes shaken slightly.

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

**September 17: 23:33.\*** San Francisco and Monterey Bay regions. Epicenter about  $37.4^{\circ}$  north,  $122.0^{\circ}$  west. Felt over a land area of approximately 4,500 square miles. Maximum intensity approximately V, reported from many places.

Strong-motion records were obtained from the accelerographs in San Jose.

#### INTENSITY V:

Alvarado, Alviso, Berkeley, Boulder Creek, Burlingame, Colma, El Granada, Felton, Half Moon Bay, Hayward, Mill Valley, Milpitas, Mount Hamilton, Newark, Olympia, Redwood City, San Francisco, Santa Cruz, Saratoga, Soquel, and Sunnyvale. At all of these places many residents were awakened and some frightened. In San Francisco disturbed objects were observed by a few, and there were a few reports of suspended objects swinging. In some sections of the city the shock was not felt. At Milpitas liquids were spilled from containers and trees and bushes shook moderately. Santa Cruz reported roaring sounds before the shock. At San Jose the telephone company reported a flood of calls.

#### INTENSITY IV:

Alamo, Aptos, Ben Lomond, Bolinas, Coyote, Daly City, Hollister, Holy City, Loma Mar, Madrone, Millbrae, Montara, Monterey, Mountain View, Morgan Hill, Niles, Oakland, Palo Alto, Pleasanton, Pescadero, Richmond, San Bruno, San Jose, San Lorenzo, San Martin, San Rafael, Sausalito, South San Francisco, Stockton, Vallejo, Vernalis, Warm Springs.

#### INTENSITY I TO III:

Alma, Big Basin, Big Sur, Carmel Valley, Glenwood, Livermore, Los Gatos, Pinole, San Carlos, San Juan Bautista, Stinson Beach.

Not felt at 45 places canvassed.

**September 21: 11:53.\*** Southern California. Epicenter  $34^{\circ}52'$  north,  $118^{\circ}56'$  west, near Cuddy Valley, P. Felt over a land area of approximately 26,000 miles. A maximum intensity of approximately VI was reported from several places.

#### INTENSITY VI:

*Gorman.*—Dishes reported broken.

*Lebec.*—Lamps sway and objects fell from shelves.

*Los Angeles.*—Generally felt. One observer reported swinging of pictures and mirror. Small vase thrown from the mantle. Trees and bushes shaken slightly.

*Taft.*—Knickknacks fell.

*Wheeler Ridge.*—Many frightened. Small objects overturned; knickknacks and pictures fell.

#### INTENSITY V:

*Antelope Valley (Lancaster).*—A few frightened. House cracked.

*McKittrick.*—Small objects and furnishings moved; clocks stopped.

*Rosamond.*—Felt by some outdoors. Small objects moved; water spilled from indoor containers.

*Sandberg.*—Felt by all. Trees and bushes shaken moderately.

#### INTENSITY IV:

Acton, Adelanto, Bakersfield, Buttonwillow, Caliente, Camarillo, Ducor, Fillmore, Glendale, Goleta, Grapevine, Lancaster, Los Alamos, Lost Hills, Mojave, Olive View, Pasadena, Porterville, Pozo, San Gabriel, Santa Ana, Shafter, Tehachapi, Ventucopa, Wasco, Weldon, Wheeler Springs.

#### INTENSITY I TO III:

Barstow, Camp Nelson (near Lindsay), Cantil, Culver City, El Segundo, Hollywood, Huntington Park, Inglewood, Kernville, Kettleman City, Lindsay, Montebello, Mount Wilson, Muroc, Pomona, Sanger, Santa Monica, Victorville, Whittier.

Not felt at 8 other places canvassed.

**September 21: 19:56.\*** Owens Valley. Epicenter  $37^{\circ}34'$  north,  $118^{\circ}44'$  west, P. At Owens River Gorge Power Plants (Bishop) and at Lakeshore (High Sierra Ranger Station) trees and bushes were shaken.

**September 24: 21:13.\*** Near Santa Barbara. Epicenter  $34^{\circ}20'$  north,  $119^{\circ}35'$  west, P. At Santa Barbara and Goleta some residents were awakened and a few frightened. At Goleta small objects moved.

**September 25: 17:55.\*** Hollister. Felt by many in Hollister and by a few at Salinas. Weak record obtained on seismograph at Tinemaha.

**October 3: 8:13.\*** Epicenter at sea off Cape Mendocino,  $40.6^{\circ}$  north,  $124.6^{\circ}$  west. Felt over a land area of approximately 12,000 square miles in northwestern California and southwestern Oregon, as shown on map. Maximum intensity about VII at Eureka.

Strong-motion records were obtained on the seismographs at Eureka and Ferndale.

#### INTENSITY VII:

*Eureka.*—Many residents frightened. Chimneys were twisted and cracked; some plaster fell. Trees and bushes shaken moderately. Some clocks stopped. Subterranean sound like rushing wind.

#### INTENSITY VI:

*Ferndale.*—A few frightened. Dishes, windows, and furniture broken. Vases, small objects, and furniture overturned. Some plaster cracked. Pictures and books fell; some pendulum clocks stopped.

*Fields Landing.*—All frightened; books fell; vases overturned; water spilled from containers and tanks.

*Korbel*.—All frightened. Walls and plaster cracked; large tanks shaken. Telephone wires, trees, and bushes shaken.

*Pepperwood*.—All frightened. Small objects and vases overturned; knickknacks fell. Damage slight.

*Punta Gorda*.—Walls and plaster cracked; water spilled from indoor and outdoor containers.

*Rio Dell*.—Many frightened. Small objects overturned and knickknacks fell.

*Rockport*.—Small objects moved; knickknacks fell.

*Upper Mattole*.—Bricks fell from one chimney. Small objects and furnishings moved. Trees and bushes shaken slightly.

#### INTENSITY V:

Arcata, Benbow, Briceland, Cape Mendocino, Carlotta, Dyerville, Garberville, Holmes, Hyampom, Kneeland, Loleta, Petrolia, Wildwood. At most of these places the shock was felt by the majority of the population, and some were frightened. At many of them trees and bushes were shaken moderately, suspended objects swung, and small objects and furnishings moved. At Loleta water spilled from indoor containers and clocks stopped. At Garberville pictures fell.

#### INTENSITY IV:

Alderpoint, Big Bar, Blue Lake, Branscomb, Bridgeville, Burnt Ranch, Capetown, Cummings, Denny, Dunsmuir, Elk, Ettersburg, Forest Glen, Fort Bragg, Fortuna, Happy Camp, Hartsook, Harris, Hayfork, Honeydew, Hoopa, Island Mountain, Klamath, Littleriver, Longvale, Miranda, Mount Shasta, Orick, Orland, Orleans, Piercy, Point Arena, Salyer, San Francisco, Sawyers Bar, Scotia, Smith River, Somesbar, Trinidad, Ukiah, Weaverville, Weitchpec, Weott, Willits, Willow Creek, Willows.

#### INTENSITY IV IN OREGON:

Harbor, Pistol River.

#### INTENSITY I TO III:

Blocksburg, Creseent City, Fort Jones, Junction City, Mad River, San Rafael, Spyrock, Stinson Beach, Vina, Zenia.

#### INTENSITY I TO III IN OREGON:

Grants Pass, Port Orford.

Not felt at 91 places canvassed in California nor at 22 in Oregon.

**October 3:** 21:59.\* Los Angeles County. Epicenter 33°47' north, 118°25' west, P. Felt at Palos Verdes, Redondo Beach, Hermosa Beach, Manhattan Beach, and El Segundo.

**October 12:** 23:25.\* Owens Valley. Epicenter 37°34' north, 118°44' west, P. Felt at Bishop (Owens River Gorge).

**October 14:** 8:30. Near Reno, Nevada. Felt in Reno by about 1/10 of the population. Strongest in the south and southeast portion of the town and in the Washoe Valley to the south. Shock believed responsible for shutting off heavy flow of water on an excavation project. Displaced objects reported by several.

Nine miles southeast of Truckee, snow slid off roof of the Martis Peak Lookout building. Small objects were moved at Loyalton. Also felt at Boca, Brushy Springs, Donner Summit, Devils Peak, Norden, north of Rubicon River (Placer County), Robbs Peak, and Verdi.

**October 18:** 2:38.\* Owens Valley. Epicenter 37°34' north, 118°44' west, P. Felt at Bishop.

**October 21:** 22:57.\* Los Angeles County. Gardena area. Epicenter 33°49' north, 118°13' west, P. Land area affected, about 2,000 square miles. Maximum intensity VII. Damage was confined to an area including Compton, Hynes, Moneta, Gardena, downtown Los Angeles, Westwood, and the Dominguez Oil Field. A large part of the information following is abstracted from an unpublished report by M. H. Gilmore of the Los Angeles office of the Coast and Geodetic Survey.

Outside of an unusual amount of damage in the oil fields, severe damage was limited to one building, cracked walls and plaster, broken windows, glassware, bottles, etc. Some heavy machinery was loosened. Thirty out of 65 gas shut-off valves installed in schools operated. Based on an average of the durations reported, the shock lasted about 10 seconds. There were no outstanding directional characteristics.

The greatest damage was in the West Dominguez Oil Field east of Gardena. Almost all of the wells went off production temporarily, and a small number required redrilling. The tubing of the wells was damaged at depths greater than 5,000 feet. According to the oil company officials, the rock displacement must have been between 5 and 10 inches.

Strong-motion records were obtained at Hollywood, Vernon, Westwood, Long Beach, and at three points in downtown Los Angeles.

#### INTENSITY VII:

*Compton*.—Many cracks developed in buildings and plaster, and some windows and dishes were broken. The greatest damage occurred in drugstores from loss of stock. In a large feedstore most of the stacks of grain were knocked down. A valuable clock was reported thrown to the floor and smashed. The damage was less than in Gardena.

*Gardena*.—Damage was estimated at \$10,000. Many buildings were cracked. Several large plate glass windows and many small ones were broken, and merchandise stocks were damaged. In several stores workers spent most of the night clearing away the bedris. In one shop the soda fountain equipment was twisted on its base. Cracks opened up in the walls of two banks buildings. Private

residences were rocked and furniture slid out of place. Some lights and telephones were out for a short time.

*Keystone*.—Considerable damage resulted from broken plaster and dishes, cracked walls, and twisted chimneys. One double bed on casters shifted 5 feet. Power poles were badly shaken and railroad switch machines thrown out of adjustment.

*Moneta*.—The fire walls on 1 building were thrown down, and small cracks appeared in the walls of the nearby post-office building. Some chimneys were cracked.

#### INTENSITY VI:

*Hollywood*.—Knickknacks fell; trees and bushes shook slightly.

*Hondo*.—Plaster cracked.

*Hynes*.—Old cracks in post-office walls made wider.

*Long Beach*.—Nearly everyone awakened; many frightened. Some knickknacks, books, and pictures fell. Vases overturned. Trees and bushes shaken moderately.

*Los Angeles*.—Nearly everyone awakened. Hotel fire escapes in downtown Los Angeles were reported alive with people. Damage confined to cracks in walls and plaster. A few small cracks opened up in the Chamber of Commerce building and in the post office and courthouse. There were few other cases of this kind. Loose and hanging objects were generally disturbed; door bells rang and some burglar alarms were set off.

*Lomita*.—Plaster cracked; small objects and furnishings shifted.

*Lynwood*.—Plaster cracked; slight damage to crockery. Press reported some stock shaken from shelves.

*Manhattan Beach*.—Plaster cracked; damage slight.

*Maywood*.—Awakened and frightened all.

*Venice*.—Plaster cracked.

*Walteria*.—Small objects shifted; trees and bushes shook slightly.

*Wilmingtton*.—All awakened.

#### INTENSITY IV:

Alhambra, Anaheim, Beverly Hills, Duarte, East Los Angeles, El Segundo, Fullerton, Glendale, Hawthorne, Huntington Beach, Inglewood, Los Alamitos, Montalvo, Monterey Park, Norwalk, Oxnard, Reseda, Santa Ana, Santa Monica, Whittier, Willowbrook.

#### INTENSITY I TO III:

Brea, Cornell, La Canada, La Habra, Newport Beach and Balboa, Pasadena, Phelan, Pomona, Riverside, San Fernando, Santa Paula, Simi, Topanga, Van Nuys, West Los Angeles.

Not felt at 40 other places canvassed.

**October 22: 2:32.\*** Los Angeles County, Gardena area. Epicenter 33°47' north, 118°12' west, P.

Strong-motion records of this aftershock were obtained from instruments at Long Beach and at one point in downtown Los Angeles.

#### INTENSITY VI:

*Compton*.—Small objects overturned; clocks stopped.

*Gardena*.—Many awakened and frightened. Plaster cracked; small objects overturned; knickknacks fell.

*Hondo*.—Plaster, windows, walls, and chimneys reported cracked.

*Pacific Palisades*.—Plaster cracked, small objects overturned.

#### INTENSITY V:

Anaheim, Clearwater, Downey, Garden Grove, Hermosa Beach, Hynes, Lomita, Lynwood, Moneta, Walteria, Willowbrook. At all of these points most of the residents were awakened. At Walteria small objects moved. At Hermosa Beach the shock was felt by some outdoors.

#### INTENSITY IV:

Bellflower, Culver City, Fullerton, Los Alamitos, Montalvo, Simi, Terminal Island, Torrance.

#### INTENSITY I TO III:

Calabasas, Cornell, Oxnard, Pomona, Riverside, San Fernando, Van Nuys.

Not felt at 46 other places canvassed.

**October 23: 12:45.\*** Owens Valley. Epicenter 37°34' north, 118°44' west, P. Trees and bushes shaken slightly at Delpiedra.

**October 24: 23:08.** Las Plumas and Willows. At Willows small objects were thrown to the floor.

**October 26: 16:42.\*** Owens Valley. Epicenter 37°34' north, 118°44' west, P. Trees and bushes shaken slightly at Bishop.

**November 1: 10:10.\*** Owens Valley. Epicenter 34°36' north, 118°35' west, north of Castaic, P. At Bishop (Owens River Gorge) all were frightened and small objects shifted. Also felt at Fairmont, Bishop (Adams Main Powerhouse) and Laws.

**November 5: 8:36.** Off Point Conception. Epicenter about 35°? north, 121°? west, P. Felt at San Simeon (Salmon Creek Guard Station).

**November 6: 2:32.** Humboldt County. Felt at Eureka, Ferndale, and Petrolia. Recorded on seismograph at Ferndale.

**November 10:** 5:22. Off Huntington Beach. Epicenter 33.6° north, 118.0° west, P. Felt at Huntington Beach.

**November 11:** 21:33. Tulare County. Felt at Kaweah and Springville. Recorded at nearby seismograph stations.

**November 14:** 0:42.\* Los Angeles County, Torrance-Gardena area. Epicenter 33°47' north, 118°15' west, P. Land area affected about 3,600 square miles as shown on map. Maximum intensity VII-VIII. No casualties. Damage approximately \$1,000,000.

Most of the following descriptive material for the central area is taken from an unpublished report of M. H. Gilmore and R. A. Wheeler of the Coast and Geodetic Survey, who covered the shock from the Los Angeles office of the Bureau. A summary of that report and additional material will be found in "Abstracts of Earthquake Reports for the Pacific Coast and Western Mountain Region, October 1, 1941, to December 31, 1941".

Strong-motion seismograph records were obtained at Vernon, Long Beach, Westwood, Hollywood and at 3 places in downtown Los Angeles.

The shock caused more damage in the Los Angeles area than any since the Long Beach earthquake of 1933. In and around Torrance and Gardena at least 50 buildings were severely damaged. At Redondo Beach, Long Beach, San Pedro, Wilmington, Lometa, and downtown Los Angeles the damage was only slight. No visible fault slipping was reported. The shock lasted from 5 to 15 seconds, averaging about 10 seconds. No special directional characteristic was observed in so far as it could be determined by falling walls, although in most cases pipe lines appeared to be pulled loose in a north-south direction. A spectacular display of blue flame resulted from the blowing out of a transformer at the Los Angeles shipyard. Suburban areas were darkened from 30 seconds to 5 minutes and longer as power lines fell. In some places telephone service was interrupted.

In spite of the large amount of damage, there was no major structural failure in any school building or other building designed and built to resist earthquake forces. The Gardena Post Office was an outstanding example. In this building there was no damage beyond slight cracks in the plaster and a settlement crack in a basement partition wall. Brick residences in Gardena, built 9 years ago, showed no damage. Many of the damaged buildings showed that failure was due either to poor workmanship, poor design, or both.

In the oil fields 2 tanks were demolished, 2 buckled badly, and a 6-inch pipe line broke in 4 additional places after having broken in 1 place during the October 21 earthquake; and an 8-inch natural gas pipe line burst. Fire was averted in all cases and most of the oil was recovered. Ground cracks were found in several cases near the broken oil line.

#### INTENSITY VII TO VIII:

**Torrance.**—The following quotations are taken from the press: "In the Torrance-Gardena sector the swaying east-west tremor knocked bricks and cornices from buildings, bowled store stocks from shelves, sent hotel and home residents fleeing in night clothes, snapped oil and pipe lines, and opened a two-foot crack in the pavement." "Torrance took the brunt of the shocks and hardly a building of any appreciable size in the town escaped damage. The business section looked like it had undergone a full scale bombing raid."

Damage to plate glass was estimated at \$25,000. In 1 liquor store 15 thousand dollars' worth of stock was thrown to the cement floor and ruined. Some stores had their shelves wired to prevent such occurrences. Part of the roof over the stage of a theater collapsed and the fire wall of a hotel caved in wrecking a low building beside it. An old market was wrecked in a similar way when a corner of the Masonic Temple collapsed. The fire station was "so badly damaged" that it was abandoned. Brick chimneys and fireplaces were down over most of the city, about 50 percent being damaged, twisted, broken loose, or thrown completely to the ground. Brick buildings were especially hard hit in the residential section; walls were cracked, bricks were toppled from corners, and brick columns were damaged. Several houses were moved off their foundations. In the library building all of the books were knocked off the shelves and cases which were not fastened to the wall overturned. In the chemical laboratory of the high school all loose bottles of chemicals were thrown to the floor and broken. The building itself suffered structural damage and was temporarily closed. Books and bookcases were thrown to the floor. A brick school about 4 miles east of Torrance suffered such severe structural damage that it was condemned.

**Gardena.**—There was considerable damage in the Monita section. A collapsing wall of a 2-story structure destroyed the roof of a 1-story adjoining building damaging practically the entire contents. Quite a few fire walls were down. The whole corner of one brick building was pulled away from the rest of it. In the residential area many chimneys were down, broken loose, or twisted at the roof line. Practically all new buildings escaped structural and chimney damage.

Along Gardena Boulevard for 2 or 3 blocks on each side of Vermont Avenue windows were broken, littering the sidewalks with glass. Bricks were loosened from walls, cornices, and fire walls; and goods in stores were thrown to the floor. The Bank of America building was severely damaged, and the roof of a nearby newspaper building nearly collapsed. Some fire walls were down. Two buildings on the north side of Gardena Boulevard were condemned.

The Gardena Elementary School building was condemned, although little damage was visible on the outside. The structure had been damaged in the October 21 earthquake and the November 14 shock caused ragged cracks to appear on the first and second floors. No damage was visible on a nearby frame building resting on a high brick foundation. One of the smaller buildings of the high school was damaged.

## INTENSITY VII:

*Huntington Park.*—There was considerable damage to masonry; plaster cracked and dishes were broken.

*Lomita.*—There was some damage from cracked walls and plaster and broken dishes. Pictures fell. One observer saw power lines striking each other and causing flashes.

*Redondo Beach.*—Some bricks fell from chimneys and a few windows were broken.

## INTENSITY VI.

*Bellflower.*—Slight damage from cracked plaster. Small objects shifted.

*Compton.*—Plaster cracked and small objects overturned.

*Hawthorne.*—Plaster, pictures, and books fell; vases overturned.

*Hermosa Beach.*—Walls, chimneys, windows and plaster cracked. Books and knickknacks fell.

*Hollywood.*—Sidewalks cracked. Small objects and furnishings moved. Damage slight.

*Long Beach.*—Plaster, windows, walls, and chimneys cracked. Damage slight.

*Lawndale.*—All were awakened and many frightened. Plaster cracked, and there were some reports of cracked plaster, windows, walls, and chimneys; damage slight. Some chandeliers swung violently.

*Los Alamitos.*—Plaster cracked.

*Los Angeles.*—Practically everyone was awakened and many were frightened. Damage was very slight. The city hall, the post office and courthouse, and the Chamber of Commerce building reported slight cracks in plaster. In the latter building old cracks which had been painted over opened up again. In some parts of the city brick structures were slightly damaged and furniture was shifted. Many reported the moving of small objects, swinging of hanging objects, the ringing of doorbell chimes, and the swinging of pictures.

*Lynwood.*—Small objects overturned.

*Manhattan Beach.*—Some vases overturned; knickknacks fell. Electric power was off for five minutes.

*Mar Vista.*—Plaster cracked and 1 card table overturned.

*Maywood.*—There was considerable damage to the fire department building; the south dormitory wall moved  $\frac{1}{2}$  inch and the brick reinforced hose tower was cracked on all sides. In other parts of the town plaster was cracked and furnishings shifted.

*North Long Beach.*—Pictures fell; small objects overturned.

*Palos Verdes Estates.*—Small objects overturned.

*San Pedro.*—One observer reported furniture, small objects, and vases overturned.

*Southgate.*—Plaster cracked; damage slight.

*Walteria.*—Small objects overturned.

*Willowbrook.*—Dishes broke; plaster cracked. Damage slight.

*Wilmington.*—Small objects overturned, books fell, and plaster cracked.

## INTENSITY V:

Artesia, Avalon, Beverly Hills, Clearwater, Culver City, Downey, El Segundo, Fullerton, Hondo, Huntington Beach, Hynes, Inglewood, Laguna Beach, Newport Beach, Norwalk, Pasadena, San Gabriel, Santa Ana, Stanton, Terminal Island, Topanga, Van Nuys, Venice, and Whittier. At nearly all of these places many residents were awakened and some frightened. There were many reports of the shifting of small objects. At a few places clocks stopped. At Huntington Beach a 35-pound weight hanging 22 inches from a ceiling swung through a 9-inch arc.

## INTENSITY IV:

Alhambra, Anaheim, Arcadia, Arlington, Balboa, Burbank, Carpinteria, Cornell, Corona, El Toro, Garden Grove, Glendale, La Habra, Monterey Park, Moreno, Oceanside, Olive, Pacific Palisades, Pico, Reseda, Riverside, San Juan Capistrano, Santa Monica, Spadra, West Los Angeles.

## INTENSITY I TO III:

Baldwin Park, Cabazon, Calabasas, De Luz, Etiwanda, Glendora, Hemet, La Crescenta, Maricopa, Norco, Orange, San Diego, San Fernando, San Jacinto, Saticoy, Summit, Ventura.

Not felt at 71 other places canvassed.

**November 14:** 1:42.\* Strong aftershock of the preceding earthquake. Epicenter  $33^{\circ}47'$  north,  $118^{\circ}15'$  west, P. Reported felt at Glendale, Long Beach, Mar Vista, Maywood, and Torrance. Strongest at Torrance where damage from previous shock was increased. At Long Beach pictures and knickknacks fell and small cracks were reported in exterior stucco.

**November 18:** 10:08.\* Near Santa Barbara. Epicenter about  $34^{\circ}20'$  north,  $119^{\circ}35'$  west, P. Felt at Santa Barbara and Carpinteria.

**November 21:** 8:56.\* Near Santa Barbara. Epicenter about  $34^{\circ}20'$  north,  $119^{\circ}35'$  west. Felt at Santa Barbara and Goleta.

**November 24:** 2:45. Near Cape Mendocino. Felt at Cape Mendocino Light Station, Eureka, Ferndale, and Petrolia.

**November 24:** 3:00. Near Cape Mendocino. Felt at Rio Dell and South Fork. Hanging objects swung at Rio Dell. Not felt at Santa Rosa.

**November 27:** 9:33.\* Los Angeles County. Epicenter about  $33^{\circ}59'$  north,  $118^{\circ}12'$  west, P. Felt in Los Angeles, Huntington Park, Lynwood, and Maywood. Very light in Los Angeles; some hanging objects swung. At Maywood rumbling noises were heard after first bump.

**November 27:** 18:25.\* Southern California. Epicenter about  $33^{\circ}17'$  north,  $117^{\circ}05'$  west, P. Felt at Escondido and Santa Ysabel.

**December 1:** 6:00.\* Near Catalina Island. Epicenter about 33°18' north, 118°15' west, P. Many awakened at Avalon.

**December 6:** 23:35. Humboldt County. Felt at Orleans, Hoopa, and Salyer Ranger Station. Strongest at Hoopa and Salyer. Lamps overturned at Hoopa.

**December 22:** 17:19.\* Off Newport Beach. Epicenter about 33°34' north, 117°59' west, P. Felt at Newport Beach.

**December 23:** 23:30.\* Imperial Valley. Epicenter about 32.6° north, 116.1° west, P. Many awakened at Plaster City. Also felt at El Centro.

**December 30:** 22:49.\* Owens Valley. Epicenter 37°34' north, 118°44' west, P. Felt over a land area of approximately 28,000 miles as shown on map. Maximum intensity VI.

#### INTENSITY VI:

*Owens River Gorge (Adams Main Powerhouse.)*—All awakened. Chimneys twisted; plaster cracked, damage slight.

#### INTENSITY V:

Benton, Fresno (Weather Bureau Office), Kings Canyon National Park, Laws, Pinehurst Ranger Station, Tinemaha Dam, and Yosemite National Park. At most of these places many residents were awakened and some frightened. Hanging objects swung and objects moved. At Fresno several downtown offices were flooded with telephone calls following the temblor. In several homes chandeliers swayed and a number of observers reported seeing flashes like lightning in the northeast section.

#### INTENSITY V IN NEVADA:

*Dyer.*—Many awakened, some frightened. Plaster cracked. Damage slight.

#### INTENSITY IV:

Auberry, Bishop, Bodfish, Crane Valley, Delpiedra, Dunlap, Friant, Giant Forest, Hanford, Kern River Powerhouse No. 3, Kernville, Madera, Martell, McKittrick, Mendota, Merced, North Fork, Sequoia National Park, Stratford, Visalia, Westhaven, Woodlake, Woody.

#### INTENSITY I TO III:

Coalinga, Georgetown, Los Hills.

#### INTENSITY III IN NEVADA:

Hawthorne.

Not felt at 14 other places canvassed in California nor at 3 in Nevada.

**December 31:** 0:08.\* 3:15.\* Owens Valley. Epicenter 37°34' north, 118°44' west, P. Felt in Owens River Gorge.

### WASHINGTON AND OREGON

(120TH MERIDIAN OR PACIFIC STANDARD TIME)

NOTE.—More details will be found in Abstracts of Earthquake Reports for the Pacific Coast and Western Mountain Region.

**January 3:** 13:20. Pullman, Wash. Light shock caused some hanging objects to swing. Felt by several.

**February 9:** 1:45.\* See California and Western Nevada section.

**February 16:** Portland, Ore. Light shock reported from scattered parts of Portland.

**April 6:** About 16:00. Republic, Wash. Light shock accompanied by rumbling sounds felt by few.

**April 7:** 1:25. North central Washington, Okanogan County. Shock approaching intensity VI felt over approximately 5,500 square miles as shown on map.

Intensity VI at Mazama where one observer reported stove moved and furniture overturned; slight damage.

Intensity V at Nespelem, Okanogan, and Omak. At Okanogan many residents were awakened and some frightened; small objects and pictures moved and several residents reported being nearly thrown out of bed. At Omak some plaster was reported cracked.

Intensity IV at Aeneas, Carlton, Chelan, Loomis, Manson, Mason City, Methow, Pateros, Riverside, Tonasket, Twisp, Wauconda, and Winthrop.

Intensity I to III at Chelan Falls, Mallott, and Monse.

Not felt at 17 other places canvassed.

**April 12:** 9:40. North central Washington. Aftershock of earthquake of April 7 felt at Chelan, Chelan Falls, Lakeside, Methow, Pateros, and Waterville. Strongest at Methow and Waterville. Not felt at 11 other places reporting.

**July 6:** 19:30. Medford, Ore. Felt by fire lookouts near Medford.

**July 29:** 12:17. Spokane, Wash. Slight shock felt in city by few; and recorded on the seismograph at Mount Saint Michaels. Faint rumbling sounds heard.

**October 19:** 22:05. Seal Rock, Ore. Slight shock.

**October 31:** 4:43. Portland, Ore. A few west side residents awakened. Door rattled and beds shook. Also felt at North Head, Wash., Weather Bureau office.

**December 29:** 10:37. Portland, Ore. A shock of intensity VI affected about 5,000 square miles in the vicinity of Portland as shown on the map.

## INTENSITY VI IN OREGON:

**Portland.**—Press reports a downtown display window shattered and a few other windows broken in various sections of the city. Felt by practically everyone. Many objects reported displaced and some trees and bushes shaken.

**Hillsboro.**—Plaster cracked; small objects and furnishings moved.

**Sherwood.**—Many frightened. Plaster cracked; trees and bushes shook moderately.

**Yamhill.**—Chimneys cracked; vases overturned. Hanging objects swung; school bell rang. Many frightened.

## INTENSITY VI IN WASHINGTON:

**Vancouver.**—Vases overturned; knickknacks fell. Small objects moved; trees and bushes shook slightly.

**Woodland.**—Plaster cracked, small objects shifted.

## INTENSITY V IN OREGON:

Buxton, Carlton, Huber, McMinnville, Milwaukee, Portland, Sandy, Tigard, Warren, and Zigzag. At Milwaukee knickknacks fell and many residents awakened. Buxton reported plaster cracked. All places reported either displaced objects or trees and bushes shaken.

