A UNITED STATES DEPARTMENT OF **COMMERCE** PUBLICATION

EARTHQUAKE HISTORY OF THE UNITED STATES

Publication 41-1
Revised Edition (Through 1970)

U.S. DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Environmental Data Service

Boulder, Colo.

EARTHQUAKE HISTORY OF THE UNITED STATES

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(Reprinted 1977)

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Contents

	Page
Introduction	1
Explanation of data in tables	3
Modified Mercalli intensity scale of 1931	3
Northeastern Region	5
Résumé	5
List of earthquakes in Northeastern Region	5
Major earthquakes	9
Intermediate and minor earthquakes	11
Eastern Region	21
Résumé	21
List of earthquakes in Eastern Region	21
Major earthquakes	25
Intermediate and minor earthquakes	28
Central Region	37
Résumé	37
List of earthquakes in Central Region	37
Major earthquakes	43
Intermediate and minor earthquakes	46
Western Mountain Region	59
Résumé	59
List of earthquakes in Western Mountain Region	59
Major earthquakes	68
Intermediate and minor earthquakes	74
Washington and Oregon	89
Résumé	89
List of earthquakes in Washington and Oregon	89
Intermediate and minor earthquakes	93
Alaska	101
Résumé	101
List of earthquakes in Alaska	101
Major earthquakes	106
Intermediate and minor earthquakes	110
Hawaii	121
Résumé	121

CONTENTS—Continued

	Page
List of earthquakes in Hawaii	121
Major earthquakes	123
Intermediate and minor earthquakes	124
Puerto Rico Region	127
Résumé	127
List of earthquakes in Puerto Rico Region	127
Major earthquakes	128
Intermediate and minor earthquakes	129
References	133
California and Western Nevada	137
Résumé	137
List of earthquakes in California and Western Nevada	137
Major earthquakes	149
Intermediate and minor earthquakes	155
Bibliography	186
Earthquakes in the Various States	191
Alabama	191
Arizona	191
Arkansas	192
Colorado	192
Connecticut	192
Delaware	193
District of Columbia	193
Florida	193
Georgia	193
Idaho	194
Illinois	194
Indiana	195
Iowa	195
Kansas	195
Kentucky	195
Louisiana	196
Maine	196
Maryland	196
Massachusetts	197
Michigan	197
Minnesota	197
Mississippi	198
Missouri	198
Montana	198
Nebraska	199

	Page
Nevada	199
New Hampshire	200
New Jersey	200
New Mexico	200
New York	201
North Carolina	201
North Dakota	202
Ohio	202
Oklahoma	202
Oregon	203
Pennsylvania	203
Rhode Island	203
South Carolina	204
South Dakota	204
Tennessee	204
Texas	205
Utah	205
Vermont	205
Virginia	206
Washington	206
West Virginia	207
Wisconsin	207
Wyoming	207

ILLUSTRATIONS

	Page
COVER. East Bay Street, Charleston, S.C., after earthquake of August 31, 1886. (U.S. Geological Survey photo)	
Earthquakes (intensity V and above) in the United States through 1970	vii
Seismic risk map for conterminous United States	1
Earthquake of August 31, 1886, caused serious damage in Charleston, S.C.	26
Fault scarp created north of Kosmo, Utah, by earthquake of March 12, 1934	71
West wing of Helena High School (Montana) damaged severely by earthquake of October 18, 1935	72

Page

State Highway 287 disappeared into Montana's Hebgen Lake during earthquake of August 17, 1959 73

Earthquake on July 9, 1958, sent a massive rockslide into Lituya Bay, Alaska, causing a 1,740-foot wave. Aerial photo shows Bay and its perimeter, now devoid of trees 107

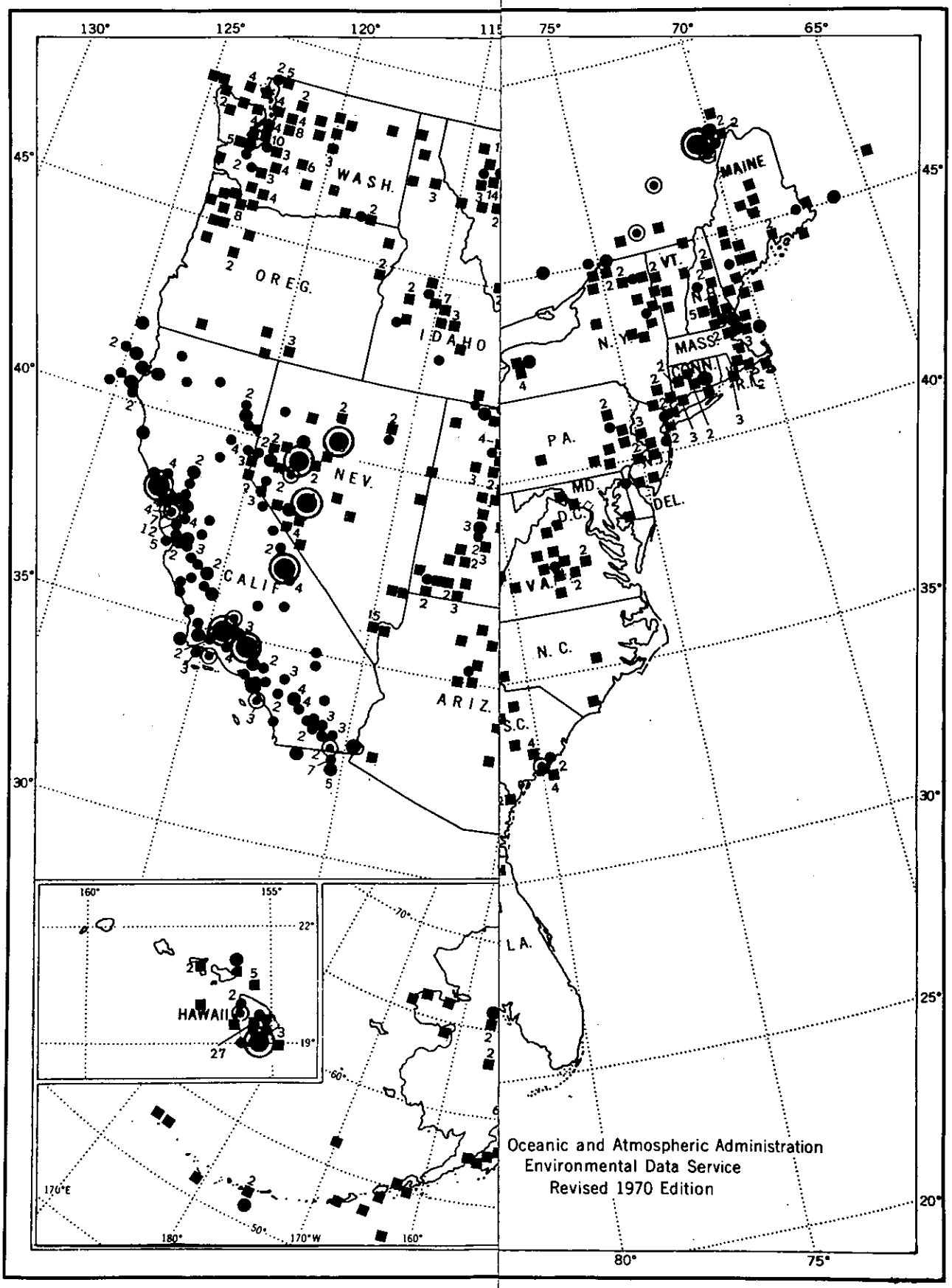
March 27, 1964, earthquake partially collapsed J.C. Penney Co. store in Anchorage, Alaska. Note building next door that appears to be completely untouched by quake 109

Part of 130 acres of land devastated by 1964 Good Friday shock in Turnagain Heights area of Anchorage, Alaska 110

San Francisco's California Street after earthquake and fire of April 18, 1906 151

Railroad tracks were shifted and bent by July 21, 1952, earthquake 154

Earthquake of December 16, 1954, left this fault scarp in Nevada 154


WASH.
OREG.
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NEV.
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Revised 1970 Edition

ADDENDA AND CORRIGENDA

Page 5: 1638, June 11, 14:00, 16:00. Change coordinates to "42.5, 69.0." Intensity should read "VIII." Change last Authority to "47A."

Page 6: 1755, Nov. 18, 04:11. Latitude should read "42.6."

Page 7: 1925, Feb. 28, 21:19*. Change coordinates to "48.25, 70.75." Change last Authority to "47A."

Page 8: 1940, Dec. 20, 02:27*. Change coordinates to "43.7, 71.5." Add "43" to Authority column.
1944, Sept. 4, 1966, 23:39*. Change latitude to "44.8." Add "43" to Authority column.

Page 9: 1966, Jan. 1, 08:24*. Area should read "18,000." Add "3-54" to Authority column.

Page 14: Second column, 1897, May 27, third line, change Hartford, N.Y., to "Hartford, Conn."

Page 17: First column, second paragraph, change 1940, Dec. 20, Lake Ossipee, N.H. to "1940. Jan. 28, Buzzards Bay, Mass. Felt..."
First column, earthquakes of 1940, Dec. 20, and 1944, Sept. 4, add "Magnitude 5.6" to both descriptions.

Page 21: 1774, Feb. 21, 14:00. Add "37.2, 77.4" as coordinates.

Page 23: 1897, May 31, 13:58. Intensity should read "VIII."

Page 24: 1945, July 26, 05:32*. Change coordinates to "34.5, 81.5." Add "43" to Authority column.

Page 25: 1964, May 12, 04:45*. Change time to "01:45*."

Page 32: Second column, first paragraph, 1916, Oct. 8. Oct. 8 should read "Oct. 18."

Page 40: 1917, Mar. 27, 13:56. Change date to Mar. "28."

Page 41: 1936, June 19, 21:24. Change time to "21:24*." Change coordinates to "35.7, 100.3."

Page 42: 1956, Jan. 28, 22:14*. Change time to "22:44."

Page 50: Second column, 1917, Mar. 27. Change date to Mar. "28."

Page 61: Add in chronological order the following:
1915, Oct. 2, 22:54*, Pleasant Valley, Nev., 40.3, 117.6, 500,000, X, 3-5, 3-29, 3-43, 3-55, 4.

Page 62: 1931, Apr. 17, 05:38. Change time to "05:38*."
1931, Aug. 16, 05:40*. Change time to "04:40*." Change latitude to "30.6."

Page 63: 1938, Sept. 17, 10:20. Change time to "10:20*." Change coordinates to "33¼, 108¾." Add "43" to Authority column.
1939, May 4, 13:44*. Change time to "13:45*." Latitude should read "37.0." Add "43" to Authority column.
1944, July 12, 12:30*. Change coordinates to "44.5, 115.5." Add "43" to Authority column.
1945, Sept. 23, 02:59*. Change time to "02:58*." Add "43" to Authority column.

Page 67: 1965, Jan. 12, 20:44*. Change Eastern Idaho to "Southwestern Montana."
1967, Sept. 23, 21:47*. Change time to "22:01*."

Page 71: First column, earthquake of Aug. 16, 1931, change latitude to "30.6."
First column, earthquake of Mar. 12, 1934, change epicenter to "41.5° N, 112.5° W, near Kosmo, Utah."
Add epicenter of second shock "41.75° N, 112.50° W."

Page 85: First column, 1965, Jan. 12. Change Eastern Idaho to "Southwestern Montana."

Page 91: 1936, July 15, 23:08*. Change longitude to "118.5."
1940, Oct. 27, 14:30. Change time to "14:29*."
1946, Feb. 14, 19:18*. Change coordinates to "47.5, 122.5." Add "43" to Authority column.
1949, Apr. 13, 11:56*. Change coordinates to "47.3, 122.5."

Page 92: 1955, Sept. 10, 08:53*. Change time to "16:53*."

Page 102: Add in chronological order the following:
1899, Sept. 10, 07:04*, 60.0, 142.0, VII, 29.
1899, Sept. 10, 11:40*. Change time to "11:41*."

Page 103: 1927, Nov. 12, 12:56*. Change time to "11:56." Delete coordinates and Do. in Authority column. Add "10" in Authority column.
1931, Oct. 17, 02:30*. Change time to "02:35*. Change coordinates to "63, 147." Add "43" to Authority column.

Page 104: 1946, Apr. 1, 02:29*. Change longitude to "163.5."

Page 106: 1964, Dec. 12, 14:33*. Change longitude to "165.7."
Under Major Earthquakes, first column, change time of occurrence of Sept. 10 shock to "07:04*, 11:41*." Change intensity to "XI, VII, and XI, respectively." Change magnitudes to 8.3, 7.8, and 8.6, respectively.

Page 112: First column, 1904, Aug. 27. Change magnitude to "8.3."

Page 128: 1959, Jan. 26, 20:20*. Intensity should read "VI."

Page 130: Second column, 1943, July 29. Change magnitude to "7.9."

Page 140: 1906, Apr. 18, 05:12. Change time to "05:12*."

Page 143: 1939, May 11, 10:05*. Change time to "10:04" and latitude to "38.5."

Page 144: 1947, June 22, 15:30*. Change time to "15:29*."

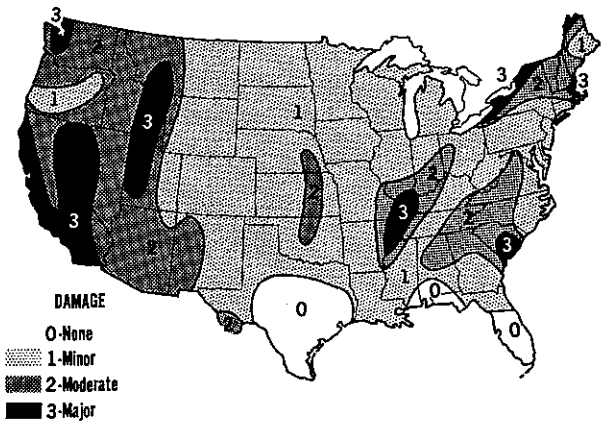
Introduction

This publication is a history of the prominent earthquakes in the United States from historical times through 1970. It supersedes all previous editions with the same or similar titles (see page ii) and, in addition to updating earthquake listings through 1970, contains several additions and corrections to previous issues. It also brings together under a common cover earthquake data previously listed in two separate reports: *Earthquake History of the United States, Part I, Stronger Earthquakes of the United States (Exclusive of California and Western Nevada)* and *Earthquake History of the United States, Part II, Stronger Earthquakes of California and Western Nevada.* Another addition to this publication is the inclusion of a section describing earthquakes in the Puerto Rico region.

For the purpose of listing and describing earthquakes, the United States has been divided into nine regions: (1) Northeastern Region, which includes New England and New York activity and observations of the principal earthquakes of eastern Canada; (2) Eastern Region, including the central Appalachian seismic region activity and the area near Charleston, S.C.; (3) Central Region, which consists of the area between the region just described and the Rocky Mountains; (4) Western Mountain Region, which includes all remaining states except those on the Pacific coast; (5) Washington and Oregon; (6) Alaska; (7) Hawaii; (8) Puerto Rico; and (9) California and Western Nevada. This arrangement has been made chiefly with reference to the natural seismic divisions. It also is a convenient arrangement because there are only three states where there is an important division of earthquake activity: In Tennessee, there are quite distinct areas at opposite ends of the state that fall into different regions. Only central and eastern Nevada are included in the Western Mountain Region, as the activity of the western part is closely associated with that of California. Some earthquake activity has occurred in the part of Texas located in the Western Mountain Region.

The map facing page 1 shows locations of all earthquakes in the regions that follow. A small map showing the area covered by each region immediately precedes the résumé of each chapter (except for the Alaska, Puerto Rico, and Hawaii regions). The seismic risk map below was developed in January 1969 for the conterminous United States by Dr. S. T. Algermissen of NOAA's Environmental Research Laboratories. Subject to revision as continuing research warrants, it is an updated edition of a map divides the United States into four zones: Zone 0, areas with no reasonable expectancy of earthquake damage; Zone 1, expected minor damage; Zone 2, expected moderate damage; and Zone 3, major destructive earthquakes may occur.

When using the statistics in this publication, it should be remembered that exact seismological information has been available for less than 70 years. The most common source of data is reports from eyewitnesses. These are often subject to error,



Seismic risk map for conterminous United States.

especially when the observations are made under conditions of mental stress, surprise, and fear. It has been noted that unless there are many reports from individuals at a certain location, such accounts are difficult to appraise properly because of differences in viewpoint. Also, even though the reports probably are accurate, they may vary greatly over short distances because of changes in character of the geology.

In the early days much of the country was unsettled, making it quite difficult to secure earthquake reports. Much of the felt information has been garnered from newspapers. In some cases it is possible that no reports were received from the region of greatest intensity. Also, there have been occasional errors in year and date, and while every effort has been made to correct errors and to assure uniform treatment, these difficulties must be considered when using the information.

Nearly all published catalogs have attempted to give a complete listing of earthquakes regardless of intensity. This publication is not a catalog and includes only earthquakes of intensity V and over (intensity VI and over in California and western Nevada). However, the area affected by each shock is also a measure of its importance. Therefore, earthquakes with questionable intensity IV–V ratings that were felt over a considerable area are included in a few cases. This plan has resulted in the inclusion of practically all earthquakes of general interest.

Technical terms have been avoided where possible, though the use of a few has been unavoidable. The term *epicenter* refers to the area on the surface of the earth directly above the subterranean origin. *Intensity* is the violence of earthquake motion in any part of the perceptible area of an earthquake and is based on the effects observed on people and objects. All intensities are stated in terms of the Modified Mercalli Intensity Scale of 1931 (see page 3). This scale has been adopted in the publications of NOAA's Environmental Data Service and Environmental Research Laboratories and is widely used by other organizations engaged in seismological investigations. Intensities, unless otherwise stated, are the maximums observed. Where sufficient information is lacking, as in the case of many earlier shocks, no intensity is given.

Magnitude, stated according to the Gutenberg-Richter scale, is a measure of the energy release at the focus of an earthquake, as determined by amplitudes produced on a seismogram. Although the magnitude scale has no top nor bottom values, the highest ever recorded was magnitude 8.9 and the lowest was about minus 3. On this logarithmic scale, a magnitude 8 earthquake represents recorded amplitudes 10 times larger than those of a magnitude 7 earthquake, 100 times larger than a shock of magnitude 6, etc. When related to energy release, each whole unit increase in magnitude represents an approximate 63-fold increase. Magnitudes given in this publication were determined by several organizations, including Dominion Observatory, Ottawa; Lamont-Doherty Geological Observatory, Palisades, N.Y.; Hawaii Volcano Observatory, Hawaii; California Institute of Technology, Pasadena; University of California, Berkeley; and NOAA's Environmental Research Laboratories, Boulder.

Users of this volume are reminded of the availability of annual earthquake reports, issued since 1928 under the title *United States Earthquakes.* Listings of all cities and towns reporting an earthquake are included, along with detailed descriptions of damage. Isoseismal (felt-area) maps are presented for earthquakes felt over extended distances. In addition, related information such as strong-motion seismographic data, geodetic work of seismological interest, and fluctuations in well-water levels is presented. Annual issues for years subsequent to 1970 are scheduled to be released approximately 18 to 21 months after the close of the reporting period. A complete price list of *United States Earthquakes* issues available, as well as other seismological publications, may be requested from: NOAA, Environmental Data Service, National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo. 80302.

References on page 133 are given in such form that the original article or publication can be found with little trouble. They are intended to give full credit to the publication and author for the information. The degree of completeness of the list is largely due to the cooperation of various persons, including the late Ernest A. Hodgson, Dominion Observatory, Ottawa, Canada; the late Rev. Francis A. Tondorf, S.J., Georgetown University, Washington, D.C.; and the late Rev. James B. Macelwane, S.J., St. Louis University, St. Louis, Mo., all of whom contributed lists of authorities or information about individual earthquakes. Spe-

cial credit is due the late Prof. Harry Fielding Reid, Johns Hopkins University, Baltimore, Md., who permitted the use of his unpublished records and additional data about earthquakes published elsewhere.

A bibliography accompanies the California and Western Nevada section. Data for shocks up to 1927 are based largely on the Townley and Allen (1939) catalog. Information for 1928 and subsequent years is generally contained in the annual *United States Earthquakes* report. The Bulletin of the Seismological Society of America also is widely referenced (see Bibliography, page 186).

EXPLANATION OF DATA IN TABLES

In the following lists, the year and the date may be accepted as correct unless doubt is expressed in the list itself. In several cases the same earthquake appears under different years in different catalogs, but it is believed that these have been corrected. Because of the small number of earthquakes listed prior to 1752, the year of the adoption of the Gregorian calendar, all dates are given according to that calendar, or new style.

The time of day given is the standard time of the epicentral region. Exceptions are Alaska, which has been standardized to 150° meridian time, and a few states in the eastern time zone that are included in the Central Region because of their seismic association with that region. Time is expressed continuously from midnight to midnight or 0 to 24 hours. When the hour alone is given the exact time is uncertain. When the minute is given the time is fairly well known, though the minute cannot be accepted as being absolutely correct, particularly before 1928.

The position of the epicenter, if somewhat indefinite, is given to the nearest degree. If the time of an earthquake is followed by an asterisk, the location and time indicated are instrumental; otherwise, the location given is, in most cases, the position of highest intensity reported. Very few earthquakes before 1928 were located by instrumental observation. The positions given are the most probable from existing data, or as stated earlier, the centers of highest intensity.

The locality given in the list is usually that of the epicenter or the town that experienced the highest intensity, though in some cases where the epicenter is uncertain, the extent of the area where it was felt is indicated.

The total felt area of an earthquake is always somewhat indefinite. In most cases it is approximately that included within isoseismal III, though the position of this line is often indefinite.

Intensities, unless otherwise stated, are the maximum reported. It usually is not possible to indicate the size of the area over which this maximum intensity was felt as the information is too incomplete.

Duration and direction of the shock, considered important information in many catalogs, are not generally given in this publication. Such information is especially subject to error. Few people are able to estimate time intervals accurately under the best conditions, and, when disturbed, are almost certain to be in error. With regard to apparent direction, the sensations are probably more accurate, but the waves in the central region are very confused and the apparent direction is of no value in epicenter determinations.

MODIFIED MERCALLI INTENSITY SCALE OF 1931[1]

(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 III Rossi-Forel Scale.)

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing truck. Duration estimated. (III Rossi-Forel Scale.)

IV. During the day felt indoors by many, outdoors by few. At night some awakened.

[1] Harry O. Wood and Frank Neumann, in *Bulletin of the Seismological Society of America,* Vol. 21, No. 4, December 1931.

Dishes, windows, and doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably. (IV to V Rossi-Forel Scale.)

V. Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (V to VI Rossi-Forel Scale.)

VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. (VI to VII Rossi-Forel Scale.)

VII. Everybody runs outdoors. Damage *negligible* in buildings of good design and construction; *slight to moderate* in well built ordinary structures; *considerable* in poorly built or badly designed structures. Some chimneys broken. Noticed by persons driving motorcars. (VIII− Rossi-Forel Scale.)

VIII. Damage *slight* in specially designed structures; *considerable* in ordinary substantial buildings, with partial collapse; *great* in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motorcars disturbed. (VIII+ to IX Rossi-Forel Scale.)

IX. Damage *considerable* in specially designed structures; well-designed frame structures thrown out of plumb; *great* in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (IX+ Rossi-Forel Scale.)

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. (X Rossi-Forel Scale.)

XI. Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines 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.

Northeastern Region

Résumé

The Northeastern Region of the country contains zones of relatively high seismic activity. New York and Massachusetts have experienced numerous shocks, several quite severe. This region also is affected by large earthquakes originating in adjacent Canada, principally in the St. Lawrence Valley and the Laurentian Trough. Earthquakes in this region may be explained by the readjustment of the crust, subsequent to the relatively recent Ice Age. Some geologists suggest the ice load deformed the earth's crust during the glacial periods, and now it is gradually coming back to its normal position. As the adjustments may occur deep within the earth, major surface faulting (a rarity in this region) need not be present.

List of Earthquakes in Northeastern Region

Year	Date	Time (EST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1638	June 11	14:00 16:00	Probably St. Lawrence Valley	46.5	72.5	.....	IX	1, 42, 47
1643	June 11	13:00	Newbury, Mass	42.8	70.8	.....	.....	1, 47
1658	Apr. 14	.....	New England	.....	.....	.....	VII	1
1661	Feb. 10	.....	St. Lawrence Valley	45.5	73.0	.....	(2)	1, 47
1663	Feb. 5	17:30	St. Lawrence River region	47.6	70.1	750,000	X	1, 1A, 41, 42, 47
1727	Nov. 9	22:40	Newbury, Mass	42.8	70.8	75,000	VIII	1, 42
1732	Sept. 16	11:00	St. Lawrence Valley	45.5	73.6	.....	IX	1, 47

See footnotes at end of table.

List of Earthquakes in Northeastern Region—Continued

Year	Date	Time (EST)	Locality	N. lat.	W. long.	Area	Intensity	Authority [1]
				degrees	*degrees*	*sq. mi.*		
1737	Feb. 17	16:30	Boston, Mass	42.4	71.0	.....	.....	1
	Dec. 18	23:00	Near New York City, N.Y	40.8	74.0	.....	VII	1, 37, 47
1741	June 24	10:35	Eastern Massachusetts	42.2	71.2	1,000	.....	1, 47
1744	June 14	10:15	..... do	.....	.....	.....	.....	42
1755	Nov. 18	04:11	East of Cape Ann, Mass	42.5	70.0	300,000	VIII	1, 40, 42, 47
	Nov. 18	05:29	..... do	42.5	70.0	.....	.....	1
	Nov. 22	20:27	..... do	42.5	70.0	.....	V	1
	Dec. 19	22:00	..... do	42.5	70.0	.....	.....	1
1783	Nov. 29	21:00 / 23:00	New Hampshire to Pennsylvania	.....	.....	.....	.....	1
1791	May 18	22:00	East Haddam, Conn	41.5	72.5	35,000	VIII	1
1792	Aug. 28	22:00	..... do	41.5	72.5	.....	.....	1
1793	Jan. 11	08:00	..... do	41.5	72.5	.....	.....	1
1794	Mar. 6	14:00 / 23:00	..... do	41.5	72.5	.....	.....	1
1805	Aug. 11	19:00	..... do	41.5	72.5	.....	.....	1
1810	Nov. 9	21:15	Exeter, N.H	43.0	70.9	.....	VI	1
1817	May 22	15:00	Central Maine	46.0	69.0	.....	VI	47
	Oct. 5	11:45	Woburn, Mass	42.5	71.2	.....	VII–VIII	1, 47
1827	Aug. 23	.....	New London, Conn	41.4	72.7	.....	IV–V	1
1837	Apr. 12	.....	Hartford, Conn	41.7	72.7	.....	V	1
1840	Aug. 9	15:30	Southern Connecticut	41.5	72.9	7,500	V	1, 47
1841	Jan. 25	a.m.	New York	.....	.....	.....	.....	1
1847	Aug. 8	10:00	Southeastern Massachusetts	42	71	.....	.....	1
1848	Sept. 9	22:00	Connecticut, New Jersey, Pennsylvania, and Rhode Island.	.....	.....	.....	.....	1
1852	Nov. 27	23:45	Northeastern Massachusetts	42.8	71.0	2,000	V	1
1853	Mar. 12	02:03	Northern New York	43.7	75.5	.....	VI	1
1854	Dec. 10	12:30	Newburyport, Mass	42.8	70.8	600	V	1
1855	Feb. 8	06:30	Canada, felt to south	46.0	64.5	85,000	VI [8]	1, 47
1857	Oct. 23	15:15	Western New York	43.2	78.6	18,000	VI	2-58
1858	June 30	22:45	New Haven, Conn	41.8	73.0	1,000	V	1
1860	Oct. 17	06:00	Canada, felt to south	47.5	70.0	700,000	VIII–IX	1, 47
1861	July 12	21:00	..... do	45.4	75.4	100,000	VII	Do.
1867	Dec. 18	03:00	Vermont	44	73	.....	V	1
1869	Oct. 22	06:00	Bay of Fundy	45.0	66.2	250,000	VIII	1, 47
1870	Oct. 20	11:25	Canada, felt to south	47.4	70.5	1,000,000	IX	1, 47, 72
1872	Jan. 9	19:54	..... do	47.5	70.5	100,000	VII	2-72
	July 11	05:25	Westchester County, N.Y	40.9	73.8	100	V	2-73
	Nov. 18	14:00	Concord, N.H	43.2	71.6	1,000	IV–V	2-73
1873	July 6	09:30	Ontario, Canada	43.0	79.5	30,000	V	2-74
1874	Feb. 27	22:40	Southeastern Maine	44.8	68.7	6,000	V	2-75
	Dec. 10	22:25	Westchester, N.Y	40.9	73.8	5,000	VI	2-75
1875	July 28	04:10	Connecticut	41.8	73.2	2,000	V	2-76
1876	Sept. 21	23:30	Southeastern Massachusetts	42.8	70.9	500	IV–V	2-81
1877	Nov. 4	01:56	Northern New York	44.5	74.0	90,000	VII	2-78, 47
1878	Oct. 4	02:30	Hudson River, N.Y	41.5	74.0	600	V	2-79

See footnotes at end of table.

List of Earthquakes in Northeastern Region—Continued

Year	Date	Time (EST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1879	Aug. 21	03:00	Canada, northwest of Buffalo, N.Y.	43.2	79.2	1,300	V	2-80
1880	May 12	07:45	Northeastern Massachusetts	42.8	70.9	500	IV–V	2-81
1881	Jan. 20	21:40	Bath, Maine	44	70	2,000	IV–V	2-81
1882	Dec. 19	17:20	New Hampshire	43.2	71.4	1,000	V	4
	Dec. 31	22:00	Maine and New Brunswick	45	67	80,000	V	8
1883	Feb. 27	22:30	Rhode Island	41.5	71.5	.....	V	4
1884	Jan. 18	02:00	Contoocook, N.H	43.2	71.7	(2)	.....	8
	Aug. 10	14:07	Near New York City, N.Y	40.6	74.0	70,000	VII	2-85
	Nov. 23	00:30	Southern New Hampshire	43.2	71.7	8,000	V–VI	2-85
1891	May 1	19:10	..... do	43.2	71.6	3,000	V	8
1893	Mar. 9	00:30	New York City, N.Y	40.6	74.0	(4)	V	8
1896	Mar. 22	19:56	Maine and New Brunswick	45.2	67.2	8,000	IV–V	8
1897	May 27	22:16	Northeastern New York	44.5	74.5	150,000	VI	8
1898	Sept. 17	10:54	Near Belfast, Maine	44.3	69.1	(4)	IV–V	8
1903	Jan. 21	a.m.	Eastern Massachusetts	42.1	70.9	500	V	8
	Apr. 24	07:30	Northeastern Massachusetts	42.7	71.0	350	V	8
	Dec. 25	07:30	Near Madrid, N.Y	44.7	75.5	1,500	V	8
1904	Mar. 21	01:04	Southeastern Maine	45.0	67.2	150,000	VII	3-1, 5, 8
1905	July 15	05:10	Maine and New Hampshire	44.3	69.8	20,000	V	8
	Aug. 30	05:42	Rockingham County, N.H	43	71	400	IV–V	4, 8
	Oct. 22	a.m.	Northern Vermont	44.9	72.2	(4)	IV–V	4, 8
1907	Jan. 24	06:30	Schenectady, N.Y	42.8	74.0	(4)	IV–V	4
	Oct. 15	19:10	Northeastern Massachusetts and southeastern New Hampshire.	42.8	71.0	1,200	V	4, 8, 9
1908	Feb. 5	03:20	Housatonic Valley, Conn	.....	.....	.....	.....	9
1910	Jan. 22	20:15	Cumberland County, Maine	43.8	70.4	150	V	8
1912	Dec. 11	05:15	Near Calais, Maine	45.0	68.0	20,000	V–VI	5, 8
1913	Apr. 28	19:30	Near Potsdam, N.Y	44.8	75.3	3,000	VI	8, 47
	Aug. 10	00:15	Lake Placid, N.Y	44	74	2,500	V	8
1914	Jan. 13	03:00	Maine and New Brunswick	45.1	67.2	(4)	V	8
	Feb. 10	13:31	Canada, felt to south	45.0	76.9	200,000	VII[8]	8, 47
	Feb. 21	19:15	Western Maine	45.0	70.5	8,000	V	8
1916	Jan. 5	08:56	Near Lake George, N.Y	43.7	73.7	300	V	4, 11
	Feb. 2	23:26	Mohawk Valley, N.Y	43	74	8,000	V	4
	June 8	16:15	Near New York City, N.Y	41.0	73.8	(4)	IV–V	4
	Nov. 1	21:32	Glens Falls, N.Y	43.3	73.7	300	V	11
1917	May 22	04:00	St. Lawrence Valley	45	75	15,000	IV–V	8
1918	Aug. 20	23:12	Southern Maine	44.2	70.6	15,000	VII	4
1924	Sept. 30	03:52	Probably St. Lawrence Valley	47.6	69.7	30,000	V[6]	10, 47
1925	Jan. 7	08:07	Eastern Massachusetts	42.6	70.6	20,000	V	3-14, 10
	Feb. 28	21:19*	St. Lawrence River region	47.7	70.5	2,000,000	VIII	3-15, 10, 13, 43, 47
	Apr. 24	02:56	Southeastern Massachusetts	41.8	70.8	1,600	V	10, 11
	Oct. 9	08:56	Southeastern New Hampshire and Maine.	43.7	70.7	15,000	VI	8, 10, 47
	Nov. 14	08:04	Near Hartford, Conn	41.5	72.5	850	VI	10
1926	Mar. 18	16:11	Near Manchester, N.H	42.9	71.4	800	VI	10, 47
	May 11	22:30	New Rochelle, N.Y	40.9	73.9	150	V	10
	Aug. 28	16:00	Western Maine	44.7	70.0	3,000	V	10

See footnotes at end of table.

List of Earthquakes in Northeastern Region—Continued

Year	Date	Time (EST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1927	Mar. 8	23:08	Concord, N.H	43.3	71.4	600	V	10, 47
1928	Feb. 8	.....	Milo, Maine	45.5	69.0	([4])	VI	11, 27
	Mar. 18	10:20	Saranac Lake, N.Y	44.5	74.3	12,000	V–VI	27, 47A
	Apr. 25	18:38	Berlin, N.H	44.5	71.2	3,000	V	27
1929	Aug. 12	06:25*	Attica, N.Y	42.9	78.3	100,000	VIII	27, 47A
	Nov. 18	15:32*	Grand Banks of Newfoundland	44	56	[5] 80,000	X	27, 43, 47A
	Dec. 2	17:14*	Attica, N.Y	42.8	78.3	([4])	V	27
1931	Jan. 7	19:14	Canada, felt to south	47.4	70.5	.....	IV[3]	27, 43
	Apr. 20	14:56*	Lake George, N.Y	43.4	73.7	60,000	VII	27
1933	Oct. 29	p.m.	St. Johnsville, N.Y	43.0	74.7	.....	IV	27
1934	Apr. 14	21:58*	Adirondack Mountains, N.Y	44.5	73.9	8,000	V–VI	27
1935	Apr. 23	20:24*	Near Cape Cod, Mass	42.2	70.2	.....	IV	27
	Nov. 1	01:04*	Timiskaming, Canada	46.8	79.1	1,000,000	VI[6]	27, 43, 47A
1938	Aug. 22	07:48	Vicinity of Bangor, Maine	44.7	68.8	3,500	V	27
1939	Oct. 19	06:54*	Canada, at confluence of Saguenay and St. Lawrence Rivers.	47.8	70.0	[5] 90,000	V[3]	27, 43, 47A
1940	Jan. 28	18:12*	Buzzards Bay, Mass	41.6	70.8	2,000	V	27
	Dec. 20	02:27*	Lake Ossipee, N.H	43.8	71.3	150,000	VII	27
	Dec. 24	08:44*	..... do	43.8	71.3	.....	VII	27
1943	Jan. 14	16:33*	Dover-Foxcroft area, Maine	45.3	69.6	50,000	V	27
1944	Sept. 4	23:39*	Massena, N.Y., and Cornwall, Ontario, Canada.	44.9	74.8	[5] 175,000	VIII	27, 37, 47A
1947	Dec. 28	14:58*	Dover-Foxcroft, Maine	45.2	69.2	6,000	V	27
1949	Oct. 4	21:34*	Southwestern Maine	44.8	70.5	16,000	V	27
1951	Sept. 3	20:26	Rockland County, N.Y	41.2	74.1	5,500	V	27
1952	Jan. 29	23:00	Burlington, Vt	44.5	73.2	([4])	VI	27
	Aug. 24	19:07	Mohawk Valley, N.Y	43.0	74.5	400	V	27
	Oct. 8	16:40	Poughkeepsie, N.Y	41.7	74.0	.....	V	27
	Oct. 14	17:04*	South-central Quebec, Canada	48.0	69.8	.....	V[3]	27, 47A
1953	Mar. 27	03:50	Stamford, Conn	41.1	73.5	.....	V	27
	Mar. 31	07:59	West-central Vermont	43.7	73.0	.....	V	27
1954	July 29	15:57	Maine-Massachusetts-New Hampshire coastal areas.	.....	.....	.....	V	27
1955	Feb. 2	p.m.	Burlington, Vt	44.5	73.2	([4])	V	27
	Aug. 16	02:35	Attica, N.Y	42.9	78.3	.....	V	27
1957	Apr. 23	19:42	St. Johnsbury, Vt	44.4	72.0	([4])	V	27
	Apr. 26	06:40*	Near coast of Maine	43.6	69.8	31,500	VI	27
1958	Sept. 19	About 12:45	Cape Elizabeth, Maine	43.5	70.2	([4])	V	27
1961	Apr. 20	08:15	Massena, N.Y	44.9	74.9	.....	V	27
1962	Mar. 27	01:37	Niagara Falls, N.Y	43.1	79.1	.....	V	27
	Apr. 10	09:31*	Vermont	44.1	73.4	20,000	V	27
	June 20	21:07*	Southern Quebec, Canada	45.4	72.7	.....	V[3]	27
	Dec. 29	01:19	Milford, N.H	42.8	71.6	.....	V	27
1963	Oct. 16	10:31*	Near coast of Massachusetts	42.5	70.8	6,800	VI	27
	Oct. 30	17:37*	Northeast of Peabody, Mass	42.7	70.8	.....	VI	27
	Dec. 4	16:33*	Tilton-Laconia, N.H	43.6	71.6	.....	V	27
1964	Mar. 29	About 04:16	Massena, N.Y	44.9	74.9	([4])	V	27

See footnotes at end of table.

List of Earthquakes in Northeastern Region—Continued

Year	Date	Time (EST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1964	June 26	07:05*	Near Warner, N.H	43.3	71.9	3,000	VI	27
	Nov. 17	12:08	Westchester County, N.Y	41.2	73.7	.....	V	27
1965	Oct. 24	About 12:45	Nantucket, Mass	41.3	70.1	([4])	V	27
	Dec. 7	22:03*	Narragansett Bay, R.I	41.7	71.4	375	V	27
1966	Jan. 1	08:24*	Attica-Varysburg, N.Y	42.8	78.2	3,500	VI	27, 57
	July 23	21:00*	Jonesport, Maine	44.5	67.6	([4])	V	27
	Oct. 23	18:06*	Manchester, N.H	43.0	71.8	.....	V	27
1967	Feb. 2	08:40*	Narragansett Bay, R.I	41.4	71.4	350	V	27
	June 13	14:09*	Attica-Alabama, N.Y	42.9	78.2	3,000	VI	27
	July 1	09:09* 11:06*	Kennebec County, Maine	44.4	69.9	2,000	V	27
	Nov. 22	17:10	Westchester County, N.Y	41.0	73.7	400	V	27
1968	Oct. 19	05:37*	Southern Ontario, Canada	45.4	74.0	.....	V[3]	27
	Nov. 3	03:34	Southern Connecticut	.....	.....	.....	V	27
1969	Aug. 6	11:03	Moultonboro, N.H	43.8	71.4	([4])	V	27

*Instrumental origin time and epicenter.
[1] See References, p. 133.
[2] Violent.
[3] Intensity in the United States.
[4] Local.
[5] United States area affected.

MAJOR EARTHQUAKES

Earthquake of February 5, 1663

Time of occurrence.—17:30.

Epicenter.—St. Lawrence River region (in the area of 47.6° N., 70.1° W.).

Area felt.—Probably all of eastern Canada and the northeastern part of the United States, about 750,000 square miles.

Intensity.—Probably X at epicenter and high over a large area.

Description.—This earthquake occurred so early in colonial history that the accounts are far from definite. Many of them are quite lurid, telling of mountains being thrown down and of great forests sliding into the St. Lawrence River. However, a number of French priests were in the country at the time, and one of them had passed through the region of greatest change several years before. There seems to be little doubt that this was a very severe earthquake, and that in the vicinity of Three Rivers (Trois-Rivières), Quebec, there were important rockslides that considerably modified a series of waterfalls. There were landslides along the St. Lawrence, and it is stated that the water remained muddy for a month.

This earthquake was felt sharply in New England; in every case the wave motion appeared to come from the northwest. On Massachusetts Bay, houses were shaken, pewter fell from shelves, and chimneys were broken or thrown down. If this earthquake had occurred at a later date, considerable property damage would have resulted.

Earthquake of November 18, 1755

Time of occurrence.—04:11 and 05:29.

Epicenter.—East of Cape Ann, Mass. (approxi-

mate position of 42.5° N., 70.0° W., estimated from distribution of intensities).

Area felt.—From Lake George, N.Y., to a point at sea 200 miles east of Cape Ann, and from the Chesapeake Bay to Annapolis River, Nova Scotia, about 300,000 square miles.

Intensity.—About VIII.

Description.—The earthquake came with a roaring sound like distant thunder, seemingly from the northwest. The shock resembled a long rolling sea, and it was necessary to hold to something to prevent being thrown to the ground. Tops of trees swayed through a large angle. Houses were shaken, windows rattled, and beams cracked. This lasted 2 minutes. The shock was felt from Chesapeake Bay to Annapolis River, Nova Scotia. It was felt on Lake George, and a ship at sea 200 miles east of Cape Ann was thought to have grounded, though the water depth was considerable. At Boston, Mass., walls and chimneys were thrown down; waves, like the swelling of the sea, were reported on the surface of the earth. Gable ends of brick buildings were thrown down. Vanes on buildings were broken off. Stone fences were generally knocked down. A very strong cistern was broken by the agitation of the liquid within it. At Pembroke and Scituate, Mass., small chasms were broken open in the earth through which fine sand reached the surface. In the harbors and along the coast, large numbers of fish were killed, and many people on vessels felt shocks as if the ships were striking bottom. On November 22 at 20:27, there was a quite severe shock, and others occurred on December 19 (one at 22:00).

Earthquake of February 28, 1925

Time of occurrence.—21:19.

Epicenter.—St. Lawrence River region (47.6° N., 70.1° W.).

Area felt.—Eastern Canada, south to Virginia, and west to the Mississippi River, approximately 2 million square miles.

Magnitude.—7.0.

Intensity.—About VIII at the epicenter. Not greater than VI in the United States and IV or less over most of the felt area.

Description.—The epicenter was near the boundary of the Laurentides Provincial Park, about half way between Murray Bay (La Malbaie) and Chicoutimi. While this earthquake was felt widely in the Northeastern United States, and especially in Michigan, there was no record of damage or of direct loss of life, though there were several deaths from shock. It was more instrumental in securing attention to the earthquake problem than any since 1906 (the great San Francisco shock).

The earthquake was remarkable for moderate intensity over a great area and for great variations in intensity at the same distance from the epicenter in various directions. It probably affected a larger number of people than any previous shock in the United States, because it was felt (intensity IV or above) in New York and Boston.

While a very large area was shaken, the area of important damage was comparatively small; it was confined to a narrow belt on both sides of the St. Lawrence River. It was not easy to determine the epicenter because the epicentral region had few inhabitants and instrumental records were somewhat conflicting.

The effects at Quebec are instructive, as they were confined to places where the depth of soil was considerable. The upper part of the wall of the Canadian Pacific Railway Station was damaged. The large grain-receiving sheds and elevators are worthy of mention, because the structure, while very well built, formed a kind of inverted pendulum with the greater part of the mass high above the ground. Cracks were found in the ground parallel to the length of the building, both outside and inside, and the floor pulled apart at these cracks. Columns pulled away from the large bolts holding them to the foundation. In some places, the reinforcing steel worked back and forth so that the concrete fell away and exposed the steel. No one was in the building, but judging from the effects, the swaying and noise must have been terrific. At a large hotel not far away on rock, it scarcely was known that an earthquake had occurred. This indicates the care that must be taken in placing the position of the epicenter from effects on buildings. Both terrain and the character of buildings are important determining factors.

There are few towns in the vicinity of the epicenter, and few buildings of considerable size except for occasional churches. At Pointe-au-Pic,

two old buildings with thick stone walls were badly damaged. At St.-Urbain, a church was badly damaged, but only a few chimneys were thrown down otherwise. These were on buildings which were new, strong, and on a rock foundation. At Rivière-Ouelle, a 53-year-old church in good repair, but built on alluvial soil, had the bells in its tower dislodged and the organ pipes twisted. Several houses were damaged there, but only 20 miles away, buildings on solid rock were undamaged.

At some places no sound was noted; in other areas it arrived before the earthquake was felt. This was more noticeable in the less disturbed area. The aftershocks were preceded by a low-frequency sound like thunder and followed by a sound somewhat like the ripping of cloth.

Vertical motion could be expected near the epicenter, but there were few opportunities for direct observation. At Rivière-Ouelle, a stone weighing 200 pounds was thrown clear of its foundation, though there were dowel pins 2 feet apart that extended 2 inches above the foundation. A chimney collapsed through vertical thrust from below.

The ground was deeply frozen. Cracks appeared on the south shore in the form of grids. A crack 4 inches wide and more than 2 feet deep, after it had partly filled, was observed near Rivière-Ouelle. No cracks in rocks were reported. In places of deep alluvium, the frozen part seemed to have slid on the unfrozen part, leaving cracks through which water and wet sand reached the surface.

The only way to determine whether change of elevation occurred was by lines of precise levels. A former line in the general region was rerun, with definite indications of changes of about 3 inches in some places. Because of the lack of railways, no previous lines had been run in the epicentral region.

There was considerable rotation of monuments. At Murray Bay (La Malbaie), furniture and statues rotated in a clockwise direction, but cemetery monuments fell in every direction except west. At Baie-St.-Paul, monuments turned counterclockwise or fell toward the southeast. In other cemeteries in this region, rotation was in both directions.

One hundred aftershocks were noted in a week at Chicoutimi, and shocks continued for several months. The strongest were felt on April 10 at Murray Bay and April 25 at Chicoutimi. A preliminary shock on September 30, 1924, is described **on page 15.**

INTERMEDIATE AND MINOR EARTHQUAKES

1638. June 11. Probably St. Lawrence Valley. This violent shock was felt near Three Rivers (Trois-Rivières), Quebec, and throughout all of the English plantations. Many persons were frightened. At Plymouth, Mass., people had to hold on to objects to keep from falling. Tops of chimneys were thrown down in the Plymouth, Salem, and Lynn areas. Ships near the coast were shaken. It was also felt in Connecticut, and at Narragansett, R.I. Smaller shocks continued for 20 days.

1643. June 11. Newbury, Mass. Strong.

1658. April 14. New England. Violent.

1661. February 10. St. Lawrence Valley. Violent. Felt at Montreal, Quebec, and Roxbury, Mass.

1727. November 9. Newbury, Mass. There was a heavy rumbling noise, followed within 30 seconds by a heavy shock. Houses shook and rocked as if falling to pieces, and pewter and china were thrown from shelves. The ground rose and fell, and it was difficult to stand. Stone walls and chimneys were shaken down. There was considerable change in flow of springs and, in some cases, in the character of the water. The shock was felt from the Kennebec to the Delaware River and from ships at sea to the extreme Western settlements.

1732. September 16. St. Lawrence Valley. A violent earthquake in Canada did considerable damage in Montreal, where seven persons were killed and some were injured. Houses were damaged at Piscataqua, N.H. It was felt slightly at Boston, Mass., and Annapolis, Md.

1737. February 17. Boston, Mass. No details.

1737. December 18. Near New York City, N.Y. Chimneys were thrown down at New York City. Also felt at Boston, Philadelphia, and at New Castle, Del.

1741. June 24. Eastern Massachusetts. Felt at Boston, Dedham, and Walpole.

1744. June 14. Eastern Massachusetts. Large numbers of bricks were shaken from tops of chimneys at Boston and other towns. Stone walls were shaken down. Many persons were alarmed at Newbury and Ipswich. Reported felt at Falmouth, Maine.

1783. November 29. New Hampshire to Pennsylvania. At New York, three shocks were felt at 21:00 and 23:00 on this date and at 02:00 the following morning, the first two being the strongest. At Philadelphia, the first and last were felt. The shocks were moderate at Boston and elsewhere in New England.

1791. May 18. East Haddam, Conn. Two heavy shocks caused the collapse of stone walls and chimneys. Latched doors were thrown open. A fissure several rods long appeared in the ground, and rocks weighing several tons were moved. At Killingworth (now Clinton), fish were observed leaping out of water. The shock was felt from Boston to New York. About 30 lighter shocks followed in a short time, and upwards of 100 were counted during the night.

1792. August 28. East Haddam, Conn. No details.

1793. January 11. East Haddam, Conn. No details.

1794. March 6. East Haddam, Conn. Two shocks. No details.

1805. August 11. East Haddam, Conn. Two slight shocks. Few details.

1810. November 9. Exeter, N.H. This earthquake was accompanied by a very unusual noise like a great explosion directly beneath the feet. It was most violent between Haverhill, Mass., and Portsmouth, N.H., lasting a minute at the latter place. A vessel in Portsmouth Harbor seemed to strike bottom. Windows were broken at Portsmouth. Also felt at Kennebunk and Portland, Maine.

1817. May 22. Central Maine. Widely felt in Maine and New Brunswick.

1817. October 5. Woburn, Mass. Walls were thrown down. Few details known.

1827. August 23. New London, Conn. Shock accompanied by heavy rumbling; lasted 40 seconds.

1837. April 12. Hartford, Conn. Jarred loose articles and set lamp swinging. Bells rang; people rushed out of houses.

1840. August 9. Southern Connecticut. This earthquake was felt in many parts of Connecticut, sharply at Hartford. At Chester, 25 miles east of New Haven and not far from East Haddam (see earthquakes of 1791 to 1805), the shock was compared to the rumble of thunder. The epicenter appears to have been 10 to 20 miles north of New Haven. The shock was felt over a distance of 100 miles, from Worcester, Mass., to Hartford and Bridgeport, Conn.

1841. January 25. New York. Several shocks were felt in the morning; duration 15 to 20 seconds in all.

1847. August 8. Southeastern Massachusetts. Felt at Boston, Dedham, Cape Cod, and Nantucket.

1848. September 9. Connecticut, New Jersey, Pennsylvania, and Rhode Island. Few details known.

1852. November 27. Northeastern Massachusetts. Explosion and rumbling at Newburyport and through the Merrimac Valley. At Exeter, N.H., the shock lasted 30 seconds and woke people. It was felt at Beverly, Woburn, Groton, and Wenham, Mass.

1853. March 12. Northern New York. Machine was thrown down at Lowville. Also felt in Canada.

1854. December 10. Newburyport, Mass. Also felt at Exeter and Portsmouth, N.H.

1855. February 8. Canada. Felt in New Brunswick, Nova Scotia, and Maine. Strongest at Moncton and Dorchester, New Brunswick. Several shocks were severe enough to damage brick buildings. Windows broke at Dorchester.

1857. October 23. Western New York. At Buffalo, a man seated on a chair was thrown to the ground. Walls vibrated and surged, bells rang, and crocks fell from shelves. At Lockport, rumbling noises were heard for a full minute. This shock was felt at Hamilton, Peterborough, and Port Hope, Ontario, Rochester, N.Y., and Warren, Pa., or over an area 75 miles long from north-northeast to south-southwest and 60 miles east-west. Reported felt at Dayton, Ohio. (This earthquake is erroneously listed in reference 1 as Oct. 8, 1858.)

1858. June 30. New Haven, Conn. There was a noise, like carriages crossing a bridge, and rattling of glass over a considerable area, but not farther than Bridgeport. At Derby, houses were strongly shaken.

1860. October 17. Canada. The epicenter was apparently near Rivière-Ouelle, which was violently shaken. Walls were damaged and chimneys thrown down. The shock was felt along the Atlantic coast of New England, as far south as Newark, N.J., and as far west as Auburn, N.Y. In New England, four moderate shocks were felt; accompanied by rumbling noise. Felt strongly at Saco, Maine.

1861. July 12. Canada. Shock centered at Ottawa where it overturned chimneys; felt strongly at Montreal. It was also felt in adjacent parts of New York, especially at Syracuse, where it lasted 4 seconds and shook furniture.

1867. December 18. Vermont. Felt in New York and adjacent Canada, from Whitehall, N.Y., near the Vermont boundary, to Belleville, Ontario, and Sackville, New Brunswick. It lasted 25 seconds. People were awakened at Hamilton, Ontario, Ogdensburg, and Syracuse, N.Y., and Burlington, Vt.

1869. October 22. Bay of Fundy. Shock widely felt throughout New England and the eastern provinces of Canada. The epicenter was apparently near Fredericton, New Brunswick, where chimneys were thrown down and walls cracked. At St. John, New Brunswick, the shock was severe, lasting about 20 seconds, and was preceded by a rumbling noise. It was felt weakly at Boston and New Haven.

1870. October 20. Canada. This shock was felt most strongly along the St. Lawrence River between Montreal and Quebec, but it was widely felt, being reported at Richmond, Va., Dubuque, Iowa, and Sault Sainte Marie, Mich. It was felt along the New England coast from New York to Portland, Maine, and in eastern New York in the vicinity of Lake George. Walls were reported cracked in Canada; windows were broken at Portland, Maine. At Albany, N.Y., the duration was 1 minute with rumbling noise, and at Cleveland, Ohio, clocks stopped. Observations at Richmond and Dubuque are questionable.

1872. January 9. Canada. Felt along the St. Lawrence River, 200 miles northeast and 60 miles southwest of Quebec. The shock was felt along the coast from Portland to Belfast, Maine. Maximum intensity was reported at Quebec where walls were cracked. At Lancaster, N.H., there were two shocks.

1872. July 11. Westchester County, N.Y. The shock was felt over a nearly circular area, 10 miles in diameter, with the center at New Rochelle, N.Y. At Port Washington, L.I., long pendulum clocks stopped. A rumbling noise, then sounds like bursts of thunder, accompanied the shock. Felt in New Jersey.

1872. November 18. Concord, N.H. Lasted 10 seconds. This was distinctly felt and heard by people walking on the streets. Shock was felt at adjacent towns and in Laconia, 30 miles to the north.

1873. July 6. Ontario, Canada. Apparently centered west of Niagara, N.Y. It lasted 1 minute in Buffalo. Rumbling was heard in many places in New York State. The shock was felt in Erie, Meadville, and Titusville, Pa., and in Wheeling, W. Va. Felt in Ohio and Ontario also.

1874. February 27. Southeastern Maine. Severe shock at Bangor and Eastport.

1874. December 10. Westchester, N.Y. Felt in Westchester and Rockland Counties, N.Y., and Bergen County, N.J. Felt from Peekskill, N.Y., to Norwalk, Conn., most strongly at Tarrytown and Nyack, N.Y. The shock lasted 5 to 6 seconds and was accompanied by a noise like a long rumble, ending in an explosion.

1875. July 28. Connecticut. Felt generally from Hartford and Springfield on the east to the Housatonic River on the west, and from Danbury and Waterbury on the south to Chester and Becket, Mass., on the north. The shock lasted 15 seconds at Collinsville, Conn., and was claimed to have lasted 40 seconds at Winsted. At most places a rumbling noise was heard.

1876. September 21. Southeastern Massachusetts. Felt at Fairhaven and Woods Hole, Mass., and Newport, R.I.

1877. November 4. Northern New York. This shock was felt in the area bounded by a line from Pembroke, Ontario, to Three Rivers (Trois-Rivières), Quebec, on the north, to a line from Boston, Providence, and Hartford to Auburn, N.Y., on the south. It was most severe along the St. Lawrence River and Lake Champlain; lasted 20 seconds at Montreal. Crockery was overturned, ceilings cracked, and chimneys were thrown down. At Saratoga, N.Y., buildings were shaken and a roaring sound was heard. At Auburn, there was damage to windowpanes. At Northampton, Mass.,

houses were shaken. The shock was felt slightly in Rhode Island.

1878. October 4. Hudson River, N.Y. Felt along Hudson River from Marlboro to Peekskill, N.Y., a distance of 25 miles. Violent enough to awaken people; accompanied by a rumbling sound.

1879. August 21. Canada. Area between Lakes Erie and Ontario was shaken severely. Felt at Buffalo, Lockport, and Niagara Falls, N.Y. Strong at St. Catharines, Ontario, where church bells rang. At most places an explosion was heard. It was felt at Beamsville (west of St. Catharines) and Welland, Ontario.

1880. May 12. Northeastern Massachusetts. Affected seaport towns from Amesbury and Newburyport to Salem, and inland to Lawrence. Shocks lasted 5 seconds with rumbling in many places.

1881. January 20. Bath, Maine. Decided earthquake lasted 10 seconds in vicinity of Bath and Brunswick. Felt at Lewiston, Portland, and at various points along the southwest coast of Maine. It was felt 50 miles north of Portland.

1882. December 19. New Hampshire. Strongest near Concord. Buildings shook at Dover, Pittsfield, and elsewhere.

1882. December 31. Near boundary of Maine and New Brunswick. Felt in Maine at Rockland, Bangor, and Eastport, and at Halifax, Nova Scotia.

1883. February 27. Rhode Island. Felt from New London, Conn., to Fall River, Mass.; in Rhode Island from Bristol to Block Island.

1884. January 18. Contoocook, N.H. Violent.

1884. August 10. Near New York City, N.Y. This strong shock affected an area extending from Portsmouth, N.H., to Burlington, Vt., southwest to Binghamton, N.Y., Williamsport, Pa., southeast to Baltimore, Md., and Atlantic City, N.J. Greatest damage occurred at Jamaica and Amityville, N.Y., where large cracks appeared in walls. Thirty towns from Hartford, Conn., to West Chester, Pa., reported fallen bricks and cracked plaster.

1884. November 23. Southern New Hampshire. Also felt in eastern Massachusetts, Connecticut, and eastern New York. At Concord, N.H., a light shock was followed 15 minutes later by a heavy one. At Henniker, N.H., the foundation of a boiler was displaced.

1891. May 1. Southern New Hampshire. Felt at Cambridge, Mass., 60 miles from Concord. People were frightened at Melrose, Mass.

1893. March 9. New York City, N.Y. Duration 5 seconds. Epicenter between 10th and 18th Streets. Animals disturbed at zoo; billiards playing affected.

1896. March 22. Near Calais, Maine. Reports meager.

1897. May 27. Northeastern New York. Felt in New York, New Hampshire, Vermont, and Massachusetts. Felt from Hartford, N.Y., to Montreal and Quebec, Canada. Severe shock but little damage.

1898. September 17. Near Belfast, Maine. Felt at Morrill and other places in vicinity. Duration 11 seconds; followed by another shock in 45 seconds.

1903. January 21. Eastern Massachusetts. Houses were shaken violently, and crockery was broken at Whitman. Shock resembled an explosion. Cracks in the ground 3 inches wide, ¾ mile long at Whitman and Attleboro.

1903. April 24. Northeastern Massachusetts. Pronounced vertical movement in Georgetown, Essex County. Sound preceded and followed.

1903. December 25. Near Madrid, N.Y. Felt at Ogdensburg, throughout St. Lawrence County, and probably over an equal area in Canada, but reports are lacking.

1904. March 21. Southeastern Maine. This shock was felt throughout the greater part of New England and the provinces of New Brunswick and Nova Scotia. It was strongest in the vicinity of Calais and Eastport, Maine, and St. Stephen, New Brunswick, where it overthrew some chimneys. It was felt as far west as the Hudson River, 340 miles; Montreal, Canada, 300 miles; and to southeastern Connecticut, 380 miles from its center. There were several light shocks near the origin a few hours after the main shock.

1905. July 15. Maine and New Hampshire. This shock was felt from southern New Hampshire to central Maine and 100 miles back from the coast. Nearly as strong as that on March 21, 1904, though the felt area was not more than 20,000 square miles.

1905. August 30. Rockingham County, N.H. Three shocks—at 05:40, 05:42, and 05:43—were felt at Portsmouth and Newton. The second shock was the strongest; lasted about 5 seconds.

1905. October 22. Northern Vermont. Felt over limited area.

1907. January 24. Schenectady, N.Y. Several moderate shocks.

1907. October 15. Northeastern Massachusetts and southeastern New Hampshire. Felt at Haverhill, Lawrence, and Lowell, Mass., and Londonderry and Manchester, N.H.

1908. February 5. Housatonic Valley, Conn. Fissures reported.

1910. January 22. Cumberland County, Maine. Articles were thrown from shelves at Windham, southeast of Sebago Lake. Felt at Gorham and Gray.

1912. December 11. Maine and New Brunswick. Felt from Augusta, Maine, to beyond Fredericton, New Brunswick. Intensity V–VI in Bangor area. Felt over about the same area, but weaker than that on March 21, 1904.

1913. April 28. Near Potsdam, N.Y. Strong at Potsdam. Windows were broken; dishes thrown on floor. Felt strongly at Ogdensburg and Morristown. Felt from Canton to Clayton, and from Gouverneur to and beyond the St. Lawrence River. Reported felt in Montreal, Canada.

1913. August 10. Lake Placid, N.Y. Felt from Fulton Chain of Lakes (near Old Forge) to Lake Placid, a distance of 60 miles.

1914. January 13. Maine and New Brunswick. Felt at Calais, Maine; also felt at St. Stephen, New Brunswick. Few details known.

1914. February 10. Canada, near Lanark, Ontario. Felt strongly at Albany, N.Y., where buildings swayed, chairs fell over, and pictures were thrown from walls. At Auburn, people were frightened and buildings swayed; the shock lasted 10 seconds. At Binghamton, a laborer was killed by a cave-in. Pipes broke at Canton. It was strong at Geneva, and there was a crack in the road at Lestershire (now known as Johnson City). At Syracuse, objects were thrown from shelves. It was felt at Elmira and Rochester. The shock was also felt in Boston, Hartford, and New Haven, and in Pennsylvania at Allentown and Harrisburg (intensity III–IV). The shock was strong throughout Quebec, especially at Montreal, and as far west as Lake Huron. North and east limits unknown.

1914. February 21. Western Maine. Felt in Somerset and Franklin Counties. It was reported from Eustis, Flagstaff Lake area, Oquossoc, and Rangeley. Second shock at 19:35.

1916. January 5. Near Lake George, N.Y. Felt at Caldwell, N.Y., near south end of Lake George, and at Gloversville, 45 miles away.

1916. February 2. Mohawk Valley, N.Y. Felt at Albany, but more strongly at Amsterdam and Ballston Spa. Plant of General Electric Co. at Schenectady strongly shaken. Throughout a 25-mile radius, houses were shaken, dishes fell from shelves, and people were thrown from beds. Also felt at Glens Falls.

1916. June 8. Near New York City, N.Y. Felt at Eastchester and Scarsdale, N.Y., but not on Manhattan Island.

1916. November 1. Glens Falls, N.Y. Houses were shaken; objects overthrown; loud noise. Intensity V at Caldwell.

1917. May 22. St. Lawrence Valley. Felt strongest at Montreal, Canada, and Canton, Malone, Ogdensburg, and Watertown, N.Y. Also felt at Ottawa, and at Montpelier, Vt. Aftershock felt at Canton at 04:19.

1918. August 20. Southern Maine. Bricks fell from chimneys, latched doors flew open, and chimneys fell at South Paris and Norway. The shock was local, though it was reported that there was a temporary change of level of 4 inches in Little Sebago Lake. The shock was felt at Bridgton, Cape Elizabeth, and Lewiston.

1924. September 30. Probably St. Lawrence Valley. Felt from Rockland to Portland, Maine. Also awakened persons at St. Johnsbury, Vt. Magnitude 6.1.

1925. January 7. Eastern Massachusetts. Epicenter near Cape Ann, Mass. Felt to Cape Cod, Providence, R.I., and Kennebunk, Maine. Felt sharply on Cape Ann where houses were jarred. Plaster fell at Rockport. In the same vicinity, a wave was observed on waters inside the cape. No reports from vessels at sea. Swaying of chandeliers and rattling of dishes were the principal effects noted.

1925. April 24. Southeastern Massachusetts. Many people were awakened, but little damage occurred. Felt area included parts of Barnstable, Bristol, Dukes, and Plymouth Counties.

1925. October 9. Southeastern New Hampshire and Maine. Chimney was thrown down at Cornish, Maine. Dishes were thrown from shelves at Ossipee and Tuftonboro, N.H. Goods fell from shelves at Effingham Falls. Many were frightened at Laconia.

1925. November 14. Near Hartford, Conn. Many persons were alarmed. Plaster fell. Noises heard at East Haddam. At Windham, dishes fell from shelves.

1926. March 18. Near Manchester, N.H. Chimneys were thrown down at Cornish. (This may be a carryover from 1925 shock on Oct. 9.) Intensity V at Amherst, Lyndeborough, Manchester, Mason, New Ipswich, and Wilton.

1926. May 11. New Rochelle, N.Y. Felt by all. Vibration felt and rumbling heard in Westchester County.

1926. August 28. Western Maine. Felt in Oxford and Franklin Counties. Lake surface disturbed at Rangeley; rumbling.

1927. March 8. Concord, N.H. Felt by many. Dishes rattled; rumbling sounds. Felt lightly in Cheshire and Hillsboro Counties.

1928. February 8. Milo, Maine. Plaster walls cracked; dishes fell from shelves. Two smaller shocks followed.

1928. March 18. Saranac Lake, N.Y. Trembling and sounds like artillery. Dishes fell from shelves at Saranac Lake and Malone, and many residents fled from homes. Felt throughout northeastern New York and on the Canadian side of St. Lawrence River.

1928. April 25. Berlin, N.H. People rushed into streets. Noises like passing heavy truck. Also felt at Gorham. Felt from Rumford, Maine, to St. Johnsbury, Vt.

1929. August 12. Attica, N.Y. The earthquake was widely felt in New England, though only in a restricted area in the Hudson River Valley. Felt area included southern Ontario, northeastern Ohio, northern Pennsylvania, eastern Connecticut, western Maine, southern Vermont, southwestern New Hampshire, and most of New York. The shock was strongest in the eastern part of Attica and the region to the east. Two hundred and fifty chimneys were thrown down, and cracking occurred along a railroad embankment. There was some damage at Batavia and at other points at similar distances. Walls cracked at Sayre, Pa. A strong aftershock occurred on December 2.

1929. November 18. Grand Banks of Newfoundland. This severe earthquake was felt throughout the New England States and that part of Canada lying south of the St. Lawrence River and Strait of Belle Isle. Greatest damage was the fracture of 12 Atlantic cables that crossed the epicentral area. A seismic seawave (tsunami) resulting from displacement of the ocean floor caused considerable damage and loss of life at Placentia Bay, Newfoundland. Small seawaves were recorded along the United States' east coast as far south as Charleston, S.C. The area of maximum intensity in the United States was the southeastern half of Maine where clocks stopped, articles were shaken from shelves, and many people were alarmed. Ships within 50 to 300 miles of the epicenter were shaken severely. Magnitude 7.2.

1929. December 2. Attica, N.Y. Strong shocks occurred at 17:14 on the 2d and at 07:50 on the 3d. Dishes fell from shelves; clocks stopped.

1931. January 7. Canada. Centering near Baie-St.-Paul, Quebec, this shock was widely felt in Maine, northern New Hampshire, and Vermont.

1931. April 20. Lake George, N.Y. An earthquake centering near Lake George threw down chimneys at Warrensburg and twisted a church spire. It knocked store goods from shelves at Lake George, damaged chimneys and broke windows at Luzerne, and cracked walls and broke dishes at Glens Falls. The shock was felt widely, but with less intensity in the Catskills than at equal distances in other directions.

1933. October 29. St. Johnsville, N.Y. One window broke. Felt over the western half of Fulton and Montgomery Counties.

1934. April 14. Adirondack Mountains, N.Y., near Lake Champlain. Felt strongest at Beekmantown, Keeseville, and Plattsburgh. Slight plaster cracks, swaying of buildings, and disturbed furniture were observed. Felt area included northern New York, Vermont, and southern Quebec.

1935. April 23. Near Cape Cod, Mass. This submarine shock was reported felt at Provincetown, Truro, and Wellfleet, Mass.

1935. November 1. Timiskaming, Canada. Felt over a great area, but in the United States caused minor damage only in New York. At Cortland, there was damage to chimneys and plaster. Elsewhere, the intensity did not exceed V. The shock was felt in eastern Maine, as far south as Washington, D.C., and as far west as Wisconsin. Magnitude 6¼.

1938. August 22. Vicinity of Bangor, Maine. Win-

dows broke and objects were displaced at Bangor. Felt by nearly all in the Bangor region. The shock was not felt in coastal towns.

1939. October 19. Canada, at confluence of Saguenay and St. Lawrence Rivers. Moderate damage in epicentral area in Canada. Not destructive in the United States, although felt over all or in parts of Connecticut, Maine, Massachusetts, New Hampshire, New York, Ohio, and Vermont. Magnitude 5.8.

1940. December 20. Lake Ossipee, N.H. Maxi- in vicinity of Fairhaven, Marion, Falmouth, Mattapoisett, New Bedford, and Pocasset. Houses were shaken rather severely, and books fell from library shelves at Fairhaven. At Falmouth, there was a gradual rumble that ended abruptly like an explosion.

1940. December 20. Lake Ossippee, N.H. Maximum intensity about VII at Tamworth and Wonalancet. Plaster fell; some walls cracked. Affected area included Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont; also parts of New Jersey, New York, and Pennsylvania.

1940. December 24. Lake Ossipee, N.H. This earthquake was at least equal in intensity to the shock of December 20. Damage to plaster walls and chimneys was reported in Maine, New Hampshire, and Vermont.

1943. January 14. Dover-Foxcroft area, Maine. Felt by all at Dover-Foxcroft and Old Town. Plaster cracked at Lisbon, about 90 miles southwest of the epicenter, and at Whitefield, N.H. Felt over a large area, including all or parts of Connecticut, Maine, Massachusetts, New Hampshire, and Vermont.

1944. September 4. Massena, N.Y., and Cornwall, Ontario. Damage in the central area was estimated at $2 million for two towns. Destroyed or damaged 90 percent of the chimneys at Massena, with similar damage at Cornwall. Minor damage in nearby towns. Felt north to Maine, west to Michigan, and in nearly all of Maryland and Pennsylvania.

1947. December 28. Dover-Foxcroft, Maine. Stoves and furniture moved; light objects toppled from shelves. Felt in Franklin, Kennebec, Penobscot, Piscataquis, and Somerset Counties.

1949. October 4. Southwestern Maine. Maximum intensity at Mechanic Falls, Rangeley, and Westbrook. Also felt in New Hampshire and eastern Vermont.

1951. September 3. Rockland County, N.Y. Many people were alarmed at Greenwood Lake and Tomkins Cove. Felt from Windsor, Conn., southwest to Pompton Lakes and Dover, N.J., and from the north shore of Long Island Sound to Walden and Middletown, N.Y.

1952. January 29. Burlington, Vt. Local shock affected an area of about 50 square miles. Minor damage included cracks in pavement, basement walls, and gas main. Ground cracks 2 miles long and 15 feet apart were observed in the North End.

1952. August 24. Mohawk Valley, N.Y. Felt by many at Fort Plain and Gloversville, N.Y., where bottles were knocked off shelves. Affected an area which included parts of Fulton and Montgomery Counties.

1952. October 8. Poughkeepsie, N.Y. Many were frightened. Several windows were broken. Also felt in Clintondale, Hyde Park, and Milton. Several small aftershocks with rumbling noises were observed.

1952. October 14. South-central Quebec, Canada. Highest intensities were observed on the Canadian side of the St. Lawrence Valley. Intensity V at Auburn, Fort Kent, and Presque Isle, Maine. Also felt in northeastern Vermont.

1953. March 27. Stamford, Conn. Many people were alarmed at Stamford and Greenwich. Homes jarred; surface sounds were heard. Felt in adjacent Westchester County, N.Y.

1953. March 31. West-central Vermont. Felt strongest from Brandon in northern Rutland County to Ludlow and Weston in southern Windsor County. Also felt in northern Washington County, N.Y.

1954. July 29. Maine, Massachusetts, and New Hampshire coastal areas. Shock caused slight damage at Gloucester, Bayview section of Gloucester, Newburyport, and Salisbury, Mass., Hampton Beach, N.H., and Kittery, Maine.

1955. February 2. Burlington, Vt. A number of persons were frightened by a series of two or three shocks which shook houses and rattled dishes. Large ground crack was reported in North Burlington.

1955. August 16. Attica, N.Y. Shock awakened many persons; several were alarmed. Guard towers

at Attica State Prison were observed swaying. Subterranean sounds reported.

1957. April 23. St. Johnsbury, Vt. Alarmed many within 15-mile radius. Police switchboard was swamped with calls about disturbance.

1957. April 26. Near coast of Maine. Felt in Maine, Massachusetts, New Hampshire, Connecticut, and Vermont. At Portland, plaster and walls cracked. Some minor damage was reported from ships at sea, 20 miles offshore. Chimneys split at Westbrook; windows and dishes broke. Awakened many in several towns in Maine; cracked foundation of new home at Scarborough. Felt by and awakened many in northeastern Massachusetts; damage to garage at Hudson. Intensity V at Lebanon, Lincoln, Milford, and Woodstock, N.H.

1958. September 19. Cape Elizabeth, Maine. Many were alarmed in Cape Elizabeth area; some glass and dishes broke. Also felt at Halfway Rock, 12 miles offshore.

1961. April 20. Massena, N.Y. Plaster cracked; windows and dishes rattled. Also felt near Cornwall, Ontario.

1962. March 27. Niagara Falls, N.Y. Many were awakened and frightened. Furniture displaced. Also felt in Ontario, Canada.

1962. April 10. Vermont. Felt over a large area of Vermont, Maine, Massachusetts, New Hampshire, and New York. At Montpelier, a beam dislodged from State House; brace dropped about 5 inches. Twenty windowpanes cracked; plaster cracked. Tile fell from ceiling at Barre; two cracks appeared in walls. Intensity V in New Hampshire and New York.

1962. June 20. Southern Quebec, Canada. Felt with intensity V in the United States. At North Montpelier, Vt., chimney cracked and moved. Alarmed several at Beebe Plain, Coventry, Derby, Derby Line, and Plainfield. Also felt at Monroe, N.H., and Elizabethtown, N.Y.

1962. December 29. Milford, N.H. Felt by and awakened many. Also felt at Newburyport and Amesbury, Mass.

1963. October 16. Near coast of Massachusetts. Felt principally in Massachusetts. At Somerville, plaster fell; wall cracked; stones fell from building foundation. Broke dishes and alarmed many at Amesbury. Window cracked at Winthrop. At Chepachet, R.I., plaster cracked. Magnitude 4.5.

1963. October 30. Northeast of Peabody, Mass. Wall plaster and sidewalk cracked at Peabody. Foundation of old house caved in at Framingham; stairs thrown out of line at Swampscott.

1963. December 4. Tilton-Laconia, N.H. At Tilton, cement cracked. Many were alarmed at Laconia; trees shook slightly. Magnitude 3.7.

1964. March 29. Massena, N.Y. Press reported many were awakened and alarmed. Three shocks in rapid succession.

1964. June 26. Near Warner, N.H. Plaster fell at Meriden, N.H. Slight damage was also reported at Bradford, N.H., and Springfield, Vt. Magnitude 2.6.

1964. November 17. Westchester County, N.Y. Objects fell from mantles at Armonk, Mount Kisco, and Pound Ridge. Also felt in Connecticut.

1965. October 24. Nantucket, Mass. Very slight damage to ornaments. Door was forced open at police headquarters; dishes and ornaments moved about in homes. Two shocks, 10 to 20 seconds apart.

1965. December 7. Narragansett Bay area, R.I. Felt on both sides of Upper Narragansett Bay. Many were frightened at Warwick where windows and doors rattled. Also felt in Massachusetts.

1966. January 1. Attica-Varysburg, N.Y. Felt in western New York, northwestern Pennsylvania, and southern Ontario, Canada. Slight damage to chimneys and walls was sustained at Attica and Varysburg, N.Y. Plaster fell at the Attica State Prison, and the main smokestack was damaged. Foreshocks at 05:30 and 06:30 were reported in some areas. Magnitude 4.7.

1966. July 23. Jonesport, Maine. Many were awakened; few alarmed. Also felt at Machias.

1966. October 23. Manchester, N.H. Felt over a small portion of southern New Hampshire. Intensity V was reported at Goffstown, Hooksett, and Manchester.

1967. February 2. Narragansett Bay area, R.I. Many were frightened at Middletown, Newport, and North Kingstown. Also felt at Adamsville and Jamestown. Magnitude 2.4.

1967. June 13. Attica-Alabama, N.Y. Felt over a small area of western New York. Plaster and ceiling damage was sustained at Attica and Alabama. Magnitude 3.9.

1967. July 1. Kennebec County, Maine. Seven shocks were reported felt. The first shock, at 09:09,

and the fifth, at 11:05, caused intensity V effects at Manchester and Wayne (09:09). Magnitude 3.2 and 3.8, respectively.

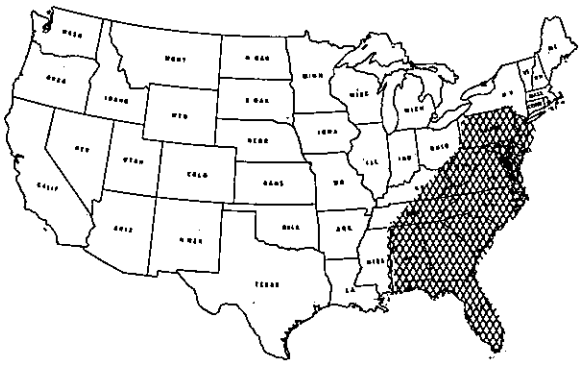
1967. November 22. Westchester County, N.Y. Felt in Westchester and Rockland Counties, N.Y., and Greenwich and Stamford Counties, Conn. Intensity V effects were reported at Ardsley, Chappaqua, Mount Pleasant, and Tarrytown, N.Y.

1968. October 19. Southern Ontario, Canada. Trees and bushes shook near Chazy, N.Y., where all were awakened and frightened by the shock. Loud earth noises were heard.

1968. November 3. Southern Connecticut. Felt along a 30-mile stretch of the Connecticut River, from Lyme in the south to Glastonbury in the north. Plaster cracked at Madison; small objects fell. Intensity V effects also were noted at Chester, Deep River, and Essex.

1969. August 6. Moultonboro, N.H. Windows cracked; small objects fell.

Eastern Region



Résumé

This region, with the exception of the Charleston, S.C., earthquake, has a moderate amount of low-level earthquake activity. It is possible that the processes that have resulted in the present condition of the Appalachian Mountains system have reached a state of relative inactivity. Earthquakes occur throughout the region and the axis of principal activity roughly parallels the coast.

The earthquakes in the mountain regions are not surprising, as there seems to be a process of adjustment generally continuing in such regions, but the occurrence of the Charleston shock in a sandy plain is more difficult to explain.

List of Earthquakes in Eastern Region

Year	Date	Time (EST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1758	Apr. 24	21:30	Annapolis, Md	38.9	76.5	.....	.....	1, 37
1774	Feb. 21	14:00	Eastern Virginia	.....	.....	58,000	.....	68
1800	Mar. 17	.....	Philadelphia, Pa	39.8	75.2	.....	.....	1, 37
	Nov. 29	.....	..... do	39.8	75.2	.....	.....	Do.
1807	Apr. 30 or May 1.	04:00	Lynchburg-Richmond, Va., area	.....	.....	.....	V	68

See footnotes at end of table.

List of Earthquakes in Eastern Region—Continued

Year	Date	Time (EST)	Locality	N. lat.	W. long.	Area	Intensity	Authority [1]
				degrees	*degrees*	*sq. mi.*		
1828	Mar. 9	22:00 to 23:00	Probably Virginia	.....	.....	218,000	V	1, 3-53, 36, 48, 68
1833	Aug. 27	06:00	Central Virginia	.....	.....	52,000	V	3-3, 36, 48
1840	Nov. 11 and 14	.....	Philadelphia, Pa	39.8	75.2	.....	.....	1, 37
1843	Feb. 8	10:40	West Indies, felt in U.S	16	62	.....	.....	2-44, 14, 36
1852	Apr. 29	13:00	Probably Virginia	.....	.....	162,000	VI	1, 3-53, 36, 48, 68
1853	May 2	09:20	Virginia-West Virginia region	.....	.....	72,000	V	68
1855	Feb. 2	03:00	Charlotte Court House, Va	37.0	78.6	9,000	V	68
1857	Dec. 19	09:04	Charleston, S.C	32.9	80.0	.....	.....	3-4
1861	Aug. 31	05:22	Probably Virginia	.....	.....	300,000	VI	1, 3-53, 36, 48
1871	Oct. 9	09:40	Wilmington, Del	39.7	75.5	.....	VII	8, 58
1872	June 17	15:00	Milledgeville, Ga	33.1	83.3	.....	V	2-73
1874	Feb. 10 to Apr. 17.	.....	McDowell County, N.C	35.7	82.1	(2)	V	2-75, 24, 36
1875	Nov. 1	21:55	Northern Georgia	33.8	82.5	25,000	VI	2-76, 8
	Dec. 22	23:45	Arvonia, Va., area	37.6	78.5	50,000	VII	2-76, 8, 36, 48, 68
1877	Sept. 10	09:59	Delaware Valley	40.3	74.9	300	IV–V	2-76, 37
	Nov. 16	02:38	North Carolina-Tennessee region	35.5	84.0	5,000	V	2-78, 4, 36
1879	Jan. 12	23:45, 23:55	Near St. Augustine, Fla	29.5	82.0	25,000	VI	2-80, 8
	Mar. 25	19:30	Delaware River	39.2	75.5	600	IV–V	2-80, 8, 36
	Dec. 13	02:00	Charlotte, N.C	35.2	80.8	.....	V	36
1880	Jan. 22	22:23	Cuba, felt in Florida	22.8	80.8	65,000	VIII[3]	2-80, 8
	Jan. 23	04:00	..... do	22.8	80.8	.....	.....	Do.
1883	Mar. 11	18:57	Harford County, Md	39.5	76.4	(2)	IV–V	2-84
	Mar. 12	00:00, 01:00	..... do	39.5	76.4	(2)	IV–V	Do.
1884	Jan. 18	08:00	Wilmington, N.C	34.3	78.0	(2)	V	2-85, 36
	May 31	.....	Allentown, Pa	40.6	75.5	(2)	V	8, 37
1885	Jan. 2	21:16	Maryland-Virginia region	39.2	77.5	3,500	V	2-86, 4, 15-85, 48, 68
	Aug. 6	08:00	Watauga County, N.C	36.2	81.6	(2)	IV–V	2-86, 36
	Oct. 9	23:35	Virginia	37.7	78.8	20,000	VI	2-86, 4, 48, 68
1886	Feb. 4	20:00	Alabama	32.8	88.0	1,600	V	4
	Feb. 13	.....	..... do	32.8	88.0	.....	.....	4
	Aug. 31	21:51, 21:59	Charleston, S.C	32.9	80.0	2,000,000	IX–X	3-4, 16, 36, 72
	Oct. 22	05:20	..... do	32.9	80.0	30,000	VI	Do.
	Oct. 22	14:45	..... do	32.9	80.0	30,000	VII	Do.
	Nov. 5	12:20	..... do	32.9	80.0	30,000	VI	3-4, 48
1889	Mar. 8	18:40	Pennsylvania	40	76	4,000	V	15-89, 37
1895	Sept. 1	06:09	West of Newark, N.J	40.7	74.8	35,000	VI	8, 37

See footnotes at end of table.

List of Earthquakes in Eastern Region—Continued

Year	Date	Time (EST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1897	May 3	12:18	Pulaski, Va	37.1	80.7	29,000	VI	4, 15-98, 36, 48, 68
	May 31	13:58	Giles County, Va	37.3	80.7	280,000	VII	8, 15-98, 36, 48, 68
	Oct. 21	22:20	Southwestern Virginia	37	81	20,000	V	4, 36, 48, 68
	Dec. 18	18:45	Ashland, Va	37.7	77.5	7,500	V	4, 48, 68
1898	Feb. 5	15:00	Pulaski, Va	37.0	80.7	34,000	VI	68
	Nov. 25	15:00	Southwestern Virginia	.....	.....	65,000	V	68
1899	Feb. 13	04:30	..... do	37	81	30,000	V	4, 36, 48, 68
1900	Oct. 31	11:15	Jacksonville, Fla	30.4	81.7	(2)	V	8
1902	May 29	02:30	Chattanooga, Tenn	35.1	85.3	(2)	V	8, 49
	Oct. 18	17:00	Tennessee-Georgia region	35.0	85.3	1,500	V	Do.
1903	Jan. 23	20:15	Georgia-South Carolina region	32.1	81.1	10,000	VI	8
1904	Mar. 4	19:30	Eastern Tennessee	35.7	83.5	5,000	V	8, 49
1905	Jan. 27 and 28	.....	Gadsden, Ala	34	86	250,000	VII	8
1906	May 8	12:41	Near Seaford, Del	38.7	75.7	400	V	8
1907	Feb. 11	08:22	Arvonia, Va	37.7	78.4	5,600	VI	3-3, 8, 48, 70
	Apr. 19	03:30	Charleston, S.C	32.9	80.0	10,000	V	8
1908	May 31	12:42	Allentown, Pa	40.6	75.5	(2)	VI	8, 37
	Aug. 23	04:30	Powhatan, Va	37.5	77.9	1,500	V	8, 48, 70
1909	Apr. 2	02:25	Charles Town-Martinsburg, W. Va.	39.4	78.0	2,500	V–VI	8, 9, 48, 70
1910	May 8	16:10	Arvonia, Va	37.7	78.4	4,000	V	3-3, 48, 70
1911	Apr. 20	.....	North Carolina-South Carolina area.	35.2	82.7	600	V	8, 36
1912	June 12	05:30	Summerville, S.C	33.0	80.2	35,000	VII	3-4, 8, 9, 36
	June 20	.....	Savannah, Ga	32	81	.....	V	9
1913	Jan. 1	13:28	Union County, S.C	34.7	81.7	43,000	VI–VII	3-3, 36
	Mar. 28	16:50	Near Knoxville, Tenn	36.2	83.7	2,700	VII	3-3, 8, 49
	Apr. 17	11:30	Southeastern Tennessee	35.3	84.2	3,500	V	3-3, 8, 9, 36, 49
1914	Jan. 23	22:24	..... do	35.6	84.5	(2)	V	8, 49
	Mar. 5	15:05	Near Atlanta, Ga	33.5	83.5	50,000	VI	3-4, 36
	Sept. 22	02:04	Summerville, S.C	33.0	80.2	30,000	V	3-5
1915	Oct. 29	About 01:00	Near Marshall, N.C	35.8	82.7	1,200	V	3-5, 3-6, 8, 36
1916	Feb. 21	17:39	Near Asheville, N.C	35.5	82.5	200,000	VI	3-6, 4, 8, 36
	Aug. 26	14:36	Western North Carolina	36	81	3,800	V	3-6, 4, 36
	Oct. 18	16:04	Northeastern Alabama	33.5	86.2	100,000	VII	Do.
1917	June 29	20:23	Western Alabama	32.7	87.5	(2)	V	4
1918	Apr. 9	21:09	Luray, Va	38.7	78.4	60,000	VI	3-8, 4, 8, 36, 70
	June 21	20:00	Lenoir City, Tenn	36.1	84.1	3,000	V	4, 49

See footnotes at end of table.

List of Earthquakes in Eastern Region—Continued

Year	Date	Time (EST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1919	Sept. 5	21:46	Near Front Royal, Va	38.8	78.2	.....	VI	3-9, 3-47, 48
1920	Dec. 24	02:30	Rockwood, Tenn., area	36	85	(2)	V	3-10, 4, 49
1921	Jan. 26	18:40	New Jersey	40	75	150	V	4
	July 15	.....	Near Mendota, Va	36.6	82.3	(2)	VI	3-11, 48, 70
	Aug. 7	01:30	New Canton, Va., area	37.8	78.4	2,800	V	4, 48, 70
1924	Oct. 20	03:30	Pickens County, S.C	35.0	82.6	56,000	V	3-14, 10, 36, 48
	Dec. 25	23:30	Roanoke, Va	37.3	79.9	(2)	V	70
1926	July 8	04:50	Southern Mitchell County, N.C	35.9	82.1	(2)	VI	10, 36
1927	June 1	07:20	Asbury Park, N.J., area	40.3	74.0	3,000	VII	10
	June 10	02:16	Near Charlottesville, Va	38	79	2,500	V	10, 48, 70
	June 16	07:00	Northeastern Alabama	34.7	86.0	2,500	V	10
1928	Nov. 2	23:03	Western North Carolina	36.0	82.6	40,000	VI	3-18, 27, 36, 55
1929	Dec. 26	21:56	Central Virginia	38.1	78.5	.....	VI	27, 70
1931	May 5	07:18	Northern Alabama	33.7	86.6	6,500	V–VI	27
1933	Jan. 24	21:00	Near Trenton, N.J	40.2	74.7	600	V	27
	Dec. 19	09:12	Summerville, S.C	33.0	80.2	(2)	IV–V	27
1934	Oct. 29	15:07	Erie, Pa	42.0	80.2	(2)	V	27
1935	Jan. 1	03:15*	North Carolina-Georgia border	35.1	83.6	7,000	V	3-25, 27, 36
1938	July 15	17:45*	Southern Blair County, Pa	40.4	78.2	100	VI	27, 37
	Aug. 22	22:36*	Central New Jersey	40.1	74.5	5,000	V	27
1939	May 4	21:45	Anniston, Ala	33.7	85.8	.....	V	27
	Nov. 14	21:54*	Salem County, N.J	39.6	75.2	6,000	V	27
1945	June 13	21:25	Cleveland, Tenn	35	84½	.....	V	27
	July 26	05:32*	Murray Lake, S.C	34.3	81.4	25,000	IV–V	27, 36
1952	Nov. 19	.....	Charleston, S.C	32.9	80.0	.....	V	27
1954	Jan. 7	02:25	Sinking Spring, Pa	40.3	76.0	.....	VI	27
	Feb. 21	15:00	Wilkes-Barre, Pa	41.2	75.9	(2)	VII	27
	Feb. 23	22:55	..... do	41.2	75.9	(2)	VI	27
1955	Sept. 28	02:02	Virginia-North Carolina border	.....	.....	1,700	V	27
1956	Sept. 7	08:36* 08:49*	Knoxville, Tenn., area	35.5	84.0	8,300	VI	27
1957	Mar. 23	14:03	West-central New Jersey	40¾	74¾	.....	VI	27
	Apr. 23	04:24*	Birmingham, Ala., area	34½	86¾	11,500	VI	27
	May 13	09:25	Western North Carolina	35¾	82	8,100	VI	27
	June 23	01:34*	East-central Tennessee	36½	84½	.....	V	27
	July 2	04:33	Western North Carolina	35½	82½	.....	VI	27
	Nov. 24	15:06*	Hartford, Tenn., area	35	83½	4,100	VI	27
1958	Mar. 5	06:54	Wilmington, N.C., and vicinity	34¼	77¾	.....	V	27
	Oct. 20	01:16	Anderson, S.C	34½	82¾	(2)	V	27
1959	Apr. 23	15:59*	Virginia-West Virginia border	37½	80½	3,000	VI	27, 70
	Aug. 3	01:08*	Near Charleston, S.C	33	79½	25,000	VI	27
	Aug. 12	13:06*	Alabama-Tennessee border	35	87	2,800	VI	27
	Oct. 26	21:07	Northeastern South Carolina	34½	80¼	4,800	VI	27
1960	Mar. 12	07:48*	Off coast of South Carolina	33	79	3,500	V	27
	Apr. 15	05:10	Eastern Tennessee	35¾	84	1,300	V	27

See footnotes at end of table.

List of Earthquakes in Eastern Region—Continued

Year	Date	Time (EST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1960	July 23	22:37	Near Charleston, S.C	33	80	(2)	V	27
1961	Sept. 14	21:17	Lehigh Valley, Pa	40¾	75½	(2)	V	27
	Dec. 27	12:06	Pennsylvania-New Jersey border	40½	74¾	.....	V	27
1963	Oct. 28	17:39*	Near Galax, Va	36.7	81.0	1,300	V	27, 38
1964	Feb. 18	04:31*	Alabama-Georgia border	34.8	85.5	.....	V	27
	Mar. 12	20:20*	Central Georgia	33.2	83.4	400	V	27
	Apr. 20	14:05*	Columbia, S.C., area	34	81	.....	V	27
	May 12	04:45*	Cornwall, Pa	40.2	76.5	(2)	VI	27
1966	May 31	01:19*	West of Richmond, Va	37.6	78.0	28,000	V	27, 57, 70
1967	Apr. 8	00:41*	Columbus, Ohio	39.6	82.5	4,000	V	27
	Oct. 23	04:04*	Near Summerville, S.C	33.4	80.7	.....	V	27
1968	Dec. 10	04:13*	Southern New Jersey	39.7	74.6	.....	V	27
	Dec. 11	10:00	Louisville, Ky	38.3	85.7	.....	V	27
1969	July 13	16:51*	Eastern Tennessee	36.1	74.3	20,000	V	27
	Nov. 19	20:00*	Southern West Virginia	37.4	81.0	100,000	VI	27, 70
	Dec. 11	18:45*	Richmond, Va	37.8	77.4	6,500	V	Do.
	Dec. 13	05:20*	Western North Carolina	35.1	83.0	3,500	V	27
1970	Sept. 9	20:41*	Northwestern North Carolina	36.1	81.4	2,000	V	27

*Instrumental origin time and epicenter.
[1] See References, p. 133.
[2] Local.
[3] Intensity at epicenter.

MAJOR EARTHQUAKES

Earthquakes of August 31, 1886

Time of occurrence.—21:51 and 21:59, with others later.

Epicenter.—Fifteen miles northwest of Charleston, S.C. (32.9° N., 80.0° W.).

Area affected.—Area with radius of 800 miles; strongly shaken to 100 miles. About 2 million square miles total.

Intensity.—IX–X.

Description.—The earthquake started with a barely perceptible tremor, then a sound like a heavy body rolling along; the sound became a roar, all movable objects began to shake and rattle, and the tremor became a rude, rapid quiver. There was no break in the increasingly heavy jar. Everyone feared instant death. Finally, the earth became quiet, the roar stopped, and human cries of pain and fear, wailing, and excited shouts became audible.

The first shock was at 21:51, the second 8 minutes later. People immediately began to gather in the large public square in Charleston to escape injury from falling buildings. The period until morning was filled with great anxiety, especially as there were exaggerated rumors of the number killed. Further shocks occurred at about 02:00 and 04:00. The utter stillness after each shock, combined with the lack of apparent cause, was appalling. A severe shock occurred at 08:30 which aroused great apprehension, as it was now seen that many of the buildings were either ruined or in a dangerous condition. It also was known that about 60 people had been killed in the night with many injured, and it was feared that more would be killed. Further shocks occurred at 13:00, 17:00, and

Earthquake of August 31, 1886, caused serious damage in Charleston, S.C. (U.S. Geological Survey photo)

about 20:00. By this time, practically all of the people were in the streets.

There was no serious lack of food, but the means for preparing it was inadequate. Because few houses escaped damage, and many were totally destroyed, the amount of debris in the streets was very great. There was only a narrow passage through the middle, which added to the difficulty. Aid from the outside was impossible, as the railroads were damaged badly and telegraph wires were down. News did not get through until late the following day. As soon as the railroads were repaired many people fled. However, a large number remained, and officials of all kinds stayed at their posts to help organize aid and relief. Fortunately, the weather remained good.

In the vicinity of Charleston special effects were noted. In one place, sulphur gas was very evident. There was a wave of some height on the Cooper River. In some places the motion was so great that people were overcome with nausea.

Much of Charleston was built on made land, some of it where a number of creeks had been filled in. In such places it was necessary to use piling. The government buildings generally were well built, though some were quite old. In addition, there were a large number of well-built residences, usually found in a city of considerable

wealth, as it had long been a custom of planters to retire and build homes in Charleston. These facts are important in connection with a study of the destruction. The early houses were, in many cases, built of hand-made brick which had a rougher surface and permitted better adherence of the mortar than later smooth bricks. The mortar used in the early days was excellent, being made of burnt shells. Though no stronger than that used later, the bond was better adapted to prevent the concealment of insufficient mortar.

