

UNITED STATES EARTHQUAKES 1943

SERIAL No. 672

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

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HENRY A. WALLACE, Secretary

COAST AND GEODETIC SURVEY

Leo Otis Colbert, Director

Serial No. 672

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1943

By

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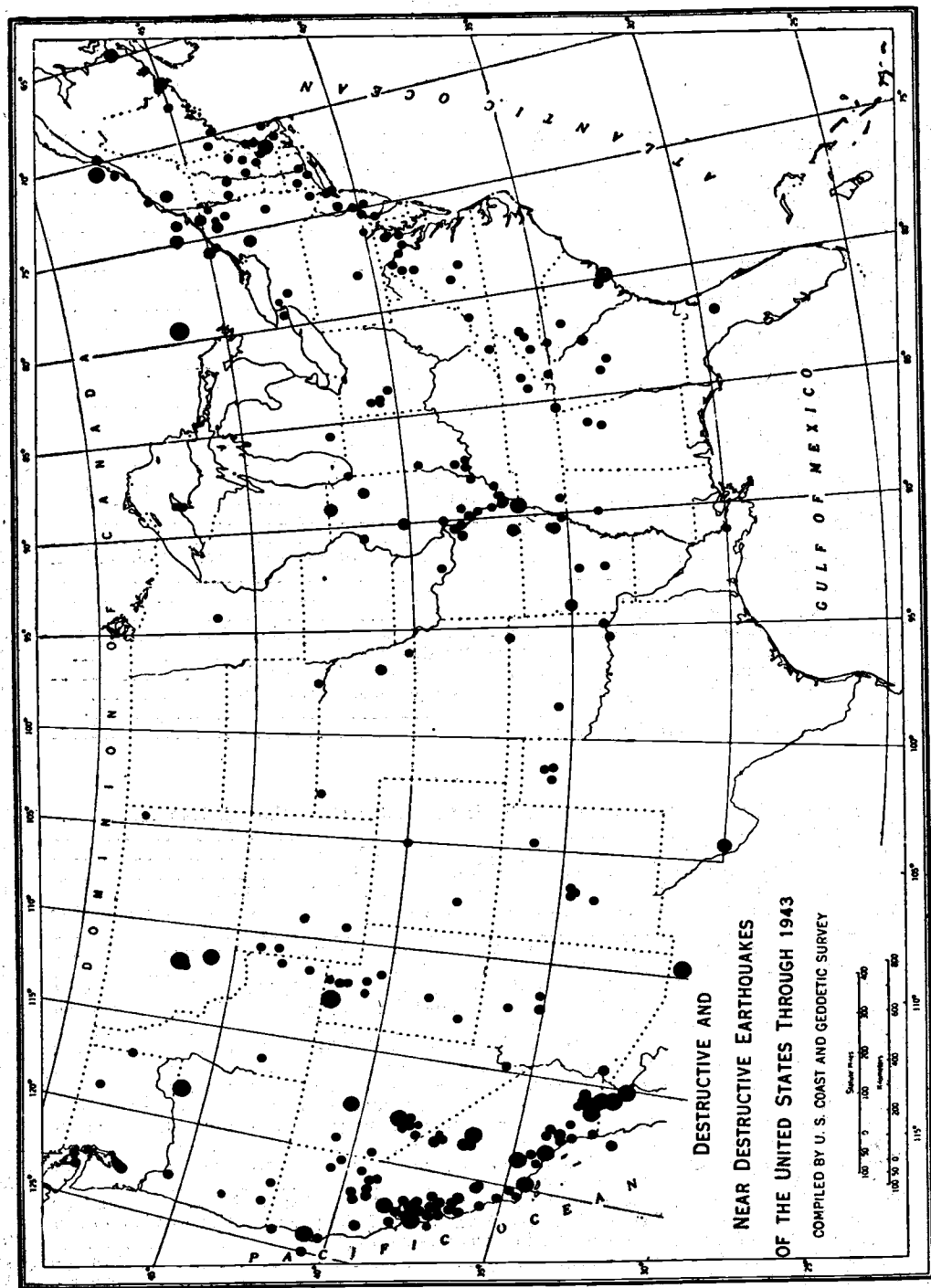


FIGURE 1.—Destructive and near destructive earthquakes in the United States through 1943.

UNITED STATES EARTHQUAKES, 1943

INTRODUCTION

THIS publication is a summary of earthquake activity in the United States and the regions under its jurisdiction for the calendar year 1943. 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.¹ 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 1943:

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

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

Idaho.—Prof. J. D. Forrester, University of Idaho, Moscow.

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

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

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

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

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

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

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

¹ 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.

In other parts of the country the Jesuit Seismological Association was active in co-operative 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) reports of the Hawaiian Volcano Observatory; and (8) reports from many interested individuals.

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 The original reports are open for inspection by anyone interested in unpublished details.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

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

MODIFIED MERCALLI INTENSITY SCALE OF 1931

(ABRIDGED)

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

- XI. Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipe lines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
- XII. Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into 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 or the Seismological Laboratory of the California Institute of Technology. The bulletins of these institutions should be consulted for further details and often for data on additional shocks.

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

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

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

Epicenter maps.—Figures 1 and 2 are designed to show earthquake distribution in the United States at a glance but the reader is cautioned in accepting all epicenter locations as correct. In a few cases, especially offshore epicenters and others in uninhabited areas, where instrumental control is not satisfactory or where results of investigations are overdue, the plotted epicenters may be in error. The maps must therefore be accepted as showing, in some cases, the existence of epicenters rather than their precise locations. The text of the publication should be consulted to appraise any individual case. This same condition prevails also, to some extent, in the case of isoseismal 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 27 is a list of Survey and cooperating teleseismic stations for which the Survey publishes results. Immediate epicenter determinations are frequently made through the cooperation of Science Service, the Jesuit Seismological Association, the Coast and Geodetic Survey, and individual stations. The results are furnished by mail to cooperators.

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

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

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

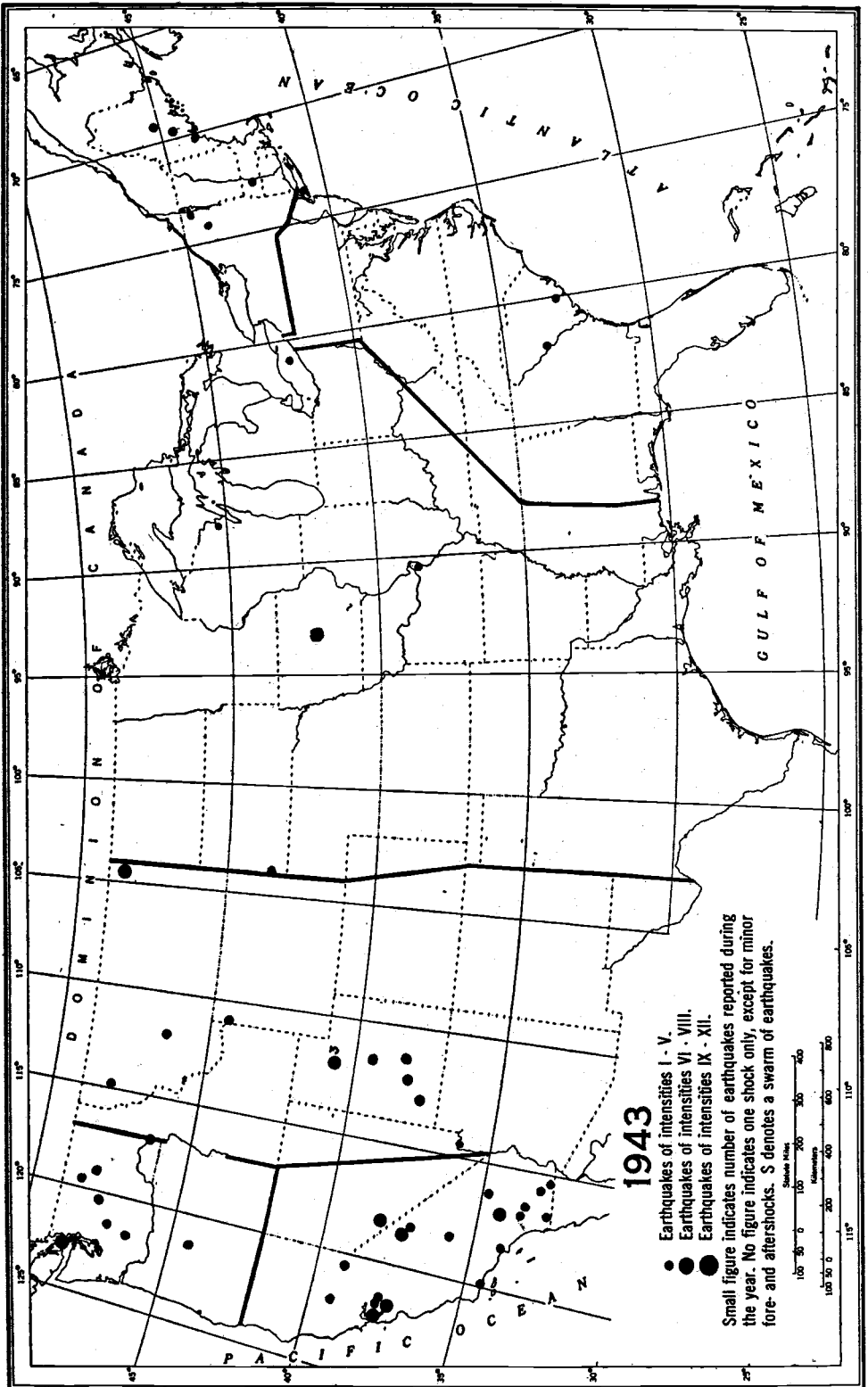


FIGURE 2.—Earthquake epicenters, 1943.

NONINSTRUMENTAL RESULTS

EARTHQUAKE ACTIVITY IN THE VARIOUS STATES

Arizona: Slight shock on July 20.

California: Five shocks, intensity VI: May 31, August 8 and 28, October 25, and November 16. Eleven shocks, intensity V: March 16 and 30, April 15, 26, and 30, May 8, July 9, November 14, 15, 17, and December 16. There were also a number of minor shocks reported.

Colorado: Slight shock on September 3.

Idaho: Minor shock on April 14.

Maine: Three shocks: January 14, February 10, and December 19.

Massachusetts: Minor earthquake on March 31.

Missouri: Light shock on June 8.

Montana: One shock, intensity VI: June 24. Light shocks on January 1, June 25, August 24, and December 12.

Nevada: One moderate shock, intensity VI: August 8. Minor shocks on January 23 and 26, February 3, March 22, April 8, May 5 and 29, June 4 and 6, September 9 and 19, November 5, and December 9 and 10.

New York: Minor shock on July 6.

Ohio: Shock of March 8, maximum intensity IV, centered in Lake Erie.

Oregon: Minor shocks on June 24 and August 4.

South Carolina: December 28, intensity IV.

South Dakota: Minor shock on May 16.

Utah: One shock, intensity VI: February 22. Weaker shocks on January 16, February 22, March 12, April 10 and 11, August 13, November 3, and December 9 and 10.

Washington: One shock, intensity VI: November 28; and one shock, intensity V: April 23. Weaker shocks on April 14, June 13, July 11, September 22, and October 6, 9, and 27.

Wisconsin: Light shock on February 9.

Wyoming: Light shocks on February 3 and September 6.

Alaska: Minor shocks on February 14 and 17, April 2 and 9, May 1, 18 and 31, July 6 and 27, August 25, September 26, November 2, 3, 11 and 13, and December 29.

Hawaii: Minor shocks on March 25, June 14, July 1, October 16 and 20, November 10, and December 22.

Panama Canal Zone: One moderate shock, intensity V, on May 2.

Puerto Rico: Minor shocks on April 22, and July 28 and 29.

NOTE.—The shock of January 14 centering in Maine was also felt in Vermont, New Hampshire, Massachusetts, Connecticut, and Rhode Island.

The shock of March 8 centering in Lake Erie was felt in Michigan, New York, Ohio, Pennsylvania, and West Virginia.

The shocks of March 30 and May 31 centering in California were also felt in Nevada.

The shock of August 8 centering in Nevada was also felt in California.

NORTHEASTERN REGION

(60TH MERIDIAN OR EASTERN WAR TIME)

January 14: 17:32.6. Central Maine.—Epicenter about 45.3° north, 69.6° west, according to the Northeastern Seismological Association. The geographic position was determined from seismographic data and is several miles west of Dover-Foxcroft. The shock was felt over an area of approximately 50,000 square miles in the United States. See map page 6. No data are available on effects in Canada. The distribution of the felt intensities was quite irregular and did not indicate the central area as well as usual. Collection of the felt reports and computation of the epicentral position was done by personnel of the Seismograph Station at Weston College, Weston, Massachusetts. The shock was strongest at Dover-Foxcroft and Old Town, Maine where it was generally felt. Estimated intensity was V. The same intensity was estimated for Lisbon, Maine; and Whitefield, New Hampshire, due to the cracking of plaster, but at these places the shock was reported felt by "many" instead of "all."

INTENSITY IV:

Bangor, Belfast, Benton, Cape Elizabeth, Ellsworth, Enfield, Farmington, Freeport, Greenville, Lewiston, Lincoln, Livermore, Portland, Richmond, Rumford, Surry, Westbrook, Westbrookfield, West Farmington, West Paris, and Yarmouth in Maine.

Greenfield in Massachusetts.

Bethlehem, Concord, Conway, Goffstown, Gorham, Groveton, Lisbon, North Conway, and West Stewartstown in New Hampshire.

Bellows Falls, Enosburg, Newport, and St. Johnsbury in Vermont.

INTENSITY III AND UNDER:

Auburn, Augusta, Bar Harbor, Bangor, Bath, Belfast, Belgrade, Brewer, Brooks, Brunswick, Carmel, Chesuncook, Conway, Cumberland Center, Dead River, Fort Fairfield, Franklin, Garner, Greenville, Harrington, Hollowell, Intervale, Lowell, Manchester, Manchester Four Corners, McKinley, Newport, North Bridgetown, Northport, Penobscot, Portland, Rochester, Rockland, Rumford, Saco, Scarboro, Seal Harbor,

Springvale, Stratton, Tamworth, Tarratine, Thompson's Point, Topsham, Unity, Waldoboror, Waterville, Wicasset, and Wytopitlock in Maine.

Hartford, New Haven, Warehouse Point, and Windsor Locks in Connecticut.

Amesbury, Amherst, Boston, Concord, Gloucester, Greenfield; Ipswich, Lawrence, Lowell, Newburyport, Plymouth, and Williamstown in Massachusetts.

Berlin, Canaan, Center Effingham, Claremont, Dover, Enfield, Henniker, Lancaster, Laconia, Lebanon, Littleton, Madison, Meredith, Newport, Salem, West Campton, and Wolfeboro in New Hampshire.

Bronxville, Lake Placid, and Syracuse in New York.

Barnet, Burlington, Craftsbury, McIndoe Falls, Montpelier, Northfield, Proctorsville, Rutland, West Burke, White River, and Woodstock in Vermont.

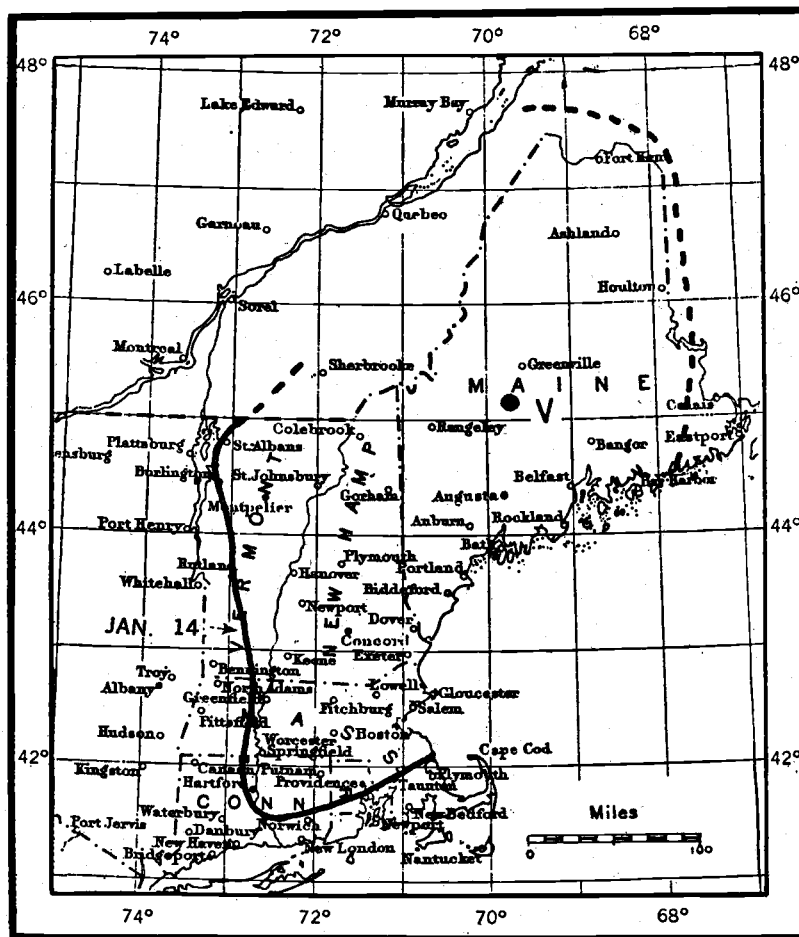


FIGURE 3.—Area affected by the New England earthquake of January 14, 1943.

February 10: 05:45. Portland, Maine. Light shock felt by many. A few cracks reported in one building.

March 31: 07:30. Northampton, Massachusetts. A slight tremor was reported felt here. Landslide on west bank of Connecticut River dislocated Boston-Maine railroad tracks. Slight disturbance recorded on Weston seismograph at 07:47, but not definitely connected with the landslide at Northampton.

July 6: 18:10. Dannemora, Lake Placid, Sunmount, and Canton, New York; and St. Albans and Burlington, Vermont. Light shock felt. Press reports indicate the shock was felt strongly at St. Albans where an explosion was suspected as people "gathered on lawns and sidewalks" to discuss the happening. St. Albans is the most easterly of all the places reporting the shock. Though the shock was felt strongest here, the true epicenter was probably elsewhere unless the shock was felt at points further east which did not report the fact.

December 19: 04:10. Waterville, Winslow, Fairfield, and East Benton, Maine. Only a few people recognized it as an earthquake. Some suspected an earthquake and called the newspaper in Waterville for confirmation.

EASTERN REGION

(60TH MERIDIAN OR EASTERN WAR TIME)

April 13: 11:00. Louisville, Kentucky. A number of reports received indicate a shock was felt by many people in south and east Louisville. The Weather Bureau Observer stated: "We believe that it was caused by blasting or by the firing of heavy guns at Fort Knox. We do not regard it as a real earthquake..."

July 28: 23:30. Augusta, Georgia. Light shock reported by two people. The shock was not generally felt. Seismic origin doubtful.

December 28: 10:25. Summerville, South Carolina. Felt by many people as three decided bumps. The intensity was about IV.

CENTRAL REGION

(75TH MERIDIAN OR CENTRAL WAR TIME)

February 9: 18:21. Thunder Mountain, Marinette County, Wisconsin. Light shock felt by several people in the vicinity of Thunder Mountain and Thunder Lake in the northern half of Township 32 and the southern half of Township 33 North, Range 18 East. According to reports similar shocks have been felt occasionally for many years but have not been severe enough to cause damage.

March 8: 22:25.5* Lake Erie. A study of the seismograph records indicated that the epicenter was in the region of 42.2° north, 80.9° west. The location of the epicenter apparently explains the general lack of a well-defined intensity area. See map page 7. Of the places reporting the higher intensities, Cleveland and Conneaut are nearest the epicentral area.

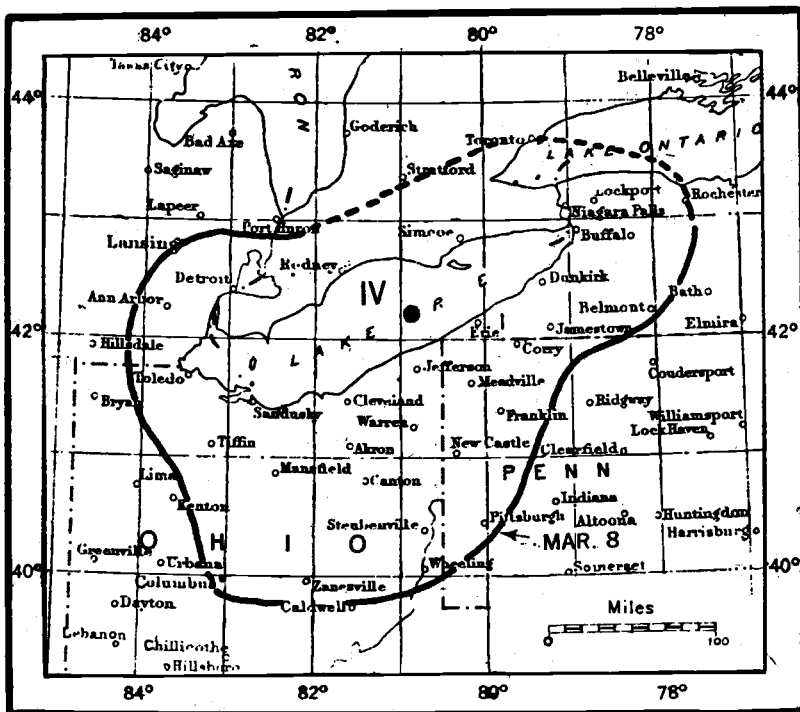


FIGURE 4.—Area affected by the Lake Erie earthquake of March 8, 1943.

INTENSITY IV:

Conneaut and Cleveland, Ohio. Detroit and Grosse Pointe, Michigan.

INTENSITY III AND UNDER:

Adrian, Ann Arbor, Dearborn, Detroit, Flint, Grand Rapids, Mount Clemens, River Rouge, Wyandotte, and Ypsilante, Michigan.

Akron, Ashtabula, Beverly, Canton, Chagrin Falls, Columbus, Dayton, Delaware, Elyria, Jefferson, Lakewood, Lorain, Marion, Massillon, Norwalk, Painesville, Phalanx, Philo, Ravenna, Sandusky, Tiffin, Toledo, Warren, Wooster, Youngstown, and Zanesville, Ohio.

Bradford, Butler, Erie, Franklin, Johnstown, Meadville, New Castle, Oil City, Pittsburgh, Union City and Warren, Pennsylvania.

Buffalo, Dunkirk, Hamburg, Hornell, Jamestown, Lewiston, Niagara Falls, North Buffalo, and Rochester, New York.

Wheeling, West Virginia.

Press reports indicate that the shock was felt at Hamilton, London, and Toronto, Canada. Information on felt effects in Canada is incomplete and is not the result of a systematic questionnaire canvass.

May 16: 14:40. Hot Springs, South Dakota, and southward for several miles. Felt by many "like heavy trucks rumbling down a street." Dishes rattled. Felt on Battle Mountain in the Black Hills.

June 8: 14:50. Webster Groves, Missouri. A light shock was felt by several. Described as a "bumping thud like a hot-water heater exploding."

WESTERN MOUNTAIN REGION

(90TH MERIDIAN OR MOUNTAIN WAR TIME)

NOTE. Only the more important shocks felt at Boulder Dam and the more important aftershocks at Helena, Montana are listed. The unabridged records are published in Abstracts of Earthquake Reports for the Pacific Coast and Western Mountain Region. An asterisk (*) indicates instrumental time.

January 1: 18:46. Marion, Montana. Abrupt trembling felt, accompanied by loud subterranean sounds like a deep underground explosion.

January 16: 05:50.3*. Cedar City, Utah. A press report stated: "An earthquake of considerable intensity awakened Cedar City residents at 05:50 a.m. Saturday, but no serious damage was reported. The shock rattled windows, and toppled dishes. Parley Dalley, Branch Agricultural College geologist, described the shock as probably more intense but of briefer duration than the worst of the series of tremors felt here last September. He ascribed it to a movement in the Hurrigan Fault which extends well under this area. The shock was felt with equal intensity at Enoch, six miles north; and at Hamiltons Fort, five miles south. Kanarraville residents said it was not felt there."