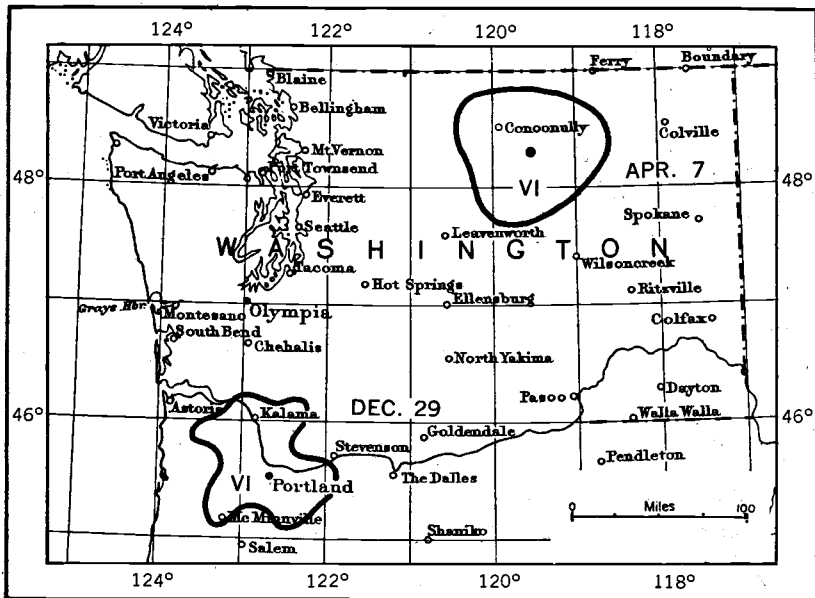


FIGURE 4.—Areas affected by the Washington earthquake of April 7, 1941, and the Oregon-Washington earthquake of December 29, 1941.

Intensity IV in Washington at Amboy, Ariel, Camas, Carrols, Cougar, Orchards, Ridgefield. Intensity IV in Oregon at Amity, Banks, Beaver Creek, Canby, Cherry Grove, Colton, Corbett, Dundee, Forest Grove, Gaston, Gladstone, Mist, Oregon City, Oswego, St. Helens, Timber, Veronia, Willamette, Wilsonville.

Intensity I to III in Washington at Brush Prairie, Elsie, South Bend. Intensity I to III in Oregon at Bonneville, Boring, Clatskanie, Dilley, Gresham.

Not felt at 15 places canvassed in Washington, nor at 42 in Oregon.

## ALASKA

(150TH MERIDIAN TIME)

**January 12:** 0:07. Fairbanks. Slight.

**January 21:** 20:37. Fairbanks. Slight.

**February 2:** 1:58. Anchorage. Slight.

**February 7:** 8:14. Fairbanks. Slight.

**March 1:** 17:56. Fairbanks. Slight.

**March 4:** 17:56, 21:35, and 22:50. Fairbanks. Slight.

**March 28:** 4:29. Fairbanks. Moderate shock felt by large part of population. Some alarm; no damage. Windows and dishes rattled and pictures were displaced on walls.

**March 31:** 6:56. Fairbanks. Slight.



**April 21:** 9:34. Near Unalaska. Epicenter about 53° north, 166° west in the North Pacific. Felt at Unalaska.

**April 30:** 12:55. Fairbanks. Slight.

**April 30:** 21:15. Unalaska. Slight.

**May 16:** 19:35. Fairbanks. Slight.

**May 18:** 3:05. Fairbanks. Slight.

**June 11:** 11:46. Anchorage. Slight.

**June 12:** 15:15. Fairbanks. Slight.

**July 1:** 5:59. Fairbanks. Slight.

**July 20:** 22:43. Fairbanks. Slight.

**July 25:** 00:01. Fairbanks. Slight.

**July 26:** 00:46. Fairbanks. Slight.

**July 29:** 15:52.\* Kenai Peninsula area. Epicenter about 60.9° north, 149.2° west. At Anchorage many residents were frightened; plaster and pictures fell and grocery stocks were thrown to the floor; dishes were broken and windows cracked. Trees and bushes were shaken strongly, and 4 breaks in pipes were reported. An isolated building was shaken from its foundations and ruined. After-shocks were reported at 16:03, 16:35, and 23:11.

**August 9:** 21:06 and 21:34. Juneau. Slight.

**August 12:** 4:05. Nome. Slight.

**August 31:** 10:55. Fairbanks. Slight.

**September 15:** 9:22. Nome. Slight.

**September 19:** 4:03. Anchorage. Slight.

**September 21:** 10:56. Anchorage. Slight.

**September 22:** 18:16. Anchorage. Slight.

**October 5:** 10:30. Attu Island. School building swayed visibly. Slight.

**October 14:** 17:20 Fairbanks. Slight.

**October 26:** 21:15. Anchorage. Two slight shocks. Teletypewriter disturbed; clock rattled.

**October 28:** 00:14. Fairbanks. Slight.

**October 31:** 18:39. Fairbanks. Slight.

**November 15:** 3:15. Fairbanks. Slight.

**December 5:** 23:00. Fairbanks. Slight.

**December 7:** 15:35. Fairbanks. Slight.

**December 7:** 15:50. Juneau. Slight. Possibly same as preceding shock.

**December 14:** 1:21. Anchorage. Slight.

**December 20:** 2:47. Fairbanks. Slight.

**December 28:** 15:40, 19:58, and 20:52. Anchorage. Slight shocks.

**December 31:** 22:01. Fairbanks. Slight.

#### HAWAIIAN ISLANDS

[157— MERIDIAN (WEST) TIME]

NOTE.—In the case of these islands with their many earthquakes of volcanic origin, only the stronger ones are listed. Reports of the Hawaiian Volcano Observatory under the jurisdiction of the National Park Service give all details. "HVO" indicates that the epicenter was determined by the Hawaiian Volcano Observatory.

**January 17:** 7:30.\* Origin 14 miles under west slope of Hualalai near seacoast at Kaiwi Point, 19°40.3' north, 156°03.5' west, HVO. Felt at Naalehu, Kailua, Hookena, Hilo, and strongly felt by everyone at Puuwaawaa.

**April 20:** 10:46.\* Origin 0.3 mile south of Keanakakoi Crater, depth 1.0 mile, 19°23.9' north 155°16.0' west, HVO. Generally felt in the Kilauea area, Kau, and Kano, and by some in Hilo.

**July 8:** 10:14.\* Kilauea Crater, HVO. Felt by many at Kilauea.

**September 25:** 7:18.\* Origin, southeast flank of Mauna Loa, 4.0 miles north of Kapapala Ranch House, depth 7.0 miles, HVO. Felt sharply over whole island of Hawaii, and by some in Honolulu. Several thousand dollars' worth of damage at Pahala, Hawaii. Dismantled all seismographs on Hawaii and one on Maui.

At Pahala safes were moved over 1 inch northward, plaster cracked, pipes were sprung, roadfills cracked, and some shoulders failed. Furniture overturned and dishes were broken in homes. Pharmaceuticals at the Pahala hospital, chemicals in the Pahala sugar laboratories, and package goods in stores were thrown from shelves. Some persons were injured in flight from their houses.

At Kapapala Ranch 2 windows and many dishes were broken, and several stone walls were partially thrown down. At Kealakakua a few books were thrown from shelves. At Hilo an old earthquake crack in one building reopened.

Boulders were shaken loose from steep slopes at the head of Wood Valley and on Hilina Pali. Numerous slides from Halemaumau's walls caused great dust clouds. Many claimed the shock was the strongest in 30 years.

All of the information on this shock has been taken from the HVO "Volcano Letter."

An aftershock at 7:30 was sharply felt at Pahala and Kapapala.

**September 25:** 7:43.\* Origin probably near Ainapo, perhaps 20 miles deep, HVO. Sharply felt at Pahala and Kapapala.

**September 25:** 8:28.\* 2.0 miles northeast of Kapapala Ranch House, 7.0 miles deep, HVO. Felt generally at Pahala and Kapapala.

**September 25:** 13:25.\* Southeast flank of Mauna Loa, 4.0 miles north northwest of Kapapala Ranch House, 7.0 miles deep, HVO. Felt by many persons at Kapapala and Pahala.

**October 25:** 8:54.\* Origin, north slope of Mauna Kea near Waimea, HVO. Generally felt on island of Hawaii.

**November 14:** 0:51\* to 17:34.\* Eight feeble shocks plainly felt at Waimea and lightly at widely scattered points on island of Hawaii.

**November 16:** 9:41.\* Origin near Waimea, 27 miles deep, HVO. Generally felt over island of Hawaii; some slight damage; instruments dismantled.

**November 18:** 2:56.\* Origin near Waimea, 27 miles deep, HVO. Strongly felt on island of Hawaii and to a lesser degree on Maui.

**November 18:** 10:30\* and 10:33.\* Generally felt on island of Hawaii.

**November 22:** 21:23.\* Origin near Waimea, HVO. Generally felt on island of Hawaii and by a few persons on Maui.

#### PHILIPPINE ISLANDS

[120TH MERIDIAN (EAST) TIME]

NOTE.—Only the more important shocks are listed and the list may be incomplete as only instrumental reports were available. Reports of the Weather Bureau of the Philippine Islands should be consulted for full details.

**February 4:** 22:05.\* Epicenter 10°25' north, 126°33' east, depth 200 km., according to Manila. Felt at Butuan, Baguio and other places.

**February 18:** 2:06.\* Epicenter 15°17' north, 120°03' east, depth about 75 km., according to Manila. Felt in western Luzon and Manila.

**April 18:** The press reports that an earthquake of moderate intensity shook Manila and many provinces. First reports indicated some damage but no casualties.

**September 28:** 17:58.\* Epicenter 14°40' north, 119°40' east, according to Manila. Felt in Manila and on Corregidor.

**November 6:** 1:39. The press reports an earthquake which caused considerable property damage and numerous injuries in Albay Province in southern Luzon.

#### PUERTO RICO

[60TH MERIDIAN TIME]

**October 2:** 22:21.\* Felt generally in San Juan and by many persons at Orocovic. Probably felt over a large part of the island. San Juan seismograph record indicates an epicentral distance of 50 to 70 km. (S—P=6 sec.) with epicenter along a line N.75°W.—S.75°E.

A stronger shock recorded, but not reported felt, at 18:33 on October 3 was about 200 km. from San Juan (S—P=19 sec.) along a line N. 80°E.—S. 80°W. through the station. Lighter shocks were recorded at 19:48 on October 3, and at 3:22 and 9:18 on October 4.

#### PANAMA CANAL ZONE

[75TH MERIDIAN TIME]

NOTE.—Instrumental times given below are the arrival times of the first recorded phases on the seismograph at Balboa Heights unless otherwise stated.

**March 9:** 22:48.\* Felt by many at Balboa Heights.

**March 9:** 23:06.\* Western Panama. Epicenter approximately 9.0° north, 81.8° west, according to Jesuit Seismological Association bulletin. Felt throughout Panama; intensity III. Many aftershocks recorded on the Balboa Heights seismograph.

**March 9:** 23:16.\* Felt throughout Canal Zone; intensity II.

**March 10:** 1:10.\* Felt by a few at Balboa Heights.

**November 22:** 0:24.\* Felt at Balboa Heights; intensity I.

**December 5:** 15:47.\* Offshore, in Pacific Ocean, near Panama-Costa Rica boundary, 8.4° north, 83.2° west. Damage reported in eastern Costa Rica and western Panama. Intensity IV at Balboa Heights; seismograph clock stopped. On the Balboa Heights seismograph 7 aftershocks were recorded on the 5th; and 40, 34, and 10 aftershocks on the 6th, 7th, and 8th respectively.

Press dispatches reported that the municipal building and a school were toppled at Santiago (midway between Panama City and David), but that most of the damage occurred in the vicinity of David.

Dispatches from Costa Rica stated that considerable property damage occurred in the central plateau region. Ten houses at Santo Domingo Heredia, 10 miles north of San Jose, were destroyed, and there was damage at Guadalupe, Corralillo Cartago, and Puerta Jimenez. See section of this report on Unclassified Regions for shocks felt at sea; also Tidal Observations, under Miscellaneous Activities.

#### UNCLASSIFIED REGIONS

##### EARTHQUAKES FELT AT SEA

NOTE.—The information in this category is taken from Hydrographic Office Bulletins unless otherwise noted.

**January 5:** 18:48, G. C. T. Celebes Sea. 2°48' north, 122°17' east. Ship vibrated severely for 4 or 5 seconds. After an interval of about 10 seconds the vibration was repeated for another 4 or 5 seconds.

**January 27:** 23:05, G. C. T. West Indies. 18°44' north, 73°15' west. Shock was sudden and severe, being felt throughout the ship. Lighter shocks felt at 23:07 and 23:20.

**April 15:** 19:10, G. C. T. Off west coast of Mexico. The disturbance was reported by 6 vessels reporting positions as follows:

17°12' north, 103°16' west.—Violent vibration at 19:10. Lighter vibration at 19:12.

17°44' north, 102°33' west.—Considerable vibration for 30 seconds. A severe 5-second shock occurred 36 minutes later.

17°52' north, 103°16' west.—Heavy seismic shock lasted about 1 minute. Difficulty experienced in steering vessel.

18°03' north, 103°16' west.—A severe 2-minute vibration; engine was stopped for 10 minutes. At 19:13 clouds of dust were observed in the mountains along the coast for about 10 or 15 minutes; but nothing was visible beyond 18°10' north, 103°18' west. A light 3-second vibration occurred at 19:48 causing clouds of dust to appear again.

18°03' north, 103°19' west.—Vessel shook severely for about 2 minutes; engine was stopped for inspection of vessel. About 3 minutes after the first shock a lighter 10-second one occurred. At 19:44 another shock was felt at 18°07' north, 103°24' west, but it was less severe than the first. A large deckload of steel assembly, some pieces weighing 6 tons, was caused to shift about 6 inches and to jump as much as 5 to 6 inches up and down from its blocks. After the first shock dust clouds began to rise from the hills and mountains around Maruata Bay and Point San Telmo. Also, a dust haze and smoke enveloped Colima Volcanoes which had been visible before. The surf on the beach seemed to rise higher after the shock. The swell increased slightly. The dust cleared to a marked degree before the second large shock, and the dust clouds were greater this time around Maruata Bay.

18°04' north, 103°57' west.—Violent shock felt and rumbling sound heard. Engine was stopped for examination of vessel. The shock lasted about 3 minutes. A lighter shock occurred 40 minutes later. A line of heavy dust was visible along the shore.

**December 6:** 21:23, G. C. T. Off west coast of Costa Rica. 8°35' north, 84°27' west. Heavy 3-second earth shock experienced. See earthquake of December 5 in the Panama Canal Zone.

#### EARTHQUAKES FELT ON LAND

**March 23:** 4:02, E. S. T. Swan Island, VI. (Swan Island is in the West Indies between Honduras and Cuba, about 17.5° north, 83.9° west. Reports from there are furnished by the local Weather Bureau Office.) Buildings swayed visibly and heavy objects were displaced. Pen of the microbarograph (mounted on a shelf) was displaced upward  $\frac{3}{4}$  inch; those of the hygromograph were displaced about  $\frac{1}{2}$  inch. The onset of the shock was rapid, reaching a peak in 5 seconds. Total duration, 15 seconds.

A 125-foot sailing schooner anchored about  $\frac{3}{4}$  mile off the west end of the island was shaken violently.

**April 26:** 21:00, E. S. T. Swan Island. Felt by all. Steel antenna towers rattled considerably; small objects were slightly displaced.

**April 27:** 5:22, E. S. T. Swan Island. Felt by all. Slowly increasing roar heard. Radio towers swayed slightly. Disturbance reached peak intensity in 4 or 5 seconds and ended at 7 seconds.

**May 5:** 9:52, E. S. T. Swan Island. Suspended objects swayed slightly.

**July 16:** 22:08, E. S. T. Swan Island. Slight shock felt by all. Microbarograph pen displaced  $\frac{3}{16}$  inch.

**October 10:** 9:44, E. S. T. Swan Island. Slight shock jerked radio towers.

**November 12:** 7:29, E. S. T. Swan Island. Slight shock accompanied by sounds like distant thunder. Outside wires and cables shook considerably.

**December 12:** 1:30 (local time) Port au Prince, Haiti. Two slight shocks reported.

## MISCELLANEOUS ACTIVITIES

### GEODETIC OPERATIONS OF SEISMOLOGICAL INTEREST

In May and June 1941 the first-order lines in the vicinity of El Centro, California, were releveled to detect possible movement resulting from the earthquake of May 18, 1940. The portions of the lines releveled were El Centro to Niland, California, El Centro to Jacumba, California, and El Centro, California, to Yuma, Arizona. This releveled has been adjusted and the results are available for distribution.

During the spring of 1941, repeat observations were made at about 50 triangulation stations in Southern California, in the vicinity of El Centro. The work extends from a fixed line near the Arizona State line, 50 miles east of El Centro, to other fixed lines 40 miles west and 50 miles north of El Centro. The original determinations of these stations were made in 1934 and 1939. The purpose of the repeat observations was to determine what earth movements, if any, occurred because of the earthquake of May 18, 1940. The final adjustment of the 1941 work has not been made because of the pressure of war activities.

### TIDAL DISTURBANCES OF SEISMIC ORIGIN

The Panama-Costa Rica earthquake of December 5, 1941, was recorded on a recording tide gage at Punta Arenas, Costa Rica. This station is one of a group of 14 Central and South American stations established through the cooperation of the countries concerned with the United States Government. The project was sponsored by the United States Department of State and carried out by the Coast and Geodetic Survey cooperating with local authorities.

At Punta Arenas, on December 5, the record showed 2 separate disturbances; the first beginning at 15:45 (90th meridian time), December 5th and continuing for about 6 hours. The average range was about  $\frac{3}{4}$  foot and the period about  $\frac{3}{4}$  hour.

The second disturbance began at 16:20 (90th meridian time), December 6th and continued for about 8 hours. The range averaged less than  $\frac{1}{4}$  foot and the average period was between 10 and 15 minutes. Both records were made at times of local high tide.

## SEISMOLOGICAL OBSERVATORY RESULTS

The Coast and Geodetic Survey publishes the results of its teleseismic stations and cooperating stations monthly 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 to the Director of the Coast and Geodetic Survey.

Instrumental results are published for the following observatories:

Balboa Heights, C. Z. (the Panama Canal).  
 Bermuda (Meteorological Station, St. George's, and International Union of Geodesy and Geophysics).  
 Boulder City, Nev. (Bureau of Reclamation, National Park Service).  
 Bozeman, Mont. (Montana State College).  
 Burlington, Vt. (University of Vermont).  
 Butte, Mont. (Montana School of Mines).  
 Chicago, Ill. (University of Chicago and United States Weather Bureau).  
 College, Alaska (University of Alaska).  
 Columbia, S. C. (University of South Carolina).  
 Des Moines, Iowa (Private station, M. M. Seeburger, director).  
 East Machias, Maine (Massachusetts Institute of Technology).  
 Honolulu, T. H. (University of Hawaii).

Huancayo, Peru (Carnegie Institution of Washington).  
 Ivigtut, Greenland (Geodætisk Institut, Copenhagen, Denmark).  
 Lincoln, Nebr. (Nebraska Wesleyan University).  
 Logan, Utah (Utah State Agricultural College).  
 Montezuma, Chile (Smithsonian Institution).  
 Philadelphia, Pa. (The Franklin Institute).  
 Rockefeller Mountain, Antarctica (Byrd Expedition).  
 Salt Lake City, Utah (University of Utah).  
 San Juan, P. R.  
 Seattle, Wash. (University of Washington).  
 Scoresby-Sund, Greenland (Geodætisk Institut, Copenhagen, Denmark).  
 Sitka, Alaska.  
 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, and Salt Lake City are cooperative stations.

Balboa Heights, Burlington, Des Moines, East Machias, Huancayo, Logan, Montezuma, Philadelphia, and Seattle are independent stations.

Through arrangements made by the International Union of Geodesy and Geophysics the Coast and Geodetic Survey is temporarily aiding in the maintenance of the Danish stations at Scoresbysund and Ivigtut, in Greenland.

The Rockefeller Mountain station was operated through parts of November and December, 1940 by the U. S. Antarctic Service, Admiral Richard E. Byrd in charge of the expedition. The instruments were loaned by The Franklin Institute of Philadelphia, and operated by Mr. Roy O. Fitzsimmons, Physicist. The Coast and Geodetic Survey cooperated in preparing the instruments for Antarctic use.

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

The provisional epicenter results for 1941 were not ready when this publication went to press. Those for the year 1940 are listed in table 1.

**TABLE 1.—Summary of instrumental epicenters for 1940**

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 near-by stations are usually given preference. More detailed information will be found in the Seismological Bulletins (formerly Seismographic Reports) of the Coast and Geodetic Survey, and in the bulletins of other organizations and stations.

1940	Greenwich civil time at origin	Region and focal depth	Coordinates of provisional epicenter	
			Latitude	Longitude
	<i>h m</i>		<i>°</i>	<i>°</i>
Jan. 1. ....	12 15.2	Fiji Islands. Depth about 550 km. ....	17.2 S.	178.7 W.
Jan. 2. ....	11 7.3	Southwest of Easter Island. Depth normal. ....	28.6 S.	113.8 W.
Jan. 4. ....	1 10.3	Northeast of New Zealand. Depth normal. ....	34 S.	162 W.
Do. ....	8 7.2	Southern California, near Clark Lake. Depth normal. ....	38.3 N.	116.3 W.
Jan. 5. ....	6 20.9	Off southwestern California. Depth normal. ....	33.1 N.	119.5 W.
Jan. 6. ....	8 15.7	Southeast of Kurile Islands. Depth normal. ....	44.6 N.	151.7 E.
Do. ....	14 3.4	East of Loyalty Islands. Depth about 90 km. ....	21.9 S.	171.0 E.

TABLE 1.—*Summary of instrumental epicenters for 1940—Continued*

1940	Greenwich civil time at origin	Region and focal depth	Coordinates of provi- sional epicenter	
			Latitude	Longitude
	<i>h</i> <i>m</i>		<i>°</i>	<i>°</i>
Jan. 7.	3 22.7	Southeast of Honshu Island, Japan. Depth normal.	34.2 N.	141.7 E.
Do.	5 3.1	Southern California, east of Salton Sea. Depth normal.	33.4 N.	115.6 W.
Do.	7 12.7	do.	38.4 N.	115.6 W.
Do.	21 34.8	Northern Peru. Depth about 100 km.	6.5 S.	78 W.
Jan. 10.	11 17.5	Central China. Depth normal.	34.5 N.	98 E.
Jan. 13.	7 49.1	Southwestern California. By Pasadena. Depth normal.	33.8 N.	118.1 W.
Jan. 16.	18 56.1	San Bernardino Mountains. Southern California. Depth normal.	34.2 N.	116.8 W.
Jan. 17.	1 15.0	East of Marianas Islands. Depth about 75 km.	17.2 N.	148.2 E.
Jan. 19.	10 6.4	Southern California, west of Salton Sea. Depth normal.	33.4 N.	116.4 W.
Do.	13 53.1	Northwest of Samoa Islands. Depth probably normal.	11 S.	173.5 W.
Jan. 20.	9 58.1	South Pacific Ocean. Depth normal.	52.5 S.	134.5 W.
Jan. 21.	2 45.6	China Sea. Depth about 350 km.	27.5 N.	126.5 E.
Jan. 21.	4 19.6	Northeast of North Island, New Zealand. Depth about 225 km.	35 S.	175 W.
Jan. 26.	6 41.8	North of New Hebrides. Depth 100 km.	14.5 S.	167.5 E.
Do.	17 4.6	East of Ryukyu Islands, Japan. Depth normal.	26.1 N.	132.1 E.
Jan. 27.	14 49.7	Off southeastern Honshu Island, Japan. Depth normal.	34 N.	139 E.
Jan. 28.	7 27.8	Off western Peru. Depth normal.	12 S.	82 W.
Do.	8 27.9	Northwestern Canada. Depth normal.	62.7 N.	137 W.
Jan. 29.	1 59.2	Near Verruga, southern California. Depth normal.	33.1 N.	116.4 W.
Feb. 7.	17 16.1	Aleutian Islands. Depth 75 km.	52.0 N.	174.0 E.
Feb. 8.	8 5.8	Northeastern California. Depth normal.	40.4 N.	121.7 W.
Feb. 9.	1 53.0	Vallecito Mountains, southern California. Depth normal.	33.0 N.	116.2 W.
Do.	11 11.3	Elsinore Fault, southern California. Depth normal.	33.4 N.	117.1 W.
Do.	11 44.5	Terwilliger Valley, southern California. Depth normal.	33.5 N.	116.6 W.
Do.	11 48.4	Elsinore Fault near Pala, southern California. Depth normal.	33.3 N.	117.1 W.
Do.	13 53.7	Off northeastern Honshu Island, Japan. Depth normal.	40.2 N.	142.5 E.
Feb. 11.	15 47.5	Southern California. Depth normal.	34.0 N.	117.0 W.
Feb. 12.	0 01.6	Northern Chile. Depth about 100 km.	26.7 S.	70.7 W.
Do.	5 25.6	Aleutian Islands. Depth normal.	50 N.	179 E.
Do.	8 21.0	Southwest of Tonga Islands. Depth about 200 km.	23.0 S.	177.7 W.
Do.	9 17.8	Alaska Peninsula. Depth about 50 km.	55.0 N.	161.9 W.
Feb. 13.	23 52.3	Northern California. Depth normal.	39.6 N.	123.7 W.
Feb. 14.	1 58.0	Northern Celebes. Depth normal.	1 N.	123 E.
Feb. 19.	12 06.9	Southern California. Depth normal.	34 N.	117.0 W.
Feb. 20.	2 18.3	North of the New Hebrides. Depth about 200 km.	14.2 S.	167.4 E.
Do.	12 54.9	New Amsterdam Island. Depth about 150 km.	37.5 S.	77.5 E.
Feb. 22.	10 38.0	Southern California. Depth normal.	33.8 N.	117.3 W.
Do.	13 30.6	Northeast of Luzon Island, Philippine Islands. Depth normal.	20.0 N.	123.3 E.
Feb. 23.	0 40.1	Adriatic Sea. Depth normal.	40.7 N.	18.8 E.
Feb. 24.	9 38.0	Eastern California. Depth normal.	37.5 N.	118.5 W.
Do.	12 0.1	Northern New Guinea. Depth normal.	2.5 S.	141.5 E.
Feb. 25.	7 58.1	Off southwestern Panama. Depth normal.	7 N.	82.5 W.
Feb. 27.	12 12.5	Off northern Guiana. Depth normal.	8 N.	58 W.
Feb. 28.	17 28.1	Southern California. Depth normal.	33.1 N.	116.1 W.
Feb. 29.	16 7.7	Crete. Depth normal.	35.1 N.	25.6 E.
Mar. 2.	13 27.1	Western California. Depth normal.	37 N.	122 W.
Mar. 3.	0 5.6	West of the New Hebrides. Depth normal.	17.9 S.	167.5 E.
Mar. 4.	19 59	Northeast of Brazil. Depth normal.	15.2 N.	44.1 W.
Mar. 5.	17 6.1	Southern California. Depth normal.	34.1 N.	117.3 W.
Do.	23 0.5	Eastern Alaska. Depth normal.	64.5 N.	145.5 W.
Do.	23 54.7	Eastern central Alaska. Depth normal.	64 N.	147.5 W.
Mar. 6.	5 51.5	Central Alaska. Depth normal.	63.9 N.	150.5 W.
Mar. 7.	7 8.6	South Pacific Ocean. Depth normal.	33 S.	110.5 W.
Mar. 9.	5 4.7	Central Alaska. Depth normal.	65.2 N.	152 W.
Do.	10 47.1	Northwest of Bonin Islands. Depth about 500 km.	27.8 N.	139.6 E.
Do.	15 47.3	Off southwestern Panama. Depth normal.	5 N.	82.5 W.
Mar. 10.	18 1.9	Southern Nevada. Depth normal.	37 N.	115 W.
Mar. 11.	0 6.5	do.	37 N.	115 W.
Do.	11 25.6	Off northeastern Honshu Island. Depth normal.	41.1 N.	142.2 E.
Mar. 14.	18 23.0	South of Tasmania. Depth about 170 km.	54.5 S.	147 E.
Do.	21 25.6	Northwestern Mexico. Depth normal.	28.1 N.	111.1 W.
Do.	21 31.3	Southwestern Mexico. Depth normal.	20 N.	105 W.
Mar. 16.	20 40.7	South of Alaska. Depth normal.	55 N.	156 W.
Mar. 18.	5 39	South of Kermadec Islands. Depth normal.	31.3 S.	178.4 W.
Mar. 19.	4 35.6	Northeastern Baluchistan. Depth normal.	29 N.	67 E.
Mar. 20.	0 35.4	Off northwestern United States. Depth normal.	46 N.	138 W.
Do.	2 45.7	Off Vancouver Island. Depth normal.	49 N.	129 W.
Do.	10 22.4	Southeastern California. Depth normal.	38.1 N.	116.1 W.
Mar. 21.	13 53	South of Java. Depth about 100 km.	10.1 S.	108.2 E.
Mar. 24.	11 48.2	Southern Bolivia. Depth normal.	21.5 S.	63 W.
Mar. 25.	21 18.3	Eastern California. Depth normal.	36.8 N.	117.1 W.
Mar. 27.	12 31.4	Aleutian Islands. Depth about 100 km.	52.2 N.	179.5 E.
Mar. 28.	15 48.5	China Sea, off northwestern Mindoro Island, Philippine Islands.	13.5 N.	120 E.
Do.	17 48.6	Off southern El Salvador. Depth about 75 km.	12.2 N.	89.5 W.
Mar. 29.	21 37.2	Off western Sumatra. Depth normal.	2 N.	95.5 E.
Mar. 30.	4 46.4	Off southwestern Guatemala. Depth normal.	14.2 N.	92.1 W.
Mar. 31.	16 52.5	Off northwestern Chile. Depth normal.	18.8 S.	70.9 W.
Apr. 1.	11 19	Northern New Guinea. Depth normal.	3.3 S.	139.7 E.
Apr. 5.	16 35.4	Volcano Islands. Depth about 200 km.	25 N.	141.5 E.
Apr. 7.	8 42.0	Southern Nevada. Depth normal.	37 N.	115 W.
Apr. 8.	8 49.3	Western Argentina. Depth normal.	33 S.	70 W.
Apr. 11.	9 4.1	East of Kurile Islands. Depth normal.	47.1 N.	154.4 E.
Apr. 12.	5 54.2	East of Honshu Island, Japan. Depth normal.	38.4 N.	141.8 E.
Apr. 13.	6 28.9	Northern Turkey. Depth normal.	40.5 N.	37.5 E.
Do.	20 18.2	South of Sumatra. Depth about 200 km.	7 S.	104 E.