The great masonry structures were found to be severely damaged, though some new portions were destroyed while the old remained intact. Brick buildings were found to be more severely damaged than was at first thought, and in some cases the bricks moved in the mortar. Buildings of three or more stories had diagonal cracks in the walls at the middle stories and vertical cracks near the top. Well-built wooden houses with parts carefully pinned together form a complete and elastic whole which tends to return to its original shape as soon as a disturbance has passed. However, some of the best houses were loosened at the joints, so that they were shaken by passing vehicles and were somewhat out of plumb. Curiously, a family living in a one-story wooden building slept through the earthquake without knowing that it had occurred. Chimneys of at least 14,000 houses were destroyed in Charleston.

Part of the damage was caused by aftershocks, and, on the whole, it was considerable. Fortunately, there was no wind and the fires which ignited were extinguished without difficulty.

The first shock lasted 35 to 40 seconds; it apparently was first vertical, then horizontal. The wave motion was very complex. Pictures were found with their faces to walls. In the cemeteries, there was no prevailing direction for the fall of monuments, indicating that the shocks came from many directions as might be expected so near the origin. Earth waves similar to ground swell were seen; they were estimated to be 2 feet high. This may have been the case in certain places, but, in general, it seems likely they were not more than 4 or 5 inches in height. Such waves explain much of the destruction. Buildings showed both horizontal and vertical displacements. There were 10 severe and numerous moderate-to-light aftershocks up to September 30, and probably countless others that could be detected only by instruments. The series of heavy aftershocks undoubtedly helped to weaken buildings previously damaged.

Careful study of reports indicates that there were two epicentral points: One near Woodstock, 16 miles N.30°W. of Charleston, surrounded by a region of maximum effect about 20 miles in diameter and nearly circular; and the other about 13 miles due west of Charleston, surrounded by an elliptical area with axes 9 and 6 miles, respectively, the major axis lying north-south. These centers were about 14 miles apart. The northern area contained two villages, Summerville and Lincolnville. In the former place, the earthquake did not come without warning; on both the 27th and 28th, there were sounds like heavy explosions. On the 31st, the earthquake had full force. People were tossed from side to side and thrown to the ground. Houses seemed to be receiving heavy blows from below and chimneys fell. In some cases chimneys, carrying fireplaces with them, sank into piles of debris. In other instances, tops of the chimneys snapped off at the roofline and were thrown considerable distances. The indications point to strong vertical motion. The aftershocks had a deep, powerful boom, followed by a heavy jar. At Lincolnville, the shocks were more severe and the vertical motion more pronounced. The rest of this area and the southern area were thinly settled. Of chief interest were ground cracks, craterlets, and effects on the railroads.

Throughout the epicentral area as defined, and in some regions outside, the ground was greatly fissured and water extruded in some cases. Cracks were rarely more than an inch wide, but near the streams, movement of the banks toward the stream left wider cracks. Where large quantities of water came up, there was a round hole of considerable size with a greater basin at the ground surface. These were of all sizes, from very small up to 20 feet in diameter. Much sand was brought up, usually from known beds of quicksand. The water rose in high jets, carrying sand and mud in some areas.

The bending of rails and lateral displacement of tracks were very evident in the epicentral region, though not at Charleston. There were severe flexures of the track in places and sudden and sharp depressions of the rail bed. At one place, there

was a sharp S-curve. At a number of locations, the effect on culverts and other structures demonstrated strong vertical force in action at the time of the earthquake. The estimated depth of focus, or depth below the surface at which the earthquake actually occurred, was 12 miles.

The area of severe effect was large. The tremors actually were felt over an area with a radius of about 800 miles, so that 2 million square miles were affected, including ocean areas. Within an area of 100 miles in diameter, the destruction would have been severe except for the character of the country; settlements were few and far between and the prevailing type of construction primitive, the log cabin being well designed to resist destruction by earthquakes. Throughout this region it was difficult for people to remain on their feet.

The belt from 50 to 100 miles in radius was strongly shaken. This included two cities, Savannah and Columbia, each about 90 miles away. At Savannah, 300 chimneys were damaged and those poorly constructed were shaken down. Columbia felt the shocks still more strongly. Buildings swayed, plaster fell, and the undulatory movement of the ground made walking difficult. The effect did not vary exactly with distance from epicenter, as geological conditions were an important factor. At Augusta, just over 100 miles from the epicenter, 100 chimneys fell and a dam fissured and broke. The shocks were as severe at Raleigh, N.C., 215 miles away, as at Wilmington, N.C., 152 miles away. The shock was felt at Boston, Mass., Milwaukee, Wis., Cuba, and as far east as Bermuda, 1,000 miles away. It was felt sharply at New York City. There appears to have been a shadow zone where it was lightly felt, as compared with other places of similar distance, in the Appalachian region of West Virginia, Maryland, and Pennsylvania.

INTERMEDIATE AND MINOR EARTHQUAKES

1758. April 24. Annapolis, Md. Lasted 30 seconds; preceded by subterranean noises. Also felt in Pennsylvania, though not so strongly.

1774. February 21. Eastern Virginia. A sharp shock was felt over much of Virginia and southward into North Carolina. Many houses moved considerably off their foundations at Petersburg and Blandford. Inhabitants ran outside in alarm. Fredericksburg residents were greatly terrified; severe at Richmond.

1800. March 17 and November 29. Philadelphia, Pa. Severe shocks.

1807. April 30 or May 1. Lynchburg-Richmond, Va., area. Severe at both towns. Most of those asleep were awakened; considerable alarm. Houses were shaken violently.

1828. March 9. Probably Virginia. Felt over a wide area of Pennsylvania, Maryland, District of Columbia, Virginia (including West Virginia), Ohio, Kentucky, North Carolina, and South Carolina. Severe shock awakened many at Raleigh, N.C. Sounds like rumbling thunder were reported at Hillsboro, N.C.

1833. August 27. Central Virginia. Felt area extended from Norfolk on the east, to at least as far west as Lexington, and from Baltimore, Md., on the north to Raleigh, N.C., on the south. Two coal miners were reported killed in the panic caused by this shock in a mine near Richmond. Felt by many in Washington, D.C., and vicinity and at Norfolk, Va. At Lynchburg, walls of buildings were visibly agitated; windows rattled violently. Distinctly felt; lasted nearly 30 seconds. Many were considerably alarmed at Fredericksburg. Severe at Charlottesville.

1840. November 11 and 14. Philadelphia, Pa. Severe. Great and unusual swell on Delaware River.

1843. February 8. West Indies. A great earthquake that caused considerable damage on Guadeloupe appears to have been felt in the eastern part of the United States, especially at Washington, D.C. It was reported felt in New York, Pennsylvania, Ohio, Maryland, Virginia (including West Virginia), and in several towns in North Carolina. It is possible there were two separate earthquakes.

1852. April 29. Probably Virginia. Felt from Washington, D.C., and Baltimore, Md., on the north to Raleigh, Greensboro, Hillsboro, and

Milton, N.C., on the south. Some ran from offices in great alarm in the District of Columbia. Chimneys were thrown down near Wytheville, Va. Tops of chimneys were shaken off at Buckingham Court House, Va. At Staunton, Va., shock lasted nearly a minute; houses were so violently shaken that "many [people] made a precipitate retreat." Much alarm in Richmond. At Scottsville, Va., in Albermarle County, boats lying in the canal were tossed to and fro. Every house in the town was shaken.

1853. May 2. Virginia-West Virginia region. Quite severe at Liberty and Lynchburg, Va. Caused alarm throughout towns of Parkersburg and Wheeling, W. Va.

1855. February 2. Charlotte Court House, Va. Windows and crockery broke in some stores. Many residents were frightened. Also felt at other towns in the region.

1857. December 19. Charleston, S.C. Series of horizontal oscillations, with vibrations lasting 6 to 8 seconds. Felt at Savannah, Ga., and Georgetown, S.C. A rumbling noise was reported over a considerable area.

1861. August 31. Probably Virginia. Two shocks were felt at Washington, D.C., at 5-second intervals. Felt along the Atlantic coast from Washington, D.C., southward to Charleston, S.C., and Columbus, Ga., and westward to Cincinnati, Ohio, Louisville, Ky., and Gallatin, Tenn. Bricks were shaken from chimneys at Wilkesboro, N.C.

1871. October 9. Wilmington, Del. A press report stated chimneys toppled and windows broke. Damage also was reported at New Castle and Oxford. Felt in New Jersey and Pennsylvania.

1872. June 17. Milledgeville, Ga. Sharp shock. Brick buildings jarred.

1874. February 10 to April 17. McDowell County, N.C. There was a series of explosive shocks, none severe, followed by a deep rumbling noise in the vicinity of Stone Mountain. At times, stout log buildings shook violently. There were probably 50 to 75 shocks, each accompanied by rumbling, during the period named. Some of the explosions were described like the rattling of artillery followed by rumbling, the ground trembling for a few seconds after each explosion. The shocks were felt over an area 25 miles in diameter, including Mount Mitchell, the highest point east of the Black Hills of South Dakota. The explosive shocks and noises were simultaneous. Shocks occurred on February 10 and 22, March 17 and 26, April 14 and 17.

1875. November 1. Northern Georgia. Felt from Spartanburg and Columbia, S.C., to Atlanta and Macon, Ga., and from Gainesville to Augusta, Ga., an area approximately 200 by 150 miles. The shock lasted 30 seconds at Washington and Augusta, Ga., and there were several aftershocks. Rumbling was heard at Washington.

1875. December 22. Arvonia, Va., area. This earthquake was preceded by a minor shock on March 10. The December shock was of intensity VII or more. This was felt in Baltimore, Md., and Greensboro, N.C., 100 and 150 miles away, respectively, and from the coast westward to Greenbrier and White Sulphur Springs, W. Va. Near the center there were five shocks in quick succession. Brick was thrown from chimneys in Goochland and Powhatan Counties. Shingles were shaken from roof at Manakin, and many lamps and chimneys were broken. A chimney was thrown down at Wilmington, N.C. At Richmond, Va., the shock was severe and lasted 20 to 30 seconds with a deep rumbling. Plaster fell; several panes of window glass broke. Bricks were knocked off a few chimneys.

1877. September 10. Delaware Valley. Felt from Trenton, N.J., to Philadelphia, Pa., over an area 20 miles wide with center near Burlington, N.J.

1877. November 16. North Carolina-Tennessee region. Felt at Knoxville, Tenn., and Murphy, N.C.

1879. January 12. Near St. Augustine, Fla. Felt from the line joining Tallahassee, Fla., to Savannah, Ga., on the north, to a line joining Punta Rassa and Daytona Beach, Fla., on the south. There were two shocks lasting 30 seconds. Doors and windows rattled at Daytona Beach; articles were thrown from shelves at St. Augustine and plaster was shaken down. Similar effects were noted at Daytona Beach, 50 miles south.

1879. March 25. Delaware River. Near Dover, Del., and below Philadelphia, Pa. Felt from Chester, Pa., to Salem, N.J., a distance of 30 miles. Felt most strongly on east side of river.

1879. December 13. Charlotte, N.C. Awakened persons in Charlotte, Pineville, Providence, and Sharon. A light foreshock occurred the previous day at 19:00.

1880. January 22 and 23. Cuba. Severe shocks felt at Key West, Fla., from Cuban earthquakes centering at Vuelta Abajo, west of Havana, where buildings were thrown down.

1883. March 11 and 12. Harford County, Md. Clocks stopped at Fallston.

1884. January 18. Wilmington, N.C. Houses rocked; crockery was thrown from shelves.

1884. May 31. Allentown, Pa. Strong shock. Dishes were thrown from tables.

1885. January 2. Maryland-Virginia region. Felt most strongly in Frederick County, Md., especially at Boonsboro and New Market. There was a heavy jar, partly vertical, but no noise except rattling of windows. At Wadesville, objects fell from shelves. At Chantilly, a bowl fell from a dresser. It also was felt in Loudoun, Fauquier, Fairfax, and Shenandoah Counties, Va. Warrenton, Va., and Washington, D.C., were on the edge of the affected area.

1885. August 6. Watauga County, N.C. Noise like thunder at Boone in Blue Ridge Mountains. Near Blowing Rock, dishes rattled and houses rocked violently.

1885. October 9. Virginia. Felt strongly at Variety Mills, Nelson County. At Staunton and Lexington, windows and furniture were shaken; people rushed out of buildings. A second shock occurred an hour later. The shock was felt in Rockingham County to the northwest and at Petersburg to the east. It was reported felt by one person in Washington, D.C.

1886. February 4 and 13. Alabama. Sumter and Marengo Counties. Felt on both sides of the Tombigbee River for 32 miles from Moscow. At that place, the earth seemed to move.

1886. October 22. Charleston, S.C. Strong shocks. The first was felt with intensity VI at Charleston, S.C., Atlanta and Augusta, Ga., and other towns. The second shock was intensity VII at Summerville, S.C. Felt at Washington, D.C., Richmond, Va., and Louisville, Ky.

1886. November 5. Charleston, S.C. Another shock was felt over the same area as the second earthquake of October 22.

1889. March 8. Pennsylvania. Felt at Harrisburg, Philadelphia, Reading, York, and other towns. Lasted 10 seconds.

1895. September 1. West of Newark, N.J. Centered in Hunterdon County, N.J., near High Bridge. Felt from Virginia to Maine. Articles fell from shelves and buildings rocked in several Hunterdon County towns. Intensity V at Atlantic Highlands, and felt in all parts of the city of Newark. Fairly sharp at Camden and Burlington. At Philadelphia, Pa., windows broke and crockery overturned. The shock seems to have been felt over a considerable distance northeast-southwest, but rather narrow at right angles to this line. Not reported in Pennsylvania west of Easton.

1897. May 3. Pulaski, Va. Strongest at Pulaski. Chimneys were damaged at Roanoke. Bricks fell from chimneys and plaster fell from walls at Radford, Va. The shock was felt at several Virginia towns and at Winston-Salem, N.C. There was a rumbling like thunder in the central region. Two shocks were felt at Lenoir, N.C.

1897. May 31. Giles County, Va. Rumbling was heard at various times between May 3 and 31. On May 31, there was a strong shock felt from Georgia to Pennsylvania and from the Atlantic coast to Indiana and Kentucky. It was felt most strongly at Pearisburg, Giles County, Va., and is generally known as the Giles County earthquake. Old brick houses and chimneys were cracked, and bricks were thrown from chimney tops. There were fissures in the ground and small landslides in places where they were easy to start. At the Narrows, it was claimed that a motion like the ground swell of the ocean was observed. Large rocks rolled down the mountains. There were loud sounds, compared by veterans to that of siege guns. At Wytheville, bricks were thrown from chimneys; some were cracked and out of place. Chimneys were shaken down at Bedford City, Houston, Pulaski, Radford, and Roanoke. In Raleigh, N.C., two shocks were reported that lasted 30 seconds and chimneys were thrown down. Chimneys were also damaged or down at Bristol and Knoxville, Tenn., and Bluefield, W. Va. These tremors continued until June 6. The main shock was felt at Spartanburg, S.C., and Cincinnati, Ohio.

1897. October 21. Southwestern Virginia. Felt also in central and western North Carolina. Many were alarmed at Lynchburg, Va. Strong at Salem.

1897. December 18. Ashland, Va. Heavy rumbling. Shock lasted 20 to 30 seconds. Felt in Buckingham, Fredericksburg, and Richmond, Va. Shook houses all over Richmond.

1898. February 5. Pulaski, Va. Bricks were thrown from chimneys; people rushed into the streets. At East Radford, the shock was severe enough to send occupants outside. Also felt at Bedford City, Lexington, Lynchburg, Salem, and Wytheville.

1898. November 25. Southwestern Virginia. Pictures fell from pianos and mantels at Fincastle. Some chinaware broke at Roanoke. Distinctly felt at Charlotte, Franklinville, Raleigh, and Winston-Salem, N.C.

1899. February 13. Southwestern Virginia. Four shocks were felt in western Virginia, eastern Tennessee, and western North Carolina. Light furniture moved at Lynchburg, Va. Almost all were awakened at Wytheville. Also aroused many from sleep at Danville, Dublin, East Radford, Lynchburg, and Pulaski.

1900. October 31. Jacksonville, Fla. Felt with intensity V. Eight distinct shocks.

1902. May 29. Chattanooga, Tenn. Houses shook and people awakened. Rumbling noise.

1902. October 18. Tennessee-Georgia region. Felt along the east face of Rocky Face Mountain, west of Dalton, Ga. Intensity V at LaFayette. Also felt at Chattanooga, Tenn.

1903. January 23. Georgia-South Carolina region. Felt at Tybee Island, Savannah, Ga., with intensity VI; Charleston, S.C., IV–V; Columbia, S.C., III–IV; and Augusta, Ga., III. Houses were shaken strongly.

1904. March 4. Eastern Tennessee. Epicenter near Marysville and Sevierville. Felt along the mountains for 90 or 100 miles. Sound was heard at Tellico Plains. Not reported outside Tennessee.

1905. January 27 and 28. Gadsden, Ala. Chimneys were thrown down; a well dried up. Felt at Birmingham, as far as Savannah, Ga., and at Louisville, Ky., more than 300 miles away. Aftershocks occurred up to November.

1906. May 8. Near Seaford, Del. Strongest at Seaford. Felt at Millsboro, Del., and Denton and Hurlock, Md. Buildings trembled.

1907. February 11. Arvonia, Va. Felt strongly from Powhatan to Albermarle County. At Arvonia and Columbia, nearly everyone ran outside; some furniture and other objects were displaced at Arvonia. Slight damage at Ashby and Buckingham. Sound like thunder at Richmond. The shock lasted 20 to 30 seconds and caused minor damage at a number of towns.

1907. April 19. Charleston, S.C. Dishes rattled and objects were thrown from shelves. Similar effects at Savannah and Augusta, Ga.

1908. May 31. Allentown, Pa. A few chimneys toppled and people were thrown down. There was a sound like an explosion or the fall of a heavy body. Not felt over more than 50 square miles; it may have been due to fall of rockmass in a subterranean cavern, this being limestone country.

1908. August 23. Powhatan, Va. Felt in Chesterfield, Powhatan, and Amelia Counties. Sharp shock. At Moseley's Junction (Powhatan County) and Skinquarter (Chesterfield County), people were aroused by a rumbling noise.

1909. April 2. Charles Town-Martinsburg, W. Va. Felt from Winchester, Va., to Mercersburg, Pa., on the north, Hagerstown, Md., on the east, and Front Royal, Va., on the south. Strong at Martinsburg and Charles Town; pictures were thrown from the wall. Many were awakened and alarmed at Winchester, Va.

1910. May 8. Arvonia, Va. Intensity V over an area 20 miles in diameter. Also felt at Cartersville, Carysbrook, and Charlottesville.

1911. April 20. North Carolina-South Carolina area. Felt area extended from Asheville, N.C., to Spartanburg, S.C. At Caesar's Head, S.C., along the Blue Ridge Mountains, cracks opened. Felt at Hendersonville, N.C., 15 miles northeast.

1912. June 12. Summerville, S.C. Chimneys were shaken down; felt at Charleston with intensity VI. It was felt as far as Brunswick and Macon, Ga., Greenville, S.C., and Wilmington, N.C.

1912. June 20. Savannah, Ga. Felt strongly.

1913. January 1. Union County, S.C. An area of approximately 43,000 square miles, roughly elliptical in shape, was shaken with an intensity VI–VII earthquake. At Union, within the epicentral region, cracks formed in the wall of the jail and plaster fell. Cracks appeared in many brick buildings; many chimneys were thrown down. It was felt at Raleigh, N.C., more than 200 miles away. At Kings Mountain, N.C., one chimney was thrown down.

1913. March 28. Near Knoxville, Tenn. Two shocks were felt over an area 70 by 40 miles, with noticeable rise and fall of ground in some places. Fire alarms were set off. Knox County Courthouse,

a massive structure, trembled for several minutes. Movable objects were overthrown; bricks fell from chimneys. People in autos did not feel the shock while those walking and in buildings did. There were some cases of nausea.

1913. April 17. Southeastern Tennessee. Also felt in North Carolina, northeastern Georgia, and South Carolina. This was felt over an elliptical area 45 to 25 miles north-northeast–south-southwest. Wavelike motion of the ground was noted in several places. There were noises like thunder. The effect was most severe in the southeast corner of Tennessee. At Brasstown, N.C., shock lasted about 30 seconds.

1914. January 23. Southeastern Tennessee. Intensity V at Niota and Sweetwater. Loud sound.

1914. March 5. Near Atlanta, Ga. Epicenter was 30 miles southeast of Atlanta, Ga. It was felt in Cherokee County, N.C., and by several persons in Raleigh. Also felt in Alabama and Tennessee.

1914. September 22. Summerville, S.C. Pictures on walls were displaced. Intensity IV at Charleston. It was felt in Macon, Ga., 150 miles away; also at Savannah and Augusta. At Summerville, the shock was preceded by a noise like a train approaching from a distance. Reports were not numerous, but it is estimated that the shock was felt over an area of 30,000 square miles.

1915. October 29. Near Marshall, N.C. Many people were awakened near Marshall and at Asheville. Two distinct shocks were felt at Asheville.

1916. February 21. Near Asheville, N.C. This earthquake occurred in the Appalachian Mountains near Skyland, N.C., not far from Asheville. Felt from Georgia to Virginia and as far west as Alabama, Tennessee, and Kentucky. It was one of the largest North Carolina shocks in historic times. The most distant felt point was Norfolk, Va., 365 miles away. In places near the center, crockery fell from shelves. At Sevierville, Tenn., a team of horses ran away and bricks were shaken from chimneys. Springs increased in volume. In a few places, plaster was cracked. Sounds were heard throughout the area included within isoseismal IV. Within 200 miles of the center—that is, to isoseismal III—rattling of dishes and windows was noted.

1916. August 26. Western North Carolina. Intensity V at Statesville and Taylorsville, N.C.

1916. October 8. Northeastern Alabama. Apparently felt most strongly at Easonville. It was felt from North Carolina to Mississippi and from Georgia to southern Indiana. Near the epicenter, frame buildings were badly shaken, windows were broken, and chimneys were thrown down. Fairly hard shock at Birmingham and Montgomery.

1917. June 29. Western Alabama. Intensity V at Rosemary; intensity IV at Greensboro.

1918. April 9. Luray, Va. Central and northern Virginia perceptibly shaken. Felt in Shenandoah Valley with intensity VI at Hamburg, Edinburg, Winchester, and Luray, Va.; intensity V at Washington, D.C., where windows were reported broken. Farthest points reporting it were Colebrookdale, Berks County, Pa., 60 miles northwest of Philadelphia; Danville, Roanoke, and Williamsburg, Va.; and Solomons, Md. Felt slightly at Baltimore, Md., and in parts of West Virginia. Sound heard over a considerable area. At Winchester, Va., it resembled vibration of heavy machinery. While houses swayed and rattled, little damage was done.

1918. June 21. Lenoir City, Tenn. Felt with intensity V. Duration 10 to 15 seconds.

1919. September 5. Near Front Royal, Va. Felt over the same general region as that of April 9, 1918. It was strongest in the Blue Ridge Mountains just south of Front Royal. The first shock was accompanied by an explosive sound. Plaster fell. Springs became muddy. Also felt in Maryland and West Virginia.

1920. December 24. Rockwood, Tenn., area. Shock of considerable violence was felt at several places in the vicinity of Rockwood.

1921. January 26. New Jersey. Moorestown and Riverton were shaken. Rumbling noise.

1921. July 15. Near Mendota, Va. Windows broke in area.

1921. August 7. New Canton, Va., area. Intensity V in Buckingham County, Va. Strongest in New Canton where many awakened. Also strong at Arlington. (Newspaper accounts stated that a meteor fell in this area on Aug. 7.)

1924. October 20. Pickens County, S.C. South Carolina, western North Carolina, northeastern Georgia, and eastern Tennessee were shaken. Highest intensities were reported at Pickens and Walhalla, S.C., and Brevard and Hendersonville, N.C.

Buildings were shaken; furniture overturned. A loud roar accompanied the shock.

1924. December 25. Roanoke, Va. Knocked pictures from walls; awakened everyone. Furniture bumped up and down; vases fell from tables.

1926. July 8. Southern Mitchell County, N.C. The following effects were observed over a small area about ½ mile long and 300 yards wide: Houses rattled, chimneys cracked, building foundations cracked, water pipeline broke, glassware displaced. Shock was reported felt 6 miles from epicenter.

1927. June 1. Asbury Park, N.J., area. Three shocks were felt along the New Jersey coast from Sandy Hook to Toms River. Highest intensities were observed from Asbury Park to Long Branch; several chimneys fell, plaster cracked, and articles were thrown from shelves.

1927. June 10. Near Charlottesville, Va. Houses rocked; people awakened. Rumbling noise.

1927. June 16. Northeastern Alabama. Felt in Madison and Jackson Counties. At Gurley and Scottsboro, many people were alarmed. Roaring sounds accompanied shock.

1928. November 2. Western North Carolina. Centered near the northeast border of Tennessee or in adjacent North Carolina. It was felt chiefly along the French Broad River, from Asheville to Newport. There was some damage at Asheville in upper stories of buildings. The motion of automobiles was affected. Felt also in Alabama, Georgia, Virginia, and Kentucky.

1929. December 26. Central Virginia. Moderate shock at Charlottesville, Va., shook bricks from chimneys in a few cases. Felt in various parts of Albermarle County.

1931. May 5. Northern Alabama. Slight damage at Cullman; generally felt in Birmingham.

1933. January 24. Near Trenton, N.J. A sharply felt shock. Pictures thrown from wall at Lakehurst.

1933. December 19. Summerville, S.C. Sharp local shock. Children ran from schoolhouses.

1934. October 29. Erie, Pa. Strong local shock with slight damage. People left theaters.

1935. January 1. North Carolina-Georgia border. Slight damage at Dahlonega, Ga., and at Almond and Gay, N.C.

1938. July 15. Southern Blair County, Pa. Broken dishes and fallen plaster were reported south of Altoona at Henrietta and Clover Creek, Pa. Wells were affected in Clover Creek Valley.

1938. August 22. Central New Jersey. Felt throughout central New Jersey, southeastern Pennsylvania, and northern Delaware. Slight damage at Gloucester City and Hightstown, N.J., and Ardmore, Pa. Four smaller shocks occurred on the 23d and one on the 27th.

1939. May 4. Anniston, Ala. Beds moved. Many ran outside. Also felt at Blue Mountain, Choccolocco, De Armanville, Jacksonville, Jenifer, Lincoln, Oxford Lake, Talladega, and Weaver.

1939. November 14. Salem County, N.J. Felt from Trenton, N.J., to Baltimore, Md., and from Cape May, N.J., to Philadelphia, Pa., and adjoining counties. Small objects overturned at Deepwater. Little or no damage noted.

1945. June 13. Cleveland, Tenn. Felt strongly between Cleveland and Blue Ridge, Ga. Many were alarmed and ran into the streets in Cleveland.

1945. July 26. Murray Lake, S.C., about 30 miles northwest of Columbia. Also felt at Asheville and Charlotte, N.C., Augusta and Macon, Ga., and Knoxville, Tenn. Many reported rumbling noises preceding the earthquake.

1952. November 19. Charleston, S.C. Many were frightened, but there was no damage. Also felt at Folly Beach, Isle of Palms, Mount Pleasant, Sullivans Island, and on Charleston Peninsula.

1954. January 7. Sinking Spring, Pa. Felt in western Berks County and eastern Lancaster County. Minor damage occurred in the City's west section. Plaster fell, dishes and bottles tumbled from shelves, and furniture was upset. Many smaller shocks were felt during the month in the vicinity of Sinking Spring.

1954. February 21. Wilkes-Barre, Pa. This local shock caused extensive damage in a five-block area. Hundreds of homes were damaged; streets and sidewalks cracked; gas and water mains snapped. Total damage was estimated at $1 million.

1954. February 23. Wilkes-Barre, Pa. Another local shock with effects similar to that of February 21.

1955. September 28. Virginia-North Carolina border. Felt over most of Alleghany and northern Ashe Counties in North Carolina and all of Grayson and parts of Smyth and Wythe Counties in Virginia. Many were awakened and frightened. Rumbling noise was reported.

1956. September 7. Knoxville, Tenn., area. Felt in parts of Kentucky, North Carolina, Tennessee, and Virginia. Greatest intensity was at Knoxville where windows shattered, plaster fell from walls, and one chimney was thrown down. First shock was stronger than the second.

1957. March 23. West-central New Jersey. Slight damage in the Lebanon-Hamden-Long Valley areas, consisting of cracked chimneys, broken windows and dishes, cracked walls and plaster, and broken well curb. Many people were frightened.

1957. April 23. Birmingham, Ala., area. Slight damage to chimneys, cement, and walls reported at Birmingham. At Newnan, Ga., many were awakened and alarmed. Thunderous earth sounds were heard in several places.

1957. May 13. Western North Carolina. Slight damage, consisting mostly of cracked plaster, was reported at Micaville and Nebo. Sprinkler pipe was shaken loose in factory; loose objects fell. Loud, roaring earth noises were heard in many places.

1957. June 23. East-central Tennessee. Awakened many in the Hardin and Clinch River Valleys.

1957. July 2. Western North Carolina. Felt strongly in Buncombe and Madison Counties. Walls and plaster cracked at Asheville. A retaining wall cracked at Marshall. Plaster cracked at Weaverville and Swannanoa. At the latter town, a few chimneys were damaged. Many were awakened and alarmed.

1957. November 24. Hartford, Tenn., area. A wall cracked at Hartford; a kitchen reportedly separated from rest of house. Furniture moved at Cherokee and Sylva, N.C. A window cracked at Gatlinburg, Tenn.

1958. March 5. Wilmington, N.C., and vicinity. Many were awakened along the coast from Hampstead to Kure Beach and 20 miles inland.

1958. October 20. Anderson, S.C. The shock awakened and frightened many residents.

1959. April 23. Virginia-West Virginia border. At Eggleston and Pembroke, Va., the earthquake damaged chimneys, cracked wall plaster, and knocked articles from shelves and pictures from walls. Also felt at Lindside, W. Va.

1959. August 3. Near Charleston, S.C. Felt by and alarmed many in parts of South Carolina and Georgia. Minor damage at Charleston, Summerville, and Wadmalaw Island. Chimneys were damaged; plaster cracked and fell; walls cracked; objects fell from shelves. Plaster cracked at Columbia, Johns Island, Meggett, and Pierpont, S.C., and Augusta, Ga. Rumbling, roaring earth sounds.

1959. August 12. Alabama-Tennessee border. Slight damage to chimneys and a building was reported at Hazel Green and Meridianville, Ala. Canned goods were thrown from shelves at New Sharon; people rushed from buildings. At Huntsville, Ala., wall plaster cracked.

1959. October 26. Northeastern South Carolina. Felt over a small area of central and northern South Carolina and southern North Carolina. At Chesterfield, plaster cracked and fell; one wall cracked. Rumbling, roaring earth sounds.

1960. March 12. Off coast of South Carolina. Felt principally in eastern and central South Carolina. At Charleston, a china closet tilted against wall. Also felt at Augusta, Ga., and Greensboro, N.C.

1960. April 15. Eastern Tennessee. The shock was felt by nearly all in Alcoa, Greenback, Knoxville, Maryville, Mount Vernon, Pumpkin Center, and Tallassee. Awakened many at Madisonville. Earth noises accompanied the shock.

1960. July 23. Near Charleston, S.C. Roof cracked at Goose Creek, 13 miles northwest of Charleston. Several were alarmed at Summerville and Murrells Inlet.

1961. September 14. Lehigh Valley, Pa. Many were awakened and alarmed at Allentown, Bethlehem, Catasauqua, Coplay, and Hellertown.

1961. December 27. Pennsylvania-New Jersey border. At Bristol, Pa., and in the northeastern part and suburbs of Philadelphia, police and newspaper offices were swamped with calls from alarmed citizens. Felt by many at Levittown and Langhorne, Pa., and Bordentown and Trenton, N.J.

1963. October 28. Near Galax, Va. Felt over a small area of Virginia and North Carolina. Concrete driveway was cracked at Galax. Furniture shifted slightly and a lamp overturned at Fries. People fled from buildings at Sparta and Glade Valley, N.C. At Ennice, N.C., goods fell from shelves. Rumbling earth noises were heard.

1964. February 18. Alabama-Georgia border. Felt by and awakened nearly all residents at Lyerly and Menlo, Ga.; many were alarmed. Dishes fell from shelves at Menlo. Also felt in De Kalb County, Ala. Magnitude 4.4.

1964. March 12. Central Georgia. Felt over a small area of Baldwin, Bibb, Jones, and Wilkinson Counties. Felt by nearly all at Haddock; residents were frightened. Magnitude 4.4.

1964. April 20. Columbia, S.C., area. Felt in Fairfield, Florence, Lexington, and Richland Counties. Intensity V was reported at Gaston and Jenkinsville.

1964. May 12. Cornwall, Pa. This local shock cracked a wall and felled plaster. Small landslides also were reported. Mine workers 1,200 feet underground felt the shock. Magnitude 4.5.

1966. May 31. West of Richmond, Va. Felt over most of Virginia and in southern Maryland. Many were awakened throughout the area. Plaster cracked at Cumberland, Va. Intensity V effects were noted in several towns, including Richmond. Magnitude 3.1.

1967. April 8. Columbus, Ohio. Windows broke; plaster cracked. Intensity V also noted at Hebron and Lancaster. Magnitude 4.2.

1967. October 23. Near Summerville, S.C. Felt principally in the Charleston-Summerville area. Press reports indicated that chunks of marl were found on the bottom of the circular drains of an underground sewage system being dug in Charleston. Magnitude 3.8.

1968. December 10. Southern New Jersey. Felt in southern New Jersey, southeastern Pennsylvania, and at Wilmington, Del. Press reported some broken windows. Many were awakened and frightened. Intensity V effects were noted at Camden, Moorestown, Palmyra, Riverside, and Willingboro, N.J., and Darby and Philadelphia, Pa. Magnitude 2.5.

1968. December 11. Louisville, Ky. Press reported a slight earthquake in portions of the Ohio River Valley. Dishes fell from cupboard at Louisville; residents ran into streets. Also felt at two towns in Indiana.

1969. July 13. Eastern Tennessee. Felt in Tennessee, North Carolina, Virginia, Kentucky, and Georgia. Slight damage occurred at Jefferson City, Tenn., where a few bricks loosened on chimneys and some rocks fell in zinc mines. At Knoxville, plaster and concrete cracked, houses shook strongly, and furniture jumped up and down. Plaster cracked at Seymour and small objects fell from shelves. No damage occurred outside Tennessee. Magnitude 3.5.

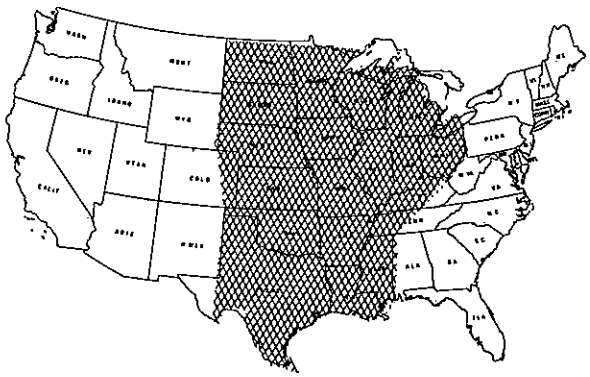
1969. November 19. Southern West Virginia. Felt over all or parts of West Virginia, Virginia, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Ohio, and Maryland. Slight damage, in the form of cracked plaster and broken windows, was noted in West Virginia at Athens, Camp Creek, Elgood, and Verona, and in Virginia at Glen Lyn and Rich Creek. In addition, a few bricks fell from a chimney at Glen Lyn, Va. In one house, plaster fell from nearly every wall; walls of an old concrete block house cracked. According to the press, a cornice was shaken from a building at Collinsville, Va. Magnitude 4.3.

1969. December 11. Richmond, Va. Felt principally in the Richmond area where the shock moved furniture about and broke one window. Intensity V effects also were noted near King William and at Ashland.

1969. December 13. Western North Carolina. Felt principally in the western sections of North and South Carolina. Intensity V at Glenville, N.C., and Pickens, S.C., where most were awakened, a few were frightened.

1970. September 9. Northwestern North Carolina. Slight damage occurred at Zionville and Boone. Intensity V also was assigned to effects at Blowing Rock, Deep Gap, Newhope, Patterson, and Sugar Grove. Felt also at Independence, Va., and Trade, Tenn.

Central Region



Résumé

Except for the flat beds of some oceans, the nonmountainous interior portions of continents usually are considered less earthquake prone than any part of the earth. However, this does not hold true for the Central United States. The Upper Mississippi and Ohio Valleys are regions of relatively frequent earthquakes. Three of the great earthquakes of known history occurred in the Upper Mississippi region in 1811–12. Only the sparse settlement of the area prevented grave damage. The extent, and severity, of topographic effects from these shocks has not been equaled by any other earthquake in the contiguous United States. The reason for most of the earthquakes in the Central Region is not fully understood. The Rough Creek Fault is believed responsible for the 1811–12 shocks. But most of the slips have occurred in formations deep in alluvial material and geologists have been able to study only the incidental effects on the alluvial soil. It is important that more studies be conducted in this seismic region.

List of Earthquakes in Central Region

Year	Date	Time (CST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1776	Summer	08:00	Muskingum River, Ohio	.....	.....	.....	.....	17, 18, 49
1779	Unknown	.....	Northern Kentucky	.....	.....	.....	.....	Do.
1791 or 1792	April or May	07:00	Northern and eastern Kentucky	.....	.....	.....	.....	Do.

See footnotes at end of table.

List of Earthquakes in Central Region—Continued

Year	Date	Time (CST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1795	Jan. 8	03:00	Kaskaskia, Ill	.....	.....	.....	.....	17, 18, 49
1804	Aug. 24	14:10	Fort Dearborn (Chicago), Ill	42.0	87.8	30,000	.....	18, 49
1811	Dec. 16	02:00	New Madrid, Mo	36.6	89.6	2,000,000	XII	3-3, 18, 19, 20, 36, 44, 72
1812	Jan. 23	.....	..... do	36.6	89.6	.....	XII	Do.
	Feb. 7	.....	..... do	36.6	89.6	.....	XII	Do.
1820	Nov. 9	16:00	Cape Girardeau, Mo	37.3	89.5	.....	IV–V	20, 49
1827	Aug. 6	22:30	New Albany, Ind	38.3	85.8	.....	VI	6, 7
	Aug. 7	01:00	..... do	38.3	85.8	.....	VI	Do.
1834	Nov. 20	13:40	Northern Kentucky	.....	.....	.....	V	55
1838	June 9	08:45	St. Louis, Mo	38.5	90.3	.....	VI	3-31
1841	Dec. 27	23:50	Near Hickman, Ky	.....	.....	.....	V	55
1843	Jan. 4	20:45	Western Tennessee	35.2	90.0	400,000	VIII	2-44, 14, 36, 49, 72
	Feb. 16	23:00	St. Louis, Mo	.....	.....	([2])	III–IV	2-44, 49, 55
1844	Nov. 28	07:00	Knoxville, Tenn	36.0	84.0	.....	VI	55
1857	Oct. 8	04:00 04:07	St. Louis, Mo	38.5	90.3	7,500	VI	2-58, 3-3, 3-31
1860	Unknown	.....	Central Minnesota	.....	.....	.....	.....	4, 8
1865	Aug. 17	09:00	Southeastern Missouri	36.5	89.5	24,000	VII	2-65, 3-31, 49, 55
1867	Apr. 24	14:22	Lawrence, Kans	39.5	96.7	300,000	VII	2-67, 3-46, 8, 55, 72
1872	Feb. 6	08:00	Wenona, Mich	43.5	83.8	([3])	V	2-72
	Oct. 9	10:00	Sioux City, Iowa	42.7	97.0	3,000	V	2-73, 72
1875	June 18	07:43	Western Ohio	40.2	84.0	40,000	VII	2-76, 4, 17
	Nov. 8	04:40	Kansas	39.3	95.5	8,000	V	2-76, 3-46, 4
1876	Sept. 25	00:15	Near Evansville, Ind	38.5	87.7	60,000	VI	2-78
1877	Aug. 17	10:50	Southeastern Michigan	42.3	83.3	200	IV–V	4
	Nov. 15	11:45 12:30	Eastern Nebraska	41	97	140,000	VII	2-78, 4, 72
1878	Mar. 12	04:00	Columbus, Ky	36.8	89.2	([3])	V	3-31, 8, 49
	Nov. 18	23:52	Southeastern Missouri	36.7	90.4	150,000	VI	2-79, 4, 49
1879	Dec. 29	00:30	South Dakota	42.9	97.3	([3])	V	2-80
1882	Feb. 9	14:00	Ohio	.....	.....	.....	V	3-55
	July 20	04:00	Southern Illinois	38	90	3,000	V	2-83, 3-31, 4
	Sept. 27	04:20	..... do	39	90	40,000	VI	2-83, 3-31, 49
	Oct. 15	00:00 05:00	..... do	39	90	40,000	V	2-83, 4, 49
	Oct. 22	16:15	Arkansas	35	94	135,000	VI–VII	2-83, 3-46, 4
1883	Jan. 11	01:12	Cairo, Ill	37.0	89.2	80,000	VI	2-84, 3-31, 4, 33, 49

See footnotes at end of table.

List of Earthquakes in Central Region—Continued

Year	Date	Time (CST)	Locality	N. lat.	W. long.	Area	Intensity	Authority [1]
				degrees	*degrees*	*sq. mi.*		
1883	Feb. 4	05:00	Kalamazoo, Mich	42.3	85.6	8,000	VI	2-84, 3-31
	Apr. 12	02:30	Cairo, Ill	37.0	89.2	(3)	VI–VII	3-31
	Dec. 5	09:20	Izard County, Ark	36.3	91.8	(3)	V	4, 8
1884	Sept. 19	14:14	Near Columbus, Ohio	40.7	84.1	125,000	VI	2-85, 3-55
1887	Feb. 6	16:15	Vincennes, Ind	38.7	87.5	75,000	VI	3-31, 6-87, 15-87, 49
	Aug. 2	12:36	Cairo, Ill	37.0	89.2	(3)	V	3-31
1889	July 19	19:32	Memphis, Tenn	35.2	90.0	(3)	VI	3-31, 8A, 49
1891	Jan. 8	00:00	Rusk, Tex	31.7	95.2	.....	VII	7
	July 26	20:28	Evansville, Ind	37.9	87.5	.....	VI	3-31, 6-91, 7
	Sept. 26	22:55	Near Cairo, Ill	.....	.....	.....	.....	3-31, 49, 72
1895	Oct. 11	17:55, 19:25	Black Hills, S. Dak	43.9	103.3	.....	IV–V	8
	Oct. 31	05:08	Charleston, Mo	37.0	89.4	1,000,000	VIII	3-3, 4, 8, 36, 49, 72
1897	Apr. 30	22:00	Tennessee, Illinois, Indiana, and Kentucky.	.....	.....	.....	IV–V	3-31, 4, 49
1899	Apr. 29	20:05	Southwestern Indiana and southeastern Illinois.	38.5	87.0	40,000	VI–VII	3-31, 4, 8, 49, 55
1901	May 17	01:00	Ohio	39.3	82.5	7,000	V	8
1902	Jan. 24	04:48	Missouri	38.6	90.3	40,000	VI	3-31, 8, 49
	July 28	12:00	Eastern Nebraska	42.5	97.5	35,000	V	8, 72
1903	Feb. 8	18:21	St. Louis, Mo	38.5	90.3	70,000	VI	3-31, 8, 49
	Nov. 4	12:18, 13:14	..... do	38.5	90.3	70,000	VI–VII	Do.
	Nov. 27	03:20	New Madrid, Mo	36.5	89.5	70,000	V	8, 49
1904	Oct. 27	p.m.	Kansas	37.7	100.0	2,700	V	3-46, 8
1905	Mar. 13	10:30	Menominee, Mich	45.0	87.7	(3)	V	4
	Apr. 13	10:30	Keokuk, Iowa	40.4	91.4	5,000	V	3-31, 8, 72
	July 26	18:20	Calumet, Mich	47.3	88.4	16,000	VII	8, 17
	Aug. 21	23:08	Mississippi Valley	.....	.....	40,000	VI	3-31, 8, 49
1906	Jan. 7	18:15	Manhattan, Kans	39.3	96.6	10,000	VII	3-46, 8, 59
	May 9	18:27	South Dakota-Nebraska border	43.0	101.3	8,000	VI	8
	May 11	00:15	Southwestern Indiana	38.5	87.2	800	V	3-31, 8
	May 21	13:00	Flora, Ill	38.8	88.5	.....	V	3-31
	May 26	About 09:00	Keweenaw Peninsula, Mich	47.3	88.4	1,000	VIII	17
	June 27	16:10	Fairport, Ohio	41.4	81.6	400	V	8
1907	July 4	03:00	Farmington, Mo	37.7	90.4	400	IV–V	3-31, 8
1908	Sept. 28	13:34	New Madrid, Mo	36.5	89.5	5,000	IV–V	3-31, 8, 49
	Oct. 27	18:27	Cairo, Ill	37.0	89.2	5,000	V	Do.
1909	Jan. 22	21:15	Houghton, Mich	47.2	88.6	(3)	V	8
	May 15	a.m.	Canada, felt to south	50	105	500,000	VI–VII [4]	8, 73
	May 26	08:42	Illinois	42.5	89.0	500,000	VII	3-31, 17, 21, 22

See footnotes at end of table.

List of Earthquakes in Central Region—Continued

Year	Date	Time (CST)	Locality	N. lat.	W. long.	Area	Intensity	Authority [1]
				degrees	*degrees*	*sq. mi.*		
1909	July 18	22:34	Illinois	40.2	90.0	40,000	VII	3-31, 8, 72
	Aug. 16	16:45	Southwestern Illinois	38.3	90.2	.....	.....	9
	Sept. 22	.....	Ohio Valley	38.7	86.5	4,000	V	9
	Sept. 27	03:45 03:50	Indiana	39.0	87.6	30,000	VII	3-31, 8, 9, 49, 72
	Oct. 23	01:10	Southeastern Missouri	37.0	89.5	40,000	V	3-31, 8
	Oct. 23	03:47	Near Robinson, Ill	39.0	87.7	8,000	V	8
1910	Feb. 26	02:00	Columbus, Nebr	41.4	97.3	(3)	IV–V	8
1911	Mar. 31	10:57 12:10	Rison, Ark	33.8	92.2	18,000	V	3-31, 8
	June 2	16:34	South Dakota	44.2	98.2	40,000	V	8, 72
1912	Jan. 2	10:21	Illinois	41.5	88.5	40,000	VI	8, 9, 23, 72
1915	Apr. 28	17:40	New Madrid-Tiptonville, Mo	36.4	89.5	200	IV–V	4, 8
	Oct. 23	00:05	Kadoka, S. Dak	43.8	101.5	(3)	V	Do.
	Oct. 26	01:40	Mayfield, Ky	36.7	88.6	(3)	V	3-31, 4, 8, 49
	Dec. 7	12:40	Near mouth of Ohio River	36.7	89.1	60,000	V–VI	Do.
1916	Dec. 18	23:42	Hickman, Ky	36.6	89.3	(3)	VI–VII	4
1917	Mar. 27	13:56	Panhandle, Tex	35.3	101.2	(3)	VI	3-16, 4
	Apr. 9	14:52	Eastern Missouri	38.1	90.6	200,000	VI	3-7, 3-46, 4, 49, 72
	Sept. 3	15:30	Staples, Minn	46.3	94.5	10,000	VI	3-7, 4
1918	Sept. 10	10:30	El Reno, Okla	35.5	98.0	(3)	V	4
	Oct. 4	03:21	Arkansas	34.7	92.3	30,000	V	3-31, 4, 49
	Oct. 13	03:30	Black Rock, Ark	36.1	91.1	(3)	V	3-31, 49
	Oct. 15	21:30	Western Tennessee	35.2	89.2	20,000	V	3-31, 4, 8, 49, 55
1919	May 25	03:45	Southern Indiana	38.5	87.5	18,000	V	3-31, 4, 49
	Nov. 3	14:40	Vicinity of Pocahontas, Ark	36.2	90.9	(3)	IV–V	4, 8
1920	May 1	09:15	Missouri	38.5	90.5	10,000	V	3-31, 4, 8, 49
1922	Mar. 22	16:30 20:20	Southern Illinois	37.3	88.6	25,000	V	3-31, 4, 49
	Mar. 23	15:45	Western Kentucky	.....	.....	.....	V	49
1923	Oct. 28	11:10	Marked Tree, Ark	35.5	90.3	40,000	VII	3-31, 4, 11, 49
	Nov. 9	22:00	Tallula, Ill	.....	.....	.....	V	3-31
	Dec. 31	21:05	Arkansas	35.4	90.3	30,000	V	3-31, 4, 10, 49
1924	Mar. 2	05:18	Kentucky	36.9	89.1	15,000	V	3-31, 10, 49
1925	Mar. 26	22:06	Southwestern Ohio	.....	.....	.....	V	3-55
	Apr. 26	22:05	Indiana	38.0	87.5	100,000	V	10, 49
	May 13	06:00	Kentucky	36.7	88.6	3,000	V	3–31, 10, 49
	July 30	06:17	Panhandle region, Tex	35.4	101.3	200,000	V	3-16, 3-31, 10, 55
	Sept. 2	05:55	Kentucky	37.8	87.6	75,000	V–VI	10, 49

See footnotes at end of table.

List of Earthquakes in Central Region—Continued

Year	Date	Time (CST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1926	Nov. 5	09:53	Southeastern Ohio	39.1	82.1	350	VI–VII	10
1927	Mar. 18	11:25	White Cloud, Kans	40.0	95.3	300	V	10
	May 7	02:28	Mississippi Valley	36.5	89.0	130,000	VII	10
1928	Sept. 9	15:00	Lorain and Cleveland, Ohio	41.5	82.0	1,500	V	27
	Nov. 16	07:45	Black Hills, S. Dak	44.0	103.7	2,000	V	27
1929	Mar. 8	04:06*	Bellefontaine, Ohio	40.4	84.2	5,000	V	27
	Sept. 23	04:00 05:00	Northeastern Kansas	39.0	96.6	15,000	V	27, 59
	Oct. 21	15:30	..... do	39.2	96.5	8,000	V	27
	Dec. 7	02:02	..... do	39.2	96.5	1,000	V	27
	Dec. 27	18:30	El Reno, Okla	35.5	98.0	8,000	VI	27
1930	Sept. 30	14:40*	Ohio	40.3	84.3	.....	VII	3-55
	Oct. 19	06:17	Louisiana	30.0	91.0	15,000	VI	27
1931	Jan. 5	20:51	Elliston, Ind	39.0	87.0	500	V	27
	Sept. 20	17:05*	Anna, Ohio	40.4	84.2	40,000	VII	27
	Dec. 16	21:40*	Northern Mississippi	34.1	89.8	65,000	VI–VII	27
1932	Apr. 9	04:15	Mexia-Wortham, Tex	31.7	96.4	1,000	V–VI	27
1933	Feb. 20	11:00	Norton, Kans	39.8	99.8	6,000	V	27, 59
	May 28	10:10	Maysville, Ky	38.7	83.7	600	V	27
	Aug. 19	13:30	El Reno, Okla	35.5	98.0	200	VI	27
	Dec. 9	02:40	Manila, Ark	35.8	90.2	100	VI	27
1934	Apr. 11	11:40	Texas-Oklahoma border	33.9	95.5	3,000	V	27
	July 30	01:20	Chadron, Nebr	42.7	103.0	23,000	VI	27
	Aug. 19	18:47*	Rodney, Mo	37.0	89.2	28,000	VII	27
	Nov. 12	08:45	Rock Island, Ill	41.5	90.5	.....	VI	27
1935	Mar. 1	05:00*	Nebraska	40.3	96.2	50,000	VI	27
1936	Mar. 14	11:20	Southeastern Oklahoma	34.0	95.2	900	V	27
	June 19	21:24	Texas Panhandle	35.8	101.3	40,000	V	27
1937	Mar. 2	08:48*	Western Ohio	40.4	84.2	70,000	VII	3-30, 27
	Mar. 3	03:50	Ohio	.....	.....	.....	V	3-55
	Mar. 8	23:45*	Western Ohio	40.4	84.2	150,000	VII–VIII	3-30, 27, 43
	May 16	18:50*	Northeastern Arkansas	36.1	90.6	25,000	IV–V	3-27, 27
	Nov. 17	11:05*	Centralia, Ill	38.6	89.1	8,000	V	3-31, 27
1938	Sept. 16	21:34*	Northeastern Arkansas	35.5	90.3	90,000	IV–V	3-29, 27
	Oct. 11	03:37	Sioux Falls, S.Dak	43.3	96.4	3,000	V	27
1939	June 19	15:43	Arkadelphia, Ark	34.1	93.1	.....	V	27
	Nov. 23	09:15*	Near Griggs, Ill	38.2	90.1	150,000	V	27
1941	Nov. 16	21:09*	Covington, Tenn	35.5	89.7	(3)	V–VI	27
1943	Mar. 8	21:26*	Lake Erie area	41.6	81.3	40,000	IV–V	27, 3-55
1946	July 23	00:45	Wessington, S.Dak	44.3	98.4	.....	VI	27
1947	June 29	22:24*	Near St. Louis, Mo	38.4	90.2	15,000	VI	3-40, 27
	Aug. 9	20:47*	South-central Michigan	42.0	85.0	50,000	VI	27
1950	Feb. 8	04:37	Near Lebanon, Mo	37.4	92.4	.....	V	27
1952	Feb. 20	16:35*	Tennessee-Missouri border	36.4	89.5	.....	V	27
	Apr. 9	10:29*	El Reno, Okla	35.4	97.8	140,000	VII	27, 43
	Apr. 16	00:05	..... do	35.4	97.8	.....	V	27
	June 20	03:38*	Southeastern Ohio	39.7	82.2	10,000	VI	27, 3-55
	July 16	17:48*	Dyersburg, Tenn	36.2	89.6	.....	VI	27
1953	Mar. 17	07:12 08:25	Concho, Okla	35.6	97.8	.....	VI	27

See footnotes at end of table.

List of Earthquakes in Central Region—Continued

Year	Date	Time (CST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1953	Sept. 11	12:26*	Southwestern Illinois	38.6	90.1	.....	VI	27
1954	Jan. 1	21:25	Middlesboro, Ky	36.6	83.7	.....	VI	27, 55
	Jan. 22	p.m.	Athens and Etowah, Tenn	35.3	84.4	.....	V	27
	Feb. 2	10:53	Missouri-Arkansas border	36.7	90.3	.....	VI	27
	Apr. 26	20:09	Memphis, Tenn	35.2	90.0	.....	V	27
1955	Jan. 25	01:24*	Tennessee-Arkansas-Missouri border.	35.6	90.3	30,000	VI	27
	Feb. 1	08:45	Gulfport, Miss	30.4	89.1	.....	V	27
	Mar. 29	03:03	Finley, Tenn	36.0	89.5	.....	VI	27
	Apr. 9	07:01*	West of Sparta, Ill	38.1	89.8	20,000	VI	27
	May 26	12:09	Cleveland, Ohio	41.5	81.7	(3)	V	27
	June 28	19:16	..... do	41.5	81.7	(3)	V	27
	Sept. 5	19:45	Finley, Tenn	36.0	89.5	.....	V	27
	Dec. 13	01:43	Dyer County, Tenn	36.0	89.5	.....	V	27
1956	Jan. 6	05:58*	Southern Kansas	37.3	98.5	16,000	VI	27, 59
	Jan. 27	06:03	West-central Ohio	.....	.....	.....	V	27, 3-55
	Jan. 28	22:14*	Tennessee-Arkansas border	35.6	89.6	.....	VI	27
	Feb. 16	17:30	Edmond, Okla	35.4	97.3	.....	VI	27
	Apr. 2	10:03	Southeastern Oklahoma	34.2	95.4	.....	V	27
	Oct. 29	03:24	Caruthersville, Mo	36.1	89.4	.....	V	27
	Oct. 30	04:36	Northeastern Oklahoma	36.2	95.9	3,700	VII	27
	Nov. 25	22:13*	Wayne County, Mo	37.1	90.6	21,500	VI	27
1957	Mar. 19	10:38	Northeastern Texas	32	95	10,000	V	27
	Mar. 26	02:27	Paducah, Ky	37.0	88.4	(3)	V	27
1958	Jan. 26	10:56	Memphis, Tenn	35.2	90.0	(3)	V	27
	Jan. 27	23:57	Illinois-Kentucky-Missouri border	37	89	300	V	27
	Apr. 8	16:26	Obion County, Tenn	36.2	89.1	400	V	27
	Apr. 26	01:30	Lake County, Tenn	36.3	89.5	.....	V	27
	May 1	16:47	Cleveland, Ohio	41.5	81.7	(3)	V	27, 3-55
	Nov. 7	20:42*	Illinois-Indiana border	38.4	87.9	33,000	VI	27, 55
	Nov. 19	12:15	Baton Rouge, La	30.3	91.1	(3)	V	27
1959	Feb. 13	02:37	Bogota, Tenn	36.2	89.5	170	V	27
	June 15	06:45	Seminole, Pontotoc, and Johnston Counties, Okla.	.....	.....	.....	V	27
	June 17	04:27*	Southwestern Oklahoma	34.5	98.5	12,000	VI	27
	Dec. 21	10:25	Finley, Tenn	36.0	89.5	400	V	27
1960	Jan. 28	15:38	Dyer County, Tenn	36.0	89.5	(3)	V	27
	Apr. 21	04:45	Lake County, Tenn	36.3	89.5	(3)	V	27
1961	Jan. 10	19:40	Southeastern Oklahoma	.....	.....	.....	V	27
	Feb. 22	03:45	Northwestern Ohio	41.2	83.4	.....	V	27, 3-55
	Apr. 13	15:15*	Kansas-Nebraska border	39.9	100.0	.....	V	27
	Apr. 27	About 01:30	Southeastern Oklahoma	35	95	.....	V	27
	Dec. 25	06:20 06:58	Kansas-Missouri border	39.1	94.6	11,000	V	27, 59
	Dec. 31	10:36*	Central South Dakota	44.4	100.5	.....	VI	27, 33
1962	Feb. 2	00:44*	New Madrid, Mo	36.5	89.6	35,000	VI	27
	June 26	19:29*	Southern Illinois	37.7	88.5	.....	V	27
	July 23	00:05*	Southern Missouri	36.1	89.8	.....	VI	27
1963	Mar. 3	11:30*	Southeastern Missouri	36.7	90.1	100,000	VI	27
	Aug. 2	18:38*	Illinois-Kentucky border	37.0	88.8	.....	V	27

See footnotes at end of table.

List of Earthquakes in Central Region—Continued

Year	Date	Time (CST)	Locality	N. lat.	W. long.	Area	Intensity	Authority [1]
				degrees	*degrees*	*sq. mi.*		
1964	Mar. 24	00:12	Hot Springs, S.Dak.	43.5	103.5	([3])	V	27
	Mar. 27	About 21:00	Near Van Tassell, Wyo	42.7	104.1	.....	V	27
	Mar. 28	04:09*	Nebraska	42.9	101.6	90,000	VII	27
	Apr. 28	15:19*	Texas-Louisiana border	31.7	93.6	.....	V	27
	Aug. 16	05:36	Hemphill, Tex., area	31.4	93.8	.....	V	27
1965	Aug. 14	07:14*	Southwestern Illinois	37.1	89.2	.....	VII	27
	Aug. 15	00:07* 22:19*	..... do	37.4	89.5	.....	V	27
	Oct. 20	20:05*	Eastern Missouri	37.8	91.1	160,000	VI	27
1966	June 26	06:00*	South Dakota	44.3	103.4	.....	VI	27, 67
	July 20	03:05*	Texas Panhandle region	35.7	101.2	.....	V	Do.
	Aug. 14	09:26*	Western Texas	32.0	102.6	.....	VI	Do.
1967	Apr. 7	23:41*	Ohio	39.6	82.5	4,000	V	27
	June 4	10:14*	Near Greenville, Miss.	33.6	90.9	25,000	VI	27
	June 29	07:57*	..... do	33.6	90.9	.....	V	27
	July 21	03:15*	Missouri	37.5	90.4	.....	VI	27
	Nov. 23	00:24*	South Dakota	43.7	99.4	.....	V	27
1968	Oct. 14	08:43*	Durant, Okla.	34.0	96.8	([3])	VI	27
	Nov. 9	11:02*	South-central Illinois	38.0	88.5	580,000	VII	3-60, 27
1969	Jan. 1	17:36*	Central Arkansas	34.8	92.6	23,000	VI	27
	May 2	05:33*	Eastern Oklahoma	35.2	96.3	13,000	V	27
1970	Nov. 16	20:14*	Northeastern Arkansas	35.9	89.9	30,000	VI	27

*Instrumental origin time and epicenter.
[1] See References, p. 133.
[2] Widespread.
[3] Local.
[4] Intensity at epicenter.

MAJOR EARTHQUAKES

Earthquakes of 1811 and 1812

Date of occurrence.—December 16, 1811; January 23 and February 7, 1812.

Epicenter.—Near New Madrid, Mo.

Area affected.—Topographic changes over an area of 30,000 to 50,000 square miles. The total area shaken was at least 2 million square miles.

Intensity.—All three earthquakes were of intensity XII.

Damage.—Very small for such great earthquakes because of sparse population.

Description.—A little after 02:00 on December 16, the inhabitants of the New Madrid region suddenly were awakened by the groaning, creaking, and cracking of the timbers of their houses and cabins, the sounds of furniture being thrown down, and the crashing of falling chimneys. In fear and trembling, they hurriedly groped their way from their houses to escape the falling debris. The repeated shocks during the night kept them from returning to their weakened and tottering dwellings until morning.

Daylight brought little improvement to their situation, for early in the morning another shock, preceded by a low rumbling and fully as severe as the first, was experienced. The ground rose and fell as earth waves, like the long, low swell of the

sea, passed across the surface, bending the trees until their branches interlocked and opening the soil in deep cracks. Landslides swept down the steeper bluffs and hillsides; considerable areas were uplifted; and still larger areas sank and became covered with water emerging from below through fissures or craterlets, or accumulating from the obstruction of the surface drainage. On the Mississippi, great waves were created which overwhelmed many boats and washed others high upon the shore, the returning current breaking off thousands of trees and carrying them into the river. High banks caved and were precipitated into the river; sandbars and points of islands gave way; and whole islands disappeared.

During December 16 and 17, shocks continued at short intervals but with diminishing intensities. They occurred at longer intervals until January 23 when there was another shock, similar in intensity and destruction to the first. This was followed by 2 weeks of quiescence, but on February 7, there were several alarming and destructive shocks, the last one equaling or surpassing any previous disturbance. For several days the earth was in constant tremor. There is a definite record, kept at Louisville, Ky., that the aftershocks lasted throughout at least 2 years.

The record of earlier earthquakes goes back only to 1776, when a shock of moderate intensity occurred. There were similar shocks in the nineties and in the first decade of the following century. These caused the Indians to predict a great earthquake, the prediction being based on the Indian tradition of an earthquake at an earlier time. The geological evidence confirms this, but the date cannot be fixed.

In spite of the great intensity of the earthquakes, the loss of life was insignificant. At New Madrid, only one life was lost through falling buildings. Of course, the log cabin, which was the most common type of building at that time, was peculiarly suited to withstand earthquake damage. Chimneys were knocked down, and all the houses were thrown down or badly damaged at New Madrid. The destruction from various causes extended over the entire site of the town, which was consequently abandoned.

Chimneys were knocked down in Cincinnati, Ohio, St. Louis, Mo., and in many places in Tennessee, Kentucky, and Missouri. Bricks were reported to have fallen from chimneys in Georgia and South Carolina. The shock also was felt strongly in Butler County, Pa.

Several persons were drowned when thrown into the river by caving banks, and a number of boatmen were lost when their boats sank. Also, many canoes were seen drifting, their occupants probably having drowned.

Of course, the record is very incomplete, but there is little doubt that the soil was so broken that cultivation at New Madrid and Caruthersville was impossible. The inhabitants feared to rebuild their houses during the period of the severe shocks. There is evidence that the Mississippi Valley was severely and even dangerously shaken in places outside the area of maximum effects.

The most seriously affected area was characterized by raised and sunken lands, fissures, sinks, sand blows, and large landslides. This area was 30,000 to 50,000 square miles in extent, from a point west of Cairo, Ill., to the latitude of Memphis, Tenn., and from Crowleys Ridge to Chickasaw Bluffs, Tenn., a distance of 50 miles.

The shock was felt from Canada to New Orleans, La., and from the headwaters of the Missouri to the Atlantic, including Boston, Mass., 1,100 miles away. Caving of river banks occurred as far away as Vicksburg, Miss. About 1 million square miles, or half the area, was so shaken that vibrations were distinctly felt. This far exceeds in land area any previous earthquake on this Continent.

The shock of December 16 was felt distinctly in Washington, D.C., and the people were frightened badly. As might be expected, the western parts of the South Atlantic States were shaken more severely than the eastern parts. The shocks were moderate in the North Atlantic States, being felt at Boston and Baltimore. This is apparently connected with the relation of the Appalachian system to the epicenter of the earthquake. The effect has been noticed to a less degree in the 1886 Charleston, S.C., shock and the 1925 St. Lawrence Valley earthquake.

During the New Madrid series, there seem to have been periods of darkness, probably caused by

rising clouds of dust. There is little doubt that sulphur gas, due to buried vegetation, escaped from many of the crevices. Flashes of light also were reported at various places, but the evidence indicates that this was lightning, since there were no such reports from towns with clear weather.

According to contemporary accounts, waves with visible depressions between the swells rolled across the earth and finally broke open leaving parallel fissures. These were reported to be from 600 to 700 feet long; one had a length of 5 miles. Another wave of smaller size resulted from the settling and caving of river banks.

There was also another type of fissure, which consisted of a long, narrow block that dropped and left a trench with vertical sides. Both types have been filled with sand, so their validity is not solely dependent on contemporary accounts. In some places, the fissures were very close together, around 10 to 15 feet apart. Those near rivers were parallel to their courses. Others were usually northeast-southwest. Simple fissures ran up to 300 feet in length; others were considerably greater. The block fissures averaged 300 to 500 feet, with others much longer. The depths were from 10 to 20 feet—the depth to quicksand below. Very few objects were lost in the fissures, though there was considerable fear of being engulfed.

There is some evidence of vertical faults, one of which is believed to have caused quite marked falls in the river, that lasted until the slope had been leveled off. Landslides occurred wherever the river banks were steep and where there were steep bluffs. In places, sections of forests were carried down or overthrown by the slides; many were split. In some cases, trees were thrown over to a sharp angle, beginning to grow in their new positions when the slide came to rest, with the lower parts of the trunks inclined and the upper parts vertical. In other areas, the vibration alone threw down trees.

Several sections were raised 15 to 20 feet above the level of the highest floods. One of these areas, known as Tiptonville Dome, is 15 miles long by 5 to 8 miles wide. There is another area about 10 miles in diameter with an uplift of 10 to 15 feet.

Large areas dropped by amounts reaching 15 feet in some cases, though 5 to 8 feet was more common. In eastern Arkansas, Lake St. Francis, so formed, is 40 miles long by a half mile wide. Over the sunken country, trees were killed by water overflowing the lower parts of the trunks. Valuable evidence is given by cypress trees, killed when the knees were submerged. (For a tree to thrive, a certain part of the knee must be out of water.) The cumulative effects of the earthquake destroyed forests over an area of 150,000 acres. The most typical sunken land of the area is Reelfoot Lake in Tennessee. This lake is 8 to 10 miles in length and 2 to 3 miles in width. The submergence ranged from 5 to perhaps 20 feet, although greater depths were reported.

Ejection of water, sand, mud, and gas were noticeable features of the quake. Sand, the most common, was mixed with carbonaceous material in some cases, undoubtedly the source of the gas, and was very noticeable in places.

Sand blows were very common. Normally, these were nearly circular, 8 to 15 feet across and 3 to 6 inches high. Some reached 100 feet in diameter, and the linear varieties were as much as 200 feet long and 50 feet wide. The sand was white, in contrast to the black alluvial soil above. All of the sand blows had craterlike depressions in the middle. They occurred frequently throughout an area of 1,400 square miles.

Sand sloughs were also found, depressions of 3 to 5 feet, and were characterized by low, ill-defined ridges of sand parallel to the trend of the depression. Water collected in these, forming long, narrow pools. Vegetation was poorly supported by the ridges, and much timber was killed by the water.

Water waves of considerable size were generated on the Mississippi. Starting from different points, they met and caused a sharp wall-like chop. Fissures opened and closed below the surface, sending out waves. Local uplifts and waves moving upstream gave the appearance of the river flowing upstream. Ponds also were noticeably agitated during the shock.

Caving of banks, disappearance of islands, lifting of snags, and floating trees brought into the river by landslides made navigation precarious for some time.

Several earth sounds accompanied the earthquake. The emission of water was accompanied by a hissing and whistling sound. Noises like the dis-

charge of a cannon, the rumbling of distant thunder, and the sound of a carriage passing through the street were heard.

This shock was unquestionably caused by a fracture in deep-seated rock, probably a further adjustment of an old break. Apparently, the doming and sinking are complementary phenomena in unconsolidated material resembling quicksand.

INTERMEDIATE AND MINOR EARTHQUAKES

1776. Summer. Muskingum River, Ohio. So violent that furniture was nearly overthrown. People and animals were frightened. Rumbling noise. Duration, 2 to 3 minutes.

1779. Date unknown. Northern Kentucky. Furniture was agitated by the jar. Probably observed farther north.

1791 or 1792. April or May. Northern and eastern Kentucky. Shock was preceded by rumbling noise. Furniture moved. Few reports.

1795. January 8. Kaskaskia, Ill. Lasted 1½ minutes; subterranean noise. Felt in Kentucky and probably in Tennessee and Arkansas.

1804. August 24. Fort Dearborn, Ill. (present site of Chicago). Appears to have been quite a strong shock. Felt also at Fort Wayne, Ind., 200 miles away.

1820. November 9. Cape Girardeau, Mo. Caused considerable agitation of the furniture and other loose articles in home.

1827. August 6 and 7. New Albany, Ind. Strong shocks.

1834. November 20. Northern Kentucky. Shock lasted 30 to 40 seconds; houses shook; plaster cracked; sounds like distant thunder.

1838. June 9. St. Louis, Mo. Threw down part of a chimney; quite noticeable in upper stories of buildings. Also reported severe at St. Charles, Mo.

1841. December 27. Near Hickman, Ky. Severe shock accompanied by a rumbling noise was reported near Hickman. Houses shook; objects were displaced. River was greatly agitated, although no wind was reported.

1843. January 4. Western Tennessee. Perhaps the most severe shock since the New Madrid earthquakes of 1811 and 1812. The shock was strong at Memphis. It was reported to have lasted 2 minutes, though this is probably exaggerated. Walls were cracked, chimneys fell, and windows were broken; dismal rumbling. At St. Louis, Mo., people were frightened; one chimney fell. Generally felt throughout Arkansas, with three shocks reported at Van Buren, though this could not be confirmed. The earth sank at some places near New Madrid, Mo., and hunters reported that a lake was formed and several hunters were drowned, but this could not be confirmed. At Louisville, Ky., it lasted 1 minute, and people found it difficult to stand. Furniture moved at Frankfort, Ky., and chimneys fell at Nashville, Tenn. At Cincinnati, Ohio, furniture and mirrors were shaken. It was stated that the entire States of North and South Carolina were shaken. People left their houses at Columbia, S.C. The shock also was felt at Gallatin, Carthage, Sparta, Shelbyton, and Trenton, Mo.; Huntsville, Ala.; Mills Point, Ky.; Madison, Ind.; Burlington, Iowa; Anderson and Pendleton, S.C.; and Augusta, Ga.

1843. February 16. St. Louis, Mo. Also felt in Louisville, Ky., Nashville, Tenn., Flora, Ala., and Cincinnati, Ohio.

1844. November 28. Knoxville, Tenn. Bricks fell from chimney. Windows and dishes rattled; sounds like distant thunder.

1857. October 8. St. Louis, Mo. Two shocks a few minutes apart. The largest buildings rocked, plaster fell, bricks dislocated, and windows rattled. The river was in tumult and animals were frightened. There was a great rumbling like that of a heavily loaded vehicle passing over rough pavement. Houses with walls 18 inches thick were affected by the horizontal movement. Felt at many places in Illinois and on the Mississippi River to the south of Hannibal, Mo. A well 2,265 feet deep was not affected. The shock was strong at Centralia, Ill., where three shocks were reported.

1860. Date unknown. Central Minnesota. Fairly strong, but little is known about it.

1865. August 17. Southeastern Missouri. Generally felt in Illinois, Tennessee, Mississippi, and Missouri. Felt from Holly Springs, Miss., to Cairo, Ill., and as far east as La Grange, Tenn. At St. Louis, furniture rocked; there was a cracking sound in the houses. At New Madrid, Mo., objects fell from shelves, chimneys were damaged, and animals alarmed. Water waves formed on the river like those from the passage of a steamboat. The earth seemed to roll in waves in a swampy area. Chimneys were thrown down at Memphis, Tenn.

1867. April 24. Lawrence, Kans. Shocks with rumbling. Doors and windows were shaken, objects were thrown from shelves, and plaster cracked. Several were injured, though not seriously. At Marysville, Marshall County, doors and shutters swung back and forth. A two-story building was strongly shaken in the upper story and there was a loud rumbling noise. Also felt strongly at Manhattan where a wave 2 feet high was observed on the Kansas River; stones loosened on buildings and walls cracked. At different places there appeared to be one or two ground waves. Plaster fell and many fled outside at Dubuque, Iowa. The shock was also felt in Illinois, Indiana, Missouri, Nebraska, Arkansas, Kentucky, and possibly Ohio.

1872. February 6. Wenona, Mich. Three shocks lasting 30 seconds.

1872. October 9. Sioux City, Iowa. Severe at Sioux City, at Yankton and White Swan, S. Dak., and elsewhere in the Dakotas. Distinctly felt on low ground, but not so much on the bluffs. There was a sound like distant thunder.

1875. June 18. Western Ohio. Most severe at Urbana and Sidney where walls were cracked and chimneys thrown down. Also sharply felt at Jeffersonville, Ind. The area affected was 250 miles east-west by 160 miles north-south and included southern Illinois, eastern Missouri, northwestern Kentucky, and southwestern Indiana. It was felt at Chicago, Columbus, and Cincinnati.

1875. November 8. Kansas. Felt at Leavenworth, Lawrence, Manhattan, and Burlingame. Lasted nearly a minute. Near Valley Falls, people awakened and buildings rocked.

1876. September 25. Near Evansville, Ind. Two distinct shocks 15 minutes apart. Felt strongly in the Wabash Valley near Evansville, and at Mount Carmel and Friendsville, Ill. Felt in southern Indiana and Illinois, from St. Louis, Mo., to Indianapolis, Ind., and Louisville, Ky.

1877. August 17. Southeastern Michigan. Felt in Redford and Greenfield Village, not far from Detroit. Horses were frightened. Noise like train.

1877. November 15. Eastern Nebraska. Also felt in Iowa, Kansas, the Dakotas, and northwestern Missouri. There were two shocks 45 minutes apart, the second being the stronger. At North Platte, Nebr., walls cracked; the shock was reported to have lasted 40 seconds. Buildings rocked at Lincoln, walls were damaged at Columbus, and the shock was strong at Omaha. Walls cracked at Sioux City, Iowa. It was felt with intensity III at St. Joseph, Mo. The felt area was elliptical in form, 600 by 300 miles.

1878. March 12. Columbus, Ky. Severe. Section of a bluff on Mississippi River caved in.

1878. November 18. Southeastern Missouri. Felt at St. Louis, Mo., Cairo, Ill., Memphis, Tenn., Little Rock, Ark., and elsewhere in the Mississippi Valley. At Cairo, the trembling lasted 40 seconds with rocking motion west-northwest–east-southeast. Strong frame buildings vibrated and creaked at every joint. Severe along the Missouri River from Glasgow to Lexington. The shock was felt over an elliptical area with major axis from Leavenworth, Kans., to Tuscaloosa, Ala., 600 miles, and minor axis from Clarksville, Ark., to a point midway between Cairo, Ill., and St. Louis, Mo., 300 miles.

1879. December 29. South Dakota. Rumbling noise at Yankton and Fort Scott.

1882. February 9. Ohio. Two distinct shocks were felt at Swanders and Botkins, near Anna. Windows and dishes rattled; people rushed into streets.

1882. July 20. Southern Illinois. Awakened people at Cairo, Ill., and Charleston, Mo. Strong at Collinsville.

1882. September 27. Southern Illinois. Severe earthquake. There were rumblings at many places; chimneys were cracked, small objects fell over, and pictures vibrated. The area affected extended from Mexico, Mo., to Washington and Henderson, Ky., in a west-east direction, and from Springfield to Pinckneyville, Ill., in a north-south direction, an ellipse 250 by 160 miles. The shock was felt at St. Louis and St. Charles, Mo.

1882. October 15. Southern Illinois. The first shock covered much the same area as that of September 27. There were three shocks at Centralia, Ill., and a noise like an approaching train at Vandalia. It was felt from St. Louis, Mo., to Springfield, Ill., and Indianapolis, Ind.

1882. October 22. Arkansas. This shock was felt in northern Texas, Oklahoma, western Arkansas, and eastern Kansas. It extended from Greenville and Paris, Tex., to Wichita and Leavenworth, Kans., a distance of 450 miles, and to Warrenton, Mo. At Sherman, Tex., heavy machinery vibrated, bricks were thrown from chimneys, and movable objects overturned. Houses were shaken at Fort Smith, Ark. It was difficult to obtain the probable epicenter because of insufficient reports from the region most affected.

1883. January 11. Cairo, Ill. Strong shock from St. Louis, Mo., to Memphis, Tenn. Four distinct shocks at St. Louis, more severe than those of previous year. Buildings rocked, chandeliers swung, engine bells rang. Greatest motion was at Cairo, Ill., in about the middle of the area shaken. (Previously listed on June 11, 1883.)

1883. February 4. Kalamazoo, Mich. Felt in northern Indiana and southern Michigan. Cracked windows and shook buildings at Kalamazoo. Felt at St. Louis, Mo., and Bloomington, Ill.

1883. April 12. Cairo, Ill. A strong shock characterized by short, jerky vibrations rattled windows and shutters and awakened everyone. One old frame house was reported shaken down, resulting in slight injury to the inhabitants. Duration was estimated at 30 seconds.

1883. December 5. Izard County, Ark. Buildings shook at Melbourne. Noise like thunder. Slides in railroad cut.

1884. September 19. Near Columbus, Ohio. Moderate earthquake in Ohio, Indiana, and parts of adjacent states. Intensity was III–IV over a large area. At many places, there were two distinct vibrations. Slight damage at Lima. At Columbus, chandeliers kept swinging from north to south for several minutes. The shock was felt at Washington, D.C., by workmen on top of the then unfinished Washington Monument, about 500 feet above the ground. Felt from Pennsylvania to Kentucky and West Virginia to Michigan.

1887. February 6. Vincennes, Ind. Strongest in southwestern Indiana and southeastern Illinois. Felt also in Kentucky and Missouri.

1887. August 2. Cairo, Ill. A severe shock stopped clocks and frightened people. Felt distinctly in St. Louis, Mo., and Nashville, Tenn. Widely felt in Missouri, Kentucky, Tennessee, and Illinois.

1889. July 19. Memphis, Tenn. Walls and chimneys cracked. People were frightened.

1891. January 8. Rusk, Tex. Two distinct shocks were felt, each accompanied by a loud, long rumbling. Several chimneys were leveled; many persons awakened.

1891. July 26. Evansville, Ind. Frightened people in several churches. Damage to property.

1891. September 26. Near Cairo, Ill. An earthquake which began slowly and became stronger in a few seconds was felt in the Mississippi Valley. Movable objects jiggled; trees swayed as if the wind were blowing. Also felt at Amana, Cedar Rapids, and Keokuk, Iowa.

1895. October 11. Black Hills, S. Dak. Two shocks; first strongest at Rochford; second strongest at Keystone and Hill City.

1895. October 31. Charleston, Mo. Considered the severest shock in the entire region since the New Madrid (1811–12) earthquakes. Near Charleston, 4 acres of ground sank and a lake was formed. At Cairo, Ill., buildings swayed, chimneys cracked, and church steeples twisted. Many chimneys were demolished. Near Bertrand, Mo., hundreds of mounds of sand were piled up, ranging from 12 inches to 10 feet in circumference. The ditches in this neighborhood were filled with water coming from the resulting holes, because there had been no rain to fill them in any other way for nearly 2 months. Near Big Lake, 4 miles north of Charleston, two small holes were formed in the earth from which water spouted to a height of 3 feet. In Dunklin County, shocks were much lighter. The shock was felt from Canada to Mississippi and Louisiana, and from Georgia and Virginia to Kansas and South Dakota, 23 states in all.

1897. April 30. Tennessee, Illinois, Indiana, and Kentucky. Shook for 20 seconds. Strong shock.

1899. April 29. Southwestern Indiana and southeastern Illinois. Strongest at Jeffersonville and Shelbyville, Ind. A few chimneys were thrown

down and brick walls cracked at Vincennes. Felt at Henderson, Ky.

1901. May 17. Ohio. Near Wellston and Portsmouth. Felt at Zanesville, Ohio, and Huntington, W. Va. (intensity III–IV).

1902. January 24. Missouri. Fairly strong at St. Louis, and at Clifton Heights just west of Quincy, Ill. Felt at Kansas City, Mo., and Leavenworth, Kans.

1902. July 28. Eastern Nebraska. Near Battle Creek. Lasted 30 seconds. Felt strongly at Yankton, S. Dak.; barely felt in Chicago, Ill. Also felt in western Iowa.

1903. February 8. St. Louis, Mo. Felt sharply; explosive sounds were heard. Strong shock from Jeffersonville, Mo., to Louisville, Ky., and from Cairo, Ill., to Hannibal, Mo. Strongly felt, with roaring noise, over 20,000 square miles.

1903. November 4. St. Louis, Mo. Felt in southern Illinois, Kentucky, Mississippi, Arkansas, Missouri, and Tennessee with intensity VI–VII. Similar in area and intensity to February 8 quake. Walls of a building cracked at New Madrid, Mo., and Cairo, Ill., and chimneys fell at Cape Girardeau, Mo. Preliminary shock on October 4 at St. Louis; aftershocks on November 24 and 27 (intensity V) at New Madrid.

1904. October 27. Kansas. At Meade and Dodge City, people were awakened; dishes rattled. Three shocks at Dodge City.

1905. March 13. Menominee, Mich. Intensity V.

1905. April 13. Keokuk, Iowa. Several shocks of intensity V.

1905. July 26. Calumet, Mich. An earthquake, which was apparently associated with the peculiarly unstable conditions brought about by mining operations, was felt all over the Keweenaw Peninsula, Mich. It was heaviest at Calumet. There was a terrific explosion, chimneys fell with a crash, and plate glass windows broke. The explosion was heard far down in the mine. Felt at Marquette, Mich.

1905. August 21. Mississippi Valley; probably southeastern Missouri. Intensity VI at Memphis, Tenn., and intensity V at Mount Vernon and Evansville, Ind. One old roof collapsed at St. Louis. Intensity IV–V at Owensboro, Ky., III–IV at Paducah, II at Henderson. Chimneys were thrown down and a wall cracked at Sikeston, Mo. At its center there were three shocks accompanied by noise. The shock also was felt in Illinois and Mississippi.

1906. January 7. Manhattan, Kans. It was strong enough to throw down some chimneys and produce some cracks in walls. At Wamego, 15 miles west, and Junction City, 19 miles southwest, plaster was knocked from walls. It was felt from Plattsmouth, Nebr., to Wichita, Kans., and from Bethany, Mo., to Beloit, Kans. It began with a tremor and was followed by two distinct shocks that died away gradually. At Manhattan, a roar preceded the shock by 10 seconds; at Topeka, it followed the shock in 10 seconds.

1906. May 9. South Dakota-Nebraska border. Reported all along the Niobrara Valley from Rushville to Valentine, Nebr.

1906. May 11. Southwestern Indiana. Petersburg and Princeton. Felt from Washington, Daviess County, to Princeton, Gibson County.

1906. May 21. Flora, Ill. A shock of 2 or 3 seconds' duration broke water mains. The quake was accompanied by a low, growling noise; also felt in Louisville, Clay City, and Iola.

1906. May 26. Keweenaw Peninsula, Mich. At the Atlantic Mine, the effects were such as might be produced by a great earthquake. Rails were twisted, and there was notable sinking of the earth above the workings. Such effects were not noted elsewhere. The area affected was about 30 to 40 miles in diameter.

1906. June 27. Fairport, Ohio. Most intense at Fairport and Put-in-Bay. Doors slammed; windows rattled. Epicenter south of Cleveland. Two shocks.

1907. July 4. Farmington, Mo. Felt with intensity IV–V; Granville, III; and Bismarck and Sunlight, II. Sounds like explosions.

1908. September 28. New Madrid, Mo. Light shock. Also felt at Cairo, Ill.

1908. October 27. Cairo, Ill. Intensity V at Cairo; IV–V near New Madrid, Mo.

1909. January 22. Houghton, Mich. Felt over a small area; believed caused by crushing of pillars in mine. Rumbling.

1909. May 15. Strong shock in Saskatchewan. Felt in North Dakota, South Dakota, and Montana.

1909. May 26. Illinois. Felt from Missouri to Michigan and Minnesota to Indiana. Intensity VII was noted over a considerable area from Bloomington, Ill., to Platteville, Wis. At Aurora, many chim-

neys fell. In Chicago, buildings swayed; especially noticeable in upper stories. Mirrors swayed, beds moved on casters, and there was fear that walls would collapse. Dubuque, Iowa, had a fairly sharp shock. Strong at Pontiac and Freeport, Ill.

1909. July 18. Illinois. Between Havana and Petersburg, a little north of Springfield. Chimneys were downed at Petersburg, Ill., Hannibal, Mo., and Davenport, Iowa. Near Petersburg, over 20 windows broke, brick pushed out over the doors, and plaster cracked.

1909. August 16. Southwestern Illinois. Strong at Waterloo; felt all over southwest part of State.

1909. September 22. Ohio Valley. Houses rocked. Felt at Louisville, Ky., and Terre Haute and Madison, Ind.

1909. September 27. Indiana. Strongest between Vincennes and Terre Haute where some chimneys fell, several buildings were cracked, light connections were severed, and pictures were shaken from walls. Strong at Indianapolis. At Oakland City, there was a succession of heavy jars, windows rattled, and furniture swayed. Also felt at Springfield and Decatur, Ill. Felt area included southwest half of Indiana, all of Illinois, eastern Iowa and Missouri, west half of Kentucky, and northern Arkansas. Noticed at Kansas City, Mo., and possibly a little farther west into Kansas.

1909. October 23. Southeastern Missouri. Felt from St. Louis to northwest corner of Mississippi, 300 miles, and probably 200 miles east-west. The area affected included Missouri, Arkansas, Mississippi, Tennessee, Kentucky, Illinois, and Indiana.

1909. October 23. Near Robinson, Ill. Felt at Newton, 23 miles northwest; Indianapolis, Ind., 100 miles northeast; and Jasper, Ind., 60 miles southeast.

1910. February 26. Columbus, Nebr. Houses shook. Several shocks.

1911. March 31. Rison, Ark. This earthquake was centered somewhere near Rison and Warren, Ark. At Rison, houses swayed; articles were thrown from shelves. The shock was felt throughout southeastern Arkansas, northeastern Louisiana, and along the Mississippi River from Memphis to Vicksburg, an area roughly 200 miles north-south by 100 miles. The area was of a half-moon shape. This may have been a result of the soft deposits along the Mississippi where the shock was more strongly felt.

1911. June 2. South Dakota. James River Valley. Reported from Huron and other places in South Dakota, Iowa, and Nebraska.

1912. January 2. Illinois. Intensity VI at Aurora, Freeport, Morris, and Yorkville, and V at Chicago. There were two distinct shocks, one of strong intensity followed by a lighter tremor. The shock was felt at Milwaukee and Madison, Wis., but not at a corresponding distance to the south. It was also felt in Iowa, Indiana, and in Fulton County, Ky.

1915. April 28. New Madrid-Tiptonville, Mo. Lasted 5 to 8 seconds.

1915. October 23. Kadoka, S. Dak. Loud noise. Cracks in ground reported.

1915. October 26. Mayfield, Ky. Epicenter in "sunken country." Pictures shook from walls.

1915. December 7. Near mouth of Ohio River. A sharp earthquake caused houses to shake and frightened people at Cairo, Ill. It was felt in Illinois, Kentucky, Tennessee, Arkansas, Mississippi, and Missouri.

1916. December 18. Hickman, Ky. Bricks were shaken from chimneys near New Madrid, Mo.

1917. March 27. Panhandle, Tex. Children left school. Plaster cracked.

1917. April 9. Eastern Missouri. Felt from Kansas to Ohio and Wisconsin to Mississippi, approximately 500 miles east-west and 600 miles north-south. In the epicentral region between St. Louis and New Madrid, windows were broken and plaster cracked; at Ironton, Mo., the ground swayed. At Granite City, a painter was thrown from a ladder. Shock lasted 30 to 60 seconds. An aftershock at 17:38 was felt in the south part of the area.

1917. September 3. Staples, Minn. Walls cracked, chimneys toppled, and objects fell from shelves. Houses swayed, windows broke, and plaster cracked. Felt at Brainerd. Previous quakes in this region are not accurately known, but one has been listed for 1860, and possibly there was another between 1860 and 1865.

1918. September 10. El Reno, Okla. A series of earthquakes. Strongest was intensity V at time given. Objects were thrown from shelves. Other shocks occurred on September 11, 06:30 and 08:00.

1918. October 4. Arkansas. Epicenter 20 to 30 miles southeast of Little Rock. Sharp shock. Felt at Black Rock, 120 miles northeast, and at Memphis, Tenn.

1918. October 13. Black Rock, Ark. Three abrupt shocks. Intensity V at Hoxie and Pocahontas. Also felt at Jonesboro.

1918. October 15. Western Tennessee. Felt at Memphis, Savannah, Union City, and Clarksville, Tenn.; Cairo and Anna, Ill.; Black Rock and Hardy, Ark.; and throughout western Kentucky. Not felt at St. Louis, Mo. Epicenter was probably in "sunken country."

1919. May 25. Southern Indiana. Intensity V at Princeton and Vincennes. Also felt in Illinois and Kentucky.

1919. November 3. Vicinity of Pocahontas, Ark. Loud rumbling; generally felt.

1920. May 1. Missouri. Felt at Columbia, Warrenton, and Poplar Bluff, Mo., and at Mount Vernon, Ill.

1922. March 22. Southern Illinois. Two shocks were felt widely in towns from Arkansas to Indiana. Mild damage was reported in some areas.

1922. March 23. Western Kentucky. Felt throughout Jackson Purchase region and east to Owensboro and Louisville. Also reported felt at Fulton and at other points along the State line.

1923. October 28. Marked Tree, Ark. Felt in Arkansas, Kentucky, Mississippi, Illinois, Missouri, and Tennessee. Windows shattered, several old chimneys were razed, and walls cracked. Surface of the St. Francis River was affected.

1923. November 9. Tallula, Ill. Dishes were broken. Shocks also were felt at Virginia, Chandlerville, and Oakford.

1923. December 31. Arkansas. Intensity V in Arkansas, just west of Memphis, Tenn. Also felt in Illinois, Kentucky, Tennessee, Missouri, Mississippi, and Alabama.

1924. March 2. Kentucky, just east of Cairo, Ill. Felt in Kentucky, Tennessee, Illinois, and Missouri. Area 160 miles north-south and 100 miles east-west affected.

1925. March 26. Southwestern Ohio. Distinct shock. Furniture moved; dishes rattled.

1925. April 26. Indiana. Intensity V at Brownstown, Evansville, and Terre Haute, Ind., and Cloverport, Henderson, and Louisville, Ky. Many persons awakened, crockery broke, and rumbling sounds heard. Felt area also included parts of Illinois and Ohio.

1925. May 13. Kentucky. Strongest at Mayfield; felt in Illinois.

1925. July 30. Panhandle region, Tex. This earthquake is of special interest because of knowledge of subterranean conditions from borings of oil wells. There were three distinct shocks over a period of 15 seconds. Chief results were the shaking of dishes from shelves and rattling and creaking of furniture. Felt at Roswell, N. Mex., at a distance of 225 miles; Tulsa, Okla., 300 miles; and Leavenworth, Kans., 400 miles. The only previously known shock in the region was that at Panhandle, Tex., March 27, 1917. From inspection of the earth's surface, this would not seem to be a region where an earthquake would be likely to occur, as there is every evidence of stability. Many persons thought that it resulted from the oil drilling, but the area over which it was felt precludes any such cause. However, the drilling has brought out the fact that the region is the site of a buried mountain with slopes of 1,500 to 2,000 feet in a few miles. In spite of long burial, there still seems to be activity, and the earthquake is probably a renewal of activity in a region once very active.

1925. September 2. Kentucky. Strongest at Mayfield, Henderson, and Louisville, Ky., and Evansville, Ind. Chimney fell and house sank at Louisville. Landslides at Henderson. Also felt in Illinois and Tennessee.

1926. November 5. Southeastern Ohio. Felt throughout Meigs County, Ohio, and Letart, W. Va. Chimneys toppled at Keno. Chimneys were thrown down and stove overturned at Pomeroy. Explosive sounds reported.

1927. March 18. White Cloud, Kans. People rushed out of houses. Houses rocked.

1927. May 7. Mississippi Valley. Strongest at North Jonesboro, Ark. Some chimneys fell; buildings rocked. Many felt ground movement. Felt from Decatur, Ala., to Carbondale, Ill., and from Pocahontas, Ark., to Jackson, Tenn. Also felt in Mississippi. While it was felt most strongly in Arkansas, the felt area indicates that the epicenter was farther to the east, near the position listed.

1928. September 9. Lorain and Cleveland, Ohio. People rushed from houses in East Cleveland. The

shock was felt along the lakeshore from Lorain to Cleveland.

1928. November 16. Black Hills, S. Dak. At Custer and Rochford, there was deep rumbling. Rocks fell on railroad tracks at Rochford.

1929. March 8. Bellefontaine, Ohio. Buildings trembled; furniture shifted. Generally felt at Cincinnati and Piqua.

1929. September 23, October 21, December 7. Northeastern Kansas. Four shocks (two on Sept. 23), all centering in the same vicinity. Houses were shaken; the shocks were felt at Manhattan and Junction City. The second shock was more generally felt.

1929. December 27. El Reno, Okla. People rushed from houses, clocks stopped, and there was slight damage to plaster and a chimney.

1930. September 30. Ohio. A brief but strong shock was felt over a wide area. Strongest at Anna. Plaster cracked and fell; chimney toppled. Rumbling noises heard.

1930. October 19. Louisiana. Chimneys were damaged and window broke at Napoleonville; trees shook at Donaldsville; small objects overturned at Franklin and Morgan City; plaster cracked at White Castle.

1931. January 5. Elliston, Ind. Dishes were thrown from shelves. Hardest in hill country east and north of Elliston.

1931. September 20. Anna, Ohio. Church buildings were damaged. At Sidney, a number of house chimneys were thrown down; plaster fell. At Houston, there was damage to walls and chimneys. Intensity V–VI was experienced over an area of about 400 square miles. Felt also in Indiana and Kentucky.

1931. December 16. Northern Mississippi. At Charleston, there were cracks in walls and foundations; some chimneys were thrown down. Buildings were damaged and plaster fell at Belzoni. Chimneys also were damaged at Tillatoba and Water Valley. Also felt in Alabama, Arkansas, and Tennessee.

1932. April 9. Mexia-Wortham, Tex. Loose bricks were thrown down; plaster cracked.

1933. February 20. Norton, Kans. People left buildings. Felt in adjacent Nebraska.

1933. May 28. Maysville, Ky. Houses were strongly shaken in vicinity. The shock was felt in Mason, Fleming, and Bracken Counties in Kentucky and at many points in Ohio. Strong at Ripley, Ohio.