January 23: 22:30. Boulder City, Nevada. Moderate shock felt.

January 26: 07:01. Boulder City, Nevada. Moderate shock felt.

February 3: 03:01. Boulder City, Nevada. Moderate shock felt.

February 3: 05:15 to 09:30. Yellowstone Park (Old Faithful), Wyoming. Intensity IV. All awakened. Houses creaked and widows rattled. "Six different quakes between 05:15 and 09:30 a.m.; severest was at 09:15 a. m."

February 22: 08:20. Utah. Central area was probably between Salt Lake City and Bingham. The shock was recorded by the seismographs at Salt Lake City and Logan, but the resulting data were not sufficient to determine an accurate epicenter. According to Professor J. Stewart Williams, Utah State Agricultural College, Logan, this shock originated in, or in a branch of, the Wasatch fault zone at considerable depth. The extension of the felt area to the west he believes is due to deep alluvium under such places as Grantsville and Tooele while points to the east are essentially on a bedrock block.

INTENSITY VI:

Bingham Canyon.—Felt by all. "In a new brick building at the Bingham High School, much plaster was shaken from the wall and ceiling. It was felt generally throughout this section or range of mountains."

Magna.—Felt generally. Cracked plaster, windows and chimneys. Clock thrown from stove at one point just east of Magna. Oven door fell down.

Salt Lake City.—Felt by many. Cracked plaster and windows. Knickknacks fell.

INTENSITY V:

Copperton, Draper, Midvale, Murray, Sandy, and Woods Cross.

INTENSITY IV:

Bountiful, Layton, Pleasant Grove, Provo, and Tooele.

INTENSITY I TO III:

Grantsville, Keetley, Lehi, Midway, Ogden, and Spanish Fork. Negative reports were received from twenty-one places.

February 22: 22:50. Hunter, Magna, and Garfield, Utah. Light shock felt. Observer's husband stated that he felt other shocks at 5:30 and 6:30 a.m.

March 12: 07:45. Ephraim, Utah. Light shock felt by several and awakened some. Windows and doors rattled.

March 22: 21:20. Boulder City, Nevada. Moderate shock felt.

April 8: 11:27. Boulder City, Nevada. Powerhouse. Felt by several. Rattled windows and doors.

April 8: 11:35. Boulder City, Nevada. Powerhouse. Felt by several. Rattled windows and doors.

April 10: 17:42. Salt Lake City, Utah. The Press reported: "A temblor of undetermined extent shook the Salt Lake-Magna area April 10, but damages apparently were negligible. It was particularly distinct in the business district and the western half of the city. The tremor lasted several seconds." Felt slightly at Magna, also at Murray, where trees and bushes shook slightly.

April 11: 14:32. Salt Lake City, Utah. According to the press, "Sunday's quake seemed to center in the Parley's Canyon area. One man residing near the Parley's Canyon 'highline' and one woman, residing near the Mountain Dell reservoir, reported the temblor as 'quite heavy.' A distinct rumble was heard in the Mountain Dell area at the time of the quake."

At Grantsville, windows rattled and walls creaked. Few awakened.

April 14: 03:53. Lewiston, Idaho. Intensity IV. According to the press two distinct shocks were felt in Lewiston and nearby areas. The second shock came after an interval of possibly two seconds. The shocks rattled dishes and swayed beds. Clocks were toppled and windows rattled, but no damage was reported. The first shock was the sharpest and was more noticeable in the outlying districts. Reports stating that the earthquake was felt slightly were received from Sweetwater, Culesac, Slickpoo, Orofino, the Soldier Meadow area, Craigmont, Reubens, and Uniontown. Residents of Orofino thought it was an explosion when dishes rattled and a few pictures fell.

May 5: 22:10. Boulder City, Nevada. Felt by many in home. Dishes rattled.

May 29: 23:17. Boulder City, Nevada. Power Plant. Felt by all. Windows rattled.

June 4: 02:45. Boulder City, Nevada. Awakened a few people. Windows rattled.

June 6: 13:58. Boulder City, Nevada. Felt by several, windows and doors rattled. This shock was followed by a very small aftershock.

June 24: 22:29. Southern Sheridan County, Montana. The shock was felt strongest around Homestead and Froid.

INTENSITY VI:

Froid.—Felt by many. Buildings swayed slightly and creaked. A well-constructed granary cracked so severely that wheat spilled out. The report from this town stated: "One man north of Brockton was outside when it occurred. He said it felt as though the earth was heaving up and down."

Homestead.—Felt by many. Faint subterranean sounds heard. House creaked and chandeliers swayed. Basement walls reported cracked.

Redstone.—Chandeliers swung, chimneys cracked.

Reserve.—Two shocks. Thunderous, roaring subterranean sounds. Many cracks in plaster. Chimneys damaged.

INTENSITY IV:

Medicine Lake and McCake: No additional reports were received.

June 25: 16:20 and 18:58. Helena, Montana. Two weak shocks felt.

July 20: 00:00. Upper end of Lake Mead, Arizona. Awakened Observer employed on the Colorado-river Expedition.

August 13: 23:40. Grover, Utah. Felt by several. Houses creaked and windows rattled. Press reports state that four distinct tremors were felt and a number of families awakened. The center of the quake seemed to be at the A.P. Clark farm, one and one-half miles west of Grover. It was accompanied by a rumbling sound. Residents of Auburn felt the shock, but it was not felt at Afton.

August 24: 06:58. Kalispell, Montana. Felt by several; houses creaked and windows rattled. Faint subterranean scraping sounds were heard.

September 3: 05:25. Ophir and Tulluride, in San Miguel County, Colorado. Disturbed objects and subterranean sounds were observed by several.

September 6: 09:00. Strongest at Buffalo (Johnson County) and Kaycee in Wyoming. At Buffalo there was a swaying motion felt by many. Houses creaked and windows rattled. A distinct sway was felt at a cabin ten miles south. It was also felt by one person at Sheep Mountain Lookout. At Kaycee, houses creaked and windows rattled. The shock was felt slightly at Arvada, Sheridan and Sussex.

September 9: 04:34.* Boulder City, Nevada. A shock of about two seconds duration rattled windows and awakened a few people.

September 19: 17:39.* Boulder City and Boulder Dam, Nevada. Felt strongest at the former where many heard sounds like thunder.

November 3: 04:30. Sevier, Utah. Awakened and frightened all in the community. Windows rattled. Also felt at Joseph where windows rattled. Not felt at Elsinore and Marysvale.

November 3: 06:30. Sevier, Utah. Slight shock felt.

November 3: 21:00. Sevier, Utah. Slight shock felt.

November 5: 21:45, 21:54 and 21:56. Caliente, Nevada. (Matthews Ranch and Beaver Dam Wash.) All awakened. Windows rattled. The second shock was heaviest, the third was light.

December 9: 11:06. Cedar City, Utah. Walls creaked. Doors and windows rattled. One report stated three shocks occurred: 11:05, 11:17 and 13:21.

December 10: 02:30. (a.m. or p.m. not given) Cedar City, Utah, Slight shock felt.

December 12: 06:41. Helena, Montana. Moderate shock, lasting two seconds.

CALIFORNIA AND WESTERN NEVADA

(105TH MERIDIAN OR PACIFIC WAR 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. An asterisk (*) indicates instrumental time.

January 2: 07:11:18.* Epicenter 33° 25' north, 116° 25' west, P. Near Santa Rosa Mountains.

INTENSITY IV:

Estelle Lookout (Section 2, T5S, R5W, SBM, USFS), Fawnskin, Riverside, San Jacinto, and Santa Ysabel.

INTENSITY I TO III.

Banning, Escondido, and San Diego.

February 4: 14:22.9* Epicenter 36.2° north, 118.5° west, P. Kern River, west of Haiwee. Felt intensity IV in Giant Forest, Sequoia National Park (Section 1, T15S, R30E, MDM). Felt slightly in Tulare County (T16S, R29E).

February 28: 22:25. Reno, Nevada. Sharp local shock with subterranean rumbling felt by many. Hanging objects moved slightly.

March 10: 18:14:25* Comptche, Potter Valley, and Stonyford. (W.L. Wrocklage, Ukiah). Intensity IV. Hanging objects swung and windows rattled. A few people felt the shock in Ukiah.

March 11 to 29: Olancha. No times given by the observer who reported a series of light shocks and stated: "We live in the mountains. These quakes are not felt within a mile east of us, except one hard quake which was felt at North and South Haiwee Dams. Every day last fall, three to six shocks; sometimes loud crackling noises in air, without the ground tremors. The same thing going on now for the past three weeks. Another sharp quake at time of filling out this report form at 11:18 a. m., March 29, 1943. Last year I inquired from the Bakersfield side of the Sierras—none felt—same this time. Quakes seem to be centered in Monachee Meadows, on west slope of Sierras, between Round Mountain and Olancha Peak. These quakes coming harder and oftener every day."

In response to an inquiry the Seismological Laboratory at Pasadena reported: "We have checked the Haiwee seismograph records for confirmation of the Olancha report. Seismic activity was rather high in March and in the beginning of April but seems to have subsided somewhat now. The magnitude of the shocks rarely exceeds III. The only shock for which a time is given in the report is confirmed by the Haiwee seismograph records. The epicenters must be very close to Haiwee. Haiwee recorded shocks on March 11 at 08:02*, March 12 at 13:18*, and March 16 at 02:59*. A long series began on March 23 at 13:57*. One hundred forty-nine tremors were recorded during the remainder of March. Two of these were large enough to be located: March 25 at 20:50:44* with epicenter at 36° 09' north, 117° 57' west, and March 29 at 03:28:11* with the same epicenter."

March 16: 17:40:44* Epicenter 32° 44' north, 115° 26' west, P. Imperial Fault, Imperial Valley. Felt by all at El Centro and Heber with intensity V and IV, respectively. Walls creaked and windows rattled.

March 16: 17:52:20* Epicenter 32° 44' north, 115° 26' west, P. Aftershock. Felt by several at El Centro.

March 16: 17:56:34* Epicenter 32° 44' north, 115° 26' west, P. Felt by many at El Centro.

March 29: 04:45* Pleasanton. Press reports stated that the shock was recorded on the seismographs at the University of California and at the University of Santa Clara. Three shocks at 04:33, 04:45, and 05:04 were felt at Pleasanton. Many were awakened. The report stated: "Three shocks Saturday, March 27 around 11 p.m. and one about 1 a.m., Sunday, March 28. I did not feel them. Light shocks were felt by some around 8 a. m., March 29."

March 29: 04:55. El Granada. Felt by several. Rattled windows.

March 30: 14:07* Epicenter 39.0° north, 120.5° west, P. Central Lake Tahoe region. About 15,000 square miles were affected in eastern California and western Nevada. See map page 11. Also recorded on the seismograph at the University of Nevada. Blue Canon and Truckee, California; and Reno Airport and Stewart, Nevada reported light objects fell and all or a large portion of the population felt the shock. Maximum intensity estimated as V. Lighter shocks were reported felt in Truckee at 13:30 and 17:00.

INTENSITY IV:

Emigrant Gap, Homewood, Loyalton, Markleeville, Nevada City, and Portola.

INTENSITY IV IN NEVADA:

Carson City, Fernley, Minden, Reno, and Sparks.

INTENSITY I TO III:

Bijou, Colusa, Downieville, Las Plumas, Marysville, Sacramento, Sierra City, and Soda Springs.

Negative reports were received from eleven places in California and six places in Nevada.

April 1: 14:06* Truckee, P. Felt by a few.

April 6: 02:03:24* Epicenter 33° 40' north, 116° 51' west, P. Hemet. Press reports indicated the shock was felt in the Hemet-San Jacinto Valley.

April 8: 06:22:41* Epicenter 34° 33' north, 118° 57' west, P. Filmore. It was felt by many. Windows rattled.

April 15: 08:31:51* West-central California, P. This shock, one of a series occurring on April 15th, was felt over an area of approximately 2,000 square miles. Maximum intensity of V was reported from Tracy where a heavy floor lamp was shaken. Reports are confusing as to the exact time of the strongest shock, but data from the seismograms recorded at the Seismological Laboratory at Pasadena indicate that the shock at 08:31:51* was probably much stronger than the others.

According to the press, a series of eleven shocks was felt in Livermore Valley as indicated in reports to the Sheriff's Office; (05:29, sharp; 06:23, light; 08:23, sharp; 08:31, light; 08:32, heavy; 08:35, 08:38, 08:50, and 09:03, light; 11:00, sharp; 15:08, light). Most people stated that the shocks at 08:32 and 11:00 were the strongest.

Press reports from Santa Clara stated that a series of fifteen distinct shocks were recorded on the seismograph there. [This report also stated that plaster was cracked at the Livermore Veterans' Hospital and that wine bottles were shaken off the shelves of a Livermore winery.]

INTENSITY IV:

Byron, Lafayette, Livermore, Moss Beach, Newark, San Francisco, Stockton, Vernalis, and Walnut Creek.

INTENSITY I TO III:

Berkeley, Brentwood, Concord, and Palo Alto.

Negative reports were received from fourteen places.

April 15: 10:30:30.* Vacaville, P. Felt by many. Houses creaked and windows rattled.

April 15: 11:00:08.* Brentwood, P. Slight shock not generally felt.

April 18: 00:48.* Truckee, P. Moderate shock felt.

April 21: 16:40:33*, and others at 10:12:53*, 16:29:00*, and 16:58:46.* Livermore, P. Press reports stated that four quakes were recorded at the University of Santa Clara and were felt in Livermore.

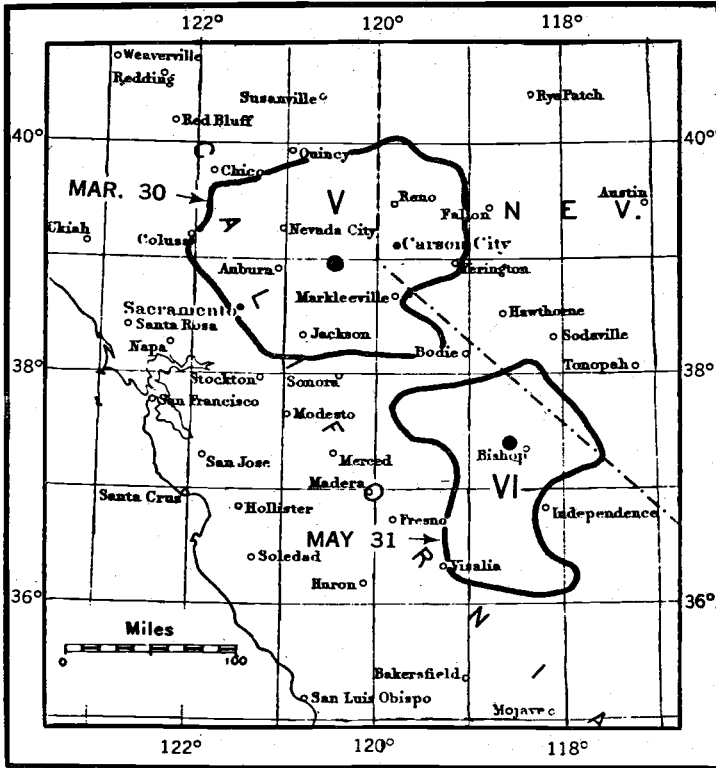


FIGURE 5.—Areas affected by the California earthquakes of March 30 and May 31, 1943.

INTENSITY IV:

Dublin, Newark and Livermore Substations (P.G. & E.), Pleasanton, and San Francisco.

INTENSITY III:

Livermore.

April 26: 04:54:50*, and 05:02:58.* Dublin, Livermore, Moraga, and Niles, P. The earthquake at 04:54:50* affected an area of approximately 1500 square miles. Maximum intensity of V was reported from Dublin, as well as the shifting of small objects. The shock was felt by many in the other places. Windows, doors, and dishes rattled. Press reports stated that two shocks were recorded on the University of California seismograph at 04:54:50* and 05:02:58.* The second shock was reported as "very small."

INTENSITY IV:

Alvarado, Decota, Diablo, Holt, Rio Vista, Sunol, Sunnyvale, and Walnut Creek.

INTENSITY I TO III:

Byron, Centerville, El Granada, Glenwood, and San Ramon.

Negative reports were received from twenty places.

April 26: 05:02:58.* Decota, Livermore, and Pleasanton, P. Intensity IV. Livermore reported additional shocks at 05:15, 05:40, and 11:24:35.* The latter was recorded on the seismograph at Pasadena.

April 26: 08:40. Isleton. Light shock felt by several in homes. Not recorded by the seismograph at Tinemaha.

April 28: 23:11:29.* Livermore, P. Slight shock felt by several. A second shock was felt slightly the following morning at 01:09.

April 30: 19:52.* Livermore, P. Intensity V. Felt by all. Buildings creaked. Windows rattled. Recorded on the seismograph at the University of California.

April 30:22:00. Grass Valley. The SSA Bulletin for July 1943 states: "A slight earthquake shock accompanied by a sound, was felt in Nevada City shortly after 10:00 p.m. P.W.T. No damage was reported." The shock was not recorded on the seismograph at Tinemaha.

May 3: 16:22:47.* Epicenter 33° 59' north, 117° 17' west, P. Felt by several in Riverside.

May 5: 04:49 and 23:03. Livermore, Arroyo Sanitarium. Many awakened and frightened. Walls creaked and windows rattled.

May 5: 11:07.* Livermore, Veterans Administration, P. Felt by all in home. The Pasadena seismogram showed a small indefinite disturbance at this time; possibly not an earthquake.

May 5: 22:05. Sierra City. "Two shocks, resembling an explosion or underground blast, were felt here by many." The shock was not recorded on the Pasadena seismograph.

May 7: 21:42.4.* Epicenter about 35.7° north, 118.4° west, P. Felt by many in homes at Kernville. Windows rattled and walls creaked.

May 8: 05:30:30.* West-central California. Livermore, P. A relatively small area of about 500 square miles was affected. Intensity V at Livermore. All were awakened in the hospital where walls creaked and windows rattled. Weaker shocks were felt at 02:30, 03:20, and 06:30.

The shock was recorded by the accelerograph at the Veterans' Hospital about five miles south of Livermore.

INTENSITY IV:

Hayward, Holt, and Milpitas.

INTENSITY I TO III:

Banta, Centerville, and Sunol.

Negative reports were received from thirty places.

May 9: 10:18:37.* Epicenter about 33° 03' north, 115° 40' west, P. According to the SSA Bulletin, June 1943, "A light earthquake shook Brawley and Niland at 10:18 a. m."

May 17: 12:45. Livermore, Arroyo Sanitarium. Many awakened. Windows rattled. Not recorded at Tinemaha.

May 18: 15:35:35.* Epicenter 33° 40' north, 118° 05' west, P. Felt very briefly at Long Beach.

May 19: 10:55:24.* Epicenter 35° 43' north, 118° 26' west, P. Felt by several. Rattled windows at Kernville.

May 23: 04:38. Ferndale. Felt by many. Walls creaked. Many awakened. At Scotia, walls creaked and windows rattled, but the shock was felt by only a few.

INTENSITY IV:

Briceland.

INTENSITY III:

Ferndale, Scotia, and Upper Mattole.

May 28: 21:57:50.* Livermore, P. Awakened many in homes and in the community.

May 29: 18:04:16.* Livermore, B. Recorded on the accelerograph at the Veterans' Hospital about five miles north where it was generally felt. The shock must have been quite local as only one felt report was received from the town of Livermore.

May 29: 19:39:15.* Epicenter 32° 58' north, 116° 00' west, P. Rattled windows and shook trees and bushes slightly at Borego Valley.

May 30: 00:50:54.* Epicenter 36° 08' north, 117° 58' west, P. Felt by a few at Haiwee Power Plant (Coso Junction). Windows rattled and houses creaked.

May 31: 13:16:53.* Epicenter 37° 23' north, 118° 36' west, P. This shock was felt over an area of approximately 5,500 square miles with a maximum intensity of VI at Bishop where plaster was cracked in the school building. See map page 11.

A strong-motion record was obtained on the accelerograph located at Bishop.

INTENSITY V:

Olancho, Owens River Gorge (near Bishop), and Tungsten City.

INTENSITY IV:

Benton, Bigpine, Dunlap, and King's Canyon National Park.

INTENSITY I TO III:

June Lake, Laws, and Yosemite National Park.

Negative reports were received from eight places.

June 2: 21:39:37.* Epicenter $33^{\circ} 30'$ north, $116^{\circ} 45'$ west, P. Felt by all with intensity IV at Oak Grove Ranger Station (Aguanga).

June 3: 19:19* and 22:10.* Potter Valley Powerhouse and north to northeast of Willits. (W. L. Wrocklage, Ukiah). Both shocks were light. The one at 19:19 was the stronger. They were recorded on the seismograph at Ukiah.

June 4: 02:50 and 04:53. Willits. Light shocks felt in north to northeast area.

June 8: 01:56. Monterey. Intensity IV. Felt by many. Awakened many and rattled windows. Observer was unable to determine whether it was an earthquake or the result of gun fire off Yankee Point.

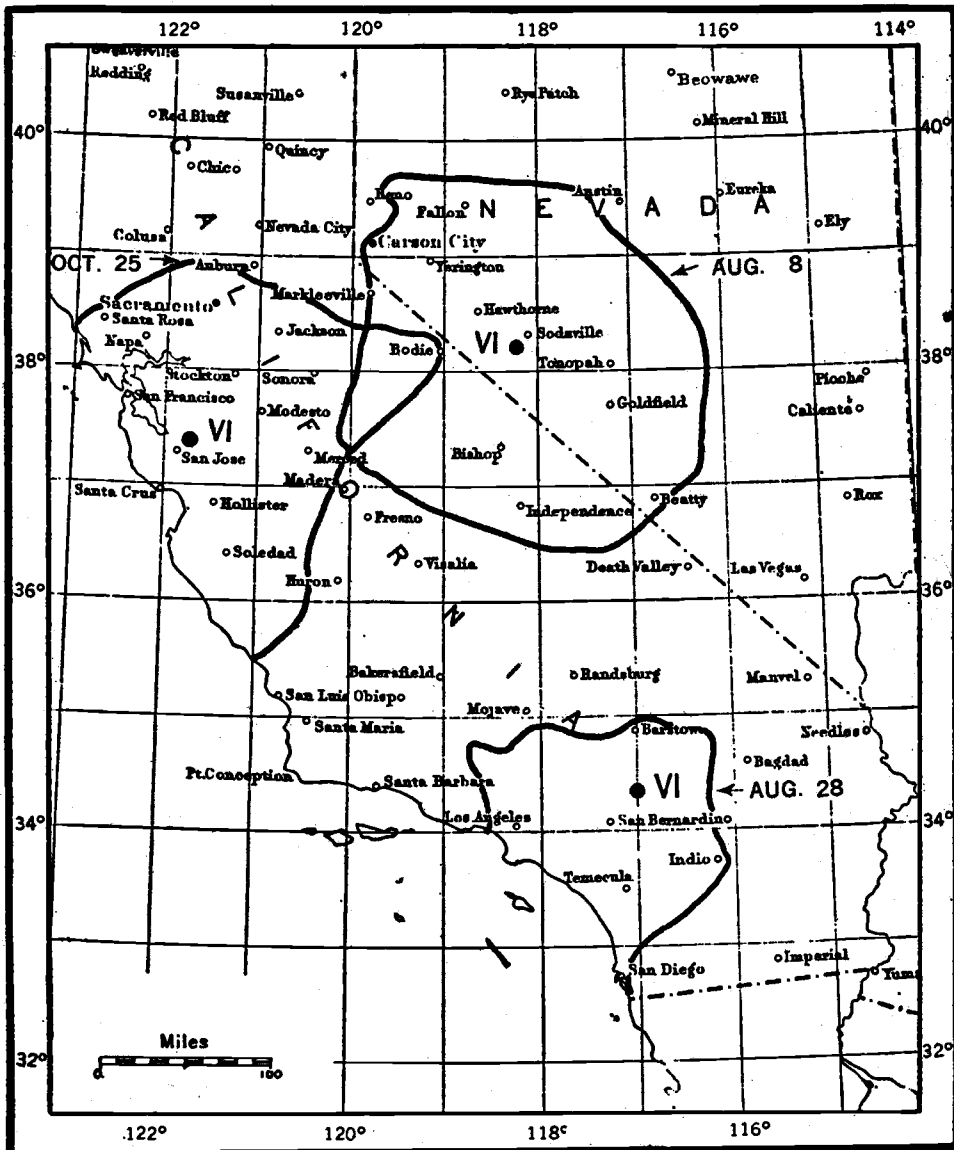


FIGURE 6.—Areas affected by the California and Nevada earthquakes of August 8, August 28, and October 25, 1943.

June 18: 09:15:46.* Epicenter $33^{\circ} 07'$ north, $116^{\circ} 07'$ west, P. Felt intensity IV at Santa Ysabel where walls creaked and hanging objects swung. Felt by a few in San Diego.

June 25: 10:00. Five miles south of Miranda. Intensity III. Felt by two. Felt as though building had been given a push.

June 28: 21:54 and 21:55. Livermore. These were the thirty-sixth and thirty-seventh in a series which began in March. Many persons reported feeling a rather long earthquake, with a rolling motion, rather than the sharp jolt usually felt.

A strong-motion record was obtained on the accelerograph located at Livermore.

June 30: 01:09. Mojave (Section 20, T10N, R12W, SBBM). Heard by two persons. Observer reported five definite thumps and sounds. Some sand fell from crack in wall. Soot fell from closed chimney to top of stove. Clock facing west stopped.

June 30: 08:15:41.* Oakland Hills, B. Slight tremors felt. Recorded at Berkeley where center was estimated to be about five miles from the University.

July 4: 14:53:10.* Epicenter 33° 57' north, 117° 37' west, P. Intensity IV at El Carriso Guard Station (Elsinore), Ontario, and Upland.

July 6: 04:05. Livermore. Light shock. Not recorded on the Tinemaha seismograph about 200 miles distant.

July 9: 20:12:33.* Epicenter 35° 44' north, 118° 14' west, P. Felt by many with intensity V in the mountains west of Inyokern. Windows rattled. Boulders were shaken loose on the mountain side.

July 14: 17:44:7.* Near Avenal, P. Windows and doors rattled.

July 17: 06:02.* Bigpine Powerhouse No. 3, P. Light shock rattled doors. Hanging objects swung. Very small shock recorded at Tinemaha at 06:02. The observer reported this shock at 05:10.

July 21: 17:10.* Ukiah and Redwood Valley. (H. G. Wrocklage, Ukiah). Felt with intensity IV. Slightly felt by two people at Elk. Recorded on the Berkeley seismograph.

July 28: 20:16.* San Diego, P. Very light shock reported felt.

August 4: 13:50:05* and 14:17:46.* Livermore, Arroyo Sanitarium, P. Felt slightly.

August 8: 22:30:04.* Epicenter 38° 12' north, 118° 12' west, P. The shock was felt over an area of about 34,000 square miles in east-central California and western Nevada. See map p. 13. Intensity VI was reported from Basalt, Nevada where it was reported that dishes fell, and from Dyer and Fallon, Nevada where it was reported that plaster and walls were cracked. The seismological Laboratory at Pasadena reported: "There were no aftershocks comparable with the main shock (22:30:04*). The four largest were on the 8th at 22:23* and 23:27*, and on the 9th at 00:44* and 21:43*."

INTENSITY V:

Keeler and Pinehurst Ranger Station, (Section 21, T14S, R28E, Miramonte).

INTENSITY V IN NEVADA:

Goldfield and Schurz.

INTENSITY IV:

Bigpine, Bishop, Bridgeport, Leavening, Huntington Lake, June Lake, Laws, Lone Pine, Owens River Gorge, Tinemaha Dam, Topaz, and Yosemite National Park.

INTENSITY IV IN NEVADA:

Beatty, Carson City, Fernley, Gabbs, Hawthorne, Ione, Luning, Stillwater, Tonopah, and Yerington.

INTENSITY I TO III:

Deep Springs and Sacramento.

Negative reports were received from five places in Nevada and twelve places in California.

August 8: 23:27.* Bishop, Bridgeport, and Leavening, P. Aftershock.

August 9: 04:17.* Lone Pine, P. "Shock felt with about the intensity and duration as the one of August 8 at 22:30." Small shock recorded at Tinemaha, but not at Haiwee.

August 11: 09:01:02.* Epicenter 33° 48' north, 117° 52' west, P. Near Anaheim. Press reports stated: "The quake was felt at various spots in southern California where it rattled windows but did no damage." It was felt by a few people in Pasadena.

August 12: 21:49.* Tinemaha and Livermore, P. Extremely small seismic motion recorded at Tinemaha. Intensity IV at Livermore. Felt by many at hospital. Windows rattled and houses creaked. Observer reports fourteen shocks were felt during the month of August.

August 17: 08:50:58.* Epicenter 32° 58' north, 116° 00' west, P. Near Borego Valley. Intensity IV at Carriso Gorge, Tunnel 15 (Jacumba). Windows rattled and walls creaked.

August 27: 01:16:53.* Epicenter 34° 26' north, 119° 52' west, P. Felt intensity IV in Santa Barbara. Felt by many who were awakened and frightened.

August 28: 20:45:13.* Epicenter 34° 16' north, 116° 58' west, P. Shock felt over an area of about 16,000 square miles. See map p. 13. The Seismological Laboratory at Pasadena recorded a foreshock at 20:43:09*, the main shock at 20:45:13*, together with aftershocks at 20:57:54* and 22:16:30.* An intensity of VI was reported from Lake Arrowhead, Big Bear Lake District, and Seven Oaks (Converse Ranger Station) where objects overturned, and knickknacks and pictures fell.

Accelerograph and displacement-meter records were obtained in Hollywood, Los Angeles, Colton, San Bernardino, and San Diego. See section on "Strong-Motion Seismograph Results" for details.

INTENSITY VI:

Big Bear Lake District (Fawnskin).—All awakened and many frightened. Small objects overturned. Houses creaked. Damage slight.

Lake Arrowhead, (Section 22, T2N, R3W, SBBM).—Many awakened. Houses creaked. Visible swaying of buildings and trees. Candles, dishes, and ornaments fell in a northeast direction.

Lake Arrowhead.—Felt by all. Small objects overturned and dishes were broken. Houses creaked.

Converse Ranger Station (Seven Oaks).—Felt by all. Overturned small objects. Trees and bushes shook moderately. Four shocks in all were felt from 20:43:09* to 22:16:30.*

INTENSITY V:

Banning, Big Bear Ranger Station (Section 8, T2N, R1E, SBBM), Colton, Corona, Fallbrook, Fullerton, Glenn Ranch, Los Angeles, Mentone (Section 13, T1S, R2W), Riverside, and San Dimas.

INTENSITY IV:

Acton, Adelanto, Alberhill, Anza, Azusa, Balboa, Barstow, Beaumont, Cabazon, Cajon, Coachella, Corona Ranger Station, De Luz, Eagle Rock, Elsinore, Escondido, Etiwanda, Fontana, Glendale, Keen Camp, La Crescenta, La Habra, Lancaster, La Jolla, Lynwood, Long Beach, Mojave (Section 20, T10N, R12W, SBBM), Monrovia, Palmdale, Palm Springs, Pasadena, San Diego, San Gabriel, San Jacinto, San Juan Capistrano, San Onofre, San Pedro, Santa Ana, Swartout, Temecula, Victorville, Warner Springs, Wildomar, and Winchester.

INTENSITY I TO III:

Baldwin Park, Castaic, Covina, El Toro, Gorman, Idyllwild, Ludlow, Newport Beach, Pomona, Sepulveda, Thermal, and Wrightwood.

Negative reports were received from twenty-four places.

September 6: 01:30. Ferndale. Felt by many. Walls creaked and windows rattled.

September 11: 10:30. Scotia. Houses creaked. Felt by several.

September 13: 05:40. Paso Robles. Shock felt with strong rumblings. Possibly gun fire.

September 14: 08:46.4.* Epicenter in general vicinity of Sierraville, P. Felt by six persons in Sierraville. Hanging objects swung.

September 16: 00:52:22.* Epicenter 36° 01' north, 117° 56' west, P. Near Haiwee. At Trona many were awakened, houses creaked, and windows rattled.

September 23: 05:39. El Centro. SSA Bulletin, January 1944 states: "Two minor earthquakes were felt in El Centro. Sleepers were awakened but there was no property damage."

September 23: 06:21:37.* Epicenter 33° 59' north, 118° 18' west, P. Intensity IV in Los Angeles where it was felt as a sudden jar, and windows rattled.

September 24: 06:00. Salinas. Felt in homes. Beds rattled.

September 26: 10:48.* San Jose. Intensity IV. Rattled windows and dishes. Press reports indicated the shock was probably heaviest at Plaza Square and that it was recorded on the seismograph at Santa Clara University.

October 1: 23:56.* Ferndale, P. Felt by many. Walls creaked. Windows and doors rattled. Also reported felt at Fortuna and near Cape Mendocino.

October 4: 17:17. San Francisco. Slight shock. Observer reported it as: "Barely perceptible. May not have been an earthquake."

October 5: 13:20. Ferndale. Felt by many. Houses creaked. Felt by several in Upper Mattole.

October 10: 21:53:22.* Epicenter 34° 00' north, 116° 41' west, P. Felt by many in Banning where a one-second jolt rattled windows and doors. One instance of cracked plaster was reported in Palm Springs.

October 13: 22:50.* Maxwell and Williams, P. Felt by several. Walls creaked and windows rattled. Frightened fowl. Also felt at Oroville and Gridley. At the latter place it caused a rocking chair to rock. According to the press some people in Oroville were awakened.

October 14: 07:28:44.* Epicenter 34° 20' north, 116° 53' west, P. San Bernardino Mountains, north of Big Bear Lake. Felt by several at San Diego.

October 14: 15:27.* Maxwell and Gridley, P. Walls creaked and dishes rattled. Felt by many at Maxwell. Also felt slightly at Oroville and Williams.

October 15: 09:50:01.* Epicenter 34° 20' north, 116° 52' west, P. San Bernardino Mountains. Felt by all in homes at Fawnskin. Windows rattled and houses creaked.

October 22: 05:00 (about). San Ardo. Two shocks, two or three minutes apart, felt by several in the community.

October 23: 17:29:21.* Near Riverside, P. Felt at Riverside, Estelle Lookout (Corona) and Idyllwild Ranger Station.

October 25: 21:50:53.* Central California, B. The earthquake was of moderate intensity but widely felt. It was recorded on the seismograph at the University of California and the epicenter placed along the Calaveras Fault about four and one-half miles northwest of Mount Hamilton, California. An area of about 20,000 square miles was affected. In the epicentral area there was some falling of plaster and a few broken windows. A maximum intensity of VI was reported. See map page 13.

A number of strong-motion records were obtained in Oakland, San Francisco, San Jose, Martinez, and Livermore. Details of these results will be found under the section on "Strong-Motion Seismograph Results."

INTENSITY VI:

Alviso.—Felt by all in community. Cracked windows and plaster. Books and plaster fell. Awakened and frightened many. Slight damage.

Boulder Creek.—Strongest felt for several years. Awakened many. Cracked plaster and overturned small objects.

Castroville.—Felt by many. Shifted small objects and cracked plaster.

Cupertino.—Felt by many and awakened many. Overturned small objects and furniture. Cracked plaster and windows. Many frightened.

Decoto.—Overturned small objects. Felt by all. Frightened and awakened many. Pictures fell.

Half Moon Bay.—Awakened and frightened many. Pendulum clocks facing north and south were stopped.

La Honda.—Felt by all. Many awakened. Houses creaked and small objects were overturned. Damage slight.

Los Gatos.—Windows rattled severely. Felt by many as beds moved and lamps swayed. Small objects and vases overturned. Some windows cracked and plaster fragments fell. Visible swaying of buildings.

Milpitas.—"Hardest shake since 1912." Awakened all and frightened many in homes. Trees and bushes shaken strongly. Small objects overturned. Plaster cracked. Pendulum clocks stopped and pictures fell.

Mountain View.—Considerable damage to glass windows. Awakened and frightened many. Small objects overturned.

Palo Alto.—Felt by all. Buildings creaked and a few windows cracked. Trees and bushes shaken strongly. Many awakened.

San Jose.—Many awakened. Walls, plaster, and windows cracked. Dishes broken and water spilled from indoor containers. Loud rustling noise heard. Small objects overturned and clocks stopped.

San Martin.—Felt by all. Dishes rattled and walls creaked. Small objects overturned and knick-knacks fell.

Santa Cruz.—Felt by all. Many awakened. Trees shaken moderately and automobiles moved. Walls creaked and small amount of plaster cracked.

Sausalito.—All frightened and many awakened. Houses creaked and some plaster cracked. Damage slight.

Sunnyvale.—Chandelier broken. Felt by all. Many awakened and frightened. Damage slight. Pendulum clock facing north stopped.

Tracy.—Awakened and frightened many. Walls creaked and small objects overturned.

Vallejo.—Felt by all. Plaster cracked. Many awakened and frightened.

Watsonville.—Many awakened and frightened. Houses creaked. Slight damage. Hanging objects swung.

INTENSITY V:

Agnew, Alma, Bayshore, Ben Lomond, Berkeley, Bolinas, Burlingame, Capitola, Corte Madera, Davenport, Emeryville, Gilroy, Hollister, Holy City, Inverness, Lafayette, Livermore, Lodi, Los Altos, Martinez, Mill Valley, Morgan Hill, Newark, Oakland, Patterson, Redwood City, Ross, San Bruno, San Francisco, San Gregorio, San Mateo, San Rafael, Santa Rosa, Saratoga, and Stockton.

INTENSITY IV:

Alameda, Alcatraz, Angels Camp, Antioch, Bodega Bay, Bridgeport, Carmel, Chinese Camp, Crockett, Davis, Delhi, Fairfield, Glen Ellen, Gustine, Ignacio, Imola, Ione, Irvington, Isleton, Jackson, Jenner (Fort Ross), Kentfield, King City, Knights Ferry, LaGrange, Livingston, Manteca, Martell, Millbrae, Modesto, Moraga, Moss Landing, Napa, Niles, Oakdale, Olema, Orinda, Petaluma, Pescadero, Pinnacles, Pinole, Pleasanton, Rockaway Beach, San Ramon, San Leandro, Seaside, Sloughhouse, South Dos Palos, Stinson Beach, Suisun, Thornton, Tiburon, Tracy, Vacaville, and Vernalis.

INTENSITY I TO III:

Belmont, Chualar, Lafayette, Lockeford, Los Banos, Merced, Monterey, Pinecrest, Sacramento, Saint Helena, Salinas, San Ardo, San Juan Bautista, Volta, and Yosemite National Park.

Negative reports were received from forty-one places.

October 26: 04:58.* Lakeport, Potter Valley and Upper Lake, P. Light shock felt. Also felt, with varying intensity, at Ukiah.

October 26: 15:10. Los Alamos. Felt by a few. Buildings creaked.

October 29: 09:31:09.* Epicenter 33° 47' north, 117° 52' west, P. Press reports indicated it was felt at Santa Ana and Orange.

October 31: 06:12:10.* Epicenter 33° 47' north, 116° 12' west, P. Little San Bernardino Mountains near Indio. Moderate shock caused buildings to creak. A rumbling sound was heard. Felt slightly at Thermal.

October 31: 13:00. Lonoak. Light shock felt by several in homes.

November 2: 09:47:59*, 09:54:14*, 09:56:02*, 09:57:16*, 10:42:28*, 10:50:41*, 10:53:05*, 11:01:13*, 11:01:34*, and 11:51. Epicenter 32° 58' north, 116° 00' west, P. The series rattled windows at Jacumba (Carriso Gorge). It was felt by a few at Oak Grove Ranger Station (Aguanga) where trees and bushes were shaken slightly.

November 8: 04:33:46.* Epicenter 36° 00' north, 119° 55' west, P. Kettleman Hills. Felt at Avenal. Moderate shock rattled windows. Many awakened.

November 11: 03:10 (about). Dyerville, Eureka, Ferndale, Scotia, and Upper Mattole. Felt by many. Walls creaked and windows rattled. May have been strongest at Ferndale and Scotia.

November 13: 21:45.8.* Epicenter 38.2° north, 119.0° west, P. Bridgeport and Bridgeport Dam. Light shock. One sudden drop felt by several. "Night watchman 1,000 feet to south of where I was sitting, as well as people in the town of Bridgeport, six miles to the south, report a swaying movement, although slight."

November 14: 05:21:07.* Epicenter 33° 46' north, 116° 48' west, P. San Jacinto fault. Felt by many at Hemet where windows rattled and houses creaked.

November 14: 13:00 (About). French Corral. "Community felt slight shock around 1 p. m." Too slight to register.

November 14: 15:03. Willows (Section 9, T19N, R3W). Bumping motion felt by many. Buildings creaked and loose objects rattled.

November 14: 22:37. Colusa and Oroville. Colusa press reports stated that four shocks were felt there at 11:29, 15:03, 22:37, and 23:56 with the one at 22:37 being the strongest. Plaster was cracked. This series of shocks was felt over approximately 5,000 square miles in north-central California. Oroville press reports mentioned two shocks were felt, and stated that the one at 22:37 caused two desks to jump off the floor in a theater office.

INTENSITY V:

Colusa and Oroville.

INTENSITY IV:

Butte City, Dunnigan (1 mile south and 1 mile east), Maxwell, Meridian, Sites, Williams, Willows, and Yuba City.

INTENSITY I TO III:

Chico, Clear Lake Highlands, Knights Landing, Yolo, and Zamora.

Negative reports were received from twenty-three places.

November 15: 23:15. Colusa and vicinity. Colusa papers stated there had been five definite shocks in 48 hours (November 14th, 15th, and 16th) with a probable total of eight including very light shocks. The shock at 23:15 was reported by some to have been as strong as the one on the 14th.

INTENSITY V:

Colusa, Oroville, and Stonyford.

INTENSITY IV:

Butte City, Chico, Las Plumas, Maxwell, Meridian, Sites, Williams, and Yuba City.

INTENSITY I TO III:

Willows.

Negative reports were received from eighteen places.

November 16: 04:25. Williams. Two shocks with east-west motion awakened all. Two lighter shocks were felt about 30 minutes later.

November 16: 11:21. Colusa and vicinity. Estimated intensity IV at Butte City, Colusa, Maxwell, Sites, and Williams.

INTENSITY III:

Chico, Meridian, and Zamora.

Negative reports were received from twenty-three places.

November 16: 14:38. San Leandro. Field investigation revealed that damage was confined to a small area in San Leandro.

A strong-motion record was obtained on the Weed accelerograph at the Chabot Observatory in Oakland.

A report on field investigations stated that of those cases where damage was more severe the outstanding case was that of a dwelling on Alice Street where the chimney to an open fireplace had pulled away from the wall of the house and left a crack at the eaves about 2½ inches wide between the chimney and the building. There was evidence that the house had shifted ¼ inch on its foundation in a southeast direction. Another building showed severe strain as the stucco had fine cracks all around following studing, sill and caps. A second chimney on the south side of another house cracked away leaving an opening about an inch wide. The San Leandro press reported: "San Leandrians were aware of two quick shakes in rapid succession accompanied by the sound of an explosion. Unlike the usual disturbance the shock was accompanied by heavy blast-like concussions which bulged and shook huge glass windows. So loud was the accompanying noise that for several hours it was a case for argument whether what had happened was an earthquake or an explosion. Phone calls were made to Hayward and Berkeley, but the shock was not felt there."

INTENSITY VI:

San Leandro.—See previous paragraphs.

INTENSITY V:

Centerville and Oakland.

INTENSITY IV:

Decoto, Diablo, Hayward, Pleasanton, and San Ramon.

INTENSITY I TO III:

Alameda and San Francisco.

Negative reports were received from ten places.

November 17: 00:12. Colusa. Press reports stated: "An initial sharp jolt, lapse of a few seconds, then a moderate shaking that lasted for perhaps eight seconds was felt by Colusans."

November 17: 04:28:41.* Epicenter $33^{\circ} 55'$ north, $116^{\circ} 42'$ west, P. Felt with intensity V in Yucaipa region. Many were awakened and frightened. Windows and dishes rattled.

INTENSITY IV:

Banning, Elsinore, Fawnskin, Hemet, Indio (two miles west), Idyllwild, Riverside, and Thermal.

November 23: 06:42. Pleasanton. Felt by many.

November 30: 21:51. San Benito. Slow motion lasting one second.

December 4: 13:15. Colusa and vicinity. Heavy jolt felt by many. No damage.

INTENSITY IV:

Colusa, Meridian, and Willows.

INTENSITY III:

Sacramento.

December 7: 07:46:40.* Epicenter $34^{\circ} 01'$ north, $118^{\circ} 22'$ west, P. Light shock felt in southwest Los Angeles, Inglewood, and San Pedro.

December 16: 17:19:25.* Epicenter $37^{\circ} 06'$ north, $118^{\circ} 16'$ west, P. Felt by many at Bigpine. Walls creaked and windows rattled.

December 16: 20:54:35.* Epicenter $37^{\circ} 06'$ north, $118^{\circ} 16'$ west, P. Felt at Bigpine and Tinemaha Reservoir. "This shock was one short jerk from west to east. No vibration immediately following. A few minor vibrations 15 to 30 minutes later."

December 16: 21:38:00.* Epicenter $37^{\circ} 06'$ north, $118^{\circ} 16'$ west, P. Felt with intensity V at Bigpine Power Plant No. 3 and Division Creek Power Plant No. 2 (Independence). Awakened many. Houses creaked and windows rattled.

INTENSITY IV:

Bigpine and Tinemaha Reservoir.

December 18: 03:34. Division Creek Power Plant, No. 2 (Independence). Slight shock rattled windows and shook trees and bushes.

December 18-19: "Livermore was rocked by two brief but sharp earthquakes on December 18 and 19. One occurred at 17:57 on the 18th, lasting less than a minute; the other, shortly before 19:00 on the 19th." (SSA Bulletin, January 1944.)

December 19: 18:45. Pleasanton. Felt by many. Windows rattled. Trees and bushes were shaken slightly.

December 22: 08:50:28.* Epicenter $34^{\circ} 20'$ north, $115^{\circ} 48'$ west, P. According to the press, the Seismological Laboratory at Pasadena estimated the center to be in the desert northeast of the Imperial Valley. The press also stated that the earthquake shook the Metropolitan Water District's Iron Mountain Station. Intensity IV at Ludlow and Amboy, where it was felt by many. Intensity I to III at Los Angeles and Needles.

December 30: 01:30. Greenville. Two shocks felt by only a few. Houses creaked.

WASHINGTON AND OREGON

(105TH MERIDIAN OR PACIFIC WAR TIME)

NOTE.—More details will be found in Abstracts of Earthquake Reports for the Pacific Coast and Western Mountain Region. An asterisk (*) indicates instrumental time.

April 14: 03:53. Clarkston, Washington. Felt by several. Dishes and windows rattled. "The fowls were disturbed and flew about."

April 23: 16:10:46.* (D. S. Carder, Lake Mead Seismological Party). The epicentral area was probably between Leavenworth and Entiat. The total affected area was about 10,000 square miles, north and south from Tonasket and Sunnyside, east and west from Coulee Dam to the crest of the Cascade Mountains at Scenic. See map page 19.

INTENSITY V:

Entiat.—Felt by all.

Leavenworth.—Felt by many in houses and by some out-of-doors. Houses creaked and windows rattled. Knickknacks fell.

Republic.—Strong shock. Shook dishes and sent slide of gravel and rocks down mountain. It was followed by a loud explosive noise. Pictures swayed.

INTENSITY IV:

Chelan, Ephrata, Lakeside, Odessa, Pateros, Scenic, Tonasket, Waterville, and Wenatchee.

INTENSITY I TO III:

Connell, Coulee Dam, and Sunnyside.

Negative reports were received from thirty-seven places.