TABLE 1.—Summary of instrumental epicenters for 1940—Continued

1940	Greenwich civil time at origin	Region and focal depth	Coordinates of provi- sional epicenter	
			Latitude	Longitude
	<i>h</i> <i>m</i>		°	°
Apr. 14	9 33.3	North of Tonga Islands. Depth about 200 km.	16.5 S.	174 W.
Do	14 56.3	Kurile Islands. Depth 100 km.	44.4 N.	149.5 E.
Apr. 16	6 7.7	Aleutian Islands. Depth normal.	51.8 N.	173.1 E.
Do	6 43.1	do.	52.7 N.	173.2 E.
Apr. 17	21 34.5	Solomon Islands. Depth normal.	9 S.	157.8 E.
Apr. 18	18 43.7	Southern California. Depth normal.	34.1 N.	117.4 W.
Do	19 43.5	East of New Britain Island. Depth about 100 km.	5.3 S.	153.1 E.
Do	21 21.9	Southern California. Depth normal.	33.2 N.	115.5 W.
Apr. 19	0 6.8	Aleutian Islands. Depth normal.	52.3 N.	173.9 E.
Do	14 40	Kurile Islands. Depth probably 100 km.	49.3 N.	155.9 E.
Apr. 20	14 46	Southeast of Mindanao Island, Philippine Islands. Depth 150 km.	6.0 N.	126.7 E.
Do	20 18.0	Southern Honshu Island, Japan. Depth 350 km.	34.5 N.	135.5 E.
Apr. 24	10 22.1	West of New Britain Island. Depth normal.	5.5 N.	148 E.
Apr. 25	10 18.7	Northwest of Samoa. Depth normal.	8.5 S.	176.5 W.
Apr. 27	9 35.6	Northeast of Solomon Islands. Depth normal.	5 S.	165 E.
Do	10 33.2	Southwest of Liberia. Depth normal.	1 N.	20 W.
Do	18 5.1	Northeast of Solomon Islands. Depth normal.	5.5 S.	166.5 E.
Apr. 29	6 56.7	Northern Lower California. Depth normal.	32 N.	115 W.
Do	7 33.2	do.	32 N.	115 W.
Do	8 48.1	do.	32.7 N.	115.5 W.
Do	15 11.9	East of Hokkaido Island, Japan. Depth normal.	42.8 N.	148.7 E.
May 1	2 33.3	Western Argentina.	30 S.	70 W.
May 2	0 53.1	Northern Lower California.	32.1 N.	116.7 W.
Do	8 24.1	East of the New Hebrides. Depth about 450 km.	18 S.	170 E.
May 4	7 24.2	Aleutian Islands. Depth normal.	52.7 N.	173.0 E.
Do	16 44.5	Western Peru. Depth normal.	6.8 S.	80.1 W.
Do	21 1.9	Northeastern Persia. Depth normal.	35.5 N.	58.9 E.
May 5	2 3.7	Northwestern Peru. Depth about 40 km.	6.8 S.	80.0 W.
Do	9 38.7	Southern California. Pinto Mountains.	34.0 N.	115.7 W.
May 7	21 33.7	Southern California.	34.1 N.	116.3 W.
Do	22 23.6	Southern Russia (Georgia). Depth normal.	42 N.	43 E.
May 10	1 25.1	Off western Mexico. Depth normal.	22.5 N.	108.5 W.
Do	1 43.5	do.	21.5 N.	109 W.
Do	14 46.5	Southern California.	33.7 N.	116.3 W.
Do	18 59.8	Off southern Java. Depth about 100 km.	9.2 S.	107.7 E.
May 11	13 54.7	Aleutian Islands. Depth normal.	52.5 N.	173.3 E.
Do	21 0.3	Central Burma. Depth normal.	23.8 N.	94.4 E.
May 12	20 43.8	Off western Mexico. Depth normal.	19.5 N.	106.5 W.
May 17	1 59.7	Off southwestern Panama. Depth apparently shallow.	7.6 N.	82.0 W.
May 18	5 4	Southern California. Depth normal.	34.1 N.	116.3 W.
Do	5 51.4	Southern California.	34.1 N.	116.3 W.
Do	6 4.5	do.	34.1 N.	116.3 W.
Do	7 21.6	do.	34.1 N.	116.3 W.
Do	9 15.2	do.	34.6 N.	118.9 W.
Do	13 47.3	do.	34.1 N.	116.3 W.
May 19	2 26.0	do.	34.1 N.	116.3 W.
Do	2 27.5	do.	34.1 N.	116.3 W.
Do	3 51.7	do.	34.1 N.	116.3 W.
Do	4 36.7	do.	32.8 N.	115.5 W.
Do	6 35.4	do.	32.8 N.	115.5 W.
Do	7 1.6	do.	32.8 N.	115.5 W.
Do	8 2.9	Northern Lower California.	30 N.	115 W.
Do	8 55.3	Southern California.	32.8 N.	115.5 W.
Do	9 17.3	do.	32.6 N.	115.5 W.
Do	12 9.5	do.	32.8 N.	115.5 W.
Do	13 40.9	do.	32.8 N.	115.5 W.
Do	15 17.9	Okhotsk Sea. Northwest of Kurile Islands. Depth 575 km.	50.9 N.	148.8 E.
Do	15 30.6	Southern California.	32.8 N.	115.5 W.
Do	15 51.8	do.	32.8 N.	115.5 W.
Do	18 6.3	Northern Lower California.	30 N.	115 W.
Do	18 16.5	Southern Mozambique, South Africa. Depth normal.	22.8 S.	32.5 E.
Do	19 7.1	Northern Lower California.	30 N.	115 W.
Do	19 39.7	Southern California.	34.1 N.	116.3 W.
May 20	6 27.3	do.	32.8 N.	115.5 W.
Do	7 6.0	do.	32.8 N.	115.5 W.
Do	11 13.4	do.	32.8 N.	115.5 W.
May 21	12 41.6	do.	32.8 N.	115.5 W.
Do	14 0.4	do.	32.8 N.	115.5 W.
Do	15 48.9	Southwest of Tonga Islands. Depth about 350 km.	22.3 S.	178.0 W.
Do	21 29.9	Southern California.	32.8 N.	115.5 W.
May 22	6 31.6	do.	34.1 N.	116.3 W.
Do	10 58.7	do.	32.8 N.	115.5 W.
Do	14 10.1	do.	34.1 N.	116.3 W.
Do	18 35.1	do.	32.8 N.	115.5 W.
Do	20 56.3	do.	32.8 N.	115.5 W.
May 23	0 12.3	do.	32.8 N.	115.5 W.
Do	3 18.3	do.	32.8 N.	115.5 W.
Do	6 1.7	South of Aleutian Islands. Depth normal.	49.5 N.	177.5 E.
May 24	16 34	Western Peru. Depth about 75 km.	10.2 S.	77.4 W.
Do	21 57.9	Off western Peru. Depth normal.	11.4 S.	78.1 W.
May 26	8 50.5	Northern Lower California.	31 N.	115 W.
May 27	3 27.4	Southern California.	34.1 N.	116.3 W.
May 28	9 40.7	Northern New Guinea. Depth normal.	2.3 S.	139.1 E.
May 29	1 57.9	Northwestern Canada. Depth normal.	66.2 N.	134 W.
May 31	0 41.2	Samoa Islands. Depth normal.	13.4 S.	173.1 W.
Do	4 56.2	South Pacific Ocean, west of Galapagos Islands. Depth normal.	4 S.	105 W.

TABLE 1.—*Summary of instrumental epicenters for 1940—Continued*

1940	Greenwich civil time at origin	Region and focal depth	Coordinates of provi- sional epicenter	
			Latitude	Longitude
	<i>h m</i>		°	°
June 1	5 27.0	Southern California. Depth normal	34.0 N.	116.3 W.
Do	5 56.8	Southern California	34.0 N.	116.3 W.
Do	6 54.5	Southern California	34.0 N.	116.3 W.
Do	23 59.6	Southern California	32.8 N.	115.5 W.
June 2	6 13.2	Southern California	34.0 N.	116.3 W.
Do	11 37.6	Aleutian Islands. Depth normal	50.3 N.	179 W.
Do	12 09.6	Southwest of Guam. Depth normal	11.3 N.	138.9 E.
June 3	18 05.3	Gulf of California. Depth normal	25.2 N.	110.0 W.
June 4	10 35.2	Southern California	33.1 N.	116.4 W.
Do	13 03.3	Southern California	32.8 N.	115.5 W.
June 5	11 01.2	Northwestern Canada. Depth normal	67.0 N.	136 W.
Do	21 12.4	Southern California	32.8 N.	115.5 W.
Do	22 53.7	do	32.8 N.	115.5 W.
June 6	22 21.2	do	34.1 N.	116.3 W.
Do	23 21.1	do	33.3 N.	116.4 W.
Do	23 28.4	do	32.9 N.	115.2 W.
Do	23 47.8	do	34.1 N.	116.3 W.
Do	23 56.6	do	34.1 N.	116.3 W.
June 7	5 11.8	do	32.8 N.	115.5 W.
Do	7 17.3	Off southeastern New Guinea. Depth normal	9.7 S.	150.9 E.
Do	15 35.6	do	34.1 N.	116.3 W.
Do	21 46.2	do	34.1 N.	116.3 W.
June 8	17 10.5	do	34.1 N.	116.3 W.
June 11	8 42.2	North of Timor Island. Depth normal	8.0 S.	125.0 E.
Do	18 50.2	Southwestern Canada	53 N.	125 W.
Do	19 51.3	Southern California	34.1 N.	116.3 W.
Do	20 35.5	do	34.1 N.	116.3 W.
June 12	5 37.4	South of Kurile Islands. Depth normal	44.5 N.	149.5 E.
Do	13 59.8	East of Honshu Island, Japan. Depth normal	35.6 N.	142.4 E.
Do	14 11.4	do	36 N.	140.5 E.
Do	18 37.0	Off southeastern Japan. Depth about 100 km.	32 N.	141.5 E.
June 13	16 54	Southern California	34.1 N.	116.3 W.
June 14	10 20.6	do	34.1 N.	116.3 W.
Do	13 57.6	do	34.1 N.	116.3 W.
Do	21 58.8	do	34.1 N.	116.3 W.
June 15	9 9.2	East of Honshu Island, Japan. Depth normal	35.8 N.	141.5 E.
June 17	10 26.8	Off northern Hawaii. Depth normal	20.7 N.	155.3 W.
June 18	6 14.5	Southern California	34.1 N.	116.3 W.
Do	13 52.6	Off southern Mindanao Island, Philippine Islands. Depth about 600 km.	5.6 N.	123.8 E.
Do	18 39	Aleutian Islands. Depth normal	52.7 N.	173.5 E.
June 22	11 36.7	Off eastern Celebes. Depth about 200 km.	3.8 S.	122.8 E.
June 23	6 55.6	East of Greenland. Depth normal	74.8 N.	14.5 W.
Do	18 59.6	Northern Venezuela. Depth normal	9.7 N.	67.8 W.
Do	21 41.5	Gulf of California. Depth normal	25.9 N.	109.9 W.
June 24	16 39.6	Southern California	34.1 N.	116.3 W.
June 25	2 52.4	Off southeastern Kamchatka Peninsula. Depth normal	52.0 N.	159 E.
June 26	4 54.7	Southern California	32.8 N.	115.5 W.
Do	8 0.3	Off southern Sumatra. Depth about 200 km.	5 S.	102.5 E.
June 27	6 52.3	Off southern Japan. Depth about 400 km.	30 N.	138 E.
June 28	20 52.1	Southern California	32.8 N.	115.5 W.
July 1	21 29.7	North of Azores. Depth normal	42.6 N.	28.8 W.
July 2	1 36.6	Off eastern Honshu Island, Japan. Depth normal	35 N.	142 E.
Do	19 09.9	Northeast of Fiji Islands. Depth normal	13.5 S.	178 W.
July 3	16 01.3	West of Queen Charlotte Islands, Canada. Depth normal	53 N.	133.5 W.
July 4	3 46.1	Southern California	32.8 N.	115.5 W.
Do	9 00.6	Off Hokkaido Island, Japan. Depth about 260 km.	44.5 N.	143.5 E.
July 5	14 03.9	Northeast of Tonga Islands. Depth normal	17.5 S.	172.5 W.
July 6	3 40.3	Off northeastern Venezuela. Depth 160 km.	13 N.	61.4 W.
July 7	18 43.0	Southern California	31.7 N.	115.1 W.
July 8	10 04.8	Nevada	38.6 N.	117.8 W.
Do	10 57.7	East Central California	37.5 N.	119.0 W.
Do	15 16.3	West of Bonin Islands, Japan. Depth about 400 km.	27 N.	139 E.
July 10	5 49.9	Manchukuo, eastern Asia. Depth about 600 km.	44.3 N.	130.2 E.
July 13	16 39.4	Southern California. San Jacinto Fault.	33.1 N.	116 W.
Do	16 47.4	Off southwestern Panama. Depth normal	7.5 N.	82.0 W.
Do	17 45.2	Southern California. San Jacinto Fault.	33.1 N.	116 W.
Do	22 50.8	do	33.1 N.	116 W.
July 14	0 1.7	do	33.1 N.	116 W.
Do	5 52.9	Aleutian Islands. Depth about 80 km.	51.7 N.	178.5 E.
Do	15 31.5	Off Honshu Island, Japan. Depth normal	36 N.	141 E.
July 15	2 32.7	Southern California, Imperial Valley	32.8 N.	115.5 W.
July 16	0 56.5	Probable epicenter. Aleutian Islands. Depth 75 km.	52 N.	178 W.
Do	3 17.6	Northeast of Hawaii. By Hawaiian Volcano Observatory. Depth normal	20.9 N.	155.1 W.
Do	22 05.9	Probable epicenter. North of Tonga Islands. Depth about 150 km.	16 S.	174 W.
July 19	4 47.5	Probable epicenter. Aleutian Islands	53 N.	174 E.
July 20	1 53.9	South of Samoa Islands. Depth normal	15.4 S.	172.2 W.
July 21	0 02.0	Off northeastern Honshu Islands, Japan	40.5 N.	141.7 E.
Do	5 16.0	Off southeastern New Hebrides Islands. Depth about 150 km.	19 S.	170 E.
Do	8 36.0	Southern California. San Jacinto Fault.	33.1 N.	116 W.
Do	15 28.3	Off northern Celebes. Depth about 100 km.	2.5 N.	122.4 E.
Do	23 06.6	South of Fiji Islands. Depth about 550 km.	23 S.	179 W.
July 22	14 32.7	East central California	37.6 N.	118.9 W.
July 24	13 32.5	East of Hokkaido Island, Japan. Depth normal	43.5 N.	147.5 E.
July 27	13 32.5	Southern Guatemala. Depth 90 km.	14.3 N.	91.5 W.
July 29	20 53.4	Southern California. San Jacinto Fault.	33.1 N.	116 W.
July 30	0 12.3	Turkey. Depth normal	38.5 N.	33.5 E.



TABLE 1.—Summary of instrumental epicenters for 1940—Continued

1940	Greenwich civil time at origin	Region and focal depth	Coordinates of provi- sional epicenter	
			Latitude	Longitude
	<i>h m</i>		°	°
July 30.....	15 27.2	Off southwestern Panama. Depth normal.	4.7 N.	82.5 W.
Do.....	16 05.4	Off southeastern Cuba. Depth normal.	19.4 N.	75.1 W.
Do.....	21 52.6	Probable epicenter. Off southwestern Peru.	15 S.	78 W.
July 31.....	11 39.3	Off southeastern New Guinea.	10.5 S.	148.5 E.
Aug. 1.....	12 39.6	Northwest of Kermadec Islands. Depth 490 km.	26.3 S.	179.8 E.
Do.....	15 08.4	Off western Hokkaido Island, Japan. Depth about 50 km.	44.7 N.	138.8 E.
Do.....	19 31.7	Southern California. Little San Bernardino Mountains.	34.1 N.	116.3 W.
Aug. 4.....	9 16.0	Honshu Island, Japan.	38 N.	140 E.
Do.....	16 06.6	Probable epicenter. Southern Peru. Depth about 50 km.	15 S.	73 W.
Do.....	18 15.3	Southern California. Little San Bernardino Mountains.	34.1 N.	116.3 W.
Aug. 5.....	8 19.8	Aleutian Islands.	53 N.	178 W.
Do.....	9 55.2	Off eastern China, in Gulf of Liaotung. Depth normal.	39.9 N.	120.8 E.
Aug. 7.....	2 56.0	Northern Chile. Depth about 115 km.	22.5 S.	68 W.
Aug. 9.....	13 43.8	Vicinity of Martinique Island.	15.4 S.	173.1 W.
Aug. 11.....	16 46.7	Southwest of Samoa Islands. Depth normal.	35.5 N.	133 E.
Aug. 13.....	15 36.8	Western Honshu Island, Japan.	36.2 N.	129.3 W.
Do.....	22 07.5	Near Oil City, California. Depth normal.	8.5 N.	82.5 W.
Aug. 15.....	2 51.7	Probable epicenter. Western Panama.	43 N.	130 W.
Do.....	4 37.0	Off Oregon coast.	18.3 N.	145.9 E.
Do.....	21 23.5	Marianas Islands. Depth about 150 km.	26.5 S.	173 W.
Aug. 18.....	5 55.1	Southeast of Tonga Islands. Depth normal.	33.7 N.	139.4 E.
Aug. 20.....	5 1.9	Off southern Honshu Island, Japan.	8.5 S.	149 E.
Do.....	17 29.7	Off eastern New Guinea. Depth normal.	53 N.	165 W.
Aug. 22.....	3 27.3	Southeast of Unalaska Island. Aleutian Islands. Depth about 60 km.	7.9 N.	82.3 W.
Do.....	11 03.5	Off southwestern Panama. Depth normal.	53 N.	154 W.
Aug. 24.....	7 53.2	Probable epicenter. South of Alaska.	14 S.	173.5 W.
Do.....	13 31.1	West of Samoa Island. Depth normal.	36.5 N.	139 E.
Aug. 25.....	10 31.7	Probable epicenter. Honshu Island, Japan.	11.5 S.	75.5 W.
Aug. 26.....	2 28	Peru. Depth about 110 km.	1.2 N.	90.7 W.
Do.....	5 0.8	North of Galapagos Islands. Depth normal.	20 S.	178 W.
Aug. 28.....	12 28.5	Southeast of Fiji Islands. Depth about 200 km.	45.7 N.	147.8 E.
Do.....	15 17.1	Kurile Islands. Depth normal.	32.8 N.	115.5 W.
Aug. 30.....	16 34.2	Southern California. Imperial Valley.	17 S.	78 W.
Aug. 31.....	17 12.7	Off southwestern Peru.	21 N.	155.3 W.
Sept. 2.....	8 44.6	North of Hawaii. By Hawaiian Volcano Observatory.	22.2 S.	171.6 E.
Sept. 3.....	1 28.0	East of Loyalty Islands. Depth about 110 km.	32 N.	93 E.
Do.....	14 40.6	Probable epicenter. Tibet. Depth normal.	34.1 N.	116.3 W.
Sept. 5.....	9 33.2	Southern California. Little San Bernardino Mountains. Depth normal.	56 N.	162 E.
Sept. 6.....	2 51.4	Off eastern Kamchatka. Depth about 50 km.	36.5 N.	121.5 W.
Sept. 7.....	10 38.6	Montgomery County, California.	36.5 N.	121.5 W.
Do.....	13 02.1	do.	9 N.	126.8 E.
Do.....	19 23.7	Off northeastern Mindanao Island, Philippine Islands. Depth 110 km.	54.5 N.	170.5 E.
Sept. 8.....	10 15.3	East of Commander Islands, Bering Sea. Depth probably about 100 km.	53.8 N.	161.9 W.
Sept. 9.....	23 01.1	Near Alaska Peninsula.	31.7 N.	115.1 W.
Sept. 12.....	0 06.5	Northern Lower California. Depth normal.	31.7 N.	115.1 W.
Do.....	0 15.5	do.	19.2 N.	107.1 E.
Do.....	0 21.5	In Gulf of Tongking. Southern China.	12 S.	176.5 E.
Do.....	9 21.5	Probable epicenter. Northwest of Samoa Islands. Depth about 200 km.	4.5 S.	150.5 E.
Do.....	13 17.1	Off northern New Britain Island. Depth about 80 km.	32.1 N.	114.3 W.
Sept. 13.....	11 50.0	Near head of Gulf of California. Depth normal.	32.1 N.	117.8 W.
Do.....	14 45.8	Off northern Lower California. Depth normal.	32.1 N.	117.8 W.
Do.....	22 55.1	do.	52.9 N.	156 W.
Sept. 14.....	2 31.1	South of Alaska. Depth normal.	7.9 S.	152.4 E.
Do.....	18 05.5	Probable epicenter. Southeast of New Britain Island.	32.7 N.	115.5 W.
Sept. 16.....	2 48.2	Southern California. Imperial Valley. Depth normal.	10 S.	80 W.
Sept. 17.....	8 52.0	Probable region of epicenter. Off Peru.	22 S.	68 W.
Sept. 18.....	15 09.2	Probable epicenter. Bolivia-Chile boundary. Depth 115 km.	34 N.	116.5 W.
Sept. 19.....	1 33.2	Southern California. Little San Bernardino Mountains. Depth normal.	38 N.	121 W.
Do.....	8 20.6	Central California. Depth normal.	23.5 S.	170.9 E.
Do.....	18 19.7	Southeast of Loyalty Islands. Depth about 75 km.	23 S.	171 E.
Sept. 20.....	0 02.9	Southeast of Loyalty Islands.	36.5 N.	115 W.
Do.....	12 21.9	Southern Nevada. Depth normal.	37 N.	71.5 E.
Sept. 21.....	13 49.0	Northeast Afghanistan. Depth about 220 km.	15 S.	173 W.
Sept. 22.....	22 11.9	Southwest of Samoa Islands.	7.5 N.	124.5 E.
Do.....	22 51.9	Mindanao Island, Philippine Islands. Depth about 700 km.	22.3 S.	63.7 W.
Sept. 23.....	7 15.2	Northern Argentina. Depth about 550 km.	67.5 N.	44.5 W.
Do.....	10 28.9	Greenland.	4 S.	144 E.
Sept. 24.....	0 47.4	Probable epicenter. Northeastern New Guinea. Depth about 100 km.	11 S.	119 E.
Sept. 25.....	14 28.9	Probable epicenter. South of Sumba Island. Netherlands East Indies.	12 S.	166.5 E.
Sept. 26.....	3 56.5	South of Santa Cruz Islands. Depth about 150 km.	40 N.	124 W.
Sept. 27.....	17 03.6	Northwestern California. Depth normal.	34.1 S.	69.2 W.
Sept. 29.....	1 21.4	Andes Mountains, western Argentina. Depth about 110 km.	54 N.	134 W.
Do.....	5 57.2	Off Queen Charlotte Islands, Canada. Depth normal.	27 S.	178 W.
Sept. 30.....	11 13.3	North of Kermadec Islands. Depth 100-150 km.	27 S.	178 W.
Do.....	14 10.6	do.	26.2 S.	71.2 W.
Oct. 1.....	10 43.5	Off Chile. Depth about 350 km.	22 N.	129 W.
Do.....	20 43.2	Off western Mexico.	59 S.	163 E.
Do.....	21 38.6	Southwest of New Zealand.	9.9 N.	84.1 W.
Oct. 2.....	3 15.8	Costa Rica. Depth normal.	15.5 S.	173.5 W.
Do.....	4 06.3	South of Samoa Islands. Depth normal.	30.5 S.	172 W.
Do.....	10 24.0	Probable epicenter. East of Kermadec Islands.	21 S.	66.5 W.
Oct. 3.....	4 56.0	Southern Bolivia. Depth about 100 km.	17.8 S.	70.4 W.
Oct. 4.....	7 55.3	Southern Peru. Depth about 200 km.	17.8 S.	70.4 W.
Do.....	9 33.7	do.	17.8 S.	70.4 W.
Oct. 5.....	4 46.6	do.	50 N.	175 E.
Do.....	9 32.4	South of Aleutian Islands. Depth probably about 100 km.	9.2 N.	84.2 W.
Do.....	14 38.7	Off western Costa Rica. Depth normal.	9.7 N.	83.3 W.
Do.....	17 17.6	Costa Rica. Depth about 150 km.		

TABLE 1.—*Summary of instrumental epicenters for 1940—Continued*

1940	Greenwich civil time at origin		Region and focal depth	Coordinates of provisional epicenter	
				Latitude	Longitude
	<i>h</i>	<i>m</i>		°	°
Oct. 6.	15	35.7	Southern Peru. Depth about 200 km.	17.8 S.	70.4 W.
Do.	15	38.8	do.	17.8 S.	70.4 W.
Do.	18	19.9	Southern California. West of Salton Sea.	33.1 N.	116.1 W.
Oct. 7.	1	25.7	North Island, New Zealand. Depth about 200 km.	38.5 S.	176.1 E.
Do.	6	43.0	Off southern Mindanao Island, Philippine Islands. Depth about 120 km.	4.9 N.	126.1 E.
Oct. 10.	17	07.9	Southern California, Imperial Valley.	32.8 N.	117.5 S.
Oct. 11.	5	57.2	Southern California, Santa Monica Bay.	33.8 N.	118.6 W.
Do.	7	53.1	Southern Alaska. Depth about 35 km.	60 N.	153 W.
Do.	18	41.2	Chile.	41 S.	73 W.
Oct. 12.	0	24.0	Southern California, Santa Monica Bay.	33.8 N.	118.6 W.
Do.	2	48.5	Probable epicenter. Southeastern Mexico. Depth about 200 km.	18 N.	89 W.
Do.	2	58.9	Southern Peru. Depth about 200 km.	17.8 S.	70.4 W.
Do.	3	45.7	Off Lower California.	31.7 N.	116.5 W.
Oct. 13.	13	25.7	Southeast of Loyalty Islands. Depth 200 km(?).	23 S.	171 E.
Oct. 14.	20	51.2	Southern California, Santa Monica Bay.	34.8 N.	118.6 W.
Oct. 15.	6	35.0	Probable epicenter. Okhotsk Sea, off Kamchatka. Depth about 40 km.	55 N.	155 E.
Do.	7	54.3	Southern Peru. Depth about 200 km.	17.8 S.	70.4 W.
Oct. 16.	17	52.2	Southern California. West of Salton Sea.	33.2 N.	116.1 W.
Oct. 17.	10	18.1	Southern California, Imperial Valley.	32.8 N.	115.5 W.
Oct. 19.	10	57.3	Southeast of Solomon Islands.	13 S.	162 E.
Oct. 21.	6	49.6	Southern California near Aguanga.	33.1 N.	116.4 W.
Do.	20	15.7	Solomon Islands. Depth about 125 km.	7 S.	156 E.
Oct. 22.	6	37.0	Eastern Rumania. Depth about 125 km.	45.8 N.	26.8 E.
Do.	11	00.8	Northern California.	40.5 N.	124 W.
Oct. 23.	2	22.8	Northern Peru. Depth about 140 km.	5.6 S.	76.4 W.
Oct. 24.	20	06.8	Off Chile. Depth about 90 km.	33.5 S.	73 W.
Oct. 26.	1	24.4	Southern Utah.	38 N.	113 W.
Do.	11	21.6	Southern California, Vallecito Mountains.	33 N.	116.3 W.
Oct. 27.	5	35.6	Costa Rica. Depth normal.	9.8 N.	84.4 W.
Do.	10	36.2	Northern Chile. Depth normal.	20 S.	69 W.
Do.	19	53.5	Gulf of California.	30 N.	114 W.
Do.	22	29.3	Northwest Washington State.	47.2 N.	123.4 W.
Oct. 28.	1	18.6	Probable epicenter. Felt in Argentina.	31 S.	73.5 W.
Do.	22	21.1	Southwestern Nevada.	37.4 N.	117 W.
Oct. 30.	3	10.2	Probable epicenter. Off northeastern Brazil.	2 S.	21 W.
Do.	11	48.5	Near Fiji Islands. Depth about 600 km.	22 S.	179 W.
Do.	22	59.7	Northern Japan. Depth probably about 300 km.	46 N.	142 E.
Oct. 31.	2	08.5	East of Martinique Island. Depth about 60 km.	15.4 N.	59.8 W.
Do.	10	43.9	Western India. Depth normal.	24 N.	70.5 E.
Nov. 1.	7	25.1	Southern California. Depth normal.	33.8 N.	118.6 W.
Do.	15	52.7	Off coast of Mexico. Depth approximately 120 km.	18 N.	107 W.
Do.	20	00.8	Southern California. Depth normal.	33.6 N.	118.2 W.
Nov. 2.	2	58.9	do.	33.8 N.	118.6 W.
Nov. 7.	10	57.9	Near Bonin Islands. Depth about 500 km.	29 N.	139 E.
Nov. 8.	10	34.2	New Hebrides region. Depth normal.	16 S.	168.7 E.
Nov. 9.	10	59.2	do.	12 S.	168 E.
Nov. 10.	1	39.1	Roumania. Destructive. Depth about 150 km.	45.9 N.	26.6 E.
Do.	20	40.4	Off coast of Nicaragua.	17 N.	83.1 W.
Nov. 16.	2	26.5	West of Aleutian Islands.	51.3 N.	168.0 E.
Nov. 17.	3	56.5	Off Oregon coast.	44.8 N.	130 W.
Do.	7	23.1	Off coast of California.	40 N.	125 W.
Nov. 19.	15	01.6	Sea of Okhotsk.	59 N.	142 E.
Do.	16	47.7	Southern California. Depth normal.	32.8 N.	116 W.
Do.	18	34.5	Off northern California.	40 N.	125 W.
Nov. 22.	9	10.2	New Hebrides Islands.	6 S.	152 E.
Nov. 23.	3	48.8	Off west coast of Costa Rica.	9 N.	84.4 W.
Do.	3	53.0	Southern California.	33.2 N.	116.1 W.
Nov. 24.	13	04.7	do.	32.8 N.	115.5 W.
Nov. 27.	14	41.6	New Britain.	3.3 S.	151.0 E.
Dec. 1.	21	10.5	Off west coast of Panama.	7.1 N.	83.5 W.
Dec. 4.	13	5.7	Near New Guinea. Depth probably less than 100 km.	4 S.	132 E.
Dec. 7.	3	19.9	Off west coast of Costa Rica.	9 N.	84 W.
Do.	14	16.5	Southern California.	31.7 N.	115.1 W.
Dec. 15.	23	53.1	Near coast of Salvador.	3.6 N.	90.1 W.
Dec. 18.	5	32	Banda Sea.	5.8 S.	128.3 E.
Dec. 20.	7	27.4	New Hampshire. Depth approximately 35 km.	43.8 N.	71.3 W.
Do.	23	41.0	Humboldt and Mendocino Counties. California.	39.5 N.	123.5 W.
Dec. 22.	12	31.6	Fiji Islands.	17 S.	178 W.
Do.	19	59.8	Near Lake Titicaca, Peru. Depth approximately 250 km.	15.5 S.	69 W.
Dec. 23.	21	50.5	Near Helena, Montana.	45.5 N.	112.5 W.
Dec. 24.	13	43.8	New Hampshire. Depth approximately 35 km.	43.8 N.	71.3 W.
Dec. 28.	16	37.8	Marianas Islands. Depth approximately 60 km.	18.1 N.	147.8 E.
Dec. 29.	16	38	Off coast of Ecuador.	2 N.	81 W.
Do.	18	05.1	Near southwest coast of Panama.	7.3 N.	83.2 W.