1933. August 19. El Reno, Okla. Chimneys and walls sustained slight cracks.

1933. December 9. Manila, Ark. Sharp local shock. Windows broke.

1934. April 11. Texas-Oklahoma border. Strong at Paris, Tex., and Hugo, Okla.

1934. July 30. Chadron, Nebr. Some chimneys were damaged; plaster fell. Guests were ordered from hotels. Also felt in eastern Wyoming and southwestern South Dakota.

1934. August 19. Rodney, Mo. Widely felt in Missouri, Illinois, and Kentucky. Some chimneys were thrown down, windows were shattered, plaster cracked, and objects were thrown from shelves in the epicentral area. There was destructive intensity over 230 square miles.

1934. November 12. Rock Island, Ill. Cornice torn from schoolhouse. Some were alarmed; bricks fell from chimneys; and pendulum clocks stopped in Davenport, Iowa, and Moline and Rock Island, Ill.

1935. March 1. Nebraska. At Tecumseh, a few windows were broken; walls and plaster cracked. Some damage at Saint Mary. Also felt in Iowa, Kansas, and Missouri.

1936. March 14. Southeastern Oklahoma. Many were alarmed at Valliant and Wright City.

1936. June 19. Texas Panhandle. Houses were jarred strongly at Borger and White Deer. Slight damage at Elkhart, Kans., and Kenton, Okla.

1937. March 2. Western Ohio. Maximum intensity occurred at Anna and Sidney. At Anna, plaster fell and walls cracked in a school house. Similar damage to churches and other buildings. A number of chimneys fell. At Sidney, the shock was strongly felt, but damage was less than at Anna. In Lima and Bellefontaine, alarm was general, but damage was minor. Two to five shocks were felt in many places. The shock was generally felt at Cincinnati, and less so in Cleveland. At Fort Wayne, Ind., objects were thrown from shelves and some plaster fell; some plaster was cracked at Indianapolis. The shock was sharply felt at Ann Arbor, Mich. Also felt in Kentucky, Wisconsin, West Virginia, Illinois, Pennsylvania, and Canada.

1937. March 3. Ohio. Felt at Sidney, Anna, Jackson Center, and Botkins. Bricks shook from chimneys; many were awakened. Rumbling noises.

1937. March 8. Western Ohio. At Anna, chimneys repaired after the March 2 quake were again thrown down, with scarcely a chimney escaping damage. In the Lutheran Church, organ pipes were twisted. Churches and school buildings were badly cracked. In Sidney, a few chimneys fell, and there was damage to plaster. The shock was not as strong in Lima and Bellefontaine as the previous one. At Dayton, hanging objects swung, and waves were seen to pass over the surface of a glass of water. Deep rumbling. At Cincinnati and Cleveland, the shock was more severe than the previous one. At Fort Wayne, Ind., pictures were shaken down and plaster cracked; the shock was strong at Lafayette. The shock was felt particularly on upper stories of high buildings in Chicago and Milwaukee, and at Toronto, Canada. Felt also in Kentucky, Michigan, Missouri, West Virginia, and Pennsylvania.

1937. May 16. Northeastern Arkansas. Not strong, but felt over an area of 25,000 square miles in Arkansas, Missouri, Kentucky, and Tennessee.

1937. November 17. Centralia, Ill. An earthquake that reached a maximum intensity of V was felt throughout south-central Illinois. The only damage consisted of fallen plaster and broken dishes, although many objects were thrown down. Also felt in Missouri. The epicenter was in the western part of Illinois Basin, approximately 2.2 miles northeast of Centralia, Ill., and about midway between Centralia and Odin.

1938. September 16. Northeastern Arkansas. Epicenter about 32 miles southwest of Jonesboro. Affected area extended into Missouri, Illinois, Kentucky, Tennessee, Mississippi, and Oklahoma. (Previously listed on Sept. 17, 1938).

1938. October 11. Sioux Falls, S. Dak. Buildings jarred, dishes rattled, and loose objects swayed. Police stations received many calls from alarmed residents.

1939. June 19. Arkadelphia, Ark. Cracked plaster in some buildings. Also felt at Crossett, Dumas, El Dorado, Fordyce, Hot Springs, Pine Bluff, and Prescott.

1939. November 23. Near Griggs, Ill. Intensity just short of damage. Affected area included most of Illinois, Missouri, and parts of Wisconsin, Indiana, Kansas, Kentucky, Tennessee, Mississippi, Arkansas, and Iowa.

1941. November 16. Covington, Tenn. Cracks appeared in courthouse. An explosive noise preceded the trembling at Henning.

1943. March 8. Lake Erie area, 60 miles northeast of Cleveland, Ohio. This area was not previously recognized as seismic. No damage was reported, though the shock was widely felt in the United States and Canada. It was noted over a large part of Ohio and in parts of Michigan, Pennsylvania, and New York.

1946. July 23. Wessington, S. Dak. Water mains cracked at two points. Strong enough to awaken sleepers in Huron. Generally felt from Pierre, eastward to De Smet, and northward including Redfield.

1947. June 29. Near St. Louis, Mo. Felt strongly in St. Louis. Several chimneys toppled; sidewalk cracked.

1947. August 9. South-central Michigan. Damaged chimneys and cracked plaster at Athens, Coldwater, Colon, Matteson Lake, Sherwood, and Union City. Also felt in parts of Indiana, Ohio, Illinois, and Wisconsin.

1950. February 8. Near Lebanon, Mo. Almost everyone awakened at Lebanon. Dishes rattled.

1952. February 20. Tennessee-Missouri border. Felt in Arkansas, Kentucky, Missouri, and Tennessee. Articles were thrown from shelves at Tiptonville, Tenn., and Hickman, Ky.

1952. April 9. El Reno, Okla. Chimneys fell, buildings cracked, and windows shattered. Minor damage also was reported in Oklahoma City and Ponca City. Felt area included all of Oklahoma, except the panhandle section, eastern Kansas, southeastern Nebraska, north-central Texas, and western sections of Iowa, Missouri, and Arkansas. Magnitude 5½.

1952. April 16. El Reno, Okla. Many people were awakened. Buildings shook.

1952. June 20. Southeastern Ohio. Highest intensity at Zanesville where an old chimney toppled.

1952. July 16. Dyersburg, Tenn. Cracks in concrete block structures. Many persons were frightened. Also felt at Finley and Jenkinsville.

1953. March 17. Concho, Okla. Minor damage to

building foundation and plaster. Felt at Union City, Minco, Okarche, and El Reno.

1953. September 11. Southwestern Illinois. Minor damage at Roxana. Frightened many at Edwardsville. Also felt in eastern Missouri.

1954. January 1. Middlesboro, Ky. Slight damage and general alarm among people at Middlesboro. Felt area included parts of Tennessee, North Carolina, and Virginia.

1954. January 22. Athens and Etowah, Tenn. Window broke at Etowah; houses shook violently at Athens.

1954. February 2. Missouri-Arkansas border. Shock caused slight damage at Poplar Bluff, Mo., and Pocahontas, Ark. Felt in parts of Arkansas, Illinois, Missouri, and Tennessee.

1954. April 26. Memphis, Tenn. Felt along New Madrid Fault from Blytheville, Ark., and Jackson, Tenn., to Corinth, Miss. Plaster cracked and houses trembled at Memphis.

1955. January 25. Tennessee-Arkansas-Missouri border. Felt from Lepanto, Ark., to Paducah, Ky., and Birmingham, Ala. Minor damage was reported at Dyersburg and Finley, Tenn., and Hayti, Mo. Felt also in Illinois and Mississippi.

1955. February 1. Gulfport, Miss. Frightened many residents. Rumbling sounds. Also felt at Biloxi, Mississippi City, and Bay St. Louis.

1955. March 29. Finley, Tenn. Plaster cracked; house shook violently. Also felt in adjoining States of Missouri and Arkansas.

1955. April 9. West of Sparta, Ill. Minor damage at Evansville, Ill., and Lemay, University City, and Webster Groves, Mo. Felt over about 20,000 square miles of Illinois, Kentucky, and Missouri.

1955. May 26. Cleveland, Ohio. Felt by many persons in southeastern suburbs. Buildings creaked; windows rattled; rumbling sounds heard.

1955. June 28. Cleveland, Ohio. Shock was similar in intensity to that of May 26.

1955. September 5. Finley, Tenn. Many persons were alarmed. Also felt at Dyersburg.

1955. December 13. Dyer County, Tenn. Two shocks awakened many persons in western Dyer County. Both shocks felt at Finley.

1956. January 6. Southern Kansas. Shock caused minor damage at Coldwater and Medicine Lodge, Kans., and at Alva, Okla.

1956. January 27. West-central Ohio. Many persons were alarmed in Allen, Shelby, and Logan Counties, Ohio. Felt slightly at Fort Wayne, Ind.

1956. January 28. Tennessee-Arkansas border. Intensity VI at Covington, Tenn., where chimneys and walls cracked. Felt by most residents in Armorel, Ark., and Brighton, Finley, Fort Pillow, Henning, and Ripley, Tenn.

1956. February 16. Edmond, Okla. Broke windows and cracked plaster. Also felt strongly at Guthrie, Oklahoma City, and Pawnee.

1956. April 2. Southeastern Oklahoma. Many persons were alarmed at Antlers. Buildings shook and objects fell. Thunderous noises reported.

1956. October 29. Caruthersville, Mo. Shook houses and awakened many persons. Explosive sounds were heard.

1956. October 30. Northeastern Oklahoma. Maximum intensity was reported at Foster Ranch, west of Catoosa. A slippage of the formation caused an oil well to be shut down. Minor damage at Tulsa and Beggs. Felt as far as Electra, Tex.

1956. November 25. Wayne County, Mo. Minor damage occurred at Grubville, Richmond Heights, St. Louis, and Sturdivant, Mo. Windows were shattered; walls cracked. Felt area included parts of Arkansas, Illinois, Kentucky, Missouri, and Tennessee. Explosive and rumbling sounds reported.

1957. March 19. Northeastern Texas. Felt over a moderate area, including northeastern Texas, Arkansas, and Louisiana. Press reported two broken windows. Clock was knocked from wall; objects overturned. At Magnolia, Ark., figurines fell from table and broke.

1957. March 26. Paducah, Ky. Awakened many. Most people thought it was an explosion. Also awakened several at Smithland.

1958. January 26. Memphis, Tenn. Felt by many and alarmed several. Kitchen utensil and clock fell to floor.

1958. January 27. Illinois-Kentucky-Missouri border. Awakened many in Cairo, Grand Tower, and Mounds, Ill., Paducah, Ky., and Cape Girardeau, Mo.

1958. April 8. Obion County, Tenn. At Troy, nearly all fled from homes. Felt by nearly all at Obion where thunderlike noises were heard.

1958. April 26. Lake County, Tenn. Awakened many. Roaring noise. Also felt at Caruthersville, Mo.

1958. May 1. Cleveland, Ohio. Many were alarmed.

1958. November 7. Illinois-Indiana border. Felt over a large area, including Illinois, Indiana, Kentucky, and Missouri. Damage was reported at Bartelso, Dale, and Maunie, Ill. Basement wall and floor cracked; plaster cracked and fell; and water heater displaced. Many were alarmed. At Fort Branch, Ind., plaster fell. Intensity V reported in Louisville, Ky., area and at St. Louis, Mo.

1958. November 19. Baton Rouge, La. Alarmed many. The police and newspaper offices received many calls from alarmed residents. Also felt at Baker and Denham Springs.

1959. February 13. Bogota, Tenn. Felt over approximately 170 square miles of Dyer, Lake, and Obion Counties. Many awakened. Roaring sounds.

1959. June 15. Seminole, Pontotoc, and Johnston Counties, Okla. Felt by many. Dishes broke at Ada.

1959. June 17. Southwestern Oklahoma. Felt over a large area of Oklahoma and Texas. Slight damage occurred in Duncan, Lawton, and Cache, Okla. It consisted of cracks in plaster, pavement, and foundation. Objects fell from shelves; many were alarmed.

1959. December 21. Finley, Tenn. Felt over 400 square miles of Dyer, Lake, and Lauderdale Counties, Tenn., and Pemiscot County, Mo. Plaster walls and ceilings cracked at Finley; many were alarmed. At Lenox, chimney cracked.

1960. January 28. Dyer County, Tenn. Felt by nearly all at Dyersburg and Finley; by many at Lenox and Boothspoint.

1960. April 21. Lake County, Tenn. Awakened many and vibrated houses. Rumbling sounds.

1961. January 10. Southeastern Oklahoma. Felt by nearly all from Dow and Hartshorne, Pittsburg County, to Wilburton, Latimer County. Thunderous earth sounds.

1961. February 22. Northwestern Oklahoma. Awakened and alarmed many at Amsden and Arcadia. Awakened nearly all at Fostoria where pictures were knocked askew.

1961. April 13. Kansas-Nebraska border. Frightened many in Norton County, Kans., and Furnas County, Nebr.

1961. April 27. Southeastern Oklahoma. Intensity V at Antlers, Coalgate, Hartshorne, Leflore, McCurtain, Panola, Talihina, and Wilburton. Many were awakened. Thunderous, deep rumbling earth sounds.

1961. December 25. Kansas-Missouri border. Felt principally in Missouri. Plaster cracked at Corder, Hardin, and Kansas City, Mo. Objects were thrown from shelves and broken. Many were awakened in various towns.

1961. December 31. Central South Dakota. Felt from Pierre, west to Midland, and as far east as Huron. Many were alarmed at Pierre; plaster and cement cracked. Felt by many and alarmed few at Murdo; plaster cracked.

1962. February 2. New Madrid, Mo. Awakened and alarmed many over a large area, including the States of Arkansas, Illinois, Kentucky, Missouri, and Tennessee. At Catron, water pipes broke, and walls and plaster cracked. At Marston, two chimneys were damaged, one was destroyed, and windows cracked. Slight damage (intensity V) also occurred at Osceola, Ark., and Union City, Tenn.

1962. June 26. Southern Illinois. Slight damage was reported at Johnston City and West Frankfort. In Williamson and Franklin Counties, flower pots toppled, pictures fell, and clocked stopped. Alarmed many at Paducah, Ky. Also felt in Missouri.

1962. July 23. Southern Missouri. Felt in Arkansas, Missouri, and Tennessee. At Dyersburg, Tenn., walls and plaster cracked; slight damage to wall at Miston. Many awakened at Bogota, Boothspoint, Elbridge, Finley, Lenox, and Newbern.

1963. March 3. Southeastern Missouri. Felt over an area of approximately 100,000 square miles in nine states. Bricks fell from chimneys; plaster cracked and fell; foundations, walls, sidewalks, chimneys, and windows cracked in Arkansas, Illinois, Kentucky, Missouri, and Tennessee. Also felt in Indiana, Kansas, Mississippi, and Oklahoma. Magnitude 4½.

1963. August 2. Illinois-Kentucky border. At Paducah, Ky., felt by all. Television station received many calls about the disturbance. Magnitude 3.6.

1964. March 24. Hot Springs, S. Dak. Felt by all at Wind Cave National Park where small rocks fell in cave.

1964. March 27. Near Van Tassell, Wyo. Furniture vibrated and moved at Van Tassell. Also felt in Nebraska and South Dakota.

1964. March 28. Nebraska. Felt over a large area of Nebraska, South Dakota, and border areas of Montana and Wyoming. It was the most widely felt shock since that of November 15, 1877, and was the first to center in this State since March 1, 1935. At Alliance, part of a chimney cap fell on one residence. A highway about 10 miles south of Merriman sustained some 75 cracks, and steep banks reportedly tumbled along the Niobrara River. Plaster fell, walls cracked, and several dishes broke at Rushville. Slight damage (intensity V) was sustained at Martin and Deadwood, S. Dak. Magnitude 5.1.

1964. April 28. Texas-Louisiana border. This was the strongest of a series of shocks that began on April 23 and ended in May. Wallpaper and plaster cracked at Hemphill, Tex. Magnitude 4.4.

1964. August 16. Hemphill, Tex., area. Plaster cracked at Hemphill, and disturbed objects were observed. Several were awakened.

1965. August 14. Southwestern Illinois. This strong local shock knocked chimneys down, cracked walls, muddied water, and shook groceries from shelves at Tamms. Thunderous earth sounds accompanied the shock. Intensity V effects were noted at Unity. Magnitude 5.0.

1965. August 15. Southwestern Illinois. The shock at 00:07 was felt at Tamms with a probable intensity V. That at 22:19 was reportedly felt at Unity with a similar intensity to that of the August 14 shock (intensity V). Magnitude of first shock, 5.1.

1965. October 20. Eastern Missouri. Felt in Arkansas, Illinois, Iowa, Kansas, Kentucky, Missouri, Nebraska, Oklahoma, and Tennessee. To date, the only earthquakes in Missouri history that have exceeded this felt area (160,000 square miles) were the great shocks of 1811–12, an intensity VIII shock in October 1895, and an intensity VI earthquake in April 1917. Intensity VI was reported from Augusta, Illmo, Pacific, Reynolds, and St. Louis, Mo., where various types of minor damage occurred. Reports of cracked walls, windows, and tile were received from Bismarck, Columbia, Fayette, New Haven, Saint Joseph, and Syracuse, Mo.; Jerseyville, Ill.; Indianola, Iowa; and Emporia and Ottawa, Kans. Magnitude 5.2.

1966. June 26. South Dakota. Felt over a small area of southwestern South Dakota. Well water muddied for several hours at Keystone; a patio and concrete steps cracked at Rapid City. Intensity V effects were noted at Deadwood and Silver City. Magnitude 4.1.

1966. July 20. Texas Panhandle region. Chairs moved, books fell from shelves, and loud earth noises were heard at Amarillo and Borger. Magnitude 4.8.

1966. August 14. Western Texas. At Kermit, windows were broken, and several street signs were knocked down. Also felt at Wink, near Kermit, and at Loco Hills, N. Mex. Magnitude 3.4.

1967. April 7. Ohio. Felt in central and southeastern Ohio. The shock broke plaster at Columbus. Magnitude 4.2.

1967. June 4. Near Greenville, Miss. Felt in Arkansas, Louisiana, Mississippi, and Tennessee. A few cases of cracked plaster were noted. An observer near the epicenter reported a ground crack ¼ to ½ inch wide and 39 feet long in his lawn. Magnitude 3.8.

1967. June 29. Near Greenville, Miss. Felt over a small area of Bolivar, Sunflower, and Washington Counties. Intensity V at Shaw. Magnitude 3.4.

1967. July 21. Missouri. Felt considerably in southeastern Missouri and southern Illinois. Some plaster damage occurred at Elvins, Fredericktown, and Poplar Bluff, Mo. Magnitude 3.9.

1967. November 23. South Dakota. Felt over a small area of southern South Dakota and northern Nebraska. Dishes fell from shelves in the Winner-Rosebud-White River areas of South Dakota. The earthquake shifted furniture and cracked windows at Gregory. Magnitude 4.4.

1968. October 14. Durant, Okla. This was a local shock, felt only in Durant and immediate area. Several instances of minor damage occurred at Durant: Plaster cracked, windows broke, wall cracks enlarged, and in one case, an east-west wall sustained a crack approximately 4 feet long. Many alarmed residents fled from their homes and offices.

1968. November 9. South-central Illinois. This was the strongest earthquake in this region since 1895. It was felt over all or portions of 23 states, from eastern Minnesota to northwestern Florida, and from western North Carolina to central Kansas. There were isolated felt reports from people in tall buildings at more distant localities—Boston, Mass., and southern Ontario, Canada. Earthquake damage in south-central Illinois consisted

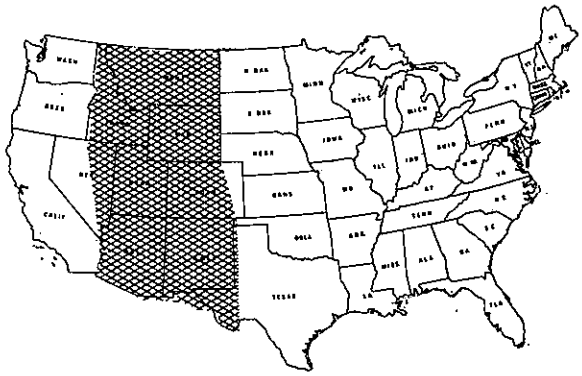
primarily of bricks thrown from chimneys, broken windows, toppled television aerials, and cracked or fallen plaster. In the epicentral area, intensity VII was characterized by downed chimneys, cracks in foundations, overturned tombstones, and scattered instances of collapsed parapets. Most buildings sustaining chimney damage were 30 to more than 50 years old. Considerable masonry damage occurred at the City Building at Henderson, Ky., 50 miles east-southeast of the epicenter. Several thousand dollars' damage was sustained to a large two-story brick house near Dale, Ill. A few miles west of Dale near Tuckers Corners, a concrete and brick cistern collapsed. Moderate damage to chimneys and/or walls occurred in several towns in south-central Illinois, southwestern Indiana, northwestern Kentucky, and at Hermann, St. Charles, Sikeston, and St. Louis, Mo. Magnitude 5.3.

1969. January 1. Central Arkansas. The earthquake cracked walls and floors and broke dishes at Little Rock and North Little Rock. Felt over most of northern and central Arkansas, a small area of southern Missouri, and at Memphis, Tenn. Magnitude 4.2.

1969. May 2. Eastern Oklahoma. Plaster cracked at Wewoka; small objects shifted in a few towns. Intensity V effects also were noted at Chandler, Crowder, Dustin, Henryetta, Holdenville, Indianola, Lamar, Okemah, Savanna, Seminole, and Yeager. Magnitude 4.6.

1970. Nov. 16. Northeastern Arkansas. Felt over all or parts of Arkansas, Illinois, Kentucky, Mississippi, Missouri, and Tennessee. Minor damage occurred at Keiser and Manila, Ark., and Collierville, Tenn. Slight damage (mostly plaster cracks) also was reported from several Arkansas towns, Abbeville, Miss., Braggadocio and Lilbourn, Mo., and Alamo, Halls, and Memphis, Tenn. Magnitude 3.6.

Western Mountain Region



Résumé

Less is known about the earthquake history of this part of the United States than of any other section. The list begins with 1852, a very recent date compared to other regions, and for some time even after that date accounts are very inadequate. There has been much activity in this region, but many of the earthquakes have occurred in sparsely populated regions. Montana, Utah, and Nevada have been subject to earthquakes of considerable severity, and there is a region in Mexico, just south of the border, which has had one major earthquake and many minor ones. Less damage in loss of lives and property is likely in much of this region because of the wide separation of towns. However, a danger of considerable importance was shown in the Montana earthquake of 1959, when a great avalanche claimed 28 lives, formed a barrier which blocked the Madison River, and created a lake.

List of Earthquakes in Western Mountain Region

Year	Date	Time (MST)	Locality	N. lat.	W. long.	Area	Intensity	Authority [1]
				degrees	*degrees*	*sq. mi.*		
1852	Nov. 9	.....	Near Fort Yuma, Ariz.	33	114½	.....	VIII–IX	3-29, 25, 28
1853	December	.....	Fort Yuma, Ariz.	.....	.....	.....	.....	3-29, 28

See footnotes at end of table.

List of Earthquakes in Western Mountain Region—Continued

Year	Date	Time (MST)	Locality	N. lat.	W. long.	Area	Intensity	Authority [1]
				degrees	*degrees*	*sq. mi.*		
1853	Dec. 1	11:15	Nephi, Utah	39.7	111.8	.....	V	3-43
1868	Apr. 28	.....	Socorro, N. Mex	34.0	107.0	.....	V	20
1869	Unknown	.....	..... do	34.0	107.0	.....	VII	20
	May 22	a.m.	Helena, Mont	46.6	112.0	.....	VI	30
1872	Dec. 10	16:30	Western Montana	46.4	112.5	.....	VI	2-73
	Dec. 11	06:55	..... do	46.4	112.5	.....	.....	Do.
1873	July 30	20:15	Beaver, Utah	38.3	112.7	1,000	VI	3-43
1879	Unknown	.....	Socorro, N. Mex	34.0	107.0	.....	V	20
1880	July 11	22:00	Portage, Utah	42.0	112.3	(2)	VI	3-43
	Sept. 16	22:27	Salt Lake City, Utah	40.8	112.0	3,000	V	3-43, 4
1881	Mar. 25	19:15	Hebron, Utah	.....	.....	2,000	V	3-43
1882	Nov. 7	18:30	Colorado	40	105	11,000	V	2-83, 60
1884	Nov. 9	02:00	Utah	41.5	111.2	6,000	VI	2-85
1886	July 6	.....	Socorro, N. Mex	34.0	107.0	.....	V	20
1887	May 3	14:13	Sonora, Mexico	31	109	.....	VIII–IX	3-8, 3-10, 15-88
	Dec. 5	08:30	Kanab, Utah	37.1	112.5	(2)	VI	3-43
1891	Apr. 20	06:55	Washington County, Utah	.....	.....	1,000	VI	Do.
	Sept. 12	20:48	Cedar City, Utah	37.7	113.0	.....	.....	25
1893	July 12	06:00–07:00	Albuquerque, N. Mex	35.0	106.4	.....	V	25
	Sept. 7	.....	New Mexico	34.7	106.6	.....	VII	25
1894	June 8	11:00	Fish Springs, Utah	.....	.....	(2)	V	3-43
	June 25	.....	Casper, Wyo	42.9	106.3	.....	V	35
	July 18	15:50	Ogden, Utah	41.2	112.0	(2)	VI–VII	3-43, 4, 7, 8A
1895	Mar. 22	.....	Colorado	.....	.....	1,500	V	8
	Oct. 7	.....	New Mexico	34.5	106.7	.....	V	8
	Oct. 31	05:00	Socorro, N.Mex	34.0	107.0	.....	VI	20
1897	Nov. 4	02:29	Montana	45	113	.....	VI	4
	Unknown	.....	Socorro, N.Mex	34.0	107.0	.....	VI	20
	Nov. 14	.....	Casper, Wyo	42.9	106.3	.....	VI–VII	35
1899	Dec. 13	06:50	Utah	41	112	5,000	V	4
1900	Aug. 1	12:45	..... do	39.8	112.2	600	VI–VII	8
1901	July 26	14:40	Nevada	40.8	115.7	3,500	VII	3-55, 8
	Nov. 13	21:30	Southern Utah	38.7	112.1	50,000	VIII	3-43, 8
	Nov. 15	a.m.	Colorado	38.8	106.2	(2)	VI–VII	8
1902	Nov. 17	12:53	Pine Valley, Utah	37.4	113.5	10,000	VII	3-43, 7, 8A
	Dec. 5	.....	Southeastern Utah	.....	.....	.....	.....	8
1904	Jan. 19 to Sept. 10.	.....	Socorro, N.Mex	34.0	107.0	.....	V–VI	20
	Aug. 3	20:00	Montana	45.5	111.8	(2)	V	8
1905	Nov. 11	14:26	Shoshone, Idaho	42.9	114.5	.....	VII	3-43, 3-49, 8
1906	Jan. 25	13:33	Flagstaff, Ariz	35.2	111.7	15,000	VII	3-29, 8
	May 24	14:10	West Weber, Utah	41.2	112.0	(2)	V	3-43
	July 12	05:15	Socorro, N.Mex	34.0	107.0	40,000	VII–VIII	3-1, 8A, 20
	July 16	12:00	..... do	34.0	107.0	100,000	VIII	Do.
	Oct. 18	19:06	Idaho	42.5	111.4	3,000	V	8

See footnotes at end of table.

List of Earthquakes in Western Mountain Region—Continued

Year	Date	Time (MST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1906	Nov. 15	05:15	Socorro, N.Mex	34.0	107.0	100,000	VII–VIII	3-1, 8A, 20
1908	Dec. 20 to 29	16:30	Virginia City, Mont	45.3	111.9	(2)	VI	8
1909	Oct. 5 to Dec	.....	Utah	42	113	(2)	VII	3-29, 3-43, 8
1910	Jan. 10 to 12	.....	Richfield, Utah	38.7	112.1	(2)	VI	Do.
	May 22	07:28	Salt Lake City, Utah	40.8	111.9	3,500	VII	3-29, 3-43, 8, 9
	July 25	18:30	Rock Springs, Wyo	41.5	109.3	(2)	V	9
	Sept. 23	21:05	Northeastern Arizona	36.0	111.1	45,000	VI	3-29, 8, 9
1912	Aug. 18	14:12	Northeast of Williams, Ariz	36.5	111.5	55,000	VI–VII	3-29, 3-43, 8, 9
1913	Apr. 12	01:25	Southeastern Idaho	42	112	8,000	V	8
	July 18	.....	Socorro, N.Mex	34.0	107.0	.....	.....	9
	Nov. 11	14:55, 15:18, 16:45	Southwestern Colorado	38.2	107.7	7,500	V	8
	Dec. 5	17:15	Arizona and New Mexico	34.1	106.8	(3)	.....	3-29, 8
1914	Apr. 8	09:06	Utah	.....	.....	1,000	V	3-43
	May 13	10:15	..... do	42	112	8,000	VII	3-29, 3-43, 8
	Dec. 20	22:25	Enterprise, Utah, and vicinity	37.6	113.8	.....	V	3-29, 3-43, 4, 8
1915	May 8	09:10	Wyoming	44.9	110.7	10,000	V	4
	July 15	15:00	Utah	40.3	111.7	5,000	VI	3-29, 3-43, 4
	July 30	11:50	Northern Utah	41.8	112.2	(2)	V	Do.
	Aug. 11	03:20	..... do	40.5	112.7	(2)	V	3-29, 4
	Oct. 5	01:00	Near Utah-Nevada border	40.1	114.0	.....	V	3-43, 4
	Nov. 17	15:35	Elko, Nev	40.9	115.8	.....	V	3-29, 4
1916	Feb. 4	23:25	Utah	40.0	111.7	(2)	V	3-43
	May 12	19:30	Boise, Idaho	43.7	116.2	50,000	VII	3-29, 4
	May 25	23:36	Idaho City, Idaho	43.8	116.0	10,000	V	Do.
	Aug. 3	06:21	Nevada	41.0	117.5	(2)	IV–V	3-6, 3-29, 4
	Sept. 9	19:57	Hailey Center, Idaho	43.5	114.3	(2)	V	4
	Dec. 12	04:45	Eastern Arizona	34	110	70,000	V	4
1917	Apr. 19	21:30	Pierson, Idaho	44.0	114.8	(2)	V	3-29, 4
	Dec. 12	05:00	Southern Idaho	43.0	111.3	8,000	V	4
1918	Mar. 11	20:26	Near Rathdrum, Idaho	47.6	117.0	6,000	V	3-8
	May 28	04:30	Santa Fe County, N.Mex	35.5	106.6	7,500	VII–VIII	4
1919	Jan. 31	21:30	Socorro, N.Mex	34.0	107.0	(2)	IV–V	4
	Feb. 1	13:30	..... do	34.0	107.0	(2)	V	4
1920	Sept. 18	14:05	Northern Utah	41.5	112.0	2,000	V–VI	3-43, 4
	Sept. 19	06:50	..... do	41.5	112.0	(2)	.....	Do.
	Nov. 19	22:40	..... do	41.5	112.0	(2)	.....	Do.
	Nov. 25	17:00	St. George, Utah	37.1	113.5	(2)	V	4
1921	Sept. 29	07:12	Elsinore, Utah	38.8	112.2	(3)	VIII	3-11, 3-43, 4
	Sept. 29	19:30	..... do	38.8	112.2	.....	VII	Do.

See footnotes at end of table.

List of Earthquakes in Western Mountain Region—Continued

Year	Date	Time (MST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1921	Oct. 1	08:32	Elsinore, Utah	38.8	112.2	.....	VIII	3-11, 3-43, 4
	Oct. 27	07:15	..... do	38.8	112.2	.....	.....	3-43
	Nov. 1	08:35	..... do	38.8	112.2	.....	.....	4
1923	Mar. 23 to Apr. 12.	21:00	Kelly, Wyo	43.6	110.6	1,500	V	4
1924	Aug. 12	21:23	New Mexico	36.0	104.5	.....	V	10
	Nov. 25	07:10	Southeastern Idaho	42.5	111.5	20,000	V	10
1925	June 27	18:21*	East of Helena, Mont	46.0	111.2	310,000	VIII	3-16, 10, 43
	July 10	07:45	..... do	46.0	111.2	.....	VI	10
	Aug. 10	09:30	Sweet Grass, Mont	49.3	112.5	25,000	V	10
	Nov. 17	18:50	Wyoming	44.6	107.0	3,000	V	10
1926	May 31	05:25	Three Forks, Mont	46.0	111.4	1,000	V	3-16, 10
	Nov. 27	18:25	Idaho	47.5	116.0	2,000	V	3-29, 10
	Dec. 12	17:44	South-central Montana	46.1	111.2	30,000	V	3-16, 10
1928	Feb. 13	07:00	Central Wyoming	43.5	108.2	3,000	V	27
	Apr. 20 to May 10.	Various	Creede, Colo	37.8	107.0	(2)	IV–V	27
	Oct. 31	21:16	Mexico, felt in Texas	26	106	.....	V[4]	27
1929	Feb. 15	20:00	Montana	46.1	111.3	40,000	V	27
1930	Mar. 16	06:00?	Helena, Mont	46.6	112.0	(2)	VI	27
	June 12	02:15	Grover, Wyo	42.6	111.0	(2)	VI	27
	July 9	18:00	Western Montana	47	115	[2] large	V	27
	Aug. 24 to Dec. 22.	Various	Yellowstone National Park, Wyo	44	111	.....	IV–V	27
	Dec. 3	14:36	Albuquerque, N.Mex	35.0	106.4	(3)	V–VI	27
1931	Feb. 4	21:48	..... do	35.0	106.4	(3)	VI	27
	Apr. 17	05:38	Eastern Arizona	34.0	110.5	3,500	V	27
	July 28	01:40*	Cottonwood, Ariz	35.0	112.0	1,500	V	27
	Aug. 16	05:40*	Western Texas	30.9	104.2	450,000	VIII	3-24, 27, 43
	Aug. 18	13:36	..... do	30.6	104.1	(3)	V	27
1932	Jan. 26	03:13	Western Wyoming	43.6	110.8	1,000	V–VI	27
1933	Jan. 20	06:05	Parowan, Utah	38	113	1,000	VI	27
	June 10	22:59	Helena, Mont	46.6	112.0	(2)	V	27
	Aug. 19	03:13	Logan, Mont	45.8	111.3	(2)	V	27
	Nov. 2	09:26	Gray, Idaho	43.0	111.3	(2)	V	27
	Nov. 29	10:00	Virginia City, Mont	45.3	111.9	200	IV–V	27
1934	Jan. 7	18:32	Socorro, N.Mex	34.0	107.0	(2)	V	27
	Mar. 12	08:06* 11:20*	Kosmo, Utah	41.7	112.8	170,000	VIII	27, 43
	May 6	01:10*	Northern Utah	42	113	17,500	VI	Do.
	May 6	22:22	Silver City, N.Mex	32.7	108.2	200	V	27
	Nov. 23	16:40	Lander, Wyo	43	109	8,000	V	27
1935	Jan. 2	00:30?	Wellton, Ariz	32.8	114.2	(2)	VI	27
	Jan. 10	01:10	Grand Canyon, Ariz	36.1	112.2	(2)	VI	27
	Feb. 20	18:25	Bernardo, N.Mex	34.5	106.8	(2)	VI	27
	Mar. 29	00:39	Rollins, Mont	47.8	114.2	(2)	V	27
	Oct. 3	19:47	Helena, Mont	46.6	112.0	(2)	V	27
	Oct. 7	12:30	Craig, Mont	47.0	111.9	(2)	VI	27

See footnotes at end of table.

List of Earthquakes in Western Mountain Region—Continued

Year	Date	Time (MST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1935	Oct. 12	00:51*	Helena, Mont.	46.6	112.0	70,000	VII	27
	Oct. 18	21:48*	do	46.6	112.0	230,000	VIII	27, 30, 43
	Oct. 27	12:00	do	46.6	112.0	(2)	VI	27
	Oct. 31	11:38*	do	46.6	112.0	140,000	VIII	27
	Nov. 21	20:58	do	46.6	112.0	13,000	VI	27
	Nov. 28	07:42	do	46.6	112.0	90,000	VI	27
	Dec. 17 to 30	22:33*	Belen, N.Mex.	34.7	106.8	2,000	V–VI	27
1936	Jan. 11	11:02	Great Falls, Mont.	47.0	111.3	750	V	27
	Jan. 14	21:40	Yellowstone National Park, Wyo.	44	111	1,200	VI	27
	Feb. 13	16:55, 17:30	Helena, Mont.	46.6	112.0		VI	27
	Mar.	Various	Marysville, Mont.	46.8	112.3		V	27
	May 9	03:25	Zion National Park, Utah	37.5	113.0	1,500	V–VI	27
	June 11	16:13	Helena, Mont.	46.6	112.0	(2)	V–VI	27
	June 22	20:30	Marysville, Mont.	46.8	112.3	(2)	V	27
	Sept. 19	21:13	Hoover Dam, Nev.	36	115	(2)	V	27
1937	Feb. 17	21:15	Southern Utah	38.0	112.5	2,000	V	27
	Apr. 24	20:28*	West-central Nevada	39	117	20,000	V	27
	Apr. 27	21:15	Hoover Dam, Nev.	36	115	(2)	V	27
	June 18	10:18	do	36	115	(2)	V	27
	Nov. 11	17:39	do	36	115	(2)	V–VI	27
	Dec. 18	04:00	Cascade, Idaho	44.5	116.0	1,200	V	27
1938	Sept. 17	10:20	Arizona-New Mexico border	33.2	108.6	8,000	VI	27
	Sept. 19	22:40	do			(2)	V–VI	27
	Sept. 29	16:34	do			(2)	V–VI	27
	Nov. 1	01:26*	do	33.0	108.7	(2)	V–VI	27
1939	May 4	13:44*	Near Las Vegas, Nev.	36.0	114.8	7,000	VI	27
	May 11	16:40	Trident, Mont.			(2)	V–VI	27
1940	Dec. 23	14:50*	Helena, Mont.	46.5	112.5	7,000	VI	27
1942	June 4	08:26	Boulder City, Nev.	36.0	114.9	(2)	V	27
	June 4	16:04	Northern Sanpete County, Utah			(2)	V	27
	Aug. 5	14:34	Yellowstone National Park, Wyo.	44	111	(2)	V	27
	Aug. 30	16:08	Cedar City, Utah	37.7	113.0	(3)	VI	27
	Sept. 8	22:15	Boulder City, Nev.	36.0	114.9	(3)	V	27
	Nov. 1	11:50*	Sandpoint, Idaho	48.0	116.7	25,000	VI	27
1943	Feb. 22	07:20*	Near Salt Lake City, Utah	41.0	111.5	(2)	VI	27
	June 24	21:25*	Southern Sheridan County, Mont.	48.5	105.0	(2)	VI	27
1944	July 12	12:30*	Seafoam, Idaho	44.7	115.2	70,000	VII	27
	Sept. 8	21:12*	Western Colorado	39.0	107.5	3,000	VI	27
1945	Feb. 13	20:01*	Near Clayton, Idaho	44.7	115.4	60,000	VI	27
	June 1	09:55*	Helena, Mont.	46.6	112.0	6,000	V	27
	Sept. 23	02:59*	Western Montana	48.0	114.2	36,000	VI	27
1946	May 5	21:30	Northern Utah	41.8	112.0		V	27
	Dec. 11	08:09	Northwestern Montana	48.4	114.4	3,000	VI	27
1947	Mar. 14	11:00	Seeley Lake, Mont.	47.2	113.5		VI	27
	Nov. 6	09:50	San Antonito, N.Mex.	35.0	106.4		VI	27
	Nov. 23	02:46*	Southwestern Montana	44.8	112.0	150,000	VIII	27, 43
	Dec. 17	05:38*	Western Montana	46.5	112.0		V	27
1948	Feb. 23	19:39*	Northwestern Wyoming	43.5	111.0	1,500	VI	27
	Mar. 11	21:29*	Northwestern Texas	36	102½	50,000	VI	27

See footnotes at end of table.

List of Earthquakes in Western Mountain Region—Continued

Year	Date	Time (MST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1948	May 15	23:45	Western Montana	46.0	111.5	.....	V	27
	Nov. 2	09:48*	Hoover Dam area, Nev	35.9	114.8	.....	VI	27
1949	Mar. 6	23:50	Salt Lake City, Utah	40.8	111.9	.....	V–VI	27
	Mar. 7	00:09	..... do	40.8	111.9	.....	V–VI	27
	May 23	00:22	East Vaughn, N.Mex	34.6	105.2	.....	VI	27
	Nov. 1	19:30	Southwestern Utah	37.2	113.3	700	VI	27
1950	Jan. 16	17:53	Apache County, Ariz	35.5	109.5	.....	VI	27
	Jan. 17	18:56*	Near Soldier Summit, Utah	40½	110½	.....	V	27
	May 8	15:35	Payson, Utah	40.0	111.4	(2)	V	27
	June 27	21:31*	West Yellowstone, Mont	44¾	110½	.....	VI	27
	Aug. 19	18:45*	Western Montana	47¼	113½	4,000	VI	27
	Oct. 18	02:30 07:00 10:30 15:30	Cascade, Idaho	44.5	116.0	(2)	V	27
1951	June 20	12:37*	Northern Texas	35½	103	.....	VI	27
	Aug. 5	17:37	Butte, Mont	46.0	112.5	(2)	V	27
	Dec. 9	00:08	Helena, Mont	46.6	112.0	.....	V	27
1952	Feb. 8	01:59	Boulder City, Nev., area	36.0	114.9	.....	V	27
	Feb. 20	06:41	..... do	36.0	114.9	.....	VI	27
	Mar. 31	17:38*	Northwestern Montana	48.0	113.8	35,000	VII	27
	Apr. 14	13:37	Moiese and St. Ignatius, Mont	47.2	114.1	.....	V	27
	Apr. 22	09:55*	Western Montana	46.2	111.4	1,500	VI	27
	May 23	21:15*	Arizona-Nevada border	36.1	114.7	1,000	V	27
	May 29	20:15	Western Montana	46.2	111.4	.....	V	27
	Aug. 3	20:42*	Cimarron, N.Mex	36.5	105.0	.....	V	27
	Aug. 17	03:45	Los Alamos, N.Mex	35.5	106.2	.....	V	27
	Sept. 28	13:00 13:30	Lehi, Utah	40.2	111.5	.....	V	27
	Oct. 7	02:20	Colorado-New Mexico border region.	37.0	106.0	.....	V	27
1953	May 23	19:54*	North-central Utah	40½	111½	.....	VI	27
	Aug. 8	09:50	Flathead Lake, Mont	48	114	.....	VI	27
	Oct. 21	20:00	Panguitch, Utah	37.5	112.3	.....	V	27
	Nov. 23	06:30	Helmville, Mont	46.5	112.6	(2)	V	27
1954	Jan. 20	13:50*	Southeastern Wyoming	41½	105½	2,000	V	27
	June 7	17:16*	Northern Idaho	47.5	116.0	.....	V	27
	July 4	09:33*	Yellowstone National Park, Wyo	44.9	110.8	.....	V	27
	Nov. 3	13:39	Albuquerque, N.Mex	35.1	106.7	.....	V	27
1955	Jan. 10	03:07*	Southeastern Nevada	37.0	114½	.....	V	3-45, 27
	Feb. 2	12:23	Salt Lake City, Utah	40.8	111.9	.....	V	27
	Feb. 10	10:30*	Northwestern Colorado	40.5	107.0	.....	V	27
	May 12	15:57	Davis and Salt Lake Counties, Utah	41	112	.....	V	27
	May 31	21:56	Southwestern Montana	45.8	111.5	.....	V	27
	Aug. 2	23:40	Southwestern Colorado	38	107	2,000	VI	27
	Aug. 12	09:20	Santa Fe, N.Mex	35.7	106.1	.....	V	27
1956	Aug. 6	21:06*	Western Idaho	44.5	115.0	1,200	V	27
	Dec. 25	06:58	Helena, Mont	46.6	112.0	.....	V	27
1957	May 17	10:41	Southwestern Montana	.....	.....	.....	V	27
	Dec. 18	23:25	Wallace, Idaho	47.5	116.0	.....	VI	27
1958	Feb. 13	15:52*	North-central Utah	40½	111½	1,200	VI	27

See footnotes at end of table.

List of Earthquakes in Western Mountain Region—Continued

Year	Date	Time (MST)	Locality	N. lat.	W. long.	Area	Intensity	Authority [1]
				degrees	*degrees*	*sq. mi.*		
1958	Apr. 19	02:01	Boulder City, Nev	36.0	114.9	(3)	VI	27
	Apr. 28	13:59	Yellowstone National Park, Wyo	44	111	(2)	V	27
	May 28	09:46*	Georgetown Lake area and Philipsburg, Mont.	46½	113	4,500	VI	27
	Nov. 28	06:31	Nephi, Utah	39.7	111.8	(2)	V	27
	Dec. 1	13:51*	Northern Utah	40½	112½	200	V	27
	Dec. 1	20:23*	do	40½	112½	(2)	V	27
1959	Jan. 4	00:23	Southeastern Idaho	.....	.....	500	V	27
	Feb. 11	07:01	Flagstaff, Ariz	35.2	111.7	(2)	V	27
	Feb. 27	15:20*	Southwestern Utah	38	112½	1,500	VI	27
	May 17	03:57*	Northwestern Montana	47½	113	3,000	V	27
	July 21	10:39*	Arizona-Utah border	37	112½	8,000	VI	27
	Aug. 17	23:37*	Hebgen Lake, Mont	44.8	111.1	600,000	X	27, 54
	Aug. 18	01:42*	Yellowstone National Park, Wyo	44.8	110.7	.....	VI	27
	Aug. 18	21:04*	Southwestern Montana	44.9	111.6	.....	V	27
	Aug. 20	12:11*	Hebgen Lake, Mont., area	45	111	.....	V	27
	Aug. 23	01:40	do	45	111	.....	VI	27
	Aug. 30	00:50	West Yellowstone, Mont	44.7	111.1	.....	V	27
	Sept. 4	12:18	Whitehall, Mont	45.9	112.1	.....	V	27
	Sept. 5	05:10	Yellowstone National Park, Wyo	44¾	111	(2)	VI	27
	Sept. 25	05:40	do	44¾	111	(2)	V	27
	Sept. 26	02:04	do	44¾	111	(2)	V	27
	Sept. 28	01:06*	Gallatin Gateway, Mont	45	111	(2)	V	27
	Sept. 29	18:36*	Yellowstone National Park, Wyo	45	111	(2)	VI	27
	Oct. 13	01:15*	Flagstaff, Ariz	35½	111½	(2)	V	27
	Oct. 18	05:09	West Yellowstone, Mont	44.7	111.1	.....	V	27
	Oct. 19	02:00 06:50	do	44.7	111.1	(2)	V	27
	Nov. 1	16:03*	Yellowstone National Park, Wyo	45	111	(2)	V	27
	Nov. 3	10:03	Duck Creek, Mont	.....	.....	.....	VI	27
	Nov. 4	21:42	Yellowstone National Park, Wyo	44¾	111	(2)	V	27
	Dec. 8	00:14	Ennis, Mont	45.4	111.7	.....	V	27
	Dec. 11	23:23	West Yellowstone, Mont	44.7	111.1	.....	V	27
	Dec. 12	10:47	do	44.7	111.1	.....	V	27
	Dec. 13	00:50*	do	45	110½	.....	V	27
	Dec. 13	00:57	Yellowstone National Park, Wyo	44¾	111	(2)	V	27
	Dec. 25	09:50	Foxpark, Wyo	41.1	106.2	(2)	V	27
1960	Jan. 4	21:04*	Hebgen Lake, Mont	44½	111½	(2)	V	27
	Feb. 3	11:30	Ennis, Mont	45.4	111.7	(2)	V	27
	Mar. 22	20:15*	Hebgen Lake, Mont	44½	111	.....	V	27
	Apr. 21	10:49*	do	45	111	.....	V	27
	Apr. 26	21:32*	do	44½	111	.....	V	27
	July 22	08:49*	Lajoya, N.Mex	34	106½	.....	V	27
	July 23	07:15*	do	34	106½	3,000	VI	27
	July 24	03:37	Near Bernardo, N.Mex	34.5	106.8	(2)	V	27
	Aug. 7	09:27*	Southeastern Idaho	42.4	111.5	900	VI	27
	Aug. 10	00:42*	do	42.5	111.5	.....	V	27
	Aug. 20	01:02*	do	42.3	111.3	.....	V	27
	Oct. 11	01:06*	Southwestern Colorado	38.3	107.6	10,000	VI	27
	Oct. 17	09:00	Aspen, Colo	39.2	106.9	(2)	V	27

See footnotes at end of table.

List of Earthquakes in Western Mountain Region—Continued

Year	Date	Time (MST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1961	Mar. 13	12:28	Hebgen Dam, Mont	44.9	111.4	(2)	V	27
	Apr. 6	22:51*	Southern Madison County, Mont.	44.8	112.0	2,500	V	27
	Apr. 15	22:03*	Central Utah	39.3	111.5	2,000	VI	27
	May 6	09:12*	East-central Utah	39.6	110.2	.....	V	27
	June 26	06:05	Papoose Creek at Madison River, Mont.	.....	.....	(2)	V	27
	June 29	04:45	Yellowstone National Park, Wyo.	44¾	111	(2)	V	27
	July 3	00:06*	Central New Mexico	33.6	106.9	(2)	VI	27
	Dec. 3	18:41 20:25	Virginia City, Mont	45.3	111.9	(2)	V	27
1962	Feb. 5	07:46*	Southwestern Colorado	38.2	107.6	.....	V	27
	Feb. 15	00:13*	Arizona-Utah border	36.9	112.4	.....	V	27
	Feb. 25	10:18*	Western Montana	45.2	111.2	.....	V	27
	June 18	21:55	Dupont, Colo	.....	.....	(2)	V	27
	Aug. 6	About 17:50	Dupont, Colo., area	.....	.....	.....	V	27
	Aug. 26	05:15 06:22	Yellowstone National Park, Wyo.	.....	.....	(2)	V	27
	Aug. 30	06:35*	Northern Utah	41.8	111.8	65,000	VII	27
	Sept. 4	About 20:00	Logan, Utah	41.7	111.8	(2)	V	27
	Sept. 5	09:04*	Near Salt Lake City, Utah	40.7	112.0	9,000	VI	27
	Sept. 7	a.m.	Lewiston, Utah	42	111.8	(2)	V	27
	Dec. 4	10:50*	Northeast of Denver, Colo	39.8	104.7	.....	VI	27
	Dec. 5	06:48*	North-central Colorado	39.9	104.6	6,000	VI	27, 60
	Dec. 18	06:49 06:50 06:52	Northwestern Montana	.....	.....	.....	V	27
	Dec. 28	03:01*	..... do	48.4	113.9	.....	V	27
1963	Jan. 27	08:25*	Central Idaho	44.4	114.6	6,000	VI	27
	Jan. 29	22:51*	Yellowstone National Park, Wyo.	45.0	110.8	(2)	V	27
	Feb. 1	09:39*	Central Idaho	44.3	114.5	.....	V	27
	Feb. 15	20:02*	Southwestern Montana	46.1	111.0	6,000	V	27
	Feb. 25	11:45*	Western Wyoming	42.6	109.2	.....	V	27
	Mar. 8	01:36*	Yellowstone National Park, Wyo.	44.8	110.2	(2)	VI	27
	Mar. 21	21:35*	..... do	44.8	110.5	(2)	V	27
	Mar. 25	02:29*	Near Boulder City, Nev	36.0	114.9	9,000	VI	27
	Apr. 18	03:43*	Yellowstone National Park, Wyo.	44.8	110.3	(2)	V	27
	Apr. 23	01:13	Hoover Dam, Nev	36	115	(2)	V	27
	May 11	16:07	Papoose Creek at Madison River, Mont.	.....	.....	(2)	V	27
	May 25	03:45*	Northeastern Colorado	39.8	104.7	900	V	27
	June 6	12:48	Gibbon Meadow area, Wyo	.....	.....	(2)	V	27
	July 2	01:03*	Northern Colorado	39.8	104.6	3,000	V	27, 60
	July 7	12:21*	Central Utah	39.6	111.9	1,600	VI	27
	Sept. 9	03:45*	Central Idaho	44.4	114.7	.....	V	27
	Sept. 10	19:09*	..... do	44.4	114.7	3,500	VI	27
	Sept. 11	05:00*	Southeastern Arizona	33.2	110.7	2,500	V	27
	Sept. 14	08:58*	Central Idaho	44.3	114.8	.....	V	27
	Sept. 16	05:06*	..... do	44.3	114.7	.....	V	27

See footnotes at end of table.

List of Earthquakes in Western Mountain Region—Continued

Year	Date	Time (MST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1963	Sept. 23	23:36*	Yellowstone National Park, Wyo.	44.9	111.0	(2)	V	27
	Dec. 17	02:30*	do	44.9	111.0	(2)	V	27
	Dec. 20	06:01*	Hebgen Lake, Mont., area	44.9	111.7	3,000	V	27
1964	Feb. 20	13:20*	Eastern Nevada	39.4	114.2		V	27
	Mar. 20	05:20	Polson, Mont., area	47.7	114.2	(2)	V	27
	Mar. 27	19:36	Near Ennis, Mont	45.4	111.7	(2)	V	27
	Mar. 28	03:10	Swan Lake, Mont	47.9	113.8	(2)	VI	27
	Aug. 21	20:28*	Eastern Wyoming	42.9	104.7	1,500	V	27
	Sept. 23	10:10*	Near Boulder City, Nev	35.9	114.8	3,000	V	27
	Oct. 8	19:26*	Flathead Lake, Mont	47.8	114.2		V	27
	Oct. 21	00:39*	Hebgen Lake, Mont	44.8	111.6	25,000	V	27
1965	Jan. 5	19:01*	Southwestern Montana	44.9	112.7	12,000	VI	27
	Jan. 6	03:26	Polson, Mont	47.7	114.2	650	V	27
	Jan. 12	20:44*	Eastern Idaho	44.9	112.7	(2)	V	27
	Feb. 16	15:22*	Denver, Colo., area	39.9	105.0	300	VI	27, 60
	Apr. 6	07:46*	Virginia City, Mont	45.6	111.9	(2)	V	27
	Apr. 27	06:50	Northwestern Montana			450	V	27
	Apr. 28	19:00	Nordman, Idaho	48.6	116.9	(2)	V	27
	July 18	14:41*	Denver, Colo., area	39.8	104.8		V	27, 60
	July 31	06:42*	do	39.7	104.9		V	Do.
	Sept. 13	02:58*	do	39.8	104.8		V	Do.
	Sept. 14	15:46*	do	39.9	104.6		VI	Do.
	Sept. 29	12:00*	do	39.8	105.1		VI	Do.
	Oct. 8	12:35*	Hebgen Lake, Mont	44.8	111.1		V	27
	Oct. 26	04:28*	Western Montana	47.4	113.2		V	27
	Nov. 20	21:02*	Denver, Colo., area	39.8	104.8	3,000	VI	27, 60
1966	Jan. 4	17:37*	do	39.8	104.7		V	Do.
	Jan. 22	18:57*	New Mexico-Colorado border region.	37.0	107.0	15,000	VII	27, 57
	Jan. 23	16:48*	Lumberton, N.Mex., area	36.9	107.0		V	Do.
	Mar. 7	11:10*	West-central Montana	46.3	111.5	12,500	V	Do.
	Mar. 17	04:48*	Northeastern Utah	41.7	111.5	6,000	V	Do.
	Apr. 29	23:28*	Flathead Lake, Mont	48.0	113.8	500	V	Do.
	Aug. 16	11:03*	Southern Nevada	37.4	114.2	20,000	VI	Do.
	Sept. 19	03:07*	Southwestern Montana	45.9	111.2		V	Do.
	Sept. 22	11:58*	Southern Nevada	37.4	114.2		V	Do.
	Oct. 2	19:26*	Southeastern Colorado	37.4	104.1	15,000	VI	Do.
	Oct. 11	00:30*	Hebgen Lake, Mont	44.9	111.1		V	Do.
	Oct. 11	04:48	West Yellowstone, Mont	44.7	111.1	(2)	V	Do.
	Oct. 11	10:53*	Hebgen Lake, Mont	44.8	111.2	(2)	V	Do.
	Nov. 14	13:03*	Denver, Colo., area	39.9	104.7		VI	27, 60
1967	Jan. 10	04:53*	Hebgen Lake, Mont	45.0	111.5	(2)	V	27
	Feb. 2	22:28*	Commerce City, Colo., area	39.7	104.8		V	27, 60
	Feb. 14	20:28*	Rangely, Colo	40.1	109.0	(2)	V	27
	Apr. 10	12:00*	Commerce City-Denver, Colo., area	39.9	104.8	6,500	VI	27, 60
	Apr. 27	10:25*	Denver, Colo., area	39.9	104.7		VI	Do.
	Aug. 9	06:25*	Denver, Colo., region	39.9	104.7	15,000	VII	Do.
	Sept. 23	21:47*	Salt Lake City, Utah, area	40.7	112.1		V	27
	Oct. 4	03:20*	Marysvale, Utah, area	38.5	112.1	15,000	VII	27
	Nov. 15	00:10*	Denver, Colo., area	39.9	104.6		V	27, 60
	Nov. 26	22:09*	do	40.0	104.7	17,000	VI	Do.

See footnotes at end of table.

List of Earthquakes in Western Mountain Region—Continued

Year	Date	Time (MST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1968	Jan. 16	02:42*	Central Utah	39.3	112.1	.....	V	27
	Jan. 30	08:20*	North-central Nevada	41.0	117.4	3,500	V	27
	Feb. 21	01:16*	Central Nevada	38.6	116.3	.....	V	27
	Mar. 26	11:22*	Northwestern Montana	47.7	114.4	.....	V	27
	July 6	07:03*	North-central Nevada	41.0	117.4	9,500	V	27
	July 15	11:33*	North-central Colorado	39.9	104.8	.....	V	27
1969	Jan. 29	22:18*	New Mexico	34.3	106.9	.....	V	27
	Apr. 1	09:45*	Northwestern Montana	47.9	114.3	10,000	VII	27
	Apr. 26	03:42*	Western Idaho	44.2	114.5	9,000	VI	27
	Apr. 30	20:10*	Northwestern Montana	46.7	112.8	3,000	V	27
	May 5	00:09*	Western Idaho	44.1	114.5	.....	V	27
	May 6	06:40	Proctor, Mont	47.9	114.5	(2)	V	27
	May 12	02:26* 02:49*	Texas-Mexico border region	31.8	106.4	.....	VI	27
	May 23	02:01	Commerce City, Colo	39.9	105.1	.....	V	27
	June 9	01:54*	Northwestern Montana	47.9	114.3	3,500	V	27
	June 21	04:07*	Proctor, Mont	47.9	114.5	(2)	V	27
	Sept. 14	17:03*	Northwestern Montana	47.9	114.2	2,000	VI	27
	Oct. 7	08:11	Proctor, Mont	47.9	114.5	(2)	V	27
	Oct. 13	22:16*	Flathead Lake, Mont., area	47.8	114.2	(2)	V	27
	Nov. 6	17:11*	..... do	47.9	114.2	.....	VI	27
1970	Jan. 12	04:21*	Amistad, N.Mex	36.1	103.2	3,700	VI	27
	Feb. 4	16:40*	Proctor, Mont	47.9	114.2	.....	V	27
	Mar. 29	05:41*	Grouse Creek, Utah	41.6	113.7	.....	V	27
	Apr. 21	01:54*	Rangely, Colo	40.1	108.9	.....	V	27
	May 23	01:55*	Commerce City, Colo	39.9	105.1	.....	V	27
	May 23	08:08*	Proctor, Mont	47.8	114.2	(2)	V	27
	June 25	18:27*	Southwestern Montana	45.6	111.8	.....	V	27
	Sept. 1	05:34*	Proctor, Mont	47.9	114.4	.....	V	27
	Oct. 18	13:07*	Western Montana	46.2	111.5	3,500	V	27
	Nov. 28	00:40*	Albuquerque, N.Mex	35.0	106.7	1,200	VI	27

*Instrumental origin time and epicenter.
[1] See References, p. 133.
[2] Local earthquake.
[3] Uncertain.
[4] Intensity in the United States.

MAJOR EARTHQUAKES

Earthquake of May 3, 1887

Time of occurrence.—About 14:13.

Epicenter.—Bavispe, Sonora, Mexico.

Area affected.—Unknown. Area 300 miles in diameter strongly shaken.

Intensity.—VIII–IX at epicenter.

Description.—This earthquake occurred in a very sparsely settled region and is named for the town of Bavispe, not because this was the point of maximum activity, but because it is the only village of any size in the region. The reports are due to Jose G. Aguilera, Chief of the Mexican Geological

Survey, and to George E. Goodfellow of Tombstone, Ariz., both of whom visited the region within a year after the earthquake. Correct information as to the exact time of the shock and other important details are lacking because of scarcity of timepieces, illiteracy of people and the unwillingness to give out such facts as they may have had, sparse population, inadequate communications in some parts and inaccessibility to others, and the unparalleled severity of the rainy season of 1887.

Seismic movements were felt from Toluca, near Mexico City, to Albuquerque and Santa Fe, N. Mex., on the north; from Guaymas, Mexico, and Yuma, Ariz., on the west to a point 60 miles east of El Paso, Tex., on the east. The central tract of maximum intensity was found in the San Bernardino Valley and the neighboring Teras Mountains. The Teras are part of the Sierra Madre Mountains, a southern extension of the mountains of eastern Arizona, and range from 4,000 to 10,000 feet in height. It is a region of considerable instability with evidence of past earthquakes.

There is a single large fault on the eastern margin of the San Bernardino Valley where the mesas merge into the foothills. With a length of about 35 miles, the fault is somewhat irregular as it follows the base of the foothills. The average difference in height between its sides is 7 feet, but, in one place, the difference is as much as 26 feet. There is evidence of similar movement in the past.

Great numbers of cracks were found in the riverbeds, and there were outbursts of water and sand through fissures and holes. At Batepito Ranch, an area 2 miles long by 1 mile wide was covered with water to an average depth of 4 inches. At first the streams and springs almost went dry; they then had a greatly increased flow at least a month before the start of the rainy season.

Millions of cubic feet of rock were thrown from the mountains. Cliffs of solid crystalline rock were shattered. One narrow canyon contained an immense amount of material from adjacent cliffs.

Bavispe, the principal town damaged, was built on very unconsolidated material. The houses were built of 24- by 12-inch adobe blocks laid double so that the walls were 24 inches thick. Roofs were made of rafters and covered with brush and mud, making them very heavy. The principal damage was caused by collapsing roofs, indicating a lateral earth movement of at least a foot. Only in part of the town was the destruction serious. The church, which was not as well built as the houses, but which had stood for more than 200 years, was completely destroyed. All the damage was done by the first shock. The energy of the shock varied greatly throughout the region. A town 9 miles north and one 3½ miles south of Bavispe were practically undamaged.

From Guaymas to Nogales, Mexico, Benson and Tucson, Ariz., El Paso, Tex., and at places as far away as Albuquerque, N. Mex., water in tanks slopped over, railroad cars were set in motion on tracks, chimneys were thrown down, and buildings cracked. Mr. Goodfellow felt the tremors at Tombstone and heard sounds like prolonged artillery fire. They came from the south and died away to the north. He fixed the time of arrival at 14:13. While investigating the earthquake region he also experienced many aftershocks. By means of a crude seismograph of the simple pendulum type, the epicenter was fixed in the Teras Mountains.

Earthquake of October 2, 1915

Time of occurrence.—22:54.

Epicenter.—Pleasant Valley, Nev.

Area affected.—Approximately 500,000 square miles.

Intensity.—X at epicenter.

Magnitude.—7¾.

Description.—This earthquake occurred along a fault on the eastern side of Pleasant Valley, which lies south of Winnemucca. While felt over a larger area than the California earthquake of 1906, it did little damage because of few structures and people. There were two shocks scarcely felt outside Nevada, one at 15:40 and another at 17:49. At Kennedy, there was a roar and people had trouble remaining on their feet; the shock was intensity V at Reno. At Kennedy, the motion continued until the main shock at 22:54. At this time there was a great roar, people were thrown from their beds, and some were thrown to the floor. Adobe houses were destroyed. Concrete mine foundations cracked and mine tunnels caved in. As usual, effects were greater where materials were unconsolidated. In such cases,

ground cracks appeared for considerable distances. At Winnemucca, damage was moderate and was confined to that part of the city on low ground. At Lovelock, large water tanks were thrown down and cracks appeared in the road. There was a great increase in flow of water, so much so that applications were filed for new water rights. A rift was formed with a fresh vertical scarp 5 to 15 feet high and 22 miles long, parallel to the base of the Sonoma Mountains. It was felt from Baker, Oreg., to San Diego, Calif., and from the Pacific coast to beyond Salt Lake City, Utah.

Earthquakes of September 29 and October 1, 1921

Time of occurrence.—07:12 and 19:30, September 29; 08:32, October 1.

Epicenter.—38.8° N., 112.2° W., Elsinore, Utah.

Area affected.—Considerable.

Intensity.—VIII.

Description.—Elsinore is in Sevier Valley, 150 miles south of Salt Lake City and 5,335 feet above sea level. The valley is about 5 miles wide and is flanked by an abrupt rise of plateaus to several hundred feet. Elsinore is fairly old. Its early houses were built of sun-dried brick and fragments of black basaltic lava, but later houses were of modern construction. At the time of the earthquake, there were about 1,000 inhabitants.

After several weeks of preliminary tremors, the first sharp shock occurred at Elsinore at 07:12 on September 29. It lasted 7 to 10 seconds and was probably of intensity VIII. It threw down scores of chimneys, tore plaster from ceilings, and fractured walls. Another shock of intensity VII occurred at 19:30 the same day. At 08:32 on October 1, there was yet another shock, like the blow of a great hammer, unaccompanied by noise except the creaking of buildings and falling of chimneys; it was probably of intensity VIII. Great clouds of dust arose because of the very dry country.

The first shock was strongest at Elsinore but also caused damage at Richfield and Monroe. Most severely damaged was the Elsinore schoolhouse, a new two-story brick building. The collapse of a section of the wall could have caused heavy loss of life had it occurred during school hours. Nearby, an old building of rectangular blocks of rock was only slightly damaged. Half the buildings were damaged to some degree, their chimneys thrown down or otherwise rendered unsafe. Plaster fell from ceilings; pictures were thrown from walls. One chimney was twisted through 45°. A hot spring with iron oxide in the water ran blood red for a time after the earthquake.

The shocks lasted from September 12 to December 20, the most important being those of October 27, felt sharply at Richfield, and November 1.

Earthquake of June 27, 1925

Time of occurrence.—18:21*.

Epicenter.—46.0° N., 111.2° W., east of Helena, Mont.

Area affected.—Violent shaking was felt over 600 square miles; total felt area was 310,000 square miles.

Intensity.—VIII.

Magnitude.—6¾.

Description.—The greatest damage was sustained at Manhattan, Logan, Three Forks, and Lombard. At Manhattan, a large schoolhouse was badly wrecked, though reinforced concrete buildings escaped damage. Many chimneys fell. Interestingly, there appeared to be a twist, rather than a general direction, as the chimneys fell in every possible direction. At Logan, a large brick roundhouse sustained only a few cracks. At Trident, on the Missouri River, a house rocked so violently that the family could scarcely get outside. Railroad tracks moved with a sinuous motion. Rockfalls from the cliffs delayed trains on the Northern Pacific Railroad, and a great slide of rock blocked the Deer Park entrance of the Lombard Tunnel of the Chicago, Milwaukee & St. Paul. At Bozeman, a loud roar was heard with each shock; the second was as severe as the first. At Three Forks, a boiler chimney of cement brick laid in lime mortar was damaged and moved 4 inches to the south. The schoolhouse, with brick walls in lime mortar, was badly damaged, and the walls bulged on all sides. The church was damaged considerably. Its walls were excessively high, and were not tied together by an upper floor as were those in other buildings. Masonry buildings showed cracks, while frame buildings had only plaster cracks and fallen chimneys. Crevices occurred in fills on roads, but not in cuts or where the natural surface had not been dis-

turbed. Approaches to many bridges settled, in some cases as much as a foot.

The earthquake was felt from the North Dakota line to Washington, and from the Canadian border to central Wyoming. There were numerous aftershocks for several months, the strongest being that of July 10 at 07:45. Others occurred on June 27 at 19:06, 20:40, and 23:30.

The epicenter as given above coincides with a known fault; that of the second shock was somewhat to the south and west.

Earthquake of August 16, 1931

Time of occurrence.—05:40*.

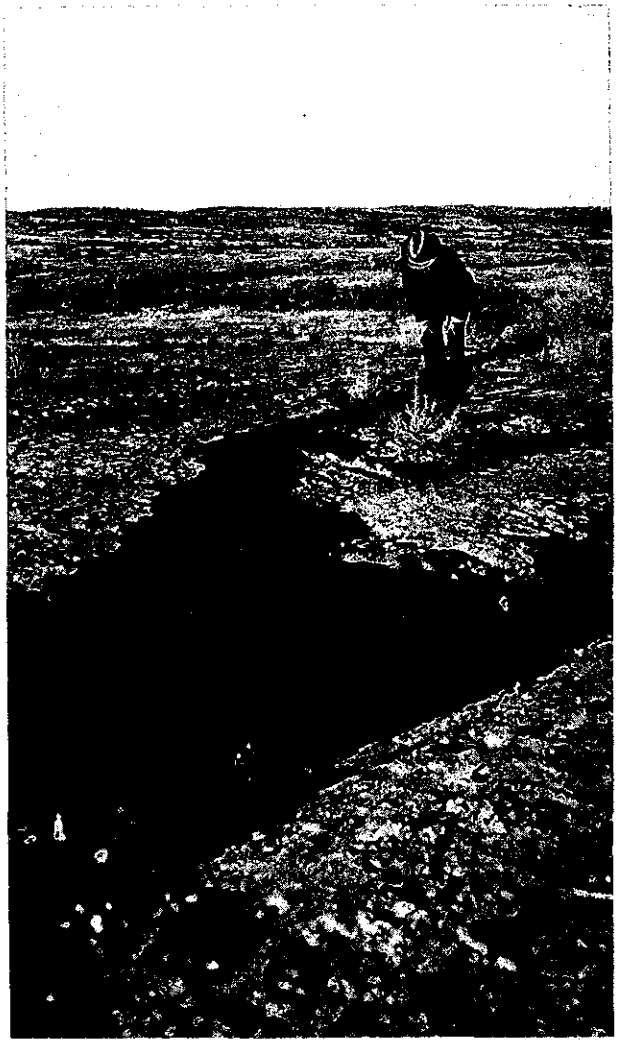
Epicenter.—30.9° N., 104.2° W., at Mount Livermore in western Texas.

Area affected.—450,000 square miles, including Mexico.

Intensity.—VIII.

Magnitude.—6.4.

Description.—At Valentine, the point of maximum destruction, all types of buildings, especially adobe, were heavily damaged; many chimneys fell. There were some cracks in the ground, and tombstones rotated both clockwise and counterclockwise. While people were panic-stricken, there were no fatalities and only a few minor casualties. There were cracked walls and damaged chimneys in several towns in Brewster, Jeff Davis, Culberson, and Presidio Counties. Some rockslides occurred in the mountains. There were rumbling and roaring sounds. This earthquake would have been severe in a densely populated region.



Fault scarp created north of Kosmo, Utah, by earthquake of March 12, 1934.

Earthquake of March 12, 1934

Time of occurrence.—08:06* and 11:20*.

Epicenter.—41.7° N., 112.8° W., near Kosmo, Utah, at the north end of Great Salt Lake.

Area affected.—170,000 square miles.

Intensity.—VIII.

Magnitude.—6.6 and 6.0, respectively.

Description.—The earthquakes could have caused great damage in a densely populated area, but because of the sparse settlement in the region, there was little loss except for damage to chimneys and cracks in walls. The outstanding feature was the emission of large quantities of water from fissures and craterlets. Considerable faulting occurred in the epicentral region. Precise leveling revealed that areas sank by amounts up to 15 inches. There was moderate damage over a considerable area, including Salt Lake City where plaster fell. All chimneys fell in Kosmo. Fissures, holes, cracks, and springs appeared in the ground. There were ground fissures, rockslides, and several new springs at Monument. All chimneys were knocked down by the shock. Another earthquake of similar intensity with a magnitude of 6 followed at 11:20. It is very difficult to separate the reports of the two shocks, because many observers tried to describe both in a single report and confused their accounts.

Earthquakes of October 12–November 28, 1935

Date and time of occurrence	Intensity	Magnitude	Area affected (*sq. mi.*)
Oct. 12, 00:51*	VII	.....	70,000
Oct. 18, 21:48*	VIII	6¼	230,000
Oct. 27, 12:00	VI	.....	(local)
Oct. 31, 11:38*	VIII	6	140,000
Nov. 21, 20:58	VI	.....	13,000
Nov. 28, 07:42	VI	.....	90,000

*Instrumental time.

Epicenter.—46.6° N., 112.0° W. All shocks originated along a subsurface fault, north and northeast of the center of Helena, Mont.

Description.—The Montana earthquake series will be discussed together. The destruction was due to the occurrence of shocks almost directly beneath the city, and to the fact that each successive shock further damaged previously weakened buildings. All of the earthquakes centered close to Helena; the stronger ones appear to have had nearly the same epicenter.

The first shock on October 3 was merely a hard vertical jolt. On October 12, there was a stronger shock, but it was not felt outside Montana. It caused damage only in Helena, especially in the eastern part, and at Fort Harrison where a large hospital was damaged to some extent. The total damage was about $50,000, but it was confined chiefly to a few structures. Smaller shocks continued until October 18 when the strongest of the series occurred. This tremor caused damage of about $3 million. Some 300 buildings were damaged in varying degrees, and of these, more than 200 lost their chimneys. Damage was greatest at the junction of rock and unconsolidated materials. It was especially severe in two- and two and one-half story houses in northeast Helena, and in Last Chance Gulch where the effect of dredging

West wing of Helena High School (Montana) damaged severely by earthquake of October 18, 1935.

for gold resulted in conditions practically equivalent to made land. Many large buildings were damaged severely, but damage to the State Capitol, Federal Building, and Cathedral was slight. An interesting example of variations in damage was the entirely unharmed, tall minaret tower of the Shrine Temple and the severely damaged auditorium from which it rises. The newly completed Helena High School was damaged severely. But with all this destruction, only two people were killed and a very few injured. Telegraph, telephone, and electric services were stopped for about 1 hour. Monuments were thrown down or twisted at a cemetery northwest of town. Eastward there were ground cracks from which water issued; one was 150 feet long and 3 feet deep. There were considerable changes in ground water, some only temporary. While the intensity V felt area was confined to Montana, the shock was widely felt in Wyoming, Idaho, eastern Washington, and adjacent part of Canada.

On October 21 a strong-motion seismograph was set up at Helena. All strong shocks occurring thereafter were recorded, furnishing a large amount of valuable information for engineers and architects concerned with building design.

A fairly strong shock on October 27 caused additional damage to weakened structures. The next strong earthquake in the series occurred on October 31.

The shock of October 31 caused two deaths and additional destruction, bringing the death toll to four and the damage total to $4 million. Many buildings previously damaged were demolished, including the new high school. Damage was most severe in the business section, and was worse on the West Side than on October 18. The ground again cracked and water issued. This earthquake was felt in the same states as that of October 18, but the total area was somewhat less. Shocks continued to occur, with a fairly strong one on November 21 and the fourth strongest on November 28. The latter tremor caused additional damage to previously weakened buildings.

Earthquake of August 17, 1959

Time of occurrence.—23:37*.

Epicenter.—44.8° N., 111.1° W., near Hebgen Lake, Mont.

Area affected.—600,000 square miles. As far as Seattle, Wash., to the west; Banff, Canada, to the north; Dickinson, N. Dak., to the east; and Provo, Utah, to the south.

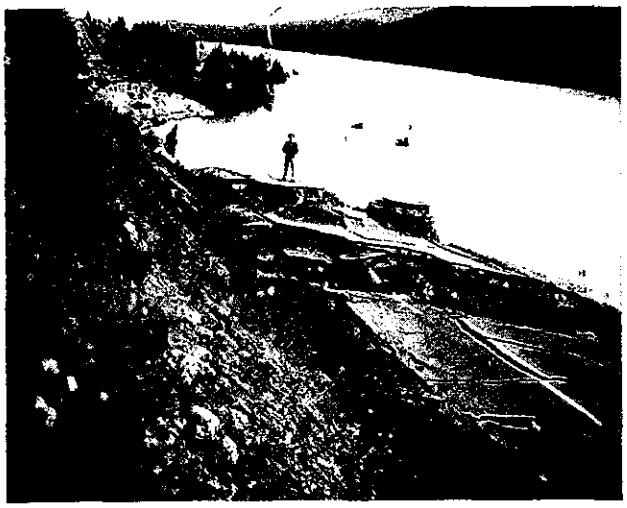
Intensity.—X.

Magnitude.—7.1.

Description.—The most spectacular and disastrous effect of the earthquake was the great avalanche of rock, dirt, and trees which cascaded from the steep south wall of the Madison River Canyon, about 1,300 feet above the canyon floor. This slide formed a barrier that completely blocked the gorge and flow of the Madison River, and within a few weeks, created a lake nearly 175 feet deep. Most of the 28 persons killed were engulfed by this and several smaller slides in the epicentral area.

Extensive fault scarps were observed near Hebgen Lake. Maximum vertical displacement of 21 feet was observed near Red Canyon Creek. Hebgen Dam sustained cracks in the concrete core and spillway. Many summer homes in the Hebgen Lake area were badly damaged. Some houses and cabins shifted off foundations, chimneys fell, and pipelines were broken. There was considerable cracking and shifting of roadways, and much timber was destroyed. It was estimated that timber and road damage exceeded $11 million.

High intensities (VII–VIII) were observed in the northwestern section of Yellowstone National



State Highway 287 disappeared into Montana's Hebgen Lake during earthquake of August 17, 1959.

Park. New geysers started erupting, and large steaming cracks resulting from massive slumping were observed. Many hot springs became muddy.

Minor to moderate damage occurred throughout southern Montana, northeastern Idaho, and northwestern Wyoming. The principal damage in this area was cracked chimneys and plaster and broken windows.

One hundred and fifty-six aftershocks were reported felt at Old Faithful Ranger Station, Yellowstone National Park, during the first 21 hours after the main shock. Aftershocks continued for many months.

INTERMEDIATE AND MINOR EARTHQUAKES

1852. November 9. Near Fort Yuma, Ariz. A violent shock threw down portions of Chimney Peak. Fissures and cracks opened in the clay desert bordering the Colorado River. Fort Yuma was at this time on the California side of the Colorado. Shocks occurred almost daily for many months.

1853. December. Fort Yuma, Ariz. Many shocks. Possibly of destructive force.

1853. December 1. Nephi, Utah. People ran from their homes. Roofs moved visibly. Felt also at Provo.

1868. April 28. Socorro, N. Mex. See 1906 earthquakes at Socorro.

1869. Date unknown. Socorro, N. Mex. See 1906 earthquakes at Socorro.

1869. May 22. Helena, Mont. Threw down furniture. Earth sounds like a large wagon on rough road.

1872. December 10. Western Montana. Two shocks, lasting 5 seconds and of equal intensity, were felt at Helena and Deer Lodge. Plaster cracked, stovepipes parted, and rumbling noises were heard at Helena. The shock was stronger at Deer Lodge. Another shock on December 11 at 06:55, of slightly less intensity, was felt at Helena and Deer Lodge.

1873. July 30. Beaver, Utah. Felt throughout Beaver County. Bottles were thrown from shelves; plaster was thrown down; and a new brick building cracked.

1879. Date unknown. Socorro, N. Mex. See earthquakes of 1906.

1880. July 11. Portage, Utah. Houses were badly shaken; people ran into streets. Two shocks reported.

1880. September 16. Salt Lake City, Utah. Lasted 15 seconds. Felt in various parts of the territory from Salt Lake City to Provo.

1881. March 25. Hebron, Utah. Shook houses and threw dishes from shelves. The shock staggered people in the streets.

1882. November 7. Colorado. Felt along the line of the Southern Pacific Railroad from Laramie and Cheyenne, Wyo., to Georgetown and Louisville, Colo. Clocks stopped at Denver; chandeliers vibrated. There was rumbling at Cheyenne; houses were shaken. At some places three shocks were felt. A report of the shock was received from Salina, Kans.

1884. November 9. Utah. Felt at Fort Bridger, Wyo., Salt Lake City, Utah, and Paris, Idaho. Telegraph wires swung at Fort Bridger. There were six shocks at Paris, from 02:00 to 04:00, that caused considerable damage to houses. People suffered from nausea.

1886. July 6. Socorro, N. Mex. See earthquakes of 1906.

1887. December 5. Kanab, Utah. Local shock caused slight damage.

1891. April 20. Washington County, Utah. One chimney fell at St. George. Plaster fell and dishes broke.

1891. September 12. Cedar City, Utah. Heavy shock with noise like heavily loaded wagon on rough street.

1893. July 12. Albuquerque, N. Mex. Three shocks shook every house in Albuquerque. Clocks stopped. A chandelier swung for 10 minutes.

1893. September 7. New Mexico. The central area was subjected to shocks for 3 months during this period, the most severe being on the date given here. At Los Lunas, five shocks threw down many adobe buildings already weakened by previous earthquakes. No lives were lost; many suffered from nausea. Also felt at Sabinal.

1894. June 8. Fish Springs, Utah. People ran outside at Emma Mine; dishes were thrown down at Utah Mine. Rumbling sounds.

1894. June 25. Casper, Wyo. Dishes fell to floor. A number of people were thrown from their beds. Platte River was thick with mud.

1894. July 18. Ogden, Utah. Three distinct shocks. Walls cracked. Dishes shook from tables. People were frightened.

1895. March 22. Colorado. Noise like blast at Steamboat Springs; low rumble. Felt from Pleasant Valley, 12 miles south, to Hayden, 25 miles northwest.

1895. October 7. New Mexico. Articles were thrown from shelves at Sabinal and Jarales. Felt at Albuquerque.

1895. October 31. Socorro, N. Mex. See earthquakes of 1906.

1897. Date unknown. Socorro, N. Mex. See earthquakes of 1906.

1897. November 4. Montana. Most severe at Dillon, Mont. Courthouse and many other buildings cracked. Felt in Idaho and Utah.

1897. November 14. Casper, Wyo. Grand Central Hotel was damaged considerably, with 2- to 4-inch crack extending from third to first story. Frightened citizens dashed into streets.

1899. December 13. Utah. Rumbling noises were heard in Weber, Morgan, Davis, and Salt Lake Counties.

1900. August 1. Utah. Deep shafts of mine twisted so that cage could not be operated. Dishes were thrown from shelves. Plaster fell, dishes broke, and a chimney was damaged at Goshen. At Santaquin, an adobe house split in two; people were thrown from their beds.

1901. July 26. Nevada. Felt over 3,500 square miles in the Nevada Desert. Shock severe at Elko, and felt 50 miles to the north.

1901. November 13. Southern Utah. Brick buildings and chimneys were damaged from Parowan to Richfield. In the mountains between Beaver and Marysvale there were extensive rockslides. Creeks increased their flow, and some earth cracks with ejection of water and sand were reported. Intensity VI was observed over 10,000 square miles; intensity VIII, 3,000 square miles. Aftershocks continued for several weeks. The strongest was on November 14 at 04:31.

1901. November 15. Colorado. At Buena Vista, windows cracked; boulders fell on road. Water of Cottonwood Lake affected.

1902. November 17. Pine Valley, Utah. Chimneys were damaged. Crockery fell from shelves. Considerable damage at St. George and Santa Clara.

1902. December 5. Southeastern Utah. Strong shock.

1904. January 19 to September 10. Socorro, N. Mex. During this period, five shocks of intensity V to VI were reported. In addition, many smaller shocks were observed, 34 in the first 3 months of 1904. (See earthquakes of 1906.)

1904. August 3. Montana. Shock lasted 12 seconds. Objects were thrown from shelves at Pony and Norris.

1905. November 11. Shoshone, Idaho. Strong. Felt in southern Idaho, northern Utah, and eastern Oregon. At Shoshone, walls cracked and plaster fell.

1906. January 25. Flagstaff, Ariz. Epicenter probably in San Francisco Mountains. Felt from Gallup, N. Mex., to Seligman, Ariz., an estimated felt area of 50 by 300 miles. At Flagstaff, chimneys fell and plaster cracked.

1906. May 24. West Weber, Utah. People in fields at West Weber almost were thrown from their feet. Much excitement was reported at Ogden.

1906. July 12, July 16, and November 15. Socorro, N. Mex. There was a series of shocks on these dates. Shocks occurred almost daily from July 2 until well into 1907. The shock of July 12 (intensity VII–VIII) cracked some adobe walls and threw others down. There were fissures in the ground, and waves were seen on the ground surface. The shock of July 16 was more severe. It was felt at Raton, N. Mex., 235 miles northeast of Socorro, and Douglas, Ariz., 250 miles southwest. A train, stopped about 10 miles west of Socorro, was nearly derailed; probably the epicenter was near there. The November 15 shock was intensity VII–VIII, and was felt over an area of about 100,000 square miles. There was frequent rumbling.

The history of this region shows frequent quakes of some intensity. The list includes 1868, April 28, intensity V; 1869, intensity VII, springs changed flow and became muddy; 1879, intensity V; 1895, October 31, intensity VI; 1897, intensity VI, waves seen in ground; 1904, January 19, intensity

V; January 30, intensity V; February 21, intensity V; March 8, intensity V; September 10, intensity VI. Also in 1893, July 12 and September 7, the region to the north was strongly shaken. There were various later shocks through 1907 and a strong shock on July 18, 1913. Additional tremors occurred on January 31, 1919, intensity IV–V, and on February 1, intensity V.

1906. October 18. Idaho, near Paris and Montpelier. Buildings swayed. Felt at Soda Springs and Henry, about 18 miles north of Idaho Falls, where buildings were strongly shaken. Also reported from Afton, Wyo.

1908. December 20 to 29. Virginia City, Mont. Epicenter near Crater Lake, 7 miles to southeast. Several cracks in buildings. Thirty shocks in a week. Shocks lasted until December 29.

1909. October 5 to end of December. Utah. North of Great Salt Lake in the vicinity of Garland and Tremonton, 30 to 60 shocks were reported, some strong enough to throw down chimneys. Not felt at Brigham City, 20 miles away.

1910. January 10 to 12. Richfield, Utah. Windowpanes broke. Shocks lasted 2 days, but over a small area.

1910. May 22. Salt Lake City, Utah. Damage to chimneys and old buildings. Several shocks.

1910. July 25. Rock Springs, Wyo. Houses were shaken and mine shafts disturbed.

1910. September 23. Northeastern Arizona. Felt over an area 300 by 150 miles in northern Arizona, southern Utah, and northwestern New Mexico. Strong at Flagstaff where there were 52 shocks from September 10 to 23. Felt from Kanab, Utah, to beyond Gallup, N. Mex., along Santa Fe Railroad. One construction gang was frightened and stopped work.

1912. August 18. Northeast of Williams, Ariz. Felt over an elliptical area 300 by 250 miles, including Seligman and Prescott, Ariz., Gallup, N. Mex., and southern Utah. Houses were damaged. Epicenter was apparently in the San Francisco Mountains where rockslides occurred. An earth crack 50 miles long was reported north of the San Francisco Range.

1913. April 12. Southeastern Idaho. Felt over an area of 8,000 square miles of Bannock County, Idaho, and northeastern Utah.

1913. July 18. Socorro, N. Mex. See earthquakes of 1906.

1913. November 11. Southwestern Colorado. Strong at Montrose, Ouray, and Telluride. Objects were thrown from shelves and rocks rolled down cliffs at Ouray.

1913. December 5. Arizona and New Mexico. Few details known. Felt throughout these states.

1914. April 8. Utah. Frightened all at Salt Lake City and Ogden.

1914. May 13. Utah. Windows were broken and chimneys thrown down at Ogden. Probably caused by a slip along the Wasatch Fault near the Idaho line. Felt 30 miles south of Salt Lake City and over a total distance of 140 miles.

1914. December 20. Enterprise, Utah, and vicinity. No details.

1915. May 8. Wyoming. Felt in the north-central part of Yellowstone National Park.

1915. July 15. Utah. Ceilings cracked at Provo. Intensity VI at Salt Lake City; V at Heber and Midvale.

1915. July 30. Northern Utah. Dishes were shaken from shelves.

1915. August 11. Northern Utah. South of Great Salt Lake. No details.

1915. October 5. Near Utah-Nevada border, southwest of Great Salt Lake. Clocks stopped at Ibapah, Utah. Rumbling noises.

1915. November 17. Elko, Nev. No details.

1916. February 4. Utah. Awakened persons at Payson; some rushed into streets. Clocks stopped at Santaquin, Utah County, at 22:10.

1916. May 12. Boise, Idaho. Strong shock. Chimneys were wrecked, and people rushed into the street. Strong at Weiser, 60 miles west. The epicenter was probably northwest of Boise. Reclamation ditches were damaged, and the flow of gas was altered. Felt at Loon Creek, 120 miles northeast, and reported felt at Anaconda, Mont., 240 miles northeast. Also felt in eastern Oregon.

1916. May 25. Idaho City, Idaho. Strongest at that town. Felt at Boise, 25 miles southwest, and Payette, 60 miles west-northwest.

1916. August 3. Nevada. Winnemucca, Rebel Creek, Elko, and McDermitt. Objects were thrown from shelves.

1916. September 9. Hailey Center, Idaho. Rumbling. Duration 30 seconds.

1916. December 12. Eastern Arizona. Doors slammed at Pinto; plaster cracked at St. Michaels. Felt area at least 300 miles east-west.

1917. April 19. Pierson, Idaho. Duration 60 seconds. Rumbling.

1917. December 12. Southern Idaho. Chesterfield and Irwin. Lasted 20 seconds. Felt at Ashton.

1918. March 11. Near Rathdrum, Idaho. Probably strongest at Rathdrum. Felt from Spokane, Wash., to Heron, Mont., a distance of 80 to 100 miles. Felt 60 miles in north-south direction.

1918. May 28. Santa Fe County, N. Mex. Probably intensity VII, though intensity VIII was assigned to effects at Cerrillos. At that place plaster fell, people were thrown off their feet, and there was a break in the earth's surface at the edge of the town. A rapid, twisting effect was noted at several places. There was a sound like distant thunder. At Stanley, doors rattled, a piano sounded, and walls and plaster cracked. People were thrown down. The shock apparently was quite local, its force fading rapidly with distance from epicenter.

1919. January 31 and February 1. Socorro, N. Mex. See earthquakes of 1906.

1920. September 18 and 19, November 19. Northern Utah. Sharp shocks. Intensity V–VI at Brigham City.

1920. November 25. St. George, Utah. Local shock.

1923. March 23 to April 12. Kelly, Wyo. Thirteen shocks.

1924. August 12. New Mexico. Strongest at Abbott and Roy.

1924. November 25. Southeastern Idaho. Also felt in Wyoming.

1925. August 10. Sweetgrass, Mont. All movable objects were disturbed. Felt in Canada.

1925. November 17. Wyoming. Strong shake and rumbling at Big Horn. Felt in Sheridan and Johnson Counties.

1926. May 31. Three Forks, Mont. Felt at Lombard. Rocks rolled down on railroad tracks; people were frightened.

1926. November 27. Idaho, near Rathdrum. Two distinct shocks. Felt at 1,000-foot level in Hecla Mine, but not at 2,000 feet. Strongly felt at Wallace. Vertical jar noted. Slight damage at Kellogg. Felt area extended to Thompson Falls, Mont.

1926. December 12. South-central Montana. Moderate shock centered near Manhattan.

1928. February 13. Central Wyoming. Near Thermopolis, in the Cooper Mountains, mine props loosened during earthquake and later became tight.

1928. April 20 to May 10. Creede, Colo. A series of shocks. Four shocks on May 1 and one on May 10 were the strongest and most widely felt of the series.

1928. October 31. Mexico. Shock that caused damage at Guadalupe was felt at Valentine, Tex. (clocks stopped), and at El Paso. Magnitude 6.3.

1929. February 15. Montana. Strong at Trident. Dishes fell from shelves in Anaconda and Helena. Severe at Deer Park.

1930. March 16. Helena, Mont. A widely felt shock caused cracks in plaster.

1930. June 12. Grover, Wyo. Some bricks and concrete cracked; clocks stopped. Aftershocks continued until November 16.

1930. July 9. Western Montana. Widely felt shock centered near Paradise.

1930. August 24 to December 22. Yellowstone National Park, Wyo. A long series of moderate shocks. Some of them shook down dishes and did other light damage.

1930. December 3. Albuquerque, N. Mex. Two shocks cracked plaster and threw down dishes.

1931. February 4. Albuquerque, N. Mex. A strong, localized shock caused people to leave houses and near panic in theaters. Some building damage and landslides occurred.

1931. April 17. Eastern Arizona. Especially felt at White River, Snowflake, and Standard.

1931. July 28. Cottonwood, Ariz. Pictures fell; dishes broke. Felt strongly at Jerome.

1931. August 18. Western Texas. A moderate aftershock of the earthquake of August 16 (see page 71). Uncertain epicenter. Intensity V at Alpine, Lobo, Pecos, and Valentine. Widely felt.

1932. January 26. Western Wyoming. At Grovont, Kelly, Moran, and Jackson, plaster cracked and dishes broke. A telephone line was put out of order. There were a number of aftershocks.

1933. January 20. Parowan, Utah. Plaster cracked; slight damage to structures.

1933. June 10. Helena, Mont. A vertical jolt alarmed many persons, but did no damage.

1933. August 19. Logan, Mont. Generally felt shock caused very slight damage.

1933. November 2. Gray, Idaho. Schoolhouse wall cracked. Trees and buildings swayed. Trembling motion, accompanied by earth sounds.

1933. November 29. Virginia City, Mont. Generally felt.

1934. January 7. Socorro, N. Mex. Slight damage.

1934. May 6. Northern Utah. This was the strongest aftershock of the March 12 earthquake (see page 71). Minor damage, People left houses in Salt Lake City. Magnitude 5½.

1934. May 6. Silver City, N. Mex. Considerable excitement; slight cracks in old adobe buildings.

1934. November 23. Lander, Wyo. Slight damage. People left buildings. Strong also at Atlantic City, from Fort Washakie to Dubois, at Green River, and at South Pass City.

1935. January 2. Wellton, Ariz. Some cracked walls and plaster.

1935. January 10. Grand Canyon, Ariz. Windows broke; plaster cracked; minor rockslides.

1935. February 20. Bernardo, N. Mex. Damage to various kinds of buildings. Some walls cracked. The shock was accompanied by a thunderous roar.

1935. March 29. Rollins, Mont. Strong enough to stop clocks.

1935. October 3. Helena, Mont. First of a series. Slight damage.

1935. October 7. Craig, Mont. Objects fell from shelves; clocks stopped. Plaster and walls cracked. Chimneys damaged.

1935. December 17 to 30. Belen, N. Mex. At 22:33, the first moderately strong shock of a series that lasted from December 12 to 30 occurred. There was slight damage. Other shocks on December 19 and 21 caused some damage to old adobe buildings.

1936. January 11. Great Falls, Mont. Also felt at Highwood.

1936. January 14. Yellowstone National Park, Wyo., south entrance. Several chimneys were cracked. Generally felt.

1936. February 13. Helena, Mont. Two shocks caused minor damage.

1936. March. Marysville, Mont. A series of moderate shocks.

1936. May 9. Zion National Park, Utah. Two shocks caused slight damage. Also felt at Cedar City, Kanab, and Orderville, Utah.

1936. June 11. Helena, Mont. Shock strong enough to cause slight damage.

1936. June 22. Marysville, Mont. Strong shock. Apparently a secondary center of disturbance to that at Helena.

1936. September 19. Hoover Dam, Nev. Strongest of a series of minor shocks in the general region of Hoover Dam. Continued into December.

1937. February 17. Southern Utah. Two shocks at Panguitch and Parowan City. Radiator moved. Shocks felt at Panguitch until February 25.

1937. April 24. West-central Nevada. The greatest intensity occurred at Potts; felt area was mainly westward.

1937. April 27, June 18, November 11. Hoover Dam, Nev. Strongest of a series of moderate to light shocks in region. These three were strong jolts; first and last activated strong-motion seismographs.

1937. December 18. Cascade, Idaho. Felt throughout west-central Idaho. Furniture moved; awakened many. Similar effects at Arling.

1938. September 17. Arizona-New Mexico border. At Duncan, Ariz., bottles fell from shelves. Plaster and walls cracked slightly. Deep rumble was heard by many in Clifton, Ariz. Affected area about evenly divided between New Mexico and Arizona. Aftershocks of similar intensity occurred on September 19 and 29, and November 1. Magnitude 5½.