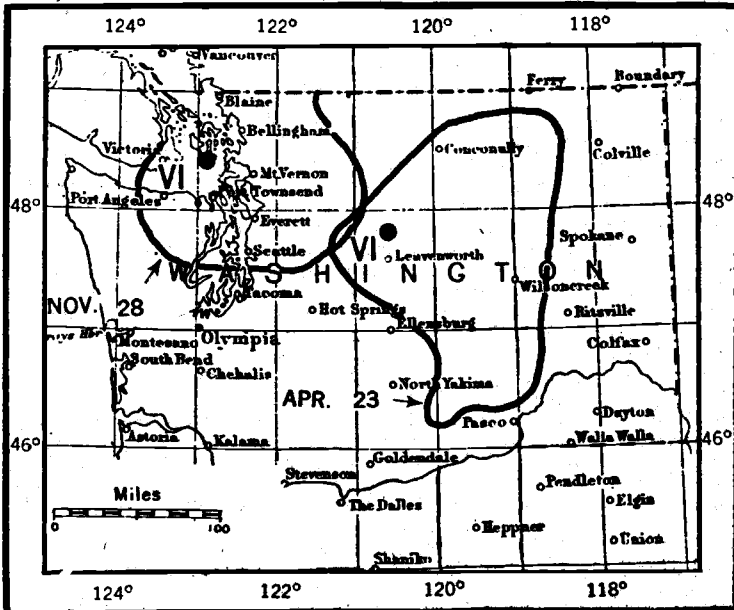


FIGURE 7.—Areas affected by earthquakes in the state of Washington on April 23 and November 28, 1943.

June 13: 06:20. Entiat, Washington. Windows rattled.

June 24: 09:44. Bend, Oregon. Felt by a few. Slight tremor felt by all upstairs.

July 11: 21:40. Longmire (Mt. Rainier National Park). Felt by many. Windows rattled, walls creaked. Negative reports were received from twelve places.

August 4: Rockville, Oregon. A special report states that minor tremors were being felt at the Leake ranch and had been more or less continuous for three days. Similar disturbances have been noted at this point two or three times a year for the past six or seven years. They usually last for a week or ten days. The tremors are probably related to a steamvent in the hillside northeast of the ranch. This vent was first noticed several years ago and still steams in cold weather, melting the snow nearby. The observer stated that she lived in Santa Barbara, California at the time of the San Francisco earthquake and knows the characteristics of an earthquake.

September 22: 21:50. Coulee Dam, Mason City, and Grand Coulee, Washington. Felt by many as windows rattled and houses creaked slightly. Direction of motion was up and down. Negative reports were received from nine places.

October 6: 08:09. Snoqualmie, North Bend, and Preston, Washington. Generally felt in these places where windows rattled and houses creaked. Negative reports were received from seven places.

October 9: 05:56. Entiat and Waterville, Washington. Light shock rattled windows and dishes. Clocks stopped. Negative reports were received from six places.

October 27: 01:54. Okanogan, Washington. Felt by many and awakened many. Slightly felt at Coulee Dam (Right Powerhouse Guard Station), and twelve miles from Wauconda. Not felt at Chesaw, Laurier and Republic.

November 28: 17:43. Puget Sound Region. Felt over an area of about 9,000 square miles in the state of Washington. Intensity VI was reported from Richardson where chimneys were cracked. Vancouver, British Columbia, and Vancouver Island trembled under two distinct shocks. See map page 19.

INTENSITY VI:

Richardson.—Felt by many. Windows rattled and small objects and furniture shifted. Chimneys cracked.

INTENSITY V:

Coupeville, Eastsound, La Conner, Langley, Quilcene, and Roche Harbor.

INTENSITY IV:

Anacortes, Arlington, Bellingham, Chimacum, Darrington, Edison, Everett, Granite Falls, Lynden, Mt. Vernon, Oak Harbor, Olga, Port Angeles, Port Ludlow, Scenic, Seattle, near Bremerton, (Section 25, T24N, R1E) Sequim, Startup, and Sultan.

INTENSITY I TO III:

Cle Elum, Concrete, Nooksack, Port Townsend, and Sedro-Woolley.
Negative reports were received from fifty-two places.

ALASKA

(150TH MERIDIAN TIME)

February 14: 16:22. Fairbanks. "One sharp shock" felt by several.

February 17: 00:50. Fairbanks. Slight earth tremor felt by several.

April 2: 17:19. Fairbanks. Slight tremor felt by several.

April 9: 03:00. Anchorage, near Merrill Field. Many awakened but most did not realize what woke them.

May 1: 18:50. Fairbanks. "One single, sharp shock" felt by several.

May 18: 23:27. Kotzebue. A slight trembling ending with a sharp shock was felt by several.

May 31: 23:21. Yukon Standard Time. Northway. Slight shock felt by Weather Observer in one story wooden building resting on piling in a silt-sand foundation.

July 6: 12:04. Anchorage. Felt by many in Anchorage but not noticed in Weather Bureau Office two miles east of town. The shock caused "trembling such as vibrations from a steam engine."

July 27: 18:05. Anchorage. Slight shock felt by several. Windows rattled.

August 25: 09:56. Anchorage. Slight shock rattled windows and was felt by several.

September 26: 23:45. Anchorage. Slight tremor felt by several.

November 2: 04:30. Fairbanks. Slight shock felt by one as a west to east rocking motion.

November 3: 04:32.3*. Anchorage. Sharp shock with abrupt heaving motion made doors swing and windows rattle. Generally felt. A light after-shock occurred at 05:40. Several slight tremors were felt at intervals until about 07:30. Pen on recording rain gage made mark about $\frac{1}{4}$ inch wide at time of main shock. Similar marks were recorded on the barograph traces. Epicenter probably near 62° north, 151° west.

Felt at McGrath 04:33. Slight shock reported by Weather Bureau Observer as continuing for about fifteen seconds. "Wall clocks in the Civil Aeronautics Administration and Weather Bureau Offices were stopped. The barograph trace showed no indication of the quake....."

Felt at Bethel 04:37. Tremors lasting 20 seconds were felt by several. Faint rumbling underground and moderately loud cracking of ice was heard. Building swayed. "The noise moved down the river quickly and then seemed to pass under the station making the earth tremble comparable to a locomotive passing. The ice in the river made a cracking noise for about an hour after the tremors, which lasted about 20 seconds."

November 11: 14:36. Fairbanks (Garden Island). Single sharp shock felt by several. Dishes rattled.

November 13: 15:25. Fairbanks (Garden Island). Single slight shock felt by a few.

December 29: 17:55. Fairbanks. Slight tremors felt by several.

HAWAIIAN ISLANDS

(HAWAIIAN STANDARD 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 and the University of Hawaii give all details.

March 25: 13:05. Mauna Loa. Slight.

June 14: 21:38. Island of Hawaii near Waima. Slight.

July 1: 1:51. Felt locally at Volcano Observatory and at Kapopala near Ainapo. Slight.

October 16: 2:36. East slope of Mauna Kea. Felt slightly at Hakalan.

October 20: 2:07. Felt at Volcano Observatory and at Hilo. Slight.

November 10: 16:22. Widely felt on southern half of Hawaii. Stone walls were thrown down southwest of Pahala. Moderate.

December 22: 19:50. Felt at Volcano Observatory and at Hilo on the southwest slope of Mauna Loa. Slight.

PANAMA CANAL ZONE

(EASTERN WAR TIME)

May 2: 13:18:47.* This shock as felt at Balboa Heights was rated at intensity V, and was the heaviest shock in the Canal Zone since May 6, 1936. The time of the first onset as recorded on the seismographs was 13:18:47. The pendulum clock used as a time marker for the seismograph record was stopped one minute and one second later at 13:19:48. Out of seven pendulum clocks in the Administration Building

at Balboa Heights, five were stopped and two continued to run. A six-pin seismometer installed at Miraflores Locks, consisting of six steel pins one fourth inch in diameter and ranging in height from 6 to 15 inches, had all six pins knocked over. The shock was generally felt by residents of the Canal Zone and many were alarmed and ran out of doors. Some dishes and mirrors were broken but there was no material damage. The U. S. Coast and Geodetic Survey accelerograph installed in the basement of the Administration Building at Balboa Heights was not operated.

The first two minutes of record on the seismograph is very indistinct on account of the rapid vibrations and it is impossible to identify the onset of the "S" waves. However the seismograph record shows that the main shock was followed within the next 12 hours by nine aftershocks in some of which the "P" and "S" waves are clearly shown. None of these aftershocks were strong enough to be felt in the Canal Zone. Distance to epicenter estimated to be about 125 miles.

PHILIPPINE ISLANDS

Reports from the Philippine Islands have been suspended for the duration of the war.

PUERTO RICO

(60TH MERIDIAN TIME)

April 22: 17:16. San Juan, Puerto Rico. Slight shock felt by several in Weather Bureau Office. Recorded on the seismograph at the U. S. Coast and Geodetic Survey station near San Juan.

July 28: 23:02. Felt in San Juan by many. Instrumental data indicated the shock centered near 19.0° north, 67.2° west, about thirty-five miles off northwestern Puerto Rico.

One hundred twenty aftershocks were recorded on the seismograph near San Juan.

July 29: 21:04. San Juan, Puerto Rico. Considerably less intense than the shock on the 28th, but was of sufficient intensity to stop the pendulum clock in the Weather Bureau Office. It was felt by thousands of persons in Puerto Rico.

UNCLASSIFIED REGIONS

EARTHQUAKES FELT ON LAND.

April 1: 19:32, Eastern War Time. Swan Island (near 17.5° north, 83.9° west). Estimated intensity IV. Twenty of the twenty-five people on the island felt the shock. The barograph and thermograph traces at the Weather Bureau showed slight displacement. No damage.

The shock was reported felt on a forty-ton schooner approaching from the north about three miles off shore.

April 19: 23:49, Eastern War Time. Swan Island. Abrupt rocking motion felt by all. The barograph trace showed a slight displacement. No damage.

December 21: 09:46, Eastern War Time. Island of Aruba, Netherland West Indies. A minor earthquake was reported felt. Instrumental data indicated the epicenter was in the region of 13.3° north, 70.4° west. This position is off-shore and about fifty miles northwest of Aruba.

December 22: 08:51, Eastern War Time. Similar to quake of December 21.

December 23: 11:45, Eastern War Time. Similar to quake of December 21.

December 23: 20:57, Eastern War Time. Similar to quake of December 21.

MISCELLANEOUS ACTIVITIES

GEODETIC WORK OF SEISMOLOGICAL INTEREST

No triangulation or leveling of seismological interest was executed during the calendar year 1943.

TIDAL DISTURBANCES OF SEISMIC ORIGIN

Seismic sea wave disturbances were noted for only one earthquake during the year. The earthquake occurred on April 6, 1943 at 16h 07.3m, G. C. T. Seismographic data indicates the shock centered near 31.5° south, 71.4° west. It was destructive at Salamanca and Ilapel, Chile.

The marigram on which the seismic wave was recorded shows that the water wave arrived at Valparaiso at about 16h 30m, G. C. T. (see Figure 13) and continued recording for about 36 hours. Initial ranges were just over three feet. Periods were indefinite and variable but averaged about 40 minutes. The geographic position of this recorder was 33° 01.5' south, 71° 38.4' west. Distance and direction from epicenter to recorder was roughly 100 miles, south 7° west.

This station is one of a group of 14 stations located in central and South American countries through cooperation with the United States Government. The projects were sponsored by the United States Department of State and were carried out by the Coast and Geodetic Survey in cooperation with local authorities.

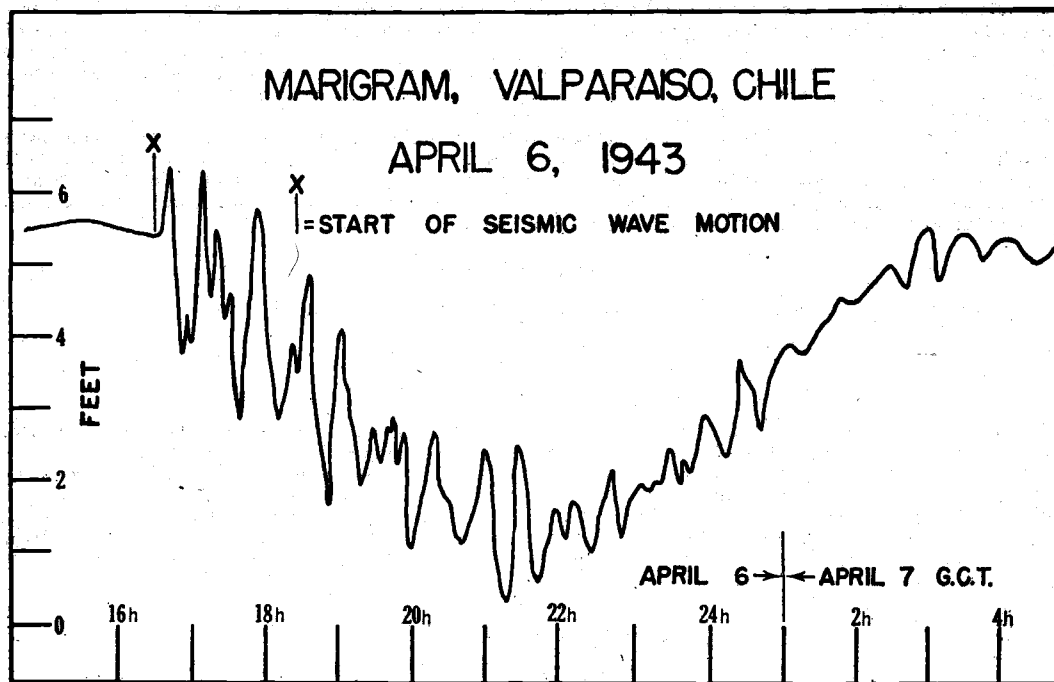


FIGURE 8.—Marigram obtained at Valparaiso, Chile on April 6, 1943.

EARTHQUAKE FLUCTUATION IN WELLS

In recent years it has been found that earthquakes may cause fluctuations in well water levels. Some wells are apparently more affected than others, probably due to geological conditions at the well site. The earthquake center may be nearby or, in some instances, at distances approaching the antipodes.

For the purpose of more thorough studies of both phenomena the U. S. Geological Survey has furnished and authorized publication of the following tabular data. They include descriptions of the wells and tabulations of well water levels taken from the records of automatic recorders.

TABLE 1.—*Earthquake Fluctuations in Wells in southern Florida—January 1 to December 31, 1943*

Well No.	Date	Time (E.W.T.)	Depth to water in feet				Amplitude of fluctuation in feet
			Before disturbance	After disturbance	At highest point of fluctuation	At lowest point of fluctuation	
S-1042	1-24-43*	15:45	8.365	8.365			Less than 0.01
S-1042	1-27-43	17:00	8.456	8.459			Less than 0.01
S-182	1-28-43	01:00	11.195	11.20			Less than 0.01
S-1042	1-28-43	01:00	8.46	8.435	8.435	8.46	0.025
F-179	1-28-43	01:00	10.08	10.055	10.052	10.067	0.015
F-213	1-28-43	01:00	17.39	17.39	17.374	17.395	0.021
G-72	1-28-43	01:15	7.942	7.93	7.928	7.942	0.014
F-210	1-29-43	09:00	10.11	10.113	10.1092	10.119	0.01
S-1042	2-22-43*	05:45	8.62	8.62	8.528	8.698	0.17
S-68	2-22-43*	05:45	10.995	11.01	10.945	11.065	0.12
S-18	2-22-43*	05:45	9.345	9.345	9.315	9.375	0.06
G-72	2-22-43*	05:45	8.25	8.25	8.24	8.26	0.02
F-179	2-22-43*	05:45	10.20	10.19	10.188	10.214	0.046
F-210	2-22-43*	No record	10.23	10.23	10.158	10.22	0.072
F-210	4-6-43*	13:00	9.965	9.952	9.936	9.973	0.037
S-1042	4-6-43*	12:15	8.90	8.915	8.862	8.976	0.114
F-179	4-6-43*	13:00	9.80	9.80			Less than 0.01
S-68	4-6-43*	13:00	10.33	10.33	10.32	10.345	0.025
F-213	4-6-43*	13:00	17.42	17.42*	17.405	17.433	0.028
G-72	4-6-43*	13:00	8.18	8.18			Less than 0.01
S-18	4-6-43*	13:00	8.38	8.375	8.353	8.40	0.047
S-18	4-6-43*	13:00	9.53	9.54*	9.53	9.54	0.01
F-210	4-19-43	10:00	10.07	10.06	10.05	10.07	0.02
S-1042	4-19-43	10:00	8.97	8.97			Less than 0.01
S-68	4-19-43	10:00	9.635	9.625	9.615	9.64	0.025
S-18	4-19-43	10:00	8.355	8.33	8.325	8.355	0.03
F-210	5-2-43*	13:45	9.91	9.91	9.875	9.95	0.075
S-1042	5-2-43*	13:45	9.21	9.21	9.185	9.235	0.05
F-179	5-2-43*	13:45	9.80	9.80	9.797	9.81	0.013
S-68	5-2-43*	13:45	9.90	9.90	9.875	9.92	0.045
F-213	5-2-43*	13:45	17.62	17.65*	17.62	17.655	0.035
S-19	5-2-43*	13:45	8.355	8.355	8.325	8.355	0.06
S-18	5-2-43*	13:45	9.273	9.271*			Less than 0.01
F-179	5-17-43	09:30	9.805	9.805	9.798	9.81	0.012
F-213	5-17-43	09:30	17.295	17.285*	17.28	17.295	0.015
F-210	5-17-43	09:30	9.90	9.89	9.885	9.90	0.015
F-179	5-26-43*	12:00	9.485	9.485			Less than 0.01
S-1042	5-26-43*	12:00	9.52	9.515	9.51	9.52	0.01
F-210	6-8-43*	18:30	9.057	9.06			Less than 0.01
S-1042	6-8-43*	18:30	8.928	8.932			Less than 0.01
S-68	6-8-43*	18:30	9.55	9.55			Less than 0.01
F-210	6-9-43*	00:30	9.075	9.05	9.072	9.085	0.013
S-1042	6-9-43*	00:30	8.933	8.928	8.918	8.943	0.025
S-68	6-9-43*	00:30	9.57	9.565	9.555	9.59	0.025
S-329	6-9-43*	00:30	7.75	7.75	7.745	7.755	0.01
F-210	6-15-43*	14:30	9.405	9.41	9.353	9.463	0.11
S-1042	6-15-43*	14:30	9.11	9.11	9.082	9.152	0.07
F-179	6-15-43*	14:30	9.55	9.552	9.53	9.57	0.04
S-68	6-15-43*	14:30	9.82	9.82	9.782	9.85	0.068
F-213	6-15-43*	14:30	17.66	17.69*	17.66	17.705	0.045
S-19	6-15-43*	14:30	7.805	7.82	7.765	7.86	0.095
F-210	6-15-43*	17:00	9.42	9.42	9.415	9.425	0.01
S-1042	6-15-43*	17:00	9.115	9.115	9.11	9.12	0.01
S-68	6-25-43	10:00	9.615	9.615	9.615	9.625	0.01
S-1042	6-25-43	10:00	8.755	8.75	8.75	8.76	0.01
F-210	6-25-43	10:00	9.75	9.75			Less than 0.01
F-210	7-28-43*	23:15	9.14	9.14			Over 1.00*
S-1042	7-28-43*	23:30	7.14	7.14			Over 1.00*
S-329	7-28-43*	23:15	6.46	6.46			Over 1.00*
F-179	7-28-43*	23:15	9.44	9.46	9.12	9.80	0.68
S-68	7-28-43*	23:15	8.92	8.92	8.48	9.40	0.92
S-18	7-28-43*	23:15	8.08	8.04	7.91	8.17	0.26
G-72	7-28-43*	23:15	4.55	4.55	4.48	4.61	0.13
G-3	7-28-43*	23:45	6.79	6.775	6.79	6.775	0.015
F-213	7-28-43*	23:15	17.46	17.49*	17.02	17.96	0.94
S-182	7-28-43*	23:15	9.76	9.77	9.76	9.77	0.01

TABLE 1.—*Earthquake Fluctuations in Wells in southern Florida—January 1 to December 31, 1943—Continued*

Well No.	Date	Time (E.W.T.)	Depth to water in feet				Amplitude of fluctuation in feet
			Before disturbance	After disturbance	At highest point of fluctuation	At lowest point of fluctuation	
F-210.....	7-29-43*	21:05	9.18	9.18			Less than 0.01
S-68.....	7-29-43*	21:05	8.98	8.98			Less than 0.01
F-210.....	8-15-43	15:00	9.20	9.20			Less than 0.01
S-68.....	8-15-43	15:00	8.36	8.37	8.36	8.37	0.01
F-210.....	8-31-43*	12:15	8.09	8.085	8.08	8.09	0.01
S-68.....	8-31-43*	12:15	7.75	7.75	7.748	7.76	0.012
S-19.....	8-31-43*	12:15	6.06	6.06			Less than 0.01
S-329.....	8-31-43*	12:15	5.44	5.44			Less than 0.01
F-213.....	8-31-43*	12:15	16.94	16.94			Less than 0.01
F-210.....	9-6-43*	00:30	8.50	8.50	8.49	8.505	0.015
S-68.....	9-6-43*	00:30	8.455	8.455	8.45	8.465	0.015
S-329.....	9-6-43*	00:30	5.54	5.535	5.43	5.542	0.012
S-19.....	9-23-43*	11:15	6.675	6.685	6.675	6.69	0.015
F-210.....	9-23-43*	11:15	8.632	8.64	8.632	8.642	0.01
S-68.....	9-23-43*	11:15	8.91	8.91	8.90	8.915	0.015
S-1042.....	9-23-43*	12:20	6.52	6.53	6.52	6.53	0.01
S-329.....	9-23-43*	11:15	5.06	5.07	5.06	5.07	0.01
S-68.....	9-27-43	04:00	8.86	8.86			Less than 0.01
F-210.....	9-27-43	04:00	8.72	8.71	8.70	8.72	0.02
F-210.....	11-3-43*	10:45	9.02	9.02	8.82	9.20	0.38
S-1042.....	11-3-43*	12:30	7.505	7.52	7.38	7.67	0.29
S-19.....	11-3-43*	10:45	6.70	6.70	6.46	6.93	0.47
F-179.....	11-3-43*	11:45	8.95	8.96	8.93	9.00	0.07
F-213.....	11-3-43*	11:15	17.37	17.37	17.35	17.38	0.03
G-72.....	11-3-43*	10:45	3.63	3.635	3.62	3.65	0.03
S-329.....	11-3-43*	11:00	5.52	5.52	5.39	5.64	0.25
S-18.....	11-3-43*	11:45	7.99	8.00	7.98	8.02	0.04
S-68.....	11-3-43*	11:45	9.05	9.05	8.98	9.13	0.15
F-210.....	11-6-43*	05:00	9.15	9.15	9.14	9.165	0.025
S-1042.....	11-6-43*	08:15	7.58	7.59	7.58	7.595	0.015
S-19.....	11-6-43*	06:15	6.45	6.45	6.44	6.46	0.02
F-213.....	11-6-43*	06:00	17.22	17.22			Less than 0.01
G-72.....	11-6-43*	05:45	3.65	3.65			Less than 0.01
S-329.....	11-6-43*	05:45	5.67	5.67	5.65	5.68	0.03
S-68.....	11-6-43*	06:15	8.96	8.96	8.95	8.98	0.03
S-1042.....	12-8-43	16:30	7.49	7.49			Less than 0.01
F-210.....	12-8-43	16:30	9.525	9.53	9.525	9.535	0.01
S-19.....	12-8-43	16:00	6.89	6.89			Less than 0.01
S-68.....	12-8-43	16:00	9.13	9.13	9.12	9.14	0.02
S-19.....	12-21-43*	10:15	7.15	7.15			Less than 0.01
S-19.....	12-23-43*	12:10	7.15	7.15			Less than 0.01
S-19.....	12-23-43*	16:30	7.15	7.15			Less than 0.01
F-210.....	12-23-43*	16:15	9.71	9.72	9.71	9.725	0.015
F-179.....	12-23-43*	13:00	9.63	9.63			Less than 0.01
S-18.....	12-23-43*	16:00	8.64	8.64			Less than 0.01
S-68.....	12-23-43*	16:30	9.33	9.33	9.33	9.34	0.01

* Date corresponds with that for which U. S. C. & G. S. reported an earthquake disturbance.