## 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 eight preceding issues of this series, Serials 579, 593, 600, 610, 619, 629, 637, and 647, 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. 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.

For 1941 the only record thus processed was the Santa Barbara accelerograph record of the Santa Barbara Channel earthquake of June 30. Tabulations of the measured and computed ordinates of the curves shown in figures 8, 9, and 10 may be obtained for special investigations by writing to the Director, Coast and Geodetic Survey, Washington.

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

*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 1.43 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 3 in this issue, and 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 3 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.

TABLE 2.—*List of shocks recorded and records obtained on strong-motion seismographs in 1941*

Date, epicenter, and recording station	Records			Date, epicenter, and recording station	Records		
	Accelerograph	Displacement meter	Weed strong-motion seismograph		Accelerograph	Displacement meter	Weed strong-motion seismograph
Jan. 23: northern California: Ferndale.....	1	-----	-----	Oct. 21: Los Angeles County: Gardena.....	1	-----	-----
Feb. 9: northern California: Ferndale.....	1	-----	-----	Long Beach.....	1	-----	-----
Eureka.....	1	1	-----	Los Angeles Subway Terminal.....	2	1	-----
May 13: northern California: Ferndale.....	1	-----	-----	Vernon.....	1	-----	-----
June 30: Santa Barbara: Santa Barbara, including two aftershocks.....	3	-----	-----	Westwood.....	1	-----	-----
Hollywood.....	3	-----	-----	Los Angeles Chamber of Commerce.....	1	-----	-----
Los Angeles Subway Terminal.....	2	1	-----	Los Angeles Edison Bldg.....	1	-----	-----
Los Angeles Chamber of Commerce.....	2	-----	-----	Hollywood Storage Company Bldg.....	3	-----	-----
Long Beach.....	1	-----	-----	Oct. 22: Los Angeles County: Gardena.....	1	-----	-----
Vernon.....	1	-----	-----	Long Beach.....	1	-----	-----
Sept. 3: Boulder Dam: 1215 Gallery.....	1	-----	-----	Los Angeles Subway Terminal.....	2	1	-----
Intake Tower.....	1	-----	-----	Nov. 14: Los Angeles County: Torrance-Gardena.....	1	-----	-----
Oil House.....	1	-----	-----	Vernon.....	1	-----	-----
Sept. 7: Santa Barbara: Santa Barbara.....	1	-----	-----	Long Beach.....	1	-----	-----
Sept. 14: Owens Valley: Bishop (two shocks).....	2	-----	-----	Westwood.....	1	-----	-----
Sept. 14: Santa Barbara region: Santa Barbara.....	1	-----	-----	Hollywood Storage Company Bldg.....	3	-----	-----
Sept. 17: San Francisco Bay region: San Jose.....	2	-----	-----	Los Angeles Edison Bldg.....	1	-----	-----
Oct. 3: northern California: Eureka.....	1	1	-----	Los Angeles Chamber of Commerce.....	2	-----	-----
Ferndale.....	1	-----	-----	Los Angeles Subway Terminal.....	2	1	-----
				Santa Ana.....	-----	-----	1
				Total.....	51	5	1

## NORTHERN CALIFORNIA EARTHQUAKE OF JANUARY 23

Epicenter roughly 10 miles offshore near Cape Mendocino. Maximum intensity on shore, V.

*Ferndale*.—Figure 5. Station about 18 miles S.  $81^{\circ}$  E. of epicenter. Intensity V. Maximum acceleration 19 cm./sec.<sup>2</sup>

## NORTHERN CALIFORNIA EARTHQUAKE OF FEBRUARY 9

Epicenter about 55 miles off Humboldt Bay. Maximum intensity on shore, VI. Felt also over large area in Oregon.

*Ferndale*.—Figure 5. Station about 65 miles S.  $70^{\circ}$  E. of epicenter. Intensity, VI. Maximum acceleration 47 cm./sec.<sup>2</sup>

*Eureka*.—Figure 6. Station about 65 miles S.  $80^{\circ}$  E. of epicenter. Intensity, VI. Maximum acceleration 12 cm./sec.<sup>2</sup> Maximum recorded displacement 0.6 cm.

## NORTHERN CALIFORNIA EARTHQUAKE OF MAY 13

Epicenter about 35 miles offshore, near Cape Mendocino. Maximum intensity on shore, V.

*Ferndale*.—Figure 7. Station about 40 miles S.  $85^{\circ}$  E. of epicenter. Maximum acceleration 10 cm./sec.<sup>2</sup>

## SANTA BARBARA EARTHQUAKE OF JUNE 30

Epicenter in Santa Barbara Channel; maximum intensity on shore, VIII. About \$100,000 damage at Santa Barbara and nearby points.

*Santa Barbara*.—Figures 8, 9 and 10. Station about 10 miles N.  $35^{\circ}$  W. of epicenter. Intensity VIII at Santa Barbara and Carpinteria. Maximum acceleration at Santa Barbara 172 cm./sec.<sup>2</sup>; maximum velocity and displacement, based on analysis by integration, respectively 16 cm./sec. and 2.0 cm. These values are not resultant motions. Two aftershocks were recorded on the same day having amplitudes of 33 and 15 cm./sec.<sup>3</sup> See Fig. 14.

*Hollywood*.—Figure 11. Stations about 73 miles S.  $78^{\circ}$  E. of epicenter. Intensity, IV. Records were obtained from the basement and penthouse of the Hollywood Storage Company building and on the adjoining lot. Maximum intensities were 4 cm./sec.<sup>2</sup>, 19 cm./sec.<sup>2</sup>, and 5 cm./sec.<sup>2</sup> respectively.

*Los Angeles Subway Terminal*.—Figure 12. Station about 78 miles S.  $76^{\circ}$  E. of epicenter. Intensity IV to V. Maximum accelerations in basement and on the thirteenth floor of the Terminal building, respectively 2 cm./sec.<sup>2</sup> and 9 cm./sec.<sup>2</sup> Maximum displacement recorded in the basement was 0.2 cm.

*Los Angeles Chamber of Commerce Building*.—Figure 13. Station about 78 miles S.  $76^{\circ}$  E. of epicenter. Intensity, IV to V. Maximum accelerations in basement and penthouse, respectively 2 cm./sec.<sup>2</sup> and 9 cm./sec.<sup>2</sup>

*Long Beach*.—Figure 7. Station about 87 miles S.  $65^{\circ}$  E. of epicenter. Intensity, V. Maximum acceleration 4 cm./sec.<sup>2</sup>

*Vernon*.—Figure 7. Station about 80 miles S.  $76^{\circ}$  E. of epicenter. Intensity, probably V. Maximum acceleration 4 cm./sec.<sup>2</sup>

## BOULDER DAM EARTHQUAKE OF SEPTEMBER 3

Epicenter about 4 miles east of Boulder Dam. Maximum intensity near dam about V.

*1215 Gallery*.—Figure 15. Station about 4 miles west of epicenter. Maximum acceleration 12 cm./sec.<sup>2</sup>

*Intake Tower*.—Figure 15. Station about 4 miles west of epicenter. Maximum acceleration 15 cm./sec.<sup>2</sup>

*Oil House*.—Figure 15. Station about 4 miles west of epicenter. Maximum acceleration 5 cm./sec.<sup>2</sup>

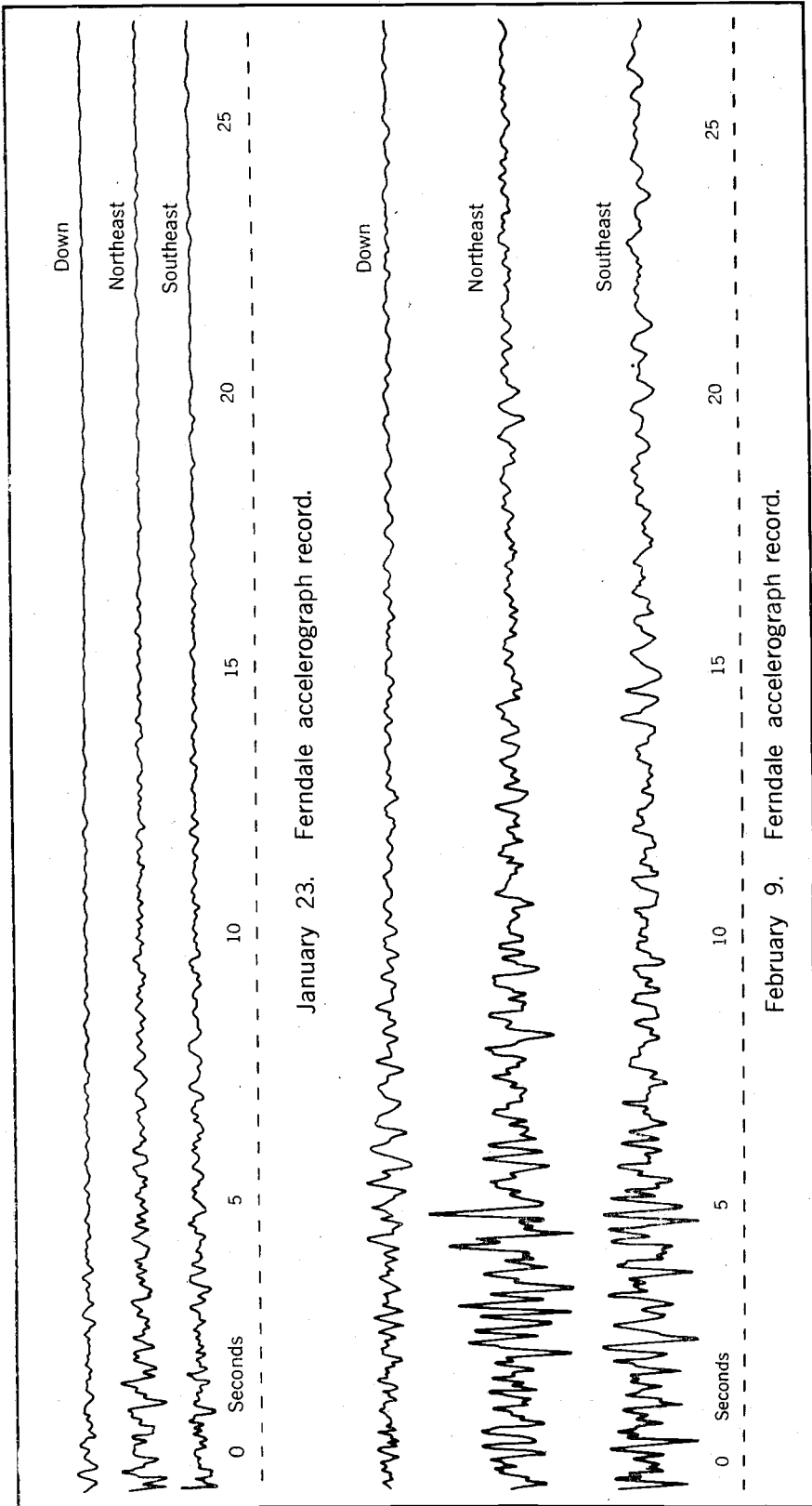


FIGURE 5.—Tracings of accelerograph records obtained at Ferndale on January 23 and February 9, 1941.

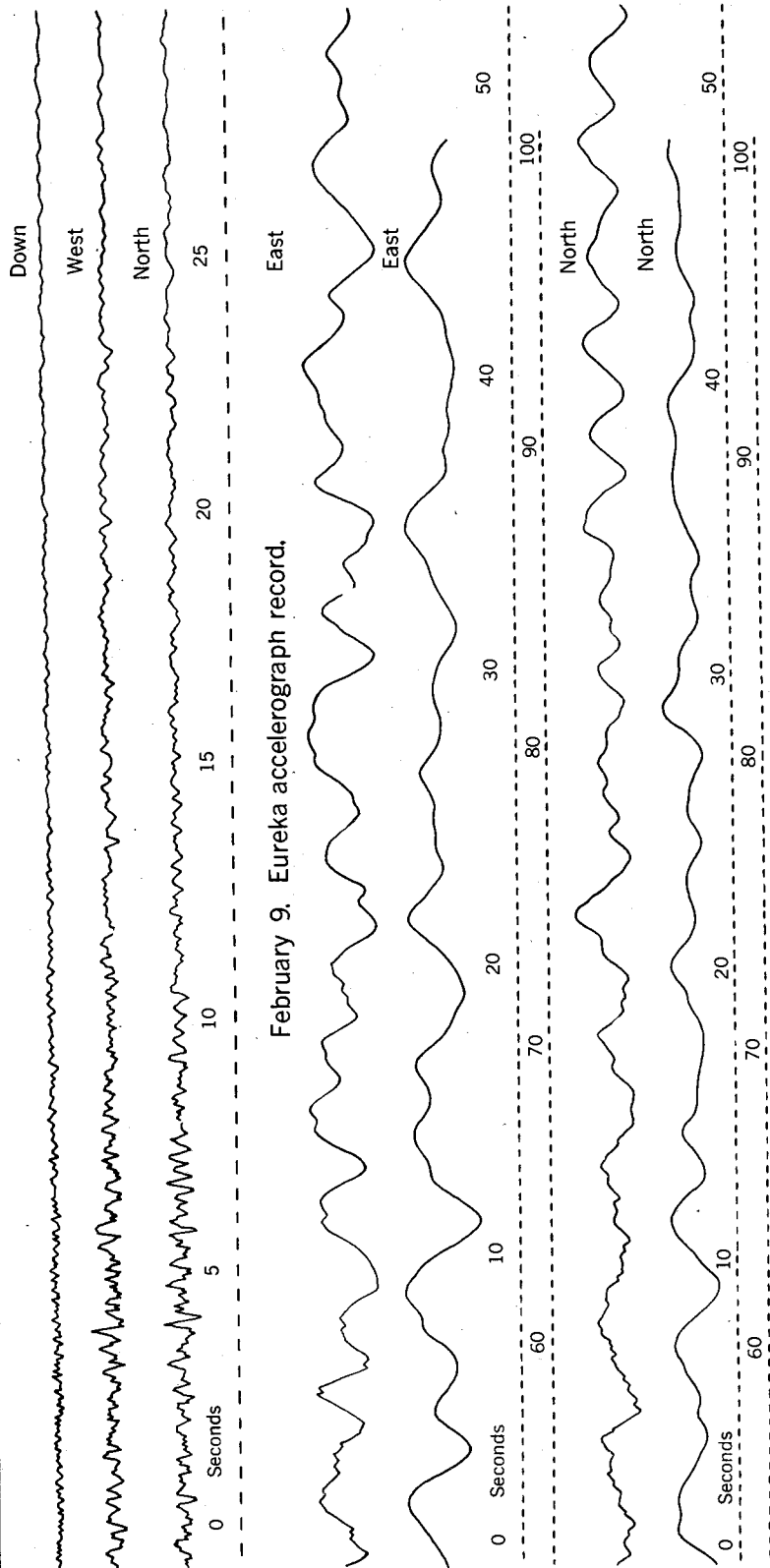


FIGURE 6.—Tracings of strong-motion seismograph records obtained at Eureka on February 9, 1941.

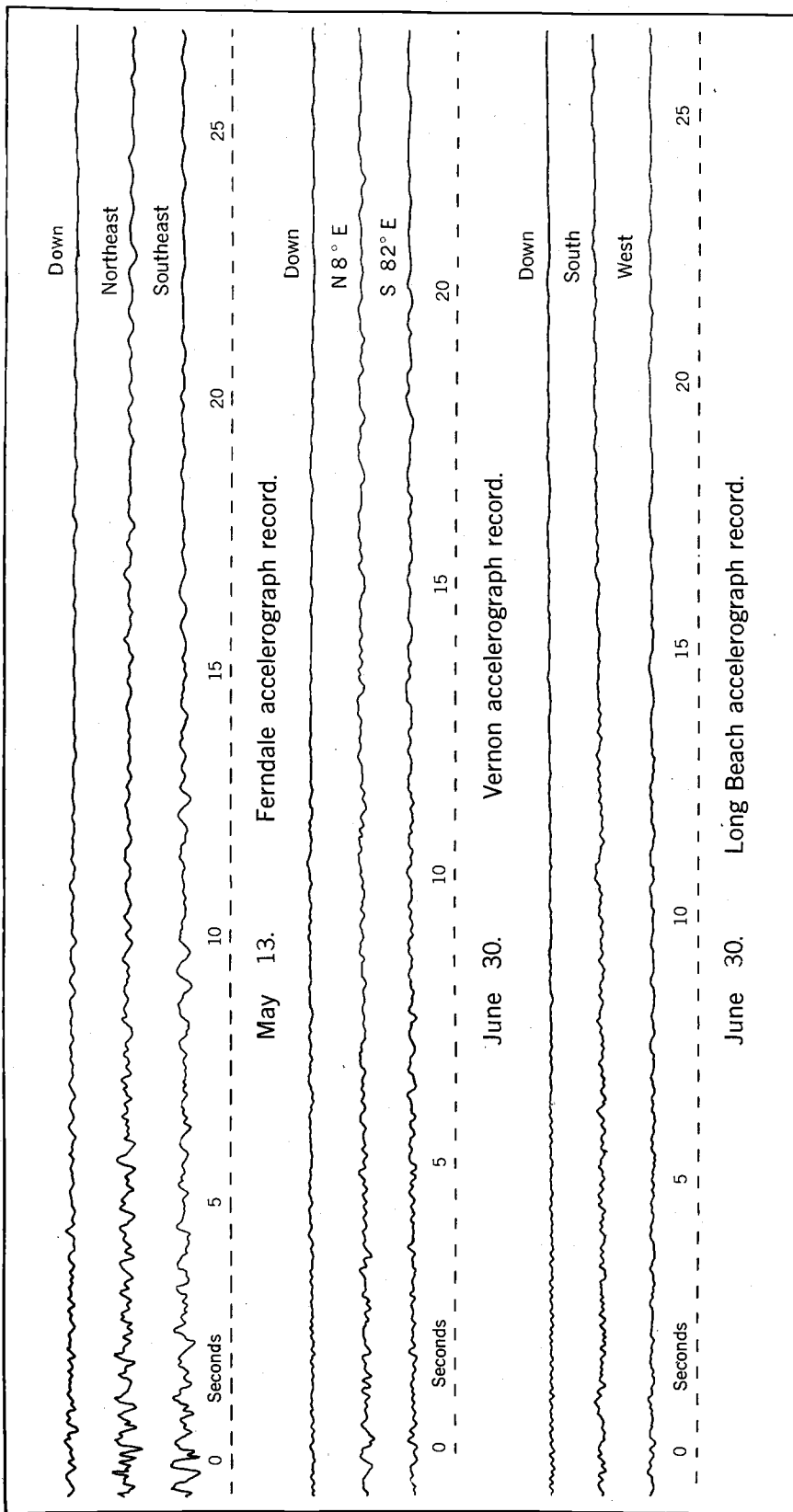
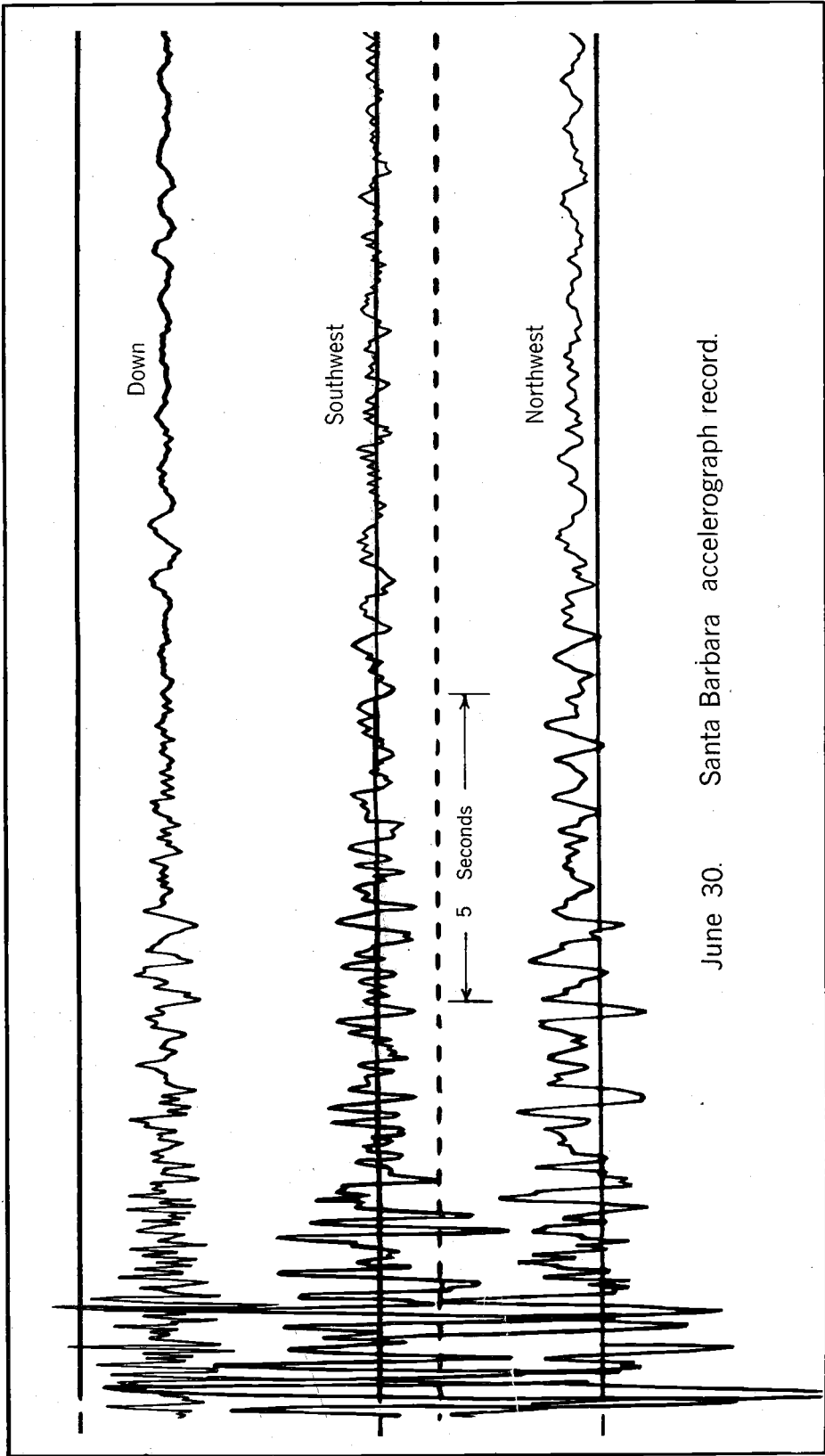


FIGURE 7.—Tracings of accelerograph records obtained at Ferndale on May 13, 1941, and at Vernon and Long Beach on June 30, 1941.





June 30. Santa Barbara accelerograph record.

FIGURE 8.—Original accelerograph record obtained at Santa Barbara on June 30, 1941.

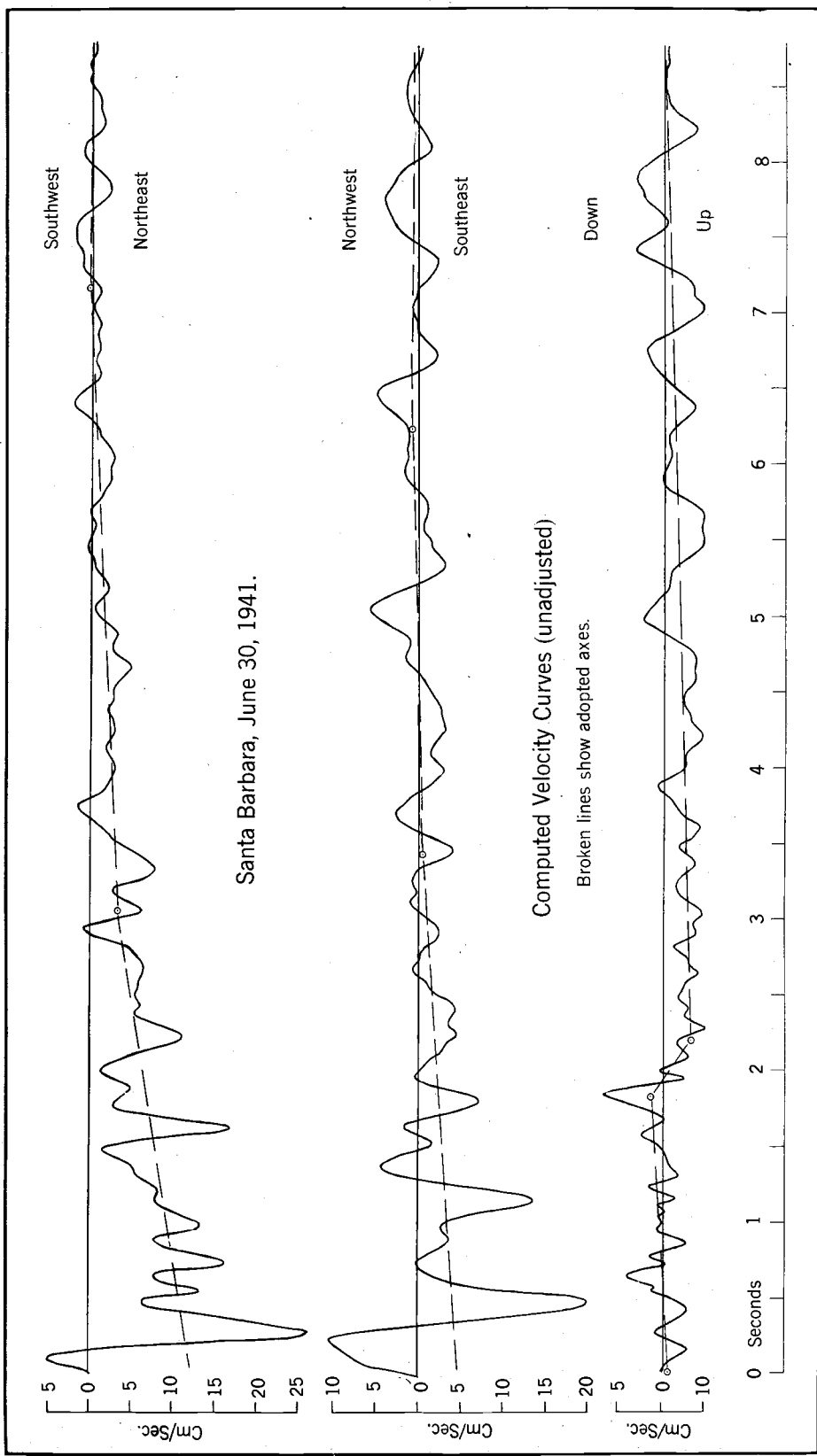


FIGURE 9.—Velocity computed from the Santa Barbara accelerograph record of June 30, 1941.