1939. May 4. Near Las Vegas, Nev. Several towns reported minor damage. Maximum intensity reported was VI, but may have been higher at epicenter. Large rocks were loosened and nearly blocked roads at a few points near Hoover Dam. A large dust cloud was seen to the south of Boulder City, probably caused by earthslides in the mountains. Plaster was cracked at Mojave City and Oatman, Ariz.

1939. May 11. Trident, Mont. Sharp local shock cracked some plaster. Felt by nearly all. Some ran outdoors.

1940. December 23. Helena, Mont. Minor damage. Canned goods were thrown from shelves; pictures fell from walls. Moderately loud rumbling heard.

1942. June 4. Boulder City, Nev. Rattled dishes and cracked some plaster.

1942. June 4. Northern Sanpete County, Utah. May have originated on the fault that bounds

Sanpete Valley on the west. Tremors felt at Mt. Pleasant, Fairview, and Ephraim.

1942. August 5. Yellowstone National Park, Wyo. Felt by all at West Thumb Ranger Station.

1942. August 30. Cedar City, Utah. Bricks were shaken from chimney. Plaster fell.

1942. September 8. Boulder City, Nev. Probably centered about 6½ miles north-northeast of Hoover Dam. Felt strongly at Boulder City, sharply at Las Vegas.

1942. November 1. Sandpoint, Idaho. Small furnishings moved and some stocks fell from store shelves at Sandpoint, and at Colfax, Wash. Church services were disrupted at Sandpoint. Area affected included western Montana and eastern Washington.

1943. February 22. Near Salt Lake City, Utah. Epicenter probably on Wasatch Fault between Salt Lake City and Bingham. In a new brick building at the Bingham High School, much plaster was shaken from the wall and ceiling. Plaster and windows cracked at Magna and Salt Lake City.

1943. June 24. Southern Sheridan County, Mont. A well-constructed granary at Froid cracked so severely that wheat spilled out. Plaster and chimneys cracked at Homestead, Redstone, and Reserve.

1944. July 12. Seafoam, Idaho. At Seafoam Ranger Station, a new cabin set on concrete piers was nearly displaced. Many boulders rolled down mountains. One man reported rocks rose at least a foot into the air. Felt in Montana, Oregon, and Washington.

1944. September 8. Western Colorado. Slight cracking of walls and chimneys at Basalt, Colo. Similar effects at Montrose and Riland.

1945. February 13. Near Clayton, Idaho. Residents at Clayton, Idaho City, and Weiser reported cracked plaster and broken dishes. Also felt in Montana, Oregon, and Washington.

1945. June 1. Helena, Mont. Slight damage to old chimneys. Strong at Basin, Boulder, and Elliston.

1945. September 23. Western Montana. Felt strongest at Bigfork, DeBorgia, Elmo, and Polson. General awakening of populace. Some chimneys cracked; small objects overturned. Also felt in Idaho and Washington.

1946. May 5. Northern Utah. Widely felt in western Bear River Valley, Utah. Intensity V at Garland and Tremonton.

1946. December 11. Northwestern Montana. Plaster and chimneys cracked at Kalispell and Whitefish. Also strong at Trout Creek and Warland. Rumble accompanied the earthquake.

1947. March 14. Seeley Lake, Mont. Plaster cracked and fell.

1947. November 6. San Antonito, N. Mex. Felt by all at Zamora Ranch; plaster and fireplace cracked; south wall of house was damaged. Intensity V at San Antonito, Sandia Park, and near Cedar Crest.

1947. November 23. Southwestern Montana. Maximum intensity in central Madison County at Alder, Cameron, Ennis, Laurin, and Virginia City. Brick, masonry, and concrete structures suffered considerable damage. Creeks became muddy; new mud springs opened up. Felt area included western Montana, northwestern Wyoming, Idaho, and eastern Washington. Magnitude 6¼.

1947. December 17. Western Montana. Felt in Lewis and Clark County. Picture fell from wall and several persons awakened at Ovando.

1948. February 23. Northwestern Wyoming. Maximum intensity in Teton County. No damage, but heavy objects shifted at Moran.

1948. March 11. Northwestern Texas. Earthquake caused minor damage, consisting mainly of cracked plaster, in northern Texas (Amarillo, Electric City, Panhandle, Perico, and Perryton), northeastern New Mexico (Bueyeros, Ione, and Logan), northwestern Oklahoma (Boise City and Kenton), and southeastern Colorado (Trinchera). Also felt in Kansas.

1948. May 15. Western Montana. Intensity V at Clarkston, Trident, and Wickes.

1948. November 2. Hoover Dam area, Nev. Cracked plaster at Boulder City; no structural damage. Felt within a 50-mile radius of Boulder City.

1949. March 6 and 7. Salt Lake City, Utah. Two sharp tremors awakened residents. A 10-inch waterline was broken; some walls were cracked. Lighter shocks reported on March 6 at 23:54 and March 7 at 01:06 and 01:16.

1949. May 23. East Vaughn, N. Mex. Objects fell from shelves. Rumbling and grinding sounds were heard. Felt from Pastura to East Vaughn.

1949. November 1. Southwestern Utah. At Rockville and St. George, hanging objects swung and knickknacks fell. Also felt in Arizona where small

landslides occurred on east side of Tuweep Valley.

1950. January 16. Apache County, Ariz. Ground cracks ½ inch wide and 12 feet long were found in Ganado. Rumbling sounds heard.

1950. January 17. Near Soldier Summit, Utah. Strongest at Grand Junction, Colo., where plaster cracked. Building cracked at Green River.

1950. May 8. Payson, Utah. Plaster cracked; dishes broke.

1950. June 27. West Yellowstone, Mont. Knick-knacks and groceries fell from shelves. Six additional shocks of less intensity occurred.

1950. August 19. Western Montana. Intensity VI at Desert Mountain Lookout, Mud Lake Lookout (minor rockslide), Niarada, and Spotted Bear Ranger Station. Towers swayed; two wells became muddy.

1950. October 18. Cascade, Idaho. A series of minor shocks cracked the combing on the roof of one house and damaged plaster in the school building.

1951. June 20. Northern Texas. Epicenter in the Texas Panhandle-South Plains area. Damage to plaster at Amarillo and Hereford. Felt from Lubbock to Borger, Groom, and Vega.

1951. August 5. Butte, Mont. A local earthquake shook buildings and moved furniture. Deep rumble.

1951. December 9. Helena, Mont. Glasses and pictures fell; alarmed some people. Felt distinctly by persons driving cars. Houses were shaken quite noticeably.

1952. February 8. Boulder City, Nev., area. Felt by many at Boulder City and Hoover Dam. Small objects shifted and overturned.

1952. February 20. Boulder City, Nev., area. Small objects shifted and overturned at Boulder City and Hoover Dam. Also felt at Henderson and Las Vegas.

1952. March 31. Northwestern Montana. A large area of Montana, Idaho, and southern British Columbia was affected by this shock. Walls cracked and chimneys twisted and fell at Flathead Lake, Mont. Slight damage at Eureka and Swan Lake.

1952. April 14. Moiese and St. Ignatius, Mont. Knickknacks fell; small objects and furnishings shifted.

1952. April 22. Western Montana. Maximum intensity was reported near Townsend and Toston. Plaster fell; several bricks fell from a chimney.

1952. May 23. Arizona-Nevada border. A shock caused slight damage at Boulder City and Whitney. Plaster, walls, and foundations cracked.

1952. May 29. Western Montana. Aftershock of April 22 quake. Maximum intensity at Greyson Creek and Townsend.

1952. August 3. Cimarron, N. Mex. Awakened and frightened few. Small objects and furnishings shifted.

1952. August 17. Los Alamos, N. Mex. Damaged walls. Shifted bassinet.

1952. September 28. Lehi, Utah. Felt as far west as Saratoga and north to Point of the Mountain. Floor lamps swayed; dishes broke. Rumbling noises.

1952. October 7. Colorado-New Mexico border region. Reported felt over a small area of the border regions of southern Colorado and northern New Mexico. Rocks and boulders dislodged at Antonito, Colo. Awakened many and shifted small objects at Chama and Tres Piedras, N. Mex. Felt strongly at Osier, Colo.

1953. May 23. North-central Utah. Shock alarmed residents of Salt Lake City and Herriman. Houses rocked; furniture shifted.

1953. August 8. Flathead Lake, Mont. Sharp, jarring movement felt. Cracks reported in an old building at Yellow Bay. Felt by many at Swan Lake.

1953. October 21. Panguitch, Utah. North of Panguitch, three 2-foot pine log timbers snapped; tons of dirt fell into a potato cellar. Some thought boiler or furnace had exploded.

1953. November 23. Helmville, Mont. Waterpipe broke in basement; clock fell from shelf.

1954. January 20. Southeastern Wyoming. Intensity V at Centennial, Foxpark, Jelm, and Laramie.

1954. June 7. Northern Idaho. Intensity V at Coeur d'Alene and Kellogg. Pendulum clock stopped.

1954. July 4. Yellowstone National Park, Wyo. Small objects shifted. Shock at 00:40 awakened many residents.

1954. November 3. Albuquerque, N. Mex. Minor plaster cracks reported. Also felt at Bernalillo, Sandoval, and Sandia Pueblo. A lighter shock on November 2 at 10:00 was felt over the same area.

1955. January 10. Southeastern Nevada. Minor damage at Caliente. Also felt at Gunlock, Utah.

1955. February 2. Salt Lake City, Utah. Small cracks in buildings reported in Salt Lake City and Arthur. Furniture moved. Felt as far west as Arthur, north to Centerville, and south beyond Kearns.

1955. February 10. Northwestern Colorado. Shock caused minor damage at Steamboat Springs. Buildings rattled at Hayden, Kremmling, and Oak Creek.

1955. May 12. Davis and Salt Lake Counties, Utah. Intensity V at Centerville, Murray, and Salt Lake City.

1955. May 31. Southwestern Montana. Sharp shock at Trident caused many people to leave their homes. Many awakened at Logan and Three Forks.

1955. August 2. Southwestern Colorado. Ground and chimneys reported cracked at Lake City. Shock awakened persons at Silverton, Ouray, and Telluride.

1955. August 12. Santa Fe, N. Mex. Plaster wall cracked in building 15 miles southwest of Santa Fe. At Santa Fe, houses and buildings were shaken and objects rattled.

1956. August 6. Western Idaho. Felt over a large area of southwestern and central Idaho. Slight damage was reported at Stanley.

1956. December 25. Helena, Mont. Many persons were awakened by a strong, double jolt. Rumbling noises reported.

1957. May 17. Southwestern Montana. Felt by many in Twin Bridges area, Silver Star, Melrose, and Glen. Small objects shifted.

1957. December 18. Wallace, Idaho. Extensive damage at Galena Silver Mine (1 mile west of Wallace). Timber fell and walls caved in, frightening miners 3,400 feet underground. Awakened all and frightened many at Wallace. Also felt at Osburn and Mullan.

1958. February 13. North-central Utah. Felt principally in the region east of Utah Lake. Plaster and wall cracked at Provo. Frightened all at Wallsburg.

1958. April 19. Boulder City, Nev. Plaster cracked; dishes broke. Moderate earth noises.

1958. April 28. Yellowstone National Park, Wyo. (Old Faithful Ranger Station). Small objects shifted. Five shocks reported felt between 13:54 and 15:05.

1958. May 28. Georgetown Lake area and Philipsburg, Mont. Slight damage at Philipsburg. Possible rockslide in Georgetown Lake area. Aftershock at about 12:30 was generally felt from Philipsburg to Rock Creek.

1958. November 28. Nephi, Utah. Felt by many but caused no damage. Also felt at Levan.

1958. December 1. Northern Utah. Felt principally in the Nephi-Levan area. Plaster cracked at Nephi. Mortar trickled down stove chimney.

1958. December 1. Northern Utah. Aftershock of 13:51. Not as strong as main shock. Plaster cracked at Nephi. Also felt at Levan and Mona.

1959. January 4. Southeastern Idaho. Although the shock caused no damage, it awakened many at Bern, Bloomington, and Ovid. Moderate to loud earth noises. Also felt at Montpelier and Raymond.

1959. February 11. Flagstaff, Ariz. Awakened many. Lasted 3 to 5 seconds.

1959. February 27. Southwestern Utah. Plaster and walls cracked, dishes and windows broke at Panguitch. Frightened many at Bear Valley Junction, 10 miles north of Panguitch.

1959. May 17. Northwestern Montana. Although no damage occurred, this was the sharpest shock in Montana since May 1958. Awakened all in community at Ovando. Fracturing in Ophir Cave was reported (possibly not caused by the earthquake). Large subsidence on Highway 35 (east shore of Flathead Lake) was thought to have occurred on the day of the shock.

1959. July 21. Arizona-Utah border. The shock cracked plaster and knocked bricks from chimneys at Kanab, Utah. Minor damage to chimneys, walls, and windows occurred at Fredonia. A rockslide at Grand Canyon (Mather Point, near Canyon Rim), Ariz., was attributed to the shock. Magnitude 5½–5¾.

1959. August 18. Yellowstone National Park, Wyo. (Old Faithful Ranger Station). Aftershock of August 17 earthquake. Broken chimney reported. Intensity V at Fairfield, Idaho. Magnitude 6.

1959. August 18. Southwestern Montana. Aftershock of August 17 earthquake. Intensity V at Spencer, Idaho. Magnitude 6.

1959. August 20. Hebgen Lake, Mont., area. Aftershock of August 17 earthquake. The press reported three hard shocks. People ran from buildings. Rockslide west of Hebgen Dam.

1959. August 23. Hebgen Lake, Mont., area. Aftershock of August 17 earthquake. A large rockslide blocked the road above Selby Dam. Awakened many at West Yellowstone.

1959. August 30. West Yellowstone, Mont. Aftershock of August 17 earthquake. Many were awakened.

1959. September 4. Whitehall, Mont. Aftershock of August 17 earthquake. Pendulum clock stopped. Sound like heavy truck passing. Brief power stoppage.

1959. September 5. Yellowstone National Park, Wyo. Aftershock of August 17 earthquake. Dishes and plumbing were broken at Canyon. Rockslides in Grand Canyon smashed viewing platform and stairway.

1959. September 25 and 26. Yellowstone National Park, Wyo. Aftershocks of August 17 earthquake. First shock awakened many at Lake Ranger Station; second awakened many and frightened few at Old Faithful Ranger Station.

1959. September 28. Gallatin Gateway, Mont. Aftershock of August 17 earthquake. Small objects shifted and vases overturned at 320 Ranch.

1959. September 29. Yellowstone National Park, Wyo. Aftershock of August 17 earthquake. Felt by many at Old Faithful Ranger Station. Rocks fell from cliff.

1959. October 13. Flagstaff, Ariz. Awakened many, but caused no damage.

1959. October 18 and 19. West Yellowstone, Mont. Aftershocks of August 17 earthquake. Awakened many in community.

1959. November 1. Yellowstone National Park, Wyo. Aftershock of August 17 earthquake. Rocks fell from mountain at Madison Junction.

1959. November 3. Duck Creek, Mont. Aftershock of August 17 earthquake. Furnishings shifted at Duck Creek and West Yellowstone. Roaring noise accompanied shock.

1959. November 4. Yellowstone National Park, Wyo. Aftershock of August 17 earthquake. No damage, but felt by all at Old Faithful Ranger Station.

1959. December 8. Ennis, Mont. Aftershock of August 17 earthquake. Small objects and furnishings shifted.

1959. December 11. West Yellowstone, Mont. Aftershock of August 17 earthquake. Generally felt. Merchandise toppled from shelves in store. Furniture shifted at Duck Creek.

1959. December 12. West Yellowstone, Mont. Aftershock of August 17 earthquake. Merchandise fell from store shelves.

1959. December 13. West Yellowstone, Mont. Aftershock of August 17 earthquake. Furnishings shifted; merchandise fell.

1959. December 13. Yellowstone National Park, Wyo. Aftershock of August 17 earthquake. Awakened and frightened all at Mammoth Hot Springs.

1959. December 25. Foxpark, Wyo. Concrete block buildings cracked slightly.

1960. January 4. Hebgen Lake, Mont. Cans fell from shelves at West Yellowstone.

1960. February 3. Ennis, Mont. Coffee pot tumbled from stove. Also felt about 6 miles southeast.

1960. March 22. Hebgen Lake, Mont. Objects fell from shelves at West Yellowstone. Roaring noises. Strongly felt.

1960. April 21. Hebgen Lake, Mont. Merchandise and dishes fell at West Yellowstone. Water sloshed over the sides of a fish bowl in Yellowstone National Park, Wyo.

1960. April 26. Hebgen Lake, Mont. Furnishings shifted at West Yellowstone. People were thrown off balance. Objects rocked and displaced.

1960. July 22. Lajoya, N. Mex. Trophies fell from shelf. Also felt near Bernardo and at Socorro and San Acacia.

1960. July 23. Lajoya, N. Mex. A weak adobe wall toppled; adobe buildings cracked. People fled from homes at Bernardo; canned goods fell from shelves.

1960. July 24. Near Bernardo, N. Mex. Two small windows were broken.

1960. August 7. Southeastern Idaho. Felt principally in the Soda Springs area of Caribou County. Plaster and concrete foundation cracked at a ranch about 9 miles east of Soda Springs. Loud earth noises.

1960. August 10. Southeastern Idaho. At Soda Springs, concrete patio and foundation of house cracked. Glasses fell from shelf. Described as quite strong.

1960. August 20. Southeastern Idaho. Slight damage occurred at Conda. About 100 aftershocks were felt during the night 10 miles south of Conda.

1960. October 11. Southwestern Colorado. Fountain cracked at Montrose. Damage at other towns consisted of cracked chimneys and plaster and broken dishes and windows. Magnitude 5½.

1960. October 17. Aspen, Colo. Generally felt. Small objects fell from shelves.

1961. March 13. Hebgen Dam, Mont. Power and telephone wires swayed and bounced; bottles tipped over. Loud, roaring earth noises.

1961. April 6. Southern Madison County, Mont. Slight damage was reported at Jeffers and Virginia City. Booming, roaring, and whistling earth noises.

1961. April 15. Central Utah. Felt principally in central Sanpete County. Several towns reported cracked plaster and damaged chimneys.

1961. May 6. East-central Utah. Slight damage to brick at Columbia. Also felt at Sunnyside.

1961. June 26. Papoose Creek at Madison River, Mont. Plaster cracked. Awakened and frightened many.

1961. June 29. Yellowstone National Park, Wyo. Awakened many in Canyon area, but caused no damage.

1961. July 3. Central New Mexico. Slight damage to plaster at Socorro. Small objects shifted.

1961. December 3. Virginia City, Mont. Plaster cracked; objects displaced. Loud, explosivelike earth noises.

1962. February 5. Southwestern Colorado. Slight damage at Cimarron. Also felt at Montrose and Ridgway.

1962. February 15. Arizona-Utah border. Intensity V at Kanab and Orderville, Utah. Also felt at Rockville. Magnitude 4.5.

1962. February 25. Western Montana. Intensity V at Papoose Creek. Also felt in upper Gallatin River area.

1962. June 18. Dupont, Colo. Frightened all in community; some went outside. Entire house creaked.

1962. August 6. Dupont, Colo., area. Felt over a small area northeast of Denver, principally in the Derby-Dupont area. Plaster cracked at Dupont. Furniture shifted at Henderson. Explosivelike shocks.

1962. August 26. Yellowstone National Park, Wyo. Pendulum clock stopped at Canyon. Many were awakened and frightened.

1962. August 30. Northern Utah. Damage was estimated at about $1 million. Cache County was declared a disaster area. Principal building damage was in areas on the east side of Cache Valley from Logan to Lewiston. Many old, unreinforced brick buildings and other older structures were heavily damaged. The greatest damage occurred at Richmond. At least nine houses were declared unsafe; one church was damaged beyond repair; numerous houses lost walls; and 75 percent of the older brick chimneys fell. At Logan, principal building damage was cracked and twisted walls. Brick and timber fell through a church roof. At Lewiston, one brick wall fell. Chimneys were damaged severely. A sugar refinery near Lewiston sustained major damage when large pieces of cement coping fell, penetrating the lower roofs. Four schools of Cache County were seriously damaged. At Franklin, the school sustained roof damage and plaster cracked in every room. Some foundations were cracked, and a ground crack was reported on a farm west of Franklin. Older structures sustained most damage at Preston. A few homes had cracked walls and fireplaces; some chimneys fell. Mudslides were noted west of Lewiston, along the Bear River, and at Cornish. At the mouth of Logan Canyon, falling rock broke a water flume, causing a mudslide which partially blocked the highway. At Fairview, Idaho, two large areas of land broke loose to a depth of 5 feet and slid 300 yards down a hill. This was the most damaging and widely felt earthquake in Utah since the 1934 Hansel Valley shock. It was also the only damaging shock in history to originate on the East Cache Valley Fault. Magnitude 5.7.

1962. September 4. Logan, Utah. Plaster fell; cracks widened.

1962. September 5. Near Salt Lake City, Utah. This shock was felt principally in north-central Utah. Damage, mainly in the Granger, Hunter, Magna, and Salt Lake City areas, consisted of minor wall and plaster cracks, damaged chimneys, broken windows, and broken merchandise. Three older-type houses in Salt Lake City sustained interior cracks and one wall fell through ceiling. Magnitude 5.1.

1962. September 7. Lewiston, Utah. Additional damage was reported to a house that was damaged in an earlier quake.

1962. December 4. Northeast of Denver, Colo. Frightened many at Dupont; picture window broke; bed in upstairs room moved 6 inches to west. Windows broke at school at Irondale; electrical wall outlets came out and hung by wires; brick tile loosened. All children were very frightened. Magnitude 3.5.

1962. December 5. North-central Colorado. Slight damage in Derby-Dupont area, consisting principally of cracked plaster. Magnitude 4.0.

1962. December 18. Northwestern Montana. Principally felt in northern Flathead Lake region. Awakened all and frightened many at Ferndale. Felt by all at Proctor.

1962. December 28. Northwestern Montana. Awakened many at Bigfork. Furnishings shifted.

1963. January 27. Central Idaho. Plaster and windows cracked at Clayton; large boulders rolled down hill at Livingston Camp (14 miles south of Clayton). Intensity V at Atlanta, Hailey, Ketchum, Stanley, and about 9 miles southeast of Stanley.

1963. January 29. Yellowstone National Park, Wyo. Intensity V effects were noted at Mammoth Hot Springs.

1963. February 1. Central Idaho. At Clayton, dishes fell off shelves and tables. Loud roar.

1963. February 15. Southwestern Montana. Felt principally in the Belgrade-Bozeman-Churchill area of Gallatin County. Frightened few at Belgrade and Gallatin Gateway. Small objects shifted; trees and bushes shook. Magnitude 4.5.

1963. February 25. Western Wyoming. Intensity V at Fort Washakie and Lander. Magnitude 4.3.

1963. March 8. Yellowstone National Park, Wyo. At Canyon, plaster cracked and fell; large cracks separated walls and ceilings in several houses. Magnitude 3.8.

1963. March 21. Yellowstone National Park, Wyo. Intensity V at Mammoth Hot Springs. Magnitude 4.1.

1963. March 25. Near Boulder City, Nev. Minor damage at Boulder City, consisting principally of cracked plaster and broken dishes. Several rockslides reported. Intensity V at Davis Dam, Ariz., Nipton, Calif., and Santa Clara, Utah. Magnitude 4.3.

1963. April 18. Yellowstone National Park, Wyo. Minor damage to facilities. Press reported some geysers were thrown off schedule.

1963. April 23. Hoover Dam, Nev. Intensity V at powerplant.

1963. May 11. Papoose Creek at Madison River, Mont. Intensity V.

1963. May 25. Northeastern Colorado. Awakened many at Adams City, Erie, Brighton, and Hudson. Small objects shifted; earth noises.

1963. June 6. Gibbon Meadow area (Yellowstone National Park), Wyo. Six shocks, beginning at 12:40 and ending at 13:32, were felt by all in fishing group in Gibbon Meadow area. Visible ground motion during some of the shocks. Bus and fishing gear shook during first and last shocks. Rumbling earth noises heard.

1963. July 2. Northern Colorado. Felt over a small region in north-central Colorado. Plaster cracked at Pinecliffe. Awakened many in various communities. Moderate to loud earth noises heard. Magnitude 4.6.

1963. July 7. Central Utah. At Levan and Nephi, plaster, walls, and chimneys cracked; plaster fell. Many were frightened. Magnitude 4.9.

1963. September 9. Central Idaho. Felt by several and awakened few at Challis; awakened many at Clayton and Obsidian. Also felt at Stanley. Magnitude 4.1.

1963. September 10. Central Idaho. Slight damage at Redfish Lake where plaster jarred loose. Windowpane broke at Lookout Mountain Fire Station, Challis National Forest. Generally felt throughout Obsidian-Stanley-Sunbeam area. Magnitude 4.9.

1963. September 11. Southeastern Arizona. Felt over a small area of Gila, Graham, and Pinal Counties. Slight damage reported at Globe, San Carlos, and Ray. Alarmed residents of Miami. Magnitude 4.1.

1963. September 14. Central Idaho. Stone knocked out of fireplace at ranch 15 miles west of Clayton. Slight damage in Sawtooth Valley area. Also felt at Stanley. Magnitude 4.3.

1963. September 16. Central Idaho. Intensity V at Clayton. Magnitude 4.2.

1963. September 23. Yellowstone National Park, Wyo. Two shocks were felt at West Yellowstone, Mont. The second shock (at 23:36) knocked out a

cracked window and shifted pictures on wall. Magnitude 3.1 and 4.7, respectively.

1963. December 17. Yellowstone National Park, Wyo. At Mammoth Hot Springs, mirror and pictures shifted during the first of a series of shocks.

1963. December 20. Hebgen Lake, Mont., area. Felt over a small area of southwestern Montana. Small earth and treeslide occurred at Hebgen Dam. At Mammoth Hot Springs, Yellowstone National Park, Wyo., people awakened and pictures tilted on wall. Magnitude 4.3.

1964. February 20. Eastern Nevada. Furnishings shifted at Lehman Caves National Monument. Also felt at Garrison, Utah (intensity IV). Magnitude 3.7.

1964. March 20. Polson, Mont., area. Awakened many in Kerr Dam and Polson areas. Rapid motion.

1964. March 27. Near Ennis, Mont. At Ennis, well water was muddied; pictures shifted.

1964. March 28. Swan Lake, Mont. A large insulator broke; well water was muddied.

1964. August 21. Eastern Wyoming. Intensity V effects were reported from Lusk, Keeline, and Lost Springs. Magnitude 4.5.

1964. September 23. Near Boulder City, Nev. Described as explosivelike in the Boulder City area where it was felt strongest. Pictures jarred from walls in some places. Doors jarred open; lamp teetered back and forth at Henderson. Magnitude 4.4.

1964. October 8. Flathead Lake, Mont. Intensity V at Polson. Accompanied by loud rumble. Magnitude 4.6.

1964. October 21. Hebgen Lake, Mont. The shock knocked items from shelves and shifted furnishings in several Montana towns and at Kilgore and Tendoy, Idaho. Window cracked at Maxville, Mont. Magnitude 5.8.

1965. January 5. Southwestern Montana. Felt also in northern Idaho. A 35-foot metal pipe flagpole at Dewey, Mont., broke in three places; objects fell from shelves. Intensity V at Butte, Dell, Divide, Grant, Jeffers, Lima, Sula, and Walkerville, Mont. Magnitude 5.1.

1965. January 6. Polson, Mont. Intensity V effects were noted.

1965. January 12. Eastern Idaho. Framed wall pictures were knocked askew at Virginia City, Mont. Other disturbed objects were observed. Magnitude 3.8.

1965. February 16. Denver, Colo., area. At Northglenn, a large crack appeared in one house; other wall cracks enlarged. Furnishings shifted at Commerce City. Intensity V also noted at Adams City and Eastlake. Magnitude 4.9.

1965. April 6. Virginia City, Mont. Fine plaster fell from ceiling in the Masonic Temple. Customers ran from a café. Magnitude 3.7.

1965. April 27. Northwestern Montana. Strongest in the Big Arm area and at Polson and Kerr Dam.

1965. April 28. Nordman, Idaho. Series of shocks from 19:00 to 21:00. Cans fell from shelves at Nordman. Felt 7 miles from Nordman.

1965. July 18. Denver, Colo., area. Many felt a heavy jolt at Commerce City. Outside, water in pan was disturbed. Several glasses and plates were broken north of Commerce City. Magnitude 4.6.

1965. July 31. Denver, Colo., area. Furnishings moved at Commerce City. Magnitude 4.6.

1965. September 13. Denver, Colo., area. Intensity V at Commerce City. Magnitude 4.5.

1965. September 14. Denver, Colo., area. Dishes and windows broke at Denver; chimneys cracked at Broomfield. Magnitude 4.7.

1965. September 29. Denver, Colo., area. Slight damage occurred at Commerce City and Denver. Refrigerator moved several inches at Northglenn. Magnitude 4.7.

1965. October 8. Hebgen Lake, Mont. Sharply felt in the Hebgen Lake-West Yellowstone area. Several boards fell from a stack of lumber at West Yellowstone. Magnitude 4.9.

1965. October 26. Western Montana. Felt from the north end of Seeley Lake to about 15 miles south. Intensity V at Ovando. Roaring noise. Magnitude 4.0.

1965. November 20. Denver, Colo., area. Plaster cracks and broken windows were noted at Commerce City, Hudson, Louisville, Northglenn, and Thornton. Heavy furniture rolled and a chair moved at Westminster. One injury was reported in Denver. Magnitude 4.5.

1966. January 4. Denver, Colo., area. Small objects were knocked from shelves in the Denver-Northglenn area. Felt by all and frightened many at Commerce City. Loud, roaring earth noises. Magnitude 5.0.

1966. January 22. New Mexico-Colorado border region. Felt over a large area of northwestern New Mexico and southwestern Colorado. Many buildings were damaged at Dulce, N. Mex. Nearly every house was affected to some degree, and chimneys were damaged throughout the area. The principal property damage was sustained at the Bureau of Indian Affairs School and Dormitory Complex and at the Dulce Independent Schools. Considerable plaster fell from ceilings in the dormitories, and several outside brick walls had vertical fractures from ground to roof. In the steam-heating plant, brick walls were displaced as much as 2 inches from vertical alinement. Several small ground cracks appeared in the fill across the frozen roads in the Dulce area. A prominent point, generally known as Dulce Point, had a complete change of configuration by the collapse of huge masses of shale and sandstone. Minor damage also occurred at Edith, Colo. Magnitude 5.5.

1966. January 23. Lumberton, N. Mex., area. At Lumberton, furniture moved around in one house. Severely felt at Dulce, N. Mex., and Edith, Colo. Magnitude 4.6.

1966. March 7. West-central Montana. Plaster cracked at Reedpoint. Intensity V effects were noted at Anaconda, Elkhorn, Maudlow area, Radersburg, and Virginia City. Magnitude 4.8.

1966. March 17. Northeastern Utah. Felt principally in the Cache Valley areas of northeastern Utah and southeastern Idaho. Plaster cracked at Logan, Utah. Intensity V was reported at Hyrum, Lewiston, Logan, Paradise, Providence, Randolph, Richmond, and Smithfield. Magnitude 4.4.

1966. April 29. Flathead Lake, Mont. Intensity V effects occurred at Coster, Polson, and Proctor. Magnitude 3.9.

1966. August 16. Southern Nevada. Main shock of a large series. Felt over a large area of southern Nevada and southwestern Utah, and in a small area along the Arizona border. At Caliente, Nev., pendulum clocks stopped and knickknacks, books, and pictures fell. Felt by all and frightened few at Beryl, Utah, where furniture and small objects shifted. Magnitude 5.6.

1966. September 19. Southwestern Montana. Principally felt in the Belgrade, Bozeman, Gallatin Gateway, Livingston, and Manhattan areas. Concrete cracked in several places on a ranch about 8½ miles west of Amsterdam. Objects fell from shelves, and many were awakened throughout the area. Magnitude 4.0.

1966. September 22. Southern Nevada. Largest of a swarm in the area. Small objects and furnishings shifted at Lund and Panaca; windows cracked at Lund. Magnitude 5.3.

1966. October 2. Southeastern Colorado. Felt over a large area of southeastern Colorado and northeastern New Mexico. Minor damage was reported at Aguilar, Segundo, Trinchera, and Trinidad, Colo. Magnitude 4.5.

1966. October 11. Hebgen Lake, Mont. Awakened and frightened all in home at Hebgen Lake; many awakened in community at West Yellowstone. Magnitude 4.0.

1966. October 11. West Yellowstone, Mont. Strongly felt. Many were awakened; few frightened.

1966. October 11. Hebgen Lake, Mont. Felt by all in home at Hebgen Lake, and by all in community at West Yellowstone. Magnitude 4.3.

1966. November 14. Denver, Colo., area. Plaster cracked; one existing crack lengthened 1 foot at Commerce City. At Eastlake, felt by all; furniture shifted. Magnitude 4.3.

1967. January 10. Hebgen Lake, Mont. Awakened all in home. Magnitude 3.8.

1967. February 2. Commerce City, Colo. Crack in house lengthened ¼ inch. Many were frightened in area. Magnitude 4.3.

1967. February 14. Rangely, Colo. Frightened all in community. Magnitude 4.4.

1967. April 10. Commerce City-Denver, Colo., area. Plaster cracked, windows broke, and merchandise fell in stores. At the Rocky Mountain Arsenal, 118 windowpanes broke. An asphalt parking lot in the Derby area cracked. Magnitude 4.8.

1967. April 27. Denver, Colo., area. Minor damage at Commerce City and Boulder. Magnitude 4.4.

1967. August 9. Denver, Colo., region. This was the strongest earthquake in Denver's history. Principal damage occurred in Northglenn, a community in the northern suburbs of Denver. Windows broke, plaster cracked, and much merchandise was broken in markets. One liquor store estimated damage at $10,000 to $12,000. Concrete pillars were damaged at a church; acoustical tile fell at a school. Minor damage (intensity VI) was also noted in Adams City, Arvada, Aurora, Broomfield, Central City,

Commerce City, Denver, Dupont (and north of), Eastlake, Empire, Evergreen, Firestone, Frederick, Golden, Hazeltine Heights, Henderson, Irondale, Jamestown, Lafayette, Lakewood, Nederland, Pinecliffe, Rocky Mountain Arsenal area, Thornton, Welby, Westminster, and Wheat Ridge. Magnitude 5.3.

1967. September 23. Salt Lake City, Utah, area. Walls cracked and porch displaced at one location. One light aftershock was felt. Magnitude 3.7.

1967. October 4. Marysvale, Utah, area. Well water was muddied; ceilings and walls cracked. At Koosharem, chimneys and plaster cracked. Chimneys were partially knocked down at Joseph. Rockslides were reported in the Joseph, Junction City, and Sevier areas. Several aftershocks were felt. The main shock was felt in northern Arizona. Magnitude 5.2.

1967. November 15. Denver, Colo., area. Slight damage was reported at Commerce City and Thornton. Magnitude 3.7.

1967. November 26. Denver, Colo., area. This was the second largest shock since the onset of the Denver series in 1962. Damage, which was generally light, occurred mainly in the suburban area of northeast Denver. Plaster cracked; existing cracks enlarged; walls and basement floors cracked. Also felt in Kansas and Wyoming. Aftershocks at 22:35 and 22:43 were felt over a considerable area. Magnitude of first shock, 5.2.

1968. January 16. Central Utah. Slight damage reported (no location given).

1968. January 30. North-central Nevada. Small objects shifted at Golconda; table moved and pendulum clock stopped at Valmy. Magnitude 4.5.

1968. February 21. Central Nevada. At Hot Creek Valley (about 30 miles west of Currant), drill rig shook strongly, and men in trailer were thrown from beds. Magnitude 4.1.

1968. March 26. Northwestern Montana. New cracks occurred in block part of house at Big Arm. Magnitude 4.3.

1968. July 6. North-central Nevada. At Golconda, small objects shifted; pendulum clocks stopped. Clocks stopped at Winnemucca where a trailer house shook strongly. Magnitude 5.1.

1968. July 15. North-central Colorado. Slight damage at Commerce City. Small objects overturned. Magnitude 3.4.

1969. January 29. New Mexico. Small cracks in weak adobe at Lajoya were enlarged; new cracks appeared in adobe at Alamillo. Intensity V effects were also observed at Polvadera and San Acacia. Magnitude 4.1.

1969. April 1. Northwestern Montana. The shock damaged a boathouse, a dock, and muddied well water at Big Arm. Four chimneys were destroyed at Dayton; one was damaged at Proctor. In addition, windows broke at Proctor and some deep wells increased in flow. At Lake Mary Ronan, chimneys cracked, paneling loosened, and a concrete floor cracked. Magnitude 4.7.

1969. April 26. Western Idaho. Floors sustained cracks at Ketchum and Warm Springs. Plaster cracked at Livingston Mill; objects fell to the floor. Magnitude 4.9.

1969. April 30. Northwestern Montana. The shock was most strongly felt at Lincoln and in the Rogers Pass area. Magnitude 3.9.

1969. May 5. Western Idaho. Intensity V at Clayton. Magnitude 4.6.

1969. May 6. Proctor, Mont. Intensity V effects were noted. Loud earth noises.

1969. May 12. Texas-Mexico border region. At El Paso, hairline cracks appeared in ceiling; cement driveway cracked. Also felt at Newman. Magnitude 3.4 (Three aftershocks occurred, the largest at 02:49, magnitude 3.3).

1969. May 23. Commerce City, Colo. Loud rumblings before shock. Rock in garden fell; objects shifted in bookcase. Slight aftershock at 03:43. Magnitude 3.3.

1969. June 9. Northwestern Montana. Felt principally in the southwest Flathead Lake area; no damage. Magnitude 4.2.

1969. June 21. Proctor, Mont. Sharp shock with loud earth noises. Two slight foreshocks and one minor aftershock were felt. Magnitude 3.1.

1969. September 14. Northwestern Montana. Felt mainly in the Big Arm-Dayton-Proctor area of southwest Flathead Lake. At Big Arm, one building developed a crack that extended in both horizontal and vertical directions. One basement wall cracked. Loud, explosivelike rumbling. Magnitude 4.3.

1969. October 7. Proctor, Mont. Small objects shifted. Loud earth noises.

1969. October 13. Flathead Lake, Mont., area. Intensity V at Proctor. Very loud, explosivelike earth noises. Magnitude 4.4.

1969. November 6. Flathead Lake, Mont., area. Slight damage at Dayton. Plaster fell; small objects shifted. Intensity V effects also were noted at Big Arm and Elmo. Magnitude 4.3.

1970. January 12. Amistad, N. Mex. Several feet of ceiling fell; adobe bricks in a wall crumbled. Intensity V effects also were noted at Clapham, Nara Visa (slight plaster damage), Pasamonte, and Sedan. Magnitude 3.5.

1970. February 4. Proctor, Mont. Very hard shock. Objects danced and moved on shelves.

1970. March 29. Grouse Creek, Utah. Slight chimney damage; lamp overturned. Also felt in Rosette area. Magnitude 4.6.

1970. April 21. Rangley, Colo. Small objects shifted and overturned at the Texas Oil Camp. An aftershock was felt about 6 hours later. Magnitude 3.9.

1970. May 23. Commerce City, Colo. Strongest in this area. Awakened many; loud earth noises. Magnitude 3.2.

1970. May 23. Proctor, Mont. Hard shock. Felt by all. Shook everything on store shelves. Magnitude 3.6.

1970. June 25. Southwestern Montana. Slight damage occurred at Harrison and McAllister. Intensity V also was noted at Ennis and Jeffers. Magnitude 4.9.

1970. September 1. Proctor, Mont. Felt by all. Hard shaking; loud earth noises. Magnitude 4.0.

1970. October 18. Western Montana. Small objects fell to the floor at Maudlow and Radersburg. Magnitude 4.3.

1970. November 28. Albuquerque, N. Mex. Felt principally in the Albuquerque region. There were numerous reports of minor damage. Plaster, garage floor, and block wall fence cracked. Windows broke. Air-conditioner on roof of one house shook loose and fell through skylight. Many burglar alarms were activated. Magnitude 3.8.

Washington and Oregon

Résumé

From 1841 to 1970, many earthquakes of intensity V or greater centered in Washington and Oregon. Others were felt, but centered either offshore in the Pacific, in British Columbia to the north, or in neighboring states. Most of the activity occurred in the western part of the region, while the stronger shocks were in the neighborhood of Puget Sound. Indications are that the heaviest activity occurred in 1946 a few miles west of Tacoma, in 1949 near Olympia, and in 1965 near Seattle. A few of the earlier shocks may have equaled or possibly exceeded the 1946 shocks in intensity, but lack of detailed information prevents satisfactory comparison.

List of Earthquakes in Washington and Oregon

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity	Authority [3]
				degrees	*degrees*	*sq. mi.*		
1841	Dec. 2	16:00	Vancouver, Wash	45.6	122.7	([1])	V	3-53, 32
1856	Dec. 26	.....	Port Townsend, Wash	48	123	.....	.....	3-25, 25
1859	Apr. 2	02:30	Olympia, Wash	47	123	([1])	V	32
1860	May 7	.....	Port Townsend, Wash	48	123	([1])	.....	32
1864	Oct. 29	18:10	Victoria, B.C	48.5	123.5	.....	VI [4]	25
1865	Aug. 25	21:00	Vancouver Island, B.C	48.5	123.5	.....	VI [4]	3-25, 25

See footnotes at end of table

List of Earthquakes in Washington and Oregon—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity	Authority [3]
				degrees	*degrees*	*sq. mi.*		
1868	May 30	.....	Mukilteo, Wash	48	122	.....	.....	3-25, 25
1871	May 19	.....	Mt. Rainier, Wash	.....	.....	.....	.....	Do.
1872	Dec. 14 to 16	Various	Puget Sound, Wash	.....	.....	150,000	VI	3-25, 25, 56
	Dec. 16 to Jan. 4, 1873.	.....	Walla Walla, Wash	46.0	118.3	.....	.....	Do.
1877	Oct. 12	13:53	Cascade Mountains, Oreg	.....	.....	.....	VII	3-53, 25
1880	Aug. 22	13:25	Northwestern Washington	.....	.....	.....	.....	3-25, 25
	Dec. 12	20:40	Puget Sound, Wash	.....	.....	.....	VI	Do.
1883	Sept. 28	00:00	Portland, Oreg	45.5	122.6	(2)	.....	Do.
1885	Oct. 9	08:00	Olympia, Wash	47	123	.....	V	Do.
	Dec. 8	22:40	Puget Sound, Wash	47.5	122.5	(2)	V	25
1891	Sept. 22	03:40	Port Angeles, Wash	48.0	123.5	(2)	V	3-25, 25, 56
	Nov. 29	15:21	Puget Sound region, Wash	.....	.....	4,000	V–VI	3-25, 25
1892	Feb. 3	20:30	Portland, Oreg	45.5	122.8	10,000	VI	3-53, 25
	Apr. 17	14:50	Near Olympia, Wash	47	123	.....	VI	3-25, 25
1893	Mar. 6	17:03	Umatilla, Oreg	46	119	(2)	VI–VII	3-53, 25
1895	Feb. 25	04:47	Green River, Wash	46.5	122.4	.....	V	3-25, 25
	Apr. 16	00:02	Port Townsend, Wash	48	123	(2)	V–VI	Do.
1896	Jan. 3	22:15	Victoria, B.C	.....	.....	.....	VI [4]	Do.
	Feb. 6	21:55	East Clallam, Wash	48.3	124.3	(2)	VI	3-25
	Apr. 2	03:17	McMinnville, Oreg	45.3	123.3	1,000	VI	3-53, 25
1897	Dec. 15	.....	Lakeside, Wash	47.8	120.0	.....	.....	4, 26
1903	Mar. 13	18:15	Sand Point, Wash	47.7	122.2	10,000	V	3-25
1904	Mar. 16	20:20	Victoria, B.C	48.5	122.8	20,000	V [4]	3-25, 56
1906	Jan. 2	05:45	Northeastern Washington	.....	.....	7,000	VI	3-29, 56
	Apr. 19	01:30	Paisley, Oreg	42.7	120.6	.....	V	3-53
	Nov. 1	17:49	Colville, Wash	48.5	117.9	.....	V	3-29, 4
1909	Jan. 11	15:49	Northwestern Washington	49.0	122.7	25,000	VII	3-25, 56
	May 24	09:20	Waterville, Wash	47.6	120.0	(2)	.....	8
1911	Sept. 28	18:39	Northwestern Washington	48.8	122.7	.....	VI	3-25
1913	July 29	08:15	Mt. Rainier, Wash	47	122	1,500	V	3-25
	Oct. 14	15:00	Seven Devils District, Oreg	45.7	117.1	.....	V	3-9, 3-53
	Dec. 25	06:40	Puget Sound, Wash	47.7	122.5	8,000	V	3-25
1914	Sept. 5	01:35	Olympia, Wash	47	123	1,000	V	3-25
1915	May 18	19:00	Portland, Oreg	45.5	122.7	(2)	V	3-9, 3-53
	Aug. 18	10:00	Northwestern Washington	48.5	121.4	30,000	V	3-25
1916	Jan. 1	16:52	Puget Sound, Wash	47.3	122.3	12,000	V	3-25
	Feb. 22	03:45	Marietta, Wash	48.8	122.6	.....	V	3-25
1917	Nov. 12	02:47	Mt. Rainier, Wash	46.8	121.8	1,000	VI	3-25
1918	Feb. 28	15:45	Yakima, Wash	46.5	120.5	(2)	V	3-8
	Nov. 1	09:20	Corfu, Wash	46.7	119.5	(2)	V–VI	3-8
	Dec. 6	00:41*	Vancouver, B.C	49.7	126.5	.....	V [4]	3-25, 43
1920	Jan. 23	23:09	Northwestern Washington	49.0	122.7	.....	VII	3-25, 56
	Apr. 14	15:45	Crater Lake, Oreg	42.9	122.1	.....	V	3-53
	Nov. 28	03:30	Spokane, Wash., region	.....	.....	.....	.....	3-10
1921	Feb. 25	12:00	Cascadia, Oreg	44.4	122.4	.....	V	3-53
1923	Jan. 10	20:30	Oregon	42.0	120.5	.....	V	3-53, 11
	Feb. 12	10:30	Bellingham, Wash	49.0	122.7	(2)	V	3-25

See footnotes at end of table

List of Earthquakes in Washington and Oregon—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity	Authority [3]
				degrees	*degrees*	*sq. mi.*		
1923	Sept. (?)	.....	Sultan, Wash.	47.8	121.8	(1)	.....	3-25
1926	Dec. 4	05:55	Victoria, B.C.	48.5	123.5	4,000	V [4]	3-25
	Dec. 30	09:57	East-central Washington	.....	.....	15,000	V	3-53, 10
1927	Apr. 8	21:00	Eastern Oregon	44.8	117.2	400	V	Do.
1928	Feb. 2	04:52	Startup, Wash.	47.8	121.7	(2)	VI	27
	Feb. 9	03:05	Vancouver Island, B.C.	48.5	125.0	10,000	V [4]	27
1930	July 18	18:38	Near Perrydale, Oreg.	45.0	123.2	.....	V–VI	27
1931	Apr. 17	20:00	Bellingham, Wash.	48.7	122.2	5,000	VI	27
	Aug. 16	19:20	Talent, Oreg.	42.3	122.8	(2)	V	27
	Dec. 31	07:25	Puget Sound, Wash.	47.5	123.0	10,000	VI	27
1932	Jan. 5	15:13	Near Sultan, Wash.	48.0	121.8	1,500	V	27
	July 17	22:03	..... do	48.0	121.8	14,000	V	27
	Aug. 6	14:16	Seattle, Wash.	47.7	122.3	500	VI	27
1934	May 4	20:06	Puget Sound, Wash., region	48	123	10,000	V	27, 56
	Sept. 18	00:00	Ellensburg, Wash.	47	121	(2)	V	27
	Sept. 26	16:15	..... do	47	121	(2)	V	27
	Oct. 19	23:31	..... do	47	121	(2)	V	27
	Nov. 1	07:28	..... do	47	121	(2)	V	27
	Nov. 2	15:17	..... do	47	121	(2)	V	27
	Nov. 3	06:50	Cascade Mountains, Wash.	48	121	10,000	IV–V	27
1935	July 9	14:45	Chelan Falls, Wash.	47.7	120.0	(2)	V	27
1936	July 15	23:08*	Northern Oregon	46.0	118.3	105,000	VII	27, 43
	July 18	08:30	..... do	46.0	118.3	(2)	V	27
	Aug. 4	01:19	..... do	45.8	118.6	(2)	V	27
	Aug. 27	20:39	Milton-Freewater, Oreg.	.....	.....	.....	V	3-53
1938	Jan. 6	05:11	Puget Sound, Wash.	47.8	122.4	.....	V	27
1939	Nov. 12	23:46*	Olympia, Wash.	47.4	122.6	60,000	VII	27, 43, 61
1940	Oct. 27	14:30	Puget Sound, Wash.	47.2	123.4	12,000	V	27, 56
1941	Apr. 7	01:25	Mazama, Wash.	48.3	119.6	5,500	VI	27
	Dec. 29	10:37	Portland, Oreg.	45.5	122.7	5,000	VI	27
1942	May 12	16:52	Corvallis, Oreg.	44.6	123.4	(1)	V	27
	June 12	01:30	Halfway, Oreg.	44.9	117.1	(1)	V	27
	Oct. 14	03:30	Stehekin, Wash.	48.3	120.6	(1)	V	27
	Nov. 1	09:00	Portland, Oreg.	45.5	122.6	(1)	V	3-53, 27
1943	Apr. 23	15:11	Entiat, Wash.	47.8	120.6	10,000	V	27
	Nov. 28	16:43	Puget Sound, Wash.	48.4	122.9	9,000	VI	27
1944	Mar. 31	13:15	Olympia, Wash.	47	123	2,500	V	27
	Oct. 31	03:34	Entiat, Wash.	47.8	120.6	(1)	V	27
1945	Apr. 29	12:16*	Southeast of North Bend, Wash.	47.4	121.7	50,000	VI–VII	27, 43
	Apr. 29	23:46	..... do	47.4	121.7	.....	VI	27
	May 1	11:46	..... do	47.4	121.7	.....	V	27
1946	Feb. 14	19:18*	Puget Sound, Wash.	47.3	122.9	70,000	VII	27, 61
	June 23	09:13*	Georgia Strait, B.C.	49.9	125.3	100,000	VIII [4]	27, 43
1948	Sept. 24	14:35	Port Gamble, Wash.	47.8	122.6	.....	V	27
1949	Apr. 13	11:56*	Olympia, Wash.	47.1	122.7	150,000	VIII	27, 43, 61
	Aug. 21	20:01*	Queen Charlotte Islands region	54	133	2,220,000	.....	27, 43, 56
1950	Apr. 14	03:04*	Near Langley, Wash.	48	122½	7,000	VI	27
	Dec. 2	17:57	Mukilteo, Wash.	48.0	122.3	(1)	V	27
1952	Aug. 6	09:31	Seattle, Wash.	47.4	122.2	.....	V	27
1953	Dec. 15	20:32	Northwestern Oregon	45.5	122.7	3,000	VI	27

See footnotes at end of table

List of Earthquakes in Washington and Oregon—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[a]
				degrees	*degrees*	*sq. mi.*		
1954	Mar. 16	07:56*	Western Washington	47.1	121.8	3,000	V	27
	May 4	17:42*	Northwestern Washington	47.3	122.4	1,500	V	27
	May 15	05:02*	Puget Sound, Wash	47.4	122.3	17,000	VI	27
	May 23	05:42	Methow Valley, Wash	.....	.....	.....	V	27
1955	Jan. 11	02:20*	Western Olympic Mountains, Wash	47.8	124.0	.....	V	27
	Mar. 25	22:56*	Near Hartford, Wash	48.0	122.0	8,500	VI	27
	Sept. 10	08:53*	Neah Bay, Wash	48.4	124.6	.....	V	27
	Nov. 2	17:40*	Near Robe, Wash	48.1	121.7	.....	V	27
1956	Jan. 6	20:30*	Puget Sound, Wash	47.3	122.4	2,500	V	27
	Feb. 8	16:57*	Northwestern Washington	48.3	122.6	4,000	V	27
1957	Jan. 25	17:16*	..... do	48.3	122.4	15,000	VI	27
	Feb. 11	09:05*	..... do	47.5	121.1	4,000	VI	27
	May 4	13:09*	Puget Sound, Wash	47.3	122.4	2,000	V	27
	Nov. 1	02:12*	Near Mount Rainier, Wash	47	121	1,500	V	27
	Nov. 16	22:00*	Northwest of Salem, Oreg	45.3	123.8	4,500	VI	27
1958	Apr. 12	14:37*	North-central Washington	48	120	8,000	VI	27
	Aug. 22	21:00	Eastsound, Wash	48.7	122.9	.....	V	27
	Oct. 6	21:08*	Willapa Bay, Wash	46.7	124.0	1,800	VI	27
1959	Jan. 20	About 23:15	Milton-Freewater, Oreg	.....	.....	.....	V	27
	Aug. 4	15:53*	Southwestern Washington	45.7	122.3	600	V	27
	Aug. 5	19:45* 20:36*	Near Chelan, Wash	47.8	120.0	25,000	VI	27
	Oct. 14	13:36*	Near Monroe, Wash	47.8	122.0	2,800	V	27
	Nov. 23	10:15*	Near Longmire, Wash	46.7	121.7	1,000	V	27
	Dec. 11	22:24*	Northwestern Washington	48.7	123.3	8,000	V	27
1960	Jan. 7	01:16*	Southwestern Washington	46.7	122.7	3,500	V	27
	Apr. 10	22:48*	Western Washington	47.6	122.3	600	VI	27
	Sept. 10	07:07*	Northwestern Washington	47.7	123.1	14,000	VI	27
1961	Jan. 3	23:26*	Southwestern Washington	46.0	122.1	2,000	V	27
	Feb. 1	21:50	Mt. Rainier National Park, Wash	46.7	121.9	.....	V	27
	Aug. 18	20:56*	Northwestern Oregon	44.7	122.5	7,000	VI	27
	Sept. 15	19:25*	Southwestern Washington	46.0	122.2	7,000	VI	27
	Sept. 16	03:45	Amboy, Wash	46.0	122.2	([a])	V	27
	Sept. 17	07:56*	Southwestern Washington	46.0	122.2	9,000	VI	27
	Oct. 30	19:35*	Okanogan County, Wash	48.4	120.0	1,200	V	27
	Nov. 6	17:29*	Northwest of Portland, Oreg	45.7	122.9	9,000	VI	27
	Nov. 7	13:30	Portland, Oreg	45.5	122.6	.....	V	27
1962	Jan. 14	21:29*	North-central Washington	47.8	120.2	3,000	V	27
	Nov. 5	19:37*	Near Vancouver, Wash	45.6	122.7	20,000	VII	27, 50
	Dec. 31	12:50*	West-central Washington	47.0	122.0	13,000	VI	27
1963	Jan 24	13:43*	Western Washington	47.4	122.1	5,500	VI	27
	Mar. 7	15:53*	Northwestern Oregon	44.9	123.5	.....	V	27
	Dec. 21	18:54*	Okanogan County, Wash	48.3	119.3	3,000	V	27
	Dec. 26	18:36*	Northwestern Oregon	45.7	123.4	4,000	VI	27
1964	Jan. 26	13:41*	Merrill Lake, Wash	46.1	122.4	2,000	V	27
	July 14	07:50*	Near Bellingham, Wash	48.9	122.5	8,000	VI	27
	July 30	04:45*	British Columbia-Washington border region.	49.2	122.3	3,000	V	27
	July 30	07:33*	Near Seattle, Wash	47.7	122.1	1,500	V	27

See footnotes at end of table

List of Earthquakes in Washington and Oregon—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[3]
				degrees	*degrees*	*sq. mi.*		
1964	Oct. 1	04:31*	Washington-Oregon border region	45.7	122.8	.....	V	27
	Oct. 15	06:33*	Near Seattle, Wash.	47.7	122.1	900	V	27
1965	Apr. 29	07:29*	..... do	47.4	122.3	130,000	VII–VIII	27, 61
1967	Mar. 6	19:51*	Puget Sound, Wash., area	47.8	122.7	7,500	V	27
1968	May 29	About 21:00	Adel, Oreg.	42.2	119.9	([1])	V	27
	June 3	05:28*	California-Oregon border	42.2	119.8	.....	V	3-59, 27
	June 3	18:34*	..... do	42.3	119.9	7,000	VI	Do.
	June 3	18:38*	Southern Oregon	42.3	119.8	([1])	V	Do.
	Sept. 6	04:17*	Northwestern Washington	47.8	122.8	4,000	V	27
	Nov. 30	06:40*	Southwestern Washington	46.5	122.4	1,000	V	27
1969	Feb. 14	00:34*	Vancouver Island region, B.C.	48.7	123.0	5,000	V[4]	27
	Oct. 9	09:08*	Near Elbe, Wash.	46.8	121.7	2,000	V	27
	Nov. 1	07:44*	Northwestern Washington	47.9	121.9	7,000	V	27
	Nov. 9	23:39*	..... do	48.5	121.4	7,000	V	27
1970	Feb. 10	12:21*	..... do	47.7	122.3	1,500	V	27
	Oct. 24	14:32*	..... do	47.3	122.4	2,300	V	27

*Instrumental origin time and epicenter.
[1] Uncertain.
[2] Local earthquake.
[3] See References, p. 133.
[4] Intensity in United States.

INTERMEDIATE AND MINOR EARTHQUAKES

1841. December 2. Vancouver, Wash. Two shocks occurred after the eruption of Mount Baker. The first caused some unstable objects to fall. A loud report preceded or attended the shock, and a roaring noise continued for some time. The second shock was undulatory, appeared to come from the west, and did some damage to a house foundation.

1856. December 26. Port Townsend, Wash. House jarred.

1859. April 2. Olympia, Wash. Crockery rattled; many were awakened. The Surveyor-General of the territory described its intensity as about equal to the effect of a 60 mile-per-hour gale upon a frame house.

1860. May 7. Port Townsend, Wash. No details.

1864. October 29. Victoria, B.C. Strong shock. Must have been felt strongly on Olympic Peninsula, Wash.

1865. August 25. Vancouver Island, B.C. Strong shock. Probably felt strongly on Olympic Peninsula, Wash.

1868. May 30. Mukilteo, Wash. Severe earthquake at Mukilteo and the Tulalip Reservation.

1871. May 19. Mount Rainier, Wash. Shocks during the entire month at Mount Rainier, in Washington Territory, and along the coast.

1872. December 14 to 16. Puget Sound, Wash. At Olympia, there was a severe shock at 21:40 on December 14, followed by many others through December 16. At 09:18 on that date, there was a shock, apparently most severe at Victoria, British Columbia. Very strong elsewhere in British Columbia. Dishes were thrown from shelves at Seattle; slight damage at Olympia.

1872. December 16 to January 4, 1873. Walla Walla, Wash. A series of moderate shocks.

1877. October 12. Cascade Mountains, Oreg. Shock felt at Marshfield, Cascades, and Portland. Chimneys were thrown down in the area.

1880. August 22. Northwestern Washington. Earthquake felt at Port Townsend and Seattle, and on southern Vancouver Island. In Victoria, British Columbia, plaster cracked; loose bricks fell.

1880. December 12. Puget Sound, Wash. Strongest of shocks continuing from December 7 to December 29, and at intervals to March 14, 1881; apparently strongest at Bainbridge Island, Puget Sound, Wash. Felt from Victoria, British Columbia, to Portland, Oreg. There were four shocks in succession at Olympia.

1883. September 28. Portland, Oreg. Two moderately strong shocks.

1885. October 9. Olympia, Wash. Intensity V.

1885. December 8. Puget Sound, Wash. Awoke sleepers at Olympia. Three light shocks at East Sound; loud rumbling at Victoria, British Columbia.

1891. September 22. Port Angeles, Wash. People were awakened. Also felt at Victoria, British Columbia.

1891. November 29. Puget Sound region, Wash. Strong shock. Epicenter uncertain. Strong at Seattle where an elevator jammed in the shaft; waters of Lake Washington were disturbed. Also strong at Port Townsend where people rushed from buildings, and at Pysht where slight damage occurred.

1892. February 3. Portland, Oreg. Severe shock. Buildings swayed; terrified people rushed into the street. Strong vibration at Astoria, Salem, and Yaquina Head, Lake Harney.

1892. April 17. Near Olympia, Wash. A shock whose epicenter was uncertain, but probably near Olympia, was felt sharply at Portland, Oreg., and at Tacoma, Wash. At Portland, people rushed into the street when buildings trembled.

1893. March 6. Umatilla, Oreg. Some damage to buildings.

1895. February 25. Green River, Wash. Eastern part of Cowlitz County, southwestern Washington. Strongest at Green River Mines and along the Toutle River. Felt at Tacoma and at Portland, Oreg.

1895. April 16. Port Townsend, Wash. Many persons were frightened.

1896. January 3. Victoria, B.C. People hurried into streets. At Port Angeles, Wash., lamp chimneys were shaken off and articles tumbled from shelves.

1896. February 6. East Clallam, Wash. Shook every house but caused no damage. Felt at Neah Bay Reservation, Tatoosh Island, and on a vessel in Neah Bay.

1896. April 2. McMinnville, Oreg. Three shocks in succession awakened everyone. The main shock was felt in Portland and Salem.

1897. December 15. Lakeside, Wash. Severe. Felt at Waterville. Aftershocks through December 20, and January 11–15, 1898.

1903. March 13. Sand Point, Wash. Two widely felt shocks were noted at Tacoma and Aberdeen.

1904. March 16. Victoria, B.C. Apparently strongest at Victoria, but widely felt over western Washington.

1906. January 2. Northeastern Washington. Three shocks felt from south boundary of Spokane County, Wash., to a point north of Bradshaw, British Columbia. Felt at Colville, Davenport, and Grand Forks. Plaster fell at Nelson, British Columbia.

1906. April 19. Paisley, Oreg. Strong enough to awaken people. Three additional shocks followed within 1½ hours.

1906. November 1. Colville, Wash. Felt over a distance of 60 miles north-south and 70 miles east-west.

1909. January 11. Northwestern Washington. Walls cracked at Blaine; plaster thrown down at Bellingham. Sidewalks twisted and piers were slightly damaged at Anacortes. Felt at Olympia and Aberdeen.

1909. May 24. Waterville, Wash. Objects fell from shelves at Douglas and Waterville.

1911. September 28. Northwestern Washington. Intensity VI at Victoria, British Columbia, and IV at Bellingham, Wash.

1913. July 29. Mount Rainier, Wash. Intensity V.

1913. October 14. Seven Devils District, Oreg. A strong earthquake along the Oregon-Idaho border broke windows and dishes.

1913. December 25. Puget Sound, Wash. Two shocks were felt at Seattle and Edmonds, Wash.; second was stronger.

1914. September 5. Olympia, Wash. There was a tremor, followed by severe jolt. Felt at Auburn, Tacoma, and other places.

1915. May 18. Portland, Oreg. A sharp local shock rattled dishes and rocked chairs.

1915. August 18. Northwestern Washington. Felt from Seattle to Laurier and from Victoria, British Columbia, to Okanogan, Wash.

1916. January 1. Puget Sound, Wash. Felt at Tacoma, Seattle, Olympia, and Silverton. Buildings shook; doors moved.

1916. February 22. Marietta, Wash. Houses rocked; dishes rattled. Felt throughout southwestern British Columbia and northwestern Washington.

1917. November 12. Mount Rainier, Wash. Rockslides at Longmire, Cedar Lake, and Summit Inn.

1918. February 28. Yakima, Wash. Houses swayed. Felt throughout Yakima Valley.

1918. November 1. Corfu, Wash. Strong tremor shook articles from shelves and caused landslides.

1918. December 6. Vancouver, B.C. Felt in southern British Columbia and northwestern Washington. Buildings shook at Seattle. Magnitude 7.0.

1920. January 23. Northwestern Washington. Walls cracked at Bellingham and Anacortes. Epicenter probably under the Straits of Georgia. Strongly felt at Vancouver and Victoria, British Columbia. Some damage to houses on Vancouver Island. The crews of several vessels felt the shock.

1920. April 14. Crater Lake, Oreg. Three shocks felt at Fort Klamath.

1920. November 28. Spokane, Wash., region. Fairly strong and widely felt shocks in Washington and Oregon, apparently centering somewhere near Spokane; continued on 29th.

1921. February 25. Cascadia, Oreg. Felt by nearly all over an area of 6 by 12 miles.

1923. January 10. Oregon. Lakeview and Klamath Falls. Probably rather strong in an unsettled region, as it was widely felt. Plaster fell at Alturas, Calif.

1923. February 12. Bellingham, Wash. Plaster broke in building. Two shocks at Victoria, British Columbia. Felt at Marietta, Wash.

1923. September (?). Sultan, Wash. Indefinite reports of a strong earthquake. No accurate details, but general agreement as to occurrence and wide felt area.

1926. December 4. Victoria, B.C. Epicenter probably in Straits of Juan de Fuca, southwest of Victoria. Strong at Bellingham, Wash., and Victoria, British Columbia. Felt sharply at Port Townsend and Port Angeles, Wash.

1926. December 30. East-central Washington. Strongest at Wenatchee and Leavenworth where people rushed into the street. Widely felt; epicenter uncertain.

1927. April 8. Eastern Oregon. Widely felt over sparsely settled area. At Richland and Halfway, entertainments were interrupted.

1928. February 2. Startup, Wash. Generally felt. Plaster cracked; people were alarmed.

1928. February 9. Vancouver Island, B.C. Strong. Fairly strong at Tatoosh Island; loud roar. Felt at Port Townsend, Wash.

1930. July 18. Near Perrydale, Oreg. Plaster cracked at McCoy. Roadbed cracked ½ mile west of Perrydale.

1931. April 17. Bellingham, Wash. At Acme, a few bricks fell; at Saxon, a severe twisting motion was observed. Intensity V also was assigned to Bellingham and other towns in the area. Felt slightly at Vancouver and Victoria, British Columbia.

1931. August 16. Talent, Oreg. Lamp was shaken from ceiling. Widely felt.

1931. December 31. Puget Sound, Wash. At Lilliwaup, wall cracked; articles were thrown from store shelves at a number of places.

1932. January 5. Near Sultan, Wash. Superficial damage at Monroe.

1932. July 17. Near Sultan, Wash. A widely felt shock.

1932. August 6. Seattle, Wash. Strong local shock. A few chimneys were demolished; others were badly damaged.

1934. May 4. Puget Sound, Wash., region. Sharp shock, followed by numerous aftershocks. Furniture moved at Anacortes and Bellingham, Wash. People left theaters at Port Angeles. Also felt at Victoria and Vancouver, British Columbia.

1934. September 18. Ellensburg, Wash. This was the first of a series of local shocks to attain intensity V. They began on September 14 and continued until December 2. The series resembled the Helena, Mont., shocks of 1935, except they were of much lower intensity. Other shocks of intensity V occurred on September 26 (2), October 19, and November 1 and 2. Damage was confined to crack-

ing of plaster and slight damage to chimneys and cornices. Continued shocks terrified people who anticipated greater severity.

1934. November 3. Cascade Mountains, Wash. A moderate shock east of the Puget Sound region probably reached intensity V. Felt most strongly at Rockport, Wash.

1935. July 9. Chelan Falls, Wash. Frightened many. Felt at Waterville.

1936. July 15. Northern Oregon. The earthquake was destructive at Freewater, State Line, and Umapine. At Freewater, plaster and windows were broken, chimneys were shifted at the roofline, and there were various types of damage to schoolhouses and other buildings. At Umapine, walls and chimneys were cracked; a few chimneys were demolished. Some damage was sustained to two schools and three houses. One concrete residence collapsed. Well water changed. Cracks appeared in the ground; the largest was 3 feet wide and 8 feet deep. Moderate damage also was sustained at Athena and Milton. At Waitsburg and Walla Walla, Wash., movable objects were shifted; chimneys were wrecked. In the central region, there was much cracking of the ground, in one case over an area 1,500 by 75 feet. Some cracks were 200 feet long and water issued from many of them. The shock was felt over a large area in Washington, Oregon, and Idaho. Magnitude 5¾. There were numerous aftershocks up to November 17. The two strongest attained intensity V on July 18 and August 4.

1936. August 27. Milton-Freewater, Oregon. Intensity V.

1938. January 6. Puget Sound, Wash., about 10 miles northwest of Seattle. Felt strongest at Kingston, Port Orchard, and Seattle where many were awakened, some frightened. Loose objects were displaced.

1939. November 12. Olympia, Wash. Chimneys fell at Auburn, Brooklyn, Centralia, Elma, Oakville, and Tacoma. Slight damage to chimneys, plaster, and windows occurred throughout the area. Epicenter in mountains a few miles north and slightly west of Olympia. Also felt in Oregon and to some extent in Canada. Magnitude 5¾.

1940. October 27. Puget Sound, Wash. Strongest in the Port Angeles-Port Townsend-Everett area. Also felt in Canada.

1941. April 7. Mazama, Wash. Furniture overturned; stove moved. Intensity V reported at Nespelem, Okanogan, and Omak.

1941. December 29. Portland, Oreg. Generally felt. Some windows broke; display windows shattered. Plaster cracked at Hillsboro and Sherwood; chimneys cracked at Yamhill.

1942. May 12. Corvallis, Oreg. Local shock; strongly felt.

1942. June 12. Halfway, Oreg. Dishes broke. Table upset at Eagle Valley. Also felt at Baker, Pine, and Richland.

1942. October 14. Stehekin, Wash. At Stehekin and south of Mt. McGregor, boulders crashed down mountain, all awakened, and plaster cracked. Also felt at Holden, Lucerne, and Mazama.

1942. November 1. Portland, Oreg. Plaster cracked. Felt at Spokane, Wash., Coeur d'Alene, Idaho, and into Canada.

1943. April 23. Entiat, Wash. A sharp shock was felt by all. Knickknacks fell at Leavenworth; rockslide occurred at Republic.

1943. November 28. Puget Sound, Wash. Strongest at Richardson where chimneys cracked. Also felt in Canada.

1944. March 31. Puget Sound, Wash. Sharp shock felt at Grapeview, Olympia, Orting, Shelton, and Tacoma.

1944. October 31. Entiat, Wash. Felt by all. Also felt at Chelan Falls, Lakeside, Orondo, and Waterville.

1945. April 29. Southeast of Seattle, Wash. Felt area included most of Washington and small portions of Idaho and Oregon. Minor damage at Cle Elum, Elma, Greenwater, Index, Leavenworth, North Bend, Palmer, Snoqualmie, and Stampede Pass. Plaster, windows, and chimneys cracked. Large rockslides occurred on west face of Mount Si. Muffled earth sound was heard before and during shock. Magnitude 5½.

1945. April 29. Southeast of Seattle, Wash. Aftershock of April 29 earthquake caused light damage at North Bend. Another aftershock on May 1, strongest at Cle Elum, Stampede Pass, and Waterville, was felt widely in west-central Washington.

1946. February 14. Puget Sound, Wash. Epicenter about 20 miles west of Tacoma, Wash. Light damage at Bremerton, Burton, Olympia, Seattle, and Tacoma. Greatest damage, estimated at $250,000, occurred at Seattle. Also felt in southwestern

British Columbia and in northwestern Oregon. Magnitude 5¾.

1946. June 23. Georgia Strait, B.C. This was one of the strongest shocks on record for the Puget Sound area. Heavy damage occurred in the epicentral region. The Canadian Hydrographic Department reported the bottom of Deep Bay in Georgia Strait sank from 9 to 84 feet. A 10-foot vertical ground shift occurred on Read Island. Ground settlements up to 100 feet were noted at other points. South of the boundary in the State of Washington, some chimneys fell at East Sound, and a concrete mill was damaged at Port Angeles. It was felt strongly at Olympia, Seattle, Tacoma, Raymond, and Bellingham. Seattle, which sustained damage in the upper floors of tall buildings, was hardest hit in the Puget Sound area. Magnitude 7.3.

1948. September 24. Port Gamble, Wash. Felt throughout the Puget Sound area, but caused no damage. Books fell and trees and bushes shook at Port Gamble. Also strong at Everett and Langley.

1949. April 13. Olympia, Wash. This earthquake caused heavy property damage over a wide area in Washington and Oregon. Eight persons were killed, many were injured; total damage was estimated at about $25 million. At Olympia, nearly all large buildings were damaged and water and gas mains were broken. A half-mile section of a 300-foot cliff toppled into Puget Sound near Tacoma. Many towns reported toppled chimneys, cracked walls, and fallen plaster. Felt area extended eastward to western Montana and southward to Cape Blanco, Oreg. Magnitude 7.0.

1949. August 21. Queen Charlotte Islands region. This shock, which did some damage near the epicenter, was felt as far south as Portland, Oreg. Small powerlines and water mains broke in Seattle. Boats broke loose from moorings. Water level rose in Seattle lakes and sloshed from swimming pools in Tacoma. Magnitude 8.1.

1950. April 14. Near Langley, Wash. Many persons awakened in Coupeville, Langley, and Port Townsend. Plaster cracked and fell.

1950. December 2. Mukilteo, Wash. Sharp tremors were felt from 17:57 to 18:05. Stovepipes were shaken loose; dishes were broken.

1952. August 6. Seattle, Wash. Plaster fell; old plaster cracks opened.

1953. December 15. Northwestern Oregon. Slight damage at Portland and Roy and at Vancouver, Wash.

1954. March 16. Western Washington. Shock centered near the Mud Mountains area of Mt. Rainier. Intensity V in parts of King and Pierce Counties.

1954. May 4. Northwestern Washington. Shock was felt sharply at Tacoma, Lakewood, and North Bend.

1954. May 15. Puget Sound, Wash. A moderately strong shock; felt throughout northwestern Washington. Slight damage occurred at Belfair, Lake Stevens, North Bend, Seattle, and Skykomish.

1954. May 23. Methow Valley, Wash. Sharp, brief shock at Winthrop and Twisp. Roaring sounds were heard.

1955. January 11. Western Olympic Mountains, Wash. Intensity V at Port Angeles where many persons were awakened. Also felt at Victoria, British Columbia, and along the Strait of Juan de Fuca.

1955. March 25. Near Hartford, Wash. A house foundation near Everett was reported cracked. At Hartford, Monroe, Preston, and Sultan, many persons were awakened by the shock. Earth noises heard.

1955. September 10. Neah Bay, Wash. Concrete buildings shook; small objects shifted. Also felt strongly at Tatoosh Island and at Clallam Bay.

1955. November 2. Near Robe, Wash. Felt throughout Snohomish County. Felt by all at Gold Bay. Principal effects were rattling of windows and dishes.

1956. January 6. Puget Sound, Wash. Intensity V at Burley, Dash Point, Dieringer, and Retsil. Small objects shifted.

1956. February 8. Northwestern Washington, near the northwest corner of Whidbey Island. Maximum intensity V reported from Anacortes, Bar View, Burlington, La Conner, Mount Vernon, and Oak Harbor.

1957. January 25. Northwestern Washington, near mouth of Skagit River. Felt by many over a large area. Strongest at Clearlake where plaster fell in school and knickknack shelf shifted. Intensity V effects were observed in numerous towns.

1957. February 11. Northwestern Washington, near North Bend. Slight damage to plaster wall-

board and plaster at North Bend and Snoqualmie. Chimney cracked at Fall City.

1957. May 4. Puget Sound, Wash., near Dash Point. Intensity V at Algona, Auburn, Buckley, Des Moines, Redondo, Sumner, and Zenith.

1957. November 1. Near Mount Rainier, Wash. Felt principally in Pierce and Lewis Counties. Awakened many at Longmire, Packwood, and Randle.

1957. November 16. Northwest of Salem, Oreg. Frightened all at Salem. Plaster and walls cracked in West Salem; furnishings shifted.

1958. April 12. North-central Washington, about 8 miles southwest of Pateros. Slight damage consisted of cracked plaster and broken windows and dishes. Rocks slid onto roads near Chelan. Loud earth noises heard. A second shock was reported at Electric City (at about 17:00 or 18:00) with about the same effects as the first shock.

1958. August 22. Eastsound, Wash. (Orcas Island). Felt by several. Furnishings shifted.

1958. October 6. Willapa Bay, Wash. Felt principally in Grays Harbor and Pacific Counties. Patio cracked in several places at Tokeland. Moderate earth noises heard.

1959. January 20. Milton-Freewater, Oreg. Awakened many and frightened few. Pictures swayed. Also felt in Walla Walla, Wash., area.

1959. August 4. Southwestern Washington, about 13 miles northeast of Portland, Oreg. Felt over a small area of Washington and Oregon, approximately 600 square miles. In Fairview, Oreg., pendulum clock stopped; small objects shifted. Sharply felt in downtown Portland area.

1959. August 5. Near Chelan, Wash. Minor damage at several localities. At Chelan, part of chimney and bricks fell; dishes broke. Chimney cracked and bricks loosened and fell at Waterville. Rockslides occurred near Chelan and Waterville; many were frightened. Severe shocks.

1959. October 14. Near Monroe, Wash. Felt principally on the east side of Puget Sound. Felt by all at Monroe, Sultan, and Pinehurst. Small objects shifted.

1959. November 23. Near Longmire, Wash. Awakened many at Ashford and Longmire.

1959. December 11. Northwestern Washington, northwest of Orcas Island. At Port Angeles, windows broke; window cracked at Marysville.

1960. January 7. Southwestern Washington. Felt principally in Lewis, Pierce, and Thurston Counties. Awakened and frightened many. Small objects shifted. Also felt at Portland, Oreg.

1960. April 10. Western Washington, about 5 miles southeast of Seattle city center. Felt principally in western King County. At Seattle, concrete and wood walls were slightly damaged and plaster cracked.

1960. September 10. Northwestern Washington. Upper Duckabush River, near boundary between Olympic National Park and Olympic National Forest. Concrete basement floor and wall cracked at Bremerton. Considerable plaster cracking at Seattle.

1961. January 3. Southwestern Washington. Epicenter 15 miles south-southeast of Mount St. Helens, Wash. (Skamania County). Felt principally in Clark and Skamania Counties. Felt by several and frightened few at Amboy; furnishings shifted. At North Bonneville, awakened all in home.

1961. February 1. Mt. Rainier National Park, Wash. Felt by all at Longmire. Set off snow avalanches in mountains.

1961. August 18. Northwestern Oregon. Felt from southwest Lane County, Oreg., to Cowlitz County, Wash. At Lebanon, two chimneys toppled, windows broke, and traffic lights and signs fell. Plaster cracked at Albany. Generally felt. Magnitude 4.5.

1961. September 15. Southwestern Washington. Southeast of Cougar, in Gifford Pinchot National Park. Felt by all and frightened many at Swift Dam. Knickknacks fell; trees and bushes shook strongly. Intensity V at Corbett, Oreg.

1961. September 16. Amboy, Wash. Aftershock of September 15 (19:25). Felt by and frightened many.

1961. September 17. Southwestern Washington, southeast of Cougar, Wash., in Gifford Pinchot National Park. Principal aftershock of September 15 (19:25). Slight damage consisted of cracks in chimneys, foundations, and basement floor; old house shifted on foundation. Intensity VI in Oregon at Latourell Falls.

1961. October 30. Okanogan County, Wash. Felt by all at Conconully, Malott, and Methow.

1961. November 6. Northwest of Portland, Oreg. Felt over a large area of northwestern Oregon and southwestern Washington. Felt by all throughout

Portland area. Plaster cracked, part of chimney fell, and windows and lights broke.

1961. November 7. Portland, Oreg. Television slid across floor; pictures tilted. Also felt at Vancouver and Washougal, Wash.

1962. January 14. North-central Washington. Epicenter 16 miles due west of Chelan, Okanogan County, close to Navarre Coulee. Felt in Chelan, Douglas, and Okanogan Counties. Plaster cracked at Malaga.

1962. November 5. Near Vancouver, Wash. Intensity VII in Portland, Oreg., where numerous chimneys were cracked or shaken down, windows broke, and plaster cracked. A loud noise and a thunderlike roar were reported. Minor damage was reported from several towns in Washington, consisting principally of broken windows, cracked plaster and chimneys, and fallen bricks from chimneys. Magnitude 4¾.

1962. December 31. West-central Washington. Epicenter 5 miles due west of the northwest corner of Mt. Rainier National Park. Slight damage consisted of cracks in plaster, chimneys, and walls; broken dishes; and twisted columns.

1963. January 24. Western Washington, west of Maple Valley. Plaster and walls cracked at Maple Valley and Tacoma; furniture moved; objects fell to the floor.

1963. March 7. Northwestern Oregon, west of Salem. Felt from Portland, south to Eugene, and in some coastal areas. In the West Salem area, plaster cracked and dishes broke. Magnitude 4.6.

1963. December 21. Okanogan County, Wash., about 10 miles southeast of Omak. Felt by all at Malott, Loomis, Okanogan, and Synarep. Moderately loud earth noises heard. Magnitude 4.4.

1963. December 26. Northwestern Oregon. Plaster cracked at North Plains and Timber, Oreg., and at Toutle, Wash. Furniture shifted; books and pictures fell. Magnitude 4.5.

1964. January 26. Merrill Lake, Wash. Felt over a moderate area of southwestern Washington. Felt by all at Woodland. Faint earth noises.

1964. July 14. Near Bellingham, Wash. Felt in northwestern Washington and British Columbia, Canada. Slight damage was sustained at Bellingham, Custer, Lummi Island, Lynden, Nooksack, and Sumas, Wash., and Abbotsford and White Rock, British Columbia. Loud earth noises were heard in several towns. Magnitude 5.0.

1964. July 30. British Columbia-Washington border region. Felt principally in Whatcom and San Juan Counties. Intensity V effects were noted at Blanchard, Bow, Edison, Lopez, Lynden, and Nooksack.

1964. July 30. Near Seattle, Wash. Felt in scattered communities in northwestern Washington. Strongest at Edison and La Conner.

1964. October 1. Washington-Oregon border region. Felt strongly at Portland, Oreg., and Swift Dam, Wash. Magnitude 5.3.

1964. October 15. Near Seattle, Wash. Felt principally in King and Snohomish Counties. Although no damage occurred, the shock was felt strongly at Bellevue, Kirkland, Medina, and Preston. Magnitude 4.1.

1965. April 29. Near Seattle, Wash. This was the second largest earthquake in the history of Washington. It was felt over 130,000 square miles of Washington, Oregon, northern Idaho, western Montana, and British Columbia, Canada. The shock was characterized by a relatively large intensity VII area and small pockets of intensity VIII damage in Seattle and surrounding suburbs. Extensive damage to chimneys was noted in West Seattle. Two schools were damaged considerably. Slumping was observed along a steep slope adjacent to 36th Avenue SW., near Admiral Way. Other pockets of high intensity which fit marginally into intensity VIII were Harbor Island in South Seattle and Issaquah, about 15 miles southeast of Seattle. In Issaquah, a brick garage partially collapsed, and two brick school buildings were extensively damaged. There was also extensive chimney damage in this area. Seven persons were killed by this earthquake, either by falling debris or heart attacks, and property damage reached an estimated $12½ million. Although building damage was generally light, it was spectacular in many cases. In general, damage patterns repeated those experienced during the 1949 shock. Buildings which apparently had been damaged in 1949 often sustained additional damage in 1965. This recurring earthquake damage was sometimes intermixed with preearthquake settlement cracks which opened wider or caused failure in this shock. Magnitude 6.5.

1967. March 6. Puget Sound, Wash., area. Sharp, and felt throughout the Puget Sound area. Intensity V effects occurred at Baring, Chimacum (east

of), Dash Point, Edmonds, Hadlock, Indianola, Keyport, Lowell, Preston, Quilcene, Seattle, and Silverton. Magnitude 4.4.

1968. May 29. Adel, Oreg. Intensity V.

1968. June 3. California-Oregon border. A series of shocks began on May 26 and continued daily through June 11. This earthquake was felt by all at Plush and Lakeview, Oreg.; also felt by all at Fort Bidwell, Calif. Magnitude 5.0.

1968. June 3. California-Oregon border. Strongest shock to date at Adel, Oreg. Old chimneys fell or were cracked; part of old rock cellar wall fell; building cracked. Merchandise fell from shelves; lamps overturned. An old brick flue broke at Paisley. Ground fissured 2.5 miles northwest of Fort Bidwell, Calif., along Bidwell Creek. Houses shifted; foundations cracked. Magnitude 4.7.

1968. June 3. Southern Oregon. Slight damage at Adel. Magnitude 4.0.

1968. September 6. Northwestern Washington. Intensity V at Baring, Edmonds, La Conner, Langley, Preston, Seabeck, and Tracyton. Magnitude 4.3.

1968. November 30. Southwestern Washington. Small objects fell at Ajlune and shifted at Mossyrock. Intensity V effects also were noted at Glenoma, Cinebar, Mineral, and Morton. Magnitude 4.3.

1969. February 14. Vancouver Island region, B.C. Intensity V effects were reported at several towns in northwestern Washington. Magnitude 4.5.

1969. October 9. Near Elbe, Wash. Although no damage was noted, intensity V effects occurred at Elbe and Packwood. Magnitude 4.0.

1969. November 1. Northwestern Washington. Felt over a wide area, but caused no damage. Intensity V at Baring, Duvall, Edmonds, Gold Bar, Grotto, Index, Lake Stevens, Skykomish, Startup, and Sultan. Magnitude 4.0.

1969. November 9. Northwestern Washington. Slight damage occurred at Marblemount. Intensity V also was assigned to effects at Rockport and west of Concrete. Magnitude 4.7.

1970. February 10. Northwestern Washington. Felt principally in the Puget Sound region. No damage was noted, but intensity V effects occurred at Bothell and Richmond Beach. Magnitude 3.9.

1970. October 24. Northwestern Washington. Felt over a large area, but caused no damage. Strongest at Elbe, Milton, and Puyallup. Magnitude 4.2.

Alaska

Résumé

Alaska and the Aleutian Islands are part of the great seismic belt that circumscribes the Pacific. Although earthquake activity here is greater than in any other state, few of the shocks have caused severe damage because of the absence of large population centers. The activity is separated into two zones. One zone, approximately 200 miles wide, extends from Fairbanks through the Kenai Peninsula to the Near Islands. The second zone begins north of Yakutat Bay and extends southeastward to the west coast of Vancouver Island.

In 1899, the Yakutat Bay area experienced one of the notable earthquakes of the last century. The shore was raised over a considerable length, and at one point, there was a vertical fault slip of 47½ feet—one of the greatest fault movements known. On July 9, 1958, a major shock near Lituya Bay was felt as far south as Seattle, Wash., and eastward to Whitehorse, Yukon Territory. On March 27, 1964, one of the greatest geotectonic events of our time occurred in southern Alaska. In minutes, thousands of people were made homeless, 131 lives were lost, and the economy of the entire State was disrupted. Tsunamis swept the Pacific Ocean from the Gulf of Alaska to Antarctica, causing extensive damage along coastal Alaska, British Columbia, and California.

Time of occurrence for this region has been standardized to 150° meridian time.

List of Earthquakes in Alaska

Year	Date	Time (AST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1786	Unknown	.....	Alaska Peninsula	59	154	.....	.....	7, 25, 39
1788	July 27	.....	Sanak Island, Shumagin Islands, and Alaska Peninsula.	55	161	.....	.....	Do.
1796	May	.....	Unalaska Island	54	167	.....	.....	25, 39, 65
1802	Unknown	.....	..... do	54	167	.....	.....	7, 25, 39
1812	Unknown	.....	Atka Island	52	174½	.....	.....	Do.
1817	April	.....	Umnak Island	53	168	.....	.....	25, 39
1818	Unknown	.....	Vicinity of Makushin, Unalaska Island.	54	167	.....	.....	Do.
1826	June	.....	Unalaska Island	54	167	.....	.....	Do.
1835	Apr. 14	.....	Pribilof Islands	57	170	.....	.....	7
1836	Apr. 2 and August.	.....	St. Paul and St. George Islands, Pribilof Islands.	57	170	.....	.....	7, 25, 39, 65
1843	Dec. 15	01:20	Sitka	57	136	.....	.....	29
	Dec. 16	13:30 16:00	..... do	57	136	.....	.....	29

See footnotes at end of table

List of Earthquakes in Alaska—Continued

Year	Date	Time (AST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1847	Unknown	.....	Sitka	57	136	.....	.....	29
1857	Sept. 8	11:—	Kodiak Island	58	152	.....	.....	29
1861	May 3	.....	St. George Island, Pribilof Islands	59½	170	.....	.....	29
1866	Sept. 5	.....	Kodiak Island	58	152	.....	.....	7
1867	July 19	23:00	Ikogmut, Lower Yukon River	62	161	.....	.....	29
1868	Unknown	.....	Unga, Shumagin Islands	55	161	.....	.....	29
1878	Aug. 29	.....	Makushin, Unalaska Island	54	167	.....	.....	2
1879	June 3	09:32	Atka Island	52	174½	.....	.....	2
1880	Sept. 28	18:—	Ukamok or Chirikof Island	56	156	.....	.....	2
	Oct. 26	20:45	Sitka and Hoonah Village	58	136	.....	.....	2
1883	Oct. 6	08:—	Alaska Peninsula	59	154	.....	.....	2, 67
1896	Late May	.....	Mount St. Elias and Prince William Sound region.	61	146	.....	.....	29
1897	Jan. 11	.....	Yakutat Bay	60	140	.....	.....	29
	May 6	.....	Southeastern Alaska	.....	.....	.....	.....	29
1898	August	.....	Susitna Station	61	150	.....	.....	29
	Aug. 24	22:—	Valdez	61	146	.....	.....	29
1899	Apr. 1	16:45	Shumagin Islands	55½	161	.....	.....	29
	July 11	.....	Tyonek	61	151	.....	.....	29
	Sept. 3	14:22*	Near Cape Yakataga	60	142	.....	XI	29, 44, 67
	Sept. 10	11:40*	Yakutat Bay	60	140	.....	XI	29, 44
	Sept. 22	21:30	Unga, Shumagin Islands	55	161	.....	.....	29
1900	Aug. 10	.....	Skagway and Dawson	.....	.....	.....	.....	8
	Oct. 7	.....	Tyonek	61	151	.....	.....	29
	Oct. 9	02:28*	Chugach Mountains area	60	142	120,000	VII–VIII	8, 29, 44
1901	March	.....	Fort Gibbon	65	152	.....	.....	29
	Dec. 30 to 31	.....	Kenai, on Cook Inlet	60½	151	.....	.....	8A
1902	Aug. 17	.....	Between Muir and Yakutat	.....	.....	.....	.....	8
1903	March	.....	Valdez	61	146	.....	.....	29
	June 2	15:45	do	61	146	.....	.....	29
	July 26	.....	Dry Bay	59	138	.....	.....	29
1904	Aug. 27	11:56*	Rampart	64.0	151.0	.....	VI	8, 43
1905	Dec. 8	.....	Kuskokwim River	61	162	.....	.....	29
1907	Sept. 24	03:58	Skagway	59½	135¼	.....	V–VI	8, 29
	Dec. 29	.....	Northwest of Nome	66	168	.....	.....	8
1908	Feb. 14	01:25	Prince William Sound	61	146¼	.....	.....	29, 67
	May 14	22:32*	Southeastern Alaska	59	141	.....	VI	8, 29, 43
	Oct. 29 and Nov. 2.	.....	Northeast of Katalla	60½	144	.....	V–VI	8
1909	Feb. 16	.....	Near Yakutat	.....	.....	.....	.....	29
	May 6	.....	Yakutat	59½	139½	.....	.....	29
	Sept. 8	06:50*	Aleutian Islands	52½	169	.....	.....	29, 43
	Sept. 19	10:00	Seward and Kenai Peninsulas	.....	.....	.....	.....	29
1910	Mar. 14	05:09	Skagway	59½	135¼	.....	V	8, 29
	Aug. 5	.....	Yakutat Bay	60	140	.....	.....	29
	Sept. 1	.....	Dutch Harbor	54	166	.....	.....	29
	Nov. 20	23:32	Nome	64	165	.....	V	29
1911	Jan. 7	04:43	Near Fairbanks	65	148	.....	V	29
	Early September	.....	Yakutat	59½	139½	.....	.....	29

See footnotes at end of table

List of Earthquakes in Alaska—Continued

Year	Date	Time (AST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1911	Sept. 21	19:01*	Prince William Sound and Kenai Peninsula.	60.5	149.0	120,000	VII–VIII	29, 43, 67
	Oct. 17	.....	Southwestern Alaska	.....	.....	.....	.....	3
1912	Early January	.....	Aleutian Islands	.....	.....	.....	.....	8
	Jan. 31	10:12*	Prince William Sound area	61.0	147.5	150,000	.....	8, 29, 43
	June 4 to 5	.....	Kanatak, Nushagak, and Uyak	.....	.....	.....	.....	31
	June 6	23:56*	Cook Inlet	59	153	.....	.....	31, 43
	June 6	.....	Kodiak	58	152½	.....	.....	31
	June 7	About 22:00	Kanatak	57½	156	.....	.....	31
	July 6	21:58*	Central Alaska	64.0	147.0	200,000	.....	3-2, 8, 31, 43
	Aug. 17	.....	Naknek	58½	157	.....	.....	31
	Nov. 6	21:40*	Kodiak Island region	57.5	155.0	.....	.....	3-2, 8, 43
	Nov. 21	15:56	British Columbia, Canada	50	124	.....	.....	3, 8
1914	May 29	06:03	Near Fairbanks	65	148	.....	.....	3, 4, 8
1915	Oct. 15	19:10	Kenai Peninsula	62	146	.....	V–VI	3-5
1917	May 30	22:47	Unga, Shumagin Islands	55	161	.....	.....	11
	Dec. 14	16:10	Sitka	57	136	.....	.....	8
1920	June 25	16:41	Fairbanks	65	148	.....	.....	11
1922	Sept. 21	Early a.m.	Anchorage	61	150	.....	.....	11
1925	Feb. 23	13:55	Kenai Peninsula	62	146	.....	VII	10, 67
	Feb. 24	03:00	Latouche	60	148	.....	VI	10
	Feb. 24	03:45	Matanuska	61½	149	.....	V	10
1926	Nov. 14	18:23	Prince William Sound region	.....	.....	.....	V	10
1927	Oct. 24	06:00*	Southeastern Alaska	57.5	137.0	.....	VI	10, 43
	Nov. 12	12:56*	..... do	57.5	137.0	.....	VI	Do.
	Nov. 21	06:14	Sitka	57	136	.....	V	10
	Dec. 31	10:07	Southeastern Alaska	.....	.....	.....	V	10
1928	Jan. 24	16:35	Seward	60	150	.....	VI	27
	Feb. 6	20:03	Prince William Sound	61	149	.....	.....	27
	Feb. 19	11:08	Prince William Sound and Kenai Peninsula.	61	147	.....	.....	27
	June 8	00:30	Cordova	60	146	.....	V	27
	June 21	06:27*	South-central Alaska	60.0	146.5	.....	VI	27, 43
	Oct. 29	21:13	Prince William Sound	61	149	.....	.....	27
1929	Jan. 21	00:31* 04:20*	South of Fairbanks	64.0	148.0	200,000	.....	27, 43
	Mar. 6	15:35*	Dutch Harbor	51	170	.....	.....	27, 43, 67
	Apr. 6	00:33*	Matanuska	61½	149	.....	V	27
	May 26	12:40*	Near Queen Charlotte Islands, B.C.	51	131	.....	VI–VII	27, 43, 56
	Aug. 19	07:40	Kodiak Island	58	152	.....	.....	27
	Nov. 11	19:45	Southeastern Alaska	.....	.....	.....	.....	27
1931	May 28	19:16*	Girdwood	63	149	.....	.....	27, 43
	May 30	00:00	Attu Island	53	173 E	.....	VI	27
	June 11	12:40	Chitina and Valdez	.....	.....	.....	V	27
	July 6	12:04	Kanatak	57½	156	.....	V	27
	July 13	02:30*	Girdwood	60½	149	.....	V	27, 43
	Oct. 17	02:30*	Girdwood and Wasilla	61	149	.....	V	27

See footnotes at end of table

List of Earthquakes in Alaska—Continued

Year	Date	Time (AST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1931	Nov. 20	00:30	Girdwood and Valdez	.....	.....	.....	V	27
	Nov. 21	04:28*	Girdwood	60½	149	.....	V	27
	Dec. 23	17:41*	Near Kodiak Island	60.0	152.0	.....	.....	27, 43
1932	Mar. 3	02:31	Girdwood	60½	149	.....	V	27
	Mar. 25	13:59*	South-central Alaska	62.5	152.5	.....	VII	27, 43
	Sept. 13	22:43*	Prince William Sound and Kenai Peninsula.	61	148	.....	V	Do.
	Oct. 6	07:05	Homer	59½	151½	.....	V	27
1933	Jan. 3	17:59*	Near Seward	61.0	148.0	.....	VI	27, 43
	Apr. 26	16:36*	Northwest of Anchorage	61.2	150.7	.....	VII	Do.
	Apr. 26	17:03	Homer	59½	151½	.....	V	27
	Apr. 26	18:50	Anchorage	61	150	.....	V	27
	June 13	12:20*	Old Tyonek	61	151	.....	.....	27, 43
	June 28	13:35*	Fox Islands	53.5	165.0	.....	.....	Do.
	July 28	01:49	Dutch Harbor, Unalaska Island	54	166	.....	.....	27
	Aug. 30	16:52*	Southeastern Alaska	59.2	137.5	.....	V	27, 43, 45
	Sept. 19	13:40*	Yukon Territory	60	138	.....	V	27, 43
1934	Feb. 11	21:50	Juneau	58	134½	.....	V	27
	Apr. 19	08:52	Anchorage	61	150	.....	V	27
	May 3	18:36*	South-central Alaska	61.2	147.5	.....	VI	27, 43
	May 14	12:13*	Kodiak Island	57.7	152.2	.....	VI	Do.
	May 15	12:—	Kodiak and Seward	.....	.....	.....	V	27
	June 17	23:14*	South-central Alaska	60.5	151.0	.....	V	27, 43, 45
	Aug. 1	21:13*	..... do	61.5	147.5	.....	V	Do.
	Nov. 28	19:13	Gustavus	58	136	.....	V	27
1935	Aug. 23	12:09	Anchorage	61	150	.....	V	27
1936	Oct. 22	20:24*	South-central Alaska	61.1	149.2	.....	VI	27, 45
1937	July 22	07:09*	Central Alaska	64.7	146.7	.....	VIII	27, 43, 45, 62
	Oct. 24	01:36*	South-central Alaska	62	150	.....	V	27, 45
1938	Nov. 10	10:18*	East of Shumagin Islands	55.5	158.0	.....	.....	27, 43, 67
1939	Feb. 13	21:52	Fairbanks	65	148	.....	V	27
	Feb. 24	04:16*	Fox Islands	53.0	164.5	.....	V	27, 45
	Mar. 31	05:30	Ellamar	61	147	.....	V	27
	Aug. 19	21:17*	Fox Islands	54.0	164.0	.....	V	27, 43
	Oct. 16	11:47	Southeast of Fairbanks	.....	.....	.....	.....	27
1940	Jan. 6	.....	Big Delta and Fairbanks	.....	.....	.....	V	27
	Feb. 11	23:18*	False Pass and Port Moller	55	161½	.....	V	27, 43
	Mar. 5	12:37 13:01 13:55	McKinley Park and Healy	.....	.....	.....	.....	27
	July 19	04:47	Near Anchorage	61	150	.....	VI	27, 45
	Aug. 29	21:32*	Fairbanks	65	148	.....	V	27
1941	July 29	15:51*	Kenai Peninsula area	61.0	151.0	.....	VI	27, 43
1943	Nov. 3	04:32*	South-central Alaska	61.7	151.0	.....	V	27, 43, 45
1946	Apr. 1	02:29*	South of Unimak Island	52.8	162.5	.....	VI	27, 43, 67
1947	Oct. 15	16:10*	Fairbanks area	64.5	148.8	.....	VIII	27, 43, 62
1949	Sept. 27	05:31*	South-central Alaska	59.8	149.0	.....	V	27, 43, 45, 67
1950	Aug. 25	18:39*	Seward Peninsula	64.3	161.8	.....	V	27, 45
1951	June 25	06:13*	Near Anchorage	61	150	.....	V	Do.

See footnotes at end of table

List of Earthquakes in Alaska—Continued

Year	Date	Time (AST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1952	Mar. 9	10:00*	Alaska-Canada border	59½	136	.....	V	27
	Nov. 21	07:27	Lost River area	66	166	.....	V	27, 45
	Dec. 6	14:58	Shemya Air Force Base, Shemya Island.	53	174 E	.....	VI	27
1954	Mar. 3	10:46*	Valdez	61½	146½	.....	V	27, 45
	May 16	03:00	St. George Island, Pribilof Islands	56½	170	.....	V	27
	Aug. 23	04:58*	Kenai Peninsula	61	148½	.....	V	27, 45
	Oct. 3	01:19*	..... do	60½	151	.....	VIII	Do.
1956	Mar. 31	01:54	McGrath	63	155½	.....	V	27
	May 17	18:19	Fairbanks	65	148	.....	V	27
	June 8	16:27*	Hot Springs	64	148	.....	V	27, 45
1957	Mar. 9	04:07*	Fairbanks area	65	149	.....	V	27
	Mar. 9	04:22*	Andreanof Islands	51.3	175.8	.....	VIII	27, 67
1958	Jan. 13	00:29	College	65	148	.....	V	27
	Feb. 16	12:20	McGrath	63	155½	.....	V	27
	Mar. 31	05:50	Huslia	65½	156	.....	V	27
	Apr. 7	05:31*	Central Alaska	66.1	156.8	150,000	VIII	27, 46
	Apr. 8	20:15*	Gulf of Alaska	56½	139	.....	V	27
	Apr. 11	02:18	Kotzebue	66	162½	.....	V	27
	Apr. 12	23:07*	Central Alaska	66	156	.....	V	27
	May 5	13:53*	Near coast of southeastern Alaska	57½	136½	.....	V	27
	May 10	12:55*	Central Alaska	65	152½	.....	V	27
	May 10	13:13*	..... do	64½	152½	.....	V	27
	May 10	19:24*	..... do	65	152½	.....	V	27
	July 9	20:16*	Southeastern Alaska	58.6	137.1	400,000	XI	27, 67
	Aug. 31	13:00*	Central Alaska	63	144½	.....	V	27
	Aug. 31	16:30	Tanacross	63	144	.....	V	27
	Nov. 19	05:02*	Kenai Peninsula	60½	150½	.....	V	27
	Nov. 25	20:15	Yakutat	59½	139½	.....	V	27
1960	Jan. 3	01:38*	South-central Alaska	61	152	.....	V	27
	Feb. 18	19:09*	Kenai Peninsula	60½	151	.....	VI	27
	Mar. 2	18:59*	Central Alaska	64½	150	8,000	V	27
	Mar. 9	14:24*	..... do	64	149	.....	V	27
	July 16	11:20* 12:03*	Seward Peninsula	65½	167½	.....	V	27
	Oct. 14	03:12*	Southeastern Alaska	60.0	136.4	.....	V	27
1961	Jan. 30	02:13*	Central Alaska	65.3	149.9	.....	V	27
	Sept. 5	01:35*	Kenai Peninsula	60.0	150.6	.....	VI	27
1962	May 9	14:04*	Southern Alaska	62.0	150.1	.....	V	27
	July 16	02:55*	..... do	62.3	153.1	.....	V	27
	Aug. 18	06:44* 07:46*	South-central Alaska	62.3	152.5	.....	V	27
	Oct. 20	16:05*	Vicinity of Anchorage	61.1	149.7	.....	VI	27
	Dec. 13	04:57*	Kenai Peninsula	61.4	147.2	.....	V	27
1963	June 23	18:27*	Cook Inlet	59.5	151.7	.....	VII	27
	Dec. 7	18:18	Fairbanks-College area	65	148	.....	V	27
1964	Jan. 6	08:31	Homer	59½	151½	.....	V	27
	Feb. 6	03:07*	South of Alaska	55.7	155.8	.....	V	27
	Mar. 27	17:36*	Southern Alaska	61.0	147.8	700,000	IX–X	3-58, 27, 66, 67
	Apr. 3	12:00* 12:34*	..... do	61.6	147.6	.....	V	27

See footnotes at end of table

List of Earthquakes in Alaska—Continued

Year	Date	Time (AST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1964	Apr. 14	12:56*	Kodiak Island region	58.0	152.6	.....	VI	27
	Dec. 12	14:33*	Nome	64.9	156.7	.....	VI	27
1965	Feb. 3	19:01*	Rat Islands	51.3	178.6 E	.....	VI	27
	Apr. 16	13:22*	Central Alaska	64.7	160.1	.....	VI	27
	Apr. 26	10:29*	Alaska Peninsula	54.5	162.6	.....	V	27
	July 2	10:59*	Fox Islands	53.1	167.6	.....	VI	27
	Dec. 22	09:41*	Kodiak Island region	58.4	153.1	.....	V	27
1966	Aug. 26	00:20*	Kotzebue	67.1	161.5	.....	V	27
	Aug. 30	10:21* 10:23*	South-central Alaska	61.3	147.5	30,000	V	27
1967	Feb. 6	04:49*	Central Alaska	64.8	147.4	20,000	V	27
	June 20	15:00	Dot Lake	64	144	(2)	VI	27
	June 21	08:13*	Central Alaska	64.8	147.4	90,000	VII	27, 62
	June 23	01:55*	..... do	64.8	147.4	(2)	VI	Do.
1968	Oct. 29	12:16*	East-central Alaska	65.4	150.1	250,000	VII–VIII	27
	Nov. 10	22:54*	Alaska Peninsula	57.3	155.3	.....	V	27
	Dec. 17	02:02*	Southern Alaska	60.2	152.8	100,000	VI	27
1969	Feb. 5	23:34*	Andreanof Islands	51.6	176.2	.....	V	27
	May 14	09:33*	..... do	51.3	179.9	.....	V	27
	May 17	22:44*	Southern Alaska	60.3	146.0	.....	V	27
	Nov. 23	23:42	Near Cold Bay	55.2	162.5	.....	V	27
	Dec. 25	16:30	King Cove	55.0	162.3	.....	V	27
1970	Jan. 15	22:06*	Southern Alaska	60.3	152.7	.....	V	27
	Mar. 11	12:39*	Kodiak Island region	57.5	153.9	.....	V	27
	Apr. 17	22:51*	Southern Alaska	59.9	152.8	.....	V	27
	Aug. 13	17:40*	Central Alaska	64.9	147.8	.....	V	27
	Nov. 2	16:30*	..... do	62.0	151.2	.....	V	27

*Instrumental origin time and epicenter.

[1] See References, p. 133.

MAJOR EARTHQUAKES

Earthquakes of September 3 and 10, 1899

Time of occurrence.—Sept. 3, 14:22; Sept. 10, 11:40.

Epicenter.—60° N., 142° W., near Cape Yakataga; 60° N., 140° W., Yakutat Bay.

Area affected.—Widely felt, but the total area is unknown.

Intensity.—XI.

Magnitude.—8.3 and 8.6, respectively.

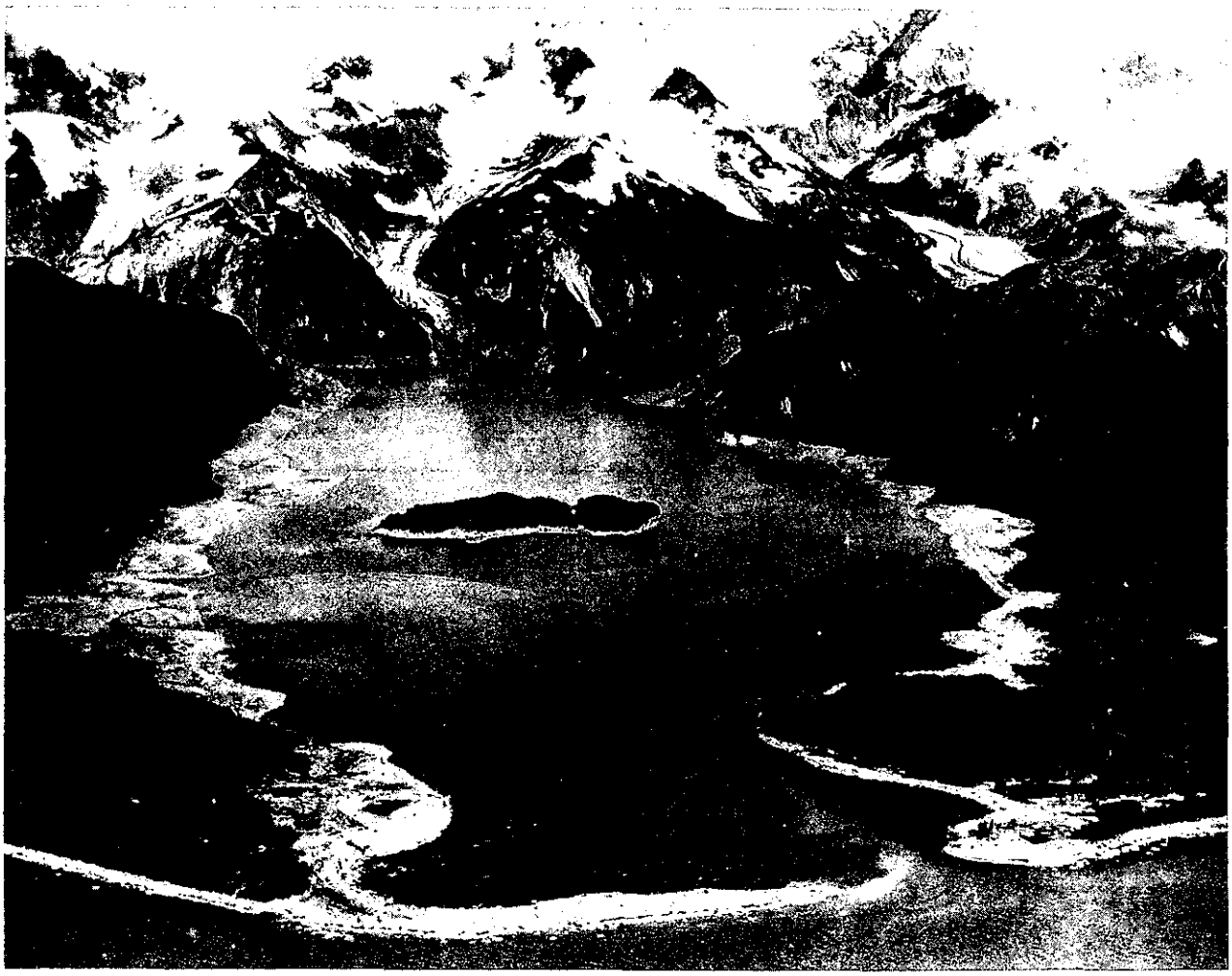
Description.—The first shock was moderately severe at Yakutat, but extremely violent at Cape Yakataga, about 100 miles west of Yakutat. The latter was the great earthquake which was accompanied by important topographic changes. Both shocks were felt widely but over a largely unsettled region, so the total felt area is not known. In the central region there was no damage to life or property as there were no villages. A few prospectors and Indians were eyewitnesses.

The evidence of topographic change was unmistakable, although no observations were made until a U.S. Geological Survey party studied the region 6 years later. During June 1899, the Harriman

Scientific Expedition had visited the region to study glaciers. They took pictures of the area which showed no indication of such changes up to that time. It was not difficult to measure the approximate changes because there were a number of raised beaches, and dead barnacles and other shellfish were found everywhere. The maximum uplift of 47½ feet was found on the west coast of Disenchantment Bay. Changes of 17 feet or more affected a considerable area. In a few cases, there was depression of 1 to 7 feet. The variations in uplift and depression indicate tilting of blocks. The net gain of land area was not more than ½ square mile.

There was a destructive tsunami in Yakutat Bay, perhaps 35 feet high. Tsunamis also were observed at other places along the Alaskan coast; a possible seiche was observed in Lake Chelan, Wash.

There were important changes in the glaciers. At the time of the earthquakes there were reports of volcanic eruptions, undoubtedly due to snow arising from great snowslides which often included rock and debris. This sudden additional load change altered the regimen of the glaciers even 150 miles away. There was a sudden advance followed by important recessions. In some cases, greatly crevassed glacier fronts were found 6 years later, showing that it had required this time for the fractured area to reach the sea.



Earthquake on July 9, 1958, sent a massive rockslide into Lituya Bay, Alaska, causing a 1,740-foot wave. Aerial photo shows Bay and its perimeter, now devoid of trees.

There were several large aftershocks during September and the following months.

Earthquake of July 9, 1958

Time of occurrence.—20:16*.

Epicenter.—58.6° N., 137.1° W., southeastern Alaska.

Area affected.—Approximately 400,000 square miles of southeastern Alaska, as far south as Seattle, Wash., and east to Whitehorse, Yukon Territory.

Intensity.—XI.

Magnitude.—7.9.

Description.—This was the strongest Alaska shock since that of September 1899 at Yakutat. As the only permanent settlement in the epicentral region was Yakutat, effects on manmade works were relatively small. Three persons were killed on Khantaak Island, and two were missing and presumed dead after being caught by a huge wave in Lituya Bay. A massive rockslide at the head of Lituya Bay caused water to surge 1,740 feet and generated a gravity wave which swept out of the Bay. A fishing vessel with two persons aboard was carried from Anchorage Cove in front of the wave crest. Those aboard estimated that they cleared La Chausse Spit by 100 feet or more. A cabin collapsed and land fissured at Dry Bay (East River). At Yakutat, bridges, docks, and oil lines were damaged, a water tower fell, and a few cabins were destroyed. Large landslides were reported in the mountain areas; many sand blows and fissures were noted on the low coastal plain southeast of Yakutat. Large trees, the majority of which were dead, were snapped off or uprooted. Submarine cables of the Alaska Communication System were severed in the Haines-Skagway area. A chimney toppled and the dock was damaged at Auk Bay. Slight damage also was reported at Baranof, Pelican, and Sitka.

Earthquake of March 27, 1964

Time of occurrence.—17:36*.

Epicenter.—61.04° N., 147.73° W., southern Alaska.

Area affected.—Approximately 700,000 square miles of Alaska, and portions of western Yukon Territory and British Columbia, Canada.

Intensity.—IX–X.

Magnitude.—8.3 ±0.33.

Description.—This earthquake, one of the most violent ever recorded, was accompanied by vertical displacement over an area of 170,000 to 200,000 square miles. The major area of uplift trended northeast from southern Kodiak Island to Prince William Sound, and east-west to the east of the Sound. Vertical displacements ranged from 38 feet of uplift to 7½ feet of subsidence relative to sea level, with seaward horizontal shifts of roughly 64 feet and subsidiary reverse faulting with dip-slip offsets to 26 feet. Off the southwest end of Montague Island, there was absolute vertical displacement of between 42 and 50 feet. Uplift also occurred along the extreme southeast coast of Kodiak Island, Sitkalidak Island, and over part or all of Sitkinak Island. The zone of subsidence covered about 110,000 square miles and included the northern and western parts of Prince William Sound, the western segment of the Chugach Mountains and portions of the lowlands north of the mountains, most of Kenai Peninsula, and almost all of the Kodiak Island group. The primary fault along which displacement occurred is probably a complex thrust fault 550 to 600 miles long and 110 to 180 miles wide which dips at less than 15° from the vicinity of the Aleutian Trench beneath the Aleutian Arc.

Anchorage, about 80 miles northwest of the epicenter, sustained the greatest earthquake damage, although it was greater than the apparent intensity because of geological features. Violent ground motion triggered numerous rockslides, snow avalanches, and landslides throughout south-central Alaska. Fractures or cracks developed, chiefly in the unconsolidated deposits; mud spouts, slumping, and subsidence resulted from compaction; and sand boils were produced. Cracks and pressure ridges were observed in lake and river ice.

About 30 blocks of dwellings and commercial buildings were severely damaged or destroyed in downtown Anchorage. The J.C. Penney Company store, a new five-story building, was damaged beyond repair. The Four Seasons apartment building, a new six-story structure, collapsed. Twin 14-story apartment buildings, although a mile apart, sustained extensive, nearly identical vibratory damage. Many other multistory or large-area buildings were damaged greatly.

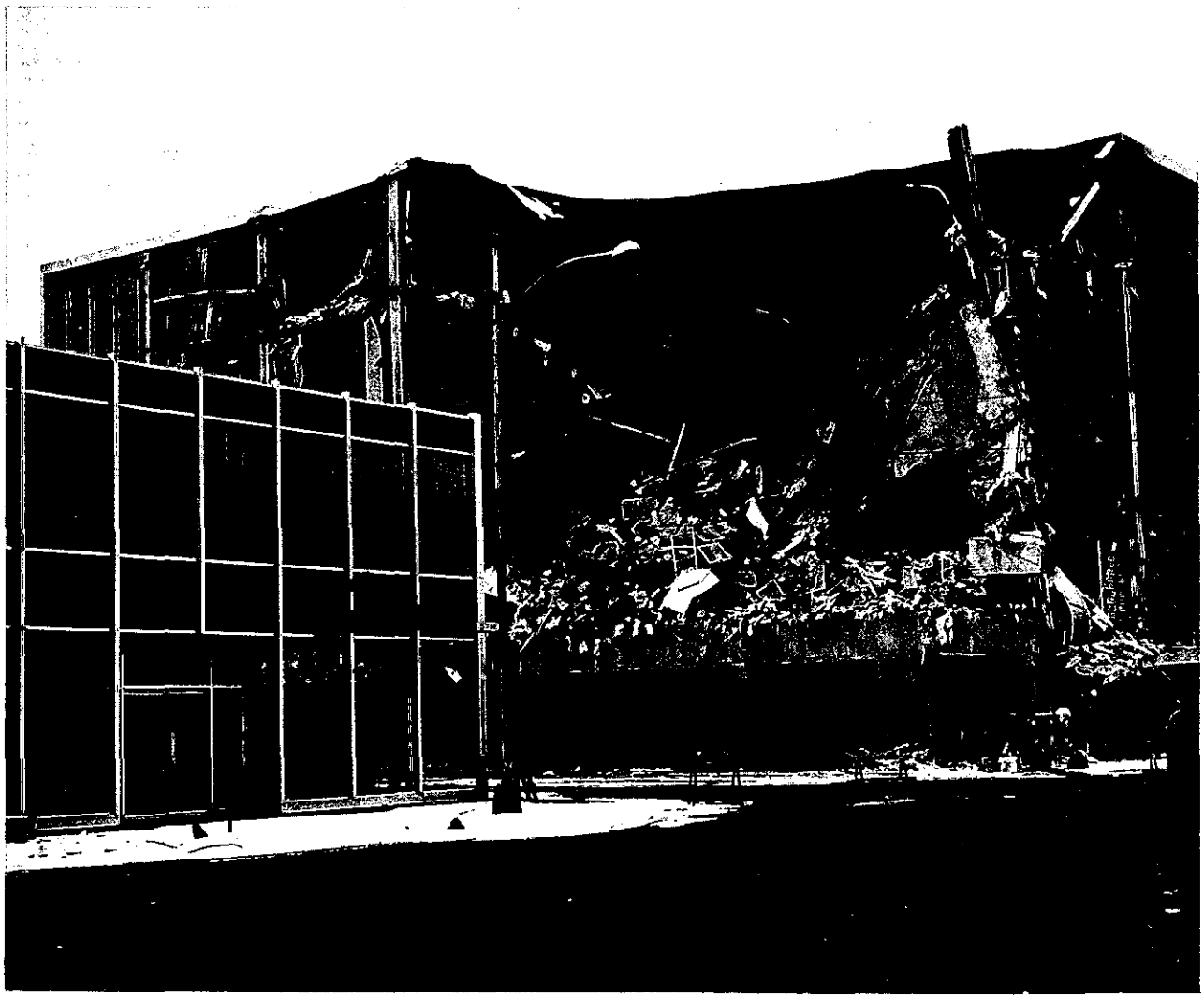
The school system was hit hard. Denali Grade School was damaged by ground cracks. Anchorage High School was severely damaged. Government Hill Grade School, astride a landslide, was nearly a total loss.

Water mains and gas, sewer, telephone, and electric systems were disrupted.

Landslides caused greatest devastation in Anchorage. Great slides occurred in the downtown business section, at Government Hill, and at Turnagain Heights. Less destructive slides occurred in many other locations.

The Turnagain Heights slide was the largest, most complex, and most devastating landslide. It extended west to east along the bluff line about 8,600 feet. The slide destroyed about 75 homes. A total area of about 130 acres was completely devastated by displacements that broke the ground into numerous deranged blocks, which were collapsed and tilted at odd angles.

During the month following this great earthquake, numerous aftershocks were recorded. Through April 30, 19 shocks were reported with magnitude 6 or above. None was recorded in this magnitude range in May or June. Shocks on April 3 and 20 were felt in the Anchorage area.



March 27, 1964, earthquake partially collapsed J.C. Penney Co. store in Anchorage, Alaska. Note building next door that appears to be completely untouched by quake.

Part of 130 acres of land devastated by 1964 Good Friday shock in Turnagain Heights area of Anchorage, Alaska.

This earthquake generated a seismic seawave (tsunami) that devastated towns along the Gulf of Alaska and left serious damage at Alberni and Port Alberni, Canada, along the west coast of the United States, and in Hawaii.

Seiche action in rivers, lakes, bayous, and protected harbors and waterways along the Gulf Coast of Louisiana and Texas caused minor damage and was recorded on tide gages as far east as Guantanamo Bay, Cuba, and San Juan, Puerto Rico.

Only the sparse population and time of occurrence when schools were closed, business areas uncrowded, and tides low prevented the death toll from surpassing 131. (Civil Defense estimates included 122 deaths from the tsunami and 9 from the earthquake.) Total damage from the earthquake and tsunami was between $400 and $500 million.

INTERMEDIATE AND MINOR EARTHQUAKES

1786. Date unknown. Alaska Peninsula. Pavlof Volcano became active. The northern crater fell in, and after a violent earthquake, activity ceased.

1788. July 27. Sanak Island, Shumagin Islands,

and Alaska Peninsula. Land was flooded by a tsunami. Some natives lost their lives; hogs drowned.

1796. May. Unalaska Island. The earthquake was accompanied by fearful noises. Rocks were thrown from the Bogoslof Volcano as far as Umnak.

1802. Date unknown. Unalaska Island. Makushin Volcano erupted with great violence. Shocks of the earthquake were felt on Unalaska.

1812. Date unknown. Atka Island. Sarycheff Volcano erupted. The earthquakes were very violent and terrified the inhabitants.

1817. April. Umnak Island. Violent earthquake occurred. Yunaska Volcano erupted; ashes and stones were reported to have reached Unalaska and Unimak.

1818. Date unknown. Vicinity of Makushin, Unalaska Island. An earthquake was reported to have made great changes in Amatignak.

1826. June. Unalaska Island. Two earthquakes.

1835. April 14. Pribilof Islands. Severe.

1836. April 2 and August. St. Paul and St. George Islands, Pribilof Islands. Shocks were so severe that people could not remain standing. Rocks were split and broken in many places. Less violence occurred in August.

1843. December 15 and 16. Sitka. Two fairly sharp shocks, followed by a third and stronger one, occurred. At 16:00, houses were rent and trees swayed. (Recorded on magnetograph at Sitka, the first shocks ever instrumentally recorded in Alaska.)

1847. Date unknown. Sitka. Severe. Generally felt along the coast. At the time of the Yakutat Bay earthquake of 1899, it was stated to be the most severe since the time of the Russians, evidently referring to this one.

1857. September 8. Kodiak Island. Two shocks several seconds apart occurred at Kodiak. The second was more severe, but did no damage.

1861. May 3. St. George Island, Pribilof Islands. Light shock with subterranean noise.

1866. September 5. Kodiak Island. Strong.

1867. July 19. Ikogmut, Lower Yukon River. Felt at Russian Mission. An observer on Yukon River at time of shock reported it felt as if boat had struck a snag. Shock threw books and other articles from shelves at Russian Mission.

1868. Date unknown. Unga, Shumagin Islands. No details.

1878. August 29. Makushin, Unalaska Island. Town was destroyed by an earthquake and tsunami.

1879. June 3. Atka Island. Eight shocks in rapid succession.

1880. September 28. Ukamok or Chirikof Island. Three heavy shocks. Another shock occurred at 21:00, and others at 03:00 and 13:00 on the 29th. Shocks continued until October 16 with frequent trembling and subterranean sounds. Ground cracks 15 to 20 inches wide were numerous.

1880. October 26. Sitka and Hoonah Village. Other shocks lasted until October 29 at Sitka. Shocks were strong at Hoonah Village. Additional shocks were reported on November 13 and 14.

1883. October 6. Alaska Peninsula. Mount St. Augustine burst into volcanic activity; accompanied by a very severe earthquake and tsunami.

1896. Late May. Mount St. Elias and Prince William Sound region. Observed at Orca and 8 miles north of Orca. Trees bent; waves appeared in the ground; it was difficult for people to remain on their feet. Shocks were frequent at Orca for a year.

1897. January 11. Yakutat Bay. Severe. Houses shook.

1897. May 6. Southeastern Alaska. Buildings shook; small landslides occurred along streams.

1898. August. Susitna Station. Trees swayed violently.

1898. August 24. Valdez. Heavy.

1899. April 1. Shumagin Islands. Coal Harbor, Sand Point, and Unga. Strong earthquake threw light articles from shelves.

1899. July 11. Tyonek. Severe.

1899. September 22. Unga, Shumagin Islands. Severe shock.

1900. August 10. Skagway and Dawson. Shook Skagway; severe at Dawson and on Stewart River. Ice was shaken from glaciers.

1900. October 7. Tyonek. Severe shock.

1900. October 9. Chugach Mountains area. Felt from southwestern Yukon Territory, Canada, to Kodiak, and probably much farther west because effects at Kodiak were severe. The felt area was at least 120,000 square miles. At Woody Island, near Kodiak, a man was thrown from his bed; chimneys were thrown down. Intensity VII–VIII at Kodiak,

VI–VII at Skagway, and VI at Whitehorse. Magnitude 8.3. Shocks were continuous at Kodiak for 6 hours; many aftershocks.

1901. March. Fort Gibbon. Strong shock.

1901. December 30 to 31. Kenai, on Cook Inlet. A strong volcanic eruption. Earthquake which accompanied it caused several tsunamis.

1902. August 17. Between Muir and Yakutat. Ice was shaken from glaciers.

1903. March. Valdez. People ran into the street.

1903. June 2. Valdez. Strong shock.

1903. July 26. Dry Bay. Cliffs were shaken down.

1904. August 27. Rampart. Buildings swayed and cracked. Another shock was reported on September 10. Magnitude 7¾.

1905. December 8. Kuskokwim River. Felt at Ogavik where houses rocked; also felt at Bethel.

1907. September 24. Skagway. Clocks stopped; chandeliers swayed. There must have been many landslides to account for the reports of volcanic eruptions. Also felt at Juneau, Haines, Ketchikan, and Sitka.

1907. December 29. Northwest of Nome, Cape Prince of Wales. A large area was shaken; heavy amounts of material fell from cliffs.

1908. February 14. Prince William Sound. Severe at Valdez where cables broke. Objects were thrown from shelves. Observer considered it comparable to the 1906 California earthquake which he had experienced.

1908. May 14. Southeastern Alaska. At Katalla, there were sharp shocks in rapid succession during which buildings rocked. Rockslides were reported at Yakataga. Felt from Sitka to Seward. Magnitude 7.0.

1908. October 29 and November 2. Northeast of Katalla. Seven shocks in all, the strongest on dates given.

1909. February 16. Near Yakutat. Also strong at Skagway where clocks stopped. Felt at Juneau, Sitka, and Valdez.

1909. May 6. Yakutat. Spilled water out of reservoir on stove and from barrels outdoors.

1909. September 8. Aleutian Islands. Sufficiently strong to upset dinners and disarrange furniture in some homes. Magnitude 7.4.

1909. September 19. Seward and Kenai Peninsulas. Strong. Noise like thunder. Magnitude 7.4.

1910. March 14. Skagway. Strong. Also felt at Juneau and Sitka.

1910. August 5. Yakutat Bay. Buildings shook; windows rattled.

1910. September 1. Dutch Harbor. Two violent shocks. Probably associated with the formation of new islands in Bogoslof group.

1910. November 20. Nome. Intensity V. Another shock was reported on the 22d at 06:32.

1911. January 7. Near Fairbanks. Sounds heard; vertical movement felt.

1911. Early September. Yakutat. Severe.

1911. September 21. Prince William Sound and Kenai Peninsula. Cables were broken and buried at the same places as on February 14, 1908. Heavy rockslides at head of Sound. Many fish were killed, apparently from concussion. Little damage at Valdez. Water was greatly agitated at Wells Bay. Magnitude 6.9.

1911. October 17. Southwestern Alaska. Newspapers reported a severe earthquake on the southwestern Alaskan coast. The glaciers were affected considerably.

1912. Early January. Aleutian Islands. Violent shocks. Region uncertain.

1912. January 31. Prince William Sound area. Generally felt throughout Prince William Sound and in Copper and Tanana Valleys. Epicenter apparently west of Valdez. Strong at Valdez and felt at Fairbanks; lasted 20 seconds at each place. Cables broke. Magnitude 7¼.

1912. June 4 to 5. Kanatak, Nushagak, and Uyak. Severe shocks were felt 56 to 131 miles from Mount Katmai in various directions. Reportedly, not directly related to the eruption of Mount Katmai on June 6.

1912. June 6. Cook Inlet. Severe earthquake; strong glare of light at Katmai Volcano seen from Kanatak, 59 miles southwest. The shock was recorded at Harvard, Mass., Ottawa, Canada, and Pulkovo and Irkutsk, U.S.S.R. Magnitude 6.4. Another earthquake of magnitude 7.0 occurred in this area on June 10 at 06:06.

1912. June 6. Kodiak. Severe shocks were reported during the night.

1912. June 7. Kanatak. Strong shock accompanied by heavy rumbling and rockslides.

1912. July 6. Central Alaska. Violent at Fairbanks, with other shocks lasting until the 9th. Felt strongly at Kennecott. It was reported that the earth heaved and rolled at the northern base of Mount McKinley, and the country far and near

was scarred with landslides. Magnitude 7.4.

1912. August 17. Naknek (about 76 miles west-northwest of Mount Katmai). A strong shock upset lamps on table.

1912. November 6. Kodiak Island region. Felt by Steamer *Bertha* between Uyak and Kodiak. Strong at Seward. Magnitude 7.5.

1912. November 21. British Columbia, Canada. Moderate at Sitka.

1914. May 29. Near Fairbanks. Numerous shocks continued through the following night. Sounds preceded the shocks.

1915. October 15. Kenai Peninsula. Intensity V–VI at Seward where people rushed into the streets. A loud roar was heard.

1917. May 30. Unga, Shumagin Islands. There were several shocks lasting 10 seconds in all.

1917. December 14. Sitka. Heaviest in years, but damage was not serious.

1920. June 25. Fairbanks. Fairly strong. Felt 100 miles north of Anchorage.

1922. September 21. Anchorage. Severe.

1925. February 23. Kenai Peninsula. Earthquake caused considerable alarm. A bridge and some dwellings were damaged, and a cable was broken between Seward and Valdez. Intensity VII at Anchorage. Felt slightly at Haines. Two shocks reported; the second was more severe and followed the first very closely. Numerous aftershocks until February 28.

1925. February 24. Latouche. No details.

1925. February 24. Matanuska. Earth sounds.

1926. November 14. Prince William Sound region. Unusually severe. Trees and buildings swayed at Latouche; antenna masts shook at Cordova. Also felt at Katalla and Kodiak.

1927. October 24. Southeastern Alaska. Felt from Cape Spencer to Dixon Entrance; the shock also was felt to the north of Fairbanks. Cables were broken between Petersburg and Wrangell and between Juneau and Skagway. At Sitka, clocks stopped and cracks appeared in buildings. At Juneau, hanging objects swayed. Little damage at Wrangell. At Seattle, Wash., small waves were seen in swimming pools. Magnitude 7.1.

1927. November 12. Southeastern Alaska. Moderate shock at Juneau. Felt at Haines. Ice was shaken from glaciers in the Mount St. Elias region. Generally felt at Sitka.

1927. November 21. Sitka. People generally awakened; pictures moved. Also felt at Juneau.

1927. December 31. Southeastern Alaska. Felt by many at Juneau and Sitka. Objects moved at Juneau.

1928. January 24. Seward. Intensity VI. Two shocks close together; the second was heavier.

1928. February 6. Prince William Sound. Alarmed people at Latouche, fairly strong at Anchorage, and sharp at Matanuska.

1928. February 19. Prince William Sound and Kenai Peninsula. Severe at Seward. Buildings swayed. Heavy snowslides occurred along railroad.

1928. June 8. Cordova. People were generally awakened; plaster cracked.

1928. June 21. South-central Alaska. Felt from Kenai Peninsula to the Copper River Valley. Three distinct shocks were felt during the day, strongest at time given. Thirty miles north of Cordova, men were thrown from bunks. Plaster cracked at Cordova. Landslides occurred at various places in the mountains. At Seward, ground gave the sensation of rolling waves. Heavy at Valdez. Felt at Matanuska and Chickaloon. Magnitude 7.0.

1928. October 29. Prince William Sound. Felt at Anchorage, Latouche, and Matanuska.

1929. January 21. South of Fairbanks. The shocks lasted 4 hours, and there were others on the 22d. The first shock was most severe. Beds and furniture moved about, everyone awakened, and many rushed into the streets. Many houses were one-story log structures, especially designed to meet winter conditions, and were well suited to resist earthquake damage. Broken windows and displaced articles were reported, however. Heavy rumbling. Magnitude 6¼.

1929. March 6. Dutch Harbor. Severe submarine earthquake was felt on a number of ships at sea. Slight tsunami at Hilo, Hawaii. Magnitude 8.6.

1929. April 6. Matanuska. Intensity V. Shocks of less intensity were felt on the preceding day and later on the same day.

1929. May 26. Near Queen Charlotte Islands, British Columbia. Very strong. Severe at Masset; heavy landslides at many places. Strong enough to cause excitement at Hyder at head of Portland Canal. Shocks continued for 2 days. Felt at Ketchikan. Tsunami reported on Queen Charlotte Islands at Skidegate and Queen Charlotte. Magnitude 7.0.

1929. August 19. Kodiak Island. At Ouzinkie, man on wharf thought vessel had struck dock. Buildings creaked; articles moved. Possibly of volcanic origin, as Katmai and Mageek Volcanoes were smoking and volcanic dust fell.

1929. November 11. Southeastern Alaska. Widely felt. Epicenter doubtful. At Juneau, hanging objects swayed. Sharp shock was felt at Matanuska, but may not have been the same one.

1931. May 28. Girdwood. Sharp and abrupt. Prolonged at Matanuska.

1931. May 30. Attu Island. Felt by all. Clocks stopped; small objects overturned; dishes broke. Canned goods in store were thrown to floor. Magnitude 6.

1931. June 11. Chitina and Valdez. Widely felt. Awakened many.

1931. July 6. Kanatak. Felt by all. Trees and bushes shook.

1931. July 13. Girdwood. Awakened all.

1931. October 17. Girdwood and Wasilla. Awakened all. Also felt at Homer.

1931. November 20. Girdwood and Valdez. At Girdwood, all were awakened. Articles fell from shelves.

1931. November 21. Girdwood. Felt by and awakened all.

1931. December 23. Near Kodiak Island. Moderate at Whale Island. Felt over an east-west area of 400 miles. Magnitude 6¼.

1932. March 3. Girdwood. Strong shock awakened all.

1932. March 25. South-central Alaska. Water main burst at Seward. Slides occurred on railroad to the north. Felt over an east-west area of 350 miles and an unknown distance to the north of Seward. Magnitude 6.9.

1932. September 13. Prince William Sound and Kenai Peninsula. Intensity V at Ellamar, Homer, Valdez, and Wasilla. Clocks stopped. Widely recorded on seismographs. Magnitude 6¼.

1932. October 6. Homer. Awakened all.

1933. January 3. Near Seward. People rushed into the streets at Seward. Cracks appeared in the ground in many places, including the streets of the city and for 20 miles along the road leading to the north. Very severe at Anchorage. Felt at Cordova and Fairbanks. Magnitude 6¼.

1933. April 26. Northwest of Anchorage. Telegraph lines were broken for a distance of 50 miles from Anchorage. Plate glass windows broke. Felt in the Aleutian Islands and at Fairbanks and Valdez. Intensity VII at Big Susitna River District, and at Old Tyonek where houses were shaken off foundations. Several aftershocks occurred. One at 17:03 was intensity V at Homer; another at about 18:50 was intensity V at Anchorage. Magnitude of main shock 7.0.

1933. June 13. Old Tyonek. Severe shock with some damage. Magnitude 6¼.

1933. June 28. Fox Islands. Series of earthquakes felt in the vicinity of Dutch Harbor. Main shock, magnitude 6.

1933. July 28. Dutch Harbor. Strong shock. Magnitude 6.

1933. August 30. Southeastern Alaska. Intensity V at Haines and Skagway. Three heavy shocks at Skagway. Magnitude 5¼.

1933. September 19. Yukon Territory. Clocks stopped at Juneau and Skagway.

1934. February 11. Juneau. Plaster cracked; other slight damage to buildings.

1934. April 19. Anchorage. Slight damage. Felt at Seward.

1934. May 3. South-central Alaska. At Anchorage, windows broke; goods fell from shelves. Felt at Cordova and Nenana. Magnitude 7.2.

1934. May 14. Kodiak Island. Intensity VI on Kodiak and Whale Islands. People left houses; plaster cracked; landslides blocked road. Also felt at Susitna. Magnitude 6½.

1934. May 15. Kodiak and Seward. Merchandise toppled from shelves.

1934. June 17. South-central Alaska. At Anchorage, plate glass broke; small objects overturned. Felt at Afognak. Magnitude 6¾.

1934. August 1. South-central Alaska. At Anchorage, dishes broke; small objects overturned. Magnitude 6.

1934. November 28. Gustavus. Intensity V.

1935. August 23. Anchorage. Small objects overturned; knickknacks fell. Awakened many.

1936. October 22. South-central Alaska. Slight damage at Anchorage. Heavy at Seward, strong at Susitna, and felt at Cordova (?). Many aftershocks.

1937. July 22. Central Alaska. Fairbanks suffered severe shaking. Damage to buildings was prevented because of good construction and design. There was a loss of $5,000 in broken windows and bottled

goods. Thirty-four miles south of Fairbanks at Salcha Bluff, there was a slide that covered several hundred feet of roadway. In this vicinity, there was considerable cracking from which mud and silt spouted up, the cracks paralleling the adjacent sloughs whose water level rose and remained up for several days. The epicenter was probably near here, as a solidly built log house was twisted and an antenna pole on a hut snapped. There was a roar like a freight train. The shock was felt all along the Alaska Railroad and was severe at Nenana. Magnitude 7.3. There were several strong shocks and many aftershocks. The first shock was felt over an area with 300-mile radius; for later ones, the radius did not exceed 150 miles.

1937. October 24. South-central Alaska. Sleepers were awakened at Seward. Objects fell from shelves.

1938. November 10. East of Shumagin Islands. A very strong submarine shock was felt strongly at False Pass, Unimak Island. Also felt at Port Moller and Anchorage. A small tsunami was observed at Sitka, Dutch Harbor, and Seward, and at Hilo and Honolulu, Hawaii. Magnitude 8.7.

1939. February 13. Fairbanks. A sharp, 4-second shock was felt by a large part of the population.

1939. February 24. Fox Islands. A sharp shock awakened all at False Pass. Slight damage occurred. Magnitude 6¼.

1939. March 31. Ellamar. All were awakened by a moderate shock.

1939. August 19. Fox Islands. A sharp shock at Dutch Harbor cracked plaster. Four or five jolts were felt aboard a ship in the harbor. Magnitude 6¼.

1939. October 16. Southeast of Fairbanks. At Fairbanks, cabinet drawers were thrown out several inches. Greatest intensity was reported at a point 40 miles southeast of Fairbanks.

1940. January 6. Big Delta and Fairbanks. Awakened all at Big Delta; felt by many at Fairbanks.

1940. February 11. False Pass and Port Moller. All were awakened. Magnitude 6¾.

1940. March 5. McKinley Park and Healy. Moderate, explosivelike shocks occurred in both places. A third shock was rather violent, stopping clocks and moving small objects.

1940. July 19. Near Anchorage. Walls cracked. Damage slight.

1940. August 29. Fairbanks. Felt by a large part of the population. Some light objects displaced.

1941. July 29. Kenai Peninsula area. Many were frightened at Anchorage. Plaster and pictures fell from walls, dishes broke, and grocery stock fell from shelves. One building was thrown from its foundation. Magnitude 6¼.

1943. November 3. South-central Alaska. Generally felt at Anchorage. An abrupt, heaving motion swung doors and rattled windows. Also felt at McGrath and Bethel. Magnitude 7.3.

1946. April 1. South of Unimak Island. The epicenter was about 90 miles southeast of the Scotch Cap Lighthouse. Only minor damage occurred on Unimak Island as result of the earthquake. However, a tsunami was generated that completely destroyed the lighthouse and swept away its five occupants. Some damage from the tsunami occurred at other points in the Aleutian Islands, on the coasts of North and South America, and in Hawaii. Property damage in Hawaii was estimated at $25 million and 173 persons were drowned. Many structures in the vicinity of the harbor area at Hilo were completely destroyed and boats were carried inland. Magnitude 7.4.

1947. October 15. Fairbanks area. The epicenter of this earthquake was about 40 miles southwest of Fairbanks. Heavy damage to drug, grocery, and liquor supplies occurred at Fairbanks. Numerous windows broke, and a powerline near the University of Alaska short-circuited. Small fissures opened in the ground near the airport at Nenana. Streets upheaved in several places and several long cracks appeared in the ground. Cracks occurred in river mud and ice from Shaw Creek on Richardson Highway to the headwaters of the Kantishna and Tolovana Rivers. Landslides occurred on the Richardson Highway, and rockslides were observed about half way between Nenana and Fairbanks. The Alaska Railroad reported bent rails between Julius, Nenana, and Browne, and changes in roadbed elevation in some areas. Magnitude 7.

1949. September 27. South-central Alaska. Numerous small shocks occurred at Anchorage. Sleepers were awakened; a pendulum clock stopped. Felt by many at Cordova where fluorescent lights and filing cabinets swayed or were displaced. Magnitude 7.0.

1950. August 25. Seward Peninsula, about 100 miles east of Nome. At Kotzebue, one abrupt shock was felt by nearly all. Buildings swayed slightly; water in fishbowl surged up on northeast side. Also felt at Shishmaref and Wales. Magnitude 6½.

1951. June 25. Near Anchorage. Felt strongest at Spenard where grocery, clothing, and drug stocks fell to the floor. At Anchorage, parked cars bounced in the streets and liquor containers tumbled from top shelves. Light bulbs broke in the Loussac-Sogn Building; glassware shattered in homes. Also felt at Cordova and Palmer. Magnitude 6¼.

1952. March 9. Alaska-Canada border. In Juneau, the shock was felt by nearly all. A few windows and dishes cracked; doors rattled. Also felt at Angoon and Sitka. Magnitude 6.

1952. November 21. Lost River area. At Lost River, all awakened. Small objects overturned and knickknacks fell. Felt at Teller.

1952. December 6. Shemya Air Force Base, Shemya Island. Disconnected water main and electrical cables; cracked cement floor; disturbed many objects. Magnitude 6¼.

1954. March 3. Valdez. Stock tumbled from grocery shelves. Felt at Anchorage.

1954. May 16. St. George Island, Pribilof Islands. Awakened many in community. Trees and bushes shook moderately.

1954. August 23. Kenai Peninsula. Felt by and awakened many at Anchorage; few alarmed. Powerlines broke. Felt near Homer and at Kasilof, Naptowne, Seward, Valdez, and Whittier.

1954. October 3. Kenai Peninsula. Concrete walls cracked, plaster fell, plate glass windows broke, and merchandise toppled from shelves at Anchorage, Homer, Kenai, Seward, Sterling, and Valdez. Minor landslides spilled down on the Seward-Anchorage Highway. More than 140 feet of railroad tracks was knocked out of commission north of Potter. At Anchorage, the violent rocking broke water connections. At the Denali Theater, where a midnight show was in progress, some 850 patrons rushed toward the exits, climbing over seats in a frenzy to escape. Three persons were injured in the rush. Magnitude 6¾.

1956. March 31. McGrath. Felt by and awakened nearly all.

1956. May 17. Fairbanks. Felt by many. Upper floors of buildings jiggled noticeably. Felt at College.

1956. June 8. Hot Springs. Felt by and awakened several. Objects toppled from shelf. Felt at College.

1957. March 9. Fairbanks area. Alarmed many at Fairbanks; ceiling lights swayed and windows rattled. Outer marker at end of airport runway was knocked out. Also felt at College and at Ladd Air Force Base.

1957. March 9. Andreanof Islands. This great earthquake initiated more than 300 aftershocks extending over 700 miles along the southern edge of the Aleutians from Unimak Island to Amchitka Pass. On Adak, two bridges were destroyed, some houses were damaged, and a 15-foot crack was observed in the road. At Umnak, part of a dock was destroyed, and Mount Vsevidof erupted after being dormant for 200 years. A 40-foot tsunami smashed the coastline at Scotch Cap, and a 26-foot tsunami washed away many buildings and damaged oil lines at Sand Bay. The tsunami also destroyed two villages and inflicted $3 million damage on Oahu and Kauai Islands, Hawaii. A 10-foot tsunami struck the Japanese coast, and a 6-foot tsunami was reported as far away as the shores of Chile. Magnitude 8.3.

1958. January 13. College. Many were awakened; dishes broke. Also felt in Fairbanks.

1958. February 16. McGrath. Dishes fell from cupboards. Chandeliers swung; objects were disturbed.

1958. March 31. Huslia. Felt by all.

1958. April 7. Central Alaska. Felt over a wide area of central Alaska. Intensity VIII was reported within a 40- to 50-mile radius of Huslia. There was evidence of pressure ridges, lakes thawing, and craters 20 feet across and 6 feet deep. At Huslia, minor damage occurred to roofs and foundations. At Stevens Village, a very old building was condemned after poles supporting the roof split and broke. Slight damage was reported from several other central Alaska towns. River ice cracked in many locations; ground cracks were reported at Tanana. Magnitude 7.3.

1958. April 8. Gulf of Alaska. Walls and window of airport hanger bulged outward at Yakutat; awakened and frightened few. Felt by many at Sitka where objects on shelves dislodged.

1958. April 11. Kotzebue. Awakened many and alarmed few. Felt by all at Kobuk.

1958. April 12. Central Alaska. Many were awakened at Nulato and Kobuk. Cans moved on shelves at Hughes. Magnitude 6¾.

1958. May 5. Near coast of southeastern Alaska. Intensity V at Chichagof and Sitka. Felt by nearly all; alarmed numerous residents.

1958. May 10. Central Alaska. Frightened many at Manley Hot Springs. Pendulum clock stopped; knocked mirror from wall at Tanana. Magnitude 6¼–6½.

1958. May 10. Central Alaska. Felt by all at Manley Hot Springs and Tanana.

1958. May 10. Central Alaska. Felt by all and frightened many at Manley Hot Springs; shook canned goods from shelves. Magnitude 6.4.

1958. August 31. Central Alaska. Alarmed many at Tanacross. Moderately loud earth sounds heard. Magnitude 5¾–6.

1958. August 31. Tanacross. Many were alarmed.

1958. November 19. Kenai Peninsula. Intensity V at Venta where many were awakened. Bottles on shelves moved and bunks were severely shaken.

1958. November 25. Yakutat. Felt by many and alarmed few.

1960. January 3. South-central Alaska. Intensity V at Anchorage where nearly all were awakened.

1960. February 18. Kenai Peninsula. Slight damage to small articles at Anchorage. Knickknacks fell; trees shook moderately. Felt by all at Hope, Palmer, Seward, and Whittier.

1960. March 2. Central Alaska. Knickknacks fell and trees shook at College, Fairbanks, and Nenana. Also strong at several locations on Richardson Highway.

1960. March 9. Central Alaska. Felt by all at Healy Fork and Mount McKinley National Park. Trees and bushes shook slightly.

1960. July 16. Seward Peninsula. At Teller, cans fell from shelves; hanging objects swung; loose objects shifted. All were startled.

1960. October 14. Southeastern Alaska. Awakened many at Juneau. Water in containers was disturbed. Felt also at Yakutat, and at Whitehorse, Canada.

1961. January 30. Central Alaska. Felt by many and frightened few at Fairbanks. Cans fell from shelves at Manley Hot Springs. Magnitude 5½.

1961. September 5. Kenai Peninsula. At Seward, plaster cracked and dishes and mirror broke. Felt by and awakened many at Anchorage, Kenai (10 miles north of), Palmer, and Soldatna. Magnitude 6–6¼.

1962. May 9. Southern Alaska. Few alarmed at Anchorage. Dishes fell from shelves; buildings swayed. Magnitude 6.

1962. July 16. Southern Alaska. Walls cracked slightly; goods displaced on shelves in Anchorage. At Farewell, small objects and furniture overturned. Felt by all, awakened and frightened few at McGrath. Several landslides reported at Puntilla. Magnitude 6.

1962. August 18. South-central Alaska. Two shocks awakened many at Moose Pass, Nancy Lake, and Palmer. Trees and bushes shook slightly; small objects shifted. Magnitude 6–6¼ and 6¼–6½, respectively.

1962. October 20. Vicinity of Anchorage. Slight damage. At Anchorage, Girdwood, and Wasilla, plaster cracked, dishes broke, and telephone lines were damaged.

1962. December 13. Kenai Peninsula. Awakened many at Anchorage. Light fixtures swayed; small objects were disturbed. Also felt at Cordova, Kenai Lake, and Valdez.

1963. June 23. Cook Inlet. Slight damage at Barbara Point, Homer, and Seldovia. At Barbara Point, almost everything fell from shelves. Concrete foundation cracked; 6,000-pound fireplace slab moved 6 inches; rockslides occurred. At Homer, posts were torn from ground; plaster cracked; ceiling beam burst; kitchen stove was torn apart. At Seldovia, a brick chimney toppled; small objects and furnishings overturned, some broke. Dust was observed rising from apparent rockslides. Magnitude 6¾.

1963. December 7. Fairbanks-College area. Felt by many at Fairbanks. Glass fell from shelf at College.

1964. January 6. Homer. Felt by all and alarmed few.

1964. February 6. South of Alaska. Plaster cracked on Sitkinak Island. Furnishings shifted; doors swung. Awakened many at Chignik. Magnitude 6¾–7.

1964. April 3. Southern Alaska. At Anchorage, some previous cracks in buildings widened. Fright-

ened residents rushed into the streets. Damage also was reported from a foreshock at 12:00. The main shock was felt north to Fairbanks, south to Kodiak, east to Chitina, and west to Sleetmute. Magnitude 6.

1964. April 14. Kodiak Island region. At Kodiak, plaster cracked; light fixtures broke. Magnitude 4½–4¾.

1964. December 12. Nome. Crusted snow broke into chunks; concrete floor, walls, and plaster cracked. Many were alarmed at Teller where ceiling paper cracked. Magnitude 6.

1965. February 3. Rat Islands. Buildings cracked and objects fell to the floor on Adak and Shemya Islands. On Attu, hairline cracks appeared in runways. A tsunami was generated with a maximum height estimated at 35 to 40 feet at Shemya. Estimated damage of $10,000 was caused by inundation on Amchitka. Magnitude 7¾.

1965. April 16. Central Alaska. At Elim, dishes broke and walls pulled loose at seams. River ice cracked at Kaltag and Unalakleet. Magnitude 5¾–6.

1965. April 26. Alaska Peninsula. Felt by nearly all at Cold Bay. Magnitude 5–5¼.

1965. July 2. Fox Islands. On Umnak, dishes were broken and books were thrown all over one room. Felt by nearly all at Cold Bay. A minor tsunami of 0.3-foot amplitude was recorded at Unalaska. Magnitude 6.9.

1965. December 22. Kodiak Island region. Glasses were broken at the Kodiak Naval Air Station. Described as short and sharp. Magnitude 6¾–7.

1966. August 26. Kotzebue. Many were alarmed. Two bumping shocks shook buildings and rattled loose objects. Magnitude 5.2.

1966. August 30. South-central Alaska. Two shocks, both described as quite strong. At Anchorage, pictures bumped against walls; dishes rattled continuously for several minutes. Many were frightened in the Turnagain section of the city. Also felt at Cordova, Glennallen, Kenai, Palmer, Paxson, and Valdez. Magnitude 5¾–6 and 5.4 respectively.

1967. February 6. Central Alaska. All were awakened in several towns, including Nenana, Fort Greely, and Fairbanks. Magnitude 4.5.

1967. June 20. Dot Lake. The shock frightened all in the area of Mile 1361. Water in the lake was violently disturbed and trees swayed visibly.

1967. June 21. Central Alaska. Three moderate earthquakes, followed by thousands of aftershocks, caused minor property damage in Fairbanks and in some areas south and southeast of Fairbanks. The principal shocks were felt over approximately 90,000 square miles. By the end of the first week, the earthquake swarm had subsided from over 2,000 shocks on the first day to about 425 daily; nearly 6,000 aftershocks were recorded. At least 60 aftershocks were felt by residents, and some caused additional property damage in Fairbanks. In Fairbanks, the State Court and Office Building sustained the most extensive damage, with both exterior and interior cracks. Portions of hanging ceiling and light fixtures fell; plumbing broke, causing considerable flooding; and cabinets and shelves overturned. Three ground cracks, 6 feet apart, were observed at Badger Pass and Peede Road, and blue mud seeped up through the cracks. One tall chimney stack buckled, several chimneys fell, and windows broke. On Richardson Highway, water spouted from ground cracks, a sewerline broke, and chimneys were offset. Small landslides were noted in Healy Canyon, 5 miles north of Mount McKinley National Park. Magnitude of three main shocks 5.4, 5.6, and 5.4, respectively.

1967. June 23. Central Alaska. In Fairbanks, the State Court and Office Building sustained additional interior and exterior cracks; concrete columns appeared to have shifted about ¼ inch. Merchandise fell in stores. Magnitude 4.6.

1968. October 29. East-central Alaska. This was the largest magnitude earthquake in the central interior of Alaska since the magnitude 7 shock of October 15, 1947. The epicenter was southeast of the village of Rampart, on the Yukon River. This area was badly shaken, but no serious damage was sustained at Rampart because most of the buildings were of log construction. Most people there were frightened and ran from buildings. Goods toppled from shelves, and equipment not bolted down was shifted. The greatest evidence of the shock was in the Hunter Creek area less than 10 miles from Rampart. Many landslides occurred there, most of them on the south-facing slopes. Lake ice cracks were extensive in some areas, but were not evident in some places even nearer the epicenter. Ice cracking was observed some 50 miles' distant in the Minto Lakes area. At Nenana, about 50 miles

southeast of Rampart, ground cracks were reported, plaster cracked and fell, and trees and bushes were shaken. The earthquake was reported by residents of Selawik, about 300 miles west-northwest of the epicenter; at Tok, about 275 miles east-southeast; at Fairbanks, some 80 miles southeast; at McGrath, about 240 miles southwest; and at Anchorage, about 280 miles south of the epicenter. During the first 2-week period following the earthquake, NOAA's College Observatory recorded over 2,000 aftershocks; more than 750 were recorded during the first 24-hour period. Magnitude 6.5.

1968. November 10. Alaska Peninsula. Felt by and alarmed many at Akhiok, located on southwest Kodiak Island. Magnitude 5.3.

1968. December 17. Southern Alaska. Felt from Cantwell southeast to Kodiak. Slight damage at Kenai. All were awakened and frightened at Cohoe where canned goods fell and lamps and vases overturned. Small objects fell at Ninilchik. Intensity V effects also were noted at Anchorage, Chugiak, Cooper Landing, Gulkana, Kodiak, Mile 113.5 on Glenn Highway, Seward, Sterling, and Valdez. Magnitude 6½.

1969. February 5. Andreanof Islands. On Adak, mirrors broke and plaster cracked. Extensive glassware breakage. Magnitude 5.0.

1969. May 14. Andreanof Islands. Plaster cracked on Adak and Amchitka Islands. Furniture moved. Knickknacks were broken. Magnitude 7.0.

1969. May 17. Southern Alaska. No damage was reported, but intensity V effects occurred at Cordova. Magnitude 5.4.

1969. November 23. Near Cold Bay. Intensity V was assigned to effects at Cold Bay and King Cove.

1969. December 25. King Cove. This shock was similar to that of November 23. A lighter shock (intensity IV) occurred 3 days later.

1970. January 15. Southern Alaska. Felt over the Cook Inlet and Kenai Peninsula areas, and north in the College-Fairbanks area. Intensity V at Soldatna. Magnitude 6.1.

1970. March 11. Kodiak Island region. A few blocks in a wall cracked on Sitkinak Island. Magnitude 6.4.

1970. April 17. Southern Alaska. Slight damage occurred at Anchorage. Intensity V effects also were noted at Cohoe and Homer. Magnitude 5.7.

1970. August 13. Central Alaska. Minor glass breakage occurred at Fairbanks. Intensity V at College, Eielson Air Force Base, and Nenana. Cracks in ground were reported along the Chena River at Chena Pump Road picnic area. Magnitude 5.6.

1970. November 2. Central Alaska. Intensity V at Talkeetna. Felt also at Anchorage, Lake Minchumina, Palmer, and Summit. Magnitude 5.6.

Hawaii

Résumé

Seismic activity in the islands centers on the Island of Hawaii. Much of this activity is associated directly with volcanic processes because this is an active volcanic region. However, the stronger shocks that are sometimes felt throughout the islands are of tectonic origin. The greatest known earthquake, in 1868, was extremely violent and destructive, considering the sparsely settled nature of the island. Shocks north of Hawaii are often felt strongly on Maui, Lanai, and Molokai.

List of Earthquakes in Hawaii

Year	Date	Time (HST)	Locality	N. lat.	W. long.	Area	Intensity	Authority [1]
				degrees	*degrees*	*sq. mi.*		
1834	Feb. 19	.....	Island of Hawaii	.....	.....	.....	.....	3-2
1838	Dec. 12	.....	..... do	.....	.....	.....	.....	3-2
1868	Apr. 2	About 16:00	Near south coast of Hawaii	19	155½	.....	X	3-2, 3-4, 43, 44
1871	Mar. 19	.....	Oahu	.....	.....	.....	.....	7
1878	Jan. 20	.....	Maui	.....	.....	.....	.....	7
1881	Sept. 30	.....	Oahu and Maui	.....	.....	.....	.....	7
1909	Mar. 13	.....	Island of Hawaii	.....	.....	.....	.....	52
1912	Oct. 13	.....	Hawaii	.....	.....	.....	.....	52
1913	Sept. 8	12:08	Kilauea, Hawaii, area	.....	.....	.....	V	51
	Oct. 25	01:28	..... do	.....	.....	.....	V	51
1918	Nov. 2	00:03	Mauna Loa, Hawaii	.....	.....	.....	VII	4, 51, 53
1919	Jan. 28	17:53	Hawaii	.....	.....	.....	V	4
	Aug. 26	02:34	Island of Hawaii	.....	.....	.....	V	51
	Sept. 14	17:50	Kilauea, Hawaii	.....	.....	.....	VII	4, 51
1923	Jan. 14	02:58	Island of Hawaii	.....	.....	.....	.....	Do.
	Feb. 9	21:11	..... do	.....	.....	.....	.....	51
	Dec. 14	06:04	..... do	.....	.....	.....	.....	51
	Dec. 25	19:16	Hawaii	.....	.....	.....	.....	51
1924	Aug. 20	06:50	Island of Hawaii	.....	.....	.....	.....	51
1925	July 8	06:15	..... do	.....	.....	.....	.....	51
1926	Feb. 7	.....	Oahu and Maui	.....	.....	.....	.....	52
	Feb. 28	07:11	Island of Hawaii	.....	.....	.....	.....	51
	Mar. 19	23:03	..... do	.....	.....	.....	.....	51
	Apr. 22	05:02	Mauna Loa, Hawaii	.....	.....	.....	.....	51
	June 9	10:05	Island of Hawaii	.....	.....	.....	.....	51
1927	Mar. 20	05:22	..... do	.....	.....	.....	.....	51
	Aug. 3	10:12	..... do	.....	.....	.....	.....	51

See footnote at end of table

List of Earthquakes in Hawaii—Continued

Year	Date	Time (HST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1929	Sept. 25	18:51*	Kona, Hawaii	19¾	156	.....	VII	27, 43
	Sept. 28	07:40	Hilo, Hawaii	.....	.....	.....	VII	27
	Oct. 5	21:52*	Holualoa, Hawaii	19¾	156	.....	VII	27, 43
1930	May 20	19:22	Hualalai region, Hawaii	.....	.....	.....	V	27
	May 25	20:47	Kilauea, Hawaii	.....	.....	.....	V	27
1931	Jan. 30	00:08	Waiohinu, Hawaii	.....	.....	.....	V	27
1933	Dec. 2	06:30	Hilo, Hawaii	.....	.....	.....	VI	27
1934	May 10	10:39*	Near Hakalau, Hawaii	19.6	155.4	.....	V	27
1935	Jan. 2	07:17*	Kilauea, Hawaii	19.4	155.3	.....	V	27
	June 28	09:30*	Mauna Loa, Hawaii	19.6	155.2	.....	V	27
	Sept. 30	23:06*	..... do	19.4	155.7	.....	V	27
	Oct. 1	00:28*	..... do	19.6	155.4	.....	V	27
	Nov. 21	01:41*	..... do	19.5	155.5	.....	V	27
1936	Apr. 15	08:57*	Kilauea, Hawaii	19.4	155.2	.....	V	27
1938	Jan. 22	22:33*	North of Maui	21.2	156.1	.....	VIII	27, 43
	Feb. 17	02:48*	Mauna Loa, Hawaii	19.6	155.4	.....	V	27
1939	May 15	10:58*	Kilauea, Hawaii	19.4	155.1	.....	V	27
	May 23	14:44*	..... do	19.5	155.4	.....	V	27
	May 24	13:29*	..... do	19.4	155.2	.....	V	27
	May 29	19:45*	South of Maui	19.5	156.8	.....	V	27
	May 31	21:21*	Kilauea, Hawaii	19.6	155.2	.....	V	27
	June 12	01:41*	Kau Desert, Hawaii	.....	.....	.....	V	27
	July 14	04:21*	Kilauea, Hawaii	19.3	155.1	.....	V	27
1940	June 17	00:27*	North of Island of Hawaii	20.5	155.3	.....	VI	27, 43
	July 15	17:18*	..... do	20.9	155.1	.....	.....	Do.
	Sept. 1	22:45*	..... do	21.0	155.3	.....	V	Do.
1941	Sept. 25	07:48*	Mauna Loa, Hawaii	19.2	155.5	.....	VII	Do.
	Nov. 16	10:11	Near Waimea, Hawaii	.....	.....	.....	V	27
	Nov. 18	03:26	..... do	.....	.....	.....	V	27
	Nov. 22	21:53	..... do	.....	.....	.....	V	27
1943	Nov. 10	16:52	Southern Hawaii	.....	.....	.....	VI	27
1944	Nov. 12	05:26	Southwest of Halemaumau, Hawaii	.....	.....	.....	V	27
	Dec. 27	04:12*	Mokuaweoweo, Hawaii	19½	155½	.....	VI	27, 43
1945	Mar. 4	00:00	Mauna Loa, Hawaii	.....	.....	.....	V	27
	May 19	01:48	..... do	.....	.....	.....	V	27
	Sept. 19	05:33	Saddle area, Hawaii	.....	.....	.....	V	27
1947	Mar. 19	23:06	Island of Hawaii	.....	.....	.....	V	27
	Sept. 30	04:04	..... do	.....	.....	.....	V	27
1948	June 28	01:38	Oahu	.....	.....	.....	V	27
1949	Feb. 26	13:54	Mauna Loa, Hawaii	.....	.....	.....	V	27
	May 2	05:02	..... do	.....	.....	.....	V	27
1950	Mar. 25	05:43	..... do	.....	.....	.....	V	27
	May 29	15:16*	..... do	19½	156	.....	VI	27, 43
1951	Apr. 22	14:52*	Kilauea, Hawaii	19	155½	.....	VII	27
	Aug. 21	00:57*	Kona, Hawaii	19¾	156	.....	IX	27, 43
	Sept. 16	01:43*	Kaoiki Fault, Hawaii	19.2	155.5	.....	V	27
	Nov. 8	09:34	Mauna Loa, Hawaii	19.2	155.5	.....	VI	27
1952	Feb. 2	01:16	Near Kaumana, Hawaii	.....	.....	.....	V	27
	Mar. 17	17:58*	Off coast of Hawaii	19.1	155.0	.....	V	27
	Apr. 6	21:10*	South of Molokai	21	157	.....	V	27

See footnotes at end of table.

List of Earthquakes in Hawaii—Continued

Year	Date	Time (HST)	Locality	N. lat.	W. long.	Area	Intensity	Authority[1]
				degrees	*degrees*	*sq. mi.*		
1952	May 23	12:12*	Kona, Hawaii	19.5	155.5	.....	VI	27
	July 12	13:53	..... do	.....	.....	.....	V	27
1953	Jan. 9	21:10*	Mauna Loa, Hawaii	19.4	155.5	.....	V	27
	Jan. 15	02:05*	..... do	19.3	155.4	.....	V	27
	Aug. 21	19:47	Hawaii	.....	.....	.....	V	27
1954	Mar. 30	08:42*	Near Kalapana, Hawaii	20	155	.....	VII	27
	July 3	11:53*	Kilauea, Hawaii	20½	155½	.....	VI	27
1955	Mar. 27	16:02	..... do	.....	.....	.....	VII	27
	Apr. 1	04:24*	..... do	19½	155	.....	V	27
	Aug. 7	07:18*	Off north coast of Hawaii	20½	155½	.....	V	27
	Aug. 14	02:28*	Kilauea, Hawaii	19½	155½	.....	.....	27
	Oct. 26	16:56*	Near Mokuaweoweo, Hawaii	19½	155½	.....	V	27
1956	May 13	21:54*	Off north coast of Hawaii	20.3	155.3	.....	V	27
	Oct. 16	00:45*	West of Hawaii	20	157	.....	V	27
1957	Aug. 18	00:42*	Near Hana, Maui	21	156	.....	V	27
1958	Feb. 23	04:01	Near Ulupau Head, Oahu	.....	.....	.....	V	27
1961	July 23	05:24	Off coast of Island of Hawaii	.....	.....	.....	V	27
	Sept. 22	17:02*	Kilauea, Hawaii	19.4	155.1	.....	V	27
	Sept. 24	19:29*	..... do	19.4	155.1	.....	V	27
1962	June 27	18:27*	Kaoiki Fault, Hawaii	19.4	155.4	.....	VI	3-56, 27
1963	Oct. 23	10:24*	..... do	19.4	155.4	.....	V	27
1966	Nov. 5	09:43*	Southeast of Kealakekua, Hawaii	19.5	155.9	.....	V	27
1970	Oct. 25	09:55*	South of Molokai	21.0	156.8	.....	.....	27

*Instrumental origin time and epicenter.

[1] See References, p. 133.

MAJOR EARTHQUAKES

Earthquake of April 2, 1868

Time of occurrence.—About 16:00.

Epicenter.—Near south coast of Hawaii (about 19° N., 155½° W.).

Intensity.—X.

Description.—Nearly every wooden house at Keiawa, Penaluu, Ninole, and beyond was knocked off its foundation or tumbled over, and straw houses with posts in the ground were torn to shreds. It shook down almost every wall in Hilo and caused landslides beyond Hilo, as far as Waipio and Hamakua. Fissures opened and brooks became muddy. In one place a fissure opened about a foot, and, when it closed, the two sides were several inches from coincidence. At Kealakekua, strong trees were bent backward and forward like reeds in a storm. At Kohala, is was reported that the force of the shock stopped all sugar mill engines, even the large 75-horsepower engine which was running at the time with a full head of steam. Ground waves estimated at 1 to 2 feet from trough to crest were observed at Kohala. The shock was strong on Maui. At Ulupalakua, the motion was so violent it was difficult to stand. On western Maui and Lanai (130 to 160 miles from the epicenter), houses shook and rocked and rumbling sounds were heard. The shock was distinctly felt on Oahu and Kauai (about 350 miles from the epicenter). Clocks stopped at Honolulu.

A tsunami struck the Kau-Puna coast, adding to the devastation. It was reported that the wave rolled in over the tops of the coconut trees, a height of at least 60 feet. Most houses were swept

from the beach, and a number of persons were drowned. At Hilo, the height of the wave was 10 feet, and at Kealakekua, 8 feet. The tsunami also was observed on Maui and Oahu.

There were extensive surface effects in the epicentral region. Fissures extended from Pahala to Kilauea. At Kohuku, a fissure nearly 3 miles long was reported. A volcanic eruption took place from this fissure on April 7. Foreshocks began on March 27. One on March 28 at 13:28 was strong enough to throw down stone walls.

INTERMEDIATE AND MINOR EARTHQUAKES

1834. February 19. Island of Hawaii. Stone walls were thrown down; clocks stopped. Undulating motion made it difficult to walk or stand.

1838. December 12. Island of Hawaii. Similar effects to the February 1834 quake.

1871. March 19. Oahu. Felt strongly at Honolulu.

1878. January 20. Maui. A strong shock. Tsunami reported.

1881. September 30. Oahu and Maui. Felt at Honolulu and on Maui.

1909. March 13. Island of Hawaii. Felt generally.

1912. October 13. Hawaii. Felt throughout the islands.

1913. September 8. Kilauea, Hawaii, area. Felt near Kilauea. Sharply felt at Hilo.

1913. October 25. Kilauea, Hawaii, area. All were awakened and unstable objects overturned at Kilauea. The shock was preceded and accompanied by roaring sounds. Strong at Hilo.

1918. November 2. Mauna Loa, Hawaii. Water tanks and stone walls were damaged at Kapapala Ranch. Felt strongly at Hilo and Kona.

1919. January 28. Hawaii. Felt by many persons in the islands.

1919. August 26. Island of Hawaii. Felt strongly at Kona and Hilo.

1919. September 14. Kilauea, Hawaii. Chimneys fell and walls cracked in the Kau section. Slight damage was reported at Hilo; felt on Maui and Oahu.

1923. January 14. Island of Hawaii. Felt over Island of Hawaii and on Oahu.

1923. February 9. Island of Hawaii. Felt throughout Island.

1923. December 14. Island of Hawaii. Felt in Hilo, Kona, and Kau.

1923. December 25. Hawaii. Felt on Oahu, Molokai, and Lanai.

1924. August 20. Island of Hawaii. Felt at Hilo, Pahala, and Kona.

1925. July 8. Island of Hawaii. Felt all over Island.

1926. February 7. Oahu and Maui. Many persons were alarmed.

1926. February 28. Island of Hawaii. Generally felt. Strong at Kapapala Ranch.

1926. March 19. Island of Hawaii. Felt strongly at Kohala and Honomu. Also felt at Hilo (Hawaii), on Maui, and weakly at Honolulu (Oahu).

1926. April 22. Mauna Loa, Hawaii. Widely felt on the Island of Hawaii. Also felt at Honolulu, Oahu.

1926. June 9. Island of Hawaii. Widely felt.

1927. March 20. Island of Hawaii. Felt throughout the Island. Slight damage at Hilo.

1927. August 3. Island of Hawaii. Felt throughout the Island. Slight damage at Hilo.

1929. September 25. Kona, Hawaii. Walls fell in Kona District. People were frightened and rushed from homes. Magnitude 5½.

1929. September 28. Hilo, Hawaii. Strongly felt. A church was badly cracked and a street was damaged.

1929. October 5. Holualoa, Hawaii. Walls fell and houses displaced on their foundations at Holualoa. A landslide occurred near Waimea. Intensity V on Lanai and Maui and intensity IV at Waimanalo, Oahu. Magnitude 6½.

1930. May 20. Hualalai region, Hawaii. Felt strongly from Hilo to Kona.

1930. May 25. Kilauea, Hawaii. Felt strongly from Hilo to Kona. Moderate shock accompanied by thunderous noises at Honokahau.

1931. January 30. Waiohinu, Hawaii. Rocking motion felt by many.

1933. December 2. Hilo, Hawaii. The entire Island of Hawaii was shaken by shocks preceding the eruption of the Mauna Loa Volcano.

1934. May 10. Near Hakalau, Hawaii. Strong at Hakalau where residents ran from buildings. Felt throughout eastern Hawaii and on Maui.

1935. January 2. Kilauea, Hawaii. Felt over the Island of Hawaii.

1935. June 28. Mauna Loa, Hawaii. Some damage was reported at Hilo. Generally felt on Hawaii.

1935. September 30. Mauna Loa, Hawaii. Felt throughout the Island of Hawaii.

1935. October 1. Mauna Loa, Hawaii. Felt throughout the Island of Hawaii.

1935. November 21. Mauna Loa, Hawaii. Felt throughout the Island of Hawaii. Broke a window at Kapapala Ranch. The Mauna Loa eruption followed 17 hours later.

1936. April 15. Kilauea, Hawaii. Felt throughout the Island of Hawaii.

1938. January 22. North of Maui. Considerable damage on Maui, estimated at $150,000. Several were injured by landslides. Olinda Reservoir was badly cracked, and many pipelines were broken. Intensity VI on Molokai and northern Hawaii. Intensity V on Lanai and Oahu; IV on Kauai. Magnitude 6¾.

1938. February 17. Mauna Loa, Hawaii. Felt strongly at Kona; slightly at Hilo.

1939. May 15. Kilauea, Hawaii. Felt throughout the Island of Hawaii. Slight damage was reported at Hilo.

1939. May 23. Kilauea, Hawaii. Felt throughout the Island of Hawaii.

1939. May 24. Kilauea, Hawaii. Felt throughout the Island of Hawaii.

1939. May 29. South of Maui. Widely felt on Oahu and Maui.

1939. May 31. Kilauea, Hawaii. Strongly felt in the Hawaii National Park. Moderate in Kau and Hilo districts.

1939. June 12. Kau Desert, Hawaii. Felt throughout the Island of Hawaii.

1939. July 14. Kilauea, Hawaii. Generally felt on the Island with greatest intensity in the Kau-Puna area.

1940. June 17. North of Island of Hawaii. Slight damage was reported on the Island of Hawaii. At Kaunakakai, vases overturned and glass cracked. Maui experienced sharp shocks. Everyone awakened on Molokai and Lanai. Magnitude 6. Aftershocks felt on Hawaii, Maui, and Oahu at 08:17 and 13:09.

1940. July 15. North of Island of Hawaii. Felt on all the islands except Kauai.

1940. September 1. North of Island of Hawaii. Aftershock of the June 17 shock; generally felt on Hawaii.

1941. September 25. Mauna Loa, Hawaii. Sharply felt on Hawaii. Moderate damage at Pahala where plaster cracked and furniture overturned. Felt by several at Honolulu, Oahu. Magnitude 6.

1941. November 16. Near Waimea, Hawaii. Felt throughout the Island of Hawaii. Slight damage.

1941. November 18. Near Waimea, Hawaii. Strongly felt on Hawaii. Felt lightly on Maui.

1941. November 22. Near Waimea, Hawaii. Strongly felt on Hawaii. Felt lightly on Maui.

1943. November 10. Southern Hawaii. Stone walls were thrown down southwest of Pahala. Widely felt.

1944. November 12. Southwest of Halemaumau, Hawaii. Widely felt on Hawaii.

1944. December 27. Mokuaweoweo, Hawaii. Stone fences were thrown down near Hilea. Felt on Oahu.

1945. March 4. Mauna Loa, Hawaii. Moderate shock was widely felt on the Island of Hawaii. Clocks stopped at Kona.

1945. May 19. Mauna Loa, Hawaii. Generally felt on Hawaii; slightly on Oahu.

1945. September 19. Saddle area, Hawaii. Felt throughout the Island of Hawaii.

1947. March 19. Island of Hawaii. Widely felt.

1947. September 30. Island of Hawaii. Felt from Kona to Hilo.

1948. June 28. Oahu. Two sharp shocks were felt on Oahu. Several windows were broken, walls cracked, and plaster fell in and near Honolulu. Also felt slightly on Kauai, Molokai, and at Hilo, Hawaii.

1949. February 26. Mauna Loa, Hawaii. Felt strongly from Hilo to Naalehu.

1949. May 2. Mauna Loa, Hawaii. Felt from Holualoa to Naalehu. Many were awakened; some rushed outdoors.

1950. March 25. Mauna Loa, Hawaii. Widely felt on the Island of Hawaii.

1950. May 29. Mauna Loa, Hawaii. Slight damage was reported at Hilo; strong at Kona. Magnitude 6¼.

1951. April 22. Kilauea, Hawaii. Felt throughout the Island of Hawaii and by many on Maui and Oahu. Slight damage occurred in Hilo. Small earthslips and several earthslides. Magnitude 6½.

1951. August 21. Kona, Hawaii. Damage extended for more than 50 miles along the Kona coast from Holualoa to Honuapo. Many buildings were wrecked or damaged; water tanks collapsed. Two persons were injured at Kai Malino. Magnitude 6.9. Many small aftershocks continued for 3 hours. A small tsunami was observed at Napoopoo and Milolii.

1951. September 16. Kaoiki Fault, Hawaii. Strongly felt from Kona to Hilo.

1951. November 8. Mauna Loa, Hawaii. Strong at Kahuku. Felt throughout southern Hawaii.

1952. February 2. Near Kaumana, Hawaii. Felt strongly at Hilo and throughout the Island.

1952. March 17. Off coast of Hawaii. Felt at Noalehu and Kalapana.

1952. April 6. South of Molokai. Felt on Oahu, Maui, Kauai, Molokai, and Hawaii.

1952. May 23. Kona, Hawaii. Felt throughout the Island of Hawaii and on Maui. Minor damage in central Kona. Magnitude 6.

1952. July 12. Kona, Hawaii. Felt from Kona to Hilo.

1953. January 9. Mauna Loa, Hawaii. Felt strongly over southern Hawaii from Hilo to Kona. Felt slightly on Oahu.

1953. January 15. Mauna Loa, Hawaii. Felt strongly over southern Hawaii from Hilo to Kona. Felt slightly on Oahu.

1953. August 21. Hawaii. Felt strongly at Mauna Loa, Kona, and Hilo; weakly on Maui and Oahu.

1954. March 30. Near Kalapana, Hawaii. Extensive damage in Hilo and Puna districts. Water tanks were thrown down, walls cracked, and windows broke. Also felt on Maui. Magnitude 6½. A foreshock (magnitude 6) occurred at 06:40 and was strongly felt.

1954. July 3. Kilauea, Hawaii. Minor damage at Hilo. Felt extensively over southern Hawaii.

1955. March 27. Kilauea, Hawaii. Felt strongly in Hawaii National Park. Waterlines were broken, houses cracked, and cracks opened in Mamalahoa Highway.

1955. April 1. Kilauea, Hawaii. Felt over the Island of Hawaii and by several on Maui and Oahu.

1955. August 7. Off north coast of Hawaii. Felt over the Islands of Hawaii, Maui, and Oahu.

1955. August 14. Kilauea, Hawaii. Slight damage was reported 40 miles southwest of Hilo. Felt over the Island of Hawaii and on Maui and Oahu. Felt weakly on Kauai.

1955. October 26. Near Mokuaweoweo, Hawaii. Felt strongly in Hawaii National Park.

1956. May 13. Off north coast of Hawaii. Felt from the Hawaii National Park, Hawaii, to Honolulu, Oahu.

1956. October 16. West of Hawaii. Felt over the Island of Hawaii and as far as Honolulu, Oahu.

1957. August 18. Near Hana, Maui. Widely felt on the Islands of Maui and Hawaii.

1958. February 23. Near Ulupau Head, Oahu. Awakened many on Oahu.

1961. July 23. Off coast of Hawaii. Slight damage at Kohala, Hawaii. Also felt on Maui, Lanai, and Oahu. Magnitude 5.1. Followed by an aftershock at 05:28 (magnitude 4.7).

1961. September 22. Kilauea, Hawaii. Slight damage at Hilo, Pahoa, and Papaikou. Magnitude 4.1.

1961. September 24. Kilauea, Hawaii. Slight damage at Naalehu, Pahoa, and Papaikou. Magnitude 4.2. An aftershock followed at 20:29 (magnitude 4.1).

1962. June 27. Kaoiki Fault, Hawaii. A wall cracked at Hilo, and part of a cliff at Napoopoo Beach tumbled into the ocean. Felt weakly on Maui and Oahu. Magnitude 6.1.

1963. October 23. Kaoiki Fault, Hawaii. Felt on the Island of Hawaii. Books fell from shelf at Hilo. Magnitude 5.3.

1966. November 5. Southeast of Kealakekua, Hawaii. The shock was observed by many, but caused only slight alarm. A bottle was displaced on a shelf; radio tower swayed. Explosive jolt. Magnitude 3.8.

1970. October 25. South of Molokai. Felt on northern Hawaii, Maui, and Molokai. Magnitude 4.9.

Puerto Rico Region

Résumé

Many earthquakes have been felt on Puerto Rico since the settlement of the Island by Europeans, and several of the shocks have resulted in severe property damage. There is much geologic and topographic evidence that earthquakes have been of relatively frequent occurrence in this region for thousands of years.

There has not been a destructive earthquake near Puerto Rico since the October 11, 1918, shock that centered in northwestern Mona Passage. The Island sustained much damage in its western portions and 116 lives were lost.

List of Earthquakes in Puerto Rico Region

Year	Date	Time (Local)	Locality	N. lat.	W. long.	Intensity	Authority [1]
				degrees	*degrees*		
1785	July 11	.....	Probably Anegada Passage	18½	64	.....	63, 69
1824	Apr. 20	.....	St. Thomas, V.I.	18.4	64.9	VII	63, 64, 69
1843	Feb. 8	.....	Guadeloupe and Antigua, Leeward Islands.	.....	.....	.....	63, 69
1844	Apr. 16	.....	Probably north of Puerto Rico	.....	.....	VII	63, 64, 69
1846	Nov. 28	.....	Probably Mona Passage	.....	.....	VI	63
1851	Feb. 22	.....	Puerto Rico	.....	.....	V	63
1855	Dec. 14	.....	Salinas, P.R.	18.0	60.3	V	63
1860	Oct. 23	.....	Mayagüez, P.R.	.....	.....	VI	69
1865	May 12	.....	St. Thomas, V.I.	18.4	64.9	V–VI	63, 69
	Aug. 30	.....	Puerto Rico region	.....	.....	V–VI	63
1867	Nov. 18	14:45	Virgin Islands	18.2	65	VIII	63, 64, 69
1868	Mar. 17	.....	Puerto Rico and Virgin Islands	.....	.....	VII	63, 64
1875	Dec. 8	.....	Arecibo, P.R.	18.5	66.7	VII	63, 69
1900	Oct. 2	.....	Cidra, P.R.	18.2	66.2	.....	63
1901	Oct. 22	.....	..... do	18.2	66.2	V	63
1906	Sept. 27	.....	Puerto Rico region	19	66½	VI–VII	63
1908	Aug. 13	.....	Ponce, P.R.	18.0	66.6	.....	63
	Sept. 5	.....	Puerto Rico region	.....	.....	V	63
1909	Feb. 17	.....	..... do	.....	.....	V	63
1910	Sept. 9	.....	..... do	.....	.....	V	63
1913	July 24	.....	Probably Anegada Passage	18½	64	.....	63
1916	Apr. 24	00:27*	Santo Domingo, Dominican Republic	18½	68	VIII [2]	43, 63
1917	July 26	21:01*	Northwest of Puerto Rico	19	67½	V	Do.

See footnotes at end of table.

List of Earthquakes in Puerto Rico Region—Continued

Year	Date	Time (Local)	Locality	N. lat.	W. long.	Intensity	Authority[1]
				degrees	*degrees*		
1917	Aug. 7	.....	Punta Higüero, P.R.	18.4	67.3	V	63
	October or November.	.....	Mayagüez, P.R.	18.2	67.2	V–VI	63
1918	Oct. 11	10:15*	Northwestern Mona Passage	18.5	67.5	VIII–IX	43, 63, 64
	Oct. 24	.....	..... do	.....	.....	VI	63
	Nov. 12	.....	..... do	.....	.....	V–VI	63
1928	Nov. 18	22:35	Puerto Rico region	.....	.....	V	27
1929	Oct. 16	05:25	..... do	.....	.....	V	27
	Oct. 16	06:20	..... do	.....	.....	V	27
1934	Aug. 2	03:41	..... do	.....	.....	V	27
1943	July 28	23:02*	Northwest of Puerto Rico	19¼	67½	V	27, 43
	July 29	21:02*	..... do	19¼	67¾	V	Do.
1946	Aug. 4	13:51*	Dominican Republic	19¼	69	VI	Do.
1951	Sept. 15	04:11	Puerto Rico region	.....	.....	VI	27
1956	Feb. 13	11:33*	North of Puerto Rico	19	66½	V	27
1959	Jan. 26	20:20*	Eastern Dominican Republic	18	68½	V	27
	Mar. 29	01:40*	Virgin Islands region	19	64½	V	27
1961	Aug. 2	23:08*	Puerto Rico region	18.4	66.3	V	27
1962	Apr. 20	01:48*	Near north coast of Haiti	20.6	72.2	V	27
	July 23	18:12*	Virgin Islands region	19.0	65.1	.....	27
1966	Nov. 3	12:25*	Mona Passage	19.2	68.0	V	27
1967	Feb. 1	19:23	Guayanilla, P.R.	18.0	66.8	V	27
	Feb. 3	01:20	..... do	18.0	66.8	V	27
	Feb. 13	19:56	..... do	18.0	66.8	V	27
1970	July 8	00:49*	Virgin Islands	18.0	64.6	V	27

*Instrumental origin time and epicenter.

[1] See References, p. 133.

[2] Intensity at epicenter or at location named.

MAJOR EARTHQUAKES

Earthquake of November 18, 1867

Time of occurrence.—14:50 (about).

Epicenter.—Virgin Islands, between St. Thomas and St. Croix, at approximately 18°10′ N., 65° W.

Area felt.—From Santo Domingo, Dominican Republic, to Guadeloupe Island in the Leeward Islands.

Intensity.—Probably VIII.

Description.—Property damage occurred in the Virgin Islands and over all of Puerto Rico. The disturbance was followed by great sea waves, and by aftershocks lasting 5 to 6 months. At Fajardo, in eastern Puerto Rico, the church was left in ruins. At Guayama, about 31 miles to the southwest, the church was badly damaged and the roof collapsed. At San Juan, churches and homes were damaged but no walls were thrown down. Slight damage also was sustained at Isabela, Ponce, and San Germán, Puerto Rico. Reports from the Alcalde of Yabucoa in southeastern Puerto Rico indicated that the sea withdrew about 150 yards and then advanced an equal distance over the land. A tsunami was noted at Fajardo, 20 miles to the northeast, but it was very small.

Earthquake of October 11, 1918

Time of occurrence.—10:15*.

Epicenter.—Northwestern Mona Passage, 18.5° N., 67.5° W.

Area felt.—Probably throughout the Puerto Rico region.

Intensity.—VIII–IX.

Magnitude.—7.5.

Description.—This was one of the most violent earthquakes felt on Puerto Rico since its occupation by Europeans. Immediately following the shock a tsunami broke upon the shore, drowning many persons and destroying many native dwellings. Property damage was estimated at about $4 million and 116 lives were lost.

Most extensive property damage reports were received from Aguada and Anasco, both located on alluvium in western Puerto Rico. In Aguada, masonry buildings were largely demolished. Some walls, badly cracked by the main shock, were thrown down by the aftershock of October 24. The church, built prior to 1867, was entirely destroyed. Some concrete walls and foundations without reinforcement were wrecked. A one-story reinforced concrete school was practically undamaged, and frame buildings were not damaged appreciably.

At Anasco, all brick buildings were destroyed or condemned. Several concrete structures with very little reinforcement were generally wrecked during aftershocks, but those which were well reinforced sustained little damage. Wood frame buildings were not damaged except where timbers had rotted.

North of Aguada at Aguadilla, most of the buildings on alluvium were badly damaged or destroyed. As a rule, masonry structures were badly cracked.

At Mayagüez, south of Anasco, the brick Catholic Church had to be razed, but the brick Presbyterian Church was only slightly damaged. Several persons were killed in the collapse of a two-story, poorly built, concrete cigar factory.

Many bridges were damaged; railroad tracks were bent and displaced; pipelines and flumes were wrecked; and tall brick chimneys were thrown down. Two cable links were broken in Mona Passage. Before the tsunami arrived, the ocean withdrew and exposed reefs and stretches of seafloor never visible during low tide. When the water returned, it reached heights that were equally high above normal, perhaps 19½ feet.

INTERMEDIATE AND MINOR EARTHQUAKES

1785. July 11. Probably Anegada Passage. Felt on Antigua and St. Christopher, Leeward Islands, and Tortola, Virgin Islands. Most violent shock known on Antigua to that date. Clefts formed in rocks on Tortola. Felt onboard ships in area. Probably strong on Puerto Rico.

1824. April 20. St. Thomas, Virgin Islands. Very severe shock. One building was destroyed. Many persons were thrown out of bed. Probably strong on Puerto Rico.

1843. February 8. Guadeloupe and Antigua, Leeward Islands. Very destructive. Pointe-à-Pitre, Guadeloupe Island, was left in ruins. Probably felt in eastern Puerto Rico; intensity IV in the Virgin Islands.

1844. April 16. Probably north of Puerto Rico. Several houses and some public buildings were overthrown or cracked on Puerto Rico. A tower of the Catholic Cathedral at Isabela was cracked. The shock was also strong on St. Thomas, Virgin Islands.

1846. November 28. Probably Mona Passage. Felt over all of Puerto Rico, with highest intensity reported in the northwestern section. A church at Isabela, damaged in the 1844 earthquake, was further damaged. Intensity V at Cabo Rojo and Arecibo; intensity IV at San Juan.

1851. February 22. Puerto Rico. Walls of city hall (evidently at San Juan) were cracked. Three shocks were noted.

1855. December 14. Salinas, Puerto Rico. Strongest shock ever felt at Salinas. Intensity IV at Aguas Buenas.

1860. October 23. Mayagüez, Puerto Rico. Some damage was sustained.

1865. May 12. St. Thomas, Virgin Islands. Two strong earthquakes; the second caused some damage.

1865. August 30. Puerto Rico region. Churches were cracked at Manati and Ponce.

1868. March 17. Puerto Rico and Virgin Islands. Strong aftershock of November 18, 1867, earth-

quake. Another tsunami occurred along the coast of western Puerto Rico. Magnitude 6.5.

1875. December 8. Arecibo, Puerto Rico. The church was so badly cracked at Arecibo that the dome had to be taken down. Some tall statues were badly damaged. There was little or no damage reported elsewhere.

1900. October 2. Cidra, Puerto Rico. Two strong shocks were felt over the eastern two-thirds of the Island.

1901. October 22. Cidra, Puerto Rico. Felt throughout eastern Puerto Rico.

1906. September 27. Puerto Rico region. Felt from Santo Domingo, Dominican Republic, to St. Thomas, Virgin Islands. Slight to moderate damage occurred at San Juan, Humacao, Fajardo, Caguas, Guayama, Bayamón, Río Piedras, Ponce, San Germán, Mayagüez, Anasco, and Isabela. The intensity was not less than IV in any part of Puerto Rico.

1908. August 13. Ponce, Puerto Rico. Strong shock. Post office sustained some damage.

1908. September 5. Puerto Rico region. Intensity V in eastern Puerto Rico and on Vieques.

1909. February 17. Puerto Rico region. Intensity V on Culebra, Puerto Rico, and on St. Thomas, Virgin Islands.

1910. September 9. Puerto Rico region. Felt generally throughout the island. Intensity about V in western Puerto Rico.

1913. July 24. Probably Anegada Passage. Felt on St. Thomas, Virgin Islands, and throughout neighboring islands.

1916. April 24. Santo Domingo, Dominican Republic. Damaging at Santo Domingo. Probably felt on Puerto Rico.

1917. July 26. Northwest of Puerto Rico. The main shock of this series was felt over all of Santo Domingo and Haiti, except the southwest peninsula. Intensity about V at Mayagüez, Puerto Rico. Magnitude 7.0.

1917. August 7. Punta Higüero, Puerto Rico. Small cracks were sustained in a building.

1917. October or November. Mayagüez, Puerto Rico. Some houses sustained cracks. Vertical movement.

1918. October 24. Northwestern Mona Passage. An aftershock of the October 11 earthquake reached intensity VI on Puerto Rico.

1918. November 12. Northwestern Mona Passage. Another aftershock of the October 11 earthquake reached intensity V–VI on Puerto Rico.

1928. November 18. Puerto Rico region. Many residents in the central Puerto Rican town of Orocovis were alarmed. Also felt at Mayagüez and San Juan.

1929. October 16. Puerto Rico region. Residents were generally alarmed at San Germán and Mayagüez. Two shocks were noted at Mayagüez.

1934. August 2. Puerto Rico region. At San Juan, several families were awakened and alarmed. The shock was strong at Caguas, about 17 miles southeast of San Juan.

1943. July 28. Northwest of Puerto Rico. Felt strongly by many in San Juan. Magnitude 7¾.

1943. July 29. Northwest of Puerto Rico. Felt throughout Puerto Rico. A clock stopped at San Juan. Magnitude 6½.

1946. August 4. Dominican Republic. Felt over all of Puerto Rico. Minor damage was reported at some factories in the Comerío area south of San Juan, and at Maricao, west of Comerío. Magnitude 8.1.

1951. September 15. Puerto Rico region. Strongly felt throughout the island. Galvanometer and variometer were shifted at the San Juan Observatory at Cayey.

1956. February 13. North of Puerto Rico. Felt throughout Puerto Rico. Intensity V at Aguadilla, Caguas, and Mayagüez.

1959. January 26. Eastern Dominican Republic. Intensity VI at Moca, Puerto Rico; cracks occurred in concrete walls. Also felt at Mayagüez, Morovis, and San Juan.

1959. March 29. Virgin Islands region. Intensity V on Puerto Rico. Also felt on St. Thomas at Charlotte Amalie.

1961. August 2. Puerto Rico region. Felt strongly throughout the island. Intensity V at Aguadilla, Caguas, Fortuna, Guaynabo, Humacao, Mayagüez, and Utuado.

1962. April 20. Near north coast of Haiti. Minor damage was sustained at Port au Prince, Haiti. Felt at Ponce (intensity V) and at San Juan. Magnitude 6½–6¾.

1962. July 23. Virgin Islands region. Felt strongly in eastern Puerto Rico and on St. Thomas, Virgin Islands.

1966. November 3. Mona Passage. At Ponce, several residents ran into the streets, and records fell

to the floor in radio studios. Also felt at Caguas, Cayey, San Juan, and in Playa de Ponce area. Magnitude 6–6¼.

1967. February 1. Guayanilla, Puerto Rico. Felt by all and frightened many.

1967. February 3. Guayanilla, Puerto Rico. Felt by and awakened many. Three shocks were felt within 3 hours.

1967. February 13. Guayanilla, Puerto Rico. Felt by all and frightened many. Three shocks were felt.

1970. July 8. Virgin Islands. Furniture and small objects shifted at Caguas, Gurabo, Guaynabo, and Roosevelt Roads (U.S. Naval Station), Puerto Rico. Many were awakened and frightened at most towns. At Guayanilla (central San Francisco), an already damaged. chimney was further damaged. Underground pipes were reportedly damaged on St. John (Caneel Bay Plantation), Virgin Islands. Felt by all and awakened many on St. Thomas (Frenchman's Bay), Virgin Islands, but no damage was noted.

References

1. Brigham, William T., "Volcanic Manifestations in New England; Being an Enumeration of the Principal Earthquakes from 1638 to 1869," *Memoirs of the Boston Society of Natural History,* Vol. II, pp. 1–28, January 1871.

1A. *Jesuit Relations,* Thwaite translation, Vol. 47, pp. 255–257.

2. *American Journal of Science and Arts,* 1819–1886 (and its predecessor, *Silliman's Journal of Science*). Silliman's Journal continued until 1845, and then the former was published in four series: 1846–1866; 1867–1870; 1871–1847; 1898 to present. Inasmuch as all the references used are in the 19th century, only the last two digits of the year are given. Thus, 2–86, refers to the volume for the year 1886. This reference contains the important catalog of C.G. Rockwood for the years 1872 to 1877.

3. *Bulletin of the Seismological Society of America.* Annual volumes since 1911. Reference is by volume. The year may be obtained by adding 10 to the volume number. Published for the Society by Stanford University Press through the No. 2 issue of 1934, by the University of California Press through 1960, and by the Waverly Press, Baltimore, Md., thereafter.

4. *Monthly Weather Review,* U.S. Weather Bureau. The general reference to this source is sufficient because earthquakes are described in the issue for the month in which they occurred, with few exceptions. Earthquake reports are very complete for the period 1915 to June 1924.

4A. *Philosophical Transactions,* "An Account of the Earthquake Felt in New England, and the Neighbouring Parts of America, on the 18th of November 1755," Vol. L, pp. 1–18, 1757.

5. Kain, Samuel, "Recent Earthquakes in New Brunswick, 1878–1904," *Bulletin of the Natural History Society of New Brunswick,* Vol. 5, No. 22, Part 2.

6. *Nature,* London. Reference is made in the same manner as for American Journal of Science and Arts (see ref. 2).

7. Milne, J., "Catalogue of Destructive Earthquakes," *British Association for the Advancement of Science,* Appendix No. 1, pp. 649–740, 1911.

8. Reid, Harry Fielding, Unpublished records, Johns Hopkins University, Baltimore, Md. These include a card index, volumes of newspaper clippings, and special correspondence. In many cases where complete information is available from other sources, valuable supplementary information regarding area and intensity is given.

8A. Reid, Harry Fielding, "List of Strong Shocks in the United States and Its Dependencies," *British Association for the Advancement of Science,* p. 41 and Appendix 1, p. 642, 1911.

8B. Wollard, George P., "A Catalogue of Earthquakes in the United States Prior to 1925, Based on Unpublished Data Compiled by Harry Fielding Reid and Published Sources Prior to 1930," Hawaii Institute of Geophysics, University of Hawaii, Honolulu, June 1968.

9. Woodworth, J.B., Unpublished records, Harvard University, through the courtesy of Francis A. Tondorf, S.J., Georgetown University, Washington, D.C.

10. U.S. Department of Commerce, Coast and Geodetic Survey, *Quarterly Seismological Report,* 1925. The last report for 1925 also contains information for the second half of 1924. Earthquakes are described in the report for the month in which they occurred thereafter.

11. Tondorf, Francis A., *The Registration of Earthquakes and Press Dispatches on Earthquakes,* Georgetown University, Washington, D.C. Earthquakes are found under year and date of occurrence. In addition, monthly "Seismological Dispatches" give, in advance of publication, the same information in more detail.

12. *Canadian Naturalist and Geologist,* Vols. 5 and 6. Reference is made in the same manner as

for American Journal of Science and Arts (see ref. 2).

13. Hodgson, Ernest A., "The St. Lawrence Earthquake, February 28, 1925," *Transactions of the Royal Society of Canada,* 1927.

14. Deckert, Emil, "Earthquakes of North America," *Zeitschrift der Gesellschaft fur Erdkunde zu Berlin,* No. 5, 1902.

15. *Science.* Reference is made in the same manner as for American Journal of Science and Arts (see ref. 2).

16. Dutton, Capt. Clarence E., "The Charleston Earthquake of August 31, 1886," *Ninth Annual Report,* 1887–88, U.S. Geological Survey, pp. 203–528, 1889.

17. Hobbs, William Herbert, "Earthquakes in Michigan," *Michigan Geological and Biological Survey,* Publication 5, Geological Series 3, pp. 69–87, Lansing, Mich., 1911.

18. "Earthquakes of the Western United States," *Atlantic Monthly,* Vol. 24, pp. 550–551, November 1869.

19. Fuller, Myron L., "The New Madrid Earthquake," *U.S. Geological Survey Bulletin 494,* 119 pp., 1912.

20. *American Geologist.* Reference is made in the same manner as for American Journal of Science and Arts (see ref. 2).

21. *Popular Science.* Reference is made in the same manner as for American Journal of Science and Arts (see ref. 2).

22. Udden, J.A., *Transactions of the Illinois Academy of Sciences,* Vol. 3, p. 132, 1910.

23. Udden, Anton D., *Transactions of the Illinois Academy of Sciences,* Vol. 5, 1912.

24. Smith, Warren DuPré, "Series of Earthquakes in North Carolina," *Smithsonian Report,* 1874.

25. Holden, Edward S., "A Catalogue of Earthquakes on the Pacific Coast, 1769–1897, *Smithsonian Miscellaneous Collections,* Vol. 1087, 1898.

26. McAdie, Alexander G., "Catalogue of Earthquakes on the Pacific Coast, 1897–1906," *Smithsonian Miscellaneous Collections,* Vol. 1721.

27. *United States Earthquakes.* Annual publication of the U.S. Department of Commerce, Coast and Geodetic Survey from 1928 through 1968, the NOAA National Ocean Survey for 1969, and the NOAA Environmental Data Service, 1970.

28. Eppley, R.A., *Earthquake History of the United States, Part II, Stronger Earthquakes of California and Western Nevada,* Special Publication 41–1, Revised Edition (through 1963), U.S. Department of Commerce, Environmental Science Services Administration, 1966. This publication is now a part of the present report (see next section).

29. Tarr, R.S. and Martin, Lawrence, "The Earthquakes at Yakutat Bay, Alaska, in September 1899," *U.S. Geological Survey Professional Paper 69,* 135 pp., 1912.

30. Scott, Harold W., "The Montana Earthquakes of 1935," Memoir No. 16, Montana School of Mines, Butte, 1936.

31. Fenner, Clarence N., "Earth Movements Accompanying the Katmai Eruption," *The Journal of Geology,* Vol. 33, Nos. 2 and 3, 1925.

32. *Journal of the American Geographical Society,* Vol. 4, p. 358, 1874.

33. Agnew, A.F. and Tullis, E.L., "Pierre Earthquakes of 1961," *South Dakota Academy of Science Proceedings,* Vol. 41, p. 57, 1962.

34. *Nortons Union Weekly Intelligence,* Dallas, Tex., January 10, 1891.

35. *Casper Tribune-Herald,* Casper, Wyo., December 11, 1942.

36. MacCarthy, Gerald R., "An Annotated List of North Carolina Earthquakes," *Journal of the Elisha Mitchell Scientific Society,* Vol. 73, No. 1, May 1957.

37. Stone, R.W., "Earthquake—September 5, 1944—Felt in Pennsylvania," *Department of Internal Affairs, Commonwealth of Pennsylvania,* Vol. 12, No. 11, October 1944. (Also contains a list of earthquakes felt in Pennsylvania.)

38. MacCarthy, G.R. and Wascom, J.D., "The Virginia-North Carolina Earthquake of October 28, 1963," *Journal of the Elisha Mitchell Scientific Society,* Vol. 80, No. 2, pp. 82–84, December 1964.

39. Dall, William H., *Alaska and Its Resources,* pp. 466–470.

40. Crosley, Irving B., "The Earthquake Risk in Boston," *Journal of the Boston Society of Civil Engineers,* Vol. 10, No. 10.

41. *Journal of the Royal Astonomical Society of Canada,* October 1928.

42. Perley, Sidney, *Historic Storms of New England,* 1891.

43. Gutenberg, B. and Richter, C.F., *Seismicity of the Earth and Associated Phenomena,* 2d ed., Princeton University Press, Princeton, N.J., 310 pp., 1954.

44. Richter, C.F., *Elementary Seismology,* W. H. Freeman and Co., San Francisco, 768 pp., 1958.

45. Davis, T. Neil and Echols, Carol, *A Table of Alaskan Earthquakes, 1788–1961,* August 1962.

46. Davis, T. Neil, "Preliminary Report on the Alaskan Earthquake of April 7, 1958," *Transactions of the American Geophysical Union,* Vol. 39, No. 5, October 1958.

47. Smith, W.E.T., "Earthquakes of Eastern Canada and Adjacent Areas, 1534–1927," *Publications of the Dominion Observatory,* Ottawa, Vol. XXVI, No. 5, 1962.

47A. Smith, W.E.T., "Earthquakes of Eastern Canada and Adjacent Areas, 1928–1959," *Publications of the Dominion Observatory,* Ottawa, Vol. XXXII, No. 3, 1966.

48. MacCarthy, Gerald R., "A Descriptive List of Virginia Earthquakes through 1960," *Journal of the Elisha Mitchell Scientific Society,* Vol. 80, No. 2, pp. 95–114, December 1964.

49. Moneymaker, Berlen C., A series of four articles published in *Journal of the Tennessee Academy of Science:* "Some Early Earthquakes in Tennessee and Adjacent States, 1699 to 1850," Vol. 29, No. 3, July 1954; "Earthquakes in Tennessee and Nearby Sections of Neighboring States, 1851–1900," Vol. 30, No. 3, July 1955; "Earthquakes in Tennessee and Nearby Sections of Neighboring States, 1901–1925," Vol. 32, No. 2, April 1957; and "Earthquakes in Tennessee and Nearby Sections of Neighboring States, 1926–1950," Vol. 33, No. 3, July 1958.

50. Dehlinger, Peter and Berg, Joseph W., Jr., "The Portland Earthquake of November 5, 1962," *The Ore Bin,* Vol. 24, No. 11, November 1962.

51. U.S. Geological Survey, *Hawaiian Volcano Observatory Summary* (previously the Volcano Letters and published by National Park Service), Hawaii Volcano Observatory, Hawaii.

52. U.S. Department of Commerce, NOAA, Records of the Honolulu Observatory, Honolulu, Hawaii.

53. Kew Observatory, *International Seismological Summary,* 1913–1963, Kew, England. This report became the *Bulletin of the International Seismological Centre* in 1964 and was printed through 1965 at Edinburgh, Scotland.

54. Witkind, Irving J., "The Hebgen Lake, Montana, Earthquake of August 17, 1959," *U.S. Geological Survey Professional Paper 435,* pp. 1–242, 1964.

55. Moneymaker, Berlen C., "Earthquakes of Kentucky," unpublished manuscript.

56. Milne, W.G., "Seismic Activity in Canada, West of the 113th Meridian, 1841–1951," *Publications of the Dominion Observatory,* Vol. XVIII, No. 7, Ottawa, 1956.

57. U.S. Department of Commerce, Environmental Science Services Administration, *Seismological Bulletin,* MSI-301–MSI-312, monthly issues for 1966, 1968.

58. *Wilmington News,* Wilmington, Del., September 4, 1965.

59. Merriam, D.F., "Earthquakes in Kansas," *Kansas Geological Survey Bulletin 162,* pp. 221–225 and 288–290, 1963.

60. Hollister, John C. and Weimer, Robert J. (Ed.), "Geophysical and Geological Studies of the Relation Between the Denver Earthquakes and the Rocky Mountain Arsenal Well, Part A," *Quarterly of the Colorado School of Mines,* Vol. 63, No. 1, January 1968.

61. U.S. Department of Commerce, Coast and Geodetic Survey, *The Puget Sound, Washington Earthquake of April 29, 1965,* 51 pp., 1965.

62. U.S. Department of Commerce, Environmental Science Services Administration, *The Fairbanks, Alaska, Earthquakes of June 21, 1967,* 60 pp., 1968.

63. Reid, Harry Fielding and Taber, Stephen, *The Porto Rico Earthquake of 1918—with Description of Earlier Earthquakes,* Report of the Earthquake Investigation Commission, U.S. House of Representatives, Document No. 269, 66th Congress, First Session, 74 pp., 1919.

64. Weston Geophysical Research, Inc., *Geological and Geophysical Investigations of the Proposed Tortuguero (Puerto Rico) Nuclear Power Station,* Weston, Mass., 1966.

65. "Notes on the Islands of Unalaska," Vol. I, *Russian Imperial Academy,* St. Petersburg, 1840.

66. U.S. Department of Commerce, Environmental Science Services Administration, *The Prince William Sound, Alaska, Earthquake of 1964 and Aftershocks,* Publication 10–3, Vol. 1 (1966); Vol.

II, Part A (1967); and Vol. II, Parts B and C (1969).

67. Cox, Doak C. and Pararas-Carayannis, George, "Catalog of Tsunamis in Alaska," World Data Center A, U.S. Department of Commerce, Environmental Science Services Administration, Honolulu, Hawaii, May 1969.

68. Hopper, Margaret G. and Bollinger, G.A., *The Earthquake History of Virginia, 1774 to 1900,* Virginia Polytechnic Institute and State University, Blacksburg, Va., 87 pp., 1971.

69. Grases, Jose, "La Sismicidad Historica del Caribe—I. Documentos de Trabajo," Comite Conjunto del Concreto Armado, Caracas, Venezuela, October 1971.

70. Bollinger, G.A. and Hopper, Margaret G., *The Earthquake History of Virginia, 1900–1970,* Virginia Polytechnic Institute and State University, Blacksburg, Va., 85 pp., 1972.

71. Fischer, J.A. and Fox, F.L., "The Seismicity of Massachusetts," *Engineering Bulletin No. 32,* Dames and Moore, New York, pp. 11–18, December 1966.

72. Petersen, W.J., "Earthquakes in Iowa," *The Palimpsest,* State Historical Society of Iowa, Vol. XIV, No. 4, pp. 160–174, April 1933.

73. Agarwal, R.G., "Earthquake of May 15, 1909," *Journal of the Alberta Society of Petroleum Geologists,* Vol. 10, No. 4, pp. 198–202, April 1962.

74. Hansen, W.R., "Effects of the Earthquake of March 27, 1964, at Anchorage, Alaska," *The Alaska Earthquake, March 27, 1964—Effects on Communities, U.S. Geological Survey Professional Paper 542–A,* pp. A1–A68, 1965.

California and Western Nevada

Résumé

It has been estimated that earthquakes in California and western Nevada represent approximately 90 percent of the seismic activity of the contiguous United States. The majority of these shocks occur at relatively shallow focal depths of 10 to 15 miles and along known rupture zones or faults. The shallow focal depths partly account for the greater violence of earthquakes in this region, compared with those occurring in the Central or Eastern United States. The principal fault in this area—the San Andreas—extends over 600 miles through California, from near the Salton Sea in southern California northwest to Point Arena. Movement along this fault was responsible for the great earthquakes in 1857 (near Fort Tejon) and 1906 (San Francisco), and many of lesser magnitudes.

List of Earthquakes in California and Western Nevada

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity
				degrees	*degrees*	*sq. mi.*	
1769	July 28	13:00	Los Angeles region	34	118	.....	.....
1775	Dec. 26	17:00	Southeast of Hemet	.....	.....	.....	.....
1790 (?)	.....	.....	Owens Valley region	.....	.....	.....	.....
1800	Oct. 11(?)	.....	San Juan Bautista	37	121½	.....	.....
	Nov. 22	13:30	San Diego area	.....	.....	.....	VII
	.....	.....	Santa Barbara	34½	119½	.....	.....

See footnotes at end of table

List of Earthquakes in California and Western Nevada—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity
				degrees	*degrees*	*sq. mi.*	
1803	May 25	.....	San Diego	32½	117	.....	.....
1806	Mar. 24	.....	Santa Barbara	34½	119½	.....	.....
1808	June 21 (?)	.....	Presidio of San Francisco	38	122½	.....	.....
1812	Dec. 8	About 07:00	Southern California	.....	.....	.....	VIII–IX
	Dec. 21	About 11:00	Off coast of southern California	34	120	.....	X
1822	.....	.....	San Jose and Santa Clara	37½	122	.....	.....
1827	Sept. 23 (?)	.....	Los Angeles	34	118	.....	.....
1830	.....	.....	San Luis Obispo	35	121	.....	.....
1836	June 10	07:30	San Francisco Bay	38	122	.....	IX–X
1838	June	p.m.	San Francisco region	37½	122½	.....	X
1841	July 3	14:07	Monterey	36½	122	.....	.....
1843	June 23	15:30	California-Mexico border region	.....	.....	.....	.....
1851	May 15	08:10	San Francisco	37½	122½	.....	VI
1851 (?)	Nov. 26	.....	Coast of northern California	.....	.....	.....	.....
1852	Oct. 26	.....	Southern California	.....	.....	.....	.....
	Nov. 22 to 24	.....	San Francisco Peninsula	37½	122½	.....	.....
	Nov. 27 to 30	.....	Southern California	34½	119	.....	.....
	Dec. 17	.....	San Luis Obispo	35	121	.....	VII–VIII
1853	Feb. 1	13:00	San Simeon	35½	121	.....	.....
	Oct. 23	.....	Humboldt Bay	41	124	.....	.....
1855	Jan. 24	22:00	Downieville	39½	121	.....	.....
	July 10 or 11	20:15	Los Angeles County	34	118½	.....	VIII
1856	Feb. 15	05:25	San Francisco	37½	122½	.....	.....
	Sept. 20	23:30	San Diego County	33	116½	.....	VII
1857	Jan. 9	About 08:00	Near Fort Tejon	35	119	.....	X–XI
	Feb. 5	19:00	San Francisco	38	122	.....	.....
1858	Nov. 26	00:35	San Jose	37½	122	.....	VIII
1860	Mar. 15	11:00	Western Nevada	.....	.....	.....	.....
	Nov. 12	.....	Humboldt Bay	41	124	.....	VIII
1861	July 3	16:11	Contra Costa and Alameda Counties.	37½	122	.....	VIII
1862	May 27	.....	San Diego County	33	117½	.....	.....
	.....	.....	Goleta	34½	120	.....	.....
1864	Mar. 5	08:49	San Francisco	37½	122½	.....	VI
1865	Mar. 8	06:00	Sonoma County	38½	122½	.....	VII
	May 24	03:21	Central and Southern California	.....	.....	.....	.....
	Oct. 1	09:15	Fort Humboldt and Eureka	41	124½	.....	VIII–IX
	Oct. 8	12:46	Santa Cruz Mountains	37	122	.....	VIII–IX
1866	Mar. 26	12:12	San Francisco region	.....	.....	.....	.....
1867	Dec. 1	23:12	Nevada City	39½	121	.....	.....
1868	May	.....	Dos Palmas	33½	115½	.....	.....
	May 24 (?)	21:00	Nevada	.....	.....	.....	.....
	May 29	21:00	California-Nevada	.....	.....	.....	.....
	Sept. 4	08:00	Inyo County	37	118	.....	.....
	Sept. 26	00:40	Ukiah	39	123	.....	.....
	Oct. 21	07:53	Hayward	37½	122	.....	IX–X
1869	Dec. 20	20:00	Downieville	39½	121	.....	.....

See footnotes at end of table

List of Earthquakes in California and Western Nevada—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity
				degrees	*degrees*	*sq. mi.*	
1869	Dec. 26	17:30	California-Nevada	39½	120	.....	.....
	Dec. 27	02:00	..... do	39½	120	.....	VI–VII
1871	Mar. 2	13:05	Humboldt and Mendocino Counties.	40½	124	.....	VII
	July 5	.....	Inyo County	37	118	.....	VI
	July 9	.....	Kern County	.....	.....	.....	.....
	July 11	19:30	Swansea, Inyo County	37	118	.....	.....
	.....	.....	Imperial Valley	.....	.....	.....	.....
1872	Mar. 17	.....	Lone Pine	36½	118	.....	.....
	Mar. 23	13:41	Northeast of Austin, Nev.	40	117½	12,000	VI
	Mar. 26	02:30	Owens Valley	36½	118	125,000	X–XI
	Apr. 18	.....	Cerro Gordo, Inyo County	.....	.....	.....	.....
	May 17	13:00	Lone Pine	36½	118	.....	.....
1873	Nov. 22	21:00	Del Norte County	42	124	70,000	VII
1876	Jan. 3	10:55	Sonoma County	38½	123	.....	VI–VII
1877	June 11	.....	Imperial County	33	115½	.....	.....
1878	Late summer	.....	Inglewood	34	118½	.....	.....
1881	Apr. 10	02:00	Modesto region	38	121	50,000	VII
1882	Mar. 6	14:00	Hollister	37	121½	.....	.....
1883	Mar. 30	07:45	..... do	37	121½	.....	VI
	Sept. 5	04:30	Ventura	34	119	.....	.....
1884	Mar. 25	16:40	San Francisco	37½	122½	.....	.....
1885	Jan. 30	10:45	Lassen County	40½	120½	.....	VII
	Mar. 30	23:56	Southeast of Hollister	36½	121	.....	VII
	Apr. 11	20:05	Monterey County	36	121	125,000	VII–VIII
	July 31	16:10	Sonoma County	39	123	.....	.....
1887	June 3	02:48	Carson City, Nev.	39	120	.....	VII
1888	Feb. 18	02:50	Point Arena Lighthouse	39	124	.....	.....
	Feb. 29	14:50	Petaluma	38	122½	.....	VII
	Apr. 28	20:48	Nevada City	39½	121	.....	VII
	Nov. 18	14:28	Oakland	37½	122½	.....	VII
1889	May 19	03:10	Collinsville and Antioch	38	122	.....	VII
	June 19	22:00	Lassen County	40½	120½	.....	VII
	July 31	04:47	San Francisco Bay	37½	122	.....	VII
	Aug. 27	18:15	Pomona area	34	118	.....	VI
	Sept. 29	20:10	Near Bishop	.....	.....	.....	.....
1890	Feb. 9	04:06	Southern California	34	117½	.....	VI
	Apr. 24	03:36	Monterey Bay region	37	121½	.....	VII
	July 26	01:40	Petrolia	40½	124½	.....	VII
	Aug. 10 (?)	.....	Mono Lake	.....	.....	.....	.....
1891	Jan. 2	12:00	Mount Hamilton	37½	121½	.....	VI
	Oct. 11	22:28	Napa and Sonoma Counties	38½	122½	.....	VII–VIII
1892	Feb. 23	23:20	Northern Baja California	31½	116½	.....	VIII–IX [2]
	Apr. 19	02:50	Vacaville	38½	122½	.....	IX
	Apr. 21	09:43	Winters	38½	122	.....	IX
	Nov. 13	04:45	Monterey	36½	122	.....	VI
1893	Apr. 4	11:40	Northwest of Los Angeles	34½	118½	.....	VIII–IX
	May 18	16:35	Southeast of Ventura	34	119	.....	.....
	Aug. 9	01:15	Santa Rosa	38½	122½	.....	VII
1894	July 13	20:50	Northeast of Fresno	37	120	.....	.....

See footnotes at end of table

List of Earthquakes in California and Western Nevada—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity
				degrees	*degrees*	*sq. mi.*	
1894	July 29	21:12	Mojave area	35	118	.....	.....
	Sept. 30	09:36	Humboldt County	.....	.....	.....	.....
	Oct. 23	15:03	San Diego	33	117	.....	VII
	Nov. 18	02:40	Virginia City, Nev	39½	119½	.....	.....
1895	Mar. 1	01:00	Off Cape Mendocino	.....	.....	.....	.....
1896	Jan. 27	13:00	Carson City, Nev	39	120	.....	VI
1897	June 20	12:14	Near Hollister	37	121½	50,000	VIII
1898	Mar. 30	23:43	Mare Island	38	122	.....	VII
	Apr. 14	23:07	Mendocino County	39	124	.....	VIII–IX
1899	Apr. 16	02:41	Eureka	41	124	.....	.....
	Apr. 30	14:41	Watsonville	37	121½	20,000	VII
	June 1	23:19	San Francisco	37½	122½	.....	VI
	July 6	12:10	Watsonville	37	121½	40,000	.....
	July 22	12:32	San Bernardino County	34½	117½	.....	VIII
	Oct. 12	21:00	Santa Rosa	38½	122½	.....	VII
	Dec. 25	04:25	San Jacinto and Hemet	33½	116½	100,000	IX
1901	Mar. 2	23:45	Monterey County	36	120½	40,000	VII–VIII
1902	May 19	10:31	Elmira	38½	122	20,000	VII–VIII
	July 27	22:57	Santa Barbara County	34½	120½	.....	VIII
	July 31	01:20 19:30	..... do	34½	120½	.....	.....
	Dec. 12	.....	Los Alamos	34½	120½	.....	VII
1903	Jan. 23	21:30	Baja California	31½	115½	.....	.....
	June 11	05:12	Near San Jose	37½	122	40,000 to 100,000	VII
	July 24	12:26	Willows	39½	122	.....	VII
	Aug. 2	22:49	Santa Clara County	37½	122	50,000	VII
	Dec. 25	09:45	Los Angeles area	34	118	.....	VI
1905	Dec. 23	14:23	Bakersfield	35½	119	.....	.....
1906	Mar. 3	12:25	Southern California	.....	.....	.....	.....
	Apr. 18	05:12	Northwest of San Francisco	38	123	375,000	XI
	Apr. 18	16:30	Brawley, Imperial Valley	33	115	.....	VIII
	Apr. 23	01:10	Ferndale	41	124	.....	VII
	May 1	21:30	Guerneville, Sonoma County	38½	123	.....	VI
	Dec. 6	22:40	San Luis Obispo County	35½	121	.....	.....
1907	Aug. 11	04:19	Humboldt County	40½	124	.....	.....
	Sept. 19	17:54	Near San Bernardino	34	117	50,000	VII
1908	Jan. 26	About 18:00	Honey Lake region	.....	.....	.....	VII
	Aug. 18	02:59	Eureka	41	124	6,000	VII
	Nov. 4	00:37	Death Valley District	36	117	50,000 to 75,000	.....
1909	May 17	17:19	Upper Mattole	41	124	.....	VII–VIII
	June 22	23:34	Sierra County	39½	121	50,000	VII
	Oct. 28	22:45	Humboldt County	40½	124	100,000	VIII
1910	Mar. 10	22:52	Monterey Bay	.....	.....	60,000	VI
	Mar. 18	16:11	Humboldt County	40	125	.....	.....
	May 6	08:40	Near Bishop	37½	119	50,000	.....

See footnotes at end of table

List of Earthquakes in California and Western Nevada—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity
				degrees	*degrees*	*sq. mi.*	
1910	May 15	07:47	Lake Elsinore region	33½	117½	.....	VII
	Nov. 21	15:23	Tonopah Junction, Nev.	38	117	.....	.....
	Dec. 31	04:11	San Benito and Monterey Counties	36½	121½	.....	.....
1911	Mar. 11	13:30	Hollister	37	121	.....	VI
	July 1	14:00*	South of San Jose	37	122	60,000	VII–VIII
1912	Jan. 4	19:53	Bishop, Inyo County	37½	118½	50,000	.....
	Dec. 14	.....	Near Oxnard, Ventura County	34	119	.....	VI–VII
1914	Feb. 18	10:15	Near Reno, Nev.	39½	120	.....	VI
	Apr. 24	00:35	..... do	39½	120	100,000	VII
	Nov. 8	18:31	Santa Cruz Mountains	37	122	30,000	VII
1915	Jan. 11	20:31	Los Alamos	34½	120½	50,000	VIII
	Feb. 21	p.m.	Near Lassen Peak	40½	121	.....	.....
	Apr. 5	15:11	Coleville region	38½	119½	25,000	.....
	June 22	19:59, 20:56	El Centro, Calexico, and Mexicali	32.8	115.5	50,000 to 100,000	VIII
	Oct. 2	22:53*	Pleasant Valley, Nev.	40½	117½	500,000	X
	Oct. 7	21:26	Piedmont	37½	122	.....	VI
	Nov. 20	16:14*	Baja California	32	115	120,000	VII [2]
	Dec. 31	04:20*	Off Humboldt County coast	41	126	.....	.....
1916	Feb. 2	21:02	Western Nevada	40½	119½	100,000	VI
	July 4	20:40	Humboldt County	40½	124½	.....	VI
	Aug. 6	11:38	Paicines, San Benito County	36½	121	30,000	VII
	Oct. 22	18:44*	Tejon Pass	34.9	118.9	25,000 to 50,000	VII
	Nov. 10	01:11	Near Death Valley	.....	.....	.....	.....
	Dec. 1	14:53	Avila	35	121	.....	VII
1917	May 27	22:06	Imperial Valley	33	115½	40,000	.....
	July 6	03:01	Owens Valley	.....	.....	.....	VI–VII
	July 9	14:22	Lopez Canyon	.....	.....	.....	VI
1918	Mar. 12	02:30	Sierra County	39½	121	.....	VII
	Apr. 21	14:32*	Riverside County	33¾	117	150,000	IX
	Apr. 22	13:15	Corona	34	117½	.....	VI
	Apr. 30	20:32	Calexico	32½	115½	31,000	VI [3]
	June 6	14:32	Riverside County	33½	117	.....	.....
	July 14	16:23*	Off coast of Humboldt County	41	125	.....	VI
	Nov. 19	12:18	Santa Monica Bay	34	118½	.....	VI
1919	Jan. 4	15:00	Shasta County	40½	122	.....	.....
	Feb. 16	07:57	South of Maricopa	35	119	30,000	VII
	Sept. 15	06:07	Eureka	41	124	.....	VII
	Sept. 29	23:37	Baja California	32½	115	.....	.....
	Oct. 1	05:07	..... do	32½	115	.....	.....
	Dec. 31	18:35	Mesa Grande and Warner Springs	33	117	.....	VI
1920	June 21	18:48	Inglewood	34	118½	11,000	VIII
	July 16	10:08	Los Angeles	34	118½	.....	VI
	July 22	19:55	Hot Springs	40½	121½	.....	VII
1921	July 21	12:17	Eagle Lake	40½	120½	.....	VI
	Sept. 8	11:24	South of Imperial Valley	32½	115½	.....	.....
1922	Jan. 31	05:17*	Northwest of Cape Mendocino	41	125½	400,000	VI

See footnotes at end of table

List of Earthquakes in California and Western Nevada—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity
				degrees	*degrees*	*sq. mi.*	
1922	Mar. 10	03:21*	Cholame Valley	35¾	120¼	100,000	IX
	Aug. 17	21:12	Cholame region	35½	120½	25,000	.....
1923	Jan. 22	01:04*	Off Cape Mendocino	40½	124½	.....	VII–VIII
	July 22	23:30*	San Bernardino Valley	34	117¼	70,000	VII
	Nov. 5	14:07	Calexico	32½	115½	.....	VII [2]
	Nov. 7	15:57	Baja California	32½	115½	.....	VII [2]
1924	Dec. 27	20:18	Near Salinas	36.7	121.6	.....	VI
1925	Apr. 15	.....	Calexico	32½	115½	.....	VI [2]
	June 29	06:42*	Santa Barbara and vicinity	34.3	119.8	.....	VIII–IX
1926	Feb. 18	10:18	Southwest of Ventura	34	119½	.....	VI
	Apr. 3	12:08	Northeast of Banning	34	116	60,000	.....
	Apr. 19	07:17	Baja California	32½	115	.....	.....
	June 29	15:21	Santa Barbara	34½	119½	30,000	VII
	June 30	05:31	Kern River Canyon	.....	.....	30,000	.....
	July 25	09:58	Near Idria	36½	120½	30,000	VI
	Oct. 22	04:35* 05:35*	Monterey Bay	36¾	122	100,000	VIII
1927	Jan. 1	00:17* 01:13*	Imperial Valley, near Mexican border.	32½	115½	50,000	VIII [2]
	Feb. 15	15:54	Near Santa Cruz	37	122	30,000	VI
	May 28	09:38	Near San Jose	37.3	121.8	3,000	VI
	Aug. 4	04:24	Santa Monica Bay	34	118½	8,000	VI
	Aug. 20	12:05	Humboldt Bay	41	124	.....	VIII
	Sept. 17	18:07*	Near Bishop	37½	118¾	75,000	VII
	Nov. 4	05:51*	West of Point Arguello	34½	121½	.....	IX–X
	Nov. 18	19:32	Santa Maria	35	120½	.....	VI
1928	June 3	p.m.	Weaverville	41	123	.....	VII
	Sept. 5	06:42	Colorado Desert region, near Twentynine Palms.	34	116	.....	V
1929	July 8	08:46*	Whittier	34	118	.....	VII
	Nov. 28	11:49	Northwest of Bishop	36.9	118.2	35,000	VII
1930	Jan. 15	16:25* 16:34	Fawnskin and Summit	34.2	116.9	50,000	VII
	Feb. 25	18:30	Imperial Valley	33	115½	20,000	VIII
	Mar. 1	15:44	..... do	33	115½	11,000	VIII
	Apr. 9	14:00	Lake Tahoe	39	120	19,000	VI
	Apr. 12	04:57	Fernley, Nev	39½	119	15,000	VI
	Aug. 5	03:25	Santa Barbara	34½	119½	.....	VII
	Aug. 30	16:41*	Santa Monica Bay	33.9	118.6	12,000	VII
	Sept. 22	18:58	Humboldt Bay	41	124	10,000	VII
	Dec. 11	01:00	Southwest of Cape Mendocino	40½	124½	25,000	VI
1931	Aug. 23	10:02*	West of Cape Mendocino	40.2	125.6	4,500	VI
	Sept. 9	05:41*	Northwest of Cape Mendocino	40.8	125.0	15,000	VI
1932	June 6	00:44*	Humboldt County	40.8	124.3	50,000	VIII
	July 25	22:52	Upper Kern River	35.8	118.5	.....	VI
	Dec. 20	22:10*	Western Nevada	38.7	117.8	500,000	X
1933	Mar. 10	17:54*	Long Beach	33.6	118.0	100,000	IX
	May 16	03:47	Niles Canyon	38	122	8,000	VII
	June 25	12:45*	Wabuska, Nev	39.1	119.3	70,000	VII
	Oct. 2	01:10*	Signal Hill	33.8	118.1	6,000	VI

See footnotes at end of table

List of Earthquakes in California and Western Nevada—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity
				degrees	*degrees*	*sq. mi.*	
1934	Jan. 30	11:24 12:17*	Southeast of Hawthorne, Nev	38.3	118.4	110,000	VIII–IX
	June 7	20:30 20:48*	Parkfield	36	120½	34,000	VIII
	Dec. 30	05:52*	South of Calexico	32¼	115½	60,000	VI [2]
	Dec. 31	10:46*	..... do	32	114¾	80,000	VII [2]
1935	Oct. 24	06:48*	Southern California	34.1	116.9	29,000	V
1936	May 10	09:40	North of Bishop	37.5	118.5	6,000	VI
1937	Feb. 6	20:42*	Northwest of Ferndale	40½	125¼	10,000	V
	Mar. 8	02:31	Near Berkeley	37.8	122.2	5,000	VI–VII
	Mar. 25	08:49*	Terwilliger Valley	33.5	116.6	30,000	VII
1938	May 31	00:34*	Santa Ana Mountains	33.7	117.5	30,000	VI
	Aug. 30	19:18*	Near Long Beach	33.8	118.2	1,200	VI
	Sept. 11	22:11*	West of Cape Mendocino	40.3	124.8	20,000	VI
	Dec. 3	09:42*	West of Bishop	37.5	118.8	24,000	VI–VII
1939	Jan. 11	14:00	Southeast of Minden, Nev	38.8	119.6	8,000	VI
	May 11	10:05*	Northeast of Mina, Nev	38.6	117.8	38,000	VI
	June 24	05:02	Near Hollister	36.8	121.4	10,000	VII
	Dec. 27	11:29*	Long Beach	33.8	118.1	2,500	VI
1940	Feb. 8	00:06*	Chico area	39¾	121¼	30,000	VI–VII
	May 18	20:37*	Southeast of El Centro	32.7	115.5	[1] 60,000	X
	Oct. 10	21:57*	Off Redondo Beach	33.8	118.4	10,000	VI
	Nov. 19	10:34	Off Cape Mendocino	.....	.....	8,000	VI
1941	Feb. 9	01:44*	..... do	40.9	125.4	17,000	VI
	May 13	08:02*	..... do	40.3	125.0	.....	V
	June 30	23:51*	Santa Barbara and Carpinteria	34.4	119.6	20,000	VIII
	Sept. 14	08:44* 10:39*	Owens Valley	37.6	118.7	30,000	VI–VII
	Sept. 21	11:53*	Near Cuddy Valley	34.9	118.9	26,000	VI
	Oct. 3	08:13*	Off Cape Mendocino	40.6	124.6	12,000	VI–VII
	Oct. 21	22:57*	Gardena area	33.8	118.2	2,000	VII
	Nov. 14	00:42*	Torrance-Gardena area	33.8	118.2	3,600	VII–VIII
	Dec. 30	22:49*	Owens Valley	37.6	118.7	28,000	VI
1942	Oct. 21	08:22*	Near Borrego Valley	33.0	116.0	35,000	VII
	Dec. 3	01:45*	West of Wadsworth, Nev	39.9	119.0	24,000	VI
	Dec. 17	07:08*	Central California-Nevada border	38.9	119.5	.....	V
1943	Aug. 8	21:30*	Excelsior Mountains, Nev	38.2	118.2	34,000	VI
	Aug. 28	19:45*	San Bernardino Mountains	34.3	117.0	16,000	VI
	Oct. 25	20:51*	Northwest of Mount Hamilton	37.4	121.7	20,000	VI
1944	June 12	02:46* 03:17*	North of Cabazon	34.0	116.8	16,000	VI
	June 18	16:04* 19:06*	Near Dominguez Junction	33.9	118.2	12,000	VI
1945	Jan. 7	14:26*	San Benito County	36.7	121.2	13,000	VI
	Apr. 1	15:44*	Santa Rosa Island	34.0	120.0	1,000	IV
	May 17	07:07*	Near Hollister	36.8	121.4	6,000	VI
	May 19	07:07*	Off Cape Mendocino	40.6	126.4	1,500	V
	Aug. 15	09:56*	Borrego Valley	33.2	116.1	15,000	VI
	Aug. 27	01:13*	San Jose	37.3	121.8	13,000	VI
1946	Jan. 8	10:54*	Southeast of Borrego Valley	33.0	115.8	12,000	V

See footnotes at end of table

List of Earthquakes in California and Western Nevada—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity
				degrees	*degrees*	*sq. mi.*	
1946	Mar. 15	05:50*	North of Walker Pass	35.7	118.1	65,000	VIII
	July 18	06:28*	San Bernardino County	34.5	116.0	27,000	VI
	Sept. 27	23:19*	North of Beaumont	34.0	116.9	9,000	VI
1947	Apr. 10	07:58*	East of Barstow	35.0	116.6	75,000	VII
	June 22	15:30*	Gilroy	37.0	121.8	7,000	VI
	July 24	14:11*	Morongo Valley	34.0	116.5	35,000	V
	Aug. 10	13:58*	Near Hollister	36.9	121.4	3,500	VI
	Sept. 23	05:53*	Humboldt County	40.4	125.2	4,000	VI
1948	Feb. 10	19:29*	Tulare County	36.1	118.8	18,000	VI
	Dec. 4	15:43*	Desert Hot Springs	33.9	116.4	65,000	VII
	Dec. 29	04:53*	Near Verdi, Nev	39.5	120.1	40,000	VII
	Dec. 31	17:18*	Near Hollister	36.9	121.6	3,500	VII
1949	Feb. 11	13:05*	Northern Inyo County	37.1	117.8	18,000	VI
	Mar. 9	04:29*	Hollister	37.0	121.5	20,000	VII
	May 2	03:26*	Riverside County	34.0	115.7	16,000	VI
	June 9	19:07*	East of San Jose	37.4	121.6	8,000	VI
	Aug. 27	06:52*	Near Point Conception	34.5	120.5	350	VI
	Nov. 4	12:43*	Baja California	32.2	116.5	[1] 9,000	VI [2]
	Nov. 17	17:20*	Terminal Island, San Pedro Bay	33.8	118.3	.....	V
1950	Feb. 25	16:06*	Sespe Hot Springs	34.6	119.1	2,500	VI
	Mar. 20	07:22*	Lassen Peak	40.5	121.5	4,000	V
	July 29	06:37*	Imperial Valley	33.1	115.6	[1] 18,500	VIII
	Aug. 1	00:37*	..... do	33.1	115.6	.....	VI
	Sept. 5	11:20*	Northwest of Anza	33.7	116.8	10,000	VI
	Dec. 14	05:24*	Near Herlong	40.1	120.1	20,000	VII
1951	Jan. 23	23:17*	Near Calipatria	33.1	115.6	14,000	VII
	Jan. 25	13:00*	San Francisco Bay	37.8	122.2	.....	VI
	Feb. 15	02:48* 02:50*	Near Santa Rosa Mountains	33.5	116.5	7,000	V
	July 23	18:25* 19:04*	Berkeley Hills	37.9	122.3	.....	VI
	July 29	02:54*	Southeast of Mulberry	36.6	121.2	10,000	VI
	Aug. 6	01:05*	..... do	36.6	121.2	2,500	VI
	Aug. 14	23:23*	Terminal Island	33.5	118.2	.....	V
	Oct. 7	20:11*	Off Cape Mendocino	40.3	124.8	9,000	VII
	Oct. 31	12:58*	Near Hollister	36.9	121.4	2,500	VI
	Nov. 14	00:40*	Near Scotia	40.4	124.0	3,000	VI
	Dec. 5	07:53*	Imperial Valley	33.1	115.4	3,000	VII
	Dec. 25	16:47*	San Clemente Island	32.8	118.4	18,000	VI
	Dec. 27	18:49*	Near Owens River Gorge	37.6	118.6	10,000	VI
1952	Feb. 9	00:43*	Northeast of Lone Pine	36.7	117.9	.....	VI
	May 9	08:32*	North of Carson City, Nev	39.4	119.7	3,000	VI
	July 21	03:52*	Kern County	35.0	119.0	160,000	XI
	July 21	04:06*	..... do	35.0	118.8	.....	V
	July 21	11:41*	..... do	35.1	119.0	.....	V
	July 22	16:39*	..... do	35.4	118.6	.....	V
	July 22	23:53*	..... do	35.0	118.8	.....	VII
	July 23	05:17*	..... do	35.2	118.8	.....	VII
	July 23	10:14*	..... do	35.0	118.8	.....	VI
	July 25	11:10* 11:43*	..... do	35.3	118.5	.....	VII

See footnotes at end of table

List of Earthquakes in California and Western Nevada—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity
				degrees	*degrees*	*sq. mi.*	
1952	July 28	23:04*	Kern County	35.4	118.9	.....	VII
	July 31	04:09*	..... do	35.3	118.6	.....	VI
	Aug. 13	09:39*	..... do	35.2	118.7	.....	VI
	Aug. 22	14:41*	Bakersfield	35.3	118.9	40,000	VIII
	Aug. 23	02:09*	Near Acton	34.5	118.2	35,000	VI
	Aug. 29	20:56*	Kern County	35.3	118.5	.....	VI
	Sept. 2	04:42*	..... do	35.1	118.7	.....	VI
	Sept. 2	08:38*	..... do	35.3	118.5	.....	VI
	Sept. 22	03:41*	Petrolia	40.2	124.4	4,000	VII
	Oct. 12	16:34*	Oakland, Near Dimond District	37.8	122.2	3,500	V
	Oct. 21	16:46*	San Francisco Bay	37.9	122.4	2,500	V
	Nov. 21	23:47*	Near Bryson	35.8	121.2	20,000	VII
1953	May 24	19:24*	Wheeler Ridge	35.0	119.0	.....	VI
	May 24	20:08*	Calpella	39.4	123.3	.....	VI
	June 13	20:17*	Imperial Valley	32.8	115.7	4,800	VII
	Sept. 25	19:34*	Near Reno, Nev	39.6	119.8	12,000	VI
	Dec. 16	21:13*	Watsonville	36.9	121.7	3,500	VI
1954	Jan. 12	15:34*	West of Wheeler Ridge	35.0	119.0	35,000	VII–VIII
	Jan. 27	06:20*	West of Tehachapi	35.2	118.6	12,000	VI
	Mar. 19	01:54*	Santa Rosa Mountains	33.3	116.2	40,000	VI
	Mar. 22	20:15*	..... do	33.3	116.2	.....	VI
	Apr. 22	10:50*	East of Watsonville	36.9	121.7	2,500	VI
	Apr. 25	12:33*	..... do	36.9	121.7	12,000	VIII
	July 6	03:13*	East of Fallon, Nev	39.4	118.5	130,000	IX
	July 6	14:08*	Southeast of Fallon, Nev	39.3	118.5	.....	VIII
	Aug. 12	04:50*	East of Watsonville	36.9	121.7	.....	VI
	Aug. 23	21:52*	East of Fallon, Nev	39.6	118.5	150,000	IX
	Aug. 26	05:48*	Near Anacapa Island	33.9	119.5	.....	VI
	Aug. 31	14:21*	Dixie Valley, Nev	39.6	118.2	.....	VII
	Sept. 15	20:51*	East of Merced	37.3	120.0	.....	VI
	Nov. 10	10:07*	Lake and Mendocino Counties	39.1	123.0	2,500	VI
	Nov. 12	04:27*	Baja California	31½	116	.....	V [2]
	Nov. 25	03:17*	Off Cape Mendocino	40.3	125.6	9,000	V
	Dec. 16	03:07* 03:11*	Dixie Valley, Nev	39.3	118.2	200,000	X
	Dec. 16	23:09*	East of San Leandro	37.7	122.1	4,500	VI
	Dec. 21	11:56*	Eureka-Arcata areas	40.8	124.1	50,000	VII
	Dec. 30	01:16*	..... do	40.8	124.1	.....	VI
1955	Jan. 10	05:16*	Southeast of Lovelock, Nev	39.9	118.4	.....	VI
	Jan. 25	04:23	Terminal Island area	33.8	118.2	.....	IV
	Mar. 2	07:59*	Near San Ardo	36.0	120.9	7,000	VI
	Apr. 29	07:15*	Near Kelseyville	39.0	122.8	900	VI
	May 7	03:51*	..... do	38.9	122.9	2,000	VI
	Aug. 7	19:22*	North of Caliente	35.4	118.6	6,000	V
	Aug. 8	02:36*	Near Hawthorne, Nev	38.5	118.8	9,000	V
	Sept. 4	18:01*	East of San Jose	37.4	121.8	12,000	VII
	Oct. 23	20:11*	Near Concord	38.0	122.1	12,000	VII
	Nov. 2	11:40*	Near San Ardo	36.0	120.9	7,000	VI
	Nov. 21	12:55*	North of Bena	35.4	118.7	4,000	V
	Dec. 16	22:07*	Near Brawley	33.0	115.5	9,000	VII

See footnotes at end of table

List of Earthquakes in California and Western Nevada—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity
				degrees	*degrees*	*sq. mi.*	
1956	Jan. 2	16:26*	Near Glen Ivy, Temescal Canyon	33.8	117.5	9,000	VI
	Jan. 3	06:24*	Baja California	32.4	116.0	[1] 3,500	V [2]
	Feb. 6	18:18* 19:17*	North of Castaic	34.6	118.6	3,000	VI
	Feb. 9	06:33*	Baja California	31.8	115.9	[1] 30,000	VI [2]
	Feb. 14	10:34* 17:21*	..... do	31.5	115.5	Large area	V [2]
	Mar. 9	21:56*	Near Petrolia	40.3	124.2	2,500	V
	Mar. 16	12:30*	Near Baldwin Lake	34.3	116.8	8,000	VI
	Mar. 18	02:18* 02:22*	Near Manzanita Lake	40.0	121.6	.....	VI
	Apr. 4	20:29* 20:30*	Near Saint Helena	38.5	122.5	4,500	VI
	May 11	08:31*	Near Baldwin Lake	34.3	116.8	9,000	V
	July 23	00:04*	Northwest of King City	36.3	121.3	4,000	V
	Sept. 23	03:25*	Riverside County	33.5	116.6	1,500	VI
	Oct. 11	08:49*	West of Ferndale	40.7	125.8	3,500	V
	Nov. 15	19:23*	Northwest of Parkfield	36.0	120.5	8,000	VI
	Dec. 1	06:11*	West of Hollister	36.9	121.6	3,200	V
	Dec. 31	09:39*	Near Hawthorne, Nev.	38.3	119.0	6,000	VI
1957	Jan. 24	12:55*	Southeast of Palomar	33.1	116.4	6,000	V
	Jan. 29	13:20*	Off coast, southwest of Big Sur	35.9	122.1	5,000	V
	Jan. 31	23:52*	Little San Bernardino Mountains	34.0	116.3	3,000	V
	Mar. 18	10:56*	South of Oxnard	34.1	119.2	3,000	VI
	Mar. 22	11:44*	West of Daly City	37.7	122.5	12,000	VII
	Mar. 23	00:14*	..... do	37.7	122.5	3,500	VI
	Apr. 25	13:58*	Southwest end of the Salton Sea	33.2	115.9	12,000	VII
	May 26	08:00*	Southwest of the Salton Sea	33.2	116.0	7,000	V
	Oct. 30	18:48*	Near Comptche	39.2	123.7	4,000	VI
1958	May 24	15:05*	Near Petrolia	40.3	124.2	3,500	VI
	July 8	21:24*	Near Morgan Hill	37.3	121.7	3,000	V
	July 13	21:26*	Off Carpinteria	34.4	119.5	5,000	VI
	Sept. 30	23:25*	Southeast of Soledad	36.4	121.1	.....	VI
	Oct. 1	13:42*	Southeast of Sierraville	39.6	120.3	5,000	VI
	Oct. 10	05:05*	Northwest of Parkfield	35.9	120.5	3,500	V
	Oct. 30	16:26*	Northeast of San Jose	37.5	121.8	1,500	VI
	Nov. 30	19:21*	Baja California	32.3	115.8	[1] 15,000	VI [2]
	Dec. 11	01:52*	Southwest of San Francisco	37.7	122.5	6,500	VI
1959	Mar. 2	15:27*	Near Gilroy	37.0	121.6	8,000	VI
	Mar. 22	23:10*	Dixie Valley, Nev.	39.6	118.0	50,000	VI
	Apr. 1	10:19*	Northeast of Loyalton	39.7	120.2	25,000	VII
	Apr. 5	22:08*	North of Ukiah	39.3	123.2	1,200	VI
	May 26	07:58*	Near Salinas	36.7	121.6	4,500	VI
	June 13	17:27*	Near the Sierra Buttes	39.7	120.6	4,500	V
	June 17	16:30*	Northwest of Bishop	37.6	118.6	3,000	VI
	June 23	06:35*	North of Schurz, Nev.	39.1	118.8	35,000	VI
	July 1	15:49*	South of Bannister	35.2	119.1	6,000	V
	Aug. 3	23:37*	West of Bishop	37.4	118.6	12,000	VI
	Aug. 25	21:33*	Morongo Valley	34.1	116.6	10,000	V
	Sept. 24	09:02*	Northeast of Ukiah	39.4	123.0	.....	VI
	Sept. 30	20:36*	Off coast of southern California	34.4	120.6	4,500	VI

See footnotes at end of table

List of Earthquakes in California and Western Nevada—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity
				degrees	*degrees*	*sq. mi.*	
1959	Oct. 24	07:35*	Near Owens Park	35.7	118.0	.....	VI
	Dec. 21	18:39*	Off Punta Gorda	40.3	124.5	3,000	V
	Dec. 28	18:33*	Northwest of Hollister	36.9	121.5	5,000	VI
1960	Jan. 19	19:26*	South of Hollister	36.8	121.4	7,500	VI
	June 4	23:47*	Northwest of Bishop	37.5	118.6	4,800	V–VI
	June 5	17:18*	West of Arcata	40.8	124.9	8,000	VI
	Aug. 8	23:39*	Off coast of northern California	40.3	126.1	6,500	V
1961	Jan. 28	00:13*	Near Walker Pass	35.8	118.0	13,000	VI
	Apr. 4	13:32	Terminal Island, Long Beach Harbor.	.....	.....	.....	IV
	Apr. 5	20:05*	Off coast of northern California	40.1	124.8	3,500	VI
	Apr. 8	23:23* 23:26*	About 13 miles south of Hollister	36.7	121.3	13,500	VII
	May 28	05:00*	Northeast of Indio	33.8	116.1	5,000	VI
	July 3	20:56*	West of Winnemucca, Nev	40.9	118.4	10,000	V
	July 30	16:07*	Near Shandon	35.8	120.3	5,000	V
	Oct. 18	21:10*	East of Brown	35.8	117.8	12,000	VII
	Oct. 20	11:50*	Near Huntington Beach	33.6	118.0	1,200	VI
	Nov. 14	21:39*	Near Wheeler Ridge	34.9	119.0	10,000	VI
1962	Apr. 27	01:13*	Near Perris	33.7	117.2	4,500	VI
	June 6	09:50*	Near Lakeport	39.1	123.1	6,500	VII
	July 20	01:02*	Near Dixie Valley, Nev	39.8	118.1	13,500	V
	Aug. 23	11:29*	Off coast of Del Norte County	41.8	124.3	15,000	VI
	Sept. 4	09:17* 09:33*	Northwest of Arcata	41.0	124.2	7,000	VI
	Sept. 15	21:36*	Near Walker Pass	35.7	118.0	16,000	VI
	Oct. 28	18:43*	Near Big Bear	34.3	116.9	9,500	VI
1963	Feb. 28	16:26*	Near Fort Tejon	34.9	119.0	8,000	VI
	May 22	14:41*	Sunnyvale	37.3	122.2	1,500	VI
	May 22	22:44*	Imperial Valley	33.0	115.7	4,000	VI
	June 7	04:05*	Near Antioch	38.0	121.8	1,500	VI
	June 11	07:24*	Baja California	31.8	116.2	[1] 5,500	V [2]
	Sept. 14	11:46* 12:28*	Vicinity of Chittenden and Soda Lake.	36.8	121.6	5,000	VII
	Sept. 23	06:42*	Near San Jacinto	33.8	117.0	10,000	VI
	Dec. 6	00:34*	Bishop-Paradise area	37.5	118.7	10,000	VI
1964	Jan. 6	15:47*	San Bernardino County	34.3	116.5	4,500	V
	Mar. 22	08:31*	North of Hawthorne, Nev	38.8	118.7	7,500	V
	May 13	04:19*	San Benito	36.5	121.1	3,000	V
	June 21	07:33*	San Diego	32.7	117.1	[1] 2,000	VI
	June 22	20:55*	..... do	32.7	117.1	.....	VI
	Oct. 30	11:03*	Dyer, Nev	37.7	118.0	.....	VI
	Nov. 15	18:47*	North of Watsonville	37.0	121.7	12,000	VII
	Dec. 22	12:55*	Off coast, northwest of Ensenada, Mexico.	31.9	117.1	[1] 9,000	VI [2]
1965	Jan. 1	00:04*	Southwest of Fontana	34.0	117.6	4,000	VI
	Apr. 15	12:09*	San Bernardino Valley	34.1	117.5	4,000	VI
	June 3	08:26*	Bridgeport	38.3	119.2	4,000	V
	June 15	18:42*	Imperial Valley	33.0	115.5	1,000	VI
	July 15	23:46*	West of Saugus	34.4	118.6	3,000	VI

See footnotes at end of table

List of Earthquakes in California and Western Nevada—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity
				degrees	*degrees*	*sq. mi.*	
1965	Sept. 10	13:29*	Pittsburg	38.0	121.9	3,000	VI
	Sept. 19	07:42*	Kings County	35.9	120.1	3,500	V
	Sept. 25	09:44*	Southeast of Newberry Springs	34.7	116.5	25,000	VII
	Oct. 17	01:45*	Near Palm Springs	33.9	116.8	6,000	VI
	Oct. 21	00:43*	East of Yucaipa	34.0	116.7	.....	VI
	Nov. 12	15:55*	South of Glendale	34.0	118.2	800	VI
1966	Mar. 4	04:40*	Near Imperial	32.8	115.5	.....	VI
	Apr. 2	04:49*	South of Luning, Nev.	38.4	118.1	.....	VI
	May 23	19:50*	Near Chico	39.7	121.8	12,000	VI
	June 27	20:26*	Parkfield	35.9	120.9	20,000	VII
	Aug. 7	09:36*	Gulf of California	31.8	114.5	.....	VI [2]
	Sept. 12	08:41*	Near Boca	39.4	120.1	45,000	VII
	Oct. 1	21:13*	Palos Verdes Peninsula	33.9	118.3	.....	VI
	Oct. 14	12:34*	Watsonville area	37.0	121.8	.....	VI
1967	May 21	06:43*	Near Anza	33.5	116.6	9,000	VI
	June 14	20:58*	Near Whittier	34.0	118.0	.....	VI
	June 26	07:16*	Near Ukiah	39.3	123.3	1,500	VI
	July 22	01:23*	Southeast of Paicines	36.5	121.1	.....	VI
	Sept. 7	04:39*	Corralitos	37.0	121.8	6,500	VI
	Sept. 28	07:39*	Morgan Hill area	37.2	121.6	7,500	VI
	Dec. 10	04:07*	Ferndale area	40.5	124.6	6,000	VI
	Dec. 18	09:25*	Corralitos	37.0	121.8	9,000	VI
1968	Feb. 5	16:42*	Mount Montgomery, Nev., area	38.0	118.4	8,000	VI
	Mar. 21	13:55*	Corralitos area	37.0	121.7	3,500	V
	Mar. 28	13:22*	East of White Water	34.0	116.1	4,000	V
	Apr. 8	18:29*	South of Ocotillo Wells	33.2	116.1	60,000	VII
	Apr. 8	19:48*	Calexico area	33.1	116.0	.....	VI
	Apr. 18	09:42*	South of Big Bear Lake	34.3	116.9	3,600	V
	Apr. 25	11:50*	Santa Rosa	38.5	122.7	5,000	VII
	Apr. 28	16:22*	South of Willows	39.5	122.0	10,500	VI
	May 22	05:27*	Salton City area	33.3	116.2	3,500	V
	June 25	17:42*	Petrolia-Honeydew area	40.1	124.4	5,000	VII
	June 29	11:14*	Goleta	34.3	119.6	.....	VI
	July 4	16:45*	..... do	34.1	119.7	8,000	VI
1969	Jan. 23	15:01*	East of Palm Springs	33.9	116.0	5,000	V
	Feb. 7	13:26*	Ferndale area	40.4	124.5	4,000	VI
	Feb. 27	20:56*	Palmdale area	34.6	118.1	4,800	VI
	Apr. 28	15:21*	Borrego Springs area	33.4	116.4	30,000	VII
	May 19	06:41*	..... do	33.4	116.2	6,500	V
	June 7	03:27*	Capetown region	40.8	125.8	.....	VI
	Oct. 1	20:57* 22:20*	Santa Rosa	38.5	122.7	10,500	VII–VIII
	Oct. 27	03:00	Hollister region	36.8	121.4	4,000	VI
	Oct. 27	05:16*	Near Laguna Beach	33.5	117.8	4,500	V
	Nov. 17	12:49*	Pine Canyon area	36.4	121.0	4,000	V
	Nov. 18	22:29*	..... do	36.4	121.6	3,500	V
1970	Jan. 2	18:52*	Cupertino area	37.3	122.1	1,200	VI
	Mar. 30	23:02*	Gilroy-Hollister	36.9	121.4	4,800	V
	May 18	07:08*	Fort Jones area	41.4	122.8	4,500	V
	June 11	19:30*	Danville	37.8	121.9	1,300	VI
	June 12	08:04*	..... do	37.8	121.9	.....	VI

See footnotes at end of table

List of Earthquakes in California and Western Nevada—Continued

Year	Date	Time (PST)	Locality	N. lat.	W. long.	Area	Intensity
				degrees	*degrees*	*sq. mi.*	
1970	Aug. 3	20:14*	Carmel Valley region	36.6	122.2	5,500	VI
	Sept. 12	06:31*	Lytle Creek area	34.3	117.5	25,000	VII

*Instrumental origin time and epicenter.
[1] United States area affected.
[2] Intensity in United States.

MAJOR EARTHQUAKES

California Earthquake of December 21, 1812

Time of occurrence.—About 11:00.

Epicenter.—34° N., 120° W., probably offshore in the province of the Transverse Ranges.

Area affected.—Total area unknown.

Intensity.—X.

Description.—This shock was damaging in Santa Barbara, Ventura, and northern Los Angeles Counties. A strong and damaging foreshock at about 10:30 alarmed inhabitants and sent them fleeing from buildings. This undoubtedly saved many lives when the main shock came. Some people were injured, but there were no deaths reported. The church of Purisima Mission and many of the mission buildings were destroyed. At Santa Ynez Mission, a corner of the church fell, all roofs were ruined, walls cracked, and many new homes were demolished. At Santa Barbara, all mission buildings were severely damaged and the church was later rebuilt. At the presidio, some buildings were ruined and the remaining structures were damaged. The tower was wrecked and much of the facade of the church had to be rebuilt at San Buenaventura Mission. At San Fernando Mission, 30 beams had to be used to keep the walls from falling. Strong aftershocks occurred until February and shocks of less intensity continued until April 1813.

This earthquake may or may not have generated a tsunami. A recent examination of evidence for a tsunami by Marine Advisers, Inc. (1965) neither proves nor disproves the occurrence of tsunami waves. Mission records at that time mention fear of the sea, but give no details. Reports of a tsunami, which do not appear in the literature until many years after the earthquake, are based on the memory of several individuals. In light of the examination, statements concerning a tsunami in previous issues of the present report (Publication 41—2, Part II) should be considered as lacking adequate proof.

San Francisco Earthquake of June 1838

Time of occurrence.—Just after noon.

Epicenter.—37½° N., 122½° W., San Francisco region.

Area affected.—Considerable. Total felt area unknown.

Intensity.—X.

Description.—This shock was comparable to the earthquake of April 18, 1906. Extensive displacements were reported along the San Andreas Fault. At Yerba Buena, the shock was violent; walls were severely damaged at the missions of San Francisco, Santa Clara, and San Jose, and at the presidio of San Francisco. Crockery and glassware broke, building walls cracked, and the inhabitants were greatly alarmed at Monterey. Captain Paty reported frequent aftershocks up to the time his ship sailed from the San Francisco Harbor on September 19, 1838.

Southern California Earthquake of January 9, 1857

Time of occurrence.—About 08:00.

Epicenter.—35° N., 119° W., near Fort Tejon.

Area affected.—Considerable. Total felt area unknown.

Intensity.—X–XI.

Description.—Violent shock. A ground crack 40 miles long was observed in the vicinity of Fort Tejon, an army post about 4 miles from the San Andreas Fault between Los Angeles and San Francisco. Near Tejon, a corral was converted by horizontal dislocation of the ground into an open S-shaped figure; at the Fort, buildings and large trees were thrown down. The roof of the mission church at Ventura collapsed. Artesian wells in the Santa Clara Valley (near Ventura) ceased to flow, and in other places increased their flow. Several new springs were formed near Santa Barbara. There were large fissures in a number of places. Wood and Allen have considered this shock potentially the most destructive in the Coast Ranges since the advent of Europeans.

Owens Valley Earthquake of March 26, 1872

Time of occurrence.—About 02:30.

Epicenter.—36½° N., 118° W., Owens Valley, near Lone Pine.

Area affected.—Felt strongly over 125,000 square miles. Total felt area unknown.

Intensity.—X–XI.

Description.—The shock was felt over most of California, and probably most of Nevada and Arizona. It was very destructive in the Owens Valley and severe along the western slopes of the Sierra Nevadas, the Mojave Desert, and the eastern part of the Great Valley of California. The most disastrous effects of the earthquake were at Lone Pine. Of a population between 250 and 300, 27 were killed and about 56 were injured. Of 59 houses, 52 were destroyed, most of which were adobe. At Independence, 9 miles north, the same type of structure was used, but there was little loss of life. At Indian Wells, 67 miles south of Lone Pine, adobe houses were cracked. Near Owens Lake, numerous depressions formed between cracks in the earth. In one place, an area 200 to 300 feet wide sank 20 to 30 feet leaving vertical walls; several long, narrow ponds were formed. There was a disturbance of terrain from Haiwee nearly to Bishop. Well-defined scarps up to 23 feet in height were formed along the fault at the east base of the Alabama Hills and its northerly continuation, and horizontal motion ranging up to 20 feet was revealed by the movement of fences crossing the fault. Large masses of rock were dislodged from steep slopes. There appear to have been thousands of aftershocks, some severe. This shock was greater than those of 1857 and 1906.

San Francisco Earthquake of April 18, 1906

Time of occurrence.—05:12*.

Epicenter.—38° N., 123° W., northwest of San Francisco.

Area affected.—Destructive intensity extended 400 miles; felt over 375,000 square miles, including water area.

Magnitude.—8.3.

Intensity.—XI.

Description.—This was one of the greatest known shocks in California. It was associated with the largest known length of slip along a fault plane in the contiguous United States. The observed extent of displacement on the San Andreas Fault was about 180 miles in a N.35°W. direction. Assuming that the slip in the Cape Mendocino region is an extension of this, the total distance was 270 miles from San Juan, San Benito County, to Telegraph Hill, Humboldt County. The greatest slip, 21 feet, was in Marin County. In many places, dislocation of fences and roads indicated the amount of movement. Motions of 10 to 15 feet were not uncommon. In the region north of the Golden Gate some vertical slipping occurred, nowhere more than 3 feet and, in general, not more than 1 foot. Features of the movement included cracks and landslides.

The region of destructive intensity extended 400 miles. The total felt area included most of California and parts of Nevada and Oregon. On or near the rift, buildings were destroyed and trees were uprooted or broken off. One house was torn apart. Roads crossing the faultline were rendered impassable and pipelines were broken. This had an important effect in San Francisco, as lack of water supply let the fire get out of control, although it probably would have done so in any case. The amount of damage was unevenly distributed owing to subsurface conditions.

Buildings and structures in all parts of the city and county of San Francisco were damaged. Much

San Francisco's California Street after earthquake and fire of April 18, 1906.

of it was moderate in amount and character. Most chimneys toppled, plaster on walls and ceilings cracked, and there were many forms of permanent damage. In small districts on made land, where the intensity was augmented, pavements were buckled, arched, and fissured; brick and frame houses of ordinary construction were severely damaged or destroyed; sewers and water mains were broken; and heavy streetcar tracks were bent into wavelike forms.

At Santa Rosa, although 19 miles from the rift, destruction was great, and the intensity was higher than at most other points of comparable distances. The district lies directly inland from the region of greatest motion on the San Andreas Fault.

Another region of violent shock detached from the main San Andreas Rift zone was in the Los Banos region of the western San Joaquin Valley where, more than 30 miles from the rift, the intensity was fully IX. A long belt of high intensity extending northwest and southeast suggested activity of some other fault.

There was considerable cracking of alluvial surfaces. In addition to the great rift fissures, there were branch fissures. Avalanches and earth slumps occurred, and earth flows were observed where the ground contained excess water.

Trees swayed violently and were thrown down or snapped off in some cases. Springs and artesian wells either increased or decreased in flow. Where jets of water spurted through holes or fissures, a few mud or sand craterlets were formed. Although no tsunami was reported, water in the harbor was disturbed. Vibrations from the shock were felt on offshore vessels.

The great shock and resulting fires caused at least 700 deaths, about 50 of which were in Santa Rosa. According to figures compiled many years afterward by John R. Freeman, earthquake damage in San Francisco was $20 million and $4 million outside the city, but these estimates appear to be far below the actual amount.

There were numerous aftershocks, some fairly sharp. That on April 25 caused landslides along

the coastal cliffs of San Francisco Peninsula. The last shock of this type occurred in July.

Nevada Earthquake of October 2, 1915

Time of occurrence.—22:53*.

Epicenter.—40½° N., 117½° W., Pleasant Valley, Nev.

Area affected.—500,000 square miles.

Magnitude.—7¾.

Intensity.—X at epicenter.

Description.—The shock occurred along a fault on the eastern side of Pleasant Valley, which lies south of Winnemucca. It was felt over a larger area than the San Francisco earthquake of 1906—from Baker, Oreg., to San Diego, Calif., and from the Pacific coast to beyond Salt Lake City, Utah—but caused little property damage because the area had few structures and people. There were two foreshocks—15:40 and 17:49—which were barely felt outside Nevada. There was a roar at Kennedy, and people found it difficult to remain on their feet. There, the motion continued until the main shock at 22:53. There was a great roar at that time, people were thrown from beds, adobe houses were destroyed, mine tunnels caved in, and concrete mine foundations cracked. Cracks appeared for considerable distances where materials were unconsolidated. At Winnemucca, damage was moderate and generally confined to that part of the city on low ground. At Lovelock, large water tanks were thrown down and cracks appeared in the road. Applications were filed for new water rights because of the great increase in water flow. A rift, with a fresh vertical scarp 5 to 15 feet high and 22 miles long, was formed parallel to the base of the Sonoma Mountains.

Western Nevada Earthquake of December 20, 1932

Time of occurrence.—22:10*.

Epicenter.—38.7° N., 117.8° W., in the Cedar Mountain District.

Area affected.—500,000 square miles.

Magnitude.—7.3.

Intensity.—X.

Description.—Since the region was uninhabited except for an occasional miner or sheepherder, little damage occurred. Two cabins, one of stone and the other of adobe, were destroyed, and mining property was damaged. Many chimneys were thrown down at Mina and Luning. At Hawthorne, the shock cracked cement and threw down additional chimneys.

Extensive and complicated faulting occurred over an area 38 miles long and 4 to 9 miles wide in the valley between the Pilot and Cedar Mountain ranges, northeast of Mina. In this belt, 60 fissures ranging up to 4 miles in length were found, and others undoubtedly were hidden by snow when the survey was made. Boulders dislodged from hillsides in many places. At one point, large masses of coarsely crystalline limestone or marble dislodged and rolled down a hillside. Ground-water flow was either increased or decreased. The shock was felt from the Rocky Mountains to the Pacific Ocean and from San Diego to San Francisco, very noticeably at the latter.

Imperial Valley Earthquake of May 18, 1940

Time of occurrence.—20:37*.

Epicenter.—32.7° N., 115.5° W., southeast of El Centro.

Area affected.—60,000 square miles in the United States (including Arizona and Nevada) and an unknown area in Mexico.

Magnitude.—7.1.

Intensity.—X.

Description.—The epicenter was located southeast of El Centro, but there was surface slipping with surface rupture over a known distance of 40 miles. This passes the international border about 8 miles east of Calexico. The horizontal displacement reached 15 feet near the border. Vertical displacements up to 4 feet were observed. There was damage at all towns in the Imperial Valley and canals were damaged. This caused serious interruption to water service in a region that depends on irrigation for crops. Indirect loss of crops was considerable; direct earthquake loss in the United States was on the order of $6 million. Nine lives were lost.

At Imperial, the city water tanks collapsed and 80 percent of the buildings were damaged. At the more heavily populated town of Brawley there was greater total damage but less percentage of loss. Possibly 40 percent of the buildings were damaged, but the percentage was higher in business buildings. At Holtville, the city's water tank collapsed, but damage was not great. Damage at Calexico, and at Mexicali, Mexico, was not so extensive as

might have been expected. The principal loss in Mexicali was a hotel which was set on fire by a short circuit.

Kern County Earthquake of July 21, 1952

Time of occurrence.—03:52*.

Epicenter.—35.0° N., 119.0° W., south of Bakersfield.

Area affected.—160,000 square miles.

Magnitude.—7.7.

Intensity.—XI.

Description.—This was the main shock of the Kern County series and the largest earthquake in the United States since 1906. Damage to property was estimated at $50 million. Intensity XI effects were observed in a very small area on the Southern Pacific Railroad near Bealville. Reinforced concrete tunnels with walls 18 inches thick were cracked, twisted, and caved-in. The distance between portals of two tunnels was shortened about 8 feet in 300 feet. Rails were shifted and bent into S-shaped curves. Urban intensities, however, did not exceed VIII. Twelve persons were killed, nine of these at Tehachapi in the collapse of a brick wall. Eighteen persons were hospitalized and several hundred were given first-aid treatment. In the vicinity of the White Wolf Fault along the lower slopes of Bear Mountain there were many surface ruptures. Near Caliente, reinforced concrete railroad tunnels were demolished. South of Arvin, concrete irrigation pipe systems shattered, many fields required releveling, and hundreds of electric power transformers fell from elevated platforms. Near Wheeler Ridge, 10-inch-diameter steel pipelines were pulled apart and, in one case, telescoped 42 inches. Several million dollars' damage resulted at the Paloma Cycling Plant from a fire ignited by a broken gasline. At Arvin, Bakersfield, and Tehachapi, old and poorly built masonry and adobe buildings were cracked; many collapsed. Reports of long-period wave effects were widespread. Water splashed from swimming pools in the Los Angeles area. Damage to tall buildings was superficial, but costly. At Owens Lake, 100 miles from the epicenter, salt beds shifted, and brine lines bent into S-shapes. The shock was also felt at Gerlach, Nev., Phoenix, Ariz., and Stirling City, Calif.

One hundred and eighty aftershocks of magnitude 4.0 and over were recorded by the Seismological Laboratory, California Institute of Technology, Pasadena, from July 21 to September 26. Forty-seven aftershocks of magnitude 4.0 and over occurred on the 21st. Six of these were of magnitude 5.0 and over. A list of some of the larger aftershocks of this earthquake follows.

Aftershocks of Kern County Earthquake

Date	Time (PST)	Intensity	Magnitude	Remarks
July 21	04:06	V	6.4	Slight damage at Huasna.
July 21	11:41	V	5.5	Plaster chips fell at Arvin.
July 22	16:38	V	6.1	Additional building damage in Arvin and Bakersfield; slight damage at Fresno.
July 22	23:53	VII	5.4	Additional building damage at Arvin. A house slightly damaged by main shock almost destroyed. Gas and water mains broke; transformers ripped off.
July 23	05:17	VII	5.7	Weakened buildings fell at Arvin and Tehachapi. Ground cracked. Several were injured.
July 23	10:14	VI	5.2	Building seriously damaged by main shock fell at Arvin.
July 25	11:10	VII	5.7	Landslides in several localities east and northeast of Bakersfield. Pipeline damaged at Fairfax.
July 28	23:04	VII	6.1	Additional building damage at Bakersfield. Several fires ignited in area. Landslides near Bena, Fresno, and Piedra.
July 31	04:09	VI	5.8	Slight damage at Arvin, Bakersfield, and Taft.
Aug. 13	09:39	VI	4.7	Slight damage to brick at Arvin.
Aug. 22	14:41	VIII	5.8	See p. 174 for description.
Sept. 2	04:42	VI	4.6	Slight damage at Arvin.
Sept. 2	08:38	VI	4.0	Slight damage at Arvin.

Railroad tracks were shifted and bent by July 21, 1952, earthquake.

Dixie Valley, Nev., Earthquake of December 16, 1954

Time of occurrence.—03:07*.

Epicenter.—39.3° N., 118.2° W., near Frenchman's Station, Nev.

Area affected.—200,000 square miles.

Magnitude.—7.1.

Intensity.—X.

Description.—This shock was felt in California, Oregon, Idaho, Arizona, and Nevada, and as far east as Salt Lake City, Utah. Intensity X was assigned to the spectacular surface ruptures which occurred in an area roughly bounded by geographic coordinates 39°01′ to 39°50′ N., 118°00′ to 118°15′ W. Within this area there are two major fault zones—in the north, on the west side of Dixie Valley along the east base of the Stillwater Range; in the south, on the east side of Fairview Valley

Earthquake of December 16, 1954, left this fault scrap in Nevada.

in the Clan Alpine Range. Faulting extended north and south for a linear distance of approximately 55 miles. Because the epicentral tract was sparsely populated, this potentially destructive earthquake caused relatively little property damage.

Five to 15 feet of vertical movement and some horizontal displacement occurred in the Dixie Valley Fault zone. Water of about 60° temperature flowed from a fracture at Mud Springs and cut several trenches 2 to 3 feet deep down the slope toward the Dixie Valley Road. Where the fracture ran through more compact sediments, the fissure was several to many feet deep. At IXL Canyon, about 2 miles north of Mud Springs, there were large vertical displacements and a 55-foot graben. In the settlement of Dixie Valley and vicinity, all wells increased in flow, new wells formed, and water bubbled from the ground in spots. An adobe cellar, a stone wall, and gasoline and water tanks collapsed. Largest movements were observed at the eastern base of Chalk Mountain, Fairview Peak, and Slate Mountain. Vertical movement varied between 3 and 6 feet where the fault zone crossed U.S. Highway 50, south of Chalk Mountain. The highway was badly cracked. East of Fairview Peak, there were movements of 6 to 20 feet and horizontal displacements of 4 to 12 feet. Several rocks of automobile size fell onto the highway west of Carroll Summit. At Frenchman's Station, heavy furniture was displaced but damage to buildings was negligible. A ground crack extended beneath a store, raising the southeast side about 4 inches. One well decreased in flow and water became cloudy. Damage at Fallon was limited to a few toppled chimneys. Chimneys twisted and fell at Austin. At Sacramento, Calif., the shock caused an estimated $20,000 damage to a water tank. A magnitude 6.8 aftershock occurred at 03:11.

INTERMEDIATE AND MINOR EARTHQUAKES

1769. July 28. Los Angeles region. Four violent shocks were felt in a camp near the present site of Olive on the Santa Ana River; many more shocks were experienced during the next several days as the Portolá Expedition marched northwestward. The incomplete record strongly suggests a major earthquake with numerous strong aftershocks, possibly continuing into 1770.

1775. December 26. Southeast of Hemet. A brief shock was felt in camp by the Anza Expedition in San Carlos Pass (about 25 miles southeast of Hemet). It was accompanied by an "instantaneous loud noise." Possibly of destructive potential.

1790 (?). Date unknown. Owens Valley region. Indians state that about 80 years before the shocks of March 26, 1872, in Inyo County, a similar earthquake occurred in the same region. Recent small fault scarps in alluvium are proof of many major shocks in the region at unknown dates in the past.

1800. October 11 (?). San Juan Bautista. An official report dated October 31 stated that the mission experienced strong earthquakes since the 11th, with up to six shocks a day. Every habitation, though constructed with double walls, was damaged from roof to base. Threatening to fall, all were uninhabitable. The padres slept outside in mission carts for safety's sake. Cracks were observed in the ground of the rancheria; a deep fissure was reported along the slope of the Pajaro River. A visiting officer, there on the 18th, described a shock as "accompanied by a deafening noise." The date of the main shock is not known.

1800. November 22. San Diego area. Damaged the walls of adobe buildings at barracks in San Diego; cracked walls of new church under construction at San Juan Capistrano.

1800. Date unknown. Santa Barbara. A violent earthquake was felt at Santa Barbara. Little damage was done to the mission buildings.

1803. May 25. San Diego. Mission church was slightly damaged.

1806. March 24. Santa Barbara. Church walls cracked.

1808. June 21 (?). Presidio of San Francisco. A succession of shocks, 18 up to the date of the official report of July 17, 1808. Some were very strong and cracked the walls of the commandant's house, causing the collapse of one of the rooms. The soldiers' quarters were damaged and threat-

ened to fall. The date of the main shock is uncertain.

1812. December 8. Southern California. The stone and mortar church of San Juan Capistrano was destroyed and 40 persons attending services were killed. Other mission buildings were damaged. The church at San Gabriel was severely cracked, the altar overturned, and statues broke; the upper part of the tower fell and other buildings were damaged. The shock was strongly felt at San Diego, but the mission and presidio buildings were undamaged. It was also felt at Purisima where several tiles were dislodged from the church roof. Some aftershocks were felt even as far as Purisima. Aftershocks subsequent to December 21 cannot be distinguished from those of the earthquake of that date.

1822. Date unknown. San Jose and Santa Clara. It is stated that the churches of Santa Clara and Mission San Jose were severely damaged in 1822. There is some confusion regarding these records.

1827. September 23 (?). Los Angeles. People ran outdoors in panic.

1830. Date unknown. San Luis Obispo. Church was damaged.

1836. June 10. San Francisco Bay. Large fissures in the area of maximum disturbance, along the foothill belt from San Pablo to Mission San Jose, indicate an origin on the Hayward Fault. The intensity of this shock was comparable to and possibly stronger than the earthquake of October 21, 1868, which originated in the same area. A probable foreshock was felt strongly in Monterey on June 9 at about 4 p.m. Aftershocks were numerous and lasted at least a month. The shock caused great havoc in Monterey and Santa Clara and aroused great fear among the people. Intensity VII at Monterey and Mission Carmel.

1841. July 3. Monterey. Also felt at sea. Possibly a severe shock in Monterey Bay. One hundred and twenty shocks in 2 months, mostly slight.

1843. June 23. California-Mexico border region. Few details known.

1851. May 15. San Francisco. Severe shock lasting half a minute. Felt on ships in harbor; threw merchandise to floor.

1851 (?). November 26. Coast of northern California (Santa Cruz to Mendocino County). Eleven shocks; possibly attained destructive intensity. (This could be an inaccurate reference to the shocks of Nov. 27 to 30, 1852. See also Oct. 26, 1852.)

1852. October 26. Southern California. Eleven shocks at San Simeon, Los Angeles, and San Gabriel. Felt also at San Luis Obispo, San Diego, and Colorado River. During the next 6 days, all the southern part of California was shaken at short intervals. There is a possibility that the date was November 26, and the year may have been 1851. (See also Nov. 27 to 30, 1852.)

1852. November 22 to 24. San Francisco Peninsula. This shock was severe 8 miles southwest of San Francisco. Apparently, considerable fissuring occurred from Lake Merced to the sea.

1852. November 27 to 30. Southern California. Continued shocks disturbed an area of over 300 miles square, extending from San Luis Obispo to the Colorado River and to San Diego. Fissures at least 30 miles long were reported in Lockwood Valley in the northeast part of Ventura County. Many aftershocks.

1852. December 17. San Luis Obispo. Two sharp shocks fractured walls of two adobe dwellings and threw down part of the walls of another.

1853. February 1. San Simeon. Violent shocks damaged houses.

1853. October 23. Humboldt Bay. Three heavy shocks. It was reported that houses at Eureka rolled like ships at sea and that the wharf sank 4 feet.

1855. January 24. Downieville. Buildings were shaken severely. A pinnacle of rock was thrown down from Downieville Buttes. Felt strongly in region from Gibsonville to Georgetown and Nashville, Sierra and El Dorado Counties. Severe at Eureka and Orleans Flat, which probably were mining camps.

1855. July 10 or 11. Los Angeles County. Four shocks were felt in about 12 seconds. Bells in San Gabriel Mission Church were thrown down. An adobe building located directly on Raymond Fault was wrecked. Twenty-six buildings were damaged in Los Angeles (almost every structure according to one source). The walls of the Star Hotel cracked, and the west wall of the church cracked in several places. Submarine origin suggested by sea waves.

1856. February 15. San Francisco. An 8-second shock caused considerable damage to buildings. Strong at Oakland, San Jose, and Monterey. Water was disturbed in San Francisco Bay.

1856. September 20. San Diego County. At Santa Ysabel, walls cracked, and ceilings fell. Indians were terrified; cattle stampeded.

1857. February 5. San Francisco. Two shocks were felt at San Francisco, Oakland, and Stockton. In San Francisco, buildings on made ground were shaken severely.

1858. November 26. San Jose. Very severe at San Jose. Every brick, adobe, or concrete building was cracked or damaged in some way. At San Francisco, there was damage to buildings, particularly on made ground.

1860. March 15. Western Nevada. Felt over a considerable area of Nevada and portions of north and central California. Intensity in epicentral area is unknown as the shock occurred in an unsettled region. Very violent at Carson City, Nev. Intensity V at Sacramento. The shock was felt as far as Yreka to the north and Utah to the east.

1860. November 12. Humboldt Bay. The frame of a building under construction moved 2 inches on its foundation; some plastered walls cracked; chimneys settled.

1861. July 3. Contra Costa and Alameda Counties. Severe in Amador Valley, near the present site of Livermore. Adobe houses were damaged; men in fields were thrown down. In San Ramon Valley a fissure opened, and a new spring of water appeared. Strong, but no damage at San Francisco.

1862. May 27. San Diego County. Severe, with many aftershocks to June 5. Strong at San Diego, Temecula, and Anaheim.

1862. Date unknown. Goleta. Horses and cattle were frightened, trees swayed; difficult to stand.

1864. March 5. San Francisco. A widely felt shock which was apparently strongest at San Francisco. Plaster cracked and a few plate glass windows shattered. Also felt at San Jose, Santa Clara, and Stockton.

1865. March 8. Sonoma County. Severe at Santa Rosa, and more severe in the upper part of Bennett Valley. Plaster cracked, clocks stopped, and chimneys fell. (Which phenomenon took place at Santa Rosa and which in Bennett Valley is not clearly indicated.)

1865. May 24. Central and southern California. Two separate shocks reported—with practically no doubt. One was sharp at San Francisco, San Juan Bautista, and Santa Cruz; probably not destructive. The other, remarkably heavy in southern California (VII?), may have been destructive.

1865. October 1. Fort Humboldt and Eureka. At Fort Humboldt, all buildings were severely damaged, redwood trees were uprooted, and fissures opened on the parade grounds. All brick houses in Eureka were damaged, and most of the brick chimneys tumbled down.

1865. October 8. Santa Cruz Mountains. The highest intensity occurred between San Jose and Santa Cruz. At San Francisco, the greatest damage was to weakly constructed buildings on made land. Structures on solid ground, or well-constructed structures, suffered little damage. A number of weak buildings were completely ruined; water mains and gas pipes broke in several places because of shifting ground; and a crevice opened in one street. At San Jose, the walls of the jail and church fell. On the Santa Cruz Gap Road chimneys fell. At Mountain Charley's, the earth opened and boulders obstructed the road. At New Almaden, a large brick storehouse and several houses were destroyed; the earth opened and closed, throwing up clouds of dust. Wells and streams were affected.

1866. March 26. San Francisco region. Conflicting reports of minor damage in San Francisco. Intensity difficult to estimate. Also felt at Stockton, Sacramento, San Jose, and Monterey.

1867. December 1. Nevada City. Strong shock—no details known. May not have been of destructive intensity.

1868. May. Dos Palmas, east of north end of Salton Sea. One source states that a long fissure opened in the earth. (If this is true, the intensity was IX, perhaps X).

1868. May 24 (?). Nevada. Violent shocks in Nevada; two shocks at Sacramento. Possibly a misdating of the next entry as the hour is the same.

1868. May 29. California-Nevada. Series of shocks in interior of California (Lassen County and Sacramento) and Nevada. Destructive intensity possible, but not established by the record.

1868. September 4. Inyo County. Foreshocks on September 3; aftershocks very numerous, continuing into October; some of them were large. Rockslides were reported in the mountains. At Lone Pine, 40 shocks in 1 hour were reported on September 4. Apparently not felt at Visalia or Independence. In any case, this was a considerable

disturbance which would have caused damage in a settled region.

1868. September 26. Ukiah. Severe shock; furniture tumbed about.

1868. October 21. Hayward. This shock was accompanied by fault trace phenomena along the Hayward Fault, which parallels the San Andreas Fault about 18 miles to the east and is at least 40 miles in length. Damage was greatest at Hayward and nearby places along the Hayward Fault. At San Francisco, there was considerable damage on made ground; the customhouse was severely damaged, and a tall chimney fell. Well-constructed buildings on firm ground suffered little damage. A careful estimate placed the property damage in San Francisco at $350,000, and this was only part of the total damage. At Hayward, almost every building was severely damaged, many completely wrecked. At San Leandro, the courthouse and jail were thrown down; other buildings were wrecked. There was damage as far south as Gilroy and Santa Cruz, and as far north as Santa Rosa. About 30 deaths occurred in various places, chiefly from falling bricks. There were strong aftershocks continuing into November.

1869. December 20. Downieville. The "most severe" shock ever experienced (?) up to that time. Also felt at Grass Valley and Sacramento.

1869. December 26. California-Nevada. A house near Railroad Flat, Calif., was reported to have been lifted "bodily" several times. Three shocks were felt at Marysville, Calif., and Gold Hill, Nev. Also felt at Stockton, Sacramento, Grass Valley, Mokelumne Hill, Nevada City, and Chico, Calif., and at Virginia City, Nev.

1869. December 27. California-Nevada. Considerable damage at Virginia City, Genoa, Dayton, Carson City, and Steamboat Springs, Nev. Damage was also reported at Downieville and Oroville, Calif. Twenty-six aftershocks were felt at Virginia City, Nev.

1871. March 2. Humboldt and Mendocino Counties. Several strong shocks occurred at intervals extending over several hours. Chimneys were thrown down at Rohnerville and Petrolia. It shook cornices off some buildings at Eureka and damaged the Mendocino lightkeeper's house.

1871. July 5. Inyo County. Two shocks at Swansea and Independence; strong enough to cause people to run out of buildings.

1871. July 9. Kern County. Severe shock felt in the Joe Walker Mine, which was filled almost instantly with water.

1871. July 11. Swansea, Inyo County. A shock more severe than that of July 5.

1871. Date unknown. Imperial Valley. Halfway between Dos Palmas and Yuma, the shock rolled men over who were sleeping on the ground.

1872. March 17. Lone Pine. This, and the shocks of July 5 and 11 of previous year, may have been foreshocks of the great earthquake of March 26.

1872. March 23. Northeast of Austin, Nev. Violent shock at Austin. Plaster fell in courthouse. Also felt at Unionville and Winnemucca.

1872. April 18. Cerro Gordo, Inyo County. Very severe shock.

1872. May 17. Lone Pine. Strong aftershock.

1873. November 22. Del Norte County. Nearly every building in Crescent City was damaged. Chimneys were damaged in many places as far north as Port Orford, Oreg., and east to Jacksonville, Oreg. It was felt from Portland, Oreg., to San Francisco, and onboard ships at sea.

1876. January 3. Sonoma County. Most severe at Fulton and Freestone. Bottles and crockery were upset; the walls of at least one house cracked.

1877. June 11. Imperial County. Violent vibrations preceded volcanic eruption (?) in the mountains near Flowing Well Station, about 60 miles northwest of Yuma.

1878. Late summer. Inglewood. At the present site of Inglewood, kiln under construction was knocked down.

1881. April 10. Modesto region. Chimneys were damaged. The shock was felt from Greenville, Plumas County, on the north to Visalia on the south, and west to the coast.

1882. March 6. Hollister. The shock caused some damage and alarm at Hollister; "severe" but apparently no damage at Merced, Santa Cruz, Gilroy, Monterey, and Watsonville. Felt as far as Visalia and Lemoore. Many aftershocks.

1883. March 30. Hollister. Plaster fell; windows broke. Slight damage at Watsonville and Santa Cruz. Felt from San Luis Obispo to Martinez.

1883. September 5. Ventura. Strong shocks reported at several places along the coast, from Santa Barbara to Los Angeles and Wilmington. Strongest at Ventura. No damage definitely reported.

1884. March 25. San Francisco. Considerable uncertainty as to facts, but it was felt from Santa Cruz to Petaluma; also felt at Grass Valley.

1885. January 30. Lassen County. This earthquake was strongest near Janesville and on the Susan River, 12 miles from Susanville, where chimneys fell. Numerous aftershocks continued through February.

1885. March 30. Southeast of Hollister. In addition to fallen chimneys, other damage occurred in the Mulberry district on the San Andreas Fault, 17 miles southeast of Hollister. Slight damage was noted at Hollister. Cracks occurred in soft banks of the Pajaro and San Benito Rivers. Felt to San Rafael on the north with intensity IV.

1885. April 11. Monterey County. This shock strong at Martinez, Santa Rosa, Healdsburg, and may have originated on the San Andreas Fault, in the thinly settled region east of King City, Monterey County, although the actual location is uncertain. Chimneys were thrown down at Las Tablas, 30 miles northwest of San Luis Obispo. Slight damage occurred at Salinas, San Luis Obispo, and Monterey. Felt to Marysville on the north, Keeler on the east, and Ventura on the south. Little damage.

1885. July 31. Sonoma County. Strong shock at Cloverdale.

1887. June 3. Carson City, Nev. Severe shock lasting 7 seconds. Stone and brick walls cracked.

1888. February 18. Point Arena Lighthouse. Strong shock.

1888. February 29. Petaluma. Walls cracked. Less San Francisco.

1888. April 28. Nevada City. Walls of courthouse cracked. At Grass Valley, tops of chimneys fell. Orleans mine flooded; felt in Idaho mine below 1,600-foot level. At Biggs, Idaho, plaster cracked. Felt from San Francisco northeastward into Nevada.

1888. November 18. Oakland. Five chimneys fell on 23d Avenue in Oakland. Felt only in nearby places.

1889. May 19. Collinsville and Antioch. Chimneys were destroyed. Slight damage was reported from Rio Vista, Lodi, Napa, and San Francisco. Felt throughout most of central California.

1889. June 19. Lassen County. Chimney overturned at Willow Creek; frightened people ran into streets at Susanville; water of Eagle Lake muddied. The shock was felt to Chico and Sacramento, and possibly into Nevada. Seventy-five aftershocks.

1889. July 31. San Francisco Bay. Chimney fell at San Leandro. Severe at Oakland; a brick pier of the Chabot Astronomical Observatory cracked. The shock was felt from Gilroy and Santa Cruz north to Santa Rosa and Napa.

1889. August 27. Pomona area. Strongest at Pomona; windows broke. Felt from Santa Monica and Santa Ana to San Bernardino.

1889. September 29. Near Bishop. Strong shock. Felt in the region of Bishop and westward to the Sierras; rockslides reported in the Sierras. Heavy at Yosemite and Wawona; felt noticeably at Bakersfield, 140 miles from Bishop.

1890. February 9. Southern California. Felt strongly throughout southern California. The distribution of reports suggests a shock approaching in energy and comparable in location to that of April 21, 1918, on the San Jacinto Fault. However, because the region of the probable origin was essentially uninhabited, reports of actual damage to confirm this inference cannot be found. At Pomona, type in a newspaper font was "pied," and windows were broken. Telegraph dispatches at all places along the railroad from Pomona to Yuma reported the shock was as strong as at Pomona. Also felt at Los Angeles and San Diego.

1890. April 24. Monterey Bay region. At Watsonville, chimneys were thrown down. The area of highest intensity embraced Watsonville, Hollister, and Gilroy, and centered near Chittenden, with fissuring in the San Andreas Fault zone near that locality. The railroad was damaged through settling of ground and displacement of a bridge. Aftershocks occurred for many days.

1890. July 26. Petrolia. An earthquake of submarine origin and of intensity comparable to that of the shock of January 22, 1923, is indicated by the few reports available. Chimney was thrown down at Petrolia; strong, but little or no damage at Eureka and Mendocino City. Felt to Suisun, 220 miles southeast, and at Sisson, Siskiyou County.

1890. August 10 (?). Mono Lake. Strong shock. Date uncertain. Possibly refers to shock of September 29, 1889.

1891. January 2. Mount Hamilton. Ceilings cracked, plaster fell. Felt widely in central Cali-

fornia; strong, but little or no damage reported at Gilroy, Santa Cruz, and San Jose.

1891. October 11. Napa and Sonoma Counties. Many chimneys fell. Houses were damaged and people were thrown from beds. Every house in Sonoma Valley was damaged to some extent. Slight at San Francisco. Numerous aftershocks continued for several days.

1892. February 23. Northern Baja California. The intensity of this shock probably reached X near the epicenter, which was apparently in the uninhabited region of northern Baja California. It was felt strongly along the Pacific coast of Baja California, as far south as San Quentin. Effects reported from San Diego County are as follows: At Carrizo, all adobe buildings were destroyed; at Jamul, walls of stone kilns cracked; in Paradise Valley, church and schoolhouse built on stilts were brought down and demolished; at San Diego, a large number of buildings cracked and plaster dislodged. Walls were cracked at Santa Ana. Also felt at Los Angeles and San Bernardino. At Campo, there were 155 shocks in 12 hours. The shock was felt as far north as Visalia. Aftershocks were numerous for several days.

1892. April 19. Vacaville. In Vacaville, nearly all brick structures were wrecked and many frame buildings were damaged. Chimneys were twisted or thrown down. In Dixon, damage was less serious but many structures, especially schoolhouses, were severely damaged. At Winters, damage was similar to that in Vacaville and loss was about the same. Damage at Vacaville, Dixon, and Winters was estimated at about $225,000. Damage occurred at numerous other places in Solano and Yolo Counties. One chimney toppled at Sacramento, and there was slight damage at San Francisco. Fissures were found in the bed of Putah Creek, ½ mile west of Winters, and in the adjoining roadway and fields; banks of the creek were caved in. Shock was felt from Healdsburg to Fresno and east to western Nevada.

1892. April 21. Winters. Although the total energy expended was probably less, the intensity was as great as that on April 19. The shock was most severe at Winters, about 12 miles north of Vacaville. Many buildings which withstood the previous shock were leveled to the ground. On Main Street, not a single building was left habitable. They were constructed mostly of brick or stone. At Esparto, every brick chimney fell and wooden buildings were wrenched out of shape. Additional damage at Vacaville and Dixon was not great. Many chimneys were wrecked at Sacramento, in addition to other light damage. Damage was reported in Solano, Yolo, Sonoma, Napa, Contra Costa, Butte, Nevada, San Joaquin, and Yuba Counties. The shock was felt at least from Red Bluff to Fresno, and as far east as Reno, Nev.

1892. November 13. Monterey. Chimneys cracked. The shock damaged windows and dishes at Salinas and plaster at Hollister.

1893. April 4. Northwest of Los Angeles. In the Newhall and Pico Canyon oil region, 35 miles northwest of Los Angeles, all chimneys were wrecked, the earth was fissured, and boulders were shaken down the hillsides. In spite of its great local intensity, the shock was not strong at Los Angeles. However, it was strongly felt at Mojave. Aftershocks continued for days.

1893. May 18. Southeast of Ventura. Felt from San Diego to Lompoc and inland as far as San Bernardino. Highest intensity occurred in the region southeast of Ventura. Duration at Ventura was about 15 seconds. No damage was reported, but it may have been potentially destructive. Probable submarine origin.

1893. August 9. Santa Rosa. Considerable damage occurred to chimneys, etc., at Santa Rosa; slight damage at Petaluma. The unpublished records of Harry F. Reid (see Bibliography, p. 189) have an entry from a newspaper clipping of this date, but without a year: "An earthquake caused a great deal of damage at Windsor (only 6 miles from Santa Rosa), including destruction of a barber shop." Reid has entered the year as 1904, but as there is no other account of a destructive earthquake on August 9 of that year, it is probably in reference to the 1893 earthquake.

1894. July 13. Northeast of Fresno. A press item reported a sharp shock at Pineridge, in the Sierras, about 10 miles northeast of Fresno; the dam across Stephenson Creek was said to have been damaged. The shock was not felt in the San Joaquin Valley. Report suggests that no significant shock occurred. Severe electrical storm was raging.

1894. July 29. Mojave area. Strongest at Mojave and somewhat less severe at Los Angeles. At San Bernardino, railroad cars standing on track moved. The shock was felt from Bakersfield to San Diego.

1894. September 30. Humboldt County. Heavy at Hydesville and Eureka; felt strongly by Schooner *Lila and Mattie,* 35 miles off Shelter Cove. A rather large submarine earthquake off Cape Mendocino is a probable interpretation of the record. The shock was felt at Sisson, Siskiyou County. No damage on land.

1894. October 23. San Diego. Some brick walls cracked. There was considerable alarm but no serious damage. Boulders dislodged from hills. Felt at San Bernardino and Los Angeles.

1894. November 18. Virginia City, Nev. Probably the strongest of more than 100 shocks felt in the vicinity of Virginia City from November 14 to 22. It damaged walls and broke windows at Virginia City.

1895. March 1. Off Cape Mendocino. A strong submarine shock was felt on several vessels. It did not appear to be very severe on land. A sharp shock was felt at Eureka.

1896. January 27. Carson City, Nev. Plaster fell; buildings cracked.

1897. June 20. Near Hollister. At Hollister, nearly every brick structure was damaged and at Salinas, walls were thrown down. The shock was felt from Napa and Sacramento in the north, to Templeton, San Luis Obispo County, in the south. The epicenter was probably on the San Andreas Fault in San Benito County.

1898. March 30. Mare Island. Greatest damage at Mare Island where the loss required an appropriation of $350,000 for restoration. Occurrence at night was the only thing that prevented loss of life. Felt as far as Carson City, Nev. Chimneys twisted, and miscellaneous damage was considerable at San Francisco. Duration of shock 40 seconds.

1898. April 14. Mendocino County. Mountain roads east of Mendocino were rendered impassable by landslides and fallen trees. Frame houses were wrecked at Greenwood. Chimneys fell at Mendocino, and cemetery monuments fell or were twisted. At Point Arena, there was much damage, including cracking of the lighthouse tower and extinguishing of light. Many aftershocks continued for weeks. In some cases they were rather strong locally.

1899. April 16. Eureka. This long-duration shock caused some damage to a lumber mill. Felt at Hydesville and Crescent City.

1899. April 30. Watsonville. Highest intensity at Watsonville and in area toward Corralitos. Chimneys and cemetery monuments were damaged in Green Valley. There was a rolling motion of long duration at Mount Hamilton; pronounced, but no damage at San Francisco. Epicenter was probably on the San Andreas Fault east of Watsonville.

1899. June 1. San Francisco. Windows and glassware were broken south of Market Street. Also felt at Oakland and Berkeley.

1899. July 6. Watsonville. Two separate shocks within 1 minute. One, from an epicenter probably near that for the shock of April 30, caused chimneys to fall at Watsonville and broke windows and lamps at Salinas. The other caused damage to every brick building at Pleasanton, between 50 and 60 miles north of Watsonville, but appears to have been quite local. The shocks, whose effects at distance cannot be separated, were perceptible over some 40,000 square miles.

1899. July 22. San Bernardino County. Felt over nearly all of southern California; greatest intensity along the San Andreas Fault in the Cajon Pass region. Slides occurred in mountains for a distance of 20 miles west of the Pass. Roads were blocked by slides in many places. The main highway through the Pass was impassable for a distance of 20,000 feet. Property damage was greatest at San Bernardino and Patton, with some damage also at Riverdale, Redlands, Pomona, Pasadena, and Los Angeles.

1899. October 12. Santa Rosa. Plaster was knocked from walls; some chimneys fell. Some damage at Petaluma.

1899. December 25. San Jacinto and Hemet. In Hemet, nearly all brick buildings were damaged severely and only two chimneys remained standing. At Riverside, the shock threw down chimneys and cracked walls. Six were killed and eight were injured at Saboba, near San Jacinto. The shock probably centered on the San Jacinto Fault, about 10 miles southeast of San Jacinto, where there were old sinks and many fresh surface cracks. The shock was felt distinctly at San Diego and at Seligman, Ariz. There were numerous aftershocks for a few days and less frequent shocks through May 1900.

1901. March 2. Monterey County. There were surface cracks in the ground, some hundreds of feet in length, and, in some places, vertical dis-

placement of 1 foot in Stone Canyon. Chimneys were thrown down at Parkfield and Stone Canyon. Slight damage at Estrella, Paso Robles, San Miguel, and Adelaida. The shock centered on the San Andreas Fault.

1902. May 19. Elmira. Nearly all chimneys fell at Elmira; some fell at Vacaville; slight damage occurred at Fairfield and Suisun City. The shock was felt as far as San Francisco. Area of perceptibility exceeded 20,000 square miles, but reports are incomplete.

1902. July 27 and July 31. Santa Barbara County. Shocks occurred on intervening and following days at Los Alamos, Lompoc, and neighboring places, chiefly in Santa Barbara County. One adobe house was completely ruined, two oil tanks were destroyed (with a loss of 6,000 barrels of oil), store buildings were damaged, and a pipeline twisted and broke. The shocks on the 31st "completed the ruin started on July 27." In Los Alamos, no chimney was left standing, and no house escaped damage. Great and general public alarm. Fissures and cracks appeared in the ground. A dry stream resumed flow. Effects were most pronounced in a strip about 15 miles long and 4 miles wide.

1902. December 12. Los Alamos. At Santa Maria, the walls of a brick school were cracked; plaster fell in many houses.

1903. January 23. Baja California. A strong earthquake, centering in the uninhabited region south of Imperial Valley, was felt throughout southern California, southern Nevada, and western Arizona. A similar shock under present conditions in the Imperial Valley would cause damage. Recorded by distant seismographs. Magnitude 7+.

1903. June 11. Near San Jose. One chimney fell at San Jose and others fell in nearby areas. The shock was felt widely, but because it was reported at San Luis Obispo, among other places, it is possible there were two shocks. Accordingly, the area of perceptibility may have been anywhere from 40,000 to 100,000 square miles.

1903. July 24. Willows. Some brick walls cracked. Reported felt from Sacramento to Greenville and from Willows to Nevada City. It should also have been felt in the region west of Willows because origin appears to have been near that town.

1903. August 2. Santa Clara County. There was considerable damage to buildings and chimneys at San Jose. Heavy at Mount Hamilton, but no damage to astronomical instruments of Lick Observatory, even though several chimneys were thrown down. Also felt at San Francisco, Oakland, Yosemite Valley, Fresno, and Santa Rosa.

1903. December 25. Los Angeles area. In Los Angeles, some plaster and bricks were thrown down. Also reported strong at Riverside, San Bernardino, and Sierra Madre.

1905. December 23. Bakersfield. A local shock damaged a number of buildings. Considerable alarm.

1906. March 3. Southern California. Felt widely in southern California. Origin south of border. Recorded by distant seismographs, which indicates moderately destructive power.

1906. April 18. Brawley, Imperial Valley. Chimneys fell. Banks of New River caved in; water tanks were destroyed at Cocopah in Baja California. The published information is very limited, but H. O. Wood, on the basis of verbal information, reported this to be a very severe shock. Magnitude 6+.

1906. April 23. Ferndale. Chimneys and movable objects were overthrown. Strong at Eureka; felt into Oregon.

1906. May 1. Guerneville, Sonoma County. Much plaster cracked.

1906. December 6. San Luis Obispo County. Lighthouse tower cracked at Piedras Blancas. Felt at Santa Maria, Cambria, and San Luis Obispo.

1907. August 11. Humboldt County. Steady shaking for 15 seconds. Plaster loosened at Fortuna. Strong earthquake with offshore origin indicated.

1907. September 19. Near San Bernardino. Walls of building cracked at San Bernardino; building damage also occurred at San Jacinto. Strong at Redlands. At the Lez (probably Declez) quarries, large rocks were thrown down. Landslides occurred in the mountain districts, and a pipeline was broken in the Santa Ana Mountains. The shock was felt to San Diego, and to Montecito near Santa Barbara. A well-determined epicenter was not possible from available information.

1908. January 26. Honey Lake region. Chimneys toppled at Milford and Amedee. It was not widely felt nor recorded on Berkeley seismographs.

1908. August 18. Eureka. Houses cracked, chimneys toppled. At Freshwater, a few miles north of

Eureka, walls cracked, chimneys fell, and soft ground fissured.

1908. November 4. Death Valley District. This was the strongest of a series of shocks that lasted 3 weeks in late October and November. Prospectors were frightened from the region, but there was no damage because of sparse population and few buildings. M. W. Allen (see Bibliography, p. 187) considers that in a settled region, damage corresponding to intensity VII or VIII would have resulted. Strong at Lone Pine. Felt to San Bernardino and Tehachapi. Widely recorded on seismographs. Magnitude 6½ (?).

1909. May 17. Upper Mattole. The earthquake damaged all chimneys; monuments in cemetery broke and twisted. Felt at Eureka, Rohnerville, and Blocksburg.

1909. June 22. Sierra County. Chimneys were damaged at Downieville. Severe at North Bloomfield and at Bowman's Dam; slight damage at Redding and Grass Valley. Also felt at Sacramento. Principal damage was to lumber flumes and chimneys. There were numerous aftershocks.

1909. October 28. Humboldt County. All chimneys were thrown down and concrete structures were wrecked at Rohnerville. At Upper Mattole, chimneys were wrecked and cemetery monuments were thrown down. The shock was severe throughout Shasta County, but damage was moderate. Miners were badly frightened in a mine at Delamar. The shock was felt in southwestern Oregon as far as Marshfield and Grants Pass, northeast from its epicenter to beyond Redding, southeast to Nevada City and Grass Valley, and south to Ukiah. The shock was felt onboard a ship 25 miles southwest of Cape Mendocino. Magnitude 6+.

1910. March 10. Monterey Bay. Shock was widely recorded by seismographs, but no available reports indicate an intensity higher than VI at Aptos and Watsonville. The intensity was about the same all the way from Chittenden down the Pajaro Valley to Monterey Bay. A slow, rocking motion of alarming force nearly everywhere in the central region. Consequently, the epicenter is uncertain.

1910. March 18. Humboldt County. At Eureka the steady shaking lasted about 49 seconds, but no damage occurred. Shock of submarine origin and of potentially destructive strength. Magnitude 6+.

1910. May 6. Near Bishop. Felt strongly at Bishop, northern end of Owens Valley, and in Rock Creek Canyon to the northwest where there were rockslides. Felt at Bakersfield, Hollister, and Sacramento.

1910. May 15. Lake Elsinore region. Chimneys toppled in the district between Corona and Wildomar where rocks rolled down the hillside. Felt to Barstow, Ventura, and San Diego. Magnitude 6.

1910. November 21. Tonopah Junction, Nev. Windows were broken; watchman's car was thrown from track. Another shock was reported on November 18 at 18:25, but few details are available.

1910. December 31. San Benito and Monterey Counties. At Salinas, "heaviest since 1906, broke water main, and caused minor damage to dishes, etc." Felt in Sonoma County, about 135 miles from epicentral region. Anomalous distribution of "felt" reports. Long duration.

1911. March 11. Hollister. Plaster cracked; objects were thrown from walls. Some damage to chimneys and windows.

1911. July 1. South of San Jose. Strongest at Coyote, 12 miles southeast of San Jose. Fallen chimneys and cracked walls were reported at San Jose, Santa Clara, Gilroy, and Morgan Hill. Some damage to buildings and instruments occurred at Lick Observatory, Mount Hamilton. The epicenter was on the supposed southern extension of the Hayward Fault, near Coyote. Magnitude 6.6.

1912. January 4. Bishop, Inyo County. Felt strongly at Bishop; heavy at Laws and Alvord. Felt in San Joaquin Valley to the west and south to Bakersfield, 140 miles from Bishop.

1912. December 14. Near Oxnard, Ventura County. Two severe shocks overturned desks and scattered books at the Ocean View School; two barns nearby were wrecked. While very marked in the country districts, they were but slightly perceptible in the city.

1914. February 18. Near Reno, Nev. Slight damage at Truckee Meadows. Intensity was similar at Reno and Virginia City where bricks were thrown from chimneys.

1914. April 24. Near Reno, Nev. At Reno, brick chimneys fell, including some at the University of Nevada.

1914. November 8. Santa Cruz Mountains. Chimneys fell and articles were thrown from shelves near Laurel. Felt from Santa Rosa (Sonoma

County) to Soledad (Monterey County) and east to Fairmead.

1915. January 11. Los Alamos. Several well-built chimneys were shaken down, in addition to a number of poorly built ones, and water pipes were pulled apart at the unions. Some building damage occurred at Lompoc. At Harris, an oil pipe 8 inches in diameter broke in several places. There were cracks, caused by lurching in the alluvial soil, and numerous small landslides in the epicentral region. The shock was felt to San Jose on the north and to Los Angeles on the southeast. Perceptible duration 30 to 60 seconds. Many aftershocks for a month or more.

1915. February 21. Near Lassen Peak. Highly localized shock in mountains near Whitmore, northwest of Lassen Peak. Considerable dislocation of ground.

1915. April 5. Coleville region. At Coleville, rocks rolled down the hillside.

1915. June 22. El Centro, Calexico, and Mexicali. Two destructive shocks, nearly 1 hour apart. Heavy damage (about $900,000) in southern Imperial Valley was caused as much by poor quality of buildings as by the intensity of shock. In El Centro, well-constructed buildings merely suffered cracks. At Mexicali, Mexico, people returned to buildings after the first shock; six were killed and many were injured by the second earthquake. Though a few cracks were formed in the alluvium, the irrigation ditches and works were damaged very little. The unstable banks of the New and Alamo Rivers slid down in many places. Several farmers observed that after the shocks, one-third more water was required for irrigation because of the cracks in the soil. Despite the rather high local intensity, the total energy was moderate. Magnitude 6¼ for both shocks.

1915. October 7. Piedmont. A few chimneys out of many hundreds were thrown down. Felt from Sebastopol, Sonoma County, to Santa Clara.

1915. November 20. Baja California. A shock, revealed by seismograms to have been considerably greater than that of June 22, occurred in the Volcano Lake region south of the Mexican boundary. In the Imperial Valley, the highest intensity was at Calexico; at Volcano Lake, levees and damp ground were cracked. Magnitude 7.1.

1915. December 31. Off Humboldt County coast. Potentially destructive in epicentral area, but weak everywhere on land. Magnitude 6½.

1916. February 2. Western Nevada. Slight damage at Paradise Valley and Gerlach. Bells rang. Felt in Nevada, California, and Oregon.

1916. July 4. Humboldt County. Two miles west of Ferndale two chimneys cracked, a woodpile overturned, and milk spilled from pans. Plate glass window broke at Ferndale.

1916. August 6. Paicines, San Benito County. Chimneys were thrown down. Slight damage at Hollister.

1916. October 22. Tejon Pass. Rocks were shaken down on road; a crack several hundred feet long appeared in cement surface of road near Gorman. Goods were shaken from shelves. There were no towns in the epicentral area. Felt from Fresno to San Diego and from Mojave to the coast. Magnitude 6.

1916. November 10. Near Death Valley. Although this shock was potentially destructive, it caused no damage as it occurred in an unsettled region. Felt at Rhyolite and Las Vegas, Nev., and at Lone Pine, Calif.

1916. December 1. Avila. Landslide covered railroad tracks in canyon nearby. Smokestacks of refinery building tumbled over.

1917. May 27. Imperial Valley. Seems to have been most severe in open country. Walls were reported cracked at Brawley.

1917. July 6. Owens Valley. A break 100 feet long was caused in the flume of the Los Angeles aqueduct. From July 7 to 9, there were nine shocks in 3 days. Chimneys cracked; rocks rolled down hill.

1917. July 9. Lopez Canyon. Chimneys cracked; rocks rolled down hllsides. Seven other shocks felt in Lopez Canyon on July 7, 8, and 9.

1918. March 12. Sierra County. Newspaper reported fallen chimneys at Downieville. Reported felt only in Sierra County.

1918. April 21. Riverside County. San Jacinto and Hemet suffered heavy damage. Only one new concrete and one frame building remained standing in the business section of San Jacinto after the shock. The buildings wrecked were brick or artificial stone of poor construction, or old frame buildings. Concrete, substantial frame, and well-

constructed brick buildings were not damaged seriously. Property loss in the two places was in excess of $200,000. If the shock had occurred during business hours, instead of on Sunday afternoon, the loss of life would have been considerable. Numerous lengthwise cracks were found in the road between the two towns named, and concrete irrigation canals were broken in a number of places.

Damage corresponding to intensity VI and VII also occurred at Redlands, Riverside, and San Bernardino, and as far away as Los Angeles the intensity was a high V. The disturbance was most intense along about 10 miles of the San Jacinto Fault in the vicinity of San Jacinto.

Roads in the epicentral area were closed to travel by slides, and one automobile was carried off the road by a slide. Because of the extreme dryness of the ground, great clouds of dust arose from the mountains. Changes occurred in the water flow and springs either increased or decreased their output. A number of sand or mud craterlets were formed. In the region of the San Jacinto Fault southeast of Hemet, the dry earth surface in places was broken up as though by a harrow.

The shock was felt as far northwest as Fresno and Los Olivos, Santa Barbara County, east into Arizona, and undoubtedly a considerable distance into Mexico. Magnitude 6.8. There was a strong aftershock on April 22 near 08:00 that brought down tottering walls, and other shocks continued for weeks, the strongest occurring on June 6.

1918. April 22. Corona. Chimneys cracked; plaster was thrown down.

1918. April 30. Calexico. Plate glass broke. Felt over an area of about 100-mile radius.

1918. June 6. Riverside County. Four and one-half miles southeast of Hemet, the shock was sufficiently strong to crack plaster, loosen rocks on the mountainside, and to crack the ground around large trees. Strong aftershock of April 21 earthquake.

1918. July 14. Off coast of Humboldt County. Shock at sea of destructive potential. At Eureka, the intensity was estimated at VI; buildings swayed alarmingly and most people ran outdoors. Magnitude 6½.

1918. November 19. Santa Monica Bay. Two shocks, total duration 30 seconds. At Venice, plaster was brought down. At Santa Monica, pedestrians were thrown off balance and chimneys cracked.

1919. January 4. Shasta County. Chimneys were damaged at a number of ranches between Whitmore and Fern. Near Fern, there was a surface fracture that cut across the road with a vertical displacement of several feet. There is considerable probability that this was a landslide not associated with an earthquake.

1919. February 16. South of Maricopa. Buildings cracked at Maricopa and Grapevine, oil tank split at Belridge, and landslides occurred at Lebec.

1919. September 15. Eureka. Several chimneys fell. Four shocks; the first was the heaviest.

1919. September 29. Baja California. Levees slumped and many longitudinal cracks were formed in the Volcano Lake region south of Imperial Valley. Reported intensity distribution suggests that more than one shock occurred. A few foreshocks and numerous aftershocks.

1919. October 1. Baja California. A shock similar in location and energy to that of September 29.

1919. December 31. Mesa Grande and Warner Springs. At Warner Springs, adobe walls were cracked.

1920. June 21. Inglewood. This shock was highly localized in and just west of Inglewood. Typical damage was the wrecking of a two-story school building. Walls of a hotel and an electric substation fell, cemetery monuments were upset, and telephone service was interrupted. In a sparsely settled region this shock might have passed unnoticed. It was highly selective in its effects, damaging only poorly built structures. Magnitude 4.9.

1920. July 16. Los Angeles. First of seven shocks. Windows broke, bricks dropped from a few cornices, and some plaster fell.

1920. July 22. Hot Springs. This shock destroyed chimneys and caused great alarm. Felt throughout eastern Shasta County.

1921. July 21. Eagle Lake. Three shocks; the second was the strongest. On the east shore of Eagle Lake, objects were knocked over and people had difficulty in standing. Felt at Susanville.

1921. September 8. South of Imperial Valley. Duration at Calexico 30 seconds, then a second shock of same duration. Felt over a large area; probably of destructive intensity in the epicentral area.

1922. January 31. Northwest of Cape Mendocino. Large submarine shock, but so far from land that the greatest intensity on shore was VI at Eureka. Felt at San Jose, northward into Oregon, and in northwestern Nevada. Magnitude 7.6.

1922. March 10. Cholame Valley. Small ground cracks occurred in the San Andreas Fault zone; considerable damage to houses along line of San Andreas Rift in Monterey and San Luis Obispo Counties. One house was thrown from its foundation, and another was severely damaged. Chimneys were knocked down at Parkfield and in southern Cholame Valley. Oil pipelines broke between Shandon and Antelope. Felt feebly as far as Los Angeles and the Sierra Nevadas. Magnitude 6½. There was a strong aftershock on March 16.

1922. August 17. Cholame region. Strong shock in a sparsely settled region of the San Andreas Rift zone. Intensity was considerably less than that of the shock of March 10.

1923. January 22. Off Cape Mendocino. At Upper Mattole, Petrolia, Dyerville, and Pepperwood, houses were damaged and chimneys were thrown down. Slight damage at Eureka; shock lasted 45 seconds. The shock was felt 200 miles from the epicenter, but was not noted at many places at less distances because of the time of day so the area of perceptibility is uncertain. Felt on a number of vessels at sea. Magnitude 7.3.

1923. July 22. San Bernardino Valley. Severe in San Bernardino, with damage to masonry buildings and many chimneys. Buildings cracked and plate glass broke at Redlands. Good construction was not damaged. Magnitude 6¼.

1923. November 5. Calexico. The epicenter was probably near Calexico where a hotel shifted several inches on its foundation and other buildings sustained minor damage. Intensity was about the same at El Centro.

1923. November 7. Baja California. Intensity VII at Calexico. Damage caused by the shock of November 5 was increased, and one fire resulted. A stronger shock than that of November 5. Epicenter appears to have been in Baja California, south of Calexico.

1924. December 27. Near Salinas. Plaster fell. Felt from Palo Alto to King City.

1925. April 15. Calexico. Plaster was shaken from walls; inhabitants fled to the streets. Again, the epicenter probably was a short distance south of the border.

1925. June 29. Santa Barbara and vicinity. The shock was felt sharply at Ventura; some damage resulted. It was noticed throughout the San Gabriel Mountains to the east and in the Mojave Desert. At Naples, west of Santa Barbara, a stone church was damaged. The soil cracked at a few places in the Santa Ynez Mountains north of Santa Barbara, and springs increased in flow, but, in general, such effects were very moderate.

The damage at Santa Barbara, estimated at $8 million, was related both to geological conditions and to types of construction. In general, the structures in that city were equal to those of other cities, good, bad, and indifferent, with some concealment of poor work which was exposed relentlessly by the earthquake. State Street, the principal business thoroughfare which was built on made land, had few buildings that escaped damage.

A four-story brick hotel with long, unsupported side walls lost a large part of its exterior. A large office building failed at a corner when columns gave away and the whole building fell. Some large public buildings failed, revealing evidence of poor design and workmanship. A large frame church on a good foundation would have withstood the shock had not its roof, entirely too heavy for the building, collapsed. Thirteen persons lost their lives as a result of the earthquake.

Though built on marshy ground, a three-story concrete building of good design and construction stood up well. Its foundation had been carried down 19 feet to clay. In general, reinforced concrete endured the earthquake, except where there was poor workmanship. Frame buildings covered with stucco, sheathing, or lath withstood the shock, though other materials did not hold up so well. Brick, stone, cement block, hollow tile, and veneer walls generally were cracked or shattered. Yet, where the structures were properly braced and bonded and well laid in good mortar, they withstood the shock well, though chimneys fell and plaster cracked. The sewerage system was undamaged, except on made land where the loss was heavy. Pipes were cracked for considerable distances. There were cracks in pavement, and movement estimated from 8 to 14 inches was observed on a boulevard situated on a sand beach.

The earth dam of the Sheffield Reservoir (north of the city) failed, but little damage was done by the released water.

Strongly felt, with moderate damage, at a number of points in the Santa Ynez and Santa Maria Valleys, north of the Santa Ynez Mountains. Magnitude 6¼. There were a number of strong aftershocks on July 3.

1926. February 18. Southwest of Ventura. Windows broke in one Santa Barbara school; pipe broke in roundhouse. Felt along the coast from San Luis Obispo to south of Santa Ana, a distance of 200 miles.

1926. April 3. Northeast of Banning. Possibly in the region of Twentynine Palms. Of moderately destructive force, but no damage because of lack of settlements.

1926. April 19. Baja California. Volcano Lake region. Light at Calexico, duration 20 seconds. Seismograms indicate energy sufficient to be destructive over a small area. Felt as far as San Diego.

1926. June 29. Santa Barbara. Some chimneys fell, and a child was killed by a falling brick. Cracks in buildings caused by the 1925 shock were reopened. Felt slightly in Los Angeles.

1926. June 30. Kern River Canyon. Workmen in the canyon (outdoors) had difficulty maintaining their footing.

1926. July 25. Near Idria. Rocks rolled down hillsides in the vicinity of Idria and Panoche.

1926. October 22. Monterey Bay. The first shock was felt from Lompoc (Santa Barbara County) to Healdsburg (Sonoma County) and east to Snelling (Merced County). There was destruction of chimneys at Santa Cruz; lighthouse on Ano Nuevo Island was damaged. At Santa Cruz, old brick buildings sustained damage. Some damage was noted to the tile surface of a few buildings, chiefly on made ground, as far away as San Francisco; there was considerable damage to plaster; a pillar was cracked throughout its length. The second shock, an hour later, was almost as widely felt as the first, and it appears to have been the stronger of the two at points north of Monterey Bay. Magnitude 6.1 for both shocks. Shocks at 06:41 and 08:04 were less severe. Many small aftershocks occurred.

1927. January 1. Imperial Valley, near Mexican border. Two heavy shocks about an hour apart began a long earthquake series, though none of the latter exceeded VI in intensity. In Calexico and Mexicali many buildings were damaged, water mains broke, and some fires ignited. Between 15 and 20 persons were injured. At Heber, El Centro, and Imperial, slight damage was reported. At Heber, telephone service was interrupted. Magnitude 5¾ and 5½, respectively. The aftershock of February 12, 00:58, was farther north and was felt as strongly at Brawley as the main shocks. Hundreds of aftershocks occurred.

1927. February 15. Near Santa Cruz. Submarine shock just off Santa Cruz; slight damage.

1927. May 28. Near San Jose. Plaster fell at San Jose and a slight crack appeared in the wall of the old courthouse.

1927. August 4. Santa Monica Bay. Only minor damage on land; origin offshore. Felt area considerable—radius more than 50 miles.

1927. August 20. Humboldt Bay. At Eureka and Arcata, chimneys were destroyed and windows shattered. Automobiles went out of control. Cracks appeared in mud and gravel, and there were landslides of moderate extent. Intensity was somewhat lower at Fortuna, Ferndale, and Scotia. Felt up to about 90 miles away.

1927. September 17. Near Bishop. Walls were cracked; windows and chimneys broke. Felt to Bakersfield, 140 miles south, and to Stockton, the same distance northwest of Bishop. Magnitude 6.

1927. November 4. West of Point Arguello. The shock was widely recorded by seismographs. From Lompoc to the coast at Honda and Surf, there were heavy earth and rockslides on steep slopes, spurting of water, and formation of sand craterlets. Chimneys were wrecked at Lompoc and some were damaged at Arroyo Grande and Santa Maria. A house shifted on its foundation at Roberd's Ranch. Felt from Morgan Hill to Redondo Beach to Sanger. Tide gages recorded a tsunami which was about 6 feet high at Surf. Heavy shocks were felt on two vessels 27 and 14 miles, respectively, from Point Arguello. Larger than the Santa Barbara shock of June 29, 1925, but less destructive because of location. Magnitude 7.3.

1927. November 18. Santa Maria. Windows cracked; weakened chimneys collapsed.

1928. June 3. Weaverville. Chimneys were thrown down. Reported strong at Carrville and Trinity Center, and felt at Scotia and Eureka, 60 miles from Weaverville.

1928. September 5. Colorado Desert region, near Twentynine Palms. There was no damage because of lack of buildings. Felt as far as Ventura and San Diego.

1929. July 8. Whittier. A section of one schoolhouse wall caved in. Two houses were wrecked by falling chimneys. Several oil wells were damaged. Magnitude 4.7.

1929. November 28. Northwest of Bishop. Maximum intensity reported was 5 miles southeast of Aberdeen and at the headwaters of Goodale Creek, some 15 miles northwest of Independence. At the former place, concrete reservoirs were cracked and dishes broke. In the latter place, a large landslide was reported. However, there is some confusion in the reports, and it is not certain whether the landslide occurred on the day of the earthquake or the following day. The felt area included Stockton and Kernville, Calif., and Mina, Nev.

1930. January 15. Fawnskin and Summit. Chimneys fell. Felt strongly as far as Los Angeles. Magnitude 5.2 and 5.1, respectively.

1930. February 25. Imperial Valley. At Westmorland, walls cracked, chimneys toppled, and inferior buildings were damaged. Mud craterlets were found a few miles east of Westmorland. Several foreshocks and many aftershocks. Magnitude 5.0.

1930. March 1. Imperial Valley. This shock was of smaller magnitude than that of February 25. At Brawley, brick buildings were damaged, chimneys were thrown down, and plate glass shattered. Structural damage included falling of cornices and walls, severe cracks in walls, and displacement of roofs. Well-constructed buildings sustained little damage. Magnitude 4.5.

1930. April 9. Lake Tahoe. Chimneys were damaged at southeast end of Lake Tahoe; plaster cracked at Tahoe.

1930. April 12. Fernley, Nev. Chimneys and dishes broke at Fernley; plaster cracked at Fallon and objects were thrown from shelves.

1930. August 5. Santa Barbara. Windows broke. Walls cracked at Ventura.

1930. August 30. Santa Monica Bay. At Venice, a cornice fell and at Santa Monica, cracks appeared in a bluff. Minor damage to buildings in parts of Los Angeles. Magnitude 5.2.

1930. September 22. Humboldt Bay. Chimneys fell at Eureka, Arcata, and Fields Landing.

1930. December 11. Southwest of Cape Mendocino. Maximum intensity at Ferndale. Numerous aftershocks. The strongest on December 12 was intensity VI at Cummings.

1931. August 23. West of Cape Mendocino. At Punta Gorda Lighthouse, the mantle of the revolving lamp was broken and some mercury spilled. At Garberville, water spilled from outdoors containers; at Hydesville, small objects were overturned. The effects were strongest in Eel River Valley south of Eureka. Magnitude 5.3.

1931. September 9. Northwest of Cape Mendocino. Felt at Blocksburg and other towns along the lower course of the Eel River. Branches fell from trees in wooded regions. Chimneys were damaged at Weott. Magnitude 5.8.

1932. June 6. Humboldt County. This was the strongest shock in the region since 1923. It was destructive at Eureka where many chimneys fell, water mains were broken, windows shattered, and telephone and telegraph service was interrupted. One person in Eureka was killed by a falling chimney. A number of small houses in Arcata were shaken down; at Eureka Slough, a railroad drawbridge was put out of commission; at Loleta, small cracks appeared in the ground and a brick wall fell. Cracks 28 inches wide and several hundred feet long were observed on Cock Robin Island. The epicenter was located offshore near Eureka. The shock was felt north into Oregon and south to San Francisco. Magnitude 6.4.

1932. July 25. Upper Kern River. Rockslide at Mineralking; cracked chimneys at Springville.

1933. March 10. Long Beach. This shock was not of major magnitude from the seismological point of view, but because of its location near a thickly settled district with many poorly constructed buildings, it ranks as one of the most destructive shocks in the history of the United States. About 115 lives were lost and hundreds were injured. Damage of about $40 million resulted. The fire loss was small; the main damage resulted from the earthquake, an opposite condition to that which prevailed in 1906 in San Francisco.

The epicenter was located just offshore near Newport Beach. The major destruction, however, was in the more thickly settled district from Long Beach to the industrial section, south of Los Angeles, where watersoaked alluvium and other unfavorable geological conditions combined with the presence of much poor structural work to increase

damage. The strongly shaken area was bounded by a line from southern Los Angeles southwest to Manhattan Beach, and by another from southern Los Angeles to Anaheim and thence to Laguna Beach. At Compton, there was wholesale destruction of buildings over a limited area on unconsolidated and made ground. At Long Beach, buildings collapsed, tanks fell through roofs, houses displaced from foundations, and there was serious structural damage to buildings left standing. In factories, in addition to other damage, delicate machinery was thrown out of alinement.

There was little evidence of ground movement and no fault displacement visible. Slight slumps and distortion of made and unconsolidated ground took place in the region from Compton to Long Beach. Places where damage was exceptionally severe included Compton, Long Beach, and Huntington Park. Many structures, including water tanks, suffered damage. School buildings were among those most generally and severely damaged, largely because of unsuitable design to resist shaking. Had the shock taken place during school hours, great loss of life would have occurred. Magnitude 6.3.

1933. May 16. Niles Canyon, on line of Hayward Fault. Chimneys fell between Niles and Irvington. Landslide, cracked plaster, broken windows, and fallen goods were reported. Felt generally in the San Francisco Bay District.

1933. June 25. Wabuska, Nev. Brick chimneys fell; a cloud of dust rose from nearby hills. Felt to distances of about 200 miles. Distinctly felt at San Francisco and Fresno. Magnitude 6.1.

1933. October 2. Signal Hill. Moderately strong earthquake near Long Beach; possibly not a true aftershock of the March 10 shock. Considerable minor damage at Long Beach, Los Angeles, Compton, Bell, and other towns, chiefly to structures weakened in previous shocks. Felt as far as San Diego and Santa Barbara. Magnitude 5.4.

1934. January 30. Southeast of Hawthorne, Nev. Damage was relatively light because of the unsettled character of the region. A few damaged chimneys at Mina and collapse of adobe buildings at Marietta are typical examples of damage. There were changes in ground water conditions, landslides, and fissuring. A scarp 5 inches high was formed in the Excelsior Mountains. Shock also felt in Utah. Magnitude 6.5. A foreshock of intensity VII at 11:24 broke dishes and windows and damaged chimneys at Mina. Aftershocks were numerous but not very strong.

1934. June 7. Parkfield. Main shock of a series from June 5 to 7, comparable to the Long Beach earthquake of 1933, but in a relatively unsettled region. The center was along the San Andreas Fault. In Middle Mountain there were cracks in the ground, the zone of cracking being 25 feet wide and the largest crack 55 feet long and 18 inches deep. Trees were snapped off. Highway bridges near Parkfield shifted slightly on their footings. Chimneys were thrown down at Parkfield. Well-built structures sustained little damage. Magnitude 6.0. A strong foreshock at 20:30 damaged chimneys and cracked plaster in the same area affected by the main shock.

1934. December 30. South of Calexico. Intensity IX in the epicentral region in the Laguna Salada District of Baja California. On the railroads south of the border, bridges were damaged and tracks twisted. There were cracks in the surface and water spouted in a dry canal bed. Adobe houses were wrecked and a large water tank was thrown down. Maximum intensity VI in Imperial Valley towns. Magnitude 6.5.

1934. December 31. South of Calexico. A stronger shock than that of December 30, with practically the same epicenter. Maximum intensity X in Baja California. It is impossible to separate effects along the railroad from those of the previous shock. In Baja California, irrigation ditches were damaged, roads were buckled, crevices opened, and communication systems were disrupted. Strongly felt at Tijuana and other border towns. Intensity VII in southern California where chimneys and walls were thrown down at Calipatria. Also felt in Arizona and Nevada. Magnitude 7.1.

1935. October 24. Southern California. At Beaumont, landslides occurred on the southwestern slopes of San Gorgonio Mountain. Slight damage occurred at Twentynine Palms and East Highlands. Magnitude 5.1.

1936. May 10. North of Bishop. Felt in east-central California and Nevada. Timbers were wrecked in East Portal tunnel 20 miles south of June Lake. A few rockslides were noted at Bishop. Magnitude 5.

1937. February 6. Northwest of Ferndale. Slight damage occurred in the vicinity of Humboldt Bay. Magnitude 5¾.

1937. March 8. Near Berkeley. Damage to chimneys, plaster, retaining walls, and sewers was sustained at North Berkeley and in parts of El Cerrito and Kensington Park. One hundred and thirty chimneys were damaged in Albany. Magnitude 4.5.

1937. March 25. Terwilliger Valley. Moderate damage was inflicted to chimneys, plaster, and walls of some of the few houses within 30 miles of the epicenter. Magnitude 6.0.

1938. May 31. Santa Ana Mountains. Slight damage occurred in several widely scattered places northwest of Temecula. Magnitude 5.3.

1938. August 30. Near Long Beach. Slight damage occurred at Huntington Beach, Keystone, Long Beach, Los Angeles, San Pedro, and Seal Beach.

1938. September 11. West of Cape Mendocino. Slight damage occurred at Ferndale and other towns near the coast. There was damage to telephone lines, and, in the Redwoods, the ground was littered with fallen branches. Magnitude 5½.

1938. December 3. West of Bishop. No structural damage was reported as this region was very sparsely settled. Some landslides occurred. Pipelines were damaged near Owens River Gorge. Magnitude 5.5.

1939. January 11. Southeast of Minden, Nev. Felt in east-central California and west-central Nevada. Slight damage was noted at Coleville, Calif., and Gardnerville and Hudson, Nev. Magnitude 5.5.

1939. May 11. Northeast of Mina, Nev. Felt chiefly in Nevada. Strongest in vicinity of Rawhide. Intensity V at Carson City. Magnitude 5½.

1939. June 24. Near Hollister. Greatest intensity about 10 miles southwest of Hollister. There was some damage to chimneys of ranch buildings; small cracks appeared in the ground. Heavy furnishings moved and water spilled from containers. Magnitude 5¼.

1939. December 27. Long Beach. The shock cracked walls and damaged street lights at Huntington Park and Long Beach. Magnitude 4.5.

1940. February 8. Chico area. Damage, in general, was confined to cracked chimneys and broken windows at Chico and Grass Valley. Magnitude 6.

1940. October 10. Off Redondo Beach. Plaster walls and chimneys cracked at Keystone, 3 miles north of Wilmington. The shock was felt over an area extending from Santa Barbara to Palmdale, to Big Bear Lake, to Anza, and to Laguna Beach. Magnitude 4.7.

1940. November 19. Off Cape Mendocino. Felt principally in Humboldt, Mendocino, and Trinity Counties. Chimneys were damaged at Westport and Upper Mattole. Slight damage also occurred at Briceland, Bridgeville, Fields Landing, Garberville, and Honeydew.

1941. February 9. Off Cape Mendocino. Plaster cracked at Punta Gorda Lighthouse. Felt in southern Oregon. Magnitude 6.6.

1941. May 13. Off Cape Mendocino. Plaster cracked at Santa Cruz. Magnitude 6.

1941. June 30. Santa Barbara and Carpinteria. Total damage about $100,000, of which 35 percent was to drug and liquor stocks and to plate glass. A small slide covered the railroad and reached the highway about 20 miles east of Santa Barbara on Route 101. Telephone service between Santa Barbara, Carpinteria, Ventura, and San Luis Obispo was interrupted. In Santa Barbara, 30 glass-topped street lamps were snapped off, and practically every store in the 600 to 1000 block of State Street suffered considerable interior damage. There were 17 breaks in the larger water mains and 18 service breaks. Sidewalks buckled in a few places. In Carpinteria, about 25 chimneys and a number of walls fell, one cornice was shaken down, and many dishes and windows were broken. In both places, many of the structures affected had been damaged in the 1925 earthquake and imperfectly repaired. Magnitude 5.9.

1941. September 14. Owens Valley. Rockslides in the mountains near Rock Creek raised huge dust clouds and blocked roads and trails. One cabin was destroyed. The epicentral area was sparsely settled. Light damage was reported from 14 places. Magnitude 5.9 and 6.0, respectively.

1941. September 21. Near Cuddy Valley. Slight damage at Gorman, Lebec, Los Angeles, Taft, and Wheeler Ridge. Magnitude 5.2.

1941. October 3. Off Cape Mendocino. Chimneys twisted and cracked and some plaster fell at Eureka. Felt in northwestern California and southwestern Oregon. Magnitude 6.4.

1941. October 21. Gardena area. Greatest damage was in the West Dominguez oil field east of

Gardena where well tubing was damaged and almost all wells went off production temporarily. In surrounding towns, many walls and plaster cracked, windows broke, and some chimneys twisted. Store stocks suffered considerable damage. Damage in Gardena was about $10,000. In Moneta, a firewall was thrown down. Magnitude 4.9.

1941. November 14. Torrance-Gardena area. Damage was approximately $1 million. At least 50 buildings were severely damaged. Suburban areas were darkened for 30 seconds to 5 minutes as powerlines fell, and in some places telephone service was disrupted. Two oil tanks were demolished, two buckled severely, a 6-inch pipeline broke in four places, and a natural gas pipeline burst. In Torrance, about 50 percent of all brick chimneys and fireplaces were either twisted, broken loose, or thrown down. One of two schools suffering structural damage was condemned. Several houses moved off their foundations. In Gardena, the elementary school building was condemned and the Bank of America Building was damaged. Some firewalls and many chimneys were thrown down or damaged. A collapsing wall of a two-story building broke through the roof of a low, adjoining building, practically destroying its contents. Magnitude 5.4.

1941. December 30. Owens Valley. This shock twisted chimneys and cracked plaster at Owens River Gorge (Adams Main Powerhouse). Magnitude 5.4.

1942. October 21. Near Borrego Valley. Felt in southern California and western Arizona. In Carrizo Gorge, 12 miles north of Jacumba, slides broke bridge timbers and wiring on the SD&AE Railroad. Felt strongly in Imperial Valley towns and in San Diego where some plaster and windows cracked. Magnitude 6½.

1942. December 3. West of Wadsworth, Nev. Plaster cracked at Reno. Magnitude 5.5.

1942. December 17. Central California-Nevada border. Fairly hard series of shocks near Markleeville and Topaz, Calif. Magnitude 5.5.

1943. August 8. Excelsior Mountains, Nev. Plaster and walls cracked at Dyer and Fallon; dishes fell at Basalt. Magnitude 5.5.

1943. August 28. San Bernardino Mountains. Objects overturned and knickknacks and pictures fell at Lake Arrowhead, Big Bear Lake District, and Seven Oaks (Converse Ranger Station). Magnitude 5.5.

1943. October 25. Northwest of Mount Hamilton. Most damage occurred at San Jose where a gas main broke; plate glass windows and dishes broke; plaster cracked and fell. At Sunnyvale, a waterline and a chandelier broke. At Alviso, plaster fell and dishes broke. Slight damage—cracked plaster or broken windows—also was reported from Boulder Creek, Cupertino, Los Gatos, Milpitas, Mountain View, Palo Alto and Sausalito. Epicenter on Calaveras Fault. Magnitude 5.5.

1944. June 12. North of Cabazon. Slight damage at Banning and Los Angeles. Numerous localities reported shifting of small objects. Magnitude 5.1 and 5.3, respectively.

1944. June 18. Near Dominguez Junction. Two shocks caused minor property damage and jangled nerves in the Los Angeles area. At Long Beach, the shock was the heaviest since 1933. Dishes crashed to the floor, burglar alarms clattered, and many persons fled to the streets. A 4-foot marble slab toppled 12 feet from the front of a shop at Redondo Beach. Minor damage in the Compton-Torrance area. Magnitude 4.5 and 4.4, respectively.

1945. January 7. San Benito County. At Hollister, chimneys and plaster cracked; goods in stores displaced on shelves. Pendulum clocks stopped. Knickknacks, pictures, and books fell at Paicines and San Benito. Magnitude 5.1.

1945. April 1. Santa Rosa Island. Felt along the coastal area of southern California, from Santa Maria south through Santa Barbara and Ventura to Simi. Magnitude 5.4.

1945. May 17. Near Hollister. The shock caused considerable glassware damage; plaster cracked. Magnitude 4.5.

1945. May 19. Off Cape Mendocino. Small objects shifted at Upper Mattole. Magnitude 6.2.

1945. August 15. Borrego Valley. Slight damage to powerlines; plaster broke. Magnitude 5.7.

1945. August 27. San Jose. One chimney shook loose and plaster cracked. At Mount Hamilton, small objects overturned and pendulum clocks stopped.

1946. January 8. Southeast of Borrego Valley. Intensity V at Dulzura, Imperial, Lakeside, Mountain Center, Palm Springs, and San Diego. Magnitude 5.4.

1946. March 15. North of Walker Pass. In Onyx, there was considerable damage to wood, brick, masonry, and concrete. Pictures and plaster fell, and there was much cracking of windows, walls, and chimneys. Cracks appeared in the ground. Elsewhere in the region of Walker Pass and the South Fork of the Kern River there was damage to adobe structures, cracks in brick chimneys, and fallen plaster. In Bakersfield, some pipes were broken, and there was some damage in the basement of the City Hall. Plaster was cracked over a wide area. Magnitude 6¼.

1946. July 18. San Bernardino County. In Yucca Valley, near White Water, small objects shifted and knickknacks fell. Epicentral area sparsely settled. Magnitude 5¾.

1946. September 27. North of Beaumont. Plaster cracked and small objects shifted and overturned at Banning, Cabazon, Cathedral City, and Palm Springs. Magnitude 5.0.

1947. April 10. East of Barstow. Huge dust clouds were seen in the mountains where many rocks were displaced. Cracks appeared in the banks of the Mojave River and the water level raised slightly. Highways in the epicentral area were cracked in a number of places and slumped in others. In Newberry Springs, a school building was condemned and several adobe buildings were damaged severely. In Afton Canyon, 25 to 30 slides near the railroad made extensive repairs necessary. A trestle settled 2 feet. Elsewhere, a few chimneys were thrown down; concrete pools and floors, adobe walls, and plaster were cracked; and stocks were thrown from shelves. A stack of 3,000 concrete blocks and some farm tanks were shaken down. Magnitude 6.4.

1947. June 22. Gilroy. Intensity VI at Gilroy and other places in Santa Clara County and nearby areas. Hecker Pass was reported closed by slides. San Francisco Bay area was shaken. Magnitude 5.

1947. July 24. Morongo Valley. Intensity V at 15 places surrounding the sparsely settled epicentral area. Felt at Los Angeles, San Diego, and Needles. Magnitude 5.5.

1947. August 10. Near Hollister. At Hollister, several plate glass windows were broken; groceries, dishes, and pictures were knocked about; an ornamental stone pillar of a residence was split; a residential water main was broken; and the foundation of a downtown building was cracked. Nine miles south of Hollister plaster cracks were reported. Magnitude 5.0.

1947. September 23. Humboldt County. Plaster cracked at Punta Gorda Lighthouse. Magnitude 5.6.

1948. February 10. Tulare County. Intensity VI in Tulare County in and near the southern Sierras. Two old school buildings, one near Fresno and one near Dinuba, damaged in the Walker Pass earthquake of March 15, 1946, were abandoned for school use. Magnitude 4.6.

1948. December 4. Desert Hot Springs. There was slumping of cliffs and river banks; some landslides occurred. At Willis Palms, springs increased their flow and black mud appeared in wells. Minor structural damage resulted, mostly through the separation of structural parts, but some walls also were damaged severely. Hardest hit were ranch buildings near the epicenter, Desert Hot Springs, Indio, and Palm Springs. At Twentynine Palms, the frame of a 66,000-gallon elevated water tank buckled. Magnitude 6.5±.

1948. December 29. Near Verdi, Nev. An old rubblewall store in Verdi was severely damaged, sections of parapet walls of a schoolhouse fell, and 18 windows in the powerhouse were broken. Some chimneys collapsed. In Chilcoot, Calif., a rock veneer wall fell. Reno reported only slight damage. A boulder crashed through the telephone line in the Truckee River Canyon, disrupting service. Magnitude 6.0.

1948. December 31. Near Hollister. Intensity VII in epicentral area between Hollister and Monterey Bay. A number of light frame houses shifted on their foundations; one was damaged considerably. Magnitude 4.5.

1949. February 11. Northern Inyo County, near Nevada border. At Corcoran, stand pipes on an 18-inch concrete water supply line were cracked. Some old cracks were enlarged in the old City Hall at Bakersfield, and in the County Courthouse the elevator banged against the walls. Rock slab facing slightly cracked at Ash Mountain. Plaster cracked at Big Pine. At Olancha, walls cracked slightly and pumice brick was damaged slightly. A report from Hanford stated three powerlines or telephone poles fell near the Plaza underpass. Magnitude 5.6.

1949. March 9. Hollister. Wall cracked severely, three chimneys fell, plaster cracked, and windows

broke. One store suffered $2,000 damage in cracked walls and plaster. Stock in many stores was thrown off shelves. In San Francisco, 29 burglar alarms were activated. Magnitude 5.3.

1949. May 2. Riverside County. Shock centered in desert area southeast of Twentynine Palms. Slight damage at Amboy and Indio. Magnitude 5.9.

1949. June 9. East of San Jose. Three shocks; slight damage. The first shock tumbled stock from store shelves and shattered glass in Eastside homes at San Jose. A 12-inch cast-iron main was split open, causing water to bubble up through cracks in street paving and around water meters. Six miles east of San Jose, slight plaster cracks were reported.

1949. August 27. Near Point Conception. Felt in the coastal region of San Luis Obispo and Santa Barbara Counties. At Arlight and Sudden, dishes broke and chimneys fell. Broke dishes and overturned or shifted small objects at Lompoc. In the hills between Lompoc and the ocean the shock was strong enough to shake large oak trees. Magnitude 4.9.

1949. November 4. Baja California. Slight damage at Guadalupe, Mexico. Large buildings in San Diego swayed strongly; people ran to get outdoors. Palm trees swayed as though moved by a heavy wind. One-quarter-inch crack from ceiling to floor in one office building. At Coronado, cracks in auditorium of high school cancelled a scheduled assembly. In Borrego Valley, a few cement floors cracked (several shocks felt). Slight damage at several other towns. Magnitude 5.7.

1949. November 17. Terminal Island, San Pedro Bay. An intensity V shock, probably not felt more than 5 miles away, damaged over 200 oil wells near the 1,800-foot level. Damage was estimated at more than $9 million.

1950. February 25. Sespe Hot Springs. Felt area extended from Wheeler Ridge, through Cuyama to Casmalia and Lompoc, and south to Oxnard. At Ventura, an old chimney collapsed. Plaster cracked and fell, windows broke, and merchandise was thrown from shelves at Oxnard, Santa Paula, Saticoy, and Ventura. Magnitude 4.7.

1950. March 20. Lassen Peak. Intensity V at eight places. Also felt at Reno and Yerington, Nev. Magnitude 5.5.

1950. July 29. Imperial Valley. Strongest of a series of shocks centering near Calipatria on July 27, 28, and 29. Fifty thousand dollars in damage resulted, chiefly from merchandise being thrown from shelves in the Calipatria, Westmorland, and Niland areas. In Calipatria, concrete standpipes broke and a small railroad bridge shifted 6 to 8 inches. There was considerable plaster damage; chinaware broke. In the outskirts, sand boils appeared and irrigation ditch banks sloughed. In Westmorland, reinforced concrete walls of post office building cracked slightly, plaster fell, and windows were broken. Plaster cracked and windows broke at City Hall and at the Food Center Building. Also felt at Parker and Yuma, Ariz. Magnitude 5.4.

1950. August 1. Imperial Valley. Aftershock of July 29. A few bricks fell and ground fissures opened wider in the vicinity of North End Dam and Vail Canal. A portion of a wall collapsed. Additional earth boils were started in the areas previously affected, mostly at the damsite and along the levees of the Vail Canal. Magnitude 4.7.

1950. September 5. Northwest of Anza. Felt area extended from San Diego northeast to Twentynine Palms, north to Hinkley, southwest to Laguna Beach, and along the coast to San Diego. Canned goods were knocked from shelves, dishes broke, plaster cracked, and furnishings shifted at Banning, Beaumont and vicinity, Elsinore, Idyllwild, San Jacinto, and Wildomar. Magnitude 4.8.

1950. December 14. Near Herlong. Main shock of a series extending over several days. There was some structural damage and numerous cracks appeared in buildings. Many chimneys and windows broke. Several buildings shifted on foundations. Plaster cracked at Flanigan, Nev. Magnitude 5.6.

1951. January 23. Near Calipatria. Intensity VII was reported in the vicinity of Westmorland. The shock was felt over a large area of southern California and southwestern Arizona. About 3½ miles southwest of Westmorland in the Imperial Valley Irrigation District, 100 feet of ground running northwest-southeast settled 1 inch; the Westside Main in the vicinity of Trifolium was cracked; canal banks were cracked at head of Lateral 13 of Westside Main. Magnitude 5.6.

1951. January 25. San Francisco Bay. At Oakland, a window broke and at San Leandro, plaster

cracked and fell and dishes were knocked from shelves. Magnitude 2.9.

1951. February 15. Near Santa Rosa Mountains. Felt over the coastal areas of Riverside, San Diego, and Imperial Counties. Intensity V at 15 towns. Magnitude 4.8 for both shocks.

1951. July 23. Berkeley Hills. Two sharp earthquakes shook a small area of the San Francisco Bay region. Intensity VI was reported at Berkeley (first shock) where it was felt by all and frightened many. Vases overturned and knickknacks fell. At Oakland (second shock), a water pipe broke and flooded the street. Magnitude 3.2 and 3.9, respectively.

1951. July 29. Southeast of Mulberry. Slight damage to plaster walls and outside stucco occurred at Bitterwater (Lonoak). At Pinnacles, plaster fell and chimneys twisted; slight damage to concrete pipes. Plaster fell at San Benito. Road from San Benito to Hernandez Valley was covered with boulders for many miles. Magnitude 5.4.

1951. August 6. Southeast of Mulberry. Felt over the coastal region of west-central California. Felt by all at Harris Ranch, 7 miles south of Hollister. Vases overturned; knickknacks, books, pictures, and plaster fell. Magnitude 4.6. Two aftershocks at 01:54 and 09:21.

1951. August 14. Terminal Island. Intensity V at the surface. Many oil wells were damaged at a depth of approximately 1,675 feet below sea level. A subsurface survey showed 15 inches of movement at this depth, the top moving with respect to the rocks below. Damage was estimated at $3 million.

1951. October 7. Off Cape Mendocino. One mile south of Alton, considerable damage was sustained to the partially completed Van Duzen River Bridge. Bridgeville, Grizzly Bluff, Metropolitan, Rio Dell, Scotia, and Weott reported toppled chimneys, broken windows and water pipes, shattered glassware, and breakage in stores. Magnitude 6.0.

1951. October 31. Near Hollister. Felt by all, frightened many. Press reported a large window loosened in framework. Magnitude 4.7.

1951. November 14. Near Scotia. Felt in the Eel River Valley of northwestern California. Dishes and windows were broken at Eureka and Fields Landing. At Fortuna and Scotia, merchandise fell from shelves and plaster cracked. Magnitude 4.9.

1951. December 5. Imperial Valley. About 10 miles northeast of Brawley, a crack 100 feet long and 1½ inches wide appeared in gravel road. Cracks and bank damage to canals were reported. Windows and plumbing broke; stucco cracked. One artesian well spurted water 10 feet during the shock; another ran muddy. Magnitude 4.5.

1951. December 25. San Clemente Island. Slight damage reported at Avalon, Del Mar, Laguna Beach, Long Beach, San Diego, San Clemente Island, and San Pedro. Magnitude 5.9.

1951. December 27. Near Owens River Gorge. Felt by all and frightened few at Long Valley Reservoir. Dishes rattled and knickknacks fell. Magnitude 5.2.

1952. February 9. Northeast of Lone Pine. Building cracks and broken plaster were reported at Lone Pine. Magnitude 4.1. Aftershocks were felt for 5 days.

1952. May 9. North of Carson City, Nev. Felt in northeastern California and western Nevada. Slight damage at Carson City and Virginia City, Nev. Magnitude 5.4.

1952. July 21. Kern County. Many of the aftershocks of this major earthquake were of magnitude 5 and over and contributed to the existing damage. A list is given with the report on the main shock under "Major Earthquakes," page 153. The following shock (Aug. 22) is listed independently.

1952. August 22. Bakersfield. Intensity VIII was limited to downtown Bakersfield where damage was estimated to be about $10 million. Two lives were lost, 35 were injured. Many buildings of older brick construction, weakened by the July 21 shock, were wrecked beyond repair. The City Hall and Kern County Courthouse were abandoned. Additional serious damage occurred to the Kern County Hospital, County Jail, churches, and schools. Damage to underground utilities appeared to be minor. Outside the downtown district plaster and walls cracked, chimneys twisted and fell, dishes and windows broke, and some furniture overturned and broke. Magnitude 5.8.

1952. August 23. Near Acton. Slight damage reported at Amboy, Camarillo, Moorpark, and Oxnard. Magnitude 5.0.

1952. September 22. Petrolia. Several chimneys fell; many were damaged. Bricks fell from houses. Some houses moved 1 to 2 inches on foundations.

Oil well casing cracked at Petrolia Oil Well Company and bunkhouse was knocked off foundation. Magnitude 5.4.

1952. October 12. Oakland, near Dimond District. Slight damage reported. Magnitude 4.5.

1952. October 21. San Francisco Bay. Slight damage reported at Richmond.

1952. November 21. Near Bryson. Considerable damage occurred at Bradley. Chimneys twisted and fell and cracks appeared in building walls and ground. Twisting and falling of chimneys reported from Bryson and Elmo Buttle Ranch (10 miles northwest of Bradley). Pleyto School (near Bryson) was a shambles inside from broken objects. Magnitude 6±.

1953. May 24. Wheeler Ridge. The shock was reported felt over a wide area. Intensity VI at Caswell where some supplies tumbled from shelves. Magnitude 4.8.

1953. May 24. Calpella. Plaster and walls cracked and doors were twisted out of line. Two walls were reported cracked at Ukiah.

1953. June 13. Imperial Valley. Intensity VII occurred in a very limited area in the Brawley-Westmorland region. South of Westmorland, canal structures were damaged and one-half mile of canal bank cracked. A landslide was reported along the Tamarack Road near the New River Bridge. Plaster cracked at El Centro; windows broke in the Brawley area and a concrete floor was cracked. The earthquake was felt from Phoenix, Ariz., to San Diego, and from Niland to Mexicali Valley of Baja California. Magnitude 5.5. Strong aftershocks were reported on the 14th.

1953. September 25. Near Reno, Nev. Felt in western Nevada and northeastern California. At Reno, Nev., two chimneys toppled, canned goods fell, and plaster cracked. Earthslide near Vista, and slight damage at Floriston, Calif. Magnitude 5.2.

1953. December 16. Watsonville. Slight damage. Boulders were strewn on the road some 5 miles west of Chittenden Junction. Magnitude 4.6.

1954. January 12. West of Wheeler Ridge. Epicenter very close to major earthquake of July 21, 1952. East of Maricopa, corrugated-iron buildings and an elevated water tank were damaged; pipelines were cracked at the Paloma Oilfield, and power transformers were knocked from poles in the Tehachapi area. Walls were cracked at Los Angeles, Stockton, and Bakersfield. The shock was felt throughout San Joaquin Valley, from Sacramento on the north, south through Mojave, into the Imperial Valley and San Diego. Magnitude 5.9.

1954. January 27. West of Tehachapi (Cummings Valley). Slight damage at Arvin, Keene, and Tehachapi. Magnitude 5.0.

1954. March 19. Santa Rosa Mountains. Felt over much of southern California and portions of southwestern Nevada and western Arizona. Plaster was knocked from ceiling of the Los Angeles City Hall. Palm Springs reported a broken water pipe and cracks in several swimming pools. Cracked windows and plaster and a few fallen lighting fixtures occurred at Indio and Coachella. Plaster walls cracked in San Diego. Concrete cracked on two bridges near Topock, Ariz. Magnitude 6.2.

1954. March 22. Santa Rosa Mountains. Felt by and frightened many at Palm Springs. Plaster cracked; small objects and furnishings shifted. Magnitude 5.1.

1954. April 22. East of Watsonville. Felt in the coastal region of west-central California. Plaster fell, walls cracked, and dishes broke at Aptos and Gilroy. Magnitude 5.2.

1954. April 25. East of Watsonville. Heaviest damage was reported in the Watsonville area, but the tremors were strong enough in San Francisco and other Bay Area cities to shatter a few windows and knock plaster from the walls. East of Watsonville, several houses were seriously damaged, the ground cracked, and loose earth slid onto the road. Several chimneys fell at Aromas and in the Interlaken District. Magnitude 5¼.

1954. July 6. East of Fallon, Nev. Felt in California, Oregon, and Nevada. Intensity IX was assigned to the main fracture zone on the east edge of Rainbow Mountain, in the Stillwater Range about 15 miles southeast of Fallon. In other areas the intensity did not exceed VIII and was related to the movement of unstable ground. Several were injured at the Naval Auxiliary Air Station, about 5 miles southeast of Fallon, where heavy steel lockers fell. Extensive damage occurred to canals and drainage systems of the Newlands Reclamation Project. Paved highways in the Fallon-Stillwater areas settled, cracked, and buckled in several places. One section south of Fallon settled 18 inches for a distance of 200 feet. A number of

old and poorly built buildings in Fallon were damaged considerably. Magnitude 6.6.

1954. July 6. Southeast of Fallon, Nev. About 5 miles southeast of Salt Wells, U.S. Highway 50 settled, necessitating filling and resurfacing the road. Many people observed a large cloud of dust in this area. Magnitude 6.4.

1954. August 12. East of Watsonville. Rockslides were reported on a road near Logan.

1954. August 23. East of Fallon, Nev. Felt in California, Oregon, Idaho, Utah, and Nevada. Surface movement occurred in the same rupture zones as those of the July 6 shock, with the extension of ground breakage north for about 11 miles to the region southeast of Carson Sink. Only vertical movement was observed, with the west side uplifted relative to the east side. Damage to buildings, roads, and irrigation facilities occurred in the same general areas as in the July 6 shock, with the exception of the Lovelock area where Rogers Dam was considerably damaged. Further damage occurred to the Newlands Reclamation Project irrigation facilities. In some instances, damage was more severe than that observed during the shock of July 6. Estimated damage to Project facilities was approximately $91,000. Magnitude 6.8.

1954. August 26. Near Anacapa Island. Plaster was shaken from ceiling in the Ventura County Courthouse. Magnitude 4.8.

1954. August 31. Dixie Valley, Nev. A series of violent shocks caused further landslides in the Stillwater Range east and northeast of Stillwater. Everything in one cabin overturned, including stove. Slight damage at Fallon and Fernley. Magnitude 5.8.

1954. September 15. East of Merced. An irregular ground crack, about 10 feet long and ⅛ to ¼ inch wide, was observed in compact soil adjacent to gasoline tanks at the Coarsegold Forestry Camp.

1954. November 10. Lake and Mendocino Counties. Slight damage reported at Ukiah and Lakeport. Magnitude 4.4.

1954. November 12. Baja California. The main shock was felt strongly throughout San Diego and Imperial Counties and as far north as Los Angeles and San Bernardino. More than 100 persons were homeless in the virtually destroyed village of El Alamo, Baja California. Magnitude 6.3. Two strong aftershocks were reported.

1954. November 25. Off Cape Mendocino. Felt in Humboldt and Mendocino Counties. Intensity V was reported at 14 towns. Also felt at Junction City, Oreg. Magnitude 6¼.

1954. December 16. East of San Leandro. Chimneys broke in Burlingame and Oakland; water main broke in Oakland. Minor damage at San Leandro, Hayward, Santa Cruz, and Castro Valley. Magnitude 3.8.

1954. December 21 and 30. Eureka-Arcata areas. Principal structural damage occurred in the Eureka-Arcata areas. The old Eureka City Hall and County Courthouse were extensively cracked. Several old, poorly constructed brick walls bulged, and there was some parapet damage, but principal damage was to chimneys, plaster, plate glass windows, and merchandise. Damage in Eureka was estimated at $2 million. In the poorly consolidated ground areas north and east of Eureka there were some pipeline failures, and Eureka's main water reservoir was cracked. A large section of the older, downtown filled area of Eureka settled from 2 to 6 inches. Some water main breaks were reported in Arcata, but damage, estimated at $100,000, also was mainly to chimneys, plaster, plate glass windows, merchandise, and household objects. A number of persons were injured by falling objects; one death resulted. Slight damage was reported at Brookings, Oreg., where plaster and concrete walls cracked. Magnitude 6.6. On December 30, a strong aftershock at 01:16, intensity VI, broke windows in Eureka and Arcata and the main waterline between Eureka and the Sweesey Dam.

1955. January 10. Southeast of Lovelock, Nev. A ground crack about 1 inch wide and a mile long was reported at Battle Mountain.

1955. January 25. Terminal Island area. Intensity IV at the surface. Damage, estimated by engineers to exceed $3 million, occurred at the 1,500-foot level below the surface. Approximately 43 oil wells were damaged on Terminal Island and the adjacent mainland. It was reported that the area in which the wells are located had subsided more than 20 feet in some places, forming a large depression.

1955. March 2. Near San Ardo. A moderately strong earthquake. One chimney collapsed near San Lucas. Plaster cracked at Adelaida, Indian Valley, and Templeton. Slight damage was reported from several localities. Magnitude 5.1.

1955. April 29. Near Kelseyville. A sharp earthquake was felt over a small area of the Clear Lake region in Lake County. Chimneys and windows broke at Lower Lake; plaster and walls cracked. Two aftershocks occurred at 07:45 and 10:45.

1955. May 7. Near Kelseyville. Three sharp earthquakes jolted Lake County. Moderate damage in the form of a few fallen chimneys and plaster cracking occurred in some older-type buildings.

1955. August 7. North of Caliente. Felt principally in Kern County. Television tower on Mount Breckenridge swayed 2 feet at top. Magnitude 4¼.

1955. August 8. Near Hawthorne, Nev. Pendulum clocks stopped at Mason and Schurz. One glass cracked at Benton, Calif. Magnitude 5.0.

1955. September 4. East of San Jose. Extensive minor damage, estimated at $100,000, consisted mainly of toppled chimneys and broken plate glass windows in the San Jose area. Two persons were injured. Water mains burst in San Jose, Menlo Park, and Manteca. Merchandise tumbled from shelves in Hollister and Los Gatos. The earthquake was felt from Napa, south to Watsonville and Fresno. Magnitude 5.8.

1955. October 23. Near Concord. Damage was estimated at $1 million. In Oakland, an elderly woman was burned to death in an apartment house explosion and fire that firemen said were caused by the shock. Heaviest damage was at Walnut Creek where 80 plate glass windows were broken, walls cracked, and considerable damage occurred to stock in grocery, liquor, and drug stores. Groceries were knocked from shelves, windows shattered, brick chimneys toppled, and walls cracked at Concord, Martinez, Moraga, and other towns in Contra Costa and Alameda Counties. Magnitude 5.4.

1955. November 2. Near San Ardo. Felt in the coastal region of west-central California. Slight damage was reported at King City, Monterey, and Paso Robles. Magnitude 5.2.

1955. November 21. North of Bena. Felt principally in Kern County. Intensity V at Arvin, Miracle Hot Springs, and Tehachapi. Magnitude 4.3.

1955. December 16. Near Brawley. The principal shock of a numerous swarm was felt over a large area of California and Arizona. Heaviest damage occurred in Brawley where field investigations revealed that damage (estimated at $15,000) consisted of a few cracked walls, a number of broken plate glass windows, cracked plaster, and loss from breakage of merchandise. Windows were broken at Calexico, Holtville, and Imperial. Shocks were also felt at San Diego, El Cajon Valley, Chula Vista, National City, Imperial, Lakeside, Calipatria, Imperial Beach, and as far east as Yuma, Ariz. By December 20, 82 tremors were reported felt at Brawley. No damage was reported from any of the aftershocks. Magnitude 5.4.

1956. January 2. Near Glen Ivy, Temescal Canyon. Rockslides were reported in the vicinity of Glen Ivy. Slight damage, consisting of cracked plaster, broken windows and dishes, was reported from several towns in Riverside County. Magnitude 4.7.

1956. January 3. Baja California, southeast of Tecate. Maximum intensity V reported in several southern California towns. Magnitude 4.7.

1956. February 6. North of Castaic. Two sharp earthquakes were felt throughout the Los Angeles area. Landslides were reported on the Elizabeth Canyon Road. Magnitude 4.2 and 4.6, respectively.

1956. February 9 and 14. Baja California, near El Alamo. Maximum intensity VI in the United States. In Baja California, near El Alamo, a new faultline 18 miles long was observed. New springs, from deep underground sources, with water temperatures of 81° were formed along the faultline. Minor damage, consisting mainly of broken windows, cracked plaster, and damaged merchandise, was reported from a number of towns in California and from Yuma, Ariz. Magnitude 6.8. Two large aftershocks on February 14, magnitude 6.3 and 6.4, respectively, shook a large area of California and Arizona. No damage was reported.

1956. March 9. Near Petrolia. Felt in Humboldt and Mendocino Counties. No damage. Aftershocks were felt at 22:03 and 22:06.

1956. March 16. Near Baldwin Lake. A series of earthquakes, with magnitudes of 3.0 to 4.8, the largest at the time given. At Sugarloaf, knickknacks and canned goods fell in homes; frightened all. Magnitude of main shock, 4.8.

1956. March 18. Near Manzanita Lake. Plaster cracked and fell. Damage slight. Also felt at Mineral and in a cabin southeast of Lassen Peak.

1956. April 4. Near Saint Helena. Heaviest damage occurred in the Angwin-Saint Helena Sanitarium area, where numerous instances of cracked

plaster and cracked concrete foundations were reported. Magnitude 4¾.

1956. May 11. Near Baldwin Lake. Felt principally in Riverside and San Bernardino Counties. Plaster cracks widened at La Quinta; small objects shifted at Fawnskin and Pioneertown.

1956. July 23. Northwest of King City. Intensity V in several towns. In Monterey, a deep rumbling sound was heard just before the earthquake. Magnitude 4.7.

1956. September 23. Riverside County. Plaster cracked in several homes at Palm Springs. Also felt at San Diego, San Jacinto, and Hemet. Magnitude 4.3.

1956. October 11. West of Ferndale. Dishes broke in some homes at Eureka. Damage slight. Also felt at Bucks Creek Powerhouse (Plumas County) and at Medford and Shady Cove, Oreg. Magnitude 6. Two aftershocks reported felt.

1956. November 15. Northwest of Parkfield. Plaster cracked at Mee Ranch, near Lonoak. Magnitude 5.0.

1956. December 1. West of Hollister. A sharp earthquake shook the San Francisco Bay area. The tremor was felt from San Francisco to Hollister and Watsonville. Magnitude 4¼.

1956. December 31. Near Hawthorne, Nev. The main shock was felt in western Nevada and eastern California. Two cracks were reported in U.S. Highway 95. Magnitude 5.1. Foreshocks were reported at 09:36 and 09:38, magnitude 3.8 and 5.0, respectively.

1957. January 24. Southeast of Palomar. Felt in Riverside and San Diego Counties. Intensity V at Campo, Guatay, Ranchita, San Diego, and Warner Springs. No damage was reported. Magnitude 4.6.

1957. January 29. Off coast, southwest of Big Sur. Felt over the coastal region of west-central California. Merchandise fell from shelves at Cambria; small objects shifted at Marina. Magnitude 4.9.

1957. January 31. Little San Bernardino Mountains. Felt principally in Riverside County. Many awakened in several towns. Magnitude 4.5.

1957. March 18. South of Oxnard. Minor damage occurred at Oxnard, Port Hueneme, and Ventura. Magnitude 4.7.

1957. March 22 and 23. West of Daly City. About 40 minor injuries were reported in the San Francisco Bay area. Overall damage was estimated at about $1 million. State Highway 1, near Mussel Rock, was blocked by landslides; highway pavement was cracked extensively. A number of homes were damaged in the Westlake-Palisades-Daly City area, and a large reinforced concrete reservoir cracked. In San Francisco, there was minor damage to chimneys, plaster, windows, and merchandise. Magnitude 5.3. On March 23 (00:14), an aftershock caused slight damage at Menlo Park and San Francisco.

1957. April 25. Southwest end of the Salton Sea. Felt in southern California and western Arizona. Near Calipatria, water flowed from blowholes, and ground cracks were observed. Slight damage occurred at Brawley, El Centro, and Westmorland. Magnitude 5.2. A number of aftershocks, ranging in magnitudes from 2.9 to 5.1, were recorded during the afternoon of the 25th. An aftershock on May 26 (08:00) was felt over an area of approximately 7,000 square miles, but caused no damage.

1957. October 30. Near Comptche. Slight damage occurred at Comptche and Willits. Magnitude 4.7.

1958. May 24. Near Petrolia. Sharp shock. Furnishings shifted and knickknacks and books fell from shelves at Briceland, Carlotta, Ferndale, Garberville, Honeydew, Miranda, and Petrolia. Magnitude 4.8.

1958. July 8. Near Morgan Hill. The tremor was felt from Marin County south to Hollister and San Jose. Intensity V at Coyote, Holy City, Morgan Hill, Milpitas, and Santa Cruz. Magnitude 4.1.

1958. July 13. Off Carpinteria. Slight damage at Carpinteria. Plaster cracked; slight loss from fallen merchandise. Magnitude 4.7.

1958. September 20. Southeast of Soledad. This earthquake cracked a fireplace and broke dishes in the San Benito area. Magnitude 4.6.

1958. October 1. Southeast of Sierraville. Felt in northeastern California and western Nevada. Chimneys cracked at Hallelujah Junction; dishes broke at Reno, Nev. Magnitude 4.6.

1958. October 10. Northwest of Parkfield. Felt principally in Monterey and San Luis Obispo Counties. Pendulum clock stopped at Parkfield. Objects fell from shelves at Parkfield and Paso Robles. Magnitude 4.5.

1958. October 30. Northeast of San Jose. Reported felt in scattered localities but principally in southwest Alameda County and along the east shore of San Francisco Peninsula. Damage slight.

At Milpitas, a water main cracked; window broke at Berkeley. Magnitude 4.2.

1958. November 30. Baja California. Main shock of a series. Minor damage in California at Calexico, Nestor, Potrero, and Seeley. Many aftershocks. Magnitude 5.8.

1958. December 11. Southwest of San Francisco. Felt from Santa Rosa to San Jose. Slight plaster cracking, few broken dishes and windows, and slight loss from fallen merchandise occurred at several locations. A minor landslide occurred on State Highway 1, west of Daly City. Magnitude 4.7.

1959. March 2. Near Gilroy. Slight damage, consisting principally of cracked plaster, broken windows, and loss from fallen objects and merchandise, was reported from several localities. Minor earthslide occurred on Chittenden Pass Road east of Watsonville, and boulders fell on Hecker Pass Highway between Gilroy and Watsonville. At San Francisco, 70 windowpanes were broken. Magnitude 5.3.

1959. March 22. Dixie Valley, Nev. Felt over much of Nevada and a small area in northeastern California. Slight plaster cracking was reported at Frenchman's Station and Carson City, Nev. Magnitude 6.3.

1959. April 1. Northeast of Loyalton. Felt in northeastern California and western Nevada. At Loyalton, several chimneys fell; walls, plaster, and windows cracked. Near Vinton, an old stone building collapsed. Slight damage occurred at several other California localities. Magnitude 5.6.

1959. April 5. North of Ukiah. Felt in Mendocino and Lake Counties of northwestern California, principally in the Redwood Valley-Ukiah areas. Chimneys cracked, dishes broke, and stock fell from shelves at Redwood Valley. Magnitude 3.6.

1959. May 26. Near Salinas. Felt over the coastal area of west-central California, principally in the region east of Monterey Bay. Slight damage at Camp McCallum, Hollister, and Salinas. Magnitude 4.6.

1959. June 13. Near the Sierra Buttes. Felt over a moderate area of northeastern California and at two places in Nevada. Some stock fell from store shelves at Portola. Magnitude 4.6.

1959. June 17. Northwest of Bishop. Felt in east-central California, principally in the region southeast of Yosemite National Park. The shock cracked plaster and overturned small objects at Mammoth Lakes. Magnitude 4.7.

1959. June 23. North of Schurz, Nev. Main shock of a series. Felt in California and western Nevada. At Schurz, a garage attached to frame house was separated 2 inches from house; chimneys twisted and cracked; plaster cracked. Minor rockslides were reported in the adjacent mountains. Slight damage also occurred at Mason and Genoa. Magnitude 6.1.

1959. July 1. South of Bannister. The main shock of a series was felt in south-central California, principally in Kern County. The shock caused widespread alarm at Bakersfield. Pendulum clock stopped; objects fell from shelves. Magnitude 4.7.

1959. August 3. West of Bishop. Main shock of a series. Numerous rockslides occurred at Bishop; furniture shifted. Magnitude 5.2.

1959. August 25. Morongo Valley. Sharp shock felt in southern California. No damage was reported, except one small plaster crack at Ranchita. Magnitude 4.3.

1959. September 24. Northeast of Ukiah. Merchandise fell from store shelves and plaster cracked in homes at Willits. Magnitude 3.6.

1959. September 30. Off coast of southern California, at Point Conception. Felt principally in Santa Barbara County. Several large boulders fell and partially blocked U.S. Highway 101. Press reported only minor damage. Magnitude 4.5.

1959. October 24. Near Owens Park. Main shock of a series. At Sand Canyon, dead tree tops snapped off, boulders tumbled down the mountain, and landslides occurred. Magnitude 4.2.

1959. December 21. Off Punta Gorda. Felt in the coastal areas of northwestern California, principally in Humboldt County. Groceries fell from shelves at Briceland. Magnitude 4.7.

1959. December 28. Northwest of Hollister. Felt in the coastal region of west-central California, from San Francisco to San Miguel, and inland to a distance of about 30 miles. At Hollister, few chimneys toppled; piece of timber fell from roof of City Hall; merchandise fell from shelves in grocery stores. Reported as heaviest shock in years. Magnitude 4.7.

1960. January 19. South of Hollister. Felt in the west-central coastal areas of California. Minor damage occurred at the W. A. Taylor Winery, about

7 miles south of Hollister on Cienega Road. Underground pipeline broke; several cracks appeared in asphalt pavement; small portions of ceiling fell; chimney cracked at roofline. At a nearby ranch, walls cracked and reservoir crack enlarged. At Hollister, plaster cracked and quantities of stock fell in stores. Magnitude 5.1.

1960. June 4. Northwest of Bishop. Felt in east-central California. Water became muddy at Crowley Lake (Long Valley Dam). Felt at Visalia and Tulare. Magnitude 5.2.

1960. June 5. West of Arcata. At Eureka, plaster fell at old City Hall. Brick chimney twisted slightly at Crannell, about 18 miles north of Eureka. Magnitude 5.7.

1960. August 8. Off coast of northern California. Generally felt in northwestern California. Also reported felt at San Francisco, Aptos, and at two places in southwestern Oregon. Magnitude 6.

1961. January 28. Near Walker Pass. Felt in Kern and Tulare Counties. Intensity VI was reported at six places in Kern County. At Johannesburg, the concrete floor of a carport was slightly cracked; rocks rolled down a mountain at Kernville; dishes broke at Bodfish. Magnitude 5.3.

1961. April 4. Terminal Island, Long Beach Harbor. This shock was only slightly felt in the Long Beach-San Pedro-Wilmington area, but subsurface damage to oil well pipes on Terminal Island was estimated at about $4.5 million. More than 40 wells were damaged and off normal production.

1961. April 5. Off coast of northern California. Felt principally in Humboldt County. At the Bear Harbor Ranch, about 10 miles south of Ettersburg, a 50-yard slide occurred. Magnitude 5.0.

1961. April 8. About 13 miles south of Hollister, on the San Andreas Fault. Two shocks, about 3 minutes apart. More than half of all city buildings suffered some type of damage at Hollister, but major damage was confined to three buildings. The W.A. Taylor Winery, south of Hollister, was also severely damaged. A 50-foot-long fissure was observed on Cienega Road about 3 miles from the winery. A number of chimneys were damaged, some fell. Damage was estimated at about $250,000, but there were no deaths or injuries. Magnitude 5.6 and 5.5, respectively.

1961. May 28. Northeast of Indio. Felt principally in west-central Riverside County. Slight damage was reported at Coachella. Furnishings shifted; small objects overturned. Magnitude 4.4.

1961. July 3. West of Winnemucca, Nev. Epicentral tract in very sparsely settled area. Intensity V at Imlay, Mill City, Paradise Valley (Vedder Ranch), and Tungsten. Also felt at Eureka, about 170 miles southeast of the epicenter, and at Fernley, about 100 miles southwest of the epicenter. No damage reported. Several aftershocks were felt. Magnitude 5.4.

1961. July 30. Near Shandon. At San Ardo (Paris Valley), plaster cracked and fell; slight damage to adobe. Knickknacks and dishes fell at Cholame. At San Luis Obispo, few cups and saucers broke. Magnitude 4.5.

1961. October 18. East of Brown. Felt over a moderate area of south-central California. The maximum intensity was reported from a town about 5 miles east and 2 miles north of Brown. Heavy machinery and objects shifted; a change in well water level was observed. At Mojave, a bathroom was slightly cracked. Magnitude 5.2. A foreshock, magnitude 3.4, was felt at 21:01.

1961. October 20. Near Huntington Beach. A series of nine sharp shocks was felt in southern California, principally in Orange County. Slight damage, consisting mainly of cracked plaster, broken windows, and fallen merchandise in stores, was reported from a number of towns. Magnitude 4.3.

1961. November 14. Near Wheeler Ridge. Felt over a moderate area of southern California, principally in Kern County. At Wilsona, in Antelope Valley, walls, ground, and bottom of pool cracked. Magnitude 5.0.

1962. April 27. Near Perris. Felt in southern California, principally in Riverside and San Bernardino Counties. At Romoland, dishes and windows broke; vases and small objects overturned. Plaster, windows, and walls cracked at Winchester. Magnitude 4.1.

1962. June 6. Near Lakeport. Felt principally in Lake and Mendocino Counties of northwestern California. About 2 miles west of Lakeport, Scott Creek rose 1½ feet and flowed steadily for 11 days after being nearly dry before the shock. Several wells in Scott Valley rose 7 to 10 feet, and the water was milky white for 3 to 5 days. Four-inch-high undulating movement of fill soil was observed.

About 10 miles southwest of Lakeport, a geyserlike spout of water in Clear Lake was reported by the press. The slight building damage that occurred was mostly in the Lakeport-Ukiah area. Magnitude 5.2.

1962. July 20. Near Dixie Valley, Nev. Sparsely settled epicentral region. Felt by and awakened many at Austin, Fallon, and Luning. Bed moved 2 inches at Luning. Also felt at a number of other widely separated towns, including Eureka, Winnemucca, and Wells (about 190 miles northeast of the epicenter). Magnitude 4.9.

1962. August 23. Off coast of Del Norte County, near Crescent City. Felt in northwestern California and southwestern Oregon. Damage consisted mainly of cracked chimneys and plaster, broken windows, and loss from fallen merchandise. Slight damage also was reported from Brookings and Cave Junction, Oreg. Tops of some giant redwood trees were snapped off. Magnitude 5.6.

1962. September 4. Northwest of Arcata. Felt principally in Humboldt County of northwestern California. Damage consisted of cracked plaster, broken window, and loss from fallen merchandise in stores. Intensity V was reported at Cave Junction, Oreg. Magnitude 5.0 and 3.7, respectively.

1962. September 15. Near Walker Pass. Rocks fell along the Sierra front from Nine Mile Canyon to Walker Pass Road. Intensity V was reported from many towns. Magnitude 4.9.

1962. October 28. Near Big Bear. This shock was felt in southern California, principally in Riverside and San Bernardino Counties. One window was broken at Big Bear City; groceries fell from shelves in stores; mirrors and pictures fell from walls. At Redlands, a water main broke. Between Bear Valley and Lucerne Valley, rocks 2 to 3 feet in diameter fell onto the highway. Numerous aftershocks were recorded. Magnitude 4.8.

1963. February 28. Near Fort Tejon. Felt principally in southwestern Kern County. Plaster cracked at Taft. Intensity VI also was reported at Lebec, Frazier Park, and Fort Tejon State Historical Monument (about 3 miles northwest of Lebec). Magnitude 5.0.

1963. May 22. Sunnyvale. Press reported a caved-in roof at Sunnyvale. Magnitude 4.6.

1963. May 22. Imperial Valley. The main shock of this seven-shock series was felt principally in the Imperial Valley. At Brawley, a 9- by 11-foot plate glass window was broken and plaster cracked. At Westmorland, plaster cracked, and a considerable amount of merchandise fell in several stores, two of which estimated damage at several hundred dollars. Magnitude 4.7. Shocks described as "violent" were reported 8 miles west of Brawley on May 22 at 22:43 and on May 23 at 01:30 and 07:53.

1963. June 7. Near Antioch. Felt over a small area of San Francisco Bay region, principally in Contra Costa County. At Antioch, walls and foundation of school cracked, old cracks enlarged, and additional twisting of beams and doors was reported. Intensity VI also was reported at Clayton, Concord, and Cowell. Magnitude 4.0.

1963. June 11. Baja California. Felt principally in Imperial and San Diego Counties. Plaster cracked slightly at Potrero. Magnitude 5.8.

1963. September 14. Vicinity of Chittenden and Soda Lake. Minor damage occurred along the San Andreas Fault, 7½ miles east of Watsonville. The floor of a house moved 2 inches from retaining wall; ceiling separated slightly from wall in another frame house. Bridge footings of a highway bridge across the Pajaro River were damaged slightly. Water pipes broke; chimney and plaster cracked. Landslides were reported in the Soda Lake and Pajaro Gap areas. At Chittenden Pass the road was cracked. Magnitude 5.4.

1963. September 23. Near San Jacinto. At Hemet and San Jacinto, plaster cracked and fell, windows and dishes broke, and merchandise fell in stores. Also, chimneys cracked and twisted at Hemet. Magnitude 5.3.

1963. December 6. Bishop-Paradise area. Felt in east-central California and western Nevada. Plaster and a 230-kilovolt transformer bushing cracked at Bishop. About 15 miles northwest of Bishop, plaster cracked and furnishings shifted. Intensity V was reported from Dyer, Nev. Magnitude 4.4.

1964. January 6. San Bernardino County. Felt principally in Riverside and San Bernardino Counties. Many residents were frightened at Forest Falls. Small objects and furnishings shifted at Yucca Valley. Magnitude 4.4.

1964. March 22. North of Hawthorne, Nev. Felt in eastern California and western Nevada. No dam-

age was sustained in the epicentral area, but a patio was cracked at Reno, Nev. Magnitude 4.5.

1964. May 13. San Benito. At Paicines, small objects and furnishings shifted. Intensity V effects also were noted at Greenfield, King City, San Benito, and Soledad. Magnitude 4.4.

1964. June 21. San Diego. Slight damage was reported at San Diego and Coronado. Intensity V was reported at Imperial Beach and Nestor. Magnitude 3.7.

1964. June 22. San Diego. Intensity VI was assigned to minor damage at Imperial Beach. Felt generally and strongly in San Diego and vicinity. A typewriter bounced off a table and water splashed in a tub at Coronado; fire alarms were activated by the shock. Magnitude 3.6.

1964. October 30. Dyer, Nev. Series of shocks, largest at 11:03. Window, cement block, and cement foundation cracked. Preceded by roaring sounds. Magnitude 4.4.

1964. November 15. North of Watsonville. In the Corralitos area, several chimneys twisted and fell, merchandise fell from shelves, and large furniture moved. Minor damage also was reported at Alviso, Freedom, Gilroy, Gonzales, Hollister, La Honda, Morgan Hill, Moss Landing, New Almaden, Santa Cruz, and Watsonville. Magnitude 5–5¼.

1964. December 22. Off coast, northwest of Ensenada, Mexico. Slight damage was reported at Boulevard, Imperial Beach, La Mesa, Potrero, and in the San Diego area. Magnitude 5.6.

1965. January 1. Southwest of Fontana. Felt principally in Riverside and San Bernardino Counties. At Fontana, the ceiling of one home shattered, window cracked, and glassware and dishes broke. A cement sidewalk cracked at Lytle Creek. Magnitude 4.5.

1965. April 15. San Bernardino Valley. Felt in San Bernardino, Riverside, Los Angeles, and Orange Counties. Press reported broken windows and items shaken from shelves throughout the Valley. Cracked plaster and broken windows occurred at Fontana, Ontario, Rialto, and San Bernardino. Magnitude 4.5.

1965. June 3. Bridgeport. Felt principally in Mono County area. Dishes broke and pictures fell. Magnitude 4.6.

1965. June 15. Imperial Valley. Main shock of Imperial Valley series. Plate glass window and dishes broke at Westmorland. A press account stated several buildings were damaged. Walls cracked at Imperial. All residents were alarmed at Brawley where dishes fell from shelves. Magnitude 4½.

1965. July 15. West of Saugus. Felt principally in Kern and Los Angeles Counties. At Saugus (Sunshine Tract), stucco cracked in several places and a cement-slab crack extended. Magnitude 4.5.

1965. September 10. Pittsburg. Felt in the San Francisco Bay region. Slight window breakage occurred at Concord and Pittsburg. Plaster cracked at Clayton and chimneys cracked at Cowell. Minor rockslides were observed at Mount Diablo and a few rotted limbs broke off trees. Magnitude 4.8.

1965. September 19. Kings County. Felt principally in Kings County. Intensity V effects were noted at Armona, Avenal, Cholame area, Kettleman City, and Stratford. Magnitude 4.9.

1965. September 25. Southeast of Newberry Springs. Felt in southern Nevada, southern California, and along the Colorado River area of Arizona. At the Camp Cady Ranch, about 4 miles south of Manix Station, the flow of a spring was affected, first increasing and then decreasing. Gas pipes were damaged at Newberry Springs, causing an explosion. Minor damage also was sustained at Hodge and Kelso. Magnitude 5.3.

1965. October 17. Near Palm Springs. Felt principally in Riverside and San Bernardino Counties. Slight damage was reported at Cathedral City and Palm Springs. Magnitude 4.7.

1965. October 21. East of Yucaipa. Felt mainly in Riverside and San Bernardino Counties. Slight damage occurred at Coachella and Yucaipa. Magnitude 3½.

1965. November 12. South of Glendale. Felt over a small area of southwest Los Angeles County. Plaster cracked slightly at Glendale. In Los Angeles, some minor concrete cracks were sustained on the 30th floor of the Occidental Center Building. Magnitude 3.0.

1966. March 4. Near Imperial. A 6-mile-long crack was observed along the Imperial Fault, and where the fault crosses Highway 80, the horizontal displacement was about 0.4 inch. Magnitude 3.6.

1966. April 2. South of Luning, Nev. The shock reportedly separated two parts of an old building at Luning. Small objects shifted and fell. Magnitude 4.6.

1966. May 23. Near Chico. Plaster cracked at Forest Ranch. At Las Plumas, rocks were heard rolling down the hillside. Some dishes broke at Oroville. Intensity VI also was noted at Magalia, Paradise, and Yankee Hill, but no damage occurred. Magnitude 4.6.

1966. June 27. Parkfield. The main shock was preceded by a magnitude 5.0 earthquake at 20:09. Intensity VII was assigned to the minor surface faulting that occurred in a narrow zone along the San Andreas Fault. About 1 mile northeast of Cholame there was a pavement crack in Highway 466 and the white dividing line was offset about 4 inches. At the same location, a small concrete bridge had minor cracks and pavement buckling. Minor damage to bridges was also noted on the Parkfield-Cholame Highway. Tombstones overturned in Parkfield cemeteries and some swimming pools were cracked. Water splashed from pools and elevated water tanks. Magnitude 5.3.

1966. August 7. Gulf of California. Widely felt in southern California and southwestern Arizona. Minor plaster cracks were sustained at Blythe, Holtville, and Winterhaven, Calif., and at Picacho, Ariz. At Somerton, Ariz., a driveway cracked. Earth cracks were reported 30 miles south of San Luis in Mexico and in the El Golfo area. Magnitude 6.3.

1966. September 12. Near Boca. Main shock of a series centering near Boca. Minor, but extensive, ground fractures were observed in an area northeast of Truckee, principally in Russell Valley. Ground cracks also were reported in Boca and Prosser (earthfill) Dams. Several bridges on Highway 80 sustained minor damage. Chimneys fell in several towns; masonry and plaster walls cracked. Roofline was thrown out of plumb at Calpine. Magnitude 6¼–6½.

1966. October 1. Palos Verdes Peninsula. Felt over much of southwest Los Angeles County and in some sections of western Orange County. At Palos Verdes Peninsula, ground pulled away from courtyard wall, windows broke, and curb and street split. Magnitude 3.5.

1966. October 14. Watsonville area. Felt north to San Francisco and south to Monterey. At Watsonville, the shock cracked plaster and shifted furniture. Magnitude 4.2.

1967. May 21. Near Anza. Felt principally in Riverside, San Bernardino, and San Diego Counties. Rocks rolled onto Highway 74 from Nightingale to Palm Desert. Murky well water was reported near Anza. One of the two water reservoirs at Norco sustained about $40,000 damage. Slight plaster cracking occurred at Beaumont, Redlands, and Winchester. Magnitude 4.7.

1967. June 14. Near Whittier. Telephone service was interrupted at El Monte when the underground cable twisted. Hairline foundation cracks were sustained at San Gabriel. A wall cracked and water pipe broke at Whittier. Magnitude 4.1.

1967. June 26. Near Ukiah. Felt generally in Mendocino and Lake Counties. Minor damage to ceilings and chimneys was reported in the Ukiah area. Concrete spalled slightly at Coyote Dam, northeast of Ukiah. Magnitude 3.5.

1967. July 22. Southeast of Paicines. In the Paicines area, plaster and bricks cracked; small objects and furniture shifted. Magnitude 3.8.

1967. September 7. Corralitos. Field investigators reported no damage was observed in the epicentral area near Corralitos. Cans fell from shelves in store; small objects shifted and fell in home. The shock cracked a cement fence and enlarged old plaster cracks at San Jose. Magnitude 4.7.

1967. September 28. Morgan Hill area. Exterior walls of house cracked at San Jose. Rockslides occurred in the Morgan Hill area. Magnitude 5.0.

1967. December 10. Ferndale area. Minor damage was sustained at Crannell, Denny, Ferndale, and Scotia. Magnitude 5.8.

1967. December 18. Corralitos. Damage to plaster, chimneys, and windows was reported in the Corralitos-Gilroy-Watsonville area. Magnitude 5.2.

1968. February 5. Mount Montgomery, Nev., area. Felt in eastern California and western Nevada. Rocks fell onto highway 2 miles west of Mount Montgomery Pass Highway Station, Nev. Intensity V effects were noted at Benton and in the Owens River Gorge area. Magnitude 4.6.

1968. March 21. Corralitos area. Small objects fell at Corralitos; loud rumble heard. Felt by many

in scattered sections of San Francisco. Magnitude 4.3.

1968. March 28. East of White Water. Felt principally in Riverside and San Bernardino Counties. Small objects shifted at Cathedral City; felt by all at White Water. Magnitude 4.5.

1968. April 8. South of Ocotillo Wells. Main shock of a series. Felt over a large area of California, Arizona, and Nevada. Minor ground cracking and displacement occurred on the Coyote Creek Fault, and Highway 78 was cracked adjacent to Ocotillo Wells. A significant feature of this earthquake was the apparent triggering of minor ground ruptures on neighboring Superstition Hills Fault, Imperial Fault, and the Banning-Mission Creek portion of the San Andreas Fault. Large boulders fell at several points in the Anza-Borrego Desert State Park. At Ocotillo Wells, press stated a room was separated from house; walls cracked; and 3,600 gallons of water gushed from tank. At a substation about 3.2 miles south-southeast of Ocotillo Wells, large transformers shifted, shearing anchor bolts and breaking X-bracing. About 10 miles northwest of Ocotillo Wells and west of Borrego Mountain, a pipeline cracked and well water became dark. Ground cracking, minor building damage, and power disruptions occurred in some areas of the Imperial Valley. A 200-foot-long, 2-inch-wide crack occurred in a road 6 miles west of Imperial. Minor damage also was sustained at Calexico, El Centro, Los Angeles, San Diego, and at Yuma, Ariz. At Long Beach, the passenger liner *Queen Mary* rocked back and forth on keel blocks for 5 minutes after the shock. Magnitude 6.5. A widely felt aftershock (magnitude 5.2) occurred at 19:04.

1968. April 8. Calexico area. An aftershock of the 18:29 tremor. Knocked down plaster at Calexico. Magnitude 4.7.

1968. April 18. South of Big Bear Lake. Intensity V effects were noted at Big Bear Lake, Fawnskin, and Running Springs. Magnitude 4.0.

1968. April 25. Santa Rosa. Intensity VII was assigned to chimney damage at Santa Rosa. A number of pedestal tombstones were rotated slightly; plaster cracked; windows broke. Similar chimney and plaster damage occurred at Fulton. Plaster cracked and fell at Calistoga. Magnitude 4.6.

1968. April 28. South of Willows. Felt principally in Butte, Glenn, and Tehama Counties. At Chico, considerable merchandise fell in markets and burglar alarms were activated. The shock cracked plaster and knocked merchandise from shelves. A well near Tehama reportedly became dry after the earthquake. Magnitude 4.7.

1968. May 22. Salton City area. Aftershock of April 8 Borrego Mountain earthquake. Awakened many at Salton City. Sharp shake awakened all in home near Ramona and at Live Oak Springs. Magnitude 4.4.

1968. June 25. Petrolia-Honeydew area. Main shock of a series. Felt principally in Humboldt and Mendocino Counties. Minor damage was sustained in the Petrolia-Honeydew area. At Petrolia, minor landslides were noted and the press reported large ground cracks along the Mattole River. Several chimneys were destroyed; house moved 4 inches off foundation; porch was torn off building; plaster broke; windows cracked. Considerable merchandise and dish breakage in homes. At Honeydew (about 10 miles southeast of Petrolia), landslides occurred; chimneys cracked, twisted, and overturned; plaster and windows cracked. Magnitude 5.5.

1968. June 29. Goleta. Much stock was damaged in a market at Goleta. Bridge at Fairview Avenue overcrossing had spalled concrete chips and cracked tar and mortar. Magnitude 4.4.

1968. July 4. Goleta. Main shock of a series. Minor damage in the Santa Barbara area, principally at Goleta, where acoustical tile and fluorescent lights fell, windows broke, and merchandise was damaged. At Carpinteria, plaster cracked and fell, chimney cracked, and a light fixture fell. At Santa Barbara, acoustical tile lay-in panels fell at a school, but it was reported general damage was limited to store merchandise. Magnitude 5.2.

1969. January 23. East of Palm Springs. Intensity V effects were observed, principally in Riverside and San Bernardino Counties. Magnitude 4.8.

1969. February 7. Ferndale area. Slight damage at Ferndale, Honeydew, Petrolia, Rio Dell, and Scotia. More than 40 aftershocks were reported. Magnitude 4.6.

1969. February 27. Palmdale area. Felt principally in northern Los Angeles County. Minor

damage at Palmdale where fluorescent lights fell, windows broke, and telephone service was interrupted. Magnitude 4.3.

1969. April 28. Borrego Springs area. The heaviest damage occurred at Borrego Springs where large pieces of a ceiling fell, brick walls cracked, and light fixtures were damaged. The ceiling buckled at the First National Bank. A two-lane highway about 3 miles west was blocked by large boulders. Giant boulders were observed bounding down the Santa Rosa Mountains. Minor damage occurred at several towns in the vicinity. Magnitude 5.9.

1969. May 19. Borrego Springs area. Felt principally in San Diego, Riverside, and Imperial Counties. Intensity V at La Quinta, Ranchita, Salton City, Thermal, and White Water. Magnitude 4.5.

1969. June 7. Capetown region. Minor damage occurred at the Morrison Ranch, about 3½ miles east of Capetown. Magnitude 4.0.

1969. October 1. Santa Rosa. Total building damage from the shocks has been reported at $6 million, damage to dwelling contents at $1¼ million. A number of old brick and wood frame structures were damaged beyond repair at Santa Rosa. Chimneys fell. Underground pipes ruptured. Sidewalks buckled. The old Fremont Elementary School was condemned, but only minor damage occurred at other Santa Rosa schools. The Sonoma County Social Service Building, Library and Post Office Buildings, J.C. Penney Co. store, and the Veterans Memorial Building were all substantially damaged. A large portion of brick fell from the outside wall of the Miramar Tavern, and part of a ceiling collapsed at the Roxie Theatre. A house twisted off its base at Wright Avenue near 14th Street. A 100-year-old house on Beaver Street also twisted on its foundation. Virtually every store in downtown Santa Rosa sustained broken windows. There was no significant cracking or offset of roads anywhere, except for the settlement of some fill at a freeway overpass. On the north side of Santa Rosa, fresh fractures were found in the asphalt of Poppy Drive and cemetery roads immediately to the north. The cracks appeared to be a result of the heavy shaking of marshy ground. Several monuments were thrown down or twisted in nearby cemeteries. Magnitude 5.6 and 5.7, respectively.

1969. October 27. Hollister region. Slight damage to a wall joint and plaster at Hollister. Magnitude 4.6.

1969. October 27. Near Laguna Beach. Principally felt in Orange, Riverside, and San Bernardino Counties. Minor damage occurred at Huntington Beach. Magnitude 4.5.

1969. November 17. Pine Canyon area. Sidewalks cracked at Pine Canyon. Magnitude 4.3.

1969. November 18. Pine Canyon area. Strongest effects in Carmel Valley-Pine Canyon area, but no damage was reported. Magnitude 4.2.

1970. January 2. Cupertino area. Slight damage to plaster and liquor store stock occurred at Cupertino. Felt principally in the Cupertino area. Magnitude 3.7.

1970. March 30. Gilroy-Hollister. Felt from the San Francisco Bay area south to King City. Slight plaster damage was reported at Gilroy and Hollister. Magnitude 4.7.

1970. May 18. Fort Jones area. Felt principally in Siskiyou and Shasta Counties. Rocks rolled off cliff behind a building at Callahan. Slight damage occurred at Fort Jones. Magnitude 4.0.

1970. June 11. Danville. Minor damage occurred at Danville as a result of this earthquake, the strongest of the Danville series. One chimney fell; pump pipefittings broke; several windows broke. Minor cracks occurred in fireplace corners, small pieces of ceiling fell, and plaster cracked. The press reported several outside brick facades were damaged and that hundreds of items were shaken from store shelves. An aftershock was felt about a minute after the main tremor. Magnitude 4.3.

1970. June 12. Danville. Another strong shock caused minor damage in Danville. Wooden upright support beam was damaged at post office; existing plaster cracks enlarged. Branches fell from trees. Much merchandise was damaged in stores. A slight aftershock occurred about 7 minutes after the main earthquake. Magnitude 4.2.

1970. August 3. Carmel Valley region. Minor damage occurred at Carmel Valley, Castroville, and Monterey. Magnitude 4.7.

1970. September 12. Lytle Creek area. This was the main shock of a series originating near Lytle Creek, northwest of San Bernardino. The shock was strongest in the Lytle Creek area. Ground cracks, landslides, and twisted and overturned

chimneys were noted. Rockslides occurred on the San Gabriel Canyon Road, Mount Baldy Road, and Glendora Canyon Road. The shock caused an explosion at an aerospace plant in Riverside. Minor damage also occurred at Colton, Crestline, Cucamonga, Fontana, Glendora, Highland, Lucerne Valley, Norwalk, Rialto, Riverside, San Bernardino, Temecula, and Wrightwood. Magnitude 5.4.

BIBLIOGRAPHY

Bulletin of the Seismological Society of America. Annual volumes since 1911. Published for the Society by Stanford University Press through the No. 2 issue of 1934, by the University of California Press through 1960, and by the Waverly Press, Baltimore, Md., thereafter. A chronological list, by date of earthquake occurrence, of the articles in this bulletin follows. Those titles which do not refer to specific years are listed chronologically by publication date.

Townley, Sidney D. and Allen, Maxwell W., "Descriptive Catalog of Earthquakes of the Pacific Coast of the United States, 1769 to 1928," Vol. 29, No. 1, pp. 1–20, 1939.

Louderback, G. D., "Central California Earthquakes of the 1830's," Vol. 37, No. 1, pp. 33–74, 1947.

Slemmons, D.B. and others, "Catalog of Nevada Earthquakes, 1852–1960," Vol. 55, No. 2, pp. 519–565, 1965.

Wood, H. O., "The 1857 Earthquake in California," Vol. 45, No. 1, pp. 47–68, 1955.

Huber, W. L., "San Francisco Earthquakes of 1865 and 1868," Vol. 20, No. 4, pp. 261–272, 1930.

Slemmons, D. B., "Wonder, Nevada, Earthquake of 1903," Vol. 49, No. 3, pp. 251–266, 1959.

Bolt, Bruce A., "The Focus of the 1906 California Earthquake," Vol. 58, No. 1, pp. 457–471, 1968.

Templeton, E. C., "The Central California Earthquake of July 1, 1911," Vol. 1, No. 4, pp. 167–169, 1911.

Wood, H. O., "On the Region of Origin of the Central California Earthquakes of 1911," Vol. 2, No. 1, pp. 31–39, 1912.

Ballore, C.M., "The Mexican Earthquake of November 12, 1912," Vol. 7, No. 1, pp. 31–33, 1917.

Davis, E.F., "San Bruno Earthquake of January 23, 1914 (California)," Vol. 4, No. 1, pp. 25–28, 1914.

Beal, C.H., "Earthquake in Santa Cruz Mountains, November 8, 1914," Vol. 4, No. 4, pp. 215–219, 1914.

Davis, E.F., "Central California Earthquake of November 8, 1914," Vol. 5, No. 1, pp. 5–13, 1915.

Beal, C.H., "Earthquake at Los Alamos, California, January 11, 1915," Vol. 5, No. 1, pp. 14–25, 1915.

Beal, C.H., "The Earthquake in the Imperial Valley, California, June 22, 1915," Vol. 5, No. 3, pp. 130–149, 1915.

Jones, J.C., "The Pleasant Valley, Nevada, Earthquake of October 2, 1915," Vol. 5, No. 4, pp. 190–205, 1915.

Davis, E.F., "The Earthquakes of October 7, 1915, in Central California," Vol. 5, No. 4, pp. 230–235, 1915.

Beal, C.H., "Earthquake at Volcano Lake, Mexico, November 20, 1915," Vol. 6, No. 3, pp. 181–184, 1916.

Palmer, Andrew H., "California Earthquakes During 1915," (continues for each year through 1921), Vols. 6–12, No. 1, 1916–1922.

Wood, H. O., "California Earthquakes: A Synthetic Study of Recorded Shocks," Vol. 6, Nos. 2 and 3, pp. 55–180, 1916.

Branner, J.C., "The Tejon Pass Earthquake of October 22, 1916," Vol. 7, No. 2, pp. 51–60, 1917.

Mattei, A.C., "Two Santa Barbara Channel Earthquakes," Vol. 7, No. 2, pp. 61–66, 1917.

Hamlin, H., "Earthquakes in Southern and Eastern California," Vol. 7, No. 3, pp. 113–118, 1917.

Hamlin, H., "Earthquakes in Southern California," Vol. 8, No. 1, pp. 20–24, 1918.

Townley, S.D., "The San Jacinto Earthquake of April 21, 1918," Vol. 8, No. 2, pp. 45–62, 1918.

Rolfe, F., "The Earthquake of April 21, 1918, in the San Jacinto Mountains," Vol. 8, No. 2, pp. 63–67, 1918.

Hamlin, H., "Aftershocks of the San Jacinto Earthquake," Vol. 8, No. 4, pp. 131–134, 1918.

Richter, C.F., "Magnitude of the Inglewood, California, Earthquake of June 21, 1920," Vol. 60, No. 2, pp. 647–649, 1970.

Carpenter, Ford A., "Early Records of Earthquakes in Southern California," Vol. 11, No. 1, pp. 1–3, 1921.

Kemnitzer, L.E., "The Salinas Earthquake of December 27, 1924 (California)," Vol. 14, No. 4, pp. 230–232, 1924.

Allen, Maxwell W., "Some Remarks Concerning Pacific Coast Earthquakes," Vol. 15, No. 2, pp. 128–139, 1925.

Byerly, P., "The California Earthquake of November 4, 1927," Vol. 20, No. 2, pp. 53–66, 1930.

Dyk, K., "The California Earthquake of April 15, 1928," Vol. 26, No. 3, pp. 239–244, 1936.

Gutenberg, B. and Richter, C.F., "The Earthquake in Santa Monica Bay, California, on August 30, 1930," Vol. 22, No. 2, pp. 138–154, 1932.

Richter, C.F., "Earthquake of January 28, 1931 (California)," Vol. 21, No. 4, p. 284, 1931.

Wood, H.O., "Recent Earthquakes near Whittier, California," Vol. 21, No. 3, pp. 183–203, 1931.

Stoneley, R., "Note on the Eureka Earthquake of June 6, 1932 (California)," Vol. 28, No. 3, pp. 191–196, 1938.

Sparks, N.R., "The Eureka Earthquake of 6 June 1932 (California)," Vol. 26, No. 1, pp. 13–28, 1936.

Gianella, V.P., "The Cedar Mountain, Nevada, Earthquake of December 20, 1932," Vol. 24, No. 4, pp. 345–384, 1934.

Wilson, J.T., "Foreshocks and Aftershocks of the Nevada Earthquake of December 20, 1932, and the Parkfield Earthquake of June 7, 1934," Vol. 26, No. 3, pp. 189–194, 1936.

Wood, H.O., "Preliminary Report on the Long Beach Earthquake (California)," Vol. 23, No. 2, pp. 43–56, 1933.

Byerly, P., "The Central California Earthquakes of May 16, 1933, and June 7, 1934," Vol. 25, No. 3, pp. 223–246, 1935.

Callaghan, E., "The Earthquake of January 30, 1934, at Excelsior Mountains, Nevada," Vol. 25, No. 2, pp. 161–168, 1935.

Wood, H.O., "The Terwilliger Valley Earthquake of March 25, 1937," Vol. 27, No. 4, pp. 305–312, 1937.

Byerly, P., "Earthquakes off the Coast of Northern California," Vol. 27, No. 2, pp. 73–96, 1937.

Byerly, P., "Near Earthquakes in Central California," Vol. 29, No. 3, pp. 427–462, 1939.

Ulrich, F.P., "The Imperial Valley Earthquakes of 1940 (California)," Vol. 31, No. 1, pp. 13–32, 1941.

Richter, C.F., "Earthquake near Whittier California, January 29, 1941," Vol. 32, No. 1, pp. 7–10, 1942.

Wood, H.O., "Seismic Activity in the Imperial Valley, California," Vol. 31, No. 3, pp. 245–254, 1941.

Martner, S.T., "The Dominguez Hills, California, Earthquake of June 18, 1944," Vol. 38, No. 2, pp. 105–120, 1948.

Robinson, H.B., "Earthquake Swarm in Lassen Volcanic National Park (October 1945-February 1946)," Vol. 38, No. 3, pp. 179–194, 1948.

Richter, C.F., "The Manix, California, Earthquake of April 10, 1947," Vol. 37, No. 3, pp. 171–180, 1947.

Richter, C.F., "The Desert Hot Springs Earthquakes and Their Tectonic Environment (California-December 4, 1948)," Vol. 48, No. 4, pp. 315–338, 1958.

Chakrabarty, S.K. and Richter, C.F., "The Walker Pass Earthquakes and Structure of the Southern Sierra-Nevada (California)," Vol. 39, No. 2, pp. 93–108, 1949.

Gianella, V.P., "Earthquake and Faulting, Ft. Sage Mountains, California, December 1950," Vol. 47, No. 3, pp. 173–178, 1957.

Steinbrugge, K.V. and others, "An Engineering Study of the Southern California Earthquake of July 21, 1952," Vol. 44, No. 2B, pp. 199–462, 1954.

Byerly, P., "The Fallon-Stillwater Earthquakes of July 6, 1954, and August 23, 1954—Historic Introduction," Vol. 46, No. 1, pp. 1–3, 1956.

Slemmons, D.B., "The Fallon-Stillwater Earthquakes of July 6, 1954, and August 23, 1954," Vol. 46, No. 1, pp. 4–9, 1956.

Tocher, D., "The Fallon-Stillwater Earthquakes of July 6, 1954, and August 23, 1954—Movement on the Rainbow Mountain Fault (Nevada)," Vol. 46, No. 1, pp. 10–14, 1956.

Cloud, W.K., "Intensity Distribution and Strong-Motion Seismograph Results, Nevada Earthquakes of July 6, 1954, and August 23, 1954, Fallon-Stillwater," Vol. 46, No. 1, pp. 34–40, 1956.

Tocher, D., "The Dixie Valley-Fairview Peak, Nevada, Earthquakes of December 16, 1954—Introduction," Vol. 47, No. 4, pp. 299–300, 1957.

Reil, O.E., "The Dixie Valley-Fairview Peak, Nevada, Earthquakes of December 16, 1954—Damage to Nevada Highways," Vol. 47, No. 4, pp. 349–352, 1957.

Slemmons, D.B., "The Dixie Valley-Fairview Peak, Nevada, Earthquakes of December 16, 1954—Geological Effects," Vol. 47, No. 4, pp. 353–376, 1957.

Larson, E.R., "The Dixie Valley-Fairview Peak, Nevada, Earthquakes of December 16, 1954—Minor Features of the Fairview Fault," Vol. 47, No. 4, pp. 377–386, 1957.

Shor, G.G., "San Miguel, Baja California Norte, Earthquakes of February 1956—A Field Report," Vol. 48, No. 2, pp. 101–116, 1958.

Housner, G.W., "The Port Hueneme Earthquake of March 18, 1957," Vol. 48, No. 2, pp. 163–168, 1958.

Richter, C.F., "Earthquakes in Owens Valley, California, January–February 1959," Vol. 50, No. 2, pp. 187–196, 1960.

Richter, C.F., "The Walnut, California, Earthquakes of July–August 1959," Vol. 50, No. 2, pp. 181–186, 1960.

Cameron, J.B., "Earthquakes in the Northern California Coastal Region (Part I)," Vol. 51, No. 2, pp. 203–222, 1961.

Cameron, J.B., "Earthquakes in the Northern California Coastal Region (Part II)," Vol. 51, No. 3, pp. 337–354, 1961.

McEvilly, T.V. and Casaday, K.B., "The Earthquake Sequence of September 1965 near Antioch, California," Vol. 57, No. 1, pp. 113–124, 1967.

McEvilly, T.V., Bakun, W.H., and Casaday, K.B., "The Parkfield, California, Earthquakes of 1966," Vol. 57, No. 6, pp. 1221–1244, 1967.

Brune, J.N. and Allen, C.R., "A Low-Stress-Drop, Low-Magnitude Earthquake With Surface Faulting: The Imperial, California, Earthquake of March 4, 1966," Vol. 57, No. 3, pp. 501–514, 1967.

Cloud, W.K., "Intensity Map and Structural Damage, Parkfield, California, Earthquake of June 27, 1966," Vol. 57, No. 6, pp. 1161–1178, 1967.

Greensfelder, R., "Aftershocks of the Truckee, California, Earthquake of September 12, 1966," Vol. 58, No. 5, pp. 1607–1620, 1968.

Allen, C.R. and others, "The Borrego Mountain, California, Earthquake of 9 April 1968—A Preliminary Report," Vol. 58, No. 3, pp. 1183–1186, 1968.

Cloud, W.K. and Scott, N.H., "The Borrego Mountain, California, Earthquake of 9 April 1968—

A Preliminary Engineering Seismology Report," Vol. 58, No. 3, pp. 1187–1191, 1968.

Brabb, Earl E., "Chittenden, California, Earthquake of September 14, 1963," *California Division of Mines Special Report 91,* pp. 45–51, 1968.

California Department of Natural Resources, Division of Mines, *Earthquakes in Kern County, California, During 1952,* Bulletin 171, 1955.

Marine Advisers, Inc., *Examination of Tsunami Potential at the San Onofre Nuclear Generating Station,* Report A-163, La Jolla, Calif., September 1965.

Louderback, G.D., Unpublished Notes, University of California, Berkeley.

Reid, Harry Fielding, Unpublished Records, Johns Hopkins University, Baltimore, Md. These include a card index, volumes of newspaper clippings, and special correspondence. In many cases where complete information is available from other sources, valuable supplementary information regarding area and intensity is given.

U.S. Department of Commerce, Environmental Science Services Administration, *The Parkfield, California, Earthquake of June 27, 1966,* 65 pp., 1966.

U.S. Department of Commerce, Environmental Science Services Administration-California Institute of Technology, Earthquake Engineering Research Laboratory, joint report, *Strong-Motion Instrumental Data on the Borrego Mountain Earthquake of 9 April 1968,* 119 pp., 1968.

Steinbrugge, Karl V. and others, *The Santa Rosa, California, Earthquakes of October 1, 1969,* U.S. Department of Commerce, Environmental Science Services Administration, 99 pp., 1970.

Earthquakes in the Various States

The following section is a chronological listing of earthquakes by date of occurrence and by state. It includes only those shocks of intensity V and above, as described in preceding sections. An asterisk (*) beside the year indicates the earthquake centered within the state. Those without asterisks are stronger shocks that occurred in neighboring regions but were felt in that state.

Effects observed from earthquakes in nearby states are not always of intensity V. For example, an intensity VII earthquake in Tennessee may have been felt in Kentucky and Missouri with intensity IV. The date of the earthquake, with an asterisk, is then included under Tennessee, but also is listed under Kentucky and Missouri without an asterisk. Many earthquakes in this category may have been omitted because of incomplete information on the felt areas of earlier shocks. This is especially true for earthquakes before 1928.

For some shocks, there is not enough information to confirm the state in which they actually centered. In these cases, the state that experienced the highest intensity is designated as the probable epicenter.

Earthquakes of Alaska, California and Western Nevada, Hawaii, and Puerto Rico, described in separate sections of this report, are not listed in this chapter.

ALABAMA

[See Eastern Region, p. 21]

Twelve earthquakes are listed. Three were damaging and two were felt over a wide area. The shocks of January 1905 attained intensity VII at Gadsden. In October 1916, a shock of intensity VII occurred near Birmingham. Intensity VI earthquakes occurred in the state in April 1957 and August 1959.

1811 Dec. 16	1812 Feb. 7
1812 Jan. 23	1843 Jan. 4
1843 Feb. 16	1923 Dec. 31
1878 Nov. 18	1927 May 7
*1886 Feb. 4	*1927 June 16
*1886 Feb. 13	1928 Nov. 2
1886 Aug. 31	*1931 May 5
1895 Oct. 31	1931 Dec. 16
*1905 Jan. 27	*1939 May 4
*1905 Jan. 28	1955 Jan. 25
1914 Mar. 5	*1957 Apr. 23
1916 Feb. 21	*1959 Aug. 12
*1916 Oct. 18	*1964 Feb. 18
*1917 June 29	1968 Nov. 9

ARIZONA

[See Western Mountain Region, p. 59]

Fourteen earthquakes are listed. The north-central part of the state is the most active earthquake region. Strong shocks were felt near Flagstaff in 1906 and 1910. Early earthquakes felt strongly at Yuma may have occurred in Imperial Valley, Calif. Some of the California earthquakes that affected Arizona are described in the California and Western Nevada chapter, page 137.

1852 Nov. 9	*1931 Apr. 17
1853 Dec.	*1931 July 28
1872 Mar. 26	1932 Dec. 20
1887 May 3	1934 Dec. 31
1899 Dec. 25	*1935 Jan. 2
1903 Jan. 23	*1935 Jan. 10
*1906 Jan. 25	1938 Sept. 17
1906 July 16	1938 Sept. 19
*1910 Sept. 23	1938 Sept. 29
*1912 Aug. 18	1938 Nov. 1
1913 Dec. 5	1939 May 4
1915 Oct. 2	1940 May 18
1915 Nov. 20	1942 Oct. 21
*1916 Dec. 12	*1950 Jan. 16
1918 Apr. 21	1950 July 29

1951 Jan. 23
*1952 May 23
1952 July 21
1953 June 13
1954 Mar. 19
1954 July 6
1954 Aug. 23
1954 Dec. 16
1955 Dec. 16
1956 Feb. 9
1957 Apr. 25
*1959 Feb. 11
1959 July 21
*1959 Oct. 13
*1962 Feb. 15
1963 Mar. 25
*1963 Sept. 11
1965 Sept. 25
1966 Aug. 7
1966 Aug. 16
1967 Oct. 4
1968 Apr. 8
1969 Apr. 28

ARKANSAS

[See Central Region, p. 37]

This state has experienced moderate earthquake activity. Of the 16 listed, the strongest occurred in 1923 and was felt over 40,000 square miles. Five other shocks were felt over areas of 25,000 to 135,000 square miles. Most earthquakes have originated in the northeastern part of the state near the active New Madrid, Mo., region. The major New Madrid shocks of 1811–1812 caused severe topographic changes in northeastern Arkansas.

1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
1843 Jan. 4
1867 Apr. 24
1878 Nov. 18
*1882 Oct. 22
1883 Jan. 11
*1883 Dec. 5
1895 Oct. 31
1903 Nov. 4
1909 Sept. 27
1909 Oct. 23
*1911 Mar. 31 (2)
1915 Dec. 7
1917 Apr. 9
*1918 Oct. 4
*1918 Oct. 13
1918 Oct. 15
*1919 Nov. 3
1922 Mar. 22
*1923 Oct. 28
*1923 Dec. 31
1927 May 7
1931 Dec. 16
*1933 Dec. 9
*1937 May 16
*1938 Sept. 16
*1939 June 19
1939 Nov. 23
1952 Feb. 20
1952 Apr. 9
1954 Feb. 2
1954 Apr. 26
*1955 Jan. 25
1955 Mar. 29
1956 Jan. 28
1956 Nov. 25
1957 Mar. 19
1962 Feb. 2
1962 July 23
1963 Mar. 3
1965 Oct. 20
1967 June 4
1968 Nov. 9
*1969 Jan. 1
*1970 Nov. 16

COLORADO

[See Western Mountain Region, p. 59]

Forty-two moderate earthquakes are listed, a small number considering the large area of high mountains. In 1928, a 3-week series of minor shocks occurred at Creede. An unusual series of earthquakes began in April 1962 in the Denver area and continued through 1970. Most were minor, but several caused some damage.

*1882 Nov. 7
*1895 Mar. 22
*1901 Nov. 15
*1913 Nov. 11 (3)
1915 Oct. 2
*1928 Apr. 20–May 10
*1944 Sept. 8
1948 Mar. 11
1950 Jan. 17
1952 Oct. 7
*1955 Feb. 10
*1955 Aug. 2
*1960 Oct. 11
*1960 Oct. 17
*1962 Feb. 5
*1962 June 18
*1962 Aug. 6
*1962 Dec. 4
*1962 Dec. 5
*1963 May 25
*1963 July 2
*1965 Feb. 16
*1965 July 18
*1965 July 31
*1965 Sept. 13
*1965 Sept. 14
*1965 Sept. 29
*1965 Nov. 20
*1966 Jan. 4
*1966 Jan. 22
1966 Jan. 23
*1966 Oct. 2
*1966 Nov. 14
*1967 Feb. 2 (2)
*1967 Feb. 14
*1967 Apr. 10
*1967 Apr. 27
*1967 Aug. 9
*1967 Nov. 15
*1967 Nov. 26
*1968 July 15
*1969 May 23
*1970 Apr. 21
*1970 May 23

CONNECTICUT

[See Northeastern Region, p. 5]

Fifteen earthquakes are listed. The actual number is greater than this, but only a few of the East Haddam shocks are mentioned. The most severe of these, in 1791, was felt over the largest area and had the highest intensity of any earthquake in this state's history. This region has long been famous for the Moodus noises, a peculiar type of earthquake rumble. The shocks listed generally have been local and of moderate intensity.

1638 June 11
1658 Apr. 14
1727 Nov. 9
1732 Sept. 16

1737 Dec. 18
1755 Nov. 18
1783 Nov. 29
*1791 May 18
*1792 Aug. 28
*1793 Jan. 11
*1794 Mar. 6 (2)
*1805 Aug. 11
*1827 Aug. 23
*1837 Apr. 12
*1840 Aug. 9
1848 Sept. 9
*1858 June 30
1860 Oct. 17
1869 Oct. 22
1870 Oct. 20
1874 Dec. 10
*1875 July 28
1877 Nov. 4
1883 Feb. 27
1884 Aug. 10
1884 Nov. 23
1895 Sept. 1
1897 May 27
1904 Mar. 21
*1908 Feb. 5
1914 Feb. 10
1925 Feb. 28
*1925 Nov. 14
1929 Aug. 12
1929 Nov. 18
1935 Nov. 1
1939 Oct. 19
1940 Dec. 20
1943 Jan. 14
1944 Sept. 4
1951 Sept. 3
*1953 Mar. 27
1957 Apr. 26
1964 Nov. 17
1967 Nov. 22
*1968 Nov. 3

DELAWARE

[See Eastern Region, p. 21]

Three earthquakes are listed. The 1871 shock downed chimneys at Wilmington. The remaining two were felt over small areas and did not exceed intensity V.

1737 Dec. 18
1755 Nov. 18
*1871 Oct. 9
*1879 Mar. 25
1886 Aug. 31
1895 Sept. 1
*1906 May 8
1925 Feb. 28
1935 Nov. 1
1938 Aug. 22
1939 Nov. 14
1968 Dec. 10

DISTRICT OF COLUMBIA

[See Eastern Region, p. 21]

Although no earthquakes are listed as definitely occurring within the District, several shocks from nearby states have been felt there.

1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
1828 Mar. 9
1833 Aug. 27
1843 Feb. 8
1852 Apr. 29
1861 Aug. 31 (2)
1884 Sept. 19
1885 Jan. 2
1885 Oct. 9
1886 Aug. 31
1897 May 31
1918 Apr. 9
1925 Feb. 28
1935 Nov. 1

FLORIDA

[See Eastern Region, p. 21]

Three shocks are listed; all centered in the northern part of the state. The largest shock, in 1879, was felt over 25,000 square miles with intensity VI.

*1879 Jan. 12 (2)
1880 Jan. 22
1880 Jan. 23
1886 Aug. 31
1886 Oct. 31
1886 Nov. 5
*1900 Oct. 31

GEORGIA

[See Eastern Region, p. 21]

This state has experienced a number of earthquakes occurring outside its borders, especially the shocks in New Madrid, Mo. (1811–1812), Charleston, S.C. (1886), and Union County, S.C. (1913). Six earthquakes have centered within the state. Their felt areas ranged to 50,000 square miles, their intensities to VI.

1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
1843 Jan. 4
1857 Dec. 19
1861 Aug. 31
*1872 June 17
*1875 Nov. 1
1879 Jan. 12 (2)
1886 Aug. 31
1886 Oct. 22 (2)
1886 Nov. 5
*1902 Oct. 18
1903 Jan. 23
1905 Jan. 27
1905 Jan. 28
1907 Apr. 19
1912 June 12
*1912 June 20
1913 Apr. 17
*1914 Mar. 5
1914 Sept. 22
1916 Feb. 21
1916 Oct. 18
1924 Oct. 20
1928 Nov. 2
1935 Jan. 1
1945 June 13
1957 Apr. 23
1959 Aug. 3
1960 Mar. 12
1964 Feb. 18
*1964 Mar. 12
1968 Nov. 9
1969 July 13
1969 Nov. 19

IDAHO

[See Western Mountain Region, p. 59]

Thirty-five earthquakes with intensity V–VII are listed. The most severe shocks occurred in May 1916 and in 1944, both of which centered in western Idaho and caused minor damage. A number of strong earthquakes in adjoining states also have been felt. The most notable of these were the 1959 Hebgen Lake, Mont., and 1962 northern Utah shocks which were felt with intensity VII.

1884 Nov. 9
1888 Apr. 28
1897 Nov. 4
*1905 Nov. 11
*1906 Oct. 18
*1913 Apr. 12
1913 Oct. 14
1915 Oct. 2
*1916 May 12
*1916 May 25
*1916 Sept. 9
*1917 Apr. 19
*1917 Dec. 12
*1918 Mar. 11
*1924 Nov. 25
1925 June 27
*1926 Nov. 27
1932 Dec. 20
*1933 Nov. 2
1935 Oct. 18
1935 Oct. 31
1936 July 15
*1937 Dec. 18
1942 Nov. 1
*1942 Nov. 1
*1944 July 12
*1945 Feb. 13
1945 Apr. 29
1945 Sept. 23
1947 Nov. 23
1949 Apr. 13
*1950 Oct. 18
1952 Mar. 31
*1954 June 7
1954 July 6
1954 Aug. 23
1954 Dec. 16
*1956 Aug. 6
*1957 Dec. 18
*1959 Jan. 4
1959 Aug. 17
1959 Aug. 18 (2)
*1960 Aug. 7
*1960 Aug. 10
*1960 Aug. 20
1962 Aug. 30
*1963 Jan. 27
*1963 Feb. 1
*1963 Sept. 9
*1963 Sept. 10
*1963 Sept. 14
*1963 Sept. 16
1964 Oct. 21
*1965 Jan. 5
*1965 Jan. 12
*1965 Apr. 28
1965 Apr. 29
1966 Mar. 17
1969 Apr. 1
*1969 Apr. 26
*1969 May 5

ILLINOIS

[See Central Region, p. 37]

Thirty earthquakes are listed, and a number centering outside the state were felt sharply. Several have been felt in the northern part of Illinois, but the most active area is southern Illinois which adjoins the New Madrid, Mo., region. Many earthquakes of intensity V–VII have been felt over areas of 25,000 to 50,000 square miles. Intensity VII shocks were felt over 500,000 square miles in May 1909; 150,000 in 1939; and 580,000 in 1968.

1795 Jan. 8
*1804 Aug. 24
1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
1857 Oct. 8
1865 Aug. 17
1867 Apr. 24
1875 June 18
1876 Sept. 25
1878 Nov. 18
*1882 July 20
*1882 Sept. 27
*1882 Oct. 15 (2)
*1883 Jan. 11
1883 Feb. 4
*1883 Apr. 12
1887 Feb. 6
*1887 Aug. 2
*1891 Sept. 26
1895 Oct. 31
1897 Apr. 30
1899 Apr. 29
1902 Jan. 24
1902 July 28
1903 Feb. 8
1903 Nov. 4
1905 Aug. 21
*1906 May 21
1907 July 4
1908 Sept. 28
*1908 Oct. 27
*1909 May 26
*1909 July 18
*1909 Aug. 16
*1909 Sept. 22
1909 Sept. 27
1909 Oct. 23
*1909 Oct. 23
*1912 Jan. 2
1915 Dec. 7
1917 Apr. 9
1918 Oct. 15
1919 May 25
1920 May 1
*1922 Mar. 22 (2)
1923 Oct. 28
*1923 Nov. 9
1923 Dec. 31
1924 Mar. 2
1925 Feb. 28
1925 Apr. 26
1925 May 13
1925 Sept. 2
1927 May 7
1934 Aug. 19
*1934 Nov. 12
1935 Nov. 1
1937 Mar. 2
1937 Mar. 8
*1937 Nov. 17
1938 Sept. 16
*1939 Nov. 23
1947 Aug. 9
*1953 Sept. 11
1954 Feb. 2
1955 Jan. 25
*1955 Apr. 9
1956 Nov. 25
1958 Jan. 27
1958 Nov. 7
1962 Feb. 2
*1962 June 26
1963 Mar. 3
1963 Aug. 2
*1964 Aug. 14
*1964 Aug. 15 (2)
1965 Oct. 20
1967 July 21
*1968 Nov. 9
1970 Nov. 16

INDIANA

[See Central Region, p. 37]

Thirteen earthquakes are listed, three of which were felt over 60,000 to 100,000 square miles. Most of the shocks have occurred in southern Indiana.

1804 Aug. 24
1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
*1827 Aug. 6
*1827 Aug. 7
1843 Jan. 4
1867 Apr. 24
1875 June 18
*1876 Sept. 25
1882 Oct. 15
1883 Feb. 4
1884 Sept. 19
*1887 Feb. 6
*1891 July 26
1895 Oct. 31
1897 Apr. 30
1897 May 31
*1899 Apr. 29
1905 Aug. 21
*1906 May 11
1909 May 26
1909 Sept. 22
*1909 Sept. 27 (2)
1909 Oct. 23 (2)
1912 Jan. 2
1916 Oct. 18
1917 Apr. 9
*1919 May 25
1922 Mar. 22
1925 Feb. 28
*1925 Apr. 26
1925 Sept. 2
*1931 Jan. 5
1931 Sept. 20
1935 Nov. 1
1937 Mar. 2
1937 Mar. 8
1939 Nov. 23
1947 Aug. 9
1956 Jan. 27
*1958 Nov. 7
1963 Mar. 3
1968 Nov. 9
1968 Dec. 11

IOWA

[See Central Region, p. 37]

Only two earthquakes are listed. Neither shock exceeded intensity V. The Missouri shock of 1965 caused slight damage (intensity V) at Indianola.

1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
1843 Jan. 4
1867 Apr. 24
1870 Oct. 20
*1872 Oct. 9
1877 Nov. 15
1886 Aug. 31
1891 Sept. 26
1895 Oct. 31
1902 July 28
*1905 Apr. 13
1909 May 26
1909 July 18
1909 Sept. 27 (2)
1911 June 2
1912 Jan. 2
1917 Apr. 9
1925 Feb. 28
1934 Nov. 12
1935 Mar. 1
1935 Nov. 1
1939 Nov. 23
1952 Apr. 9
1965 Oct. 20
1968 Nov. 9

KANSAS

[See Central Region, p. 37]

Twelve earthquakes are listed. A shock in 1867 was felt over 300,000 square miles but caused little damage. In 1929 a series of four shocks occurred in northeastern Kansas. Earthquakes in eastern Nebraska are usually felt in Kansas.

1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
*1867 Apr. 24
*1875 Nov. 8
1877 Nov. 15
1878 Nov. 18
1882 Oct. 22
1882 Nov. 7
1895 Oct. 31
1902 Jan. 24
*1904 Oct. 27
*1906 Jan. 7
1909 Sept. 27 (2)
1917 Apr. 9
1925 Feb. 28
1925 July 30
*1927 Mar. 18
*1929 Sept. 23 (2)
*1929 Oct. 21
*1929 Dec. 7
*1933 Feb. 20
1935 Mar. 1
1936 June 19
1939 Nov. 23
1948 Mar. 11
1952 Apr. 9
*1956 Jan. 6
*1961 Apr. 13
1961 Dec. 25
1963 Mar. 3
1965 Oct. 20
1967 Nov. 26
1968 Nov. 9

KENTUCKY

[See Eastern and Central Regions, pp. 21 and 37]

Eighteen earthquakes are listed and many occurring in adjacent states have been felt. Western Kentucky has experienced a number of shocks of intensity V–VII. The earthquake in September 1925 was felt over a 75,000 square-mile area.

*1779 Unknown
*1791 or April or May
*1792
1795 Jan. 8
1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
1828 Mar. 9
*1834 Nov. 20
*1841 Dec. 27
1843 Jan. 4
1843 Feb. 16
1861 Aug. 31
1867 Apr. 24
1875 June 18
1876 Sept. 25
*1878 Mar. 12
1882 Sept. 27
1884 Sept. 19

1887 Feb. 6
1887 Aug. 2
1895 Oct. 31
1897 Apr. 30
1897 May 31
1899 Apr. 29
1903 Feb. 8
1903 Nov. 4
1905 Jan. 27
1905 Jan. 28
1905 Aug. 21
1909 Sept. 22
1909 Sept. 27 (2)
1909 Oct. 23
1912 Jan. 2
1915 Apr. 28
*1915 Oct. 26
*1915 Dec. 7
1916 Feb. 21
1916 Oct. 18
*1916 Dec. 18
1917 Apr. 9
1918 Oct. 15
1919 May 25
1922 Mar. 22
*1922 Mar. 23
1923 Oct. 28
1923 Dec. 31
*1924 Mar. 2
1925 Feb. 28
1925 Apr. 26
*1925 May 13
*1925 Sept. 2
1927 May 7
1928 Nov. 2
1931 Sept. 20
*1933 May 28
1934 Aug. 19
1935 Nov. 1
1937 Mar. 2
1937 Mar. 8
1937 May 16
1938 Sept. 16
1939 Nov. 23
1952 Feb. 20
*1954 Jan. 1
1955 Jan. 25
1955 Apr. 9
1956 Sept. 7
1956 Nov. 25
*1957 Mar. 26
*1958 Jan. 27
1958 Nov. 7
1962 Feb. 2
1962 June 26
1963 Mar. 3
*1963 Aug. 2
1965 Oct. 20
1968 Nov. 9
*1968 Dec. 11
1969 July 13
1969 Nov. 19
1970 Nov. 16

LOUISIANA

[See Central Region, p. 37]

Two shocks are listed. The earthquake in 1930 was felt over an area of 15,000 square miles with a maximum intensity VI. That in 1958 was a local shock with intensity V at Baton Rouge.

1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
1895 Oct. 31
1911 Mar. 31
*1930 Oct. 19
1957 Mar. 19
*1958 Nov. 19
1967 June 4

MAINE

[See Northeastern Region, p. 5]

Maine is adjacent to active regions in Canada, both in New Brunswick and along the St. Lawrence River, and has been affected by many Canadian earthquakes, as well as the Grand Banks of Newfoundland shock in 1929. Twenty-three earthquakes are listed within its borders. Most were felt over an area of less than 20,000 square miles, but the 1904 shock was felt over at least 150,000 square miles. In 1918 there was a more localized earthquake of considerable intensity. This state may be considered one of not infrequent minor activity with an occasional severe tremor within or near its borders.

1638 June 11
1658 Apr. 14
1661 Feb. 10
1663 Feb. 5
1727 Nov. 9
1732 Sept. 16
1744 June 14
1755 Nov. 18
1810 Nov. 9
*1817 May 22
1855 Feb. 8
1860 Oct. 17
1869 Oct. 22
1870 Oct. 20
1872 Jan. 9
*1874 Feb. 27
*1881 Jan. 20
1882 Dec. 31
1895 Sept. 1
*1896 Mar. 22
*1898 Sept. 17
*1904 Mar. 21
*1905 July 15
*1910 Jan. 22
*1912 Dec. 11
*1914 Jan. 13
*1914 Feb. 21
*1918 Aug. 20
1924 Sept. 30
1925 Jan. 7
1925 Feb. 28
*1925 Oct. 9
*1926 Aug. 28
*1928 Feb. 8
1929 Aug. 12
1929 Nov. 18
1931 Jan. 7
1935 Nov. 1
*1938 Aug. 22
1939 Oct. 19
1940 Dec. 20
1940 Dec. 24
*1943 Jan. 14
1944 Sept. 4
*1947 Dec. 28
*1949 Oct. 4
1952 Oct. 14
1954 July 29
1957 Apr. 26
*1958 Sept. 19
1962 Apr. 10
*1966 July 23
*1967 July 1 (2)

MARYLAND

[See Eastern Region, p. 21]

Four earthquakes are listed. Central Maryland residents have felt shocks centering in Virginia.

1732 Sept. 16
1755 Nov. 18
*1758 Apr. 24
1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
1828 Mar. 9
1833 Aug. 27
1843 Feb. 8
1852 Apr. 29
1875 Dec. 22
*1883 Mar. 11
*1883 Mar. 12
1884 Aug. 10
*1885 Jan. 2
1886 Aug. 31
1895 Sept. 1
1897 May 31
1906 May 8
1909 Apr. 2
1918 Apr. 9
1919 Sept. 5
1925 Feb. 28
1935 Nov. 1
1939 Nov. 14
1944 Sept. 4
1966 May 31
1969 Nov. 19

MASSACHUSETTS

[See Northeastern Region, p. 5]

In addition to being affected by some of the more severe Canadian shocks and the Grand Banks of Newfoundland earthquake of 1929, Massachusetts has 19 tremors listed. In colonial time, there were many earthquakes in the northeastern part of the state near Newbury, and several of these were widely felt. The shock of 1755 centered east of Cape Ann and was observed over a 300,000 square-mile area. Numerous minor earthquakes have been felt in the southeastern part of the state.

1638 June 11
*1643 June 11
1658 Apr. 14
1661 Feb. 10
1663 Feb. 5
*1727 Nov. 9
1732 Sept. 16
*1737 Feb. 17
1737 Dec. 18
*1741 June 24
*1744 June 14
1755 Nov. 18 (2)
1755 Nov. 22
1755 Dec. 19
1783 Nov. 29
1791 May 18
1810 Nov. 9
1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
*1817 Oct. 5
1840 Aug. 9
*1847 Aug. 8
*1852 Nov. 27
*1854 Dec. 10
1860 Oct. 17
1869 Oct. 22
1870 Oct. 20
1875 July 28
*1876 Sept. 21
1877 Nov. 4
*1880 May 12
1883 Feb. 27
1884 Nov. 23
1886 Aug. 31
1891 May 1
1895 Sept. 1
1897 May 27
*1903 Jan. 21
*1903 Apr. 24
1904 Mar. 21
*1907 Oct. 15
1914 Feb. 10
*1925 Jan. 7
1925 Feb. 28
*1925 Apr. 24
1929 Nov. 18
1935 Apr. 23
1935 Nov. 1
1939 Oct. 19
*1940 Jan. 28
1940 Dec. 20
1943 Jan. 14
1944 Sept. 4
1954 July 29
1957 Apr. 26
1962 Apr. 10
1962 Dec. 29
1963 Oct. 16
*1963 Oct. 30
*1965 Oct. 24
1965 Dec. 7

MICHIGAN

[See Central Region, p. 37]

The greater earthquakes of the St. Lawrence Valley (1925 and 1935) and the Timiskaming, Canada, shock of 1935 were felt strongly here. Of the eight earthquakes occurring in the state, only two were of more than local interest. The shock in 1905, and especially that of 1906 in the Keweenaw Peninsula, had unusual effects such as might be produced by major earthquakes, but this may have been caused by unstable conditions resulting from mining operations.

1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
1870 Oct. 20
*1872 Feb. 6
*1877 Aug. 17
*1883 Feb. 4
1884 Sept. 19
1886 Aug. 31
1895 Oct. 31
*1905 Mar. 13
*1905 July 26
*1906 May 26
*1909 Jan. 22
1909 May 26
1917 Apr. 9
1925 Feb. 28
1935 Nov. 1
1937 Mar. 2
1937 Mar. 8
1943 Mar. 8
1944 Sept. 4
*1947 Aug. 9
1968 Nov. 9

MINNESOTA

[See Central Region, p. 37]

Two moderate earthquakes are listed. Little is known about the shock of 1860.

*1860 Unknown
1909 May 26
*1917 Sept. 3
1925 Feb. 28
1935 Nov. 1
1968 Nov. 9

MISSISSIPPI

[See Central Region, p. 37]

Four earthquakes are listed for this state. The shock in 1931 was felt over an area of 65,000 square miles with intensity VI–VII. The June 4, 1967, shock was rated intensity VI and was felt over 25,000 square miles of four states.

1811 Dec. 16	1923 Oct. 28
1812 Jan. 23	1923 Dec. 31
1812 Feb. 7	1927 May 7
1843 Jan. 4	*1931 Dec. 16
1857 Oct. 8	1938 Sept. 16
1865 Aug. 17	1939 Nov. 23
1895 Oct. 31	1954 Apr. 26
1903 Nov. 4	1955 Jan. 25
1905 Aug. 21	*1955 Feb. 1
1909 Oct. 23	1963 Mar. 3
1911 Mar. 31	*1967 June 4
1915 Dec. 7	*1967 June 29
1916 Oct. 18	1968 Nov. 9
1917 Apr. 9	1970 Nov. 16

MISSOURI

[See Central Region, p. 37]

Thirty-five earthquakes are listed, many of which were very severe and accompanied by large numbers of aftershocks. The New Madrid earthquakes of 1811–12 were among the great earthquakes of all time and were accompanied by extensive topographic changes. Further changes on a smaller scale were caused by the shocks of 1895 and 1843 (Tennessee) which were felt over 1 million and 400,000 square miles, respectively. Other earthquakes of considerable intensity occurred in 1878, felt area 150,000 square miles; 1917, 200,000 square miles; 1963, 100,000 square miles; and 1965, 160,000 square miles. This is an important earthquake region with continuing moderate activity.

*1811 Dec. 16	*1865 Aug. 17
*1812 Jan. 23	1867 Apr. 24
*1812 Feb. 7	1875 June 18
*1820 Nov. 9	1876 Sept. 25
*1838 June 9	1877 Nov. 15
1843 Jan. 4	*1878 Nov. 18
*1843 Feb. 16	1882 July 20
*1857 Oct. 8 (2)	1882 Sept. 27
1882 Oct. 15	1935 Mar. 1
1882 Oct. 22	1937 Mar. 8
1883 Jan. 11	1937 May 16
1883 Feb. 4	1937 Nov. 17
1887 Feb. 6	1938 Sept. 16
1887 Aug. 2	1939 Nov. 23
*1895 Oct. 31	*1947 June 29
*1902 Jan. 24	*1950 Feb. 8
*1903 Feb. 8	1952 Feb. 20
*1903 Nov. 4 (2)	1952 Apr. 9
*1903 Nov. 27	1953 Sept. 11
*1905 Aug. 21	*1954 Feb. 2
1906 Jan. 7	1955 Jan. 25
*1907 July 4	1955 Mar. 29
*1908 Sept. 28	1955 Apr. 9
1908 Oct. 27	*1956 Oct. 29
1909 May 26	*1956 Nov. 25
1909 July 18	1958 Jan. 27
1909 Sept. 27	1958 Apr. 26
*1909 Oct. 23	1958 Nov. 7
*1915 Apr. 28	1959 Dec. 21
1915 Dec. 7	*1961 Dec. 25
1916 Dec. 18	*1962 Feb. 2
*1917 Apr. 9	1962 June 26
*1920 May 1	*1962 July 23
1922 Mar. 22	*1963 Mar. 3
1923 Oct. 28	*1965 Oct. 20
1923 Dec. 31	*1967 July 21
1924 Mar. 2	1968 Nov. 9
1925 Feb. 28	1969 Jan. 1
*1934 Aug. 19	1970 Nov. 16
1934 Nov. 12	

MONTANA

[See Western Mountain Region, p. 59]

One hundred and sixteen shocks are listed, the destructive ones occurring in 1925, 1935, and 1959. Many of the others were local. The 1925 shock was felt over 310,000 square miles with a maximum intensity of VIII. There were five main shocks in the long series that lasted from October 1935–1937. The areas and intensities were 70,000 square miles, VII; 230,000 square miles, VIII; 140,000 square miles, VIII; and 90,000 square miles, VI, respectively. The shock in August 1959 was felt over 600,000 square miles with a maximum intensity X; twenty-eight persons were killed or missing, most

of whom were engulfed by the Madison River Canyon slide.

*1869 May 22
*1872 Dec. 10
*1872 Dec. 11
*1897 Nov. 4
*1904 Aug. 3
*1908 Dec. 20
*1908 Dec. 29
1909 May 15
1915 Oct. 2
1916 May 12
1918 Mar. 11
*1925 June 27
*1925 July 10
*1925 Aug. 10
*1926 May 31
1926 Nov. 27
*1926 Dec. 12
*1929 Feb. 15
*1930 Mar. 16
*1930 July 9
*1933 June 10
*1933 Aug. 19
*1933 Nov. 29
*1935 Mar. 29
*1935 Oct. 3
*1935 Oct. 7
*1935 Oct. 12
*1935 Oct. 18
*1935 Oct. 27
*1935 Oct. 31
*1935 Nov. 21
*1935 Nov. 28
*1936 Jan. 11
*1936 Feb. 13 (2)
*1936 March (various)
*1936 June 11
*1936 June 22
*1939 May 11
*1940 Dec. 23
1942 Nov. 1
*1943 June 24
1944 July 12
1945 Feb. 13
*1945 June 1
*1945 Sept. 23
*1946 Dec. 11
*1947 Mar. 14
*1947 Nov. 23
*1947 Dec. 17
*1948 May 15
1949 Apr. 13
*1950 June 27
*1950 Aug. 19
*1951 Aug. 5
*1951 Dec. 9
*1952 Mar. 31
*1952 Apr. 14
*1952 Apr. 22
*1952 May 29
*1953 Aug. 8
*1953 Nov. 23
*1955 May 31
*1956 Dec. 25
*1957 May 17
*1958 May 28
*1959 May 17
*1959 Aug. 17
*1959 Aug. 18
*1959 Aug. 20
*1959 Aug. 23
*1959 Aug. 30
*1959 Sept. 4
*1959 Sept. 28
*1959 Oct. 18 and 19
*1959 Nov. 3
*1959 Dec. 8
*1959 Dec. 11
*1959 Dec. 12
*1959 Dec. 13
*1960 Jan. 4
*1960 Feb. 3
*1960 Mar. 22
*1960 Apr. 21
*1960 Apr. 26
*1961 Mar. 13
*1961 Apr. 6
1961 June 26
*1961 Dec. 3
*1962 Feb. 25
*1962 Dec. 18
*1962 Dec. 28
*1963 Feb. 15
*1963 May 11
1963 Sept. 23 (2)
*1963 Dec. 20
*1964 Mar. 20
*1964 Mar. 27
*1964 Mar. 28
*1964 Oct. 8
*1964 Oct. 21
1965 Jan. 5
*1965 Jan. 6
1965 Jan. 12
*1965 Apr. 6
*1965 Apr. 27
1965 Apr. 29
*1965 Oct. 8
*1965 Oct. 26
*1966 Mar. 7
*1966 Apr. 29
*1966 Sept. 19
*1966 Oct. 11 (3)
*1967 Jan. 10
*1968 Mar. 26
*1969 Apr. 1
*1969 Apr. 5
*1969 Apr. 30
*1969 May 6
*1969 June 21
*1969 Sept. 14
*1969 Oct. 7
*1969 Oct. 13
*1969 Nov. 6
*1970 Feb. 4
*1970 May 23
*1970 June 25
*1970 Sept. 1
*1970 Oct. 18

NEBRASKA

[See Central Region, p. 37]

Six earthquakes are listed and several occurring in eastern Kansas were felt within the state. The shock of 1877 was felt over 140,000 square miles, and those of 1902 and 1935 were observed over 35,000 and 50,000 square miles, respectively. The earthquake activity seems to take the form of rather strong shocks occurring at long intervals of time.

1867 Apr. 24
*1877 Nov. 15
*1902 July 28
1906 Jan. 7
1906 May 9
*1910 Feb. 26
1911 June 2
1933 Feb. 20
*1934 July 30
*1935 Mar. 1
1952 Apr. 9
1961 Apr. 13
1964 Mar. 27
*1964 Mar. 28
1965 Oct. 20
1967 Aug. 9
1967 Nov. 23
1968 Nov. 9

NEVADA

[See Western Mountain Region, p. 59]

The major part of the earthquake activity occurs in the western part of the state and is listed with California and Western Nevada (see p. 137). Many of these shocks were widely felt over central and eastern Nevada. Twenty-five earthquakes are listed

outside western Nevada. That in 1901 was of the highest intensity (VII) but was felt over a very small area. Shocks in April 1937 and August 1966 were felt over 20,000 square miles but were below intensity VII.

1872 Mar. 26
*1901 July 26
1915 Oct. 2
*1915 Nov. 17
1916 Feb. 2
*1916 Aug. 3
1932 Dec. 20
1933 June 25
1934 Jan. 30
1934 Dec. 31
*1936 Sept. 19
*1937 Apr. 24
*1937 Apr. 27
*1937 June 18
*1937 Nov. 11
*1939 May 4
1940 May 18
*1942 June 4
*1942 Sept. 8
*1948 Nov. 2
*1952 Feb. 8
*1952 Feb. 20
1952 May 23
1954 July 6
1954 Aug. 23
1954 Dec. 16
*1955 Jan. 10
*1958 Apr. 19
1959 Aug. 17
*1963 Mar. 25
*1963 Apr. 23
*1964 Feb. 20
*1964 Sept. 23
*1966 Aug. 16
*1966 Sept. 22
*1968 Jan. 30
*1968 Feb. 21
*1968 July 6

NEW HAMPSHIRE

[See Northeastern Region, p. 5]

As this state has its greatest length nearly at right angles to the trend of the St. Lawrence River, only a small portion of its area observes Canadian earthquakes. There have been many shocks in the southern portion. These are probably related to those of northeastern Massachusetts. Eighteen are listed, all affecting small areas except those of 1940 which ranged between 15,000 and 50,000 square miles.

1638 June 11
1658 Apr. 14
1661 Feb. 10
1663 Feb. 5
1727 Nov. 9
1732 Sept. 16
1755 Nov. 18
1783 Nov. 29
*1810 Nov. 9
1852 Nov. 27
1854 Dec. 10
1860 Oct. 17
1869 Oct. 22
1870 Oct. 20
1872 Jan. 9
*1872 Nov. 18
*1882 Dec. 19
*1884 Jan. 18
1884 Aug. 10
*1884 Nov. 23
*1891 May 1
1895 Sept. 1
1897 May 27
1904 Mar. 21
1905 July 15
*1905 Aug. 30
1907 Oct. 15
1925 Feb. 28
*1925 Oct. 9
*1926 Mar. 18
*1927 Mar. 8
*1928 Apr. 25
1929 Aug. 12
1929 Nov. 18
1931 Jan. 7
1935 Nov. 1
1939 Oct. 19
1940 Jan. 14
*1940 Dec. 20
*1940 Dec. 24
1944 Sept. 4
1949 Oct. 4
1954 July 29
1957 Apr. 26
1962 Apr. 10
1962 June 20
*1962 Dec. 29
*1963 Dec. 4
*1964 June 26
*1966 Oct. 23
*1969 Aug. 6

NEW JERSEY

[See Eastern Region, p. 21]

Earthquakes here have generally been moderate. Of the ten listed, that in 1895 was the most widely felt (35,000 square miles). The 1884 New York shock was strongly felt.

1727 Nov. 9
1737 Dec. 18
1755 Nov. 18
1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
1848 Sept. 9
1860 Oct. 17
1871 Oct. 9
1872 July 11
1874 Dec. 10
*1877 Sept. 10
1879 Mar. 25
1884 Aug. 10
1886 Aug. 31
*1895 Sept. 1
*1921 Jan. 26
1925 Feb. 28
*1927 June 1
*1933 Jan. 24
1935 Nov. 1
*1938 Aug. 22
*1939 Nov. 14
1940 Dec. 20
1944 Sept. 4
1951 Sept. 3
*1957 Mar. 23
*1961 Dec. 27
*1968 Dec. 10

NEW MEXICO

[See Western Mountain Region, p. 59]

Forty-five earthquakes are listed. Central New Mexico, near Socorro, has had a considerable amount of activity over a long period of years. The prevailing type has been strong but local. The July and November earthquakes of 1906 affected an

area of about 100,000 square miles. There have been several shocks near the Arizona border with epicenters that may have been in either state.

*1868 Apr. 28
*1869 Unknown
*1879 Unknown
*1886 July 6
1887 May 3
*1893 July 12
*1893 Sept. 7
*1895 Oct. 7
*1895 Oct. 31
*1897 Unknown
*1904 Jan. 19
1906 Jan. 25
*1906 July 12
*1906 July 16
*1906 Nov. 15
1910 Sept. 23
1912 Aug. 18
*1913 July 18
*1913 Dec. 5
*1918 May 28
*1919 Jan. 31
*1919 Feb. 1
*1924 Aug. 12
1925 July 30
*1930 Dec. 3
*1931 Feb. 4
*1934 Jan. 7
*1934 May 6
*1935 Feb. 20
*1935 Dec. 17
*1935 Dec. 19
*1935 Dec. 21
*1935 Dec. 30
1938 Sept. 17
1938 Sept. 19
1938 Sept. 29
*1938 Nov. 1
*1947 Nov. 6
1948 Mar. 11
*1949 May 23
*1952 Aug. 3
*1952 Aug. 17
*1952 Oct. 7
*1954 Nov. 3
*1955 Aug. 12
*1960 July 22
*1960 July 23
*1960 July 24
*1961 July 3
*1966 Jan. 22
*1966 Jan. 23
1966 Aug. 14
1966 Oct. 2
*1969 Jan. 29
*1970 Jan. 12
*1970 Nov. 28

NEW YORK

[See Northeastern Region, p. 5]

With its greatest length roughly paralleling the St. Lawrence River, New York has felt strongly the more important earthquakes of that region. In addition, 37 shocks are listed as having occurred within its borders. Most of these have affected small areas in the eastern and western sections. The shock of 1884 near New York City was felt over 70,000 square miles; 1897, 150,000 square miles; 1929, 100,000 square miles; 1931, 60,000 square miles; and 1944, 175,000 square miles. The 1929 and 1944 earthquakes caused extensive damage near Attica and Massena, respectively.

1638 June 11
1661 Feb. 10
1727 Nov. 9
1732 Sept. 16
*1737 Dec. 18
1783 Nov. 29
1791 May 18
*1841 Jan. 25
1843 Feb. 8
1852 Apr. 29
*1853 Mar. 12
*1857 Oct. 23
1860 Oct. 17
1861 July 12
1867 Dec. 18
1869 Oct. 22
1870 Oct. 20
*1872 July 11
1873 July 6
*1874 Dec. 10
*1877 Nov. 4
*1878 Oct. 4
1879 Aug. 21
*1884 Aug. 10
1884 Nov. 23
1886 Aug. 31
*1893 Mar. 9
1895 Sept. 1
*1897 May 27
*1903 Dec. 25
1904 Mar. 21
*1907 Jan. 24
*1913 Apr. 28
*1913 Aug. 10
1914 Feb. 10
*1916 Jan. 5
*1916 Feb. 2
*1916 June 8
*1916 Nov. 1
1917 May 22
1925 Feb. 28
*1926 May 11
*1928 Mar. 18
*1929 Aug. 12
1929 Nov. 18
*1929 Dec. 2
*1931 Apr. 20
*1933 Oct. 29
*1934 Apr. 14
1935 Nov. 1
1939 Oct. 19
1940 Dec. 20
1943 Mar. 8
*1944 Sept. 4
*1951 Sept. 3
*1952 Aug. 24
*1952 Oct. 8
1953 Mar. 27
1953 Mar. 31
*1955 Aug. 16
*1961 Apr. 20
1962 Mar. 27
1962 Apr. 10
1962 June 20
*1964 Mar. 29
*1964 Nov. 17
*1966 Jan. 1
*1967 June 13
*1967 Nov. 22
1968 Oct. 19

NORTH CAROLINA

[See Eastern Region, p. 21]

Of the 14 earthquakes listed, two were important—February 1916 and November 1928. They were felt over 200,000 and 40,000 square miles, respectively. The latter was near the Tennessee border and was widely felt in both states. A series of local, but fairly strong, earthquakes occurred in 1874 in western North Carolina.

1774 Feb. 21
1811 Dec. 16
1812 Jan. 23
1812 Feb. 7

1828 Mar. 9
1833 Aug. 27
1843 Jan. 4
1843 Feb. 8
1852 Apr. 29
1861 Aug. 31
*1874 Feb. 10–Apr. 17
1875 Dec. 22
1877 Nov. 16
*1879 Dec. 13
*1884 Jan. 18
*1885 Aug. 6
1886 Aug. 31
1897 May 3
1897 May 31
1897 Oct. 21
1898 Nov. 25
1899 Feb. 13
1911 Apr. 20
1912 June 12
1913 Jan. 1
1913 Apr. 17
1914 Mar. 5
*1915 Oct. 29
*1916 Feb. 21
*1916 Aug. 26
1916 Oct. 18
1924 Oct. 20
1925 Feb. 28
*1926 July 8
*1928 Nov. 2
1935 Jan. 1
1935 Nov. 1
1945 July 26
1954 Jan. 1
1955 Sept. 28
1956 Sept. 7
*1957 May 13
*1957 July 2
1957 Nov. 24
*1958 Mar. 5
1959 Oct. 26
1960 Mar. 12
1963 Oct. 28
1968 Nov. 9
1969 July 13
1969 Nov. 19
*1969 Dec. 13
*1970 Sept. 9

NORTH DAKOTA

[See Central Region, p. 37]

No earthquakes of intensity V and above are listed. Canadian shocks have been felt, and the Montana earthquake in 1959 was mildly felt. The first instrumentally located earthquake in the history of this state occurred on July 8, 1968. Its intensity did not exceed IV, however.

1872 Oct. 9
1877 Nov. 15
1909 May 15
1959 Aug. 17

OHIO

[See Central Region, p. 37]

Twenty-two earthquakes are listed, five of which are quite significant. The year and felt area of these are: 1875, 40,000 square miles; 1884, 125,000 square miles; 1931, 40,000 square miles; and two in 1937, 90,000 and 150,000 square miles. The shock on March 8, 1937, was the strongest, causing damage in the intensity VII–VIII category.

1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
1828 Mar. 9
1843 Jan. 4
1843 Feb. 8
1843 Feb. 16
1852 Apr. 29
1857 Oct. 23
1861 Aug. 31
1867 Apr. 24
1870 Oct. 20
1873 July 6
*1875 June 18
*1882 Feb. 9
*1884 Sept. 19
1897 May 31
*1901 May 17
*1906 June 27
1909 May 26
1917 Apr. 9
1925 Feb. 28
*1925 Mar. 26
1925 Apr. 26
*1926 Nov. 5
*1928 Sept. 9
*1929 Mar. 8
1929 Aug. 12
*1930 Sept. 30
*1931 Sept. 20
1933 May 28
1935 Nov. 1
*1937 Mar. 2
*1937 Mar. 3
*1937 Mar. 8
1939 Oct. 19
*1943 Mar. 8
1944 Sept. 4
1947 Aug. 9
*1952 June 20
*1955 May 26
*1955 June 28
*1956 Jan. 27
*1958 May 1
*1961 Feb. 22
*1967 Apr. 7
1968 Nov. 9
1969 Nov. 19

OKLAHOMA

[See Central Region, p. 37]

Seventeen earthquakes are listed. The strongest and most widely felt shock occurred on April 9, 1952. The intensity VII tremor was felt over 140,000 square miles. A second intensity VII earthquake, felt over a very small area, occurred in October 1956.

1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
1882 Oct. 22
*1918 Sept. 10
1925 July 30
*1929 Dec. 27
*1933 Aug. 19
1934 Apr. 11
*1936 Mar. 14
1936 June 19
1938 Sept. 16
1948 Mar. 11
*1952 Apr. 9
*1952 Apr. 16
*1953 Mar. 17 (2)
1956 Jan. 6
*1956 Feb. 16
*1956 Apr. 2
*1956 Oct. 30
*1959 June 15
*1959 June 17
*1961 Jan. 10
*1961 Apr. 27
1963 Mar. 3
1965 Oct. 20
*1968 Oct. 14
1968 Nov. 9
*1969 May 2

OREGON

[See Washington and Oregon, p. 89]

Thirty-three earthquakes are listed, most of them local. The principal shocks were the 1873 tremor near the California border, felt over 70,000 square miles, and that of 1936 near Milton, felt over 105,000 square miles. Several California shocks, especially that of 1906, and several Idaho, Washington, and Nevada shocks have been felt.

1873 Nov. 22
*1877 Oct. 12
1880 Dec. 12
*1883 Sept. 28
*1892 Feb. 3
1892 Apr. 17
*1893 Mar. 6
1895 Feb. 25
*1896 Apr. 2
1905 Nov. 11
1906 Apr. 18
*1906 Apr. 19
1906 Apr. 23
1909 Oct. 28
*1913 Oct. 14
*1915 May 18
1915 Oct. 2
1916 Feb. 2
1916 May 12
*1920 Apr. 14
1920 Nov. 28
*1921 Feb. 25
1922 Jan. 31
*1923 Jan. 10
*1927 Apr. 8
*1930 July 18
*1931 Aug. 16
1932 June 6
1932 Dec. 20
*1936 July 15
*1936 Aug. 4
*1936 Aug. 27
1939 Nov. 12
1941 Feb. 9
1941 Oct. 3
*1941 Dec. 29
*1942 May 12
*1942 June 12
*1942 Nov. 1
1944 July 12
1945 Feb. 13
1945 Apr. 29
1946 Feb. 14
1949 Apr. 13
1949 Aug. 21
*1953 Dec. 15
1954 July 6
1954 Aug. 23
1954 Nov. 25
1954 Dec. 16
1954 Dec. 21
1956 Oct. 11
*1957 Nov. 16
*1959 Jan. 20
1959 Aug. 4
1959 Aug. 17
1960 Jan. 7
1960 Aug. 8
*1961 Aug. 18
1961 Sept. 15
1961 Sept. 17
*1961 Nov. 6
*1961 Nov. 7
1962 Aug. 23
1962 Sept. 4
1962 Nov. 5
*1963 Mar. 7
*1963 Dec. 26
*1964 Oct. 1
1965 Apr. 29
1968 May 29
*1968 June 3 (3)
1969 Apr. 26

PENNSYLVANIA

[See Eastern Region, p. 21]

Fourteen earthquakes of intensity V and above are listed. Some of the stronger Canadian earthquakes, and the New York shock of 1929, were widely felt.

1732 Sept. 16
1737 Dec. 18
1758 Apr. 24
1783 Nov. 29
1791 May 18
*1800 Mar. 17
*1800 Nov. 29
1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
1828 Mar. 9
*1840 Nov. 11
*1840 Nov. 14
1843 Feb. 8
1848 Sept. 9
1852 Apr. 29
1857 Oct. 23
1860 Oct. 17
1871 Oct. 9
1873 July 6
1877 Sept. 10
1879 Mar. 25
*1884 May 31
1884 Aug. 10
1884 Sept. 19
1886 Aug. 31
*1889 Mar. 8
1895 Sept. 1
1897 May 31
*1908 May 31
1909 Apr. 2
1914 Feb. 10
1918 Apr. 9
1925 Feb. 28
1929 Aug. 12
1929 Nov. 18
*1934 Oct. 29
1935 Nov. 1
1937 Mar. 2
1937 Mar. 8
*1938 July 15
1938 Aug. 22
1939 Nov. 14
1940 Dec. 20
1943 Mar. 8
1944 Sept. 4
*1954 Jan. 7
*1954 Feb. 21
*1954 Feb. 23
*1961 Sept. 14
1961 Dec. 27
*1964 May 12
1966 Jan. 1
1968 Nov. 9
1968 Dec. 10

RHODE ISLAND

[See Eastern Region, p. 21]

Only three moderate shocks are listed, but several centering in southeastern Massachusetts have been felt.

1638 June 11
1658 Apr. 14
1727 Nov. 9
1732 Sept. 16
1737 Dec. 18
1755 Nov. 18
1783 Nov. 29
1791 May 18
1848 Sept. 9
1860 Oct. 17
1876 Sept. 21
1877 Nov. 4

*1883 Feb. 27
1895 Sept. 1
1904 Mar. 21
1925 Jan. 7
1925 Feb. 28
1929 Nov. 18
1935 Nov. 1
1940 Dec. 20
1944 Sept. 4
1963 Oct. 16
*1965 Dec. 7
*1967 Feb. 2

SOUTH CAROLINA

[See Eastern Region, p. 21]

Twenty earthquakes are listed. In addition to the Charleston shock of 1886, which was one of the great earthquakes of U.S. history, the 1924 earthquake in the western part of the state was felt over 56,000 square miles. Three additional shocks were felt over areas of 30,000, 35,000, and 43,000 square miles.

1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
1828 Mar. 9
1843 Jan. 4
*1857 Dec. 19
1861 Aug. 31
1875 Nov. 1
*1886 Aug. 31
*1886 Oct. 22 (2)
*1886 Nov. 5
1897 May 31
*1903 Jan. 23
*1907 Apr. 19
1911 Apr. 20
*1912 June 12
*1913 Jan. 1
1913 Apr. 17
*1914 Sept. 22
1916 Feb. 21
1916 Oct. 18
*1924 Oct. 20
1928 Nov. 2
*1933 Dec. 19
*1945 July 26
*1952 Nov. 19
*1958 Oct. 20
*1959 Aug. 3
*1959 Oct. 26
1960 Mar. 12
*1960 July 23
*1964 Apr. 20
*1967 Oct. 23
1968 Nov. 9
1969 Nov. 19
1969 Dec. 13

SOUTH DAKOTA

[See Central Region, p. 37]

Twelve earthquakes have centered within the borders of this state. All were rather localized, except that of 1911 which was felt over an area of 40,000 square miles.

1872 Oct. 9
1877 Nov. 15
*1879 Dec. 29
*1895 Oct. 11 (2)
1902 July 28
1906 May 9
1909 May 15
*1911 June 2
*1915 Oct. 23
*1928 Nov. 16
1934 July 30
*1938 Oct. 11
*1946 July 23
1959 Aug. 17
*1961 Dec. 31
*1964 Mar. 24
1964 Mar. 27
1964 Mar. 28
*1966 June 26
*1967 Nov. 23

TENNESSEE

[See Eastern and Central Regions, pp. 21 and 37]

The western part of this state was shaken strongly by the New Madrid, Mo., earthquakes of 1811–12, and by those of 1843 and 1895. The New Madrid shocks caused extensive topographic changes. Minor activity continues to the present time with 35 shocks listed. The activity in eastern Tennessee occurred near the North Carolina border.

1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
*1843 Jan. 4
1843 Feb. 16
*1844 Nov. 28
1861 Aug. 31
1865 Aug. 17
*1877 Nov. 16
1878 Nov. 18
1883 Jan. 11
1887 Aug. 2
*1889 July 19
1895 Oct. 31
1897 Apr. 30
1899 Feb. 13
*1902 May 29
1902 Oct. 18
1903 Nov. 4
*1904 Mar. 4
1905 Aug. 21
1909 Oct. 23
1911 Mar. 31
*1913 Mar. 28
*1913 Apr. 17
*1914 Jan. 23
1914 Mar. 5
1915 Dec. 7
1916 Feb. 21
1916 Oct. 18
1917 Apr. 9
*1918 June 21
1918 Oct. 4
*1918 Oct. 15
*1920 Dec. 24
1923 Oct. 28
1923 Dec. 31
1924 Mar. 2
1924 Oct. 20
1925 Sept. 2
*1927 May 7
1928 Nov. 2
1931 Dec. 16
1937 May 16
1938 Sept. 16
1939 Nov. 23
*1941 Nov. 16
*1945 June 13
*1952 Feb. 20
*1952 July 16
1954 Jan. 1
*1954 Jan. 22
1954 Feb. 2
*1954 Apr. 26
1955 Jan. 25
*1955 Mar. 29
*1955 Sept. 5
*1955 Dec. 13
*1956 Jan. 28
*1956 Sept. 7 (2)
1956 Nov. 25
*1957 June 23

1957 Nov. 24
*1958 Jan. 26
*1958 Apr. 8
*1958 Apr. 26
*1959 Feb. 13
1959 Aug. 12
*1959 Dec. 21
*1960 Jan. 28
*1960 Apr. 15
*1960 Apr. 21
1962 Feb. 2
1962 July 23
1963 Mar. 3
1965 Oct. 20
1967 June 4
1968 Nov. 9
1969 Jan. 1
*1969 July 13
1969 Nov. 19
1970 Sept. 9
1970 Nov. 16

TEXAS

[See Central and Western Mountain Regions, pp. 37 and 59]

Sixteen earthquakes are listed. The principal shocks were in western Texas in 1931, felt over 450,000 square miles with intensity VIII, and two in the Panhandle in 1925 and 1936, felt over 200,000 and 40,000 square miles, respectively.

1882 Oct. 22
1887 May 3
*1891 Jan. 8
*1917 Mar. 27
*1925 July 30
1928 Oct. 31
*1931 Aug. 16
*1931 Aug. 18
*1932 Apr. 9
*1934 Apr. 11
*1936 June 19
*1948 Mar. 11
*1951 June 20
1952 Apr. 9
1956 Oct. 30
*1957 Mar. 19
1959 June 17
*1964 Apr. 28
*1964 Aug. 16
*1966 July 20
*1966 Aug. 14
*1969 May 12
1970 Jan. 12

UTAH

[See Western Mountain Region, p. 59]

Seventy-four shocks are listed. The most important occurred in southern Utah in 1921, limits uncertain, intensity VIII; north of Great Salt Lake in 1934, 170,000 square miles, intensity VIII; and in northern Utah in 1962, 65,000 square miles, intensity VII. Many shocks have occurred in the Great Salt Lake area.

*1853 Dec. 1
1860 Mar. 15
*1873 July 30
*1880 July 11
*1880 Sept. 16
*1881 Mar. 25
*1884 Nov. 9
*1887 Dec. 5
*1891 Apr. 20
*1891 Sept. 12
*1894 June 8
*1894 July 18
1897 Nov. 4
*1899 Dec. 13
*1900 Aug. 1
*1901 Nov. 13–19
*1902 Nov. 17
*1902 Dec. 5
1905 Nov. 11
*1906 May 24
*1909 Oct. 5–December
*1910 Jan. 10–12
*1910 May 22
1910 Sept. 23
1912 Aug. 18
1913 Apr. 12
*1914 Apr. 8
*1914 May 13
*1914 Dec. 20
*1915 July 15
*1915 July 30
*1915 Aug. 11
1915 Oct. 2
*1915 Oct. 5
*1916 Feb. 4
*1920 Sept. 18
*1920 Sept. 19
*1920 Nov. 19
*1920 Nov. 25
*1921 Sept. 29 (2)
*1921 Oct. 1
*1921 Oct. 27
*1921 Nov. 1
1924 Nov. 25
1932 Dec. 20
*1933 Jan. 20
1934 Jan. 30
*1934 Mar. 12
*1934 May 6
*1936 May 9
*1937 Feb. 17
*1942 June 4
*1942 Aug. 30
*1943 Feb. 22
*1946 May 5
*1949 Mar. 6
*1949 Mar. 7
*1949 Nov. 1
*1950 Jan. 17
*1950 May 8
*1952 Sept. 28
*1953 May 23
*1953 Oct. 21
1954 Aug. 23
1954 Dec. 16
1955 Jan. 10
*1955 Feb. 2
*1955 May 12
*1958 Feb. 13
*1958 Nov. 28
*1958 Dec. 1 (2)
*1959 Feb. 27
*1959 July 21
1959 Aug. 17
*1961 Apr. 15
*1961 May 6
1962 Feb. 15
*1962 Aug. 30
*1962 Sept. 4
*1962 Sept. 5
*1962 Sept. 7
1963 Mar. 25
*1963 July 7
1964 Feb. 20
*1966 Mar. 17
1966 Aug. 16
1966 Sept. 22
*1967 Sept. 23
*1967 Oct. 4
*1968 Jan. 16
*1970 Mar. 29

VERMONT

[See Northeastern Region, p. 5]

Seven earthquakes are listed. Regarding Canadian shocks, the situation is similar to that de-

scribed for New Hampshire. Many of the Canadian earthquakes and those of other New England states are strongly felt. The tremors in 1905 and 1962 were both felt over an area of 20,000 square miles with a maximum intensity V.

1638 June 11
1658 Apr. 14
1661 Feb. 10
1663 Feb. 5
1732 Sept. 16
1755 Nov. 18
1783 Nov. 29
1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
1860 Oct. 17
*1867 Dec. 18
1869 Oct. 22
1870 Oct. 20
1884 Aug. 10
1895 Sept. 1
1897 May 27
1904 Mar. 21
*1905 Oct. 22
1917 May 22
1924 Sept. 30
1925 Feb. 28
1928 Apr. 25
1929 Aug. 12
1929 Nov. 18
1931 Jan. 7
1934 Apr. 14
1935 Nov. 1
1939 Oct. 19
1940 Jan. 14
1940 Dec. 20
1940 Dec. 24
1944 Sept. 4
1949 Oct. 4
*1952 Jan. 29
1952 Oct. 14
*1953 Mar. 31
*1955 Feb. 2
*1957 Apr. 23
1957 Apr. 26
*1962 Apr. 10
1962 June 20
1964 June 26

VIRGINIA

[See Eastern Region, p. 21]

Virginia is a state of considerable seismic activity, although the earthquakes are rarely strong. Thirty-one shocks are listed with epicenters within its borders. Of these, the Giles County shock in 1897 was felt over 280,000 square miles; earthquakes in 1828 and 1861 (which probably centered in Virginia) were felt over 218,000 and 300,000 square miles, respectively; one in 1852 (probably in Virginia) was felt over 162,000 square miles. Five additional earthquakes were felt over an area of from 20,000 to 72,000 square miles.

*1774 Feb. 21
*1807 Apr. 30 or May 1
1811 Dec. 16
1812 Jan. 23
1812 Feb. 7
*1828 Mar. 9
*1833 Aug. 27
1843 Feb. 8
*1852 Apr. 29
*1853 May 2
*1855 Feb. 2
*1861 Aug. 31
1870 Oct. 20
*1875 Dec. 22
1885 Jan. 2
*1885 Oct. 9
1895 Sept. 1
*1897 May 3
*1897 May 31
*1897 Oct. 21
*1897 Dec. 18
*1898 Feb. 5
*1898 Nov. 25
*1899 Feb. 13
*1907 Feb. 11
*1908 Aug. 23
1909 Apr. 2
*1910 May 8
1916 Feb. 21
*1918 Apr. 9
*1919 Sept. 5
*1921 July 15
*1921 Aug. 7
*1924 Dec. 25
1925 Feb. 28
*1927 June 10
1928 Nov. 2
*1929 Dec. 26
1935 Nov. 1
1954 Jan. 1
1955 Sept. 28
1956 Sept. 7
*1959 Apr. 23
*1963 Oct. 28
*1966 May 31
1968 Nov. 9
1969 July 13
1969 Nov. 19
*1969 Dec. 11
1970 Sept. 9

WASHINGTON

[See Washington and Oregon, p. 89]

One hundred and sixteen earthquakes are listed in this state. Some Oregon and Idaho shocks, and the 1959 Hebgen Lake, Mont., shock, were felt here. Until recently, the history of earthquakes had indicated relatively minor intensity but with rather frequent occurrence. Since 1945, the intensities have greatly increased, especially in the Puget Sound and northeastern Washington regions.

*1841 Dec. 2
*1856 Dec. 26
*1859 Apr. 2
*1860 May 7
1864 Oct. 29
1865 Aug. 25
*1868 May 30
1871 May 19
1872 Dec. 14–16
*1872 Dec. 16–Jan. 4
1880 Aug. 22
1880 Dec. 12
*1885 Oct. 9
*1885 Dec. 8
*1891 Sept. 22
1891 Nov. 29
*1892 Apr. 17
*1895 Feb. 25
*1895 Apr. 16
1896 Jan. 3
*1896 Feb. 6
*1897 Dec. 15
*1903 Mar. 13
1904 Dec. 16
*1906 Jan. 3
*1906 Nov. 1
*1909 Jan. 11
*1909 May 24
*1911 Sept. 28
*1913 July 29
*1913 Dec. 25

*1914 Sept. 5
*1915 Aug. 18 (2)
1915 Oct. 2
*1916 Jan. 1
*1916 Feb. 22
*1917 Nov. 12
*1917 Nov. 13
*1918 Feb. 28
1918 Mar. 11
*1918 Nov. 1
1918 Dec. 6
*1920 Jan. 23
1920 Nov. 28
*1923 Feb. 12
*1923 Sept. (?)
1925 June 27
1926 Dec. 4
1926 Dec. 30
*1928 Feb. 2
1928 Feb. 9
*1931 Apr. 17
*1931 Dec. 31
*1932 Jan. 5
*1932 July 17
*1932 Aug. 6 (2)
*1934 May 4
*1934 Sept. 18
*1934 Sept. 26
*1934 Oct. 19
*1934 Nov. 1
*1934 Nov. 2
*1934 Nov. 3
*1935 July 9
1935 Oct. 18
1935 Oct. 31
1936 July 15
*1938 Jan. 6
*1939 Nov. 12
*1940 Oct. 27
*1941 Apr. 7
*1942 Oct. 14
1942 Nov. 1
*1943 Apr. 23
*1943 Nov. 28
1944 Mar. 31
1944 July 12
1944 Oct. 31
1945 Feb. 13
*1945 Apr. 29 (2)
*1945 May 1
1945 Sept. 23
*1946 Feb. 14
1946 June 23
1947 Nov. 23
*1948 Sept. 24
*1949 Apr. 13
1949 Aug. 21
*1950 Apr. 14
*1950 Dec. 2
*1952 Aug. 6
1953 Dec. 15
*1954 Mar. 16
*1954 May 4
*1954 May 15
*1954 May 23
*1955 Jan. 11
*1955 Mar. 25
*1955 Sept. 10
*1955 Nov. 2
*1956 Jan. 6
*1956 Feb. 8
*1957 Jan. 25
*1957 Feb. 11
*1957 May 4
*1957 Nov. 1
*1958 Apr. 12
1958 July 9
*1958 Aug. 22
*1958 Oct. 6
1959 Jan. 20
*1959 Aug. 4
*1959 Aug. 5
1959 Aug. 17
*1959 Oct. 14
*1959 Nov. 23
*1959 Dec. 11
*1960 Jan. 7
*1960 Apr. 10
*1960 Sept. 10
*1961 Jan. 3
*1961 Feb. 1
1961 Aug. 18
*1961 Sept. 15
*1961 Sept. 16
*1961 Sept. 17
*1961 Oct. 30
1961 Nov. 6
1961 Nov. 7
*1962 Jan. 14
*1962 Nov. 5
*1962 Dec. 31
*1963 Jan. 24
*1963 Dec. 21
1963 Dec. 26
*1964 Jan. 26
*1964 July 14
*1964 July 30 (2)
*1964 Oct. 1
*1964 Oct. 15
*1965 Apr. 29
*1967 Mar. 6
*1968 Sept. 6
*1968 Nov. 30
1969 Feb. 14
*1969 Oct. 9
*1969 Nov. 1
*1969 Nov. 9
*1970 Feb. 10
*1970 Oct. 24

WEST VIRGINIA

[See Eastern Region, p. 21]

Two earthquakes are listed; several occurring in adjacent states have been felt.

1828 Mar. 9
1843 Feb. 8
1852 Apr. 29
1853 May 2
1873 July 6
1875 Dec. 22
1884 Sept. 19
1886 Aug. 31
1897 May 31
1901 May 17
*1909 Apr. 2
1918 Apr. 9
1919 Sept. 5
1925 Feb. 28
1926 Nov. 5
1935 Nov. 1
1937 Mar. 2
1937 Mar. 8
1943 Mar. 8
1944 Sept. 4
1959 Apr. 23
1968 Nov. 9
*1969 Nov. 19

WISCONSIN

[See Central Region, p. 37]

No earthquakes are listed for this state. Some of those in Illinois, northern Michigan, and Ohio have been felt.

1886 Aug. 31
1909 May 26
1912 Jan. 2
1917 Apr. 9
1925 Feb. 28
1935 Nov. 1
1937 Mar. 2
1937 Mar. 8
1939 Nov. 23
1947 Aug. 9
1968 Nov. 9

WYOMING

[See Western Mountain Region, p. 59]

Thirty-eight earthquakes of moderate intensity and extent are listed, many of which have occurred

in Yellowstone National Park. In addition, the 1959 Hebgen Lake, Mont., earthquake was felt here with intensity VII. Many aftershocks from this earthquake were reported in Yellowstone National Park through December 1959 with intensities V–VI, and numerous shocks of less intensities continued through 1960.

1882 Nov. 7
1884 Nov. 9
*1894 June 25
*1897 Nov. 14
1906 Oct. 18
*1910 July 25
*1915 May 8
*1923 Mar. 23
1924 Nov. 25
1925 June 27
*1925 Nov. 17
*1928 Feb. 13
*1930 June 12
*1930 Aug. 24–Dec. 22
*1932 Jan. 26
*1934 Nov. 23
1935 Oct. 18
1935 Oct. 31
*1936 Jan. 14
*1942 Aug. 5
1947 Nov. 23
*1948 Feb. 23
*1954 Jan. 20
*1954 July 4
*1958 Apr. 28
1959 Aug. 17
*1959 Aug. 18
*1959 Sept. 5
*1959 Sept. 25
*1959 Sept. 26
*1959 Sept. 29
*1959 Nov. 1
*1959 Nov. 4
*1959 Dec. 13
*1959 Dec. 25
1960 Apr. 21
*1961 June 29
*1962 Aug. 26 (2)
*1963 Jan. 29
*1963 Feb. 25
*1963 Mar. 8
*1963 Mar. 21
*1963 Apr. 18
*1963 June 6
*1963 Sept. 23
*1963 Dec. 17
1963 Dec. 20
*1964 Aug. 21
1964 Oct. 21
1967 Nov. 26

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1929. August 19. Kodiak Island. At Ouzinkie, man on wharf thought vessel had struck dock. Buildings creaked; articles moved. Possibly of volcanic origin, as Katmai and Mageek Volcanoes were smoking and volcanic dust fell.

1929. November 11. Southeastern Alaska. Widely felt. Epicenter doubtful. At Juneau, hanging objects swayed. Sharp shock was felt at Matanuska, but may not have been the same one.

1931. May 28. Girdwood. Sharp and abrupt. Prolonged at Matanuska.

1931. May 30. Attu Island. Felt by all. Clocks stopped; small objects overturned; dishes broke. Canned goods in store were thrown to floor. Magnitude 6.

1931. June 11. Chitina and Valdez. Widely felt. Awakened many.

1931. July 6. Kanatak. Felt by all. Trees and bushes shook.

1931. July 13. Girdwood. Awakened all.

1931. October 17. Girdwood and Wasilla. Awakened all. Also felt at Homer.

1931. November 20. Girdwood and Valdez. At Girdwood, all were awakened. Articles fell from shelves.

1931. November 21. Girdwood. Felt by and awakened all.

1931. December 23. Near Kodiak Island. Moderate at Whale Island. Felt over an east-west area of 400 miles. Magnitude 6¼.

1932. March 3. Girdwood. Strong shock awakened all.

1932. March 25. South-central Alaska. Water main burst at Seward. Slides occurred on railroad to the north. Felt over an east-west area of 350 miles and an unknown distance to the north of Seward. Magnitude 6.9.

1932. September 13. Prince William Sound and Kenai Peninsula. Intensity V at Ellamar, Homer, Valdez, and Wasilla. Clocks stopped. Widely recorded on seismographs. Magnitude 6¼.

1932. October 6. Homer. Awakened all.

1933. January 3. Near Seward. People rushed into the streets at Seward. Cracks appeared in the ground in many places, including the streets of the city and for 20 miles along the road leading to the north. Very severe at Anchorage. Felt at Cordova and Fairbanks. Magnitude 6¼.

1933. April 26. Northwest of Anchorage. Telegraph lines were broken for a distance of 50 miles from Anchorage. Plate glass windows broke. Felt in the Aleutian Islands and at Fairbanks and Valdez. Intensity VII at Big Susitna River District, and at Old Tyonek where houses were shaken off foundations. Several aftershocks occurred. One at 17:03 was intensity V at Homer; another at about 18:50 was intensity V at Anchorage. Magnitude of main shock 7.0.

1933. June 13. Old Tyonek. Severe shock with some damage. Magnitude 6¼.

1933. June 28. Fox Islands. Series of earthquakes felt in the vicinity of Dutch Harbor. Main shock, magnitude 6.

1933. July 28. Dutch Harbor. Strong shock. Magnitude 6.

1933. August 30. Southeastern Alaska. Intensity V at Haines and Skagway. Three heavy shocks at Skagway. Magnitude 5¼.

1933. September 19. Yukon Territory. Clocks stopped at Juneau and Skagway.

1934. February 11. Juneau. Plaster cracked; other slight damage to buildings.

1934. April 19. Anchorage. Slight damage. Felt at Seward.

1934. May 3. South-central Alaska. At Anchorage, windows broke; goods fell from shelves. Felt at Cordova and Nenana. Magnitude 7.2.

1934. May 14. Kodiak Island. Intensity VI on Kodiak and Whale Islands. People left houses; plaster cracked; landslides blocked road. Also felt at Susitna. Magnitude 6½.

1934. May 15. Kodiak and Seward. Merchandise toppled from shelves.

1934. June 17. South-central Alaska. At Anchorage, plate glass broke; small objects overturned. Felt at Afognak. Magnitude 6¾.

1934. August 1. South-central Alaska. At Anchorage, dishes broke; small objects overturned. Magnitude 6.

1934. November 28. Gustavus. Intensity V.

1935. August 23. Anchorage. Small objects overturned; knickknacks fell. Awakened many.

1936. October 22. South-central Alaska. Slight damage at Anchorage. Heavy at Seward, strong at Susitna, and felt at Cordova (?). Many aftershocks.

1937. July 22. Central Alaska. Fairbanks suffered severe shaking. Damage to buildings was prevented because of good construction and design. There was a loss of $5,000 in broken windows and bottled