† Recorder drum rotated more than length of chart; hence highest and lowest fluctuation and maximum amplitude are not available.

• Tidal.

TABLE 2.—*Descriptions of Wells in southern Florida*

Well No.	Location	Owner	Depth*	Casing Diam.	Finish	Record	Formation
G-72----	NW¼NE¼ sec. 3, T. 52 S., R. 39 E., Fla. Rt. 26 at Dade-Broward line.	U. S. Geological Survey.	4.6	8	Open hole; non-artesian.	Stevens Type F weekly water stage recorder operating at a normal gage height ratio of 1 to 1.	Sandy limestone.
F-179----	SE¼NW¼ sec. 16, T. 54 S., R. 41 E., southwest sec. of Miami, Fla.	City of Miami-----	77.1	6	Open hole; non-artesian.	Stevens Type F weekly water stage recorder operating at a normal gage height ratio of 1 to 1.	Calcareous sandstone or sandy limestone.
F-210----	SW¼NE¼ sec. 13, T. 53 S., R. 41 E., northwest sec. of Miami, Fla.	City of Miami-----	111.7	6	Open hole; non-artesian.	Stevens Type F weekly water stage recorder operating at a normal gage height ratio of 1 to 1.	Calcareous sandstone or sandy limestone.
F-213----	SW¼SW¼ sec. 15, T. 54 S., R. 41 E., Coconut Grove, Fla.	City of Miami-----	69.1	6	Open hole; non-artesian.	Stevens Type F weekly water stage recorder operating at a normal gage height ratio of 1 to 1.	Calcareous sandstone or sandy limestone.
S-18----	NW¼NW¼ sec. 15, T. 52 S., R. 41 E., near OpaLocka, Fla.	Mrs. LaFlesh-----	51.6	8	Open hole; non-artesian.	Lietz weekly water stage recorder operating at a normal gage height ratio of 1 to 1.	Calcareous sandstone or sandy limestone.
S-19----	NW¼NE¼ sec. 25, T. 53 S., R. 40 E., Miami Springs, Fla.	City of Miami-----	94.8	6	Open hole; non-artesian.	Lietz weekly water stage recorder operating at a normal gage height ratio of 1 to 1.	Calcareous sandstone or sandy limestone.
S-68----	SW¼NW¼ sec. 19, T. 53 S., R. 41 E., Miami Springs, Fla.	City of Miami-----	64	6	Open hole; non-artesian.	Stevens Type F weekly water stage recorder operating at a normal gage height ratio of 1 to 1.	Calcareous sandstone or sandy limestone.
S-182----	NW¼NW¼ sec. 5, T. 56 S., R. 40 E., near Peters, Fla.	International Fruit Corp.	32.7	6	Open hole; non-artesian.	Lietz weekly water stage recorder operating at a normal gage height ratio of 1 to 1.	Calcareous sandstone or sandy limestone.
S-329----	SW¼NE¼ sec. 12, T. 50 S., R. 41 E., near Ft. Lauderdale, Fla.	City of Ft. Lauderdale.	67.9	4	Open hole; non-artesian.	Stevens Type F weekly water stage recorder operating at a normal gage height ratio of 1 to 1.	Calcareous sandstone with large amount of loose fine sand.
S-1042----	NW¼NE¼ sec. 22, T. 46 S., R. 42 E., west of Delray, Fla.	Lake Worth Drainage District.	119.6	4	Open hole; non-artesian.	Stevens Type F weekly water stage recorder operating at a normal gage height ratio of 1 to 1.	Calcareous sandstone or sandy limestone.

*Feet below land surface.

TABLE 3.—*Earthquake Fluctuations in Well at Baton Rouge, Louisiana*

Well No.	Date	Time (C.W.T.)	Depth to water in feet				Amplitude of fluctuation in feet
			Before disturbance	After disturbance	At highest point of fluctuation	At lowest point of fluctuation	
FB-128-----	4-6-43	11:30	87.21	87.20	87.19	87.21	0.02

TABLE 4.—*Description of Well at Baton Rouge, Louisiana*

Well No.	Location	Owner	Depth*	Casing Diam.	Finish	Recorder	Formation
FB-128-----	135 South 15th Street, Baton Rouge, La.	Ice Service, Incorporated.	412	8	Artesian	Float type recorder.	Sand.

*Feet below land surface.

TABLE 5.—*Earthquake Fluctuations in Wells at State College, Mississippi*

Well No.	Date	Time (C.W.T.)	Depth to water in feet				Amplitude of fluctuation in feet
			Before disturbance	After disturbance	At highest point of fluctuation	At lowest point of fluctuation	
-----	11-3-43	10:00	-----	-----	Deep well	-----	0.085
-----	11-6-43	5:30	-----	-----	-----	-----	0.017

TABLE 6.—*Earthquake Fluctuations in Wells in Utah—January 1 to December 31, 1943*

Well No.	Date	Time (M.W.T.)	Depth to water in feet				Amplitude of fluctuation in feet
			Before disturbance	After disturbance	At highest point of fluctuation	At lowest point of fluctuation	
(C-2-6)36cdd.....	2-22-43	3:17	79.81	79.81	79.32	80.18	0.86
(C-2-4)33addl.....	2-22-43	3:30	37.19	37.19	36.98	37.29	0.31
(C-2-4)33addl.....	4-6-43	10:45	36.44	36.44	36.38	36.50	0.12
(C-2-6)36cdd.....	4-6-43	11:00	79.43	79.43	79.38	79.51	0.13
(C-2-6)36cdd.....	5-30-43	17:30	79.46	79.46	79.34	79.65	0.31
(B-6-1)30ccal.....	7-24-43	23:45	29.78	29.76	29.68	29.84	0.16
(C-35-11)21dbdl.....	12-9-43	11:00	25.10	25.10	25.09	25.12	0.03

TABLE 7.—*Descriptions of Wells in Utah*

Well No.	Location	Owner	Depth*	Casing Diam.	Finish	Recorder	Formation
(C-2-4)33addl.....	SW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 33, T. 2 S., R. 4 W., Salt Lake base and meridian.	Ida L. Clegg....	165	6	Artesian....	Float type recorder..	Sand and gravel.
(C-2-6)36cdd.....	SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 36, T. 2 S., R. 6 W., Salt Lake base and meridian.	Fred Arbon.....	176	6	Artesian....	Float type recorder	Gravel.
(B-6-1)30ccal.....	NW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 30, T. 6 N., R. 1 W., Salt Lake base and meridian.	California Pack- ing Corpora- tion.	731.	10	Artesian....	Float type recorder..	Sand and gravel.
(C-35-11)21dbdl.....	SE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 21, T. 35 S., R. 11 W., Salt Lake base and meridian.	D. C. Urie.....	228	12	Artesian....	Float type recorder..	Sand and gravel.

*Feet below land surface.

SEISMOLOGICAL OBSERVATORY RESULTS

The Coast and Geodetic Survey publishes the results of its teleseismic stations and cooperating stations quarterly in mimeographed form. In these reports all seismogram interpretations are tabulated, together with epicenters based on the published data and instrumental results received from seismological stations in all parts of the world. These reports will be furnished upon request made to the Director of the Coast and Geodetic Survey.

Instrumental results are published for the following observatories:

Balboa Heights, Canal Zone. (The Panama Canal.) Bermuda. (Meteorological Station, St. George's, and International Union of Geodesy and Geophysics.) Bozeman, Montana. (Montana State College.) Burlington, Vermont. (University of Vermont.) Butte, Montana. (Montana School of Mines.) Chicago, Illinois. (University of Chicago and United States Weather Bureau.) College, Alaska. (University of Alaska.) Columbia, South Carolina. (University of South Carolina.) Honolulu, T. H. (University of Hawaii.) Huancayo, Peru. (Carnegie Institution of Washington.)	Ivigtut, Greenland. (Geodaetisk Institut, Copenhagen, Denmark.) Lincoln, Nebraska. (Nebraska Wesleyan University.) Logan, Utah. (Utah State Agricultural College.) Montezuma, Chile. (Smithsonian Institution.) Philadelphia, Pennsylvania. (The Franklin Institute.) Salt Lake City, Utah. (University of Utah.) San Juan, Puerto Rico. Seattle, Washington. (University of Washington.) Scoresbysund, Greenland. (Geodaetisk Institut, Copenhagen, Denmark.) Sitka, Alaska. Tucson, Arizona. Ukiah, California. (International Latitude Observatory.)
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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, 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.

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

The provisional epicenter results for 1943 were not ready when this publication went to press. Those for the year 1942 are listed in table 8. Those for the stronger shocks of 1943 are listed in table 9.

TABLE 8.—Summary of instrumental epicenters for 1942

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.

1942	Greenwich civil time at origin		Region and focal depth	Coordinates of provisional epicenter	
				Latitude	Longitude
	h	m		° ' "	° ' "
Jan. 5	22	35.1	Costa Rica	8.5 N.	83 W.
Jan. 7	10	47.9	New Britain	6.5 S.	150 E.
Jan. 8	15	12.6	Northern Peru. Depth possibly 100 km	6.5 S.	78.5 W.
Jan. 9	6	28.1	Near Riverdale, California. Felt	33.9 N.	117.4 W.
Jan. 12	16	07.3	Solomon Islands	8 S.	158.5 E.
Jan. 16	21	53.9	Tonga Island region	15 S.	177.5 W.
Jan. 17	10	26.2	Samoa Islands	15 S.	171 W.
Jan. 17	23	19.3	West coast of Mexico	17.5 N.	100 W.
Jan. 18	7	17.3	Off coast of California	41 N.	125 W.
Jan. 18	6	25.6	West coast of Mexico	17.9 N.	105.6 W.
Jan. 20	21	41.8	California	32.8 N.	117.8 W.
Jan. 24	13	29.2	New Guinea	3.9 S.	135.3 E.
Jan. 27	9	23.8	New Hebrides Islands. Depth about 150 km	19 S.	169 E.
Jan. 29	6	49.2	Near Vancouver, British Columbia	51 N.	124 W.
Jan. 31	15	15.9	California	34.4 N.	116.9 W.
Feb. 1	15	18.5	do	34.4 N.	116.9 W.
Feb. 1	18	03.6	do	34.4 N.	116.9 W.
Feb. 2	5	56.8	do	34.4 N.	116.9 W.
Feb. 2	11	30.2	do	34.4 N.	116.9 W.
Feb. 4	9	08.4	do	37.0 N.	121.3 W.
Feb. 7	0	13.8	do	33.1 N.	116.0 W.

TABLE 8.—Summary of instrumental epicenters for 1942—Continued

1942	Greenwich civil time at origin		Region and focal depth	Coordinates of provisional epicenter	
	h	m		Latitude	Longitude
Feb. 11	11	21.2	Gulf of California	26.5 N.	100.5 W.
Feb. 12	5	56.6	Queen Charlotte Islands	14 S.	164.5 E.
Feb. 13	6	18.9	Tonga Island region	20 S.	175 W.
Feb. 13	10	26.2	California	33.8 N.	116.1 W.
Feb. 16	18	08.1	Queen Charlotte Islands	11.5 S.	167.5 E.
Feb. 21	7	07.8	Japan. Depth about 70 km	38.2 N.	141.5 E.
Feb. 23	2	44.0	Guatemala	15.5 N.	92 W.
Feb. 27	1	08.9	California	34.3 N.	117.0 W.
Feb. 27	8	23.0	East coast of Yucatan	18.5 N.	87.5 W.
Mar. 1	9	52.0	Off coast of El Salvador	13.3 N.	91.2 W.
Mar. 1	17	34.9	Off coast of Ecuador	3 N.	81.5 W.
Mar. 1	19	12.4	Southern California	33.7 N.	116.2 W.
Mar. 3	1	03.4	Southern California. Felt	34.0 N.	115.8 W.
Mar. 4	3	36.7	New Guinea	6.5 S.	145 E.
Mar. 4	11	02.2	Southern California. Felt	34.0 N.	115.8 W.
Mar. 5	19	48.2	Japan. Depth about 200 km	44.7 N.	141.1 E.
Mar. 6	20	08.7	New Hebrides Islands	16 S.	168 E.
Mar. 8	4	46.6	Atlantic Ocean	1.0 S.	29.5 W.
Mar. 9	10	19.7	Near Haiti, West Indies	19 N.	73 W.
Mar. 19	11	59.4	Off coast of British Colombia	51.2 N.	130.0 W.
Mar. 20	1	13.0	Aleutian Islands	52.4 N.	167.7 W.
Mar. 21	23	20.8	South of Japan	29 N.	132 E.
Mar. 28	14	10.5	Circleville, Utah. Felt	38.5 N.	112.5 W.
Mar. 29	4	45.2	Southern California	34.0 N.	115.8 W.
Mar. 30	9	08.8	North Atlantic Ocean	34 N.	35 W.
Apr. 4	15	11.5	Mojave Desert, California. Felt	34.8 N.	116.5 W.
Apr. 5	9	20.6	California. Felt	33.2 N.	116.2 W.
Apr. 8	15	40.3	Philippine Islands	12.5 N.	120.0 E.
Apr. 11	1	25.1	Guatemala	15.3 N.	91.1 W.
Apr. 11	5	29.2	California	33.8 N.	116.0 W.
Apr. 13	7	46.2	Off coast of Liberia	3 S.	14 W.
Apr. 16	7	28.6	Southeast of Catalina Island, California	33.4 N.	113.2 W.
Apr. 18	5	45.7	Northern Utah	41.5 N.	112.3 W.
Apr. 20	8	40.3	Japan	36.5 N.	139.0 E.
Apr. 22	11	49.4	Gulf of Panama	8.0 N.	80.5 W.
Apr. 22	23	20.2	do	7.3 N.	82.2 W.
Apr. 25	19	38.1	Santo Domingo, West Indies	19.0 N.	70.5 W.
Apr. 26	15	10.4	California. Felt	34.0 N.	116.7 W.
Apr. 27	11	27.9	Off coast of Lower California	32.0 N.	117.0 W.
Apr. 29	11	40.3	Queen Charlotte Islands	13.5 S.	167.0 E.
May 6	21	18.2	Near coast of Venezuela	11 N.	66 W.
May 6	22	50.3	do	11 N.	66 W.
May 8	17	08.1	California	34.0 N.	116.2 W.
May 10	12	25.4	Near coast of Venezuela	11 N.	66 W.
May 14	2	13.4	Ecuador. Destructive. Great loss of life	0.3 S.	80.0 W.
May 14	2	54.3	Ecuador. Aftershock	0	80 W.
May 14	8	38.7	do	0	80 W.
May 14	15	46.7	do	0	80 W.
May 15	2	51.9	Greenland Sea	61 N.	30 W.
May 15	10	50.6	Ecuador. Aftershock	0	80 W.
May 15	11	51.3	do	0	80 W.
May 15	18	12.0	do	0	80 W.
May 16	3	28.2	Off coast of Peru	16 S.	73 W.
May 16	18	58.0	Ecuador. Aftershock	0	80 W.
May 17	15	14.2	do	0.3 S.	80.0 W.
May 22	10	30.6	Near Bogota, Colombia. Felt	4.6 N.	74.5 W.
May 22	15	15.5	California	34.4 N.	116.8 W.
May 23	15	47.5	California. Felt	33.0 N.	116.0 W.
May 24	8	32.4	California. Aftershock	33.0 N.	116.0 W.
May 28	0	39.8	Northern California	40.8 N.	120.7 W.
May 28	1	01.8	Celebes Islands. Depth about 100 km	0.4 S.	122.6 E.
May 30	7	19.7	Gulf of California	23.0 N.	109.5 W.
May 31	5	20.5	Aleutian Islands	52 N.	173 W.
June 3	16	31.1	New Hebrides Islands	15.1 S.	167.5 E.
June 6	10	39.5	Ecuador	1 N.	80 W.
June 6	14	53.2	New Guinea. Depth about 100 km	6 S.	145 E.
June 7	10	48.1	Ecuador	0	81 W.
June 7	22	16.1	California	33.0 N.	116.0 W.
June 9	11	08.8	Off coast of Vancouver, British Colombia	49.5 N.	129.0 W.
June 10	1	08.0	Near Kamchatka Peninsula	57.5 N.	163.0 W.
June 10	29	50.7	Reno, Nevada. Felt	39 N.	119 W.
June 12	2	01.6	British Colombia	61.5 N.	137.5 W.
June 12	10	21.5	Ecuador	2.0 S.	76.9 W.
June 13	4	14.0	Mojave Desert, California	34.2 N.	116.4 W.
June 14	3	09.6	Mariana Islands	15.0 N.	143.8 E.
June 14	21	36.4	Salton Sea, California	33.2 N.	115.8 W.
June 14	22	25.8	do	33.2 N.	115.8 W.
June 15	13	46.9	Kermadec Islands	33 S.	176 W.
June 15	16	41.6	Off west coast of Mexico	18.9 N.	107.0 W.
June 16	7	42.9	Off coast of Ecuador	0.5 N.	80.9 W.
June 16	21	05.2	do	0.5 N.	80.9 W.
June 18	9	30.9	West of Caroline Islands	9.0 N.	100.7 W.
June 20	10	02.1	Mexico. Felt	36.2 N.	118.0 W.
June 22	22	13.8	California. Felt	36.2 N.	118.0 W.
June 22	23	51.0	California	36.2 N.	118.0 W.
June 22	23	53.4	do	36.2 N.	118.0 W.

TABLE 8.—Summary of instrumental epicenters for 1942—Continued

1942	Greenwich civil time at origin		Region and focal depth	Coordinates of provisional epicenter	
				Latitude	Longitude
	h	m		°	'
June 24	11	16.6	New Zealand	40.9 S.	175.4 E.
June 24	23	52.7	Salton Sea, California	33.2 N.	115.8 W.
June 28	0	06.9	Coast of El Salvador	13 N.	89 W.
June 29	6	26.8	Central Chile	33.5 S.	70.5 W.
July 1	21	33.7	Coast of Ecuador	0.5 N.	80.5 W.
July 2	7	52.0	do.	0.5 N.	80.5 W.
July 2	8	19.3	do.	0.5 N.	80.5 W.
July 2	13	54.9	do.	0.5 N.	80.5 W.
July 3	2	50.1	India. Felt at Karachi	25 N.	66 E.
July 3	20	59.5	Coast of Ecuador	0.5 N.	80.5 W.
July 3	23	46.4	do.	0.5 N.	80.5 W.
July 4	0	15.2	do.	0.5 N.	80.5 W.
July 4	0	40.6	do.	0.5 N.	80.5 W.
July 4	1	53.1	do.	0.7 N.	80.7 W.
July 4	4	59.5	do.	0.5 N.	80.5 W.
July 4	6	08.6	do.	0.7 N.	80.7 W.
July 4	8	52.4	California. Felt	30.2 N.	118.0 W.
July 5	10	29.9	Coast of Ecuador	0.7 N.	80.7 W.
July 5	10	31.9	do.	0.5 N.	80.5 W.
July 5	14	11.2	do.	0.5 N.	80.5 W.
July 5	23	16.1	Santo Domingo, West Indies	19 N.	70 W.
July 6	16	21.2	Coast of Ecuador	0.5 N.	80.5 W.
July 7	3	53.8	Tonga Island region. Depth about 400 km	21.4 S.	177.8 W.
July 7	12	37.7	Coast of Ecuador	0.7 N.	80.5 W.
July 7	13	40.1	do.	0.5 N.	80.5 W.
July 8	6	55.6	Chile. Felt at Copiapo. Slight depth	25.0 S.	69.7 W.
July 8	19	19.6	Chile	25 S.	69 W.
July 8	22	30.9	Coast of Ecuador	0.7 N.	80.5 W.
July 10	4	49.9	do.	0.7 N.	80.5 W.
July 11	16	41.9	Nevada. Felt	38.5 N.	117.1 W.
July 11	16	45.7	do.	38.3 N.	116.1 W.
July 12	5	15.3	Coast of Ecuador	0.3 N.	80.1 W.
July 20	13	31.9	South Pacific Ocean	35.5 S.	99 W.
July 21	7	47.8	Northern Argentina	20.5 S.	64.0 W.
July 21	8	43.8	Colombia	15 S.	75 W.
July 24	11	51.7	Near Aleutian Islands	51 N.	172 E.
July 25	6	22.5	Philippine Islands	11.9 N.	125.5 E.
July 25	15	18.9	Off coast of Ecuador	5 S.	104 W.
July 29	22	49.2	Region of Banda Sea	2.8 S.	127.9 E.
Aug. 1	12	34.0	New Zealand. Extensive damage	41.1 S.	176.2 E.
Aug. 3	20	09.0	Tonga Island region	25 S.	174 W.
Aug. 6	23	37.0	Guatemala and El Salvador. Nine killed	14.1 N.	90.9 W.
Aug. 7	1	15.6	Mojave Desert, California	34.3 N.	116.4 W.
Aug. 7	1	24.0	do.	34.3 N.	116.4 W.
Aug. 7	1	53.2	do.	34.3 N.	116.4 W.
Aug. 7	6	04.8	Guatemala. Aftershock	14.1 N.	90.9 W.
Aug. 8	0	20.2	Japan	42 N.	144 E.
Aug. 8	22	36.5	Guatemala	14.0 N.	91.0 W.
Aug. 9	13	54.7	Mojave Desert, California	34.3 N.	116.4 W.
Aug. 11	4	48.3	Guatemala	14.0 N.	91.0 W.
Aug. 11	7	11.5	do.	14 N.	91 W.
Aug. 11	10	14.0	Nevada. Felt	35.8 N.	114.8 W.
Aug. 13	15	44.7	Solomon Islands	8.0 S.	156.5 E.
Aug. 13	19	28.1	Peru	10 S.	78 W.
Aug. 14	20	50.4	Off coast of Mexico	17.5 N.	108 W.
Aug. 15	15	02.1	New Guinea	4 S.	144 E.
Aug. 16	20	07.8	Guatemala	14.0 N.	90.9 W.
Aug. 18	21	55.4	Nevada. Felt	38.6 N.	118.5 W.
Aug. 19	15	57.2	California. Felt	33.8 N.	117.8 W.
Aug. 20	6	30.6	California	34.0 N.	116.4 W.
Aug. 20	12	09.6	do.	37.6 N.	118.7 W.
Aug. 20	22	37.0	Guatemala	14 N.	91 W.
Aug. 21	23	36.7	California	37.6 N.	118.7 W.
Aug. 22	8	31.4	Aleutian Islands	54 N.	164 W.
Aug. 22	9	00.8	Region of Japan	32 N.	135 E.
Aug. 22	12	59.2	California. Felt	34.1 N.	116.3 W.
Aug. 23	6	35.7	Kamchatka. Depth about 150 km	54.8 N.	164.8 E.
Aug. 24	22	50.7	Peru. Destructive. Twenty-two killed. Depth about 150 km	14.7 S.	75.0 W.
Aug. 25	20	16.0	Peru. Aftershock. Depth about 150 km	15 S.	75 W.
Aug. 26	6	14.2	Albania. Considerable damage. A number killed	42 N.	20 E.
Aug. 29	1	39.4	Tonga Island region. Depth about 500 km	26 S.	177 W.
Aug. 29	21	40.3	Guatemala	14 N.	91 W.
Aug. 31	6	39.4	Peru	7 S.	77 W.
Sept. 2	3	17.2	Aleutian Islands	52.4 N.	169.6 W.
Sept. 3	14	06.0	California. Felt	34.5 N.	119.0 W.
Sept. 4	2	53.9	Guatemala	14.5 N.	91.3 W.
Sept. 4	6	34.6	California. Felt	34.5 N.	119.0 W.
Sept. 4	17	46.1	Aleutian Islands	52.5 N.	170.0 W.
Sept. 6	15	53.4	Chile	28.5 S.	71.5 E.
Sept. 8	16	07.3	Japan	36.5 N.	139.5 E.
Sept. 9	1	05.4	Aleutian Islands. Depth about 100 km	53.0 N.	165.7 W.
Sept. 14	11	31.2	Loyalty Islands. Depth about 200 km	22 S.	172 E.
Sept. 17	1	54.1	California. Felt	34.4 N.	117.7 W.
Sept. 22	0	46.2	Off coast of Chile	37.5 S.	98.0 W.
Sept. 24	3	39.0	Near Formosa	25 N.	123 E.
Sept. 25	8	14.1	Aleutian Islands	53 N.	168 W.

TABLE 8.—Summary of instrumental epicenters for 1942—Continued

1942	Greenwich civil time at origin		Region and focal depth	Coordinates of provisional epicenter	
				Latitude	Longitude
	<i>h</i>	<i>m</i>		° ' "	° ' "
Sept. 26	4	00.3	San Salvador	12.8 N.	87.7 W.
Sept. 27	17	02.2	Guatemala	14.5 N.	91 W.
Sept. 28	8	38.2	California. Felt	39.4 N.	122.4 W.
Sept. 29	12	45.4	Off coast of Panama	5.5 N.	83.0 W.
Oct. 0	2	52.3	Off coast of Oregon	43.5 N.	126.8 W.
Oct. 0	11	50.3	Solomon Islands	6.5 S.	155.5 E.
Oct. 8	3	02.7	Off coast of Colombia	6.9 N.	82.7 W.
Oct. 8	20	02.0	Queen Charlotte Islands	11.0 S.	164.5 E.
Oct. 12	1	16.3	Off coast of Peru	16.5 S.	74.4 W.
Oct. 14	0	14.9	Arizona	32.5 N.	113.5 W.
Oct. 16	10	07.4	California	36.2 N.	118.0 W.
Oct. 18	5	24.8	Gulf of California	22.5 N.	108.5 W.
Oct. 20	23	21.8	Philippine Islands	7 N.	123 E.
Oct. 21	16	22.2	California. Felt	33.0 N.	116.0 W.
Oct. 22	1	50.6	do	33.2 N.	115.7 W.
Oct. 25	19	59.6	do	33.0 N.	116.2 W.
Oct. 28	21	09.2	Kurile Islands	45.8 N.	152.0 E.
Oct. 28	10	44.7	Mexico	15.4 N.	96.0 W.
Nov. 1	15	41.1	Yellowstone National Park	44.8 N.	111.3 W.
Nov. 1	18	50.1	Washington. Felt	48.1 N.	116.6 W.
Nov. 2	12	59.7	California	33.0 N.	116.0 W.
Nov. 2	23	59.6	Region of Friendly Islands	18.5 S.	174.0 W.
Nov. 3	5	06.5	California	33.0 N.	116.0 W.
Nov. 3	10	18.6	do	33.0 N.	116.0 W.
Nov. 3	23	37.8	South of Panama	7 N.	82 W.
Nov. 5	11	26.8	New Hebrides Islands. Slightly deeper than normal	18 S.	168 E.
Nov. 5	11	47.6	Guatemala	15.5 N.	91.5 W.
Nov. 6	13	31.2	Peru. Slightly deeper than normal	8.2 S.	76.5 W.
Nov. 7	7	32.3	East Indies. Depth possibly 200 km	9 S.	123 E.
Nov. 8	10	16.7	Off coast of Peru	16 S.	76 W.
Nov. 9	20	34.4	Mojave Desert, California	34.4 N.	116.0 W.
Nov. 9	21	55.5	Ecuador	0	81 W.
Nov. 10	11	41.4	South of Africa	48 S.	32 E.
Nov. 11	2	02.8	Peru	6.5 S.	75.5 W.
Nov. 11	13	06.0	Costa Rica	9.6 N.	83.9 W.
Nov. 12	0	07.6	California	33.0 N.	116.0 W.
Nov. 12	4	55.5	Mexco. Damage in Tehuantepec. Depth about 100 km	16.6 N.	94.5 W.
Nov. 12	15	26.2	Off coast of Ecuador	0.1 S.	81.0 W.
Nov. 12	17	56.2	Salton Sea, California	33.2 N.	115.6 W.
Nov. 12	18	00.0	Off coast of Ecuador	0	81 W.
Nov. 12	22	30.2	do	0	81 W.
Nov. 14	5	21.2	New Guinea	6.5 E.	148.5 E.
Nov. 14	6	19.1	Off coast of Ecuador	0	81 W.
Nov. 14	17	53.9	do	0	81 W.
Nov. 14	20	57.0	do	0	81 W.
Nov. 15	0	46.0	do	0	81 W.
Nov. 15	17	12.1	Japan. Slightly deeper than normal	37.5 N.	142.0 E.
Nov. 17	23	19.3	Peru	16.5 S.	73.0 W.
Nov. 19	8	51.9	Ecuador. Felt	0	81.5 W.
Nov. 19	9	08.8	do	0	81.5 W.
Nov. 19	12	15.3	California	33.1 N.	116.4 W.
Nov. 19	14	40.0	Off coast of Ecuador	0	81.5 W.
Nov. 22	6	39.8	California	33.0 N.	116.0 W.
Nov. 25	1	18.0	Mexico. Slightly deeper than normal	16.9 N.	97.7 W.
Nov. 26	14	27.6	Kurile Islands. Depth possibly 200 km	46 N.	149 E.
Nov. 27	10	55.8	Off coast of California	42.2 N.	126.0 W.
Nov. 28	10	38.7	Atlantic Ocean	7.0 N.	35.5 W.
Nov. 30	0	47.8	Argentina. Depth about 500 km	27.8 S.	62.8 W.
Dec. 3	9	44.6	California and Nevada. Felt	39.9 N.	119.4 W.
Dec. 4	15	35.4	New Britain	5 S.	162 E.
Dec. 5	14	28.5	Alaska Peninsula	58.7 N.	152.3 W.
Dec. 9	22	19.0	Aleutian Islands	53.4 N.	166.0 W.
Dec. 10	1	59.0	California	33.0 N.	116.0 W.
Dec. 12	13	54.8	Off coast of Mexico	19.5 N.	110.0 W.
Dec. 14	3	05.7	Lower California	30.3 N.	116.0 W.
Dec. 14	3	08.0	do	30.3 N.	116.0 W.
Dec. 14	13	59.4	North Atlantic Ocean	23.5 N.	44.5 W.
Dec. 15	9	09.0	Off coast of Ecuador	0.5 S.	81.5 W.
Dec. 16	2	44.7	do	0	81 W.
Dec. 17	15	07.7	California. Felt	38.9 N.	119.5 W.
Dec. 20	14	03.0	Central Turkey. Destructive	40 N.	37 E.
Dec. 22	4	14.7	Southwest of Samoa	16.0 S.	174.5 W.
Dec. 22	6	24.9	South of Panama	7.5 N.	79.5 W.
Dec. 23	1	12.8	do	7.5 N.	79.5 W.
Dec. 23	7	43.1	California	33.3 N.	115.7 W.
Dec. 23	13	59.2	Solomon Islands	9 S.	161 W.
Dec. 26	12	31.8	North coast of Colombia	9.6 N.	75.6 W.
Dec. 27	16	39.9	Southeast of Japan	31 N.	142 E.
Dec. 29	6	50.0	South of Panama	8.0 N.	79.5 W.
Dec. 31	12	03.6	Atlantic Ocean	17.5 N.	47.0 W.
Dec. 31	19	14.1	do	17.5 N.	47.0 W.

TABLE 9.—Principal earthquakes of the world from January 1943 to December 1943, inclusive

This table lists (1) the strongest shocks of the period as revealed by seismographic records, particularly those of western hemisphere stations, (2) important destructive and near destructive earthquakes, and (3) earthquakes of unusual interest outside the two preceding categories.
An asterisk (*) indicates local time.

Date	Origin time G. C. T.	Place	Provisional Epicenters		Remarks. Depths. Principal facts.
			Latitude	Longitude	
1943	h m		°	°	
Jan. 29.....		Bosnia.....			During previous month 19 lives reported lost; 12 towns damaged.
Jan. 30.....	5 01	Peru.....			Yanaoca, Cusco Province. 200 reported killed.
Jan. 30.....	5 33.1	Ecuador.....	2.1 S.	80.0 W.	Depth about 100 km. Many buildings damaged in Guayaquil.
Feb. 16.....	7 23.7	Southeastern Peru.....	13.9 S.	70.8 W.	Depth about 100 km.
Feb. 22.....	9 20.8	Mexico.....	17.9 N.	101.5 W.	Destructive in region of Colima. 5 killed in Mexico City. About 230 km from Parícutin Volcano.
Mar. 4.....	6 32.4	Tonga Island region.....	22 S.	179 W.	Depth about 600 km.
Mar. 14.....	18 37.8	Northern Chile.....	20.5 S.	69 W.	Depth probably slightly more than 200 km.
Mar. 15.....	22 59.3	West of Samoa.....	14.5 S.	176.5 W.	Depth probably slightly more than 300 km.
Apr. 6.....	16 07.3	Central Chile.....	31.5 S.	71.4 W.	Depth about 100 km. Destructive at Salamanca and Illapel. 18 killed; 90 injured at Ovalle.
Apr. 9.....	8 43.8	Mariana Islands.....	18.8 N.	145.9 E.	Depth slightly over 100 km.
Apr. 11.....	14 46.1	Japan.....	37 N.	141 E.	Depth about 100 km.
Apr. 19.....	1 19.2	Caribbean Sea.....	17.0 N.	81.5 W.	Felt at Swan Island. Not a strong shock.
Apr. 23.....	23 43.2	South of Tonga Islands.....	25 S.	179.5 W.	Depth about 600 km.
May 2.....	17 18.2	Panama.....	6.8 N.	80.8 W.	Felt in Balboa. V R-F scale.
May 23.....		Germany.....			Damage near Stuttgart.
June 8.....	1 15.6	Atlantic Ocean.....	35 N.	35 W.	West of Azores Islands.
June 20.....	15 32.9	Turkey.....	40.6 N.	30.5 E.	Destructive. 235 killed; many injured in Anatolia. Great damage in Adapazari.
June 24.....	20 21.7	New Hebrides Islands.....	16 S.	168 E.	Depth about 200 km.
June 25.....	19 13.5	Tonga Islands.....	17.7 S.	173.3 W.	Depth about 500 km.
June 29.....	9 05.1	Celebes Sea.....	3 N.	126 E.	Depth nearly 200 km.
June 30.....	20 12.9	Peru.....	16.3 S.	73.0 W.	Depth about 100 km.
July 11.....	2 10.4	Kermadec Islands.....	34 S.	173 W.	Depth about 200 km.
July 29.....	3 02.2	Northwest of Puerto Rico.....	19.0 N.	67.1 W.	Felt strongly in Puerto Rico. No damage.
Aug. 1.....	16 18.7	New Hebrides Islands.....	20.3 S.	170.1 E.	Depth slightly more than 200 km.
Sept. 10.....	8 36.9	Japan.....	35.3 N.	133.9 E.	Destructive. Fifty percent of Tottori buildings were destroyed. 1400 killed and injured.
Oct. 21.....	23 08.2	Fiji Islands.....	15.1 S.	177.2 W.	Slight depth.
Nov. 26.....	22 20.6	Turkey.....	41 N.	33.5 E.	Reports stated about 1400 buildings were destroyed; same number damaged in northern Anatolia. 2900 deaths. Many injured. Epicenter in region east of Ankara.
Dec. 1.....	10 34.7	Bolivia.....	21.2 S.	68.7 W.	Depth slightly less than 100 km.
Dec. 5.....		Turkey.....			Northeastern Anatolia. 550 reported killed; 12 villages destroyed.
Dec. 21.....	18 46.3	Gulf of Venezuela.....	12.8 N.	71.2 W.	Slight depth.
Dec. 23.....	15 56.1	Gulf of Venezuela.....	12.8 N.	71.2 W.	do

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 ten preceding issues of this series, Serials 579, 593, 600, 610, 619, 629, 637, 647, 655, and 662, 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 but brief notes on station and instrumental changes will be found under the heading "Changes in Strong-Motion Instrumental Equipment during 1943" near the end of this report. Special Publication 201 is much broader of scope, containing data on structural and ground vibrations and detailed descriptions of the various activities which comprise the seismological program as a whole. The reader is also referred to Special Publication 206, "Selection, Installation, and Operation of Seismographs," for descriptive material on strong-motion instruments and vibration meters in addition to similar information on teleseismic instruments.

Interpretation of records.—The following analyses are based on the assumption of simple harmonic motion. This refers especially to the computation of displacement from accelerograph records. As most accelerograph records are of irregular character, and the character of the longer-period waves is often obscured by the superposing of shorter-period waves of relatively large amplitude, the estimates of displacement must be considered as only approximate. One must refer to the illustrations of the curves themselves to evaluate the probable accuracy of the estimated displacements.

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

None of the 1943 records was strong enough to require integration.

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

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

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

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

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

Seismogram illustrations.—Reproductions of 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 1.76 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 11 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 11 or from the illustrations. For convenience certain fundamental information on the earthquakes will be repeated from the noninstrumental part of the publication.

It is well to repeat here that, as the measurement of periods on records of this nature is dependent largely on the judgment of the person reading them, considerable latitude must be allowed in appraising their accuracy. The aim of such analyses is primarily to give a fair picture of the magnitudes of the various elements involved, and the figures tabulated should therefore not be used for important studies without first referring to the illustrations for some idea of the nature of the original records.

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

The pendulum periods of a number of accelerographs in southern California were reduced from 0.1 second to about 0.07 second. Also a number of the six-inch and twelve-inch recorders were interchanged. Most of this work was done during 1942. The purpose was to arrange the instruments so that their recording capacities would more nearly equal the accelerations which might be expected at the various station sites. As a result of previous experience the following expectable earthquake accelerations were used in determining the adjustment and placement; (a) rock foundation 25 percent of gravity, (b) conglomerate foundations 40 percent of gravity, (c) alluvium 70 percent of gravity, (d) top floors of tall buildings 100 to 200 percent of gravity. The four sensitivities may be roughly listed as 26, 19.5, 13, and 6.5 mm per 0.1 gravity respectively. In order to realize the desired recording capacities it was necessary to shift a number of accelerographs because of the greater recording range of the twelve-inch drums as compared with the six inch.

In the notes following table 10 listing the strong-motion records obtained during 1943 the maximum values of acceleration and displacement are given for each station. Accelerations shown may have been recorded by any one of the three components. As will be seen in table 11 maximum recorded acceleration is not necessarily associated with the same ground period as the maximum computed displacement.

LIVERMORE EARTHQUAKE OF MAY 8

This shock was not located instrumentally but apparently centered near Livermore where the maximum intensity of V was reported.

Veterans' Hospital.—Figure 9. Maximum acceleration 20 cm./sec.² Computed maximum displacement .006 cm.

LIVERMORE EARTHQUAKE OF MAY 29

A local shock was felt strongest at the Veterans Hospital about five miles north of Livermore. Not located instrumentally.

Veterans' Hospital.—Figure 9. Maximum acceleration 40 cm./sec.² Computed maximum displacement .054 cm.

TABLE 10.—*List of shocks recorded and records obtained on strong-motion seismographs in 1943*

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
May 8: Central California: Livermore.	1	-----	-----	October 25: Central California: Livermore.	1	-----	-----
May 29: Central California: Livermore.	1	-----	-----	Martinez, Suisun Bay Bridge.	2	-----	-----
May 31: East-central California: Bishop.	1	-----	-----	Oakland City Hall.	2	-----	-----
June 28: Central California: Livermore.	1	-----	-----	San Jose.	2*	-----	-----
August 8: Western Nevada: Hawthorne.	1	-----	-----	San Francisco Alexander Building.	3	-----	-----
August 28: Southern California: Hollywood Storage Company Building.	2	-----	-----	San Francisco Southern Pacific Building.	2	1	-----
Pacific Electric Company lot near Hollywood Storage Company.	1	-----	-----	San Francisco Shell Building.	3	-----	-----
Los Angeles Subway Terminal.	2	1	-----	San Francisco Sutter Building.	2	-----	-----
Los Angeles Chamber of Commerce.	2	-----	-----	Oakland—Chabot Observatory.	-----	-----	1
Colton.	1	1	-----	November 16: San Leandro: Oakland—Chabot Observatory.	-----	-----	1
San Diego.	1	-----	-----	Totals.	30	3	3
San Bernardino.	-----	-----	1				

*Plus one aftershock.

EAST-CENTRAL CALIFORNIA EARTHQUAKE OF MAY 31

Epicenter in Round Valley about ten miles west of Bishop. Maximum intensity VI. *Bishop*.—Figure 10. Maximum acceleration 35 cm./sec.² Computed maximum displacement .017 cm.

LIVERMORE EARTHQUAKE OF JUNE 28

Local shock centering near Livermore. Maximum intensity about IV. *Veterans' Hospital*.—Figure 9. Maximum acceleration 16 cm./sec.² Computed maximum displacement .010 cm.

WESTERN NEVADA EARTHQUAKE OF AUGUST 8

Epicenter near Filben, Nevada. Maximum intensity VI. The accelerograph was about thirty-five miles northwest of the epicenter.

Hawthorne.—Figure 10. Maximum acceleration 8 cm./sec.² Computed maximum displacement .007 cm.

SOUTHERN CALIFORNIA EARTHQUAKE OF AUGUST 28

Epicenter near Big Bear Lake. Maximum intensity VI.

Los Angeles Chamber of Commerce, 11th floor.—Figure 10. Station about 75 miles nearly west from the epicenter. Maximum acceleration 3 cm./sec.² Computed maximum displacement .047 cm.

Hollywood Storage Company Building, Penthouse.—Figure 9. Station about 95 miles northwest from the epicenter. Maximum acceleration 15 cm./sec.² Computed maximum displacement .090 cm.

Colton.—Figure 13. Station about 15 miles south southwest from the epicenter. Maximum acceleration 11 cm./sec.² Computed maximum displacement .031 cm.

Colton.—Figure 9.—The displacement meter recorded a maximum displacement of .100 cm. Computed maximum acceleration 2 cm./sec.²

CENTRAL CALIFORNIA EARTHQUAKE OF OCTOBER 25

Epicenter on the Calaveras fault about four and one-half miles northwest of Mount Hamilton. Maximum intensity VI.

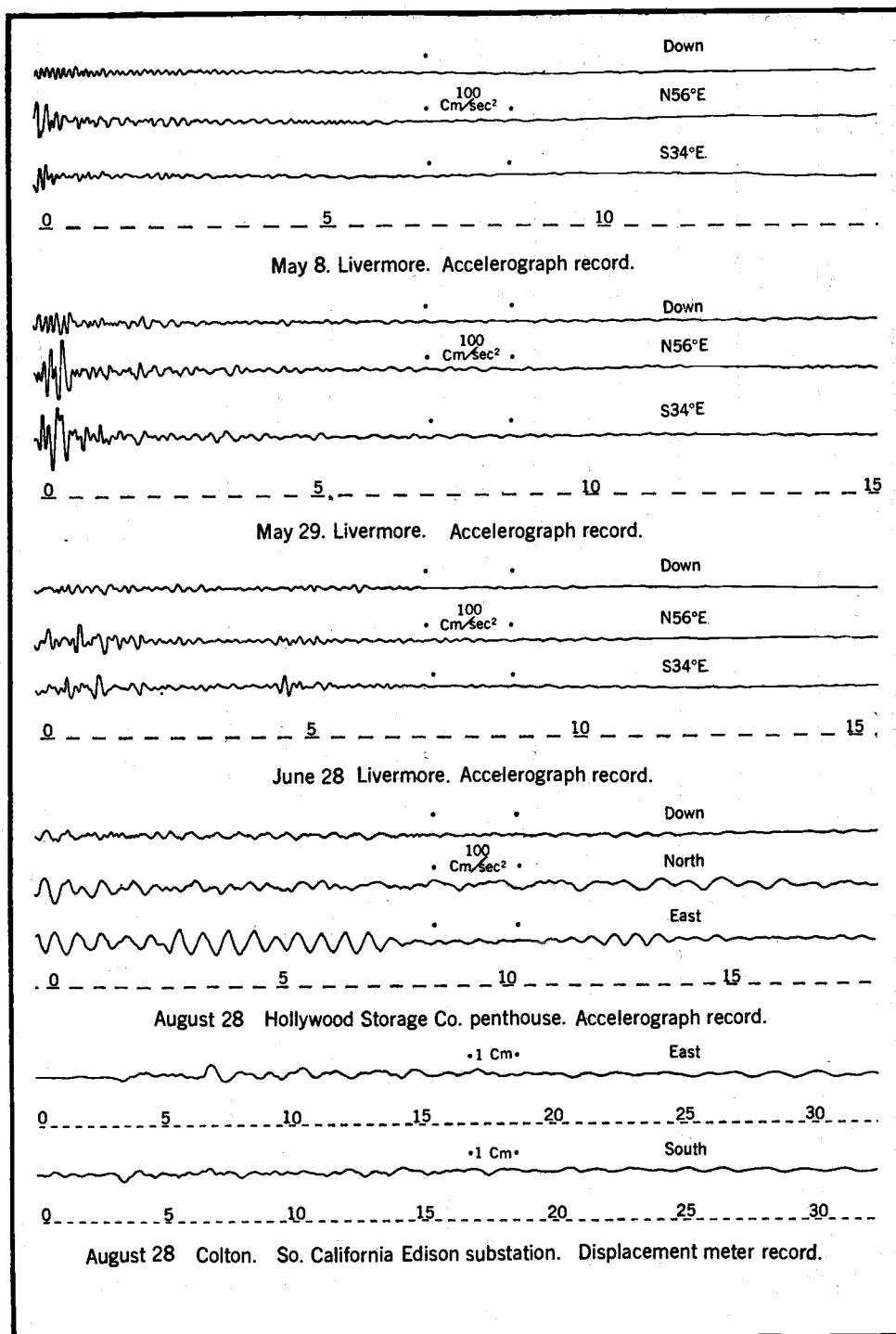


FIGURE 9.—Tracing of accelerograph records obtained at Livermore on May 8, May 29, and June 28; at Hollywood Storage Company Penthouse on August 28; and tracing of displacement-meter record obtained at Colton on August 28, 1943.

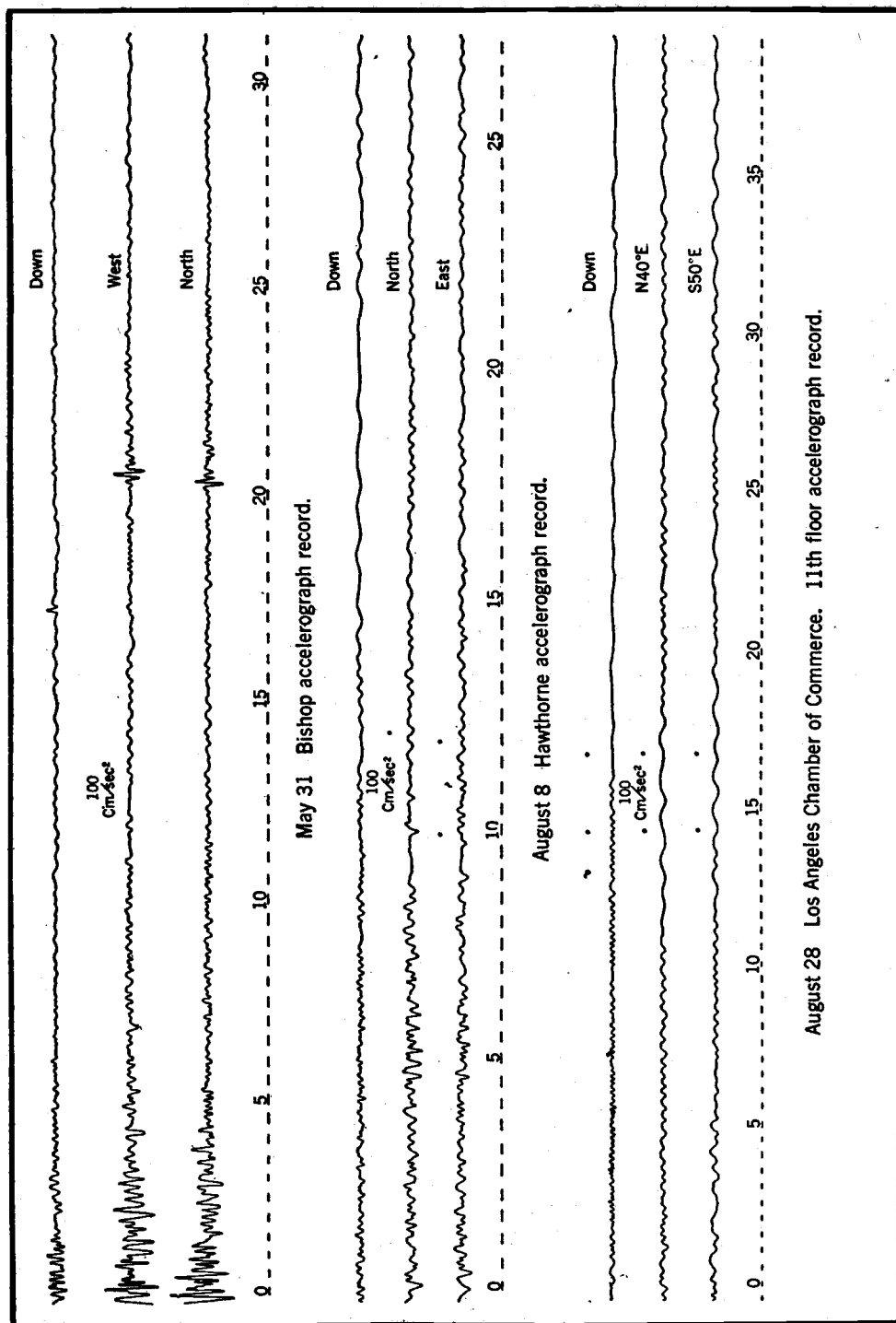


FIGURE 10.—Tracings of accelerometer records obtained at Bishop on May 31; at Hawthorne on August 8; and, on the 11th floor of the Los Angeles Chamber of Commerce on August 28, 1943.

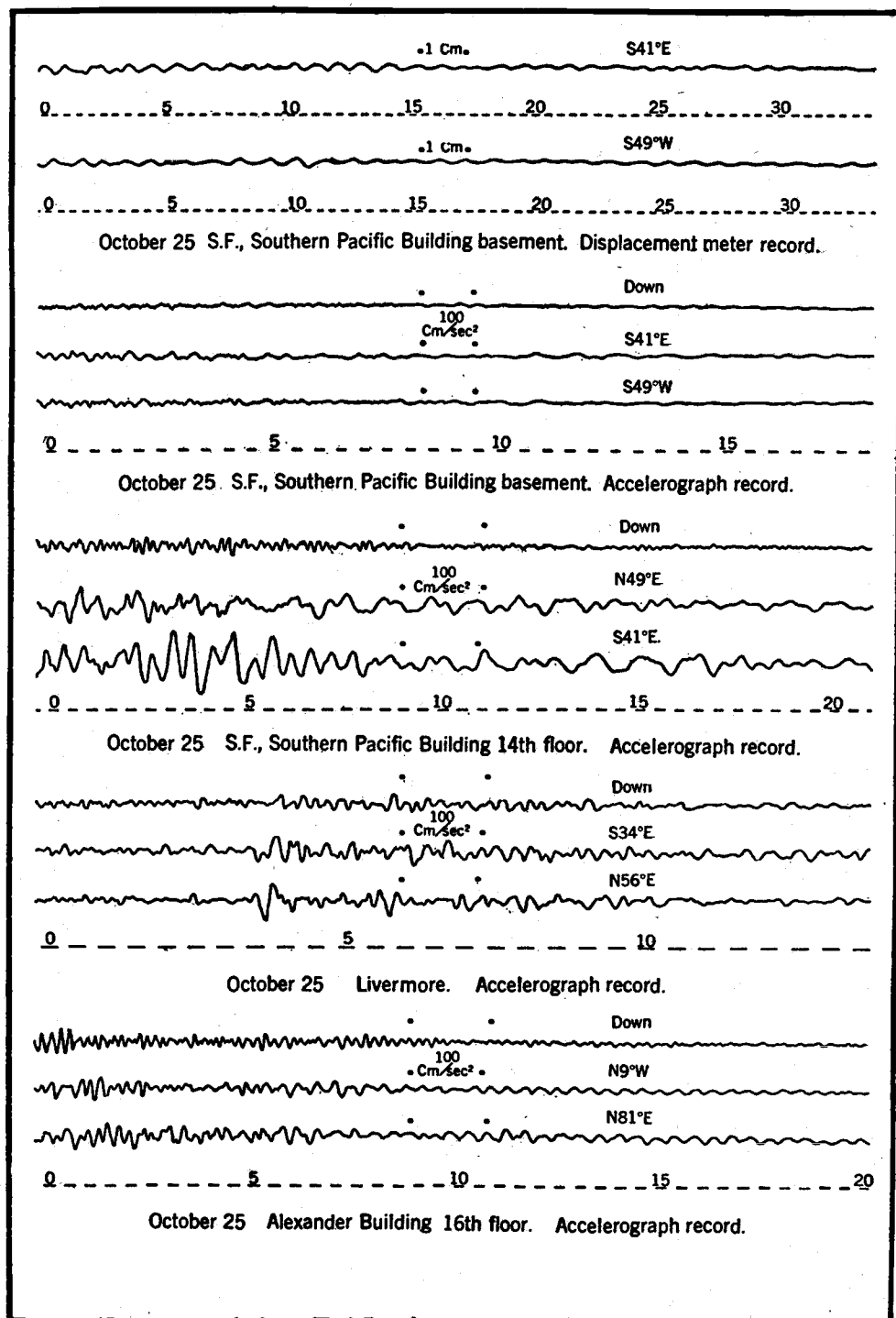


FIGURE 11.—Tracings of displacement-meter and accelerograph records obtained in the basement of the San Francisco Southern Pacific Building on October 25, 1943; accelerograph records obtained on the 14th floor of the San Francisco Southern Pacific Building; at Livermore; and, on the 16th floor of the San Francisco Alexander Building.

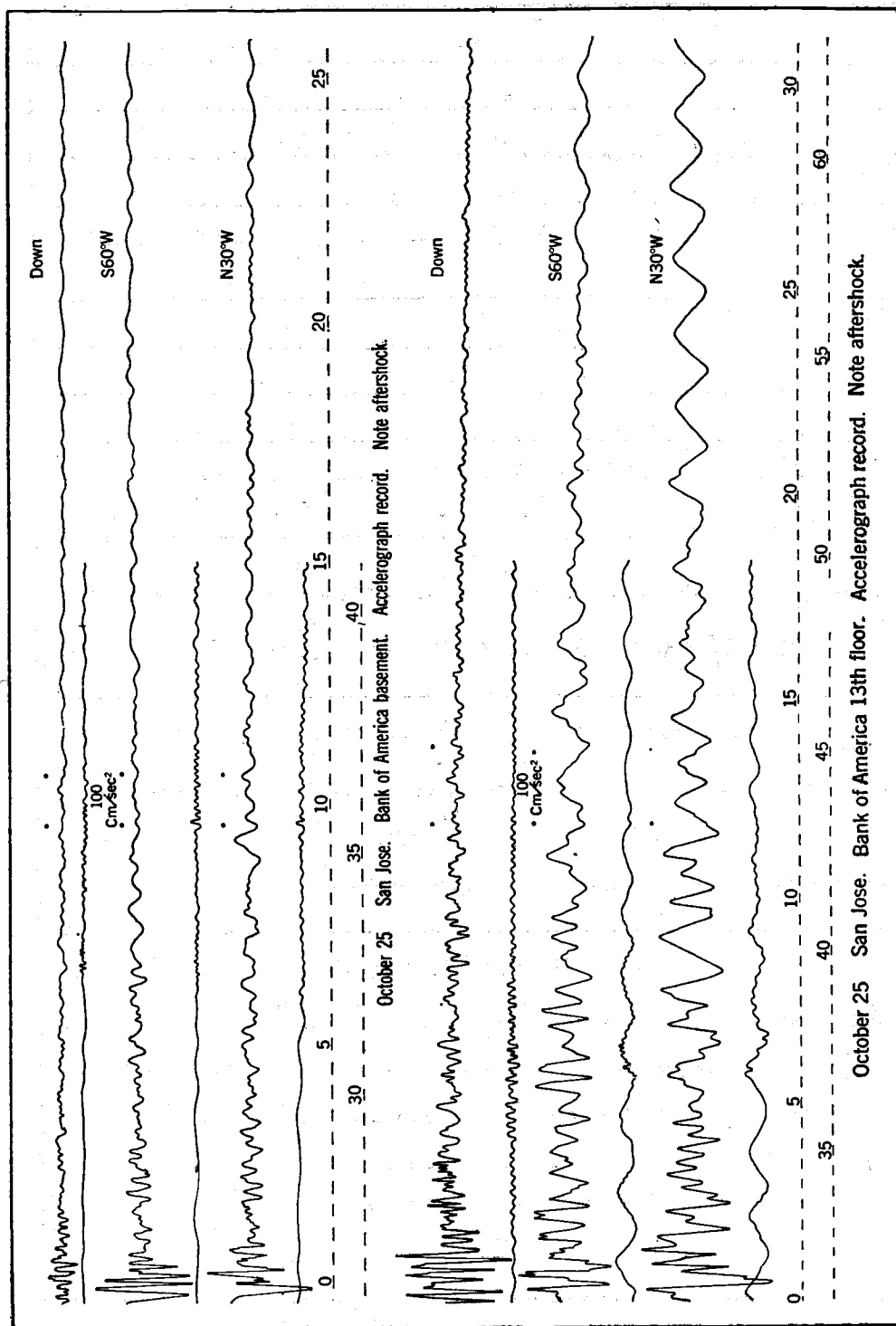


FIGURE 12.—Tracings of accelerograph records obtained in the basement and on the 13th floor of the San Jose Bank of America on October 25, 1943.

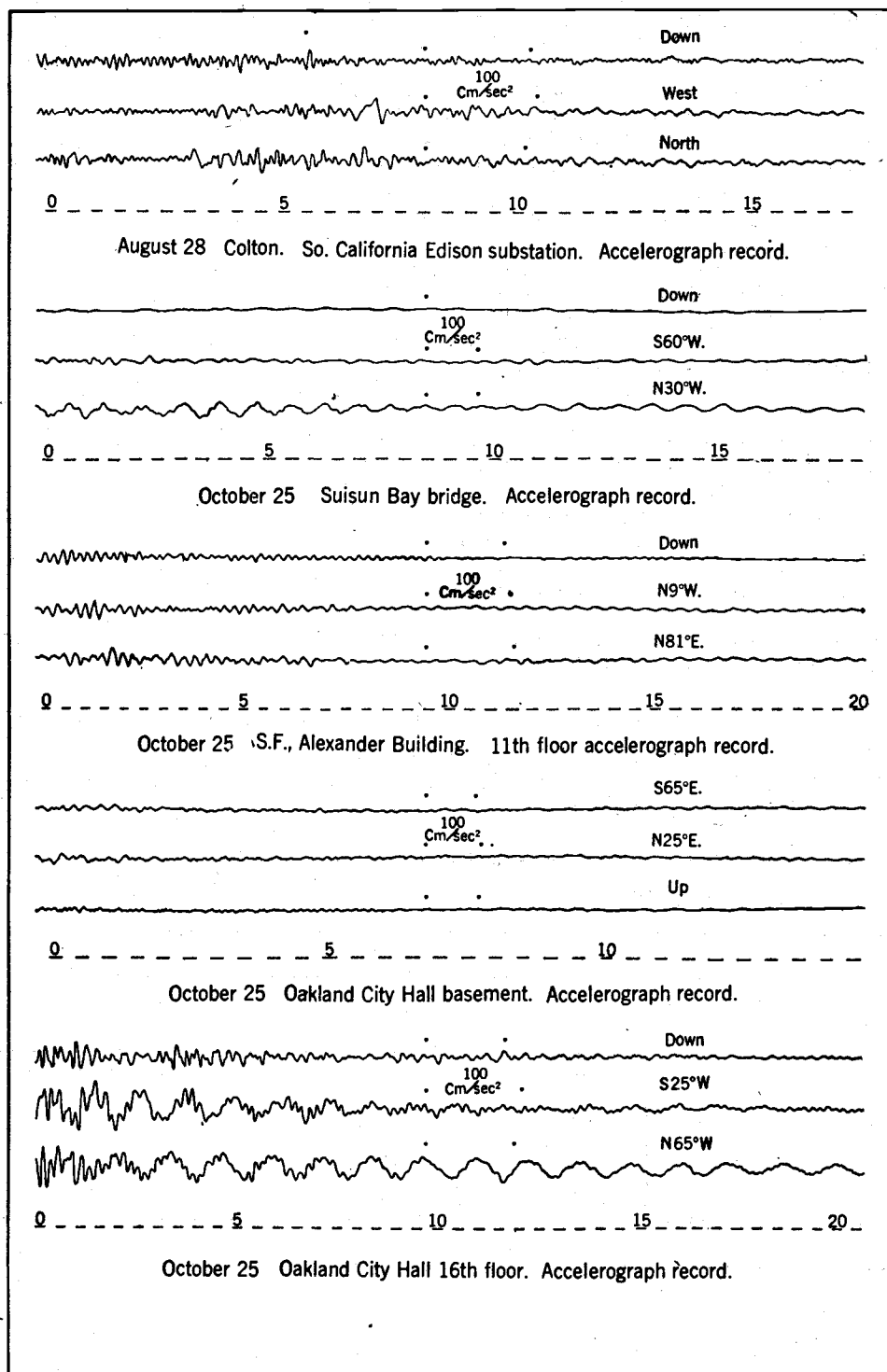


FIGURE 13.—Tracings of accelerograph records obtained at Colton on August 28; at Martinez, Suisun Bay Bridge; on 11th floor of the San Francisco Alexander Building; and, in the basement and on the 16th floor of the Oakland City Hall on October 25, 1943.

San Jose Bank of America, Basement.—Figure 12. Station about 14 miles west southwest of epicenter. Maximum acceleration 138 cm./sec.² Computed maximum displacement .459 cm.

San Jose Bank of America, 13th floor.—Figure 12. Maximum acceleration 254 cm./sec.² Computed maximum displacement 7.636 cm.

San Francisco Southern Pacific Building.—Figure 11. Station about 30 miles northwest by north of epicenter. Maximum acceleration 17 cm./sec.² Computed maximum displacement .182 cm.

The displacement meter recorded a maximum displacement of .23 cm. Computed maximum acceleration 13 cm./sec.²

San Francisco Southern Pacific Building, 14th floor.—Figure 11. Maximum acceleration 62 cm./sec.² Computed maximum displacement .921 cm.

Livermore.—Figure 11. Station about 18 miles north by west of epicenter. Maximum acceleration 46 cm./sec.² Computed maximum displacement .083 cm.

Martinez, Suisun Bay Bridge.—Figure 13. Station about 50 miles northwest by north of epicenter. Maximum acceleration 31 cm./sec.² Computed maximum displacement .558 cm.

San Francisco Alexander Building, 11th floor.—Figure 13. Station about 48 miles northwest by west of epicenter. Maximum acceleration 20 cm./sec.² Computed maximum displacement .027 cm.

San Francisco Alexander Building, 16th floor.—Figure 11. Maximum acceleration 30 cm./sec.² Computed maximum displacement .090 cm.

Oakland City Hall, Basement.—Figure 13. Station about 43 miles northwest by west of epicenter. Maximum acceleration 10 cm./sec.² Computed maximum displacement .020 cm.

Oakland City Hall, 16th floor.—Figure 13. Maximum acceleration 46 cm./sec.² Computed maximum displacement 2.310 cm.

SAN LEANDRO EARTHQUAKE OF NOVEMBER 16

Epicenter in San Leandro. Maximum intensity VI.

Chabot Observatory.—Maximum acceleration 7 cm./sec.² Computed maximum displacement .004 cm. This station is on rock foundation.

TABLE 11.—Summary of strong-motion seismograph data for the year 1943

(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.)

LIVERMORE EARTHQUAKE OF MAY 8				
Station and component	Earth-wave period	Maximum acceleration	Maximum displacement	Remarks
	Seconds	Cm./sec. ²	Cm.	
Livermore accelerograph:				
Vertical.....	0.10	4	0.001	
SW: 236°.....	.15	21	.011	
	.24	4	.006	
	.20	3	.003	
NW: 326°.....	.10	20	.005	
	.30	2	.005	
LIVERMORE EARTHQUAKE OF MAY 29				
Livermore accelerograph:				
Vertical.....	0.10	11	0.003	
	.07	1	.001	
	.29	4	.009	
SW: 236°.....	.20	35	.035	Combined with a 0.13 wave.
	.11	3	.001	
	.15	10	.006	Irregular.
	.30	2	.005	End portion.
NW: 326°.....	.10	29	.005	
	.23	40	.054	Principal portion.
	.26	6	.010	End portion.

TABLE 11.—*Summary of strong-motion seismograph data for the year 1943—Continued*

OWENS VALLEY EARTHQUAKE OF MAY 31

Station and component	Earth-wave period	Maximum acceleration	Maximum displacement	Remarks
	<i>Seconds</i>	<i>Cm./sec.²</i>	<i>Cm.</i>	
Bishop accelerograph:				
Vertical.....	0.18	11	0.009	
	.30	4	.009	
	.21	2	.002	
E: 90°.....	.10	25	.006	
	.15	20	.011	
	.16	15	.010	
	.20	15	.015	
N: 0°.....	.14	35	.017	Start of record.
	.10	8	.002	
	.16	6	.004	

Twenty seconds later another shock of about one-third the amplitude of this one was recorded.

LIVERMORE EARTHQUAKE OF JUNE 28

Livermore accelerograph:				
Vertical.....	0.09	3	0.001	Weak record.
	.10	3	.001	Irregular motion.
	.15	4	.002	
SW: 236°.....	.10	10	.003	Possibly preceded by stronger motion.
	.10	16	.004	Strong waves.
	.15	6	.003	
	.11	4	.001	Irregular waves.
NW: 326°.....	.11	12	.004	Strong motion.
	.17	14	.010	Strong motion.
	.17	12	.008	
	.19	4	.004	Weak irregular motion.

EAST-CENTRAL CALIFORNIA EARTHQUAKE OF AUGUST 8

Hawthorne accelerograph:				
Vertical.....	0.15	3	0.002	Irregular short periods superposed.
	.26	3	.005	
	.16	2	.001	
E: 90°.....	.18	8	.007	Irregular waves.
	.14	5	.002	
	.26	3	.005	
N: 0°.....	.14	4	.002	Very irregular.
	.15	8	.005	
	.33	3	.008	

SOUTHERN CALIFORNIA EARTHQUAKE OF AUGUST 28

Hollywood Storage Company Basement accelerograph:				
Vertical.....	0.45	3	0.015	Very weak trace.
	.39	3	.011	
E: 90°.....	.37	5	.017	Possibly preceded by stronger motion.
	.49	2	.012	
N: 0°.....	.34	3	.009	
	.43	1	.005	
Hollywood Storage Company P. E. Lot accelerograph:				
Vertical.....	.36	1	.003	
E: 90°.....	.23	4	.005	Irregular.
	.23	2	.004	
	.27	1	.002	
N: 0°.....	.32	7	.018	Possibly preceded by stronger motion.
	.37	4	.014	
	.32	1	.003	End portion.
Hollywood Storage Company Penthouse accelerograph:				
Vertical.....	.44	6	.030	Long periods at beginning.
	.41	4	.017	
N: 0°.....	.49	15	.090	
	.71	5	.064	Rather long periods.
	.59	2	.018	Sinusoidal waves at end.
E: 90°.....	.46	13	.070	Sinusoidal waves.
	.44	7	.035	
	.49	2	.012	
Los Angeles Subway Terminal 13th floor accelerograph:				
Vertical.....	.13	2	.002	Rather weak.
	.16	2	.002	
SW: 219°.....	.71	10	.120	Long period waves.
	.60	4	.036	
	.64	1	.010	
NW: 309°.....	.64	5	.037	Irregular long periods.
	.62	3	.029	

TABLE 11.—*Summary of strong-motion seismograph data for the year 1943—Continued*

SOUTHERN CALIFORNIA EARTHQUAKE OF AUGUST 28—Continued

Station and component	Earth-wave period	Maximum acceleration	Maximum displacement	Remarks
	<i>Seconds</i>	<i>Cm/sec.²</i>	<i>Cm.</i>	
Los Angeles Subway Terminal Basement accelerograph:				
Vertical.....	.16	1	.001	Very weak.
SE: 129°.....	.40	2	.003	
SW: 219°.....	.35	1	.003	Weak.
	.47	2	.010	
	.30	1	.002	
Los Angeles Subway Terminal Basement displacement meter:				
SE: 129°.....	1.08	1	.030	Very weak.
NE: 39°.....	.89	1	.020	
Los Angeles Chamber of Commerce 11th floor accelerograph:				
Vertical.....	.31	1	.002	Shorter period superposed.
SW: 220°.....	.37	2	.003	
	.76	2	.029	Regular.
	.95	1	.023	
NW: 310°.....	.79	3	.047	Irregular.
	.74	3	.042	Sinusoidal.
	.66	2	.022	
Los Angeles Chamber of Commerce Basement accelerograph:				
Vertical.....	.45	1	.055	Weak.
SE: 130°.....	.33	1	.003	Very weak.
	.46	1	.004	
SW: 220°.....	.28	1	.002	
	.29	1	.002	
Colton accelerograph:				
Vertical.....	.13	8	.001	
	.14	11	.005	Irregular waves superposed on longer periods.
	.13	5	.002	
E: 90°.....	.56	4	.031	
	.30	7	.015	Very irregular waves.
	.32	4	.010	
N: 0°.....	.11	4	.001	
	.15	10	.005	Irregular.
	.46	5	.027	Short periods superposed.
Colton displacement meter:				
E: 90°.....	1.28	2	.084	Irregular at beginning.
	1.60	1	.065	
	1.38	1	.049	End of record.
N: 0°.....	2.00	1	.100	
	1.06	1	.026	
San Diego accelerograph:				
Vertical.....	.15	2	.001	
E: 90°.....	.30	3	.002	Sinusoidal.
	.64	1	.011	
N: 0°.....	.64	2	.022	Short periods superposed.
	.48	1	.006	
San Bernardino Weed seismograph:				
NE: 45°.....	.33	3	.008	Well defined.
	.35	2	.008	
NW: 315°.....	.23	2	.003	

CENTRAL CALIFORNIA EARTHQUAKE OF OCTOBER 25

Livermore accelerograph:				
Vertical.....	0.14	8	0.004	Short periods superposed on irregular long periods.
	.22	11	.013	
	.19	13	.012	
	.23	17	.022	
	.42	6	.027	Weak.
NW: 326°.....	.16	12	.007	Irregular.
	.29	32	.065	Strong phase.
	.32	26	.068	
	.40	14	.056	Somewhat sinusoidal near end.
SW: 236°.....	.15	23	.013	Weak beginning.
	.27	46	.083	Strong phase.
	.26	31	.053	
	.44	19	.039	Irregular.
Martinez, Suisun Bay Bridge accelerograph:				
Vertical.....	.74	4	.056	Very weak short periods superposed on long periods.
SE: 150°.....	.28	10	.020	Weak beginning.
	.29	22	.045	
	.31	9	.021	
	.50	6	.031	Long weak traces near end for many seconds.
NE: 60°.....	.85	31	.558	Short periods superposed on long periods.
	.66	12	.123	Sinusoidal traces for most of record.

TABLE 11.—Summary of strong-motion seismograph data for the year 1943—Continued

CENTRAL CALIFORNIA EARTHQUAKE OF OCTOBER 25—Continued

Station and component	Earth-wave period	Maximum acceleration	Maximum displacement	Remarks
	<i>Seconds</i>	<i>Cm./sec.²</i>	<i>Cm.</i>	
Oakland City Hall 16th floor accelerograph:				
Vertical.....	.15	6	.003	Sharp phases.
	.20	9	.009	
	.45	4	.020	Weak.
SW: 205°.....	.15	26	.014	Possibly preceded by stronger motion.
	.95	46	.106	Large amplitudes superposed on these long waves.
	1.19	7	.252	
NW: 295°.....	1.20	9	.329	Sinusoidal for 20 seconds.
	.17	42	.003	Possibly preceded by stronger motion.
	1.46	33	2.310	Long periods near beginning.
	1.40	10	.497	Very regular.
Oakland City Hall Basement accelerograph:				
Vertical.....	.09	5	.001	Rather weak.
	.29	4	.008	
NW: 295°.....	.20	3	.003	Weak and irregular.
	.41	5	.020	
SW: 205°.....	.19	10	.001	Irregular.
	.26	6	.007	
	.26	4	.006	
San Jose Bank of America 13th floor accelerograph:				
Vertical.....	.20	108	.108	Sharp phases.
	.24	35	.042	Short periods superposed.
	.23	33	.043	
	.22	26	.026	
SE: 150°.....	.56	6	.042	
	.43	168	.790	Short periods superposed.
	.48	71	.412	Regular.
	1.84	64	5.248	
NE: 60°.....	1.89	26	2.392	
	.54	254	1.880	Irregular phases.
	.63	128	1.280	Irregular phases.
	1.47	136	7.344	
	1.92	83	7.636	Sinusoidal.
Aftershock:				
Vertical.....	.18	8	.006	Short periods superposed.
	.24	11	.017	
SE: 150°.....	.13	5	.002	Superposed on main shock.
NE: 60°.....	.21	11	.011	Superposed on main shock.
San Jose Bank of America, Basement accelerograph:				
Vertical.....	.10	25	.001	Possibly preceded by stronger motion.
	.13	54	.003	
	.18	12	.001	
	1.09	11	.307	
SE: 150°.....	.16	172	.103	Sharp phases.
	.22	41	.049	
	.38	36	.143	Irregular motion:
	.55	9	.068	
NE: 60°.....	.36	138	.459	Possibly preceded by stronger motion:
	.19	37	.033	
	.29	22	.044	
	.51	39	.257	Irregular.
	.66	9	.099	
Aftershock:				
Vertical.....	.07	8	.001	Weak.
	.18	6	.004	
SE: 150°.....	.17	14	.009	Irregular.
	.22	4	.004	
NE: 60°.....	.22	9	.010	Irregular.
	.20	4	.004	
San Francisco Alexander Building 16th floor accelerograph:				
Vertical.....	.20	26	.026	Strong at beginning.
	.22	16	.019	
	.18	19	.015	
	.41	5	.021	
SE: 171°.....	.25	27	.041	Irregular motion.
	.40	22	.090	
	.22	27	.032	
	.41	11	.047	Group of regular waves:
SW: 261°.....	.42	28	.042	Irregular at beginning.
	.27	30	.032	
	.35	23	.071	
	.42	8	.036	
San Francisco Alexander Building 11th floor accelerograph:				
Vertical.....	.22	16	.019	Possibly preceded by stronger motion.
	.24	19	.027	
	.21	6	.007	Weak.
SE: 171°.....	.26	10	.017	Regular at beginning.
	.22	20	.024	
	.25	1	.014	
	.46	2	.011	
SW: 261°.....	.28	12	.023	
	.24	10	.015	Irregular.
	.32	10	.026	
	.48	3	.017	

TABLE 11—Summary of strong-motion seismograph data for the year 1943—Continued

CENTRAL CALIFORNIA EARTHQUAKE OF OCTOBER 25—Continued

Station and component	Earth-wave period	Maximum acceleration	Maximum displacement	Remarks
	<i>Seconds</i>	<i>Cm/sec.²</i>	<i>Cm.</i>	
San Francisco Alexander Building basement accelerometer:				
Vertical.....	.16	6	.004	Very weak record.
NW: 351°.....	.25	3	.004	
	.28	10	.020	Weak and irregular.
	.14	7	.003	
NE: 81°.....	.27	6	.010	
	.26	9	.016	Weak and irregular.
	.31	5	.012	
	.32	3	.007	
San Francisco Southern Pacific building 14th floor accelerometer:				
Vertical.....	.27	12	.023	Irregular at beginning.
	.20	11	.011	
	.47	3	.016	
	.16	5	.003	Regular chain for five seconds:
SW: 229°.....	.47	14	.076	
	1.10	30	.921	Irregular long periods.
	1.18	11	.396	
	.93	7	.154	Regular long waves at end:
NW: 319°.....	.48	25	.147	Possibly preceded by stronger motion.
	.45	62	.316	Strongest motion.
	.92	24	.519	
	.42	7	.081	Regular for nine seconds.
	.97	7	.168	Near end of record.
San Francisco Southern Pacific Building basement accelerometer:				
Vertical.....	.20	7	.007	Very irregular at beginning.
	.49	9	.055	
NW: 319°.....	.42	14	.063	Irregular.
	.48	8	.044	
	.76	4	.058	
NE: 49°.....	.35	17	.053	Weak.
	.19	9	.008	
	1.02	7	.182	
San Francisco Southern Pacific Building basement displacement meter:				
NW: 315°.....	.77	13	.20	
	1.01	6	.14	Regular waves.
	.84	5	.09	
NE: 45°.....	.83	6	.13	Rather irregular.
	1.02	9	.23	
	.84	4	.08	Weak.
San Francisco Shell Building 29th floor strong-motion seismograph:				
E: 90°.....	.29	7	.014	
	.89	14	.280	Irregular motion.
	.70	2	.024	
N: 0°.....	.69	3	.036	
	1.08	14	.420	Irregular motion.
	1.08	3	.090	
San Francisco Shell Building, 21st floor strong-motion seismograph:				
E: 90°.....	.27	8	.014	
	.28	16	.032	
	.85	14	.028	Irregular.
N: 0°.....	.27	11	.022	
	.23	6	.012	Weak.
San Francisco Shell Building basement strong-motion seismograph:				
E: 90°.....	.90	2	.042	Weak.
N: 0°.....	.52	2	.014	Weak.
San Francisco Sutter Building, 29th floor strong-motion seismograph:				
E: 90°.....	.16	3	.022	Very weak.
N: 0°.....	.15	8	.005	Very weak.
San Francisco Sutter Building basement strong-motion seismograph:				
E: 90°.....	.11	6	.002	Very weak.
N: 0°.....	.10	-----	.002	Very weak.
Oakland Chabot Observatory strong-motion seismograph:				
SW: 225°.....	.24	4	.006	Weak and regular.
SE: 135°.....	.16	7	.004	Well defined.
	.21	2	.002	
SAN LEANDRO EARTHQUAKE OF NOVEMBER 16				
Oakland Chabot Observatory Strong-motion seismograph:				
SW: 225°.....	0.21	2	0.002	
SE: 135°.....	.08	7	.001	Single phase.
	.24	3	.004	

TABLE 12.—*Instrumental constants of strong-motion seismographs in 1943*

LIVERMORE EARTHQUAKE OF MAY 8

Station and instrument	Orientation of instrument ¹	Pendulum Period	Static magnification	Sensitivity ²	Damping ratio	Instrument number
		Sec.		Cm.		
Livermore accelerograph No. 44.....	Up.....	0.099	84	2.02	9	V-7
	SW: 236°.....	.098	84	1.80	7	L-2
	NW: 326°.....	.099	77	1.92	10	T-17

LIVERMORE EARTHQUAKE OF MAY 29

Livermore accelerograph No. 44.....	Up.....	0.099	84	2.02	9	V-7
	SW: 236°.....	.098	84	1.80	7	L-2
	NW: 326°.....	.099	77	1.92	10	T-17

EAST-CENTRAL CALIFORNIA EARTHQUAKE OF MAY 31

Bishop accelerograph No. 12.....	Up.....	0.100	110	2.72	11	V-23
	E: 90°.....	.100	107	2.68	10.5	L-36
	S: 180°.....	.99	108	2.66	10	T-19

LIVERMORE EARTHQUAKE OF JUNE 28

Livermore accelerograph No. 44.....	Up.....	0.099	84	2.02	9	V-7
	SW: 236°.....	.098	84	1.80	7	L-2
	NW: 326°.....	.099	77	1.92	10	T-17

EAST-CENTRAL CALIFORNIA EARTHQUAKE OF AUGUST 8

Hawthorne accelerograph No. 25.....	Up.....	0.094	109	2.47	9	V-31
	S: 180°.....	.100	106	2.67	9	L-35
	W: 270°.....	.097	106	2.42	8	T-14

SOUTHERN CALIFORNIA EARTHQUAKE OF AUGUST 28

Colton accelerograph No. 38.....	Up.....	.100	112	2.66	8	V-111
	E: 90°.....	.097	112	2.86	9	L-91
	S: 180°.....	.100	117	2.56	7	T-101
Colton displacement meter No. 16.....	W: 270°.....	9.8	1.14		9	
	N: 0°.....	9.8	1.14		9	
Hollywood Storage Company: ³ P. E. Lot accelerograph No. 1.....	Up.....	.070	108	1.37	9	V-66
	E: 90°.....	.070	108	1.35	7	L-64
	S: 180°.....	.070	111	1.34	9	T-65
Penthouse accelerograph No. 40.....	Up.....	.104	81	2.00	8	V-113
	S: 180°.....	.102	80	2.02	7	L-93
	W: 270°.....	.101	79	2.00	8	T-103
Basement accelerograph No. 22.....	Up.....	.070	103	1.27	5	V-25
	E: 90°.....	.069	111	1.34	8	L-3
	S: 180°.....	.070	109	1.36	7	T-18
Los Angeles Subway Terminal: ³ 13th floor accelerograph No. 39.....	Up.....	.100	83	2.10	11	V-112
	SW: 219°.....	.100	81	2.05	9	L-82
	NW: 309°.....	.100	80	2.01	12	T-102
Basement accelerograph No. 3.....	Up.....	.069	116	1.38	10	V-63
	SE: 129°.....	.069	118	1.41	11	L-59
	SW: 229°.....	.070	120	1.43	12	T-60
Basement displacement meter No. 13.....	NE: 39°.....	10.4	1.14		11	
	SE: 129°.....	10.3	1.14		11	
Los Angeles Chamber of Commerce: ³ 11th floor accelerograph No. 42.....	Up.....	.100	80	2.02	10	V-115
	SW: 220°.....	.098	82	2.00	9	L-95
	NW: 310°.....	.099	80	1.99	8	T-105
Basement accelerograph No. 21.....	Up.....	.067	107	1.26	9	V-28
	SE: 130°.....	.068	108	1.27	8	L-9
	SW: 220°.....	.069	111	1.34	7	T-26
San Bernardino Weed Seismograph No. 10.....	SE: 135°.....	.18	6.29		2	
	NE: 45°.....	.18	6.17		2	
San Diego accelerograph No. 5.....	Up.....	.098	102	2.49	8	V-70
	E: 90°.....	.100	104	2.64	9	L-71
	S: 180°.....	.099	108	2.68	9	T-72

TABLE 12.—*Instrumental constants of strong-motion seismographs in 1943—Continued*

CENTRAL CALIFORNIA EARTHQUAKE OF OCTOBER 25

Station and instrument	Orientation of instrument ¹	Pendulum Period	Static magnification	Sensitivity ²	Damping ratio	Instrument number
		Sec.		Cm.		
Livermore accelerograph No. 44.....	Up.....	0.101	84	2.14	8	V-7
	SW: 238°.....	.099	84	2.02	9	L-2
	NW: 326°.....	.100	77	1.90	9	T-17
Martinez, Suisun Bay Bridge accelerograph No. 9.....	Up.....	.067	118	1.34	5	V-40
	NE: 60°.....	.068	116	1.36	5	L-39
	SE: 150°.....	.070	109	1.36	5	T-38
Oakland Chabot Observatory: Weed seismograph No. 3.....	SW: 225°.....	.19	8.2	.0075	2	
	SE: 135°.....	.19	8.2	.0075	2	
Oakland City Hall: ³ 16th floor accelerograph No. 37.....	Up.....	.099	80	1.98	9	V-109
	NE: 25°.....	.104	85	2.41	7	L-89
	SE: 115°.....	.104	81	2.21	12	T-89
Basement accelerograph No. 33.....	NW: 285°.....	.068	112	1.31	6	V-16
	SW: 205°.....	.069	116	1.40	4	L-33
	Down.....	.068	118	1.38	7	T-12
San Francisco Alexander Building: ² 16th floor accelerograph No. 36.....	Up.....	.101	80	2.06	12	V-110
	SE: 171°.....	.099	74	1.84	9	L-90
	SW: 261°.....	.099	79	1.96	12	T-100
11th floor accelerograph No. 43.....	Up.....	.098	79	2.08	9	V-116
	SE: 171°.....	.098	83	2.19	10	L-96
	SW: 261°.....	.102	85	2.32	9	T-106
Basement accelerograph No. 10.....	Up.....	.069	112	1.33	9	V-44
	NW: 351°.....	.071	128	1.29	18	L-45
	NE: 81°.....	.068	113	1.28	32	T-46
San Francisco Shell Building: 29th floor Weed seismograph No. 2.....	E: 90°.....	.17	7.3	.0067	2.0	
	N: 0°.....	.17	7.3	.0067	2.2	
21st floor Weed seismograph No. 5.....	E: 90°.....	.19	6.4	.0058	1.4	
	N: 0°.....	.19	6.4	.0058	1.4	
Basement Weed seismograph No. 4.....	E: 90°.....	.17	7.6	.0057	2.0	
	N: 0°.....	.17	7.6	.0057	2.0	
San Francisco Southern Pacific Building: ³ 14th floor accelerograph No. 34.....	Up.....	.102	83	2.19	7	V-108
	SW: 229°.....	.102	80	2.12	5	L-88
	NW: 319°.....	.102	79	2.07	9	T-98
Basement accelerograph No. 27.....	Up.....	.067	116	1.32	5	V-27
	NW: 319°.....	.068	112	1.31	5	L-22
	NE: 49°.....	.068	113	1.32	4	T-1
Basement displacement meter No. 18.....	NW: 315°.....	9.8	1.14		8	
	NE: 45°.....	9.8	1.14		11	
San Jose Bank of America: ³ 13th floor accelerograph No. 8.....	Up.....	.101	79	2.08	10	V-107
	NE: 60°.....	.097	78	1.86	10	L-87
	SE: 150°.....	.098	79	1.91	8	T-97
Basement accelerograph No. 8.....	Up.....	.069	110	1.30	12	V-49
	NE: 60°.....	.068	112	1.30	10	L-50
	SE: 150°.....	.067	117	1.30	7	T-51
San Francisco Sutter Building: 29th floor Weed seismograph No. 1.....	E: 90°.....	.20	9.0	.0096	2	
	N: 0°.....	.20	9.0	.0091	2	
Basement Weed seismograph No. 6.....	E: 90°.....	.16	8.6	.0055	1.8	
	N: 0°.....	.16	8.6	.0055	1.8	

SAN LEANDRO EARTHQUAKE OF NOVEMBER 16

Oakland, Chabot Observatory. Weed seismograph No. 3.	SW: 225°.....	0.19	8.2	0.0075	2	
	SE: 135°.....	.19	8.2	.0075	2	

¹ The directions given indicate the direction of pendulum displacement relative to instrument pier, which will displace the trace upward on the original seismogram.

Directions for the horizontal components are given first by quadrant followed by specific directions expressed in degrees measured from north around by east.

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

³ Instruments at this station are wired to start simultaneously.

TABLE 13.—*Changes in strong-motion instrumental equipment during 1943*

Station	Date of Change	Remarks *	Station	Date of Change	Remarks *
Berkeley, Calif. . .	Oct. 13, 1943. . .	Period of accelerometers changed from .100 to .070 second. Sensitivity changed from approximately .0260 to approximately .0130.	San Francisco, Calif., State Building.	Oct. 6, 1943. . .	Period of accelerometers changed from .100 to .070 second. Sensitivity changed from approximately .0260 to approximately .0130.
Livermore, Calif. . .	Dec. 11, 1943. . .	Recorder No. M-44, accelerometers Nos. 2, 7, and 17 removed for shipment to South America. Station discontinued.	San Francisco, Calif., University of San Francisco.	Dec. 13, 1943. . .	12-inch Recorder No. 50, accelerometers Nos. 149, 150, and 151 removed for shipment to South America. Station not discontinued but awaiting replacement instrument.
Monterey, Calif. . .	Aug. 26, 1943. . .	Period of accelerometers changed from .100 to .070 second. Sensitivity changed from approximately .0260 to approximately .0130.	San Jose, Calif., Bank of America Building, basement.	Aug. 24, 1943. . .	Period of accelerometers changed from .100 to .070 second. Sensitivity changed from approximately .0260 to approximately .0130.
Oakland, Calif. City Hall, basement.	Aug. 4, 1943. . .	Period of accelerometers changed from .100 to .070 second. Sensitivity changed from approximately .0260 to approximately .0130.	San Jose, Calif., Bank of America Building, 13th floor.	Aug. 25, 1943. . .	6-inch Recorder No. 27, accelerometers Nos. 1, 22, and 27 removed. 12-inch Recorder No. 35, accelerometers Nos. 87, 97, and 107, formerly at San Francisco, Southern Pacific Building, basement, installed.
Oakland, Calif. City Hall, 16th floor.	Aug. 4, 1943. . .	6-inch Recorder No. 10, accelerometers Nos. 44, 45, and 46 removed. 12-inch Recorder No. 37, accelerometers Nos. 89, 99, and 109, formerly in San Francisco, Alexander Building, installed.	Martinez, Calif., Suisun Bay Bridge.	Aug. 17, 1943. . .	Period of accelerometers changed from .100 to .070 second. Sensitivity changed from approximately .0260 to approximately .0130.
Sacramento, Calif.	Aug. 14, 1943. . .	Periods of accelerometers changed from .100 to .070 Second. Sensitivity changed from approximately .0260 to approximately .0130.	Bishop, Calif. . .	July 14, 1943. . .	Recorder No. 12 removed. Recorder No. 6, formerly at Los Angeles, Edison Building, installed. Accelerometers not changed.
San Francisco, Calif. Alexander Building, basement.	July 23, 1943. . .	12-inch Recorder No. 37, accelerometers Nos. 89, 99, and 109 removed. 6-inch Recorder No. 10, accelerometers Nos. 44, 45, and 46, formerly in Oakland City Hall, 16th floor, installed.	Los Angeles, Calif., Edison Building, basement.	July 15, 1943. . .	Recorder No. 6 removed. Recorder No. 12, formerly at Bishop, Calif., installed. Accelerometers not changed.
San Francisco, Calif., Southern Pacific Building, basement.	Sept. 3, 1943. . .	12-inch Recorder No. 35, accelerometers Nos. 87, 97, and 107 removed. 6-inch Recorder No. 27, accelerometers Nos. 1, 22, and 27, formerly at San Jose Bank of America Building, 13th floor, installed.	Great Falls, Mont.	May 15, 1943. . .	Station established. Recorder No. 49, accelerometers Nos. 136, 137, and 138, formerly at Missoula, Mont., installed.

*Sensitivity in this table is expressed in cm./gal. (Cm. per 1 one-thousandth of "g".)

TILT OBSERVATIONS

With the cooperation of the University of California, three tilt-meters were kept in operation at Berkeley during the entire year. The tilt-graph of data obtained from these instruments for 1943 is shown in Figure 14.

A fourth instrument was operated at Long Beach in cooperation with the Long Beach Harbor Department. The 1943 tilt-graph for this station is shown in Figure 15.

ADDITIONS AND CORRECTIONS TO PREVIOUS PUBLICATIONS

1942. *Serial 662, P. 1.* Under the subhead "Earthquake information services" the date at the end of the second paragraph should read 1942.

Page 22, Table 2, "Principal earthquakes of the world from January 1942 to December 1942, inclusive." The intensity given in the remarks column for the shock of August 1 should be VIII.

Page 37. The next to the last paragraph under the heading "Changes in Strong-Motion Instrument Equipment During 1942" should read: During 1942 double magnification systems were installed at El Centro, Pasadena, Santa Barbara, and Westwood. At Long Beach a double magnification instrument was installed in May and replaced by a single magnification instrument in August.

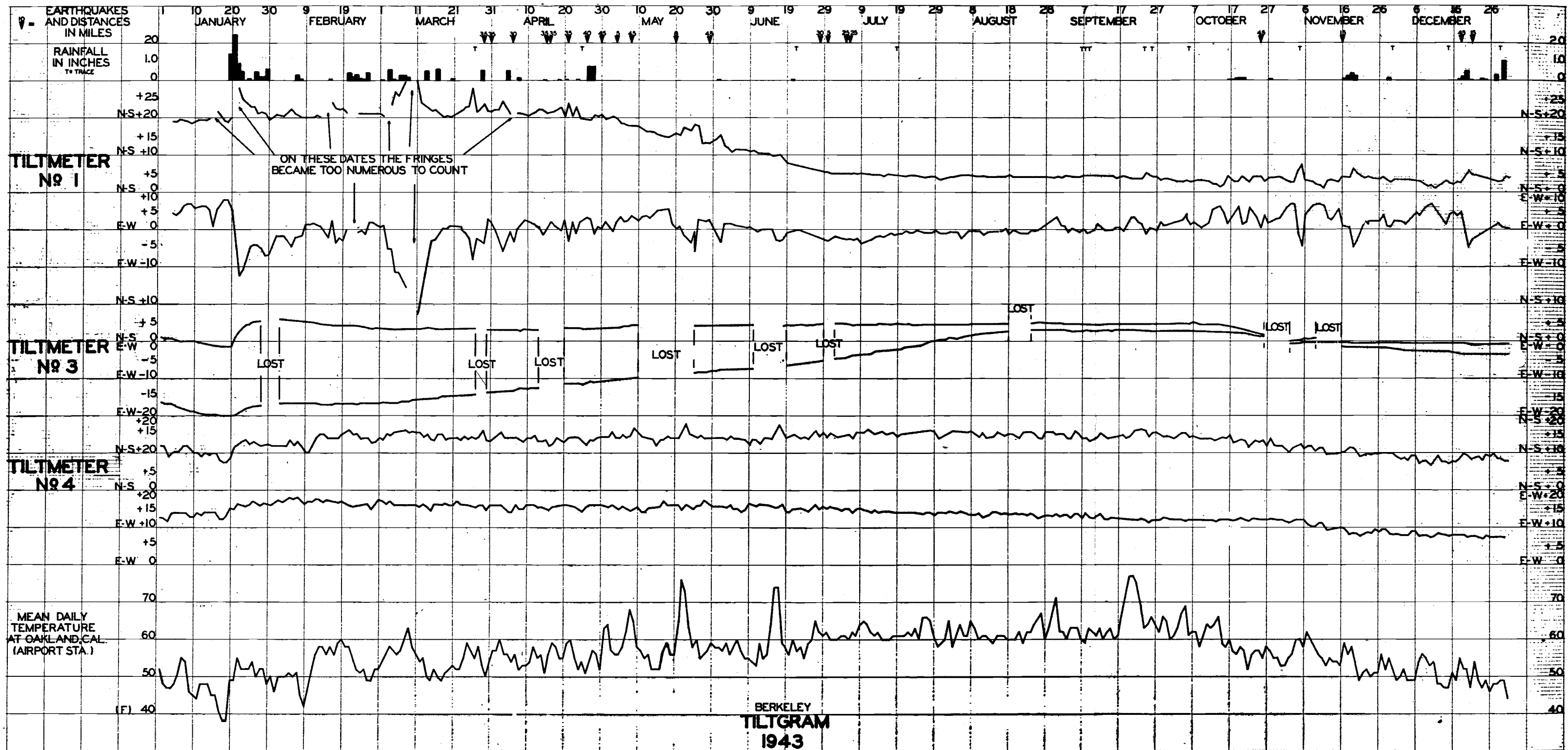


FIGURE 14.—Berkeley tilt-graph for 1943.

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