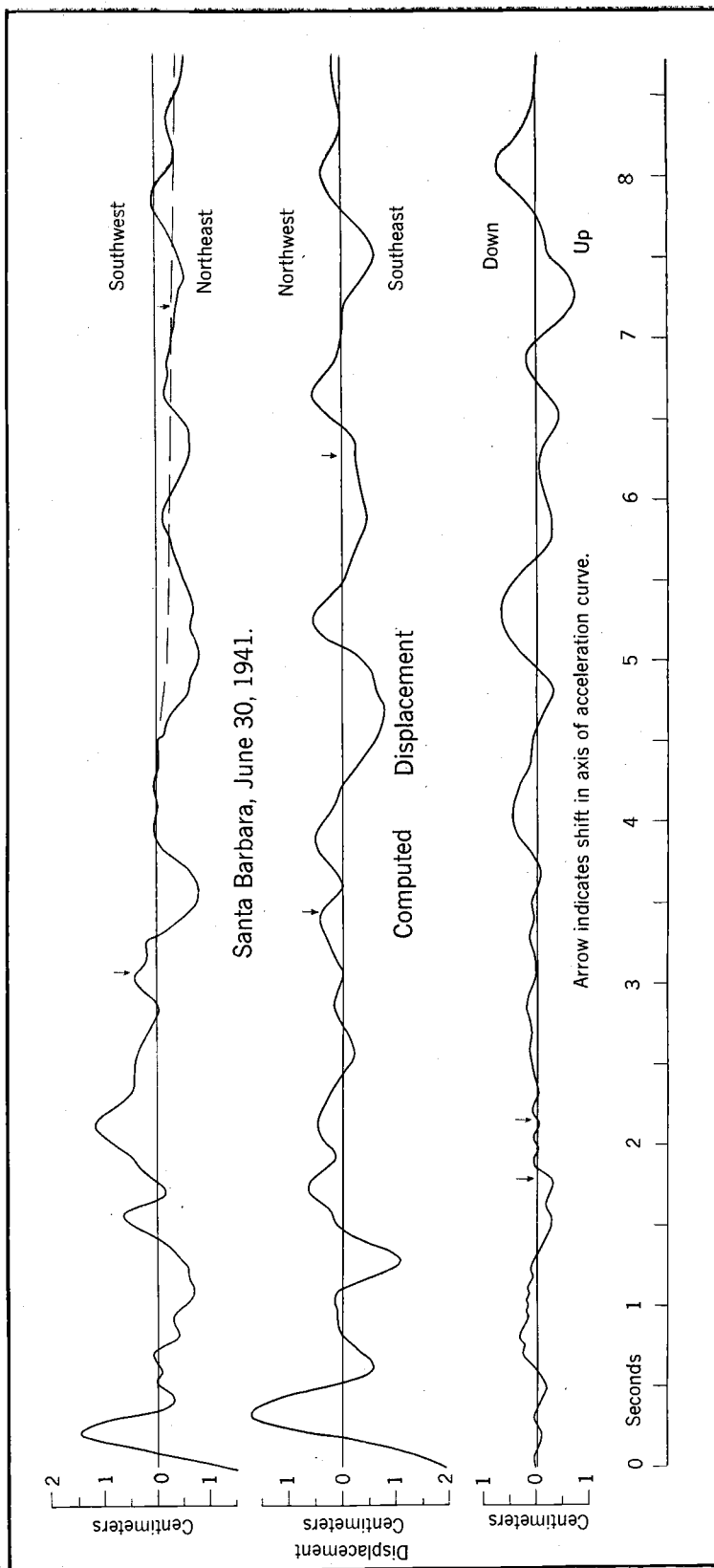


FIGURE 10.—Displacement computed from the Santa Barbara accelerograph record of June 30, 1941.

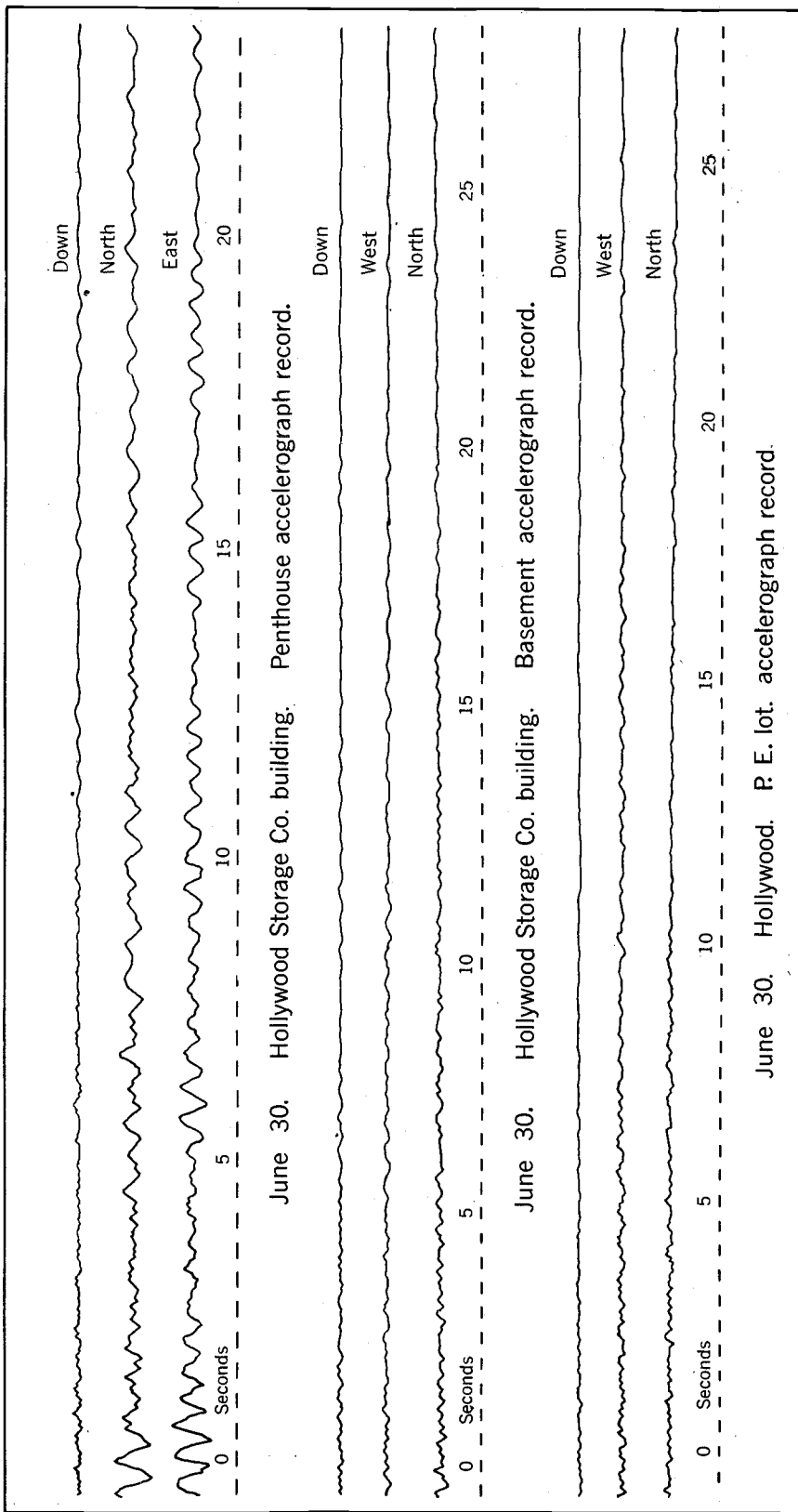


FIGURE 11.—Tracings of accelerograph records obtained at Hollywood on June 30, 1941.

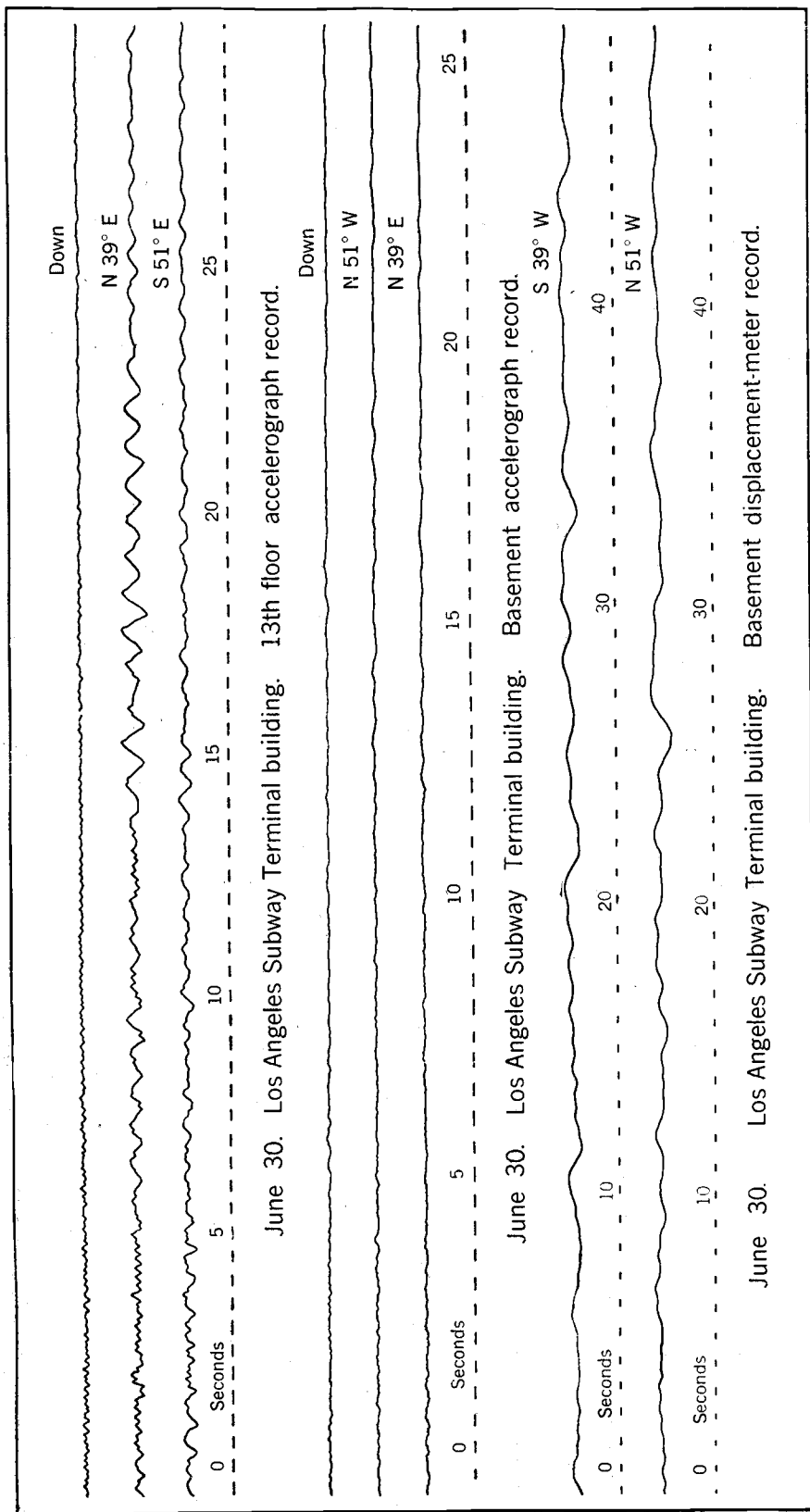


FIGURE 12.—Tracings of strong-motion seismograph records obtained at the Los Angeles Subway Terminal building on June 30, 1941.

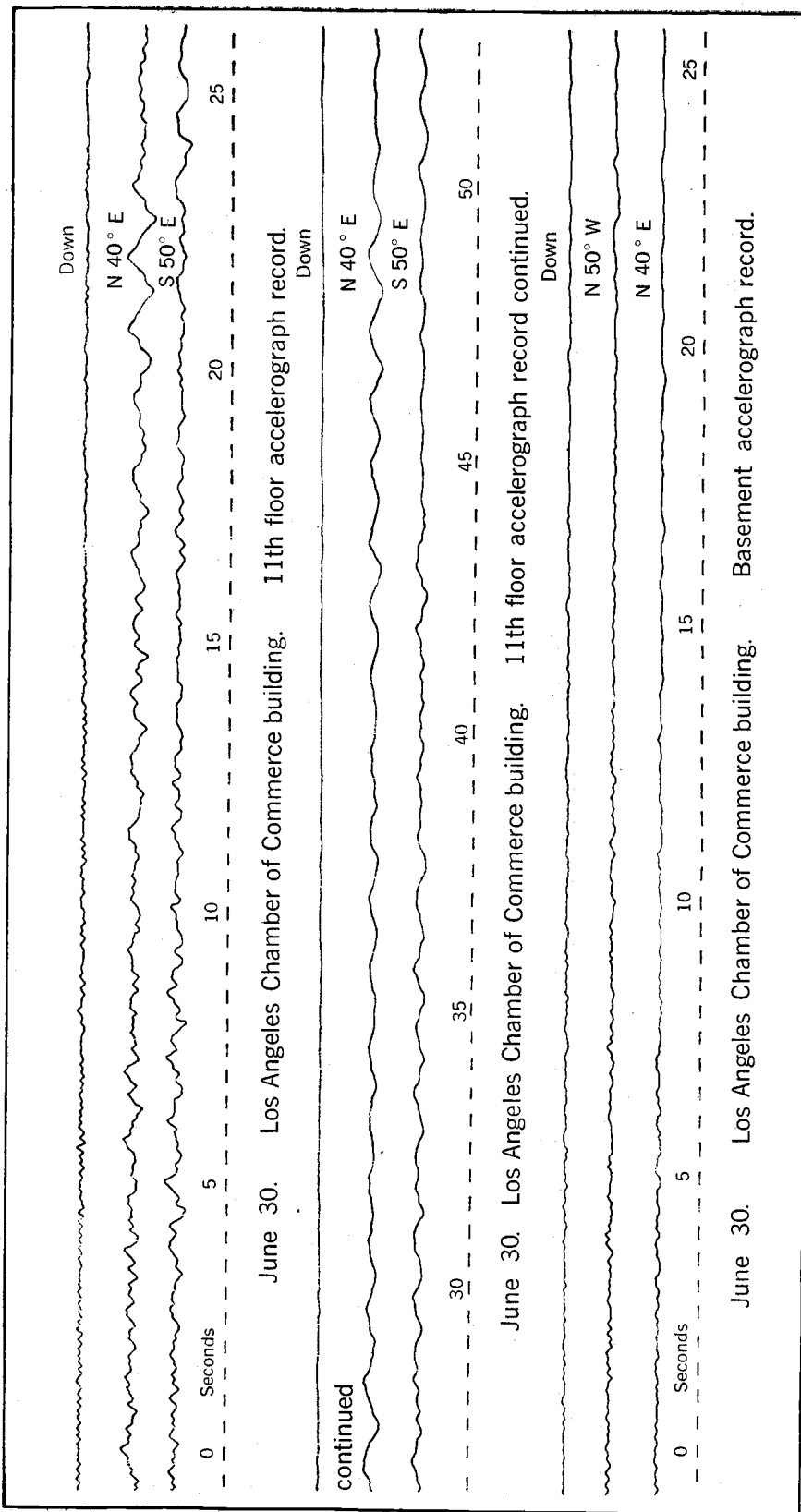


FIGURE 13.—Tracings of accelerograph records obtained in the Los Angeles Chamber of Commerce building on June 30, 1941.

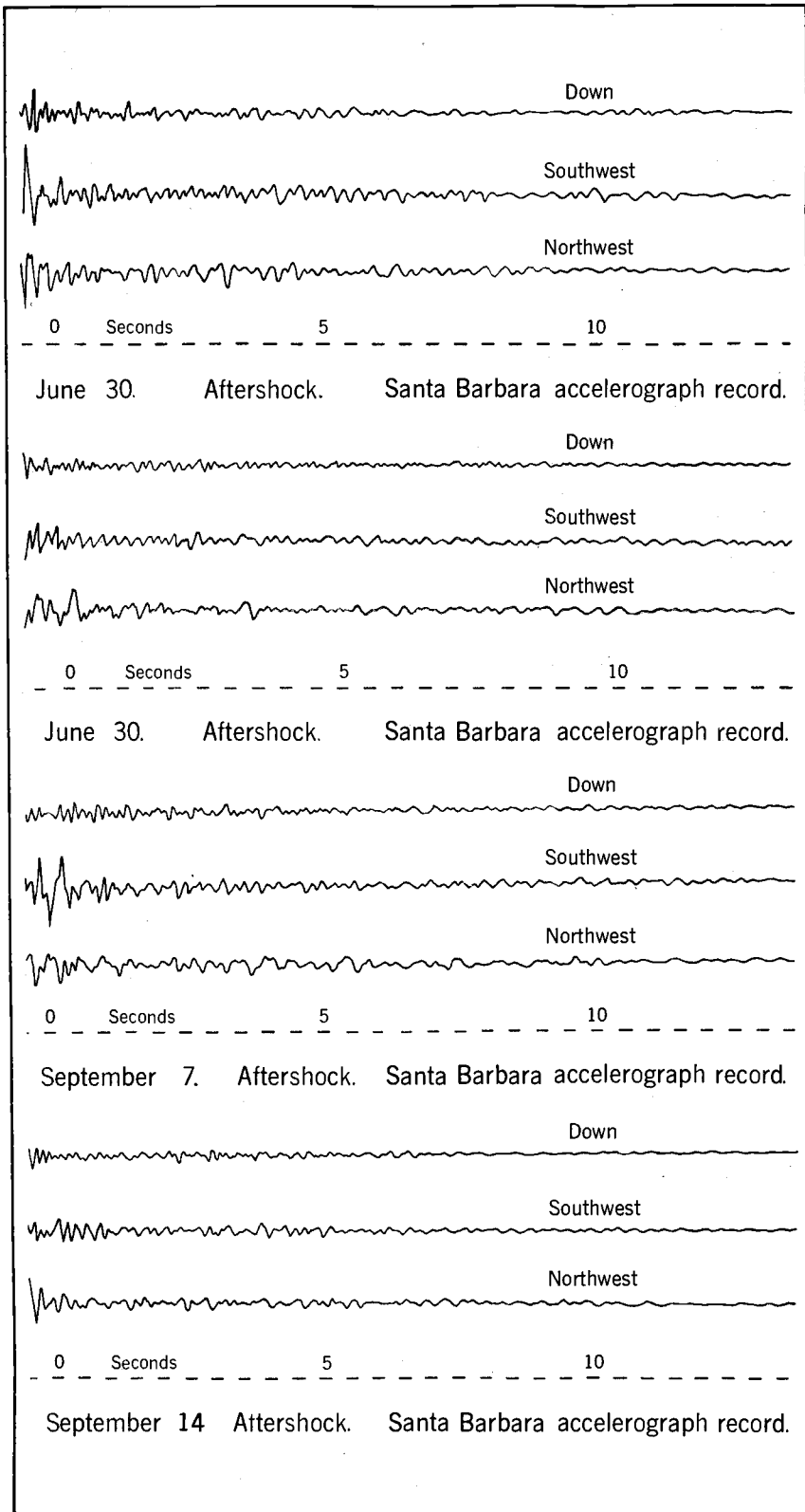


FIGURE 14.—Tracings of accelerograph records obtained at Santa Barbara on June 30 and September 7 and 14, 1941.

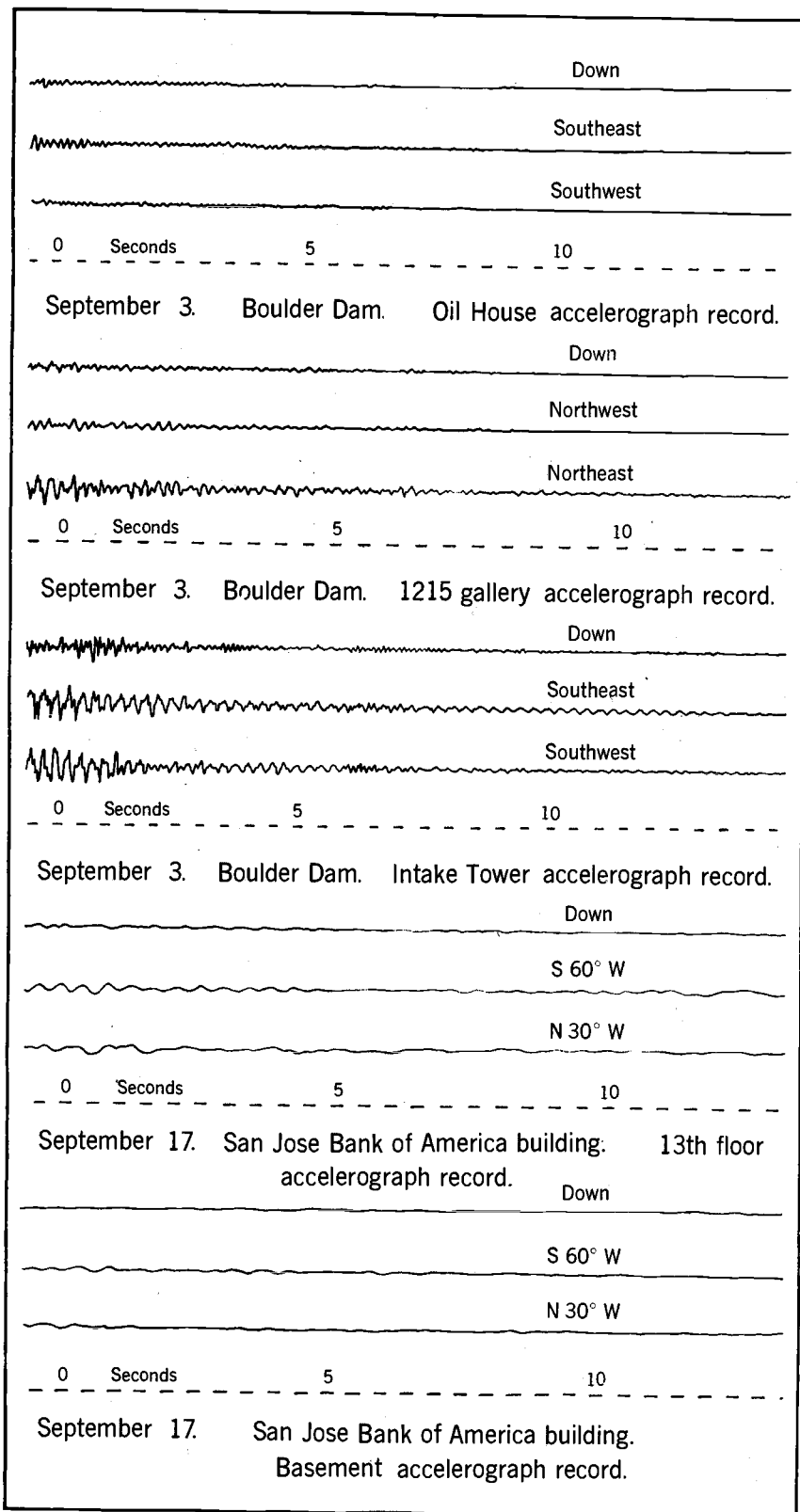


FIGURE 15.—Tracings of accelerograph records obtained at Boulder Dam on September 3, 1941, and at San Jose on September 17, 1941.



## SANTA BARBARA EARTHQUAKE OF SEPTEMBER 7

Epicenter in Santa Barbara Channel; maximum intensity unknown. Aftershock of the June 30 earthquake.

*Santa Barbara*.—Figure 14. Station about 10 miles N.  $35^{\circ}$  W. of epicenter. The record reproduced in figure 14 is for the shock at 19:12:45. Maximum acceleration, 25 cm./sec.<sup>2</sup>

There is no positive way of determining whether the last Santa Barbara record in figure 14 (dated September 14) was made at 19:14:23 on September 7 or at 17:37:02 on September 14. According to the Seismological Laboratory at Pasadena both of these shocks were of the same magnitude. Prof. Byerly reports that the Mount Hamilton records show about the same amplitudes for the 2 shocks on September 7, but amplitudes only half as great for the shock on the 14th. As the second Santa Barbara record at the bottom of figure 14 also shows amplitudes about one-half those of the shock at 19:12:45 on the 7th, it is assumed that second Santa Barbara record was made on the 14th.

## OWENS VALLEY EARTHQUAKES OF SEPTEMBER 14

Epicenters in the Rock Creek and Mono Creek basins. Maximum intensities, VI to VII, occurred in a sparsely settled region.

*Bishop*.—Figure 22 shows only the 10:21 accelerograph record. Records of the 8:44 and 10:39 shocks were obtained but due to irregular motion of the recording paper they were too difficult to trace and modify with confidence, and are therefore not reproduced. They are very similar in type to the record of the 10:21 shock. The highest accelerations were recorded during the 10:39 shock shown in figure 22, namely, 16 cm./sec.<sup>2</sup> For the records preceding and following this they were 9 and 11 cm./sec.<sup>2</sup>, respectively.

Station about 23 miles S.  $55^{\circ}$  E. of epicenter. Intensity at Bishop for all three shocks was about IV.

## SANTA BARBARA EARTHQUAKE OF SEPTEMBER 14

Epicenter in Santa Barbara Channel; maximum intensity unknown. Aftershock of the June 30 earthquake. See note under Santa Barbara shock of September 7.

*Santa Barbara*.—Figure 14. Station about 10 miles N.  $35^{\circ}$  W. of epicenter. Intensity about V. Maximum acceleration 18 cm./sec.<sup>2</sup>

## SAN FRANCISCO BAY REGION EARTHQUAKE OF SEPTEMBER 17

Epicenter from local instrumental data not yet reported; provisionally estimated at  $37.4^{\circ}$  north,  $122.0^{\circ}$  west. Intensity V was reported from many places.

*San Jose*.—Figure 15. Distance and direction of station from provisional epicenter 7 miles S.  $53^{\circ}$  E. Intensity in San Jose, about IV. Maximum acceleration recorded in basement of Bank of America building, 3 cm./sec.<sup>2</sup>; on thirteenth floor, 4 cm./sec.<sup>2</sup>

## NORTHERN CALIFORNIA EARTHQUAKE OF OCTOBER 3

Epicenter off Cap Mendocino. Maximum intensity on shore, about VII.

*Eureka*.—Figure 16. Station about 25 miles N.  $60^{\circ}$  E. of epicenter. Intensity VII in Eureka. Maximum acceleration, 18 cm./sec.<sup>2</sup>; maximum recorded displacement 0.8 cm.

*Ferndale*.—Figure 17. Station about 15 miles S.  $75^{\circ}$  E. of epicenter. Intensity VI in Ferndale. Maximum acceleration, 116 cm./sec.<sup>2</sup>

## GARDENA EARTHQUAKE OF OCTOBER 21

Epicenter in the Gardena area of Los Angeles County; maximum intensity VII. Greatest damage in the West Dominguez Oil Field east of Gardena.

*Los Angeles Chamber of Commerce Building.*—Figure 20. Station about 16 miles N.  $10^{\circ}$  W. of epicenter. Intensity about VI. Maximum acceleration 18 cm./sec.<sup>2</sup> No record from eleventh floor accelerograph.

*Los Angeles Subway Terminal Building.*—Figure 19. Station about 16 miles N.  $8^{\circ}$  W. of epicenter. Intensity about VI. Maximum acceleration in basement, 9 cm./sec.<sup>2</sup>; maximum recorded displacement 0.23 cm. Maximum acceleration on thirteenth floor, 30 cm./sec.<sup>2</sup>

*Los Angeles Edison Building.*—Figure 22. Station about 16 miles N.  $8^{\circ}$  W. of epicenter. Intensity about VI. Maximum acceleration 9 cm./sec.<sup>2</sup>

*Vernon.*—Figure 20. Station about 12 miles N.  $5^{\circ}$  E. of epicenter. Intensity about VI. Maximum acceleration 17 cm./sec.<sup>2</sup>

*Long Beach.*—Figure 20. Station about 2 miles S.  $20^{\circ}$  E. of instrumental epicenter. Intensity about VI. Maximum acceleration 32 cm./sec.<sup>2</sup>

*Westwood.*—Figure 21. Station 20 miles N.  $20^{\circ}$  W. of epicenter. Intensity about VI. Maximum acceleration 5 cm./sec.<sup>2</sup>

*Hollywood Storage Co. Building.*—Figure 18. Station 20 miles N.  $20^{\circ}$  W. of epicenter. Intensity about VI. Maximum acceleration in basement, 6 cm./sec.<sup>2</sup>; in penthouse, 21 cm./sec.<sup>2</sup>

*Lot near Hollywood Storage Co. Building.*—Figure 18. Station 20 miles N.  $20^{\circ}$  W. of epicenter. Intensity about VI. Maximum acceleration 6 cm./sec.<sup>2</sup>

#### GARDENA AFTERSHOCK OF OCTOBER 22

Epicenter in the Gardena area of Los Angeles County. Maximum intensity VI.

*Long Beach.*—Figure 21. Station 1 mile N.  $30^{\circ}$  W. of instrumental epicenter. Intensity probably IV. Maximum acceleration 8 cm./sec.<sup>2</sup>

*Los Angeles Subway Terminal Building.*—Figure 21. Station 18 miles N.  $8^{\circ}$  W. of epicenter. Intensity probably III. Maximum acceleration in basement, 1 cm./sec.<sup>2</sup>; on thirteenth floor 4 cm./sec.<sup>2</sup>

#### TORRANCE-GARDENA EARTHQUAKE OF NOVEMBER 14

Epicenter in the Torrance-Gardena area of Los Angeles County. Maximum intensity VII–VIII. Damage approximately \$1,000,000. No casualties. At least 50 buildings severely damaged.

*Vernon.*—Figure 26. Station 15 miles N.  $12^{\circ}$  E. of epicenter. Intensity VI. Maximum acceleration 19 cm./sec.<sup>2</sup>

*Long Beach.*—Figure 22. Station 4 miles S.  $80^{\circ}$  E. of epicenter. Intensity VI. Maximum acceleration 49 cm./sec.<sup>2</sup>

*Westwood.*—Figure 26. Station 20 miles N.  $4^{\circ}$  W. of epicenter. Intensity VI. Maximum acceleration 9 cm./sec.<sup>2</sup>

*Hollywood Storage Co. Building.*—Figure 23. Station 21 miles N.  $10^{\circ}$  W. of epicenter. Intensity VI. Maximum acceleration in basement, 6 cm./sec.<sup>2</sup>; in penthouse 25 cm./sec.<sup>2</sup>

*Lot near Hollywood Storage Co. Building.*—Figure 23. Station 21 miles N.  $10^{\circ}$  W. of epicenter. Intensity VI. Maximum acceleration 8 cm./sec.<sup>2</sup>

*Los Angeles Edison Building.*—Figure 26. Intensity VI. Station 17 miles due north of epicenter. Maximum acceleration 9 cm./sec.<sup>2</sup>

*Los Angeles Chamber of Commerce Building.*—Figure 25. Intensity VI. Station 17 miles due north of epicenter. Maximum acceleration 14 cm./sec.<sup>2</sup> in basement; 38 cm./sec.<sup>2</sup> on eleventh floor.

*Los Angeles Subway Terminal Building.*—Figure 24. Intensity VI. Station 17 miles due north of epicenter. Maximum acceleration 9 cm./sec.<sup>2</sup> in basement; 33 cm./sec.<sup>2</sup> on thirteenth floor.

*Santa Ana.*—Record on Weed strong-motion seismograph too indefinite for reproduction. Station 22 miles S.  $82^{\circ}$  E. of epicenter. Intensity V. Maximum acceleration about 6 cm./sec.<sup>2</sup>

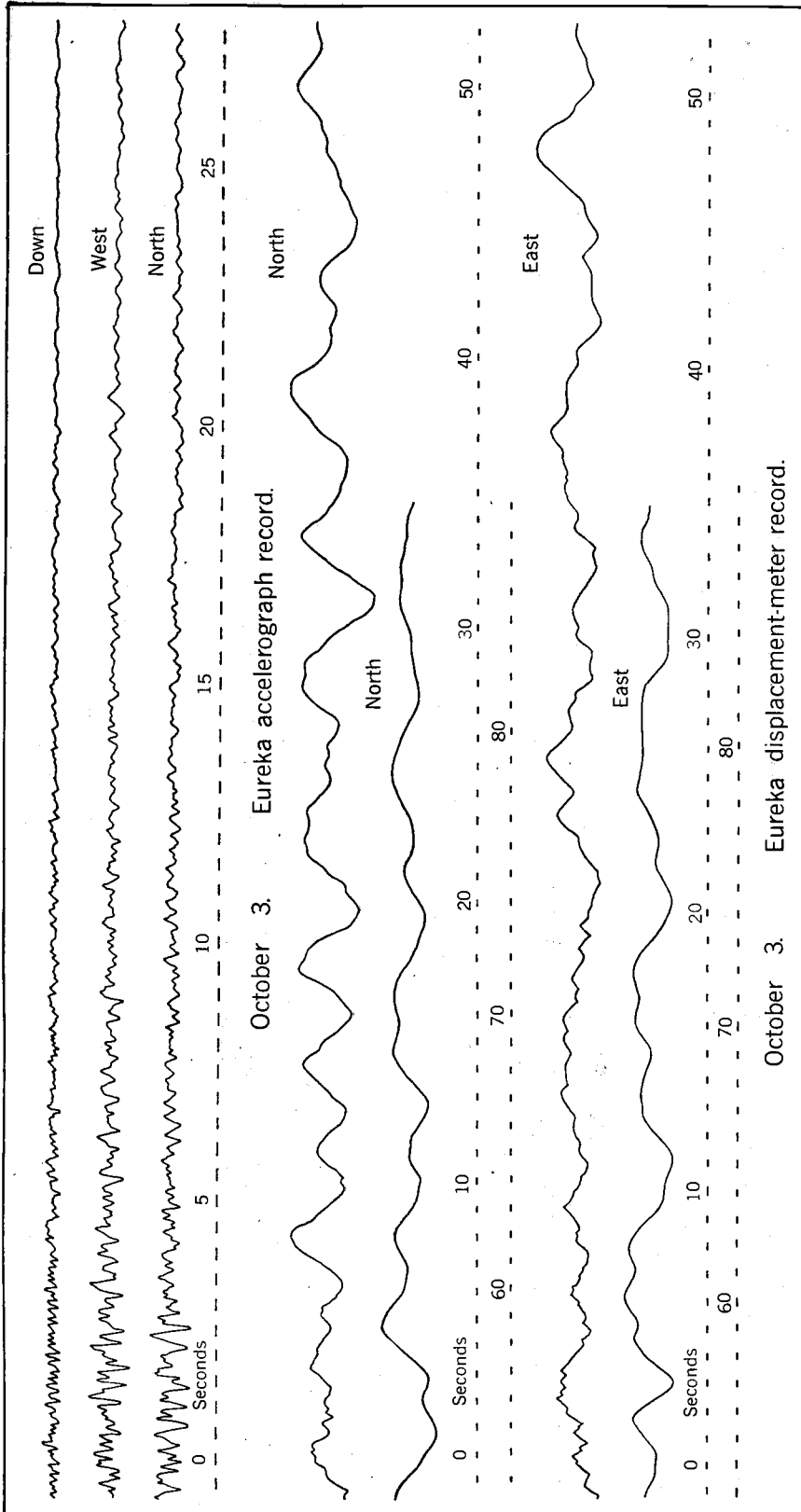


FIGURE 16.—Tracings of strong-motion seismograph records obtained at Eureka on October 3, 1941.

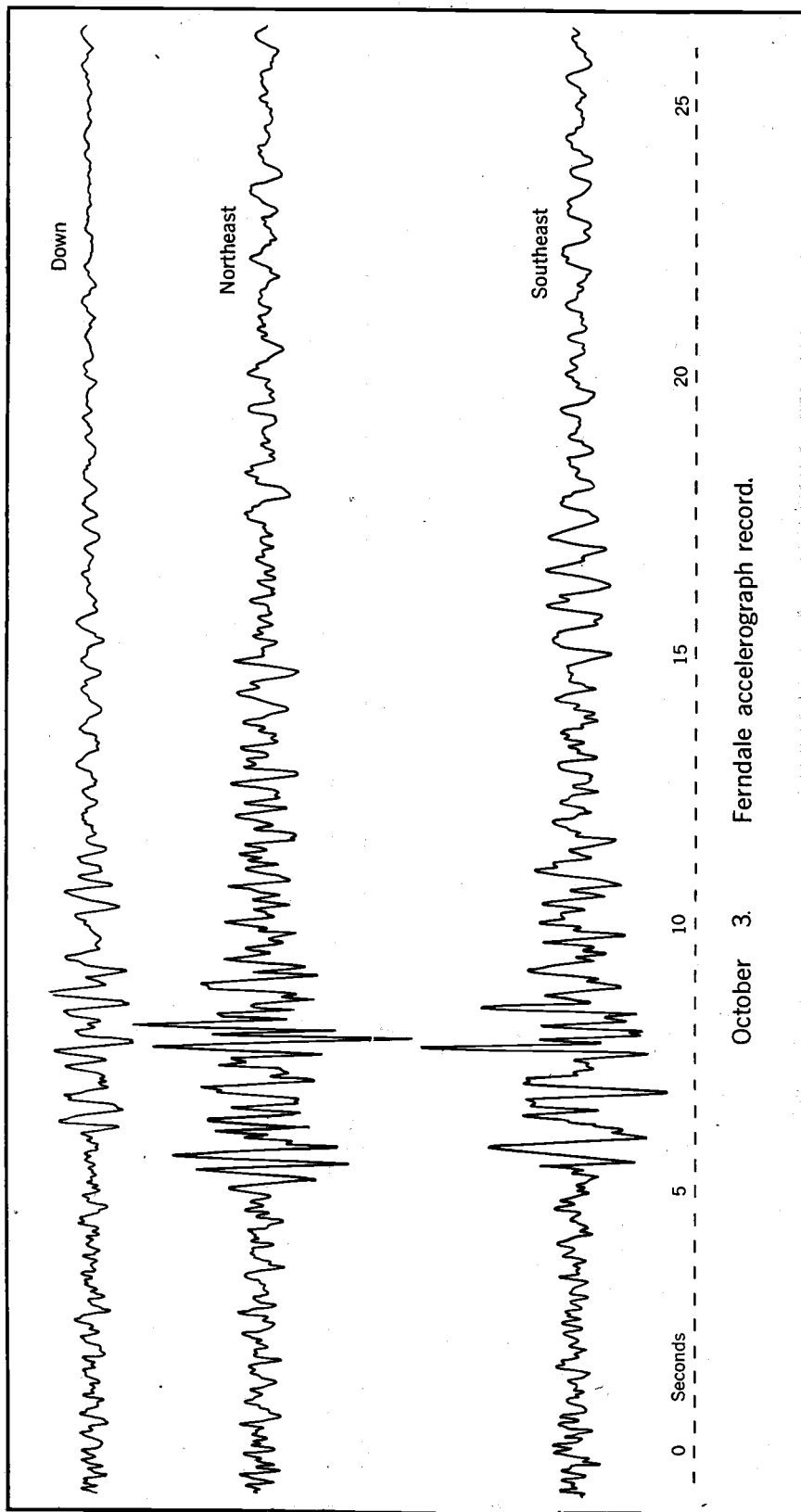


FIGURE 17.—Tracings of accelerograph record obtained at Ferndale on October 3, 1941.

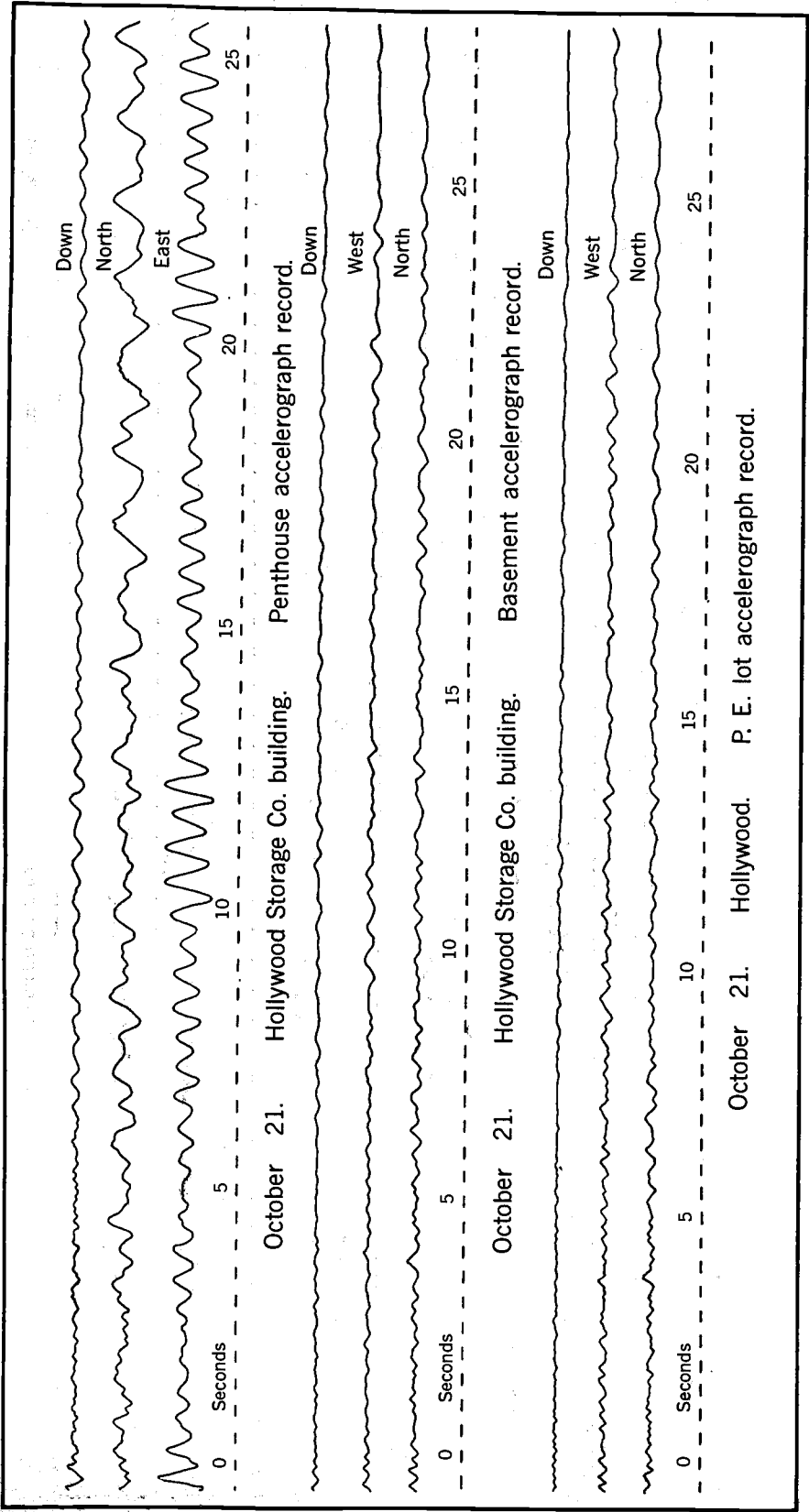


FIGURE 18.—Tracings of accelerograph records obtained at Hollywood on October 21, 1941.

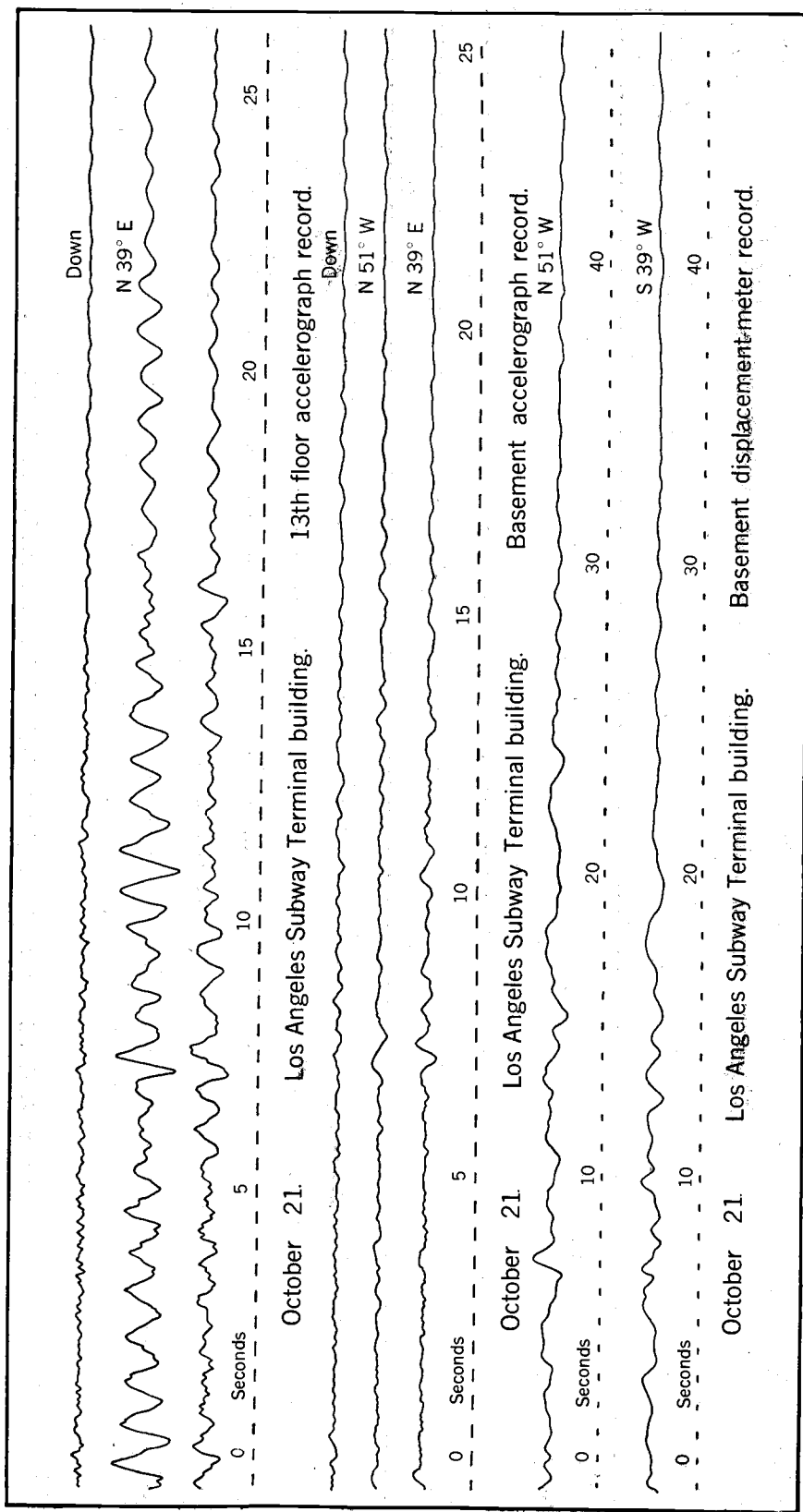


FIGURE 19.—Tracings of strong-motion seismograph records obtained in the Los Angeles Subway Terminal building on October 21, 1941.

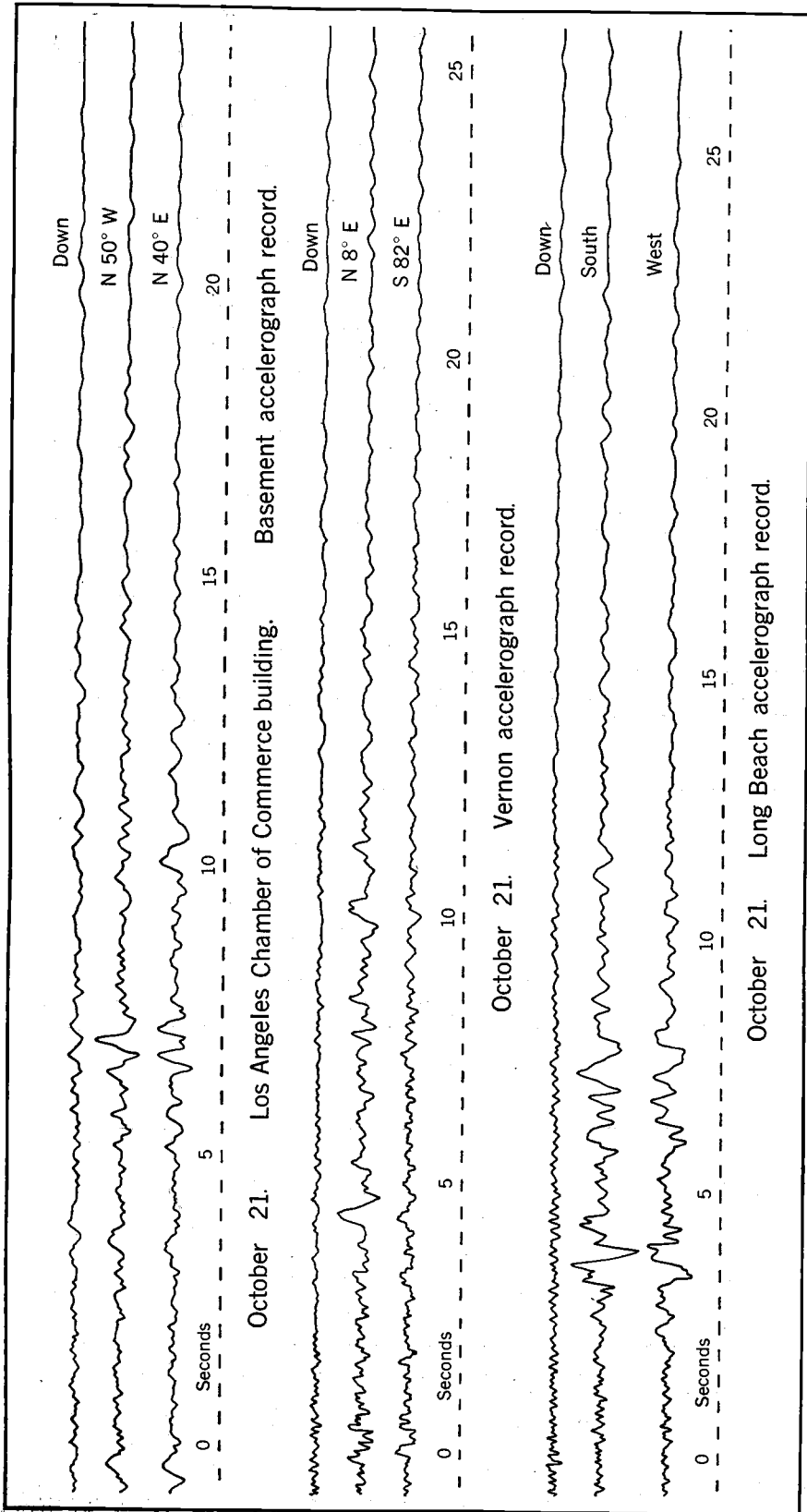


FIGURE 20.—Tracings of accelerograph records obtained in the Los Angeles Chamber of Commerce building and at Vernon and Long Beach on October 21, 1941.

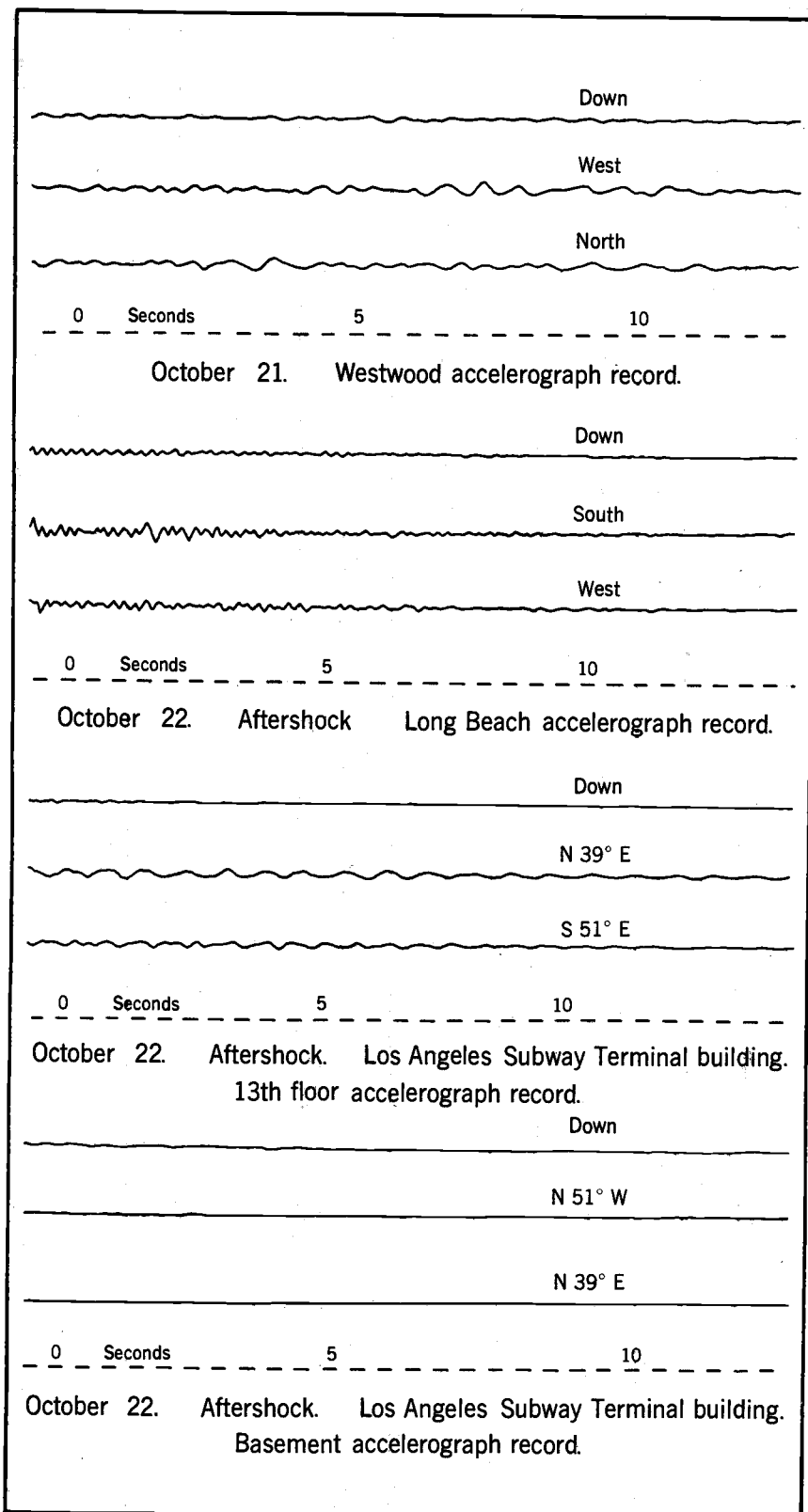


FIGURE 21.—Tracings of accelerograph records obtained at Westwood on October 21, 1941, and at Long Beach and in the Los Angeles Subway Terminal building on October 22, 1941.



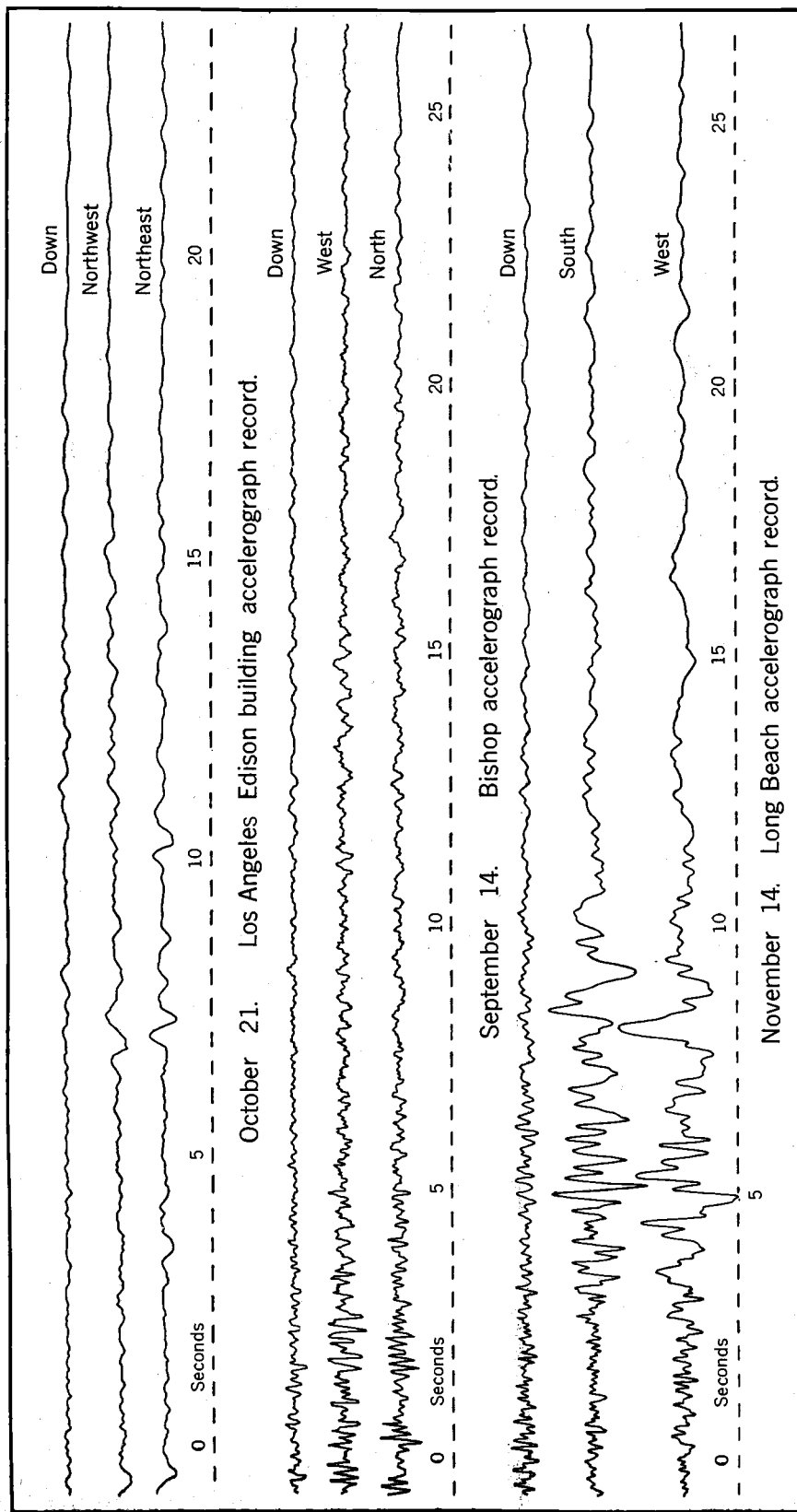


FIGURE 22.—Tracings of accelerograph records obtained in the Los Angeles Edison building on October 21, 1941, at Bishop on September 14, 1941, and at Long Beach on November 14, 1941.

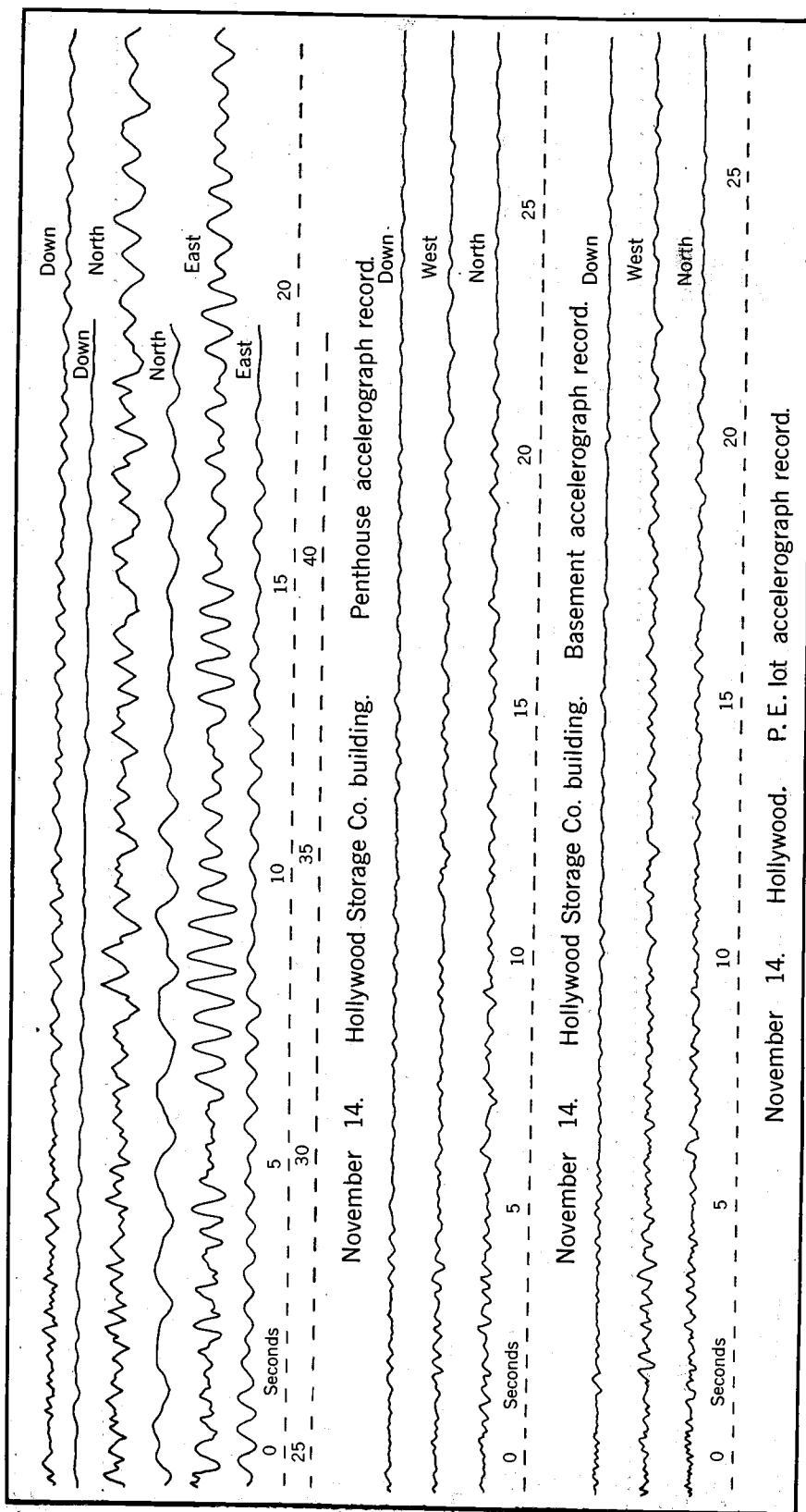


FIGURE 23.—Tracings of accelerograph records obtained at Hollywood on November 14, 1941.

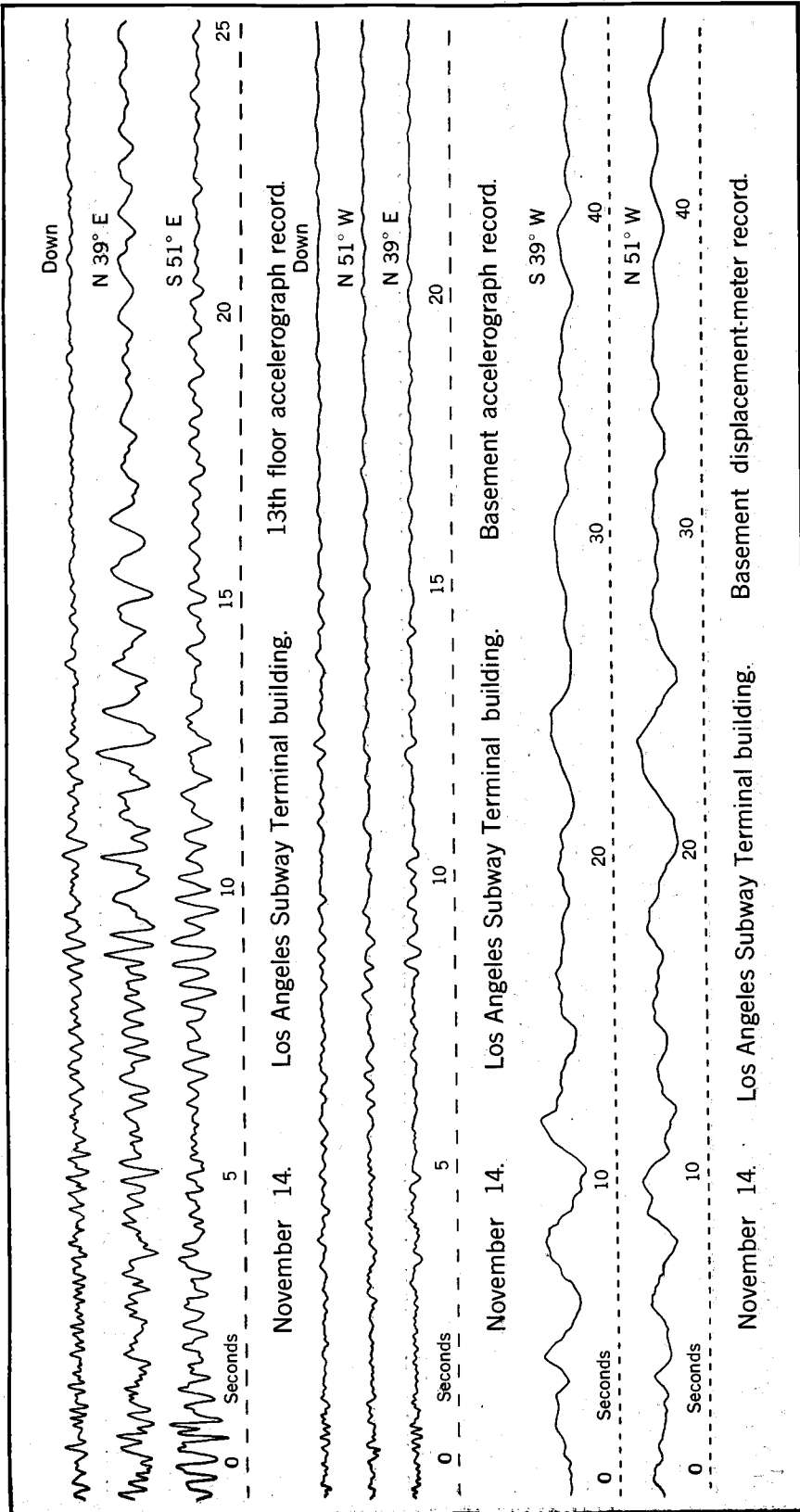


FIGURE 24.—Tracings of strong-motion seismograph records obtained in the Los Angeles Subway Terminal building on November 14, 1941.

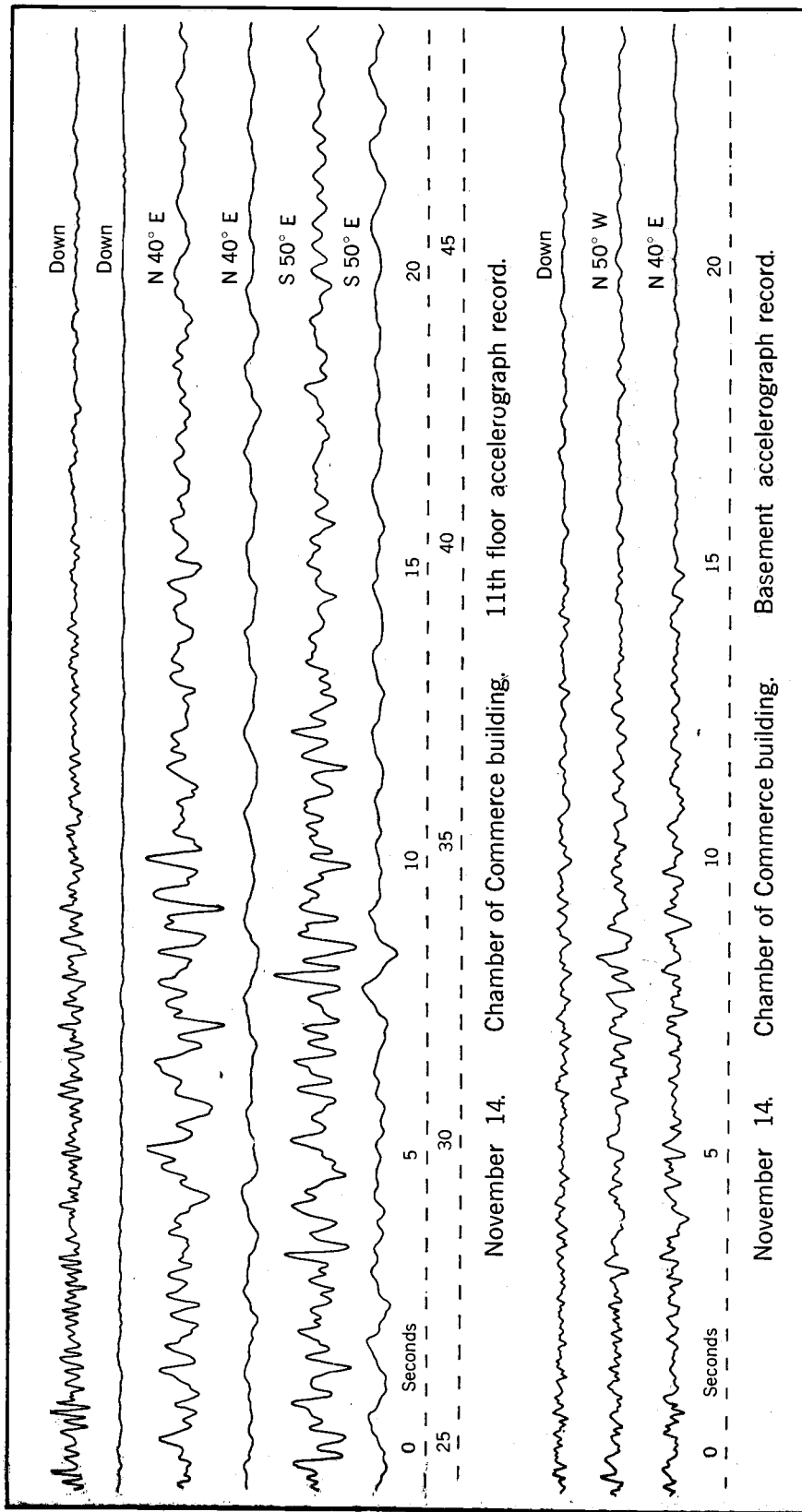


FIGURE 25.—Tracings of accelerograph records obtained in the Los Angeles Chamber of Commerce building on November 14, 1941.

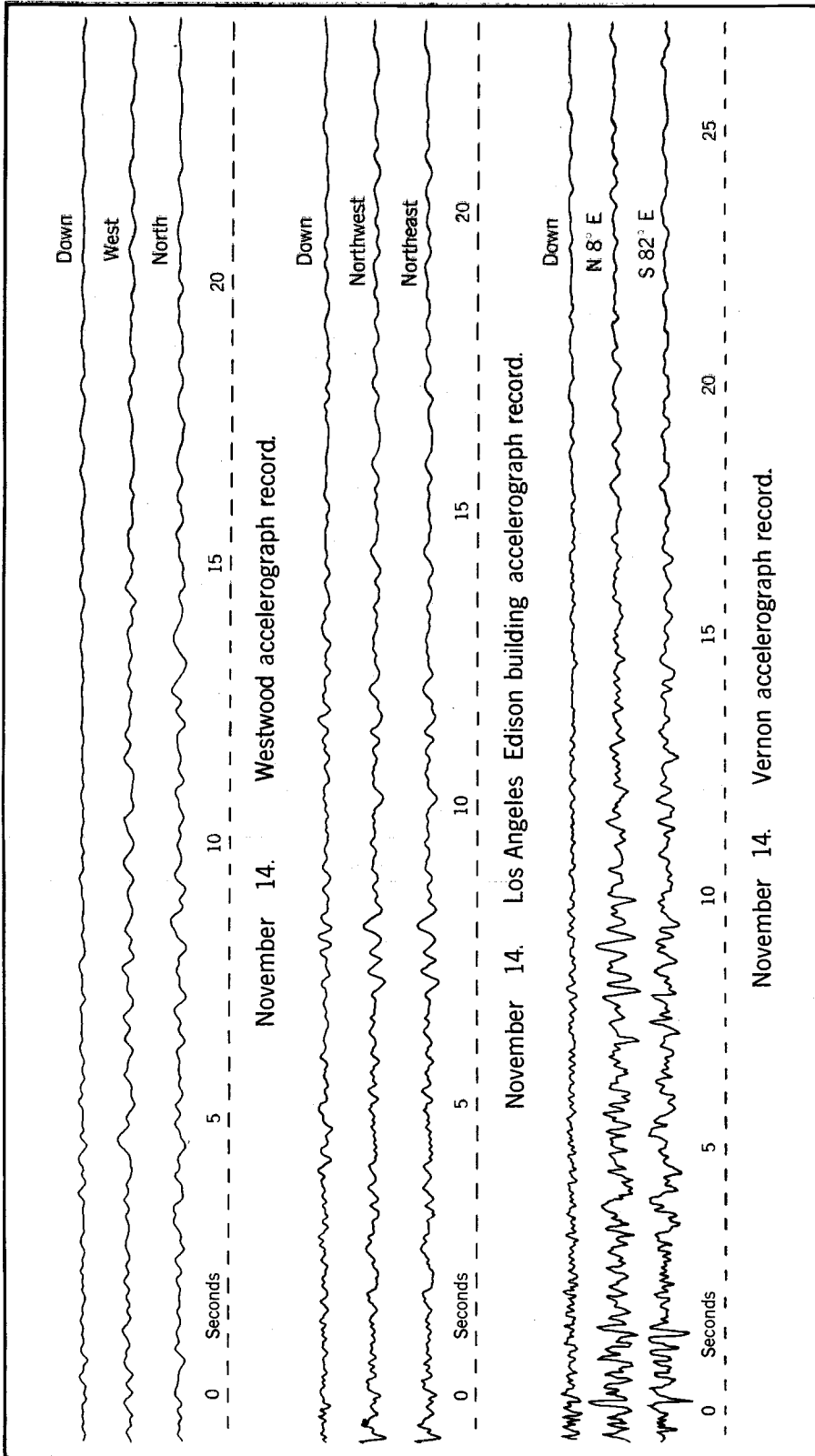


FIGURE 26.—Tracings of accelerograph records obtained at Westwood, Vernon, and in the Los Angeles Edison building on November 14, 1941.

TABLE 3.—*Summary of strong-motion seismograph data for the year 1941*

[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 JAN. 23

Station and component	Earth-wave period	Maximum acceleration	Maximum displacement	Remarks
Ferndale accelerograph:	<i>Seconds</i>	<i>Cm./sec.<sup>2</sup></i>	<i>Cm.</i>	
Vertical.....	0.37	5	0.017	
Southwest-northeast.....	0.32	9	0.022	
	0.76	6	0.086	Shorter period motion superposed.
	0.44	4	0.018	
	0.39	19	0.072	
Northwest-southeast.....	0.36	6	0.019	At beginning of record. Possibly preceded by stronger motion. Superposed on longer period.
	0.16	15	0.010	Poorly defined waves. At beginning of record. Possibly preceded by stronger motion.

## NORTHERN CALIFORNIA EARTHQUAKE OF FEB. 9

Ferndale accelerograph:				
Vertical.....	0.56	16	0.126	
	0.25	11	0.017	
Southwest-northeast.....	0.93	4	0.086	
	0.60	13	0.119	
	0.25	38	0.060	
Northwest-southeast.....	Irregular	47	-----	
	0.85	12	0.217	
	0.60	12	0.108	
	0.33	33	0.093	
Eureka accelerograph:				
Vertical.....	0.18	2	0.002	
	0.09	2	0.001	
North-south.....	Irregular	4	-----	
	0.83	1	0.019	Poorly defined.
	0.37	7	0.025	Long train of irregular waves.
	0.26	8	0.013	
East-west.....	0.34	7	0.020	
	0.26	12	0.021	Rather irregular waves.
	0.21	6	0.007	At beginning of record. Possibly preceded by stronger motion.
Eureka displacement meter:				
North-south.....	3.63	2	0.54	
	2.50	2	0.33	
	5.98	1	0.37	
East-west.....	4.09	1	0.58	
	3.63	2	0.52	

## NORTHERN CALIFORNIA EARTHQUAKE OF MAY 13

Ferndale accelerograph:				
Vertical.....	0.41	2	0.009	
	Irregular	5	-----	
Northeast-southwest.....	0.47	4	0.021	
	0.40	4	0.017	Long train.
	0.17	7	0.005	
Northwest-southeast.....	0.67	6	0.068	
	0.49	7	0.042	

## SANTA BARBARA EARTHQUAKE OF JUNE 30

Santa Barbara accelerograph:				
Vertical.....	0.86	8	0.148	Long train.
	0.63	12	0.119	
	0.13	76	0.034	
Northeast-southwest.....	1.01	9	0.230	
	0.63	19	0.193	
	0.33	155	0.422	
	0.24	172	0.248	
Southeast-northwest.....	1.06	7	0.210	
	0.63	31	0.315	
	0.32	113	0.293	
	0.21	126	0.134	Off sheet at 1 place, amplitude approximated.
Hollywood Storage Co. Bldg., adjoining lot accelerograph:				
Vertical.....	Irregular	2	-----	
North-south.....	0.61	2	0.19	
	0.41	5	0.022	At beginning of record. Possibly preceded by stronger motion.
East-west.....	0.59	3	0.025	
	Irregular	3	-----	

TABLE 3.—*Summary of strong-motion seismograph data for the year 1941*—Continued

## SANTA BARBARA EARTHQUAKE OF JUNE 30—Continued

Station and component	Earth-wave period	Maximum acceleration	Maximum displacement	Remarks
Hollywood Storage Co. Bldg., basement accelerograph:				
Vertical.....	<i>Seconds</i> 0.46	<i>Cm./sec.<sup>2</sup></i> 2	<i>Cm.</i> 0.011	Long train.
North-South.....	Irregular 0.44 0.26	2 2 3	0.012 0.005	
East-west.....	Irregular 0.59	4 2	0.18	Do.
	Irregular	3		
	Irregular	2		At beginning of record. Possibly preceded by stronger motion.
Hollywood Storage Co. Bldg., penthouse accelerograph:				
Vertical.....	0.47	2	0.011	
	0.46	3	0.016	Short period motion superposed.
North-south.....	1.25	3	0.11	
	0.71	15	0.19	At beginning of record. Possibly preceded by stronger motion.
East-west.....	0.60	8	0.071	Long train of waves.
	0.53	14	0.10	Do.
	0.48	19	0.11	Regular waves at beginning of record. Possibly preceded by stronger motion.
Los Angeles Chamber of Commerce Bldg., basement accelerograph:				
Vertical.....	Irregular	1		
S. 50° E.-N. 50° W.....	Irregular	2		
S. 40° W.-N. 40° E.....	Irregular	2		
Los Angeles Chamber of Commerce Bldg., eleventh floor accelerograph:				
Vertical.....	0.17	3	0.002	
S. 40° W.-N. 40° E.....	1.33	9	0.42	
	1.27	4	0.18	Long train.
N. 50° W.-S. 50° E.....	1.19	4	0.14	
	Irregular	7		
Los Angeles Subway Terminal, basement accelerograph:				
Vertical.....	Irregular	2		
S. 51° E.-N. 51° W.....	Irregular	2		
S. 39° W.-N. 39° E.....	Irregular	2		
Los Angeles Subway Terminal, basement displacement meter:				
N. 39° E.-S. 39° W.....	Irregular		0.15	
S. 51° E.-N. 51° W.....	Irregular		0.18	
Los Angeles Subway Terminal, thirteenth floor accelerograph:				
Vertical.....	0.18	2	0.002	
	0.14	2	0.001	
S. 39° W.-N. 39° E.....	0.79	9	0.14	Long train.
	0.56	5	0.039	At beginning of record. Possibly preceded by stronger motion.
N. 51° W.-S. 51° E.....	0.65	6	0.64	
	0.65	5	0.56	
Vernon accelerograph:				
Vertical.....	Irregular	1		
S. 8° W.-N. 8° E.....	0.58	4	0.031	
	0.18	3	0.002	
N. 82° W.-S. 82° E.....	0.51	3	0.018	Rather irregular.
	Irregular	4		
Long Beach accelerograph:				
Vertical.....	0.14	2	0.001	
North-south.....	Irregular	4		At beginning of record. Possibly preceded by stronger motion
East-west.....	0.66	2	0.022	
	0.22	2	0.002	

## FIRST SANTA BARBARA AFTERSHOCK OF JUNE 30

Santa Barbara accelerograph:				
Vertical.....	0.29	3	0.006	
	0.15	18	0.011	
Northeast-southwest.....	0.27	33	0.061	At beginning of record. Possibly preceded by stronger motion.
Southeast-northwest.....	0.24	18	0.027	
	0.18	4	0.003	

TABLE 3.—*Summary of strong-motion seismograph data for the year 1941*—Continued

## SECOND SANTA BARBARA AFTERSHOCK OF JUNE 30

Station and component	Earth-wave period	Maximum acceleration	Maximum displacement	Remarks
Santa Barbara accelerograph:	<i>Seconds</i>	<i>Cm./sec.<sup>2</sup></i>	<i>Cm.</i>	
Vertical.....	0.15	4	0.002	At beginning of record. Possibly preceded by stronger motion.
	0.12	10	0.003	
Northeast-southwest.....	0.16	5	0.003	Do.
	0.13	11	0.005	
Southeast-northwest.....	0.26	12	0.021	Do.
	Irregular	15	-----	

## BOULDER DAM EARTHQUAKE OF SEPT. 3

Boulder Dam, oil house accelerograph:				
Vertical.....	0.12	3	0.001	At beginning of record. Possibly preceded by stronger motion.
Northwest-southeast.....	0.12	5	0.002	
Northeast-southwest.....	Irregular	2	-----	Weak aftershock, about 23 seconds later, noticeable only on this component.
Boulder Dam, 1215 gallery accelerograph:				
Vertical.....	Irregular	4	-----	Long train.
Northwest-southeast.....	0.19	3	0.003	
	0.18	4	0.003	
Northeast-southwest.....	0.16	5	0.003	
	0.15	6	0.004	At beginning of record. Possibly preceded by stronger motion.
	Irregular	12	-----	
Boulder Dam, intake tower accelerograph:				
Vertical.....	0.09	11	0.002	At beginning of record. Possibly preceded by stronger motion.
	0.09	9	0.002	Long train of waves at beginning of record. Possibly preceded by stronger motion.
Northwest-southeast.....	0.22	15	0.018	
Northeast-southwest.....	0.25	14	0.018	Rather long train of waves. At beginning of record. Possibly preceded by stronger motion.

## SANTA BARBARA EARTHQUAKE OF SEPT. 7 AT 19:13

Santa Barbara accelerograph:				
Vertical.....	0.14	6	0.003	At beginning of record. Possibly preceded by stronger motion.
	0.13	6	0.002	
Northeast-southwest.....	0.32	17	0.043	Do.
	0.18	7	0.006	
	0.14	7	0.003	
Northwest-southeast.....	0.48	3	0.018	
	0.32	2	0.005	Do.
	Irregular	-----	-----	

## OWENS VALLEY EARTHQUAKE OF SEPT. 14 AT 8:44

Bishop accelerograph:				
Vertical.....	2.06	2	0.21	Period indistinguishable on account of drum irregularity. At beginning of record. Possibly preceded by stronger motion.
	0.93	1	0.022	
North-south.....	Irregular	8	-----	Period indistinguishable on account of drum irregularity.
	1.31	4	0.17	
East-west.....	Irregular	9	-----	

## OWENS VALLEY EARTHQUAKE OF SEPT. 14 AT 10:21

Bishop accelerograph:				
Vertical.....	0.41	2	0.008	
	Irregular	10	-----	
North-south.....	0.88	3	0.058	At beginning of record. Possibly preceded by stronger motion.
	0.15	10	0.005	
	0.13	13	0.005	Long train.
East-west.....	0.36	4	0.014	
	0.24	9	0.013	At beginning of record. Possibly preceded by stronger motion.
	Irregular	16	-----	



TABLE 3.—*Summary of strong-motion seismograph data for the year 1941*—Continued

## OWENS VALLEY EARTHQUAKE OF SEPT. 14 AT 10:39

Station and component	Earth-wave period	Maximum acceleration	Maximum displacement	Remarks
Bishop accelerograph:	<i>Seconds</i>	<i>Cm./sec.<sup>2</sup></i>	<i>Cm.</i>	
Vertical.....	0.67	3	0.037	
	0.35	4	0.012	
North-south.....	0.61	3	0.025	
	Irregular	11	-----	
East-west.....	0.74	4	0.055	
	0.28	8	0.017	
	0.22	8	0.010	Disturbed by irregular drum motion.

## SANTA BARBARA EARTHQUAKE OF SEPT. 14

Santa Barbara accelerograph:				
Vertical.....	0.33	2	0.005	
	0.18	8	0.006	At beginning of record. Possibly preceded by stronger motion.
Northeast-southwest.....	0.19	6	0.005	
	0.17	9	0.006	At beginning of record. Possibly preceded by stronger motion.
Northwest-southeast.....	0.22	18	0.022	Do.

## SAN FRANCISCO BAY REGION EARTHQUAKE OF SEPT. 17

San Jose Bank of America Bldg., basement accelerograph:				
Vertical.....	0.50	1	0.006	Very weak.
N. 60° E.-S. 60° W.....	0.41	2	0.008	
	0.57	3	0.025	
	0.56	2	0.016	
N. 30° W.-S. 30° E.....	0.56	3	0.024	Possibly preceded by stronger motion.
	0.5	1	0.006	
San Jose Bank of America Bldg., thirteenth floor accelerograph:				
Vertical.....	0.38	2	0.007	Regular waves.
	0.47	1	0.006	
N. 60° E.-S. 60° W.....	0.42	2	0.010	Possibly preceded by stronger motion.
	0.45	4	0.021	
	0.42	1	0.005	
	0.93	2	0.44	Very long weak period.
S. 30° E.-N. 30° W.....	0.33	2	0.005	Irregular waves.
	0.59	3	0.027	Do.
	0.69	1	0.012	

## NORTHERN CALIFORNIA EARTHQUAKE OF OCT. 3

Eureka accelerograph:				
Vertical.....	0.34	4	0.012	
	0.15	11	0.006	
North-south.....	0.38	7	0.025	
	0.29	11	0.022	
	0.21	18	0.020	
East-west.....	0.29	12	0.023	Irregular waves.
	0.20	15	0.015	Series of waves.
	0.19	7	0.006	
Eureka displacement meter:				
North-south.....	1.90	4	0.36	
	4.40	1	0.66	
	6.36	2	0.31	
East-west.....	5.67	1	0.40	
	1.23	4	0.19	
	5.23	1	0.63	
	7.4	1	0.51	
Ferndale accelerograph:				
Vertical.....	0.42	19	0.084	
	0.35	19	0.058	
	0.35	36	0.109	
	0.32	16	0.039	
Southwest-northeast.....	0.78	29	0.430	
	0.58	44	0.370	
	0.42	20	0.088	
	0.38	78	0.282	
	0.27	73	0.133	
Northwest-southeast.....	0.94	64	1.416	
	0.60	31	0.279	
	0.45	116	0.616	
	0.29	59	0.124	

TABLE 3.—*Summary of strong-motion seismograph data for the year 1941*—Continued

## GARDENA EARTHQUAKE OF OCT. 21

Station and component	Earth-wave period	Maximum acceleration	Maximum displacement	Remarks
Los Angeles Chamber of Commerce Bldg., basement accelerograph:	<i>Seconds</i>	<i>Cm./sec.<sup>2</sup></i>	<i>Cm.</i>	Two series of large amplitude waves on horizontal component about five seconds apart.
Vertical.....	0.55	5	0.039	
S. 50° E.-N. 50° W.....	0.47	2	0.011	
S. 40° W.-N. 40° E.....	0.59	18	0.156	
	0.52	14	0.095	
	0.59	9	0.078	
	0.51	13	0.095	
	0.36	15	0.048	
Los Angeles Subway Terminal, basement accelerograph:				Waves of small amplitude.
Vertical.....	0.88	6	0.117	
S. 39° W.-N. 39° E.....	0.60	5	0.045	Fairly smooth sinusoidal waves.
N. 51° E.-S. 51° W.....	0.62	9	0.086	
	0.48	6	0.035	
Los Angeles Subway Terminal, basement displacement meter:				
N. 39° E.-S. 39° W.....	1.5	4	0.23	
S. 51° E.-N. 51° W.....	Irregular		0.2	
	1.08	8	0.23	
	Irregular		0.20	
Los Angeles Subway Terminal, thirteenth floor accelerograph:				
Vertical.....	0.18	3	0.003	Very irregular.
	0.51	3	0.019	
	0.75	4	0.037	
N. 39° E.-S. 39° W.....	0.74	16	0.224	Possibly preceded by stronger motion.
	0.63	17	0.171	
	0.75	30	0.408	
	0.82	7	0.115	
N. 51° W.-S. 51° E.....	0.64	8	0.083	Smaller waves superposed.
	0.54	5	0.037	
	0.59	9	0.079	
	0.76	5	0.073	
Los Angeles Edison Bldg. accelerograph:				
Vertical.....	0.54	2	0.015	Smaller waves superposed.
	0.34	2	0.005	
	0.80	2	0.032	
North-west.....	0.54	7	0.052	Possibly preceded by stronger motion.
	0.59	2	0.017	
	0.64	4	0.042	
	0.79	3	0.047	
North-east.....	0.50	9	0.057	Possibly preceded by stronger motion.
	0.49	5	0.031	Very irregular waves.
	0.42	8	0.035	
	0.70	2	0.025	
Vernon accelerograph:				
Vertical.....				Amplitudes too small.
North-south.....	0.58	9	0.076	
	0.53	11	0.078	
	0.34	17	0.050	
East-west.....	0.44	7	0.037	
	0.42	7	0.031	
Long Beach accelerograph:				
Vertical.....	0.11	5	0.002	
North-south.....	0.76	23	0.332	
	0.62	5	0.048	
	0.49	32	0.180	
	0.19	14	0.013	Series of large amplitude waves beginning about 4 seconds after start. Duration about 5 seconds.
East-west.....	0.71	8	0.10	Series of large amplitude waves about 3 seconds after start. Duration about 7 seconds.
	0.60	21	0.189	
	0.47	13	0.072	
Westwood accelerograph:				
Vertical.....	0.52	2	0.013	Weak.
	0.54	2	0.015	
North-south.....	0.46	2	0.011	Possibly preceded by stronger motion.
	0.82	5	0.086	
	0.65	3	0.032	
East-west.....	0.34	3	0.009	Irregular.
	0.48	5	0.029	
	0.76	3	0.043	
Hollywood Storage Co. Bldg., adjoining lot accelerograph:				
Vertical.....	0.12	1	0.001	Very weak.
	0.45	2	0.011	
	0.86	2	0.038	
	0.90	2	0.041	
North-south.....	0.18	3	0.003	Possibly preceded by stronger motion.
	0.21	4	0.004	
	0.63	2	0.020	

TABLE 3.—*Summary of strong-motion seismograph data for the year 1941*—Continued

## GARDENA EARTHQUAKE OF OCT. 21—Continued

Station and component	Earth-wave period	Maximum acceleration	Maximum displacement	Remarks
Hollywood Storage Co. Bldg., adjoining lot accelerometer—Continued.	<i>Seconds</i>	<i>Cm./sec.<sup>2</sup></i>	<i>Cm.</i>	
East-west.....	0.28	5	0.010	Possibly preceded by stronger motion.
	0.29	3	0.007	
	0.54	6	0.044	Irregular waves.
	0.51	3	0.019	
Hollywood Storage Co. Bldg., basement accelerometer:				
Vertical.....	0.36	2	0.007	Possibly preceded by stronger motion.
	0.48	2	0.012	Small waves superposed.
	0.64	4	0.044	Irregular waves.
North-south.....	0.24	5	0.007	Possibly preceded by stronger motion.
	0.42	3	0.015	Smaller waves superposed.
	0.50	5	0.031	Irregular waves.
	0.68	6	0.072	
East-west.....	0.22	3	0.003	Possibly preceded by stronger motion.
	0.52	1	0.007	Irregular waves.
	0.64	5	0.052	
Hollywood Storage Co. Bldg., penthouse accelerometer:				
Vertical.....	0.60	5	0.045	
North-south.....	1.33	11	0.484	
	0.92	18	0.385	
	0.63	14	0.128	
East-west.....	0.68	18	0.20	Series of smooth waves.
	0.62	21	0.205	

## GARDENA AFTERSHOCK OF OCT. 22

Long Beach accelerometer:				
Vertical.....	0.17	2	0.001	Weak.
	0.20	1	0.001	
North-south.....	0.38	8	0.032	Possibly preceded by stronger motion.
	0.33	6	0.016	
	0.36	2	0.07	
East-west.....	0.26	5	0.008	Very irregular waves.
	0.20	4	0.004	
	0.41	1	0.004	
Los Angeles Subway Terminal, basement accelerometer:				
Vertical.....	0.39	1	0.004	Very weak.
S. 51° E.-N. 51° W.....	0.35	1	0.003	Do.
	0.51	1	0.007	
S. 39° W.-N. 39° E.....	0.40	1	0.004	Do.
Los Angeles Subway Terminal, thirteenth floor accelerometer:				
Vertical.....	0.30	1	0.002	Very weak.
S. 39° W.-N. 39° E.....	0.80	4	0.064	Regular.
	0.89	2	0.040	
N. 51° W.-S. 51° E.....	0.37	2	0.007	
	0.51	3	0.020	Irregular.
	0.62	2	0.020	

## TORRANCE-GARDENA EARTHQUAKE OF NOV. 14

Los Angeles Subway Terminal, basement accelerometer:				
Vertical.....	0.10	3	0.001	Irregular waves.
	0.39	2	0.007	
	0.33	3	0.008	
N. 51° W.-S. 51° E.....	0.29	3	0.007	Possibly preceded by stronger motion.
	0.28	2	0.004	
	0.45	3	0.015	
N. 39° E.-S. 39° W.....	0.11	2	0.001	Short periods at beginning.
	0.41	4	0.017	
	0.40	7	0.029	
	0.33	2	0.005	
Los Angeles Subway Terminal, basement displacement meter:				
N. 39° E.-S. 39° W.....	3.67	1	0.29	
	Irregular		0.42	
S. 51° E.-N. 51° W.....	5.38	1	0.40	
	4.89	1	0.30	
	2.77	1	0.28	
	Irregular		0.45	
Los Angeles Subway Terminal, thirteenth floor accelerometer:				
Vertical.....	0.36	9	0.029	
	0.24	7	0.010	
	0.19	8	0.007	
S. 51° E.-N. 51° W.....	0.76	5	0.072	
	0.36	23	0.076	
	0.30	20	0.046	

TABLE 3.—*Summary of strong-motion seismograph data for the year 1941*—Continued

TORRANCE-GARDENA EARTHQUAKE OF NOV. 14—Continued

Station and component	Earth-wave period	Maximum acceleration	Maximum displacement	Remarks
Los Angeles Subway Terminal, thirteenth floor accelerometer—Continued.	<i>Seconds</i>	<i>Cm./sec.<sup>2</sup></i>	<i>Cm.</i>	
S. 39° W.-N. 39° E.-----	0.42	17	0.075	
	0.41	7	0.030	
	0.23	23	0.031	
Los Angeles Chamber of Commerce Bldg., basement accelerometer:				
Vertical-----	0.42	6	0.025	
S. 40° W.-N. 40° E.-----	0.31	4	0.009	
	0.27	4	0.007	
	0.22	9	0.011	
N. 50° W.-S. 50° E.-----	0.42	14	0.062	
	0.26	8	0.014	
Los Angeles Chamber of Commerce Bldg., eleventh floor accelerometer:				
Vertical-----	0.22	8	0.10	
	0.17	10	0.007	Series of regular short period waves of 12-second duration.
S. 40° W.-N. 40° E.-----	0.42	17	0.075	
	0.38	33	0.119	
	0.27	16	0.029	
	0.22	8	0.010	
N. 50° W.-S. 50° E.-----	0.48	38	0.220	
	0.44	24	0.126	
	0.40	35	0.140	
Long Beach accelerometer:				
Vertical-----	0.17	8	0.006	
	0.14	9	0.004	
North-south-----	0.37	12	0.041	Beginning of a series of long period waves 3.5 seconds after start of record.
	0.32	36	0.092	
	0.32	14	0.038	
East-west-----	0.66	49	0.531	
	0.52	21	0.142	
	0.17	33	0.023	
Hollywood Storage Co. Bldg., adjoining lot accelerometer:				
Vertical-----	0.30	3	0.007	Weak.
	0.39	1	0.004	
	0.51	2	0.013	
North-south-----	0.11	2	0.001	Irregular at beginning.
	0.30	4	0.009	
	0.49	3	0.018	
	0.52	1	0.007	
East-west-----	0.14	2	0.001	Possibly preceded by stronger motion.
	0.26	5	0.009	
	0.29	8	0.017	
	0.50	4	0.025	
Hollywood Storage Co. Bldg., basement accelerometer:				
Vertical-----	0.41	2	0.008	Very irregular waves.
	0.42	3	0.014	
	0.52	1	0.007	
North-south-----	0.36	2	0.007	Smaller waves superposed.
	0.52	3	0.020	
	0.41	2	0.009	
East-west-----	0.17	2	0.002	Very irregular waves.
	0.16	6	0.004	
	0.54	2	0.015	
	0.81	3	0.051	
Hollywood Storage Co. Bldg., penthouse accelerometer:				
Vertical-----	0.36	6	0.021	
	0.32	5	0.012	
North-south-----	0.74	11	0.151	
	0.56	7	0.055	
	0.50	17	0.106	
East-west-----	0.63	25	0.249	
	0.53	7	0.049	
	0.53	10	0.070	Series of regular waves.
Vernon accelerometer:				
Vertical-----	0.24	6	0.009	
	0.19	6	0.005	Period timing uncertain because of irregular drum rate.
North-south-----	0.24	14	0.020	
	0.14	13	0.006	
	0.12	19	0.007	
East-west-----	0.43	8	0.037	
	0.26	19	0.032	
	0.17	9	0.007	
Westwood accelerometer:				
Vertical-----	0.29	1	0.002	Weak.
	0.44	2	0.009	
	0.58	2	0.017	
North-south-----	0.32	4	0.010	Irregular.
	0.45	7	0.036	
	0.55	2	0.015	

TABLE 3.—*Summary of strong-motion seismograph data for the year 1941—Continued*

## TORRANCE-GARDENA EARTHQUAKE OF NOV. 14—Continued

Station and component	Earth-wave period	Maximum acceleration	Maximum displacement	Remarks
Westwood accelerograph—Continued.	<i>Seconds</i>	<i>Cm./sec.<sup>2</sup></i>	<i>Cm.</i>	
East-west.....	0.43	3	0.013	Possibly preceded by stronger motion.
	0.53	5	0.036	
	0.65	9	0.097	
	0.45	7	0.036	
Los Angeles Edison Bldg. accelerograph:				
Vertical.....	0.12	2	0.001	Short periods at beginning.
	0.38	4	0.014	
	0.53	1	0.007	
S. 50° E.-N. 50° W.....	0.15	9	0.005	Sharp impulse at beginning.
	0.18	3	0.003	
	0.40	5	0.020	
S. 40° W.-N. 40° E.....	0.32	2	0.005	Sharp impulse at beginning.
	0.13	5	0.002	
	0.32	6	0.016	
	0.34	6	0.018	
Santa Ana Weed seismograph:				Poor record. Maximum trace amplitude 0.3 mm.
Northeast-southwest.....	1.5	6	0.3	
	0.6	2	0.02	
Southeast-northwest.....	1.5	4	0.2	
	0.9	2	0.03	

TABLE 4.—*Instrumental constants of strong-motion seismographs in 1941*

## NORTHERN CALIFORNIA EARTHQUAKE OF JANUARY 23

Station and instrument	Orientation of instrument	Pendulum period	Static magnification	Sensitivity <sup>2</sup>	Damping ratio	Instrument number
		<i>Sec.</i>		<i>Cm.</i>		
Ferndale; accelerograph No. 28	Up-down.....	0.097	102	2.42	10.5	V-10
	S.45°W.-N.45°E.....	0.097	114	2.71	10	L-4
	N.45°W.-S.45°E.....	0.097	110	2.62	10.5	T-15

## NORTHERN CALIFORNIA EARTHQUAKE OF FEBRUARY 9

Ferndale; accelerograph No. 28.	Up-down.....	0.097	102	2.42	12.5	V-10
	S.45°W.-N.45°E.....	0.096	113	2.64	10	L-4
	N.45°W.-S.45°E.....	0.099	108	2.68	11.5	T-15
Eureka: <sup>3</sup> Accelerograph No. 30.....	Up-down.....	0.099	102	2.54	9.5	V-29
	E.-W.....	0.098	109	2.66	9.5	L-13
	S.-N.....	0.099	111	2.76	8.5	T-8
Displacement meter No. 13.....	S.-N.....	9.83	1.14		8.7	R-13
	W.-E.....	9.80	1.14		9.5	L-13

## NORTHERN CALIFORNIA EARTHQUAKE OF MAY 13

Ferndale; accelerograph No. 28.....	Up-down.....	0.098	100	2.42	9	V-10
	S.45°W.-N.45°E.....	0.100	108	2.74	9	L-4
	N.45°W.-S.45°E.....	0.098	110	2.69	10	T-15

## SANTA BARBARA EARTHQUAKE OF JUNE 30

Santa Barbara; accelerograph No. 26.....	Up-down.....	0.099	105.7	2.52	10	V-11
	NE.-SW.....	0.100	111.3	2.71	10	L-24
	SE.-NW.....	0.100	106.6	2.69	8	T-6
Hollywood Storage Co. Bldg.: <sup>3</sup> Adjoining lot accelerograph No. 41.....	Up-down.....	0.101	76.0	1.92	7	V-114
	E.-W.....	0.101	82.6	2.18	9	L-94
	S.-N.....	0.099	76.4	1.90	9	T-104
Basement accelerograph No. 42.....	Up-down.....	0.100	80.8	2.01	9	V-115
	E.-W.....	0.096	84.6	1.97	10	L-95
	S.-N.....	0.100	80.6	2.04	10	T-105
Penthouse accelerograph No. 40.....	Up-down.....	0.097	78.6	1.83	8	V-113
	S.-N.....	0.102	78.4	1.96	8	L-93
	W.-E.....	0.094	82.1	1.87	8	T-103
Los Angeles Chamber of Commerce Bldg.: <sup>3</sup> Basement accelerograph No. 21.....	Up-down.....	0.099	110.0	2.68	8	V-28
	S.50°E.-N.50°W.....	0.101	109.5	2.72	8	L-9
	S.40°W.-N.40°E.....	0.097	108.0	2.79	9	T-26
Eleventh floor accelerograph No. 22.....	Up-down.....	0.100	108.5	2.72	12	V-25
	S.40°W.-N.40°E.....	0.098	107.8	2.79	10	L-3
	N.50°W.-S.50°E.....	0.101	109.7	2.72	7	T-18

See footnotes at end of table.

TABLE 4.—*Instrumental constants of strong-motion seismographs in 1941*—Continued

## SANTA BARBARA EARTHQUAKE OF JUNE 30—Continued

Station and instrument	Orientation of instrument	Pendulum period	Static magnification	Sensitivity	Damping ratio	Instrument number
Los Angeles Subway Terminal Bldg.: <sup>3</sup> Basement accelerograph No. 38	Up-down	Sec. 0.099	79.8	Cm. 1.98	7	V-111
	S. 51° E.-N. 51° W	0.097	80.8	1.92	9	L-91
	S. 39° W.-N. 39° E	0.098	77.1	1.88	8	T-101
Basement displacement meter No. 15.	N. 39° E.-S. 39° W	10.0	1.14		10	R-15
Thirteenth floor accelerograph No. 39.	S. 51° E.-N. 51° W	10.0	1.14		8	L-15
	Up-down	0.101	84.2	2.15	11	V-12
	S. 39° W.-N. 39° E	0.101	80.4	2.04	8	L-92
	N. 51° W.-S. 51° E	0.101	81.7	2.06	11	T-102
Vernon; accelerograph No. 1	Up-down	0.100	108	2.78	7.5	V-66
	S. 8° W.-N. 8° E	0.101	103	2.68	13	L-64
	N. 82° W.-S. 82° E	0.096	108	2.53	9.5	T-65
Long Beach; accelerograph No. 24	Up-down	0.099	112	2.75	11	V-7
	N.-S	0.101	108	2.73	9	L-2
	E.-W	0.098	107	2.51	8	T-17

## FIRST AND SECOND AFTERSHOCKS OF SANTA BARBARA EARTHQUAKE OF JUNE 30

No change in constants of Santa Barbara accelerograph

## BOULDER DAM EARTHQUAKE OF SEPTEMBER 3

Boulder Dam: <sup>3</sup> Oil house accelerograph No. B-3	Up-down	0.104	79	2.16	11	V-148
	N. 45° W.-S. 45° E	0.099	79	2.00	10	L-146
	N. 45° E.-S. 45° W	0.100	78	1.97	7	T-147
1215 gallery accelerograph No. B-1	Up-down	0.102	74	2.03	11	V-142
	S. 45° E.-N. 45° W	0.100	75	1.95	11	L-140
	S. 45° W.-N. 45° E	0.102	73	1.97	8	T-141
Intake tower accelerograph No. B-2	Up-down	0.099	80	2.03	10	V-145
	N. 45° W.-S. 45° E	0.099	78	1.97	12	L-143
	N. 45° E.-S. 45° W	0.098	74	1.80	11	T-144

## SANTA BARBARA EARTHQUAKE OF SEPT. 7

Santa Barbara; accelerograph No. 26	Up-down	0.099	105	2.60	9	V-11
	NE.-SW	0.100	111	2.80	10	L-24
	SE.-NW	0.100	107	2.71	8	T-6

## OWENS VALLEY EARTHQUAKES OF SEPT. 14 AT 8:44, 10:21, AND 10:39

Bishop; accelerograph No. 12	Up-down	0.101	110	2.78	10	V-23
	E.-W	0.100	107	2.72	9	L-36
	S.-N	0.099	108	2.67	9	T-19

## SANTA BARBARA EARTHQUAKE OF SEPT. 14

Santa Barbara; accelerograph No. 26	Up-down	0.099	105	2.60	9	V-11
	NE.-SW	0.100	111	2.80	10	L-24
	SE.-NW	0.100	107	2.71	8	T-6

## SAN FRANCISCO BAY REGION EARTHQUAKE OF SEPT. 17

San Jose: <sup>3</sup> Basement accelerograph No. 8	Up-down	0.099	110	2.72	9	V-49
	N. 60° E.-S. 60° W	0.098	107	2.60	9	L-50
	S. 30° E.-N. 30° W	0.100	107	2.72	8	T-51
Thirteenth floor accelerograph No. 27.	Up-down	0.098	109	2.65	12	V-27
	N. 60° E.-S. 60° W	0.098	108	2.62	11	L-22
	S. 30° E.-N. 30° W	0.100	110	2.78	9	T-1

## NORTHERN CALIFORNIA EARTHQUAKE OF OCT. 3

Eureka: <sup>3</sup> Accelerograph No. 30	Up-down	0.100	103	2.62	9	V-29
	E.-W	0.099	108	2.67	10	L-13
	S.-N	0.100	108	2.74	8	T-8
Displacement meter No 13	S.-N	9.79	1.14		9.8	R-13
	W.-E	9.62	1.14		8.5	L-13
Ferndale; accelerograph No. 28	Up-down	0.098	100	2.44	9	V-10
	S. 45° W.-N. 45° E	0.099	111	2.75	9	L-4
	N. 45° W.-S. 45° E	0.099	109	2.70	10	T-15

See footnotes at end of table.

TABLE 4.—*Instrumental constants of strong-motion seismographs in 1941*—Continued  
GARDENA EARTHQUAKE OF OCT. 21

Station and instrument	Orientation of instrument	Pendulum period	Static magnification	Sensitivity	Damping ratio	Instrument number
Los Angeles Chamber of Commerce Bldg.: <sup>3</sup>		<i>Sec.</i>		<i>Cm.</i>		
Basement accelerometer No. 21	Up-down	0.100	108	2.74	10	V-28
	S. 50° E.-N. 50° W.	0.102	108	2.86	9	L-9
	S. 40° W.-N. 40° E.	0.098	107	2.60	10	T-26
Los Angeles Subway Terminal Bldg.: <sup>3</sup>						
Basement accelerometer No. 38	Up-down	0.099	76	1.90	8	V-111
	S. 51° E.-N. 51° W.	0.097	81	1.92	9	L-91
	S. 39° W.-N. 39° E.	0.097	80	1.90	10	T-101
Basement displacement meter No. 15	N. 39° E.-S. 39° W.	10.00	1.14		10	R-15
	S. 51° E.-N. 51° W.	10.00	1.14		10	L-15
Thirteenth floor accelerometer No. 39.	Up-down	0.100	82	2.08	10	V-112
	S. 39° W.-N. 39° E.	0.101	81	2.09	10	L-92
	N. 51° W.-S. 51° E.	0.101	81	2.10	11	T-102
Long Beach; accelerometer No. 24	Up-down	0.100	109	2.77	10	V-7
	N.-S.	0.101	106	2.72	9	L-2
	E.-W.	0.098	109	2.66	9	T-17
Vernon; accelerometer No. 1	Up-down	0.100	109	2.76	10	V-66
	S.-N.	0.100	107	2.71	13	L-64
	W.-E.	0.097	105	2.49	8	T-65
Westwood; accelerometer No. 20	Up-down	0.099	114	2.82	10	V-30
	E.-W.	0.099	108	2.68	10	L-5
	S.-N.	0.100	110	2.77	12	T-34
Los Angeles Edison Bldg. accelerometer No. 6.	Up-down	0.101	107	2.76	10	V-67
	SE.-NW.	0.098	110	2.66	10	L-68
	SW.-NE.	0.100	107	2.72	10	T-69
Hollywood Storage Co. Bldg.: <sup>3</sup>						
Adjoining lot accelerometer No. 41	Up-down	0.100	76	1.92	9	V-114
	E.-W.	0.103	82	2.22	10	L-94
	S.-N.	0.100	76	1.91	10	T-104
Basement accelerometer No. 42	Up-down	0.100	79	2.01	10	V-115
	E.-W.	0.097	82	1.94	10	L-95
	S.-N.	0.101	80	2.07	10	T-105
Penthouse accelerometer No. 40	Up-down	0.102	78	2.06	9	V-113
	S.-N.	0.105	80	2.24	8	L-93
	W.-E.	0.101	79	2.04	12	T-103

## GARDENA AFTERSHOCK OF OCT. 22

No change in constants at Long Beach and Los Angeles Subway Terminal Building

## TORRANCE-GARDENA EARTHQUAKE OF NOV. 14

Westwood; accelerometer No. 20	Up-down	0.099	114	2.82	10	V-30
	E.-W.	0.099	108	2.68	10	L-5
	S.-N.	0.100	110	2.77	12	T-34
Hollywood Storage Co. Bldg.: <sup>3</sup>						
Adjoining lot accelerometer No. 41	Up-down	0.101	76	1.96	10	V-114
	E.-W.	0.102	82	2.17	10	L-94
	S.-N.	0.098	76	1.84	10	T-104
Basement accelerometer No. 42	Up-down	0.100	79	2.01	10	V-115
	E.-W.	0.097	82	1.94	10	L-95
	S.-N.	0.100	80	2.03	10	T-105
Penthouse accelerometer No. 40	Up-down	0.102	78	2.06	9	V-113
	S.-N.	0.105	80	2.24	8	L-93
	W.-E.	0.102	79	2.09	10	T-103
Vernon; accelerometer No. 1	Up-down	0.100	109	2.76	10	V-66
	S.-N.	0.100	107	2.71	16	L-64
	W.-E.	0.096	105	2.44	10	T-65
Long Beach; accelerometer No. 24	Up-down	0.099	111	2.75	9	V-7
	N.-S.	0.102	105	2.77	9	L-2
	E.-W.	0.098	105	2.55	8	T-17
Los Angeles Edison Bldg. accelerometer No. 6.	Up-down	0.101	107	2.75	11	V-67
	SE.-NW.	0.099	110	2.72	10	L-68
	SW.-NE.	0.100	107	2.72	10	T-69
Los Angeles Chamber of Commerce Bldg.: <sup>3</sup>						
Basement accelerometer No. 21	Up-down	0.101	108	2.80	10	V-28
	S. 50° E.-N. 50° W.	0.103	108	2.91	9	L-9
	S. 40° W.-N. 40° E.	0.100	107	2.71	10	T-26
Eleventh floor accelerometer No. 22	Up-down	0.100	107	2.70	10	V-25
	S. 40° W.-N. 40° E.	0.099	108	2.68	11	L-3
	N. 50° W.-S. 50° E.	0.100	108	2.74	8	T-18
Los Angeles Subway Terminal Bldg.: <sup>3</sup>						
Basement accelerometer No. 38	Up-down	0.100	76	1.94	8	V-111
	S. 51° E.-N. 51° W.	0.097	81	1.92	9	L-91
	S. 39° W.-N. 39° E.	0.098	79	1.92	10	T-101
Basement displacement meter No. 15.	N. 39° E.-S. 39° W.	10.10			10	R-15
	S. 51° E.-N. 51° W.	10.00			8	L-15
Thirteenth floor accelerometer No. 39.	Up-down	0.101	82	2.12	10	V-112
	S. 39° W.-N. 39° E.	0.100	81	2.05	9	L-92
	N. 51° W.-S. 51° E.	0.100	81	2.06	11	T-102
Santa Ana; Weed seismograph No. 12	SE.-NW.	0.17	7.6	.56	3	R-12
	NE.-SW.	0.18	7.3	.60	3	L-12

<sup>1</sup> The direction on the left ("Up" in the first case) indicates the direction of pendulum displacement, relative to instrument pier, which will displace the trace upward on the original seismogram.<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.

## STRONG-MOTION SEISMOGRAPH STATIONS, 1941

During 1941 all strong-motion seismograph installations remained substantially the same as listed in table 6 of Serial 637, United States Earthquakes, 1939, with the changes described on page 56 of Serial 647, United States Earthquakes, 1940. Simultaneous timing mechanisms were installed in several instances where there was more than one instrument in a building; and new optical systems were installed in a number of accelerometers for the purpose of increasing the recording range by decreasing the sensitivity. In such cases records are made with both the regular and the insensitive light spots.

## TILT OBSERVATIONS

Three Merritt tiltmeters, described in Special Publication 201, Earthquake Investigation in California, 1934-1935, were kept in continuous operation during the entire year with the cooperation of the University of California. Figure 27 shows the tiltgrams from these three instruments for 1941. Tiltmeter No. 3 showed a net tilt of 15 seconds to the north and 7 seconds to the east, and tiltmeter No. 4 showed a net tilt of 7 seconds to the north and 9 seconds to the east. Both are on the southwest side of the Hayward Fault zone, and both show the same general tilt to the northeast. Tiltmeter No. 1, which is northeast of the fault zone, was adjusted during the first part of December. There was some drifting after this date before the instrument became stable again. From January 1 to December 2 the net tilt was about 1 second to the north and practically no tilt in the east-west direction, indicating that this block remained very stable during the year. There were 6 earthquake shocks within 50 miles of these tiltmeters during 1941, but no unusual tilt was noted at these times.

Tiltmeter No. 1 showed a peculiar vibratory activity at times which is described in detail in a paper by Mr. F. P. Ulrich entitled "Progress Report of Seismological Work, 1941." The report is published in the October 1942 issue of the Bulletin of the Seismological Society of America.



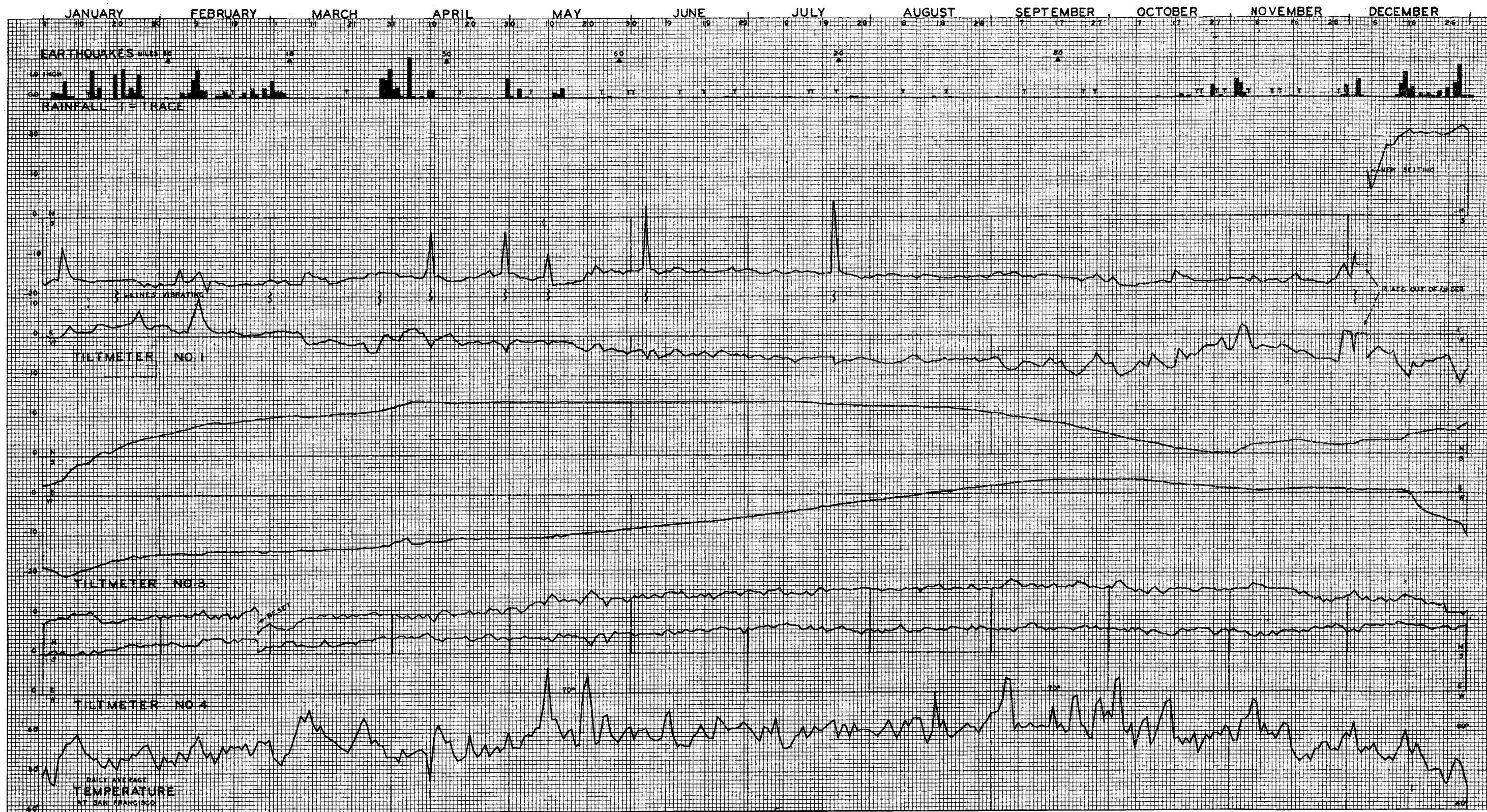


FIGURE 27.—Tilt curves for 1941.

#### ADDITIONS AND CORRECTIONS TO PREVIOUS PUBLICATIONS

**1933-40:** Fluctuations of water level in wells, for earthquakes of March 11, 1933 (Long Beach), November 10, 1938 (Alaska), January 25, 1939 (Chile), December 26, 1939 (Turkey), May 19, 1940 (California), all G. M. T. The records for 124 wells in the United States are discussed by G. A. La Rocque, Jr., of the U. S. Geological Survey in a paper entitled "Fluctuations of Water Level in Wells in the Los Angeles Basin, California, during Five Strong Earthquakes, 1933-1940." Published in Transactions of the American Geophysical Union, Twenty-second Annual Meeting, April 30-May 3, 1941; also in Earthquake Notes, Vol. XIII, Numbers 1 and 2. The maximum surge reported is 10.58 feet. Ten references are also given on other papers on water-level fluctuations.

**1940, December:** New Hampshire earthquakes. See "Macroseismic Study of the New Hampshire Earthquakes of December 1940," by James J. Devlin, S. J., Lawrence C. Languth, S. J., and R. L. Arringdale, in the Bulletin of the Seismological Society of America, Vol. 2, Number 2, April 1942; *ibid.*, Instrumental Study of the New Hampshire Earthquakes of December 1940, by L. Don Leet and D. Linehan, S. J.; *ibid.*, Geology of the Central Area of the Ossipee Mountains, New Hampshire Earthquakes, by Marland P. Billings; *ibid.*, Mechanism of Earthquakes Where There is no Surface Faulting, by L. Don Leet. Abstracts of the first two papers appear in Earthquake Notes, Numbers 1 and 2, September 1941.

**1940 December 25:** See The North Carolina Earthquake of December 25, 1940, V. C. Stechschulte, S. J., Proc. Amer. Geoph. Union, Twenty-second Annual Meeting, April 30-May 3, 1941.

## PUBLICATION NOTICES

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