United States Earthquakes, 1983

CARL W. STOVER, Editor

This publication summarizes data for earthquakes that occurred in the 50 states during 1983. Descriptions of individual earthquakes include hypocenters, magnitudes, intensities, and damages. The report also contains results from regional networks and data recorded by strong-motion seismographs.

DEPARTMENT OF THE INTERIOR
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United States Earthquakes, 1983

By Carl W. Stover, *Editor*

Introduction

This publication describes all earthquakes that were reported felt in the United States and nearby territories in 1983. Its purpose is to provide a continuous history of U.S. earthquakes to be used in estimating areal seismic risk, for designing earthquake-resistant structures, and answering inquiries from scientists, engineers, and the public.

The U.S. Geological Survey/National Earthquake Information Center (USGS/NEIC) collects intensity information primarily by mailing questionnaires, "Earthquake Report" forms, to postmasters and other public institutions (police departments and/or fire departments) in the earthquake area. Completed questionnaires are returnd to the USGS, where they are evaluated and intensities are assigned. For damaging earthquakes, the questionnaires are supplemented by USGS field investigations. The USGS/NEIC publishes preliminary maximum intensity data for United States earthquakes in the Preliminary Determination of Epicenters, Monthly Listing (PDE) (for example, Irby and others, 1982). The latest and most complete information is published with maps, diagrams, and photographs in United States Earthquakes (now published as a USGS Bulletin), issued annually since 1928. Copies of issues prior to 1982 can be obtained from the Open-File Services Section (OFSS), Western Distribution Branch, U.S. Geological Survey, Box 25425, Federal Center, Denver, CO 80225.

This publication is composed of four major sections: "Earthquake Descriptions," which includes a summary of macroseismic data reported for each earthquake and a chronological list of earthquakes by State (table 1); "Network Operations," which summarizes the results from local seismic networks; "Miscellaneous Activities," which contains information on crustal movement studies, and principal earthquakes of the world (table 10); and "Strong-motion Seismograph Data" (table 11). The intensity and macroseismic data in "Earthquake Descriptions" are compiled from questionnaire canvasses (see previous paragraph), newspaper articles, and reports prepared by other government organizations, State institutions, local organizations, and individuals. Each description includes date, hypocenter, the source of the hypocenter computation, magnitude, maximum intensity (Modified Mercalli), and/or macroseismic effects reported by localities that felt the earthquake.

DISCUSSION OF TABLES

The earthquake parameters in tables 1 and 10 include date, origin time, hypocenter (epicenter and focal depth), and magnitude. Table 1 also contains the maximum observed Modified Mercalli (MM) intensity. The origin time and date are listed in Universal Coordinated Time (UTC). The epicenters were taken principally from those published in the USGS Preliminary Determination of Epicenters, Monthly Listings. These data have been updated and new data added from subsequent publications of universities or State agencies who operate seismic networks. The accuracy of the epicenters is that claimed by the institution supplying the hypocenter and is not necessarily the accuracy indicated by the number of decimals listed. The epicenters located by the USGS/NEIC have a varying degree of accuracy, usually two-tenths of a degree or less. See Preliminary Determination of Epicenters, Monthly Listing, for an explanation of the accuracy of USGS hypocenters. Depths are listed to the nearest kilometer.

Magnitudes listed in the tables were furnished by cooperating institutions or determined by the USGS. The computational sources are indicated by letter codes identified in headnotes to the tables.

EPICENTER AND ISOSEISMAL MAPS

Figures 1-3 are computer plots of all earthquake epicenters in the conterminous United States, Alaska, and Hawaii listed in table 1. Figures 4-6 show only these earthquakes that had computed magnitudes of 5.0 or larger. Each earthquake epicenter is indicated by a small circle or square.

Figures 7-9 are maps showing the maximum intensity of earthquakes in the conterminous United States, Alaska, and Hawaii. Maximum intensities are represented by Arabic numerals at the epicentral locations. Earthquakes of intensity I-IV are represented by solid circles.

The USGS/NEIC coordinates the collection of all types of earthquake information, with the special objective of correlating instrumentally determined earthquake locations with noninstrumental locations indicated by intensity data. This correlation is achieved through regional investigations of earthquakes by local organizations and the USGS. Primary data are gathered by a mail canvass of the epicentral area using questionnaire cards. A field survey is usually carried out for damaging events. When returned and analyzed, this information is used to prepare isoseismal maps which show the areal pattern of intensity associated with individual earthquakes.

The selection of earthquakes for isoseismal maps (shown in the Earthquake Descriptions) is governed largely by the size of the area affected. This means that sharp, localized shocks of intensity VI (which often occur in California) may not be represented by these maps, whereas more widely felt earthquakes of intensity V and VI (which are characteristic of the Eastern and Central States) often will be illustrated because of the larger felt

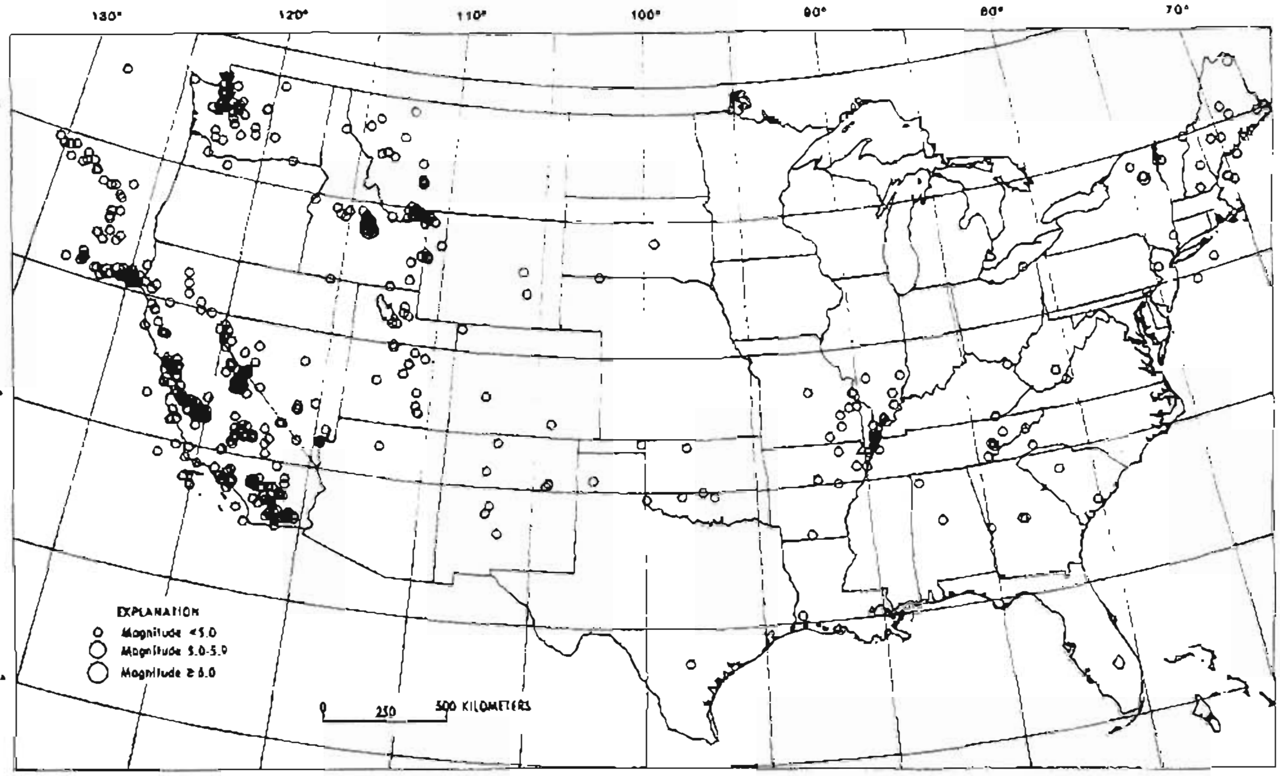

Figure 1. Earthquake epicenters in the conterminous United States for 1983 from table 1.

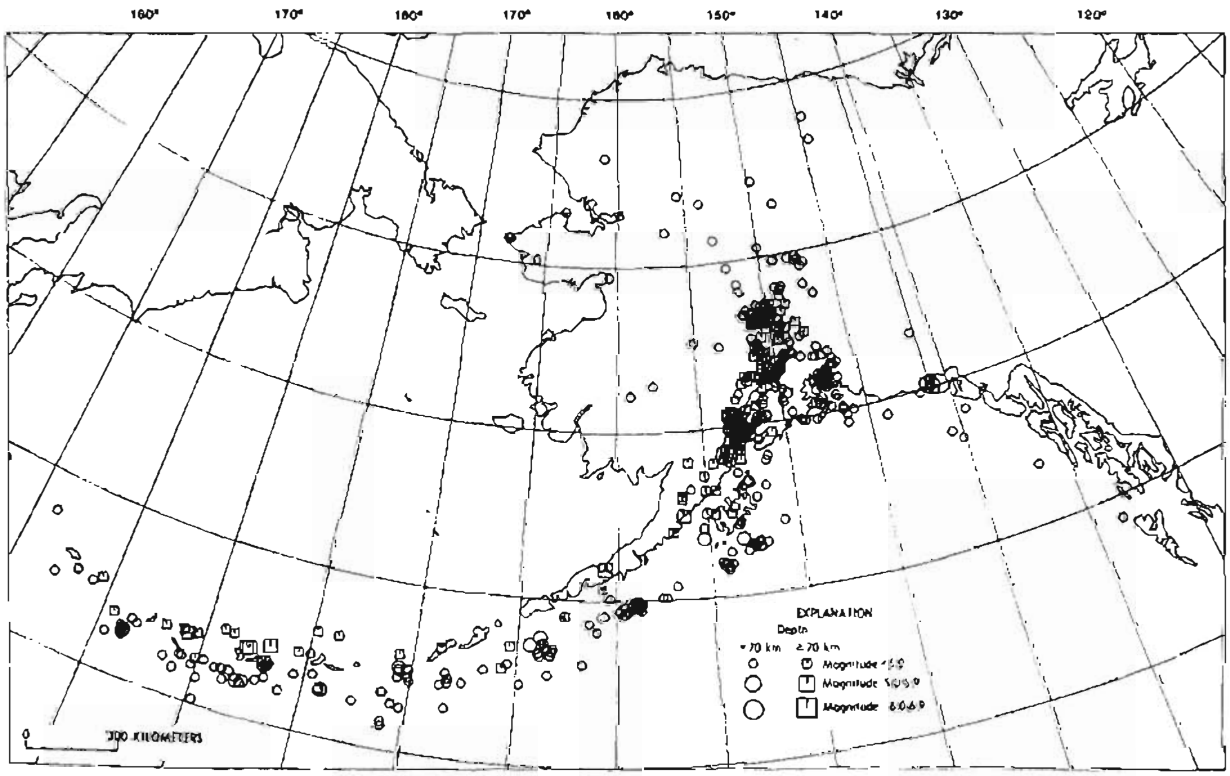

Figure 2. Earthquake epicenters in Alaska for 1983 from table 1.

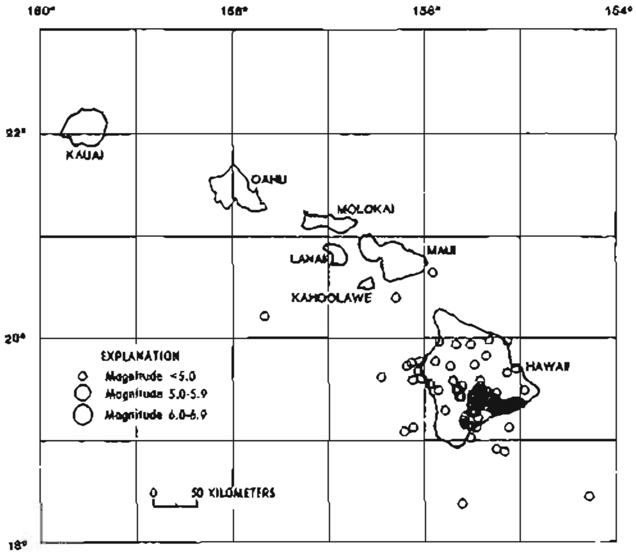

Figure 3. Earthquake epicenters in Hawaii for 1983 from table 1.

areas. Arabic numerals on these computer-plotted maps represent the maximum MM intensities at sampled localities. Isoseismal contours are a generalization of intensity data and are extrapolated in regions that have few observations. The isoseismals do not account for each intensity observation as they are drawn to show the general patterns at a level of intensity or range of intensities.

MAGNITUDE AND INTENSITY RATINGS

Magnitude, a measure of the "size" of an earthquake, is related to the energy release at the focus of an earthquake. Although the magnitude scale has neither "top" nor "bottom" values, the highest ever calculated was greater than 9 and the lowest was about -3. On this logarithmic scale, a magnitude 6 shallow-focus earthquake represents elastic-wave energy about 30 times greater than that generated by a magnitude 5 earthquake, 900 times greater than that of a magnitude 4 shock, and so forth. Many factors enter into the determination of earthquake magnitude, including earthquake focal depth, frequency content of the sampled energy, and the earthquake radiation pattern. Magnitude values calculated by the USGS are based on the following 5 formulas:

$$MS = \log(A/T) + 1.66 \log D + 3.3, \quad (1)$$

as adopted by the International Association of Seismology and Physics of the Earth's Interior (IASPEI; Bath, 1966, p. 153), where A is the maximum vertical surface-wave ground amplitude, in micrometers; T is the period, in seconds, and $18 \leq T \leq 22$; and D is the distance in geocentric degrees (station to epicenter), and $20^{\circ} \leq D \leq 160^{\circ}$. No depth correction is made for depth less than 50 km, and no MS magnitudes are computed for depths greater than 50 km.

$$mb = \log(A/T) + Q(D,h), \quad (2)$$

as defined by Gutenberg and Richter (1956), except that T, the period in seconds, is restricted to $0.1 \leq T \leq 3.0$, and A, the ground amplitude in micrometers, is not necessarily the maximum of the P-wave group. Q is a function of distance D and depth h, where $D \geq 5^{\circ}$.

$$ML = \log A - \log A_0, \quad (3)$$

as defined by Richter (1958, p. 340), where A is the maximum trace amplitude in millimeters, written by a Wood-Anderson torsion seismometer, and $\log A_0$ is a standard value as a function of distance, where the distance is $\leq$ 600 km. ML values are also calculated from other seismometers by conversion of recorded ground motion to the expected response of the torsion seismometer. ML magnitudes are listed for events with depths less than 70 km.

$$\begin{aligned} Mn &= 3.75 + 0.90(\log D) + \log(A/T) \quad 0.5^{\circ} \leq D \leq 4^{\circ}, \\ Mn &= 3.30 + 1.66(\log D) + \log(A/T) \quad 4^{\circ} \leq D \leq 30^{\circ} \end{aligned} \quad (4)$$

as proposed by Nuttli (1973) for North America east of the Rocky Mountains, where A/T is expressed in micrometers per second, calculated from the vertical-component 1-second Lg waves, and D is the distance in geocentric degrees.

$$M_W = 2/3 \log M_0 - 10.7 \quad (5)$$

as defined by Hanks and Kanamori (1979), where M_0 is the seismic moment in dyne-cm.

In this publication MD designates duration or coda length magnitude. MD is usually computed from the difference, in seconds, between Pn- or Pg-wave arrival time and the time the final coda amplitude decreases to the background-noise amplitude. Duration magnitude scales are normally adjusted to agree with ML or Mn estimates so that resulting magnitudes are compatible. Thus, the MD formulas vary for different geographic regions and seismograph systems.

Intensity, as applied to earthquakes, represents a quantity determined from the effects on people, manmade structures, and the Earth's surface (landslides, ground fissures, etc,). Intensities are assigned according to the descriptions listed in the Modified Mercalli Intensity Scale of 1931 (Wood and Neumann, 1931). There are 12 discrete steps in the MM scale (see next section). An earthquake in a populated area will have different intensities at different localities, owing to the distance from the focus of the earthquake, type of focal mechanism, local geological conditions, structural design of buildings, and the earthquake magnitude.

The text of this publication gives the intensity at locations where an earthquake was reported felt and summaries of the strongest effects. Each earthquake is further characterized by its maximum intensity, which is given in the text and in table 1. The word "FELT" in the maximum intensity columns of table 1 indicates that only minimal or sketchy information was available. This does not imply that the earthquake was felt at a low intensity level, but indicates that the available data were not sufficient for assigning a intensity value.

Although the Modified Mercalli Intensity Scale is in many instances inadequate for present-day requirements, the scale has been the guide used by the USGS and will continue to be so until a new scale has been devised and has acceptance in the engineering and seismological communities.

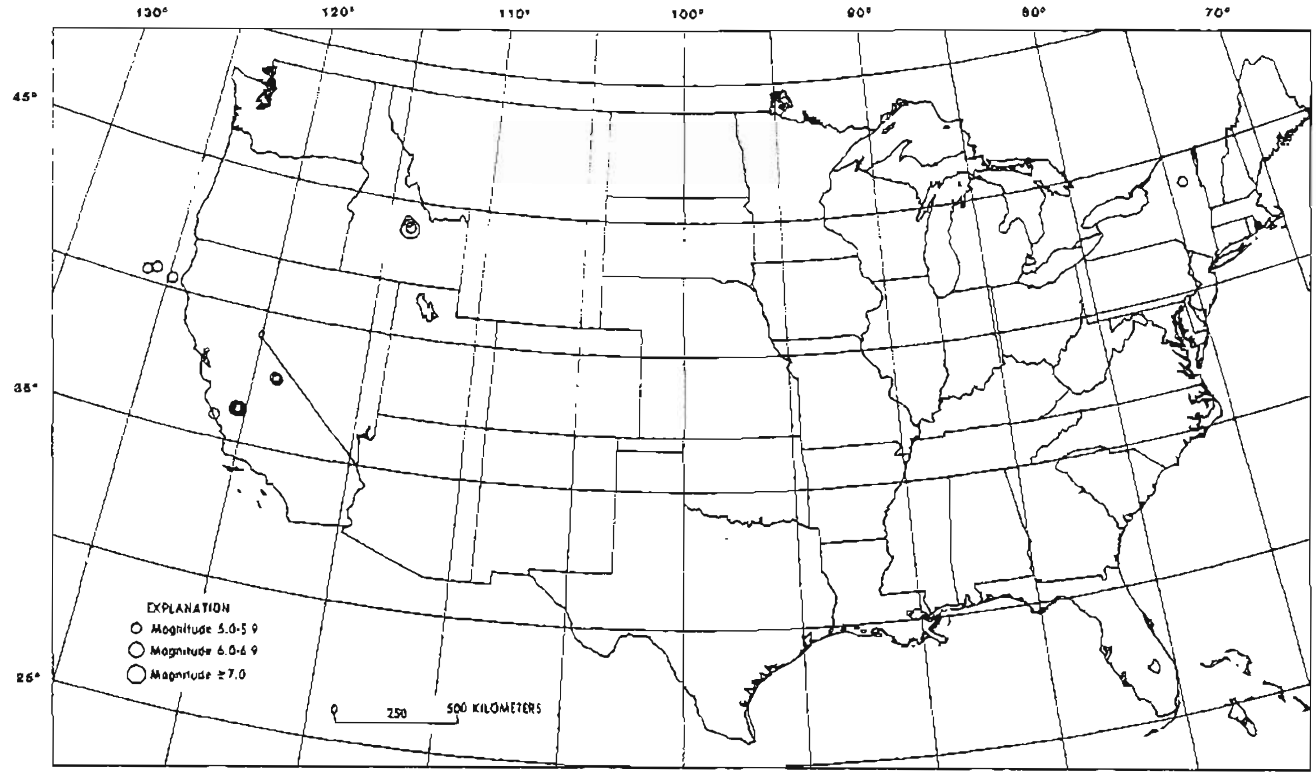

Figure 4. Epicenters in the conterminous United States for earthquakes with magnitudes 5.0 or greater in 1983.

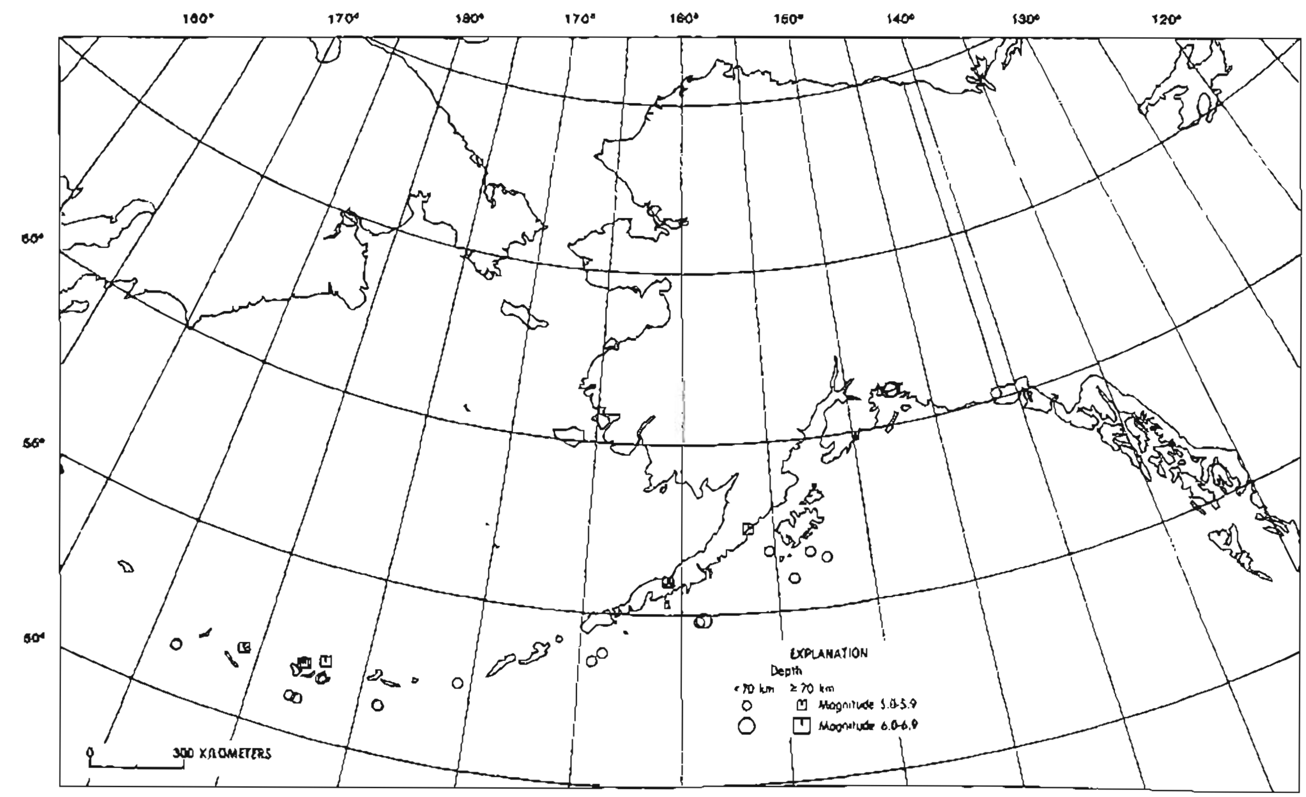

Figure 5. Epicenters in Alaska for earthquakes with magnitudes 5.0 or greater in 1983.

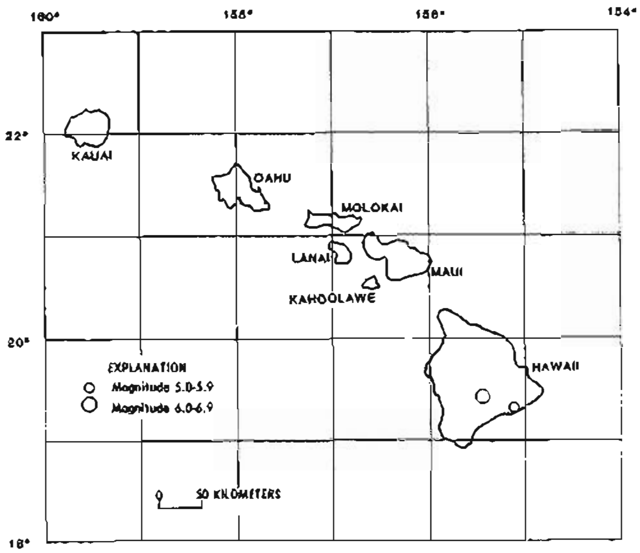

Figure 6. Epicenters in Hawaii for earthquakes with magnitudes 5.0 or greater in 1983.

MODIFIED MERCALLI INTENSITY SCALE OF 1931

Adapted from Sieberg's Mercalli-Cancani scale, modified and condensed.

I. Not felt—or, except rarely under especially favorable circumstances. Under certain conditions, at and outside the boundary of the area in which a great shock is felt: sometimes birds, animals, reported uneasy or disturbed; sometimes dizziness or nausea experienced; sometimes trees, structures, liquids, bodies of water, may sway—doors may swing, very, slowly.

II. Felt indoors by few, especially on upper floors, or by sensitive, or nervous persons. Also, as in grade I, but often more noticeably: sometimes hanging objects may swing, especially when delicately suspended; sometimes trees, structures, liquids, bodies of water, may sway, doors may swing, very slowly; sometimes birds, animals, reported uneasy or disturbed; sometimes dizziness or nausea experienced.

III. Felt indoors by several, motion usually rapid vibration. Sometimes not recognized to be an earthquake at first. Duration estimated in some cases. Vibration like that due to passing of light, or lightly loaded trucks, or heavy trucks some distance away. Hanging objects may swing slightly. Movements may be appreciable on upper levels of tall structures. Rocked standing motor cars slightly.

IV. Felt indoors by many, outdoors by few. Awakened few, especially light sleepers. Frightened no one, unless apprehensive from previous experience. Vibration like that due to passing of heavy or heavily loaded trucks. Sensation like heavy body striking building or falling of heavy objects inside. Rattling of dishes, windows, doors; glassware and crockery clink and clash. Creaking of walls, frame, especially in the upper range of this grade. Hanging objects swung, in numerous instances. Disturbed liquids in open vessels slightly. Rocked standing motor cars noticeably.

V. Felt indoors by practically all, outdoors by many or most: outdoors direction estimated. Awakened many, or most. Frightened few—slight excitement, a few ran outdoors. Buildings trembled throughout. Broke dishes, glassware, to some extent. Cracked windows—in some cases, but not generally. Overturned vases, small or unstable objects, in many instances, with occasional fall. Hanging objects, doors, swing generally or considerably. Knocked pictures against walls, or swung them out of place. Opened, or closed, doors, shutters, abruptly. Pendulum clocks stopped, started or ran fast, or slow. Moved small objects, furnishings, the latter to slight extent. Spilled liquids in small amounts from well-filled open containers. Trees, bushes, shaken slightly.

VI. Felt by all, indoors and outdoors. Frightened many, excitement general, some alarm, many ran outdoors. Awakened all. Persons made to move unsteadily. Trees, bushes, shaken slightly to moderately. Liquid set in strong motion. Small bells rang—church, chapel, school, etc. Damage slight in poorly built buildings. Fall of plaster in small amount. Cracked plaster somewhat, especially fine cracks in chimneys in some instances. Broke dishes, glassware, in considerable quantity, also some windows. Fall of knick-knacks, books, pictures. Overturned furniture in many instances. Moved furnishings of moderately heavy kind.

VII. Frightened all—general alarm, all ran outdoors. Some, or many, found it difficult to stand. Noticed by persons driving motor cars. Trees and bushes shaken moderately to strongly. Waves on ponds, lakes, and running water. Water turbid from mud stirred up. Incaving to some extent of sand or gravel stream banks. Rang large church bells, etc. Suspended objects made to quiver. Damage negligible in buildings of good design and construction, slight to moderate in well-built ordinary buildings, considerable in poorly built or badly designed buildings, adobe houses, old walls (especially where laid up without mortar), spires, etc. Cracked chimneys to considerable extent, walls to some extent. Fall of plaster in considerable to large amount, also some stucco. Broke numerous windows, furniture to some extent. Shook down loosened brickwork and tiles. Broke weak chimneys at the roof-line (sometimes damaging roofs). Fall of cornices from towers and high buildings. Dislodged bricks and stones. Overturned heavy furniture, with damage from breaking. Damage considerable to concrete irrigation ditches.

VIII. Fright general—alarm approaches panic. Disturbed persons driving motor cars. Trees shaken strongly--branches, trunks, broken off, especially palm trees. Ejected sand and mud in small amounts. Changes: temporary, permanent; in flow of springs and wells; dry wells renewed flow; in temperature of spring and well waters. Damage slight in structures (brick) built especially to withstand earthquakes. Considerable in ordinary substantial buildings, partial collapse: racked, tumbled down, wooden houses in some cases; threw out panel walls in frame structures, broke off decayed piling. Fall of walls. Cracked, broke, solid stone walls seriously. Wet ground to some extent, also ground on steep slopes. Twisting, fall, of chimneys, columns, monuments, also factory stacks, towers. Moved conspicuously, overturned, very heavy furniture.

IX. Panic general. Cracked ground conspicuously. Damage considerable in (masonry) structures built especially to withstand earthquakes: Threw out of plumb some wood-frame houses built especially to withstand earthquakes; great in substantial (masonry) buildings,

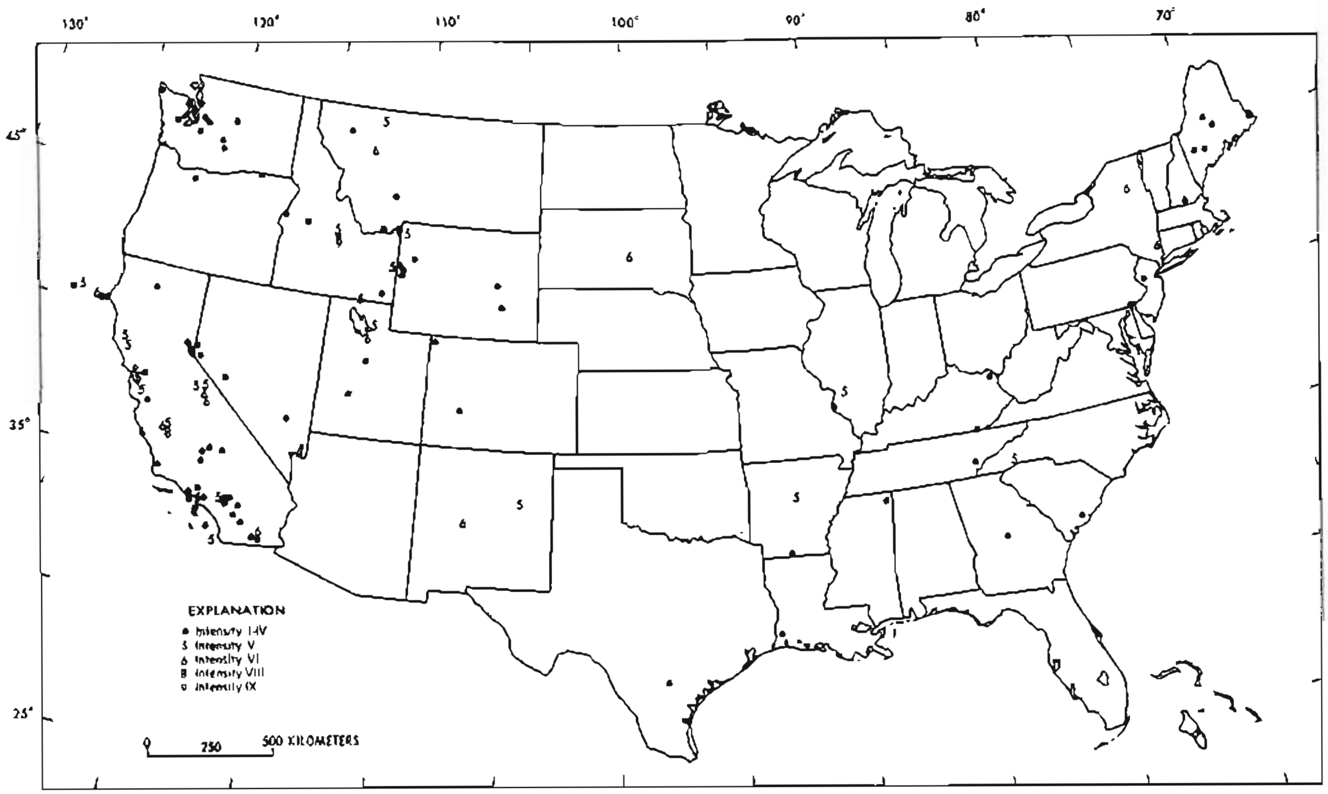

Figure 7. Earthquakes in the conterminous United States that were felt or caused damage in 1983. The intensities denote maximum observed intensity plotted at the epicenter.

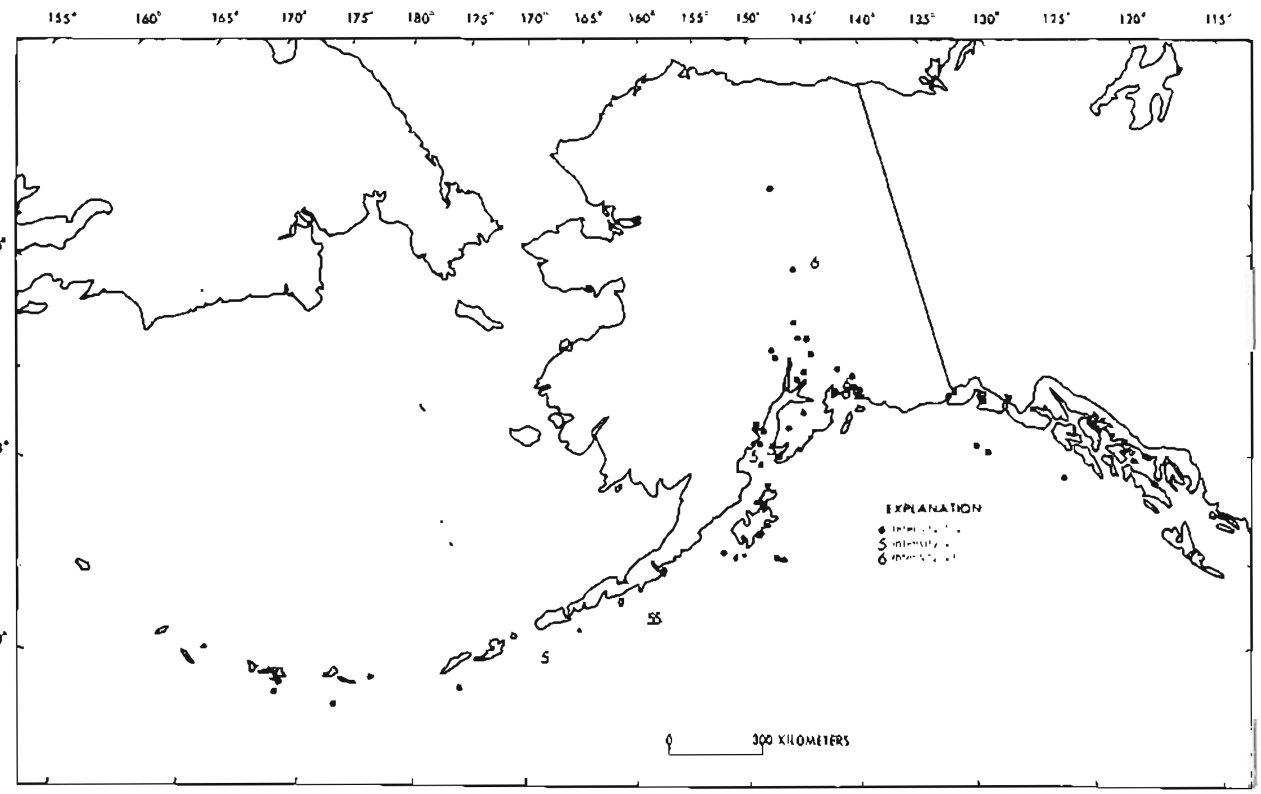

Figure 8. Earthquakes in Alaska that were felt or caused damage in 1983. The intensities denote maximum observed intensity plotted at the epicenter.

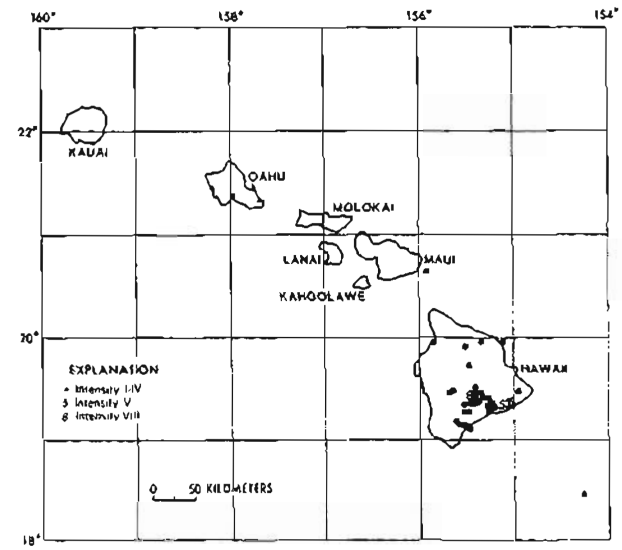

Figure 9. Earthquakes in Hawaii that were felt or caused damage in 1983. The intensities denote maximum observed intensity plotted at the epicenter.

some collapse in large part; or wholly shifted frame buildings off foundations, racked frames; serious to reservoirs; underground pipes sometimes broken.

X. Cracked ground, especially when loose and wet, up to widths of several inches; fissures up to a yard in width ran parallel to canal and stream banks. Landslides considerable from river banks and steep coasts. Shifted sand and mud horizontally on beaches and flat land. Changed level of water in wells. Threw water on banks of canals, lakes, rivers, etc. Damage serious to dams, dikes, embankments. Severe to well-built wooden structures and bridges, some destroyed. Developed dangerous cracks in excellent brick walls. Destroyed most masonry and frame structures, also their foundations. Bent railroad rails slightly. Tore apart, or crushed endwise, pipe lines buried in earth. Open cracks and broad wavy folds in cement pavements and asphalt road surfaces.

XI. Disturbances in ground many and widespread varying with ground material. Broad fissures, earth slumps, and land slips in soft, wet ground. Ejected water in large amounts charged with sand and mud. Caused sea-waves ("tidal" waves) of significant magnitude. Damage severe to wood-frame structures, especially near shock centers. Great to dams, dikes, embankments often for long distances. Few, if any (masonry) structures remained standing. Destroyed large well-built bridges by the wrecking of supporting piers, or pillars. Affected yielding wooden bridges less. Bent railroad rails greatly, and thrust them endwise. Put pipe lines buried in earth completely out of service.

XII. Damage total—practically all works of construction damaged greatly or destroyed. Disturbances in ground great and varied, numerous shearing cracks. Landslides, falls of rock of significant character, slumping of river banks, etc., numerous and extensive. Wrenched loose, tore off, large rock masses. Fault slips in firm rock, with notable horizontal and vertical offset displacements. Water channels, surface and underground, disturbed and modified greatly. Dammed lakes, produced waterfalls, deflected rivers, etc. Waves seen on ground surfaces (actually seen, probably, in some cases). Distorted lines of sight.

COLLABORATORS

Active cooperation in earthquake investigations in the United States is provided by several seismological collaborators. The following served as collaborators to the USGS during 1983.

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Canada—Staff of Pacific Geoscience Centre, Sidney, British Columbia.

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Florida and Georgia.—Leland T. Long, Georgia Institute of Technology, Atlanta.

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Wyoming.—R. A. Hutchinson, National Park Service, Yellowstone National Park.

Earthquake Descriptions

This section lists alphabetically all 1983 earthquakes in the 50 states that were reported felt. The origin time of each earthquake is given in Universal Coordinated Time (UTC). Time is expressed continuously from midnight to midnight, or 0 to 24 hours.

Sources of noninstrumental information (macroseismic data) in this publication include questionnaire canvasses conducted by the USGS; newspaper articles; bulletins of the Seismological Society of America; and special earthquake reports of other organizations. Instrumental data are provided by the USGS, National Earthquake Information Center, other government agencies, and universities that operate seismic networks.

Roman numerals in the earthquake descriptions refer to the Modified Mercalli Intensity Scale of 1931 (see pg. 5), which gives about equal weight to the disturbance of inanimate objects and to reactions of people. When more than one degree of intensity is reported from a town, the town is assigned the highest intensity reported. All earthquake questionnaires or press reports that contain only minimal information, without enough detail from which to assign an intensity, are listed as "FELT."

(The following codes are used to indicate the source of hypocenters and/or magnitudes: (BK) University of California, Berkeley; (BU) Montana Bureau of Mines and Geology, Butte; (EM) Department of Energy; (GM) U.S. Geological Survey, Menlo Park, Calif.; (GS) U.S. Geological Survey, Golden, Colorado; (GT) Georgia Institute of Technology, Atlanta; (HV) Hawaiian Volcano Observatory, U.S. Geological Survey, Hawaii National Park; (KY) University of Kentucky, Lexington; (LA) Los Alamos National Laboratory, New Mexico; (LD) Lamont-Doherty Geological Observatory, Palisades, N.Y.; (MT) University of Montana, Missoula; (PM) Alaska Tsunami Warning Center, NOAA, Palmer; (PS) California Institute of Technology, Pasadena; (SC) University of South Carolina, Columbia; (SL) St. Louis University, St. Louis, Mo.; (TC) Tennessee Earthquake Information Center, Memphis; (TU) Oklahoma Geological Survey, Leonard; (UU) University of Utah, Salt Lake City; (VP) Virginia Polytechnic Institute and State University, Blacksburg; (WA) University of Washington, Seattle; (WO) Weston Observatory, Weston, Mass. Normal depth = 33 km. Leaders (...) indicate information is not available.)

ALASKA

1 January (GM) Southern Alaska
Origin time: 11 18 07.7
Epicenter: 61.295N., 146.975W.
Depth: 38 km
Magnitude: 5.3mb(GS), 4.7ML(PM), 4.0MD(GM)
Intensity IV: Valdez (M).
Intensity III: Anchorage, Cordova, Glennallen, and Palmer (PM).

ALASKA-Continued

10 January (GS) Southern Alaska
Origin time: 12 19 58.0
Epicenter: 63.065, 150.950W.
Depth: 134 km
Magnitude: 4.0mb(GS)
Felt: Tolsona (PM).

14 February (LD) Alaska Peninsula area
Origin time: 03 20 03.7
Epicenter: 54.809N., 159.108W.
Depth: 16 km
Magnitude: 5.9mb(GS), 5.6ML(LD), 6.3MS(GS), 6.5MS(BK)
Intensity V:
Chignik— A few windows cracked; a few small objects fell; a few items were thrown from store shelves; trees and bushes shook moderately; felt by and frightened many.
Sand Point— A few small objects fell and a few items were thrown from store shelves; trees and bushes shook moderately; felt by many.
Intensity IV: Chignik Lagoon, Chignik Lake, Cold Bay, False Pass, Ivanof Bay, Port Heiden.
Intensity III: King Cove, Perryville.

14 February (LD) Alaska Peninsula area
Origin time: 08 10 02.7
Epicenter: 54.862N., 158.875W.
Depth: 14 km
Magnitude: 6.0mb(GS), 5.6MS(GS), 5.8MS(PS), 6.0ML(LD)
Intensity V: Chignik— A few items were thrown from store shelves; trees and bushes shook moderately; felt by all and frightened many.
Intensity IV: Chignik Lagoon, Cold Bay, False Pass, Port Heiden.
Intensity III: King Cove, Perryville.
Felt: Sand Point.

23 February (GM) Southern Alaska
Origin time: 07 27 57.6
Epicenter: 60.177N., 153.195W.
Depth: 119 km
Magnitude: 4.5mb(GS), 4.0MD(GM)
Intensity II: Palmer (PM).

10 March (GM) Central Alaska
Origin time: 14 03 38.6
Epicenter: 62.815N., 149.553W.
Depth: 45 km
Magnitude: 4.6mb(GS), 3.5MD(GM)
Intensity III: Ester and Fairbanks (PM).

ALASKA-Continued

15 March (GM) Southern Alaska
Origin time: 23 53 22.3
Epicenter: 59.507N., 153.197W.
Depth: 111 km
Magnitude: 4.7mb(GS), 4.4MD(GM)
Intensity V: Ninilchik— A few dishes broken; a few small objects overturned or fell; trees and bushes shook slightly; felt by many.
Intensity IV: Homer (PM).
Intensity III: Anchor Point, Clam Gulch, Kenai (M), Moose Pass.
Intensity II: Anchorage (PM), Cooper Landing.

17 March (GM) Southeastern Alaska
Origin time: 05 34 42.8
Epicenter: 58.515N., 140.637W.
Depth: 24 km
Magnitude: 4.3mb(GS), 4.2ML(PM)
Intensity IV: Yakutat— There were many reports of loud noise.

3 April (GS) Andreanof Islands, Aleutian Islands
Origin time: 19 26 24.2
Epicenter: 51.762N., 176.926W.
Depth: 60 km
Magnitude: 5.2mb(GS)
Intensity V: Adak (PM).

6 April (GS) Queen Charlotte Islands region, Canada
Origin time: 09 22 14.0
Epicenter 54.268 N., 133,823 W.
Depth 10 km
Magnitude 5.1mb(GS), 5.1MS(GS)
Intensity IV: Ketchikan (press report).
Felt: Craig, Petersburg, and Wrangell (PM).

7 April (GS) Southern Alaska
Origin time: 21 55 44.1
Epicenter: 62.313N., 148.915W.
Depth: 68 km
Magnitude: 3.0ML(PM)
Intensity III: Palmer (PM).

8 April (GS) Southern Alaska
Origin time: 14 23 58.3
Epicenter: 61.934N., 149.333W.
Depth: Normal
Magnitude: 2.3ML(PM)
Felt: Hatcher Pass (PM).

9 April (GS) Southern Alaska
Origin time: 02 10 25.9
Epicenter: 61.194N., 150.197W.
Depth: 58 km
Magnitude: 3.9ML(PM)
Felt: Anchorage and Palmer (PM).

10 April (GS) Southern Alaska
Origin time: 19 22 41.3
Epicenter: 61.479N., 149.973W.
Depth: 52 km
Magnitude: 3.5mb(GS), 3.8ML(PM)
Felt: Anchorage, Girdwood, and Palmer (PM).

15 April (GS) Central Alaska
Origin time: 18 30 43.0
Epicenter: 64.853N., 147.531W.
Depth: 10 km
Magnitude: 4.3mb(GS), 4.8ML(PM)
Intensity VI: Fairbanks— The University of Alaska reported minor damage. Other damage included cracked plaster, and disconnected pipes to the Department of Natural Resources Building.
Intensity V:
Fort Wainwright— Hairline cracks appeared in plaster; a few merchandise items were thrown from store shelves; a few glassware or dishes broke; a few small objects overturned or fell; felt by many.
North Pole— A few small objects overturned or fell; felt by many.
Intensity IV: Ester, Nenana.
Intensity III: Eilson Air Force Base.

19 April (GS) Southern Alaska
Origin time: 04 43 34.6
Epicenter: 61.194N., 147.025W.
Depth: 70 km
Magnitude: 4.0mb(GS)
Intensity III: Valdez (PM).
Intensity II: Palmer (PM).
Intensity I: Anchorage (PM).

19 April (GM) Southern Alaska
Origin time: 19 12 50.0
Epicenter: 63.270N., 149.707W.
Depth: 122 km
Magnitude: 5.1mb(GS), 4.7MD(GM)
Intensity IV: Big Lake (PM), Cantwell, Chickaloon (PM), Denali National Park (PM), Healy, McKinley Park, Palmer (PM), Skwentna, Usibelli, Wasilla (PM).
Intensity III: Anchorage, Copper Center, Spenard, Sutton, Whittier, Willow.

21 April (GS) Southern Alaska
Origin time: 07 13 27.4
Epicenter: 61.262N., 150.449W.
Depth: Normal
Magnitude: 2.9ML(PM)
Felt: Anchorage (PM).

21 April (GM) Southeastern Alaska
Origin time: 12 56 48.8
Epicenter: 58.242N., 140.100W.
Depth: 0 km
Magnitude: 4.6mb(GS), 4.3ML(PM), 3.4MD(GM)
Intensity IV: Yakutat (PM).

22 April (GS) Southern Alaska
Origin time: 03 55 16.9
Epicenter: 61.491N., 150.007W.
Depth: 72 km
Magnitude: 3.9ML(PM)
Felt: at Anchorage, Palmer, and Wasilla (PM).

24 April (GS) Southern Alaska
Origin time: 06 25 11.8
Epicenter: 61.757N., 147.095W.
Depth: 66 km

Magnitude: 3.6ML(PM)
Felt: Sheep Mountain Lodge (PM).

24 April (GS) Southern Alaska
Origin time: 10 07 35.3
Epicenter: 61.320N., 151.947W.
Depth: 109 km
Magnitude: 4.2mb(GS)
Felt: Anchorage (PM).

26 April (GS) Central Alaska
Origin time: 23 10 55.2
Epicenter: 64.811N., 149.083W.
Depth: 10 km
Magnitude: 3.3ML(PM)
Intensity IV: Minto.
Intensity III: Fairbanks.

5 May (GS) Southern Alaska
Origin time: 06 09 03.8
Epicenter: 61.604N., 146.495W.
Depth: 62 km
Magnitude: 3.3ML(PM)
Felt: Valdez (PM).

6 May (GS) Western Alaska
Origin time: 06 38 10.1
Epicenter: 66.608N., 163.891W.
Depth: Normal
Magnitude: 4.3mb(GS), 4.5ML(PM)
Intensity IV: Kotzebue.

7 May (GS) Southeastern Alaska
Origin time: 09 01 47.7
Epicenter: 56.718N., 136.615W.
Depth: Normal
Magnitude: 4.0mb(GS)
Intensity IV: Shelikof (PM).
Intensity II: Sitka (PM).

9 May (GS) Southern Alaska
Origin time: 14 56 27.4
Epicenter: 61.023N., 146.364W.
Depth: 7 km
Magnitude: 3.4ML(PM)
Intensity III: Valdez (PM).

11 May (GS) Southern Alaska
Origin time: 19 24 38.7
Epicenter: 62.600N., 151.328W.
Depth: Normal
Magnitude: 3.1ML(PM)
Intensity II: Anchorage (PM).

15 May (GS) Southern Alaska
Origin time: 05 51 20.8
Epicenter: 61.653N., 149.929W.
Depth: 54 km
Magnitude: 3.6ML(PM)
Intensity II: Palmer (PM).

25 May (GS) Near Islands, Aleutian Islands
Origin time: 10 39 55.2
Epicenter: 52.459N., 174.104E.
Depth: 66 km
Magnitude: 4.7mb(GS)
Intensity V: Shemya Air Force Base— A few small objects overturned or fell; hanging pictures swung out of place; felt by many.

9 June (GS) Andreanof Islands, Aleutian Islands
Origin time: 18 46 00.9
Epicenter: 51.414N., 174.111W.
Depth: 21 km
Magnitude: 6.2mb(GS), 5.8MS(GS), 5.8MS(BK)
Intensity III: Adak (PM).

9 June (GM) Southern Alaska
Origin time: 22 15 43.4
Epicenter: 59.260N., 152.843W.
Depth: 83 km
Magnitude: 4.7mb(GS), 3.9MD(GM)
Intensity III: Homer (PM).
Intensity II: Anchorage (PM).

12 June Southern Alaska
Origin time: 16 12
Epicenter: Not located
Depth: None computed
Magnitude None computed
Intensity IV: Homer.

27 June (GM) Southern Alaska
Origin time: 08 12 24.2
Epicenter: 60.225N., 150.937W.
Depth: 65 km
Magnitude: 4.3mb(GS), 3.6MD(GM)
Intensity IV: Homer.

28 June (GM) Southeastern Alaska
Origin time: 03 25 17.6
Epicenter: 60.182N., 141.253W.
Depth: 12 km
Magnitude: 6.0mb(GS), 5.4MS(GS), 5.9ML(PM), 4.3MD(GM)
Intensity IV: Yakutat.
Felt: Cape Yakataga (PM).

30 June (GS) Near Islands, Aleutian Islands
Origin time: 11 51 56.9
Epicenter: 52.559N., 173.245E.
Depth: Normal
Magnitude: 4.9mb(GS), 4.3ML(PM)
Intensity III: Shemya Air Force Base.

12 July (GM) Prince William Sound
Origin time: 15 10 03.7
Epicenter: 61.035N., 147.185W.
Depth: 30 km
Magnitude: 6.1mb(GS), 6.4MS(GS), 6.4ML(PM), 6.3MS(BK), 6.2MS(PS), 6.6mb(PS)

This earthquake has an epicenter near the location of the March 27, 1964 event, a great earthquake with magnitude 8.3 (MS). The July 1983 shock was felt from Yakutat on the south to Fairbanks to the north and eastward to Whitehorse in Yukon Territory, Canada (an area of approximately 675,000 km^2, see fig 10).

The Valdez airport terminal building had damage estimated at $1,000,000. The press reported that this earth-

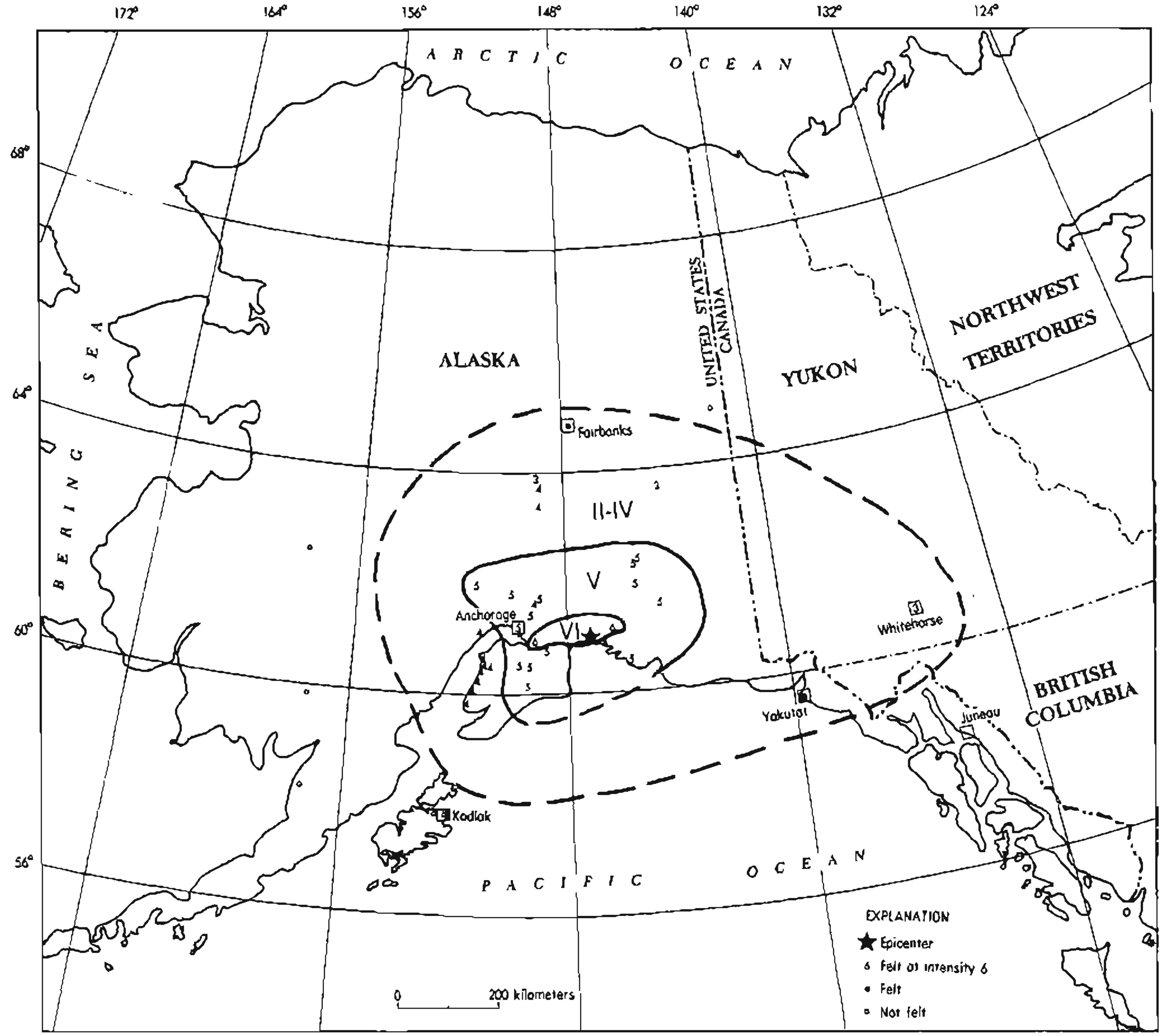

Figure 10. Isoseismal map for the Prince William Sound, Alaska, earthquake of 12 July 1983, 15 10 03.7 UTC. Roman numerals represent Modified Mercalli intensities between isoseismals; arabic numerals represent intensities at specific sites.

quake was the probable cause of a break in the Bering Glacier ice dam holding back Berg Lake, about 60 miles east of Cordova. Following the earthquake the level of water in the lake dropped about 210 ft. and the countryside was flooded.

Intensity VI:
United States—Alaska—
Girdwood— Many dishes or glassware broke, many small objects overturned or fell; a few items fell off store shelves; trees and bushes shook moderately; the vibration was described as strong; felt by all and awakened many.
Valdez— The exterior concrete-block walls of the airport terminal building cracked from roof to ground; inside walls also cracked. Many dishes or glassware broke in both businesses and homes. Both grocery stores and liquor stores had merchandise thrown off shelves. In homes pictures were knocked off walls, and furniture overturned. Ceiling tiles fell in the elementary and high school buildings. Sidewalks and streets cracked; both standing and moving vehicles rocked moderately and it was felt by and awakened many.
Intensity V: The most common effects at the places listed below were a few merchandise items thrown off store shelves, a few small objects overturned or fell, trees and bushes shook slightly to moderately, standing vehicles shook slightly. The vibration was described as strong, and felt by many or all. Additional effects are listed after each locality.
United States—Alaska—
Anchorage— Buildings shook strongly.
Chitina.
Chugiak— Hanging pictures fell.
Copper Center— People had difficulty in standing or walking; hairline cracks appeared in interior walls.
Cooper Landing— People had difficulty in standing or walking; water splashed onto sides of ponds.
Cordova— Moving vehicles rocked moderately.
Elmendorf Air Force Base— Moving vehicles rocked slightly.
Fort Richardson— Hairline cracks appeared in interior walls.
Gakona— A few windows cracked.
Glennallen.
Moose Pass— Hairline cracks appeared in interior walls; bricks fell from chimneys.
Seward— A video machine fell off a television; bells hung from the ceiling rang.
Skwentna.
Sutton— A few cracked windows.
Tatitlek—(press report).
Whittier— Hairline cracks in appeared in interior walls.
Willow.
Intensity IV:
United States—Alaska—
Anchor Point, Anchorage International Airport, Cantwell, Clam Gulch, Glacier Park Resort (base of Matanuska Glacier), Kasilof, Kenai, McKinley Park, Ninilchik, Palmer (PM), Soldotna, Sterling (ground cracks on dry and level ground), Tyonek.
Intensity III:
Canada—Yukon Territory—
Whitehorse (PM).
United States—Alaska—
Dot Lake, Healy.

Felt:
United States—Alaska—
Eagle River (press report), Fairbanks and Yakutat (PM).

12 July (GS) Prince William Sound
Origin time: 15 33 03.2
Epicenter: 60.942N., 147.299W.
Depth: Normal
Magnitude: 3.8ML(PM)
Intensity III: Valdez (PM).
Intensity II: Anchorage (PM).

12 July (GS) Southern Alaska
Origin time: 17 31 24.1
Epicenter: 59.924N., 152.855W.
Depth: 107 km
Magnitude: 4.2mb(GS)
Intensity II: Anchorage (PM).

15 July (GS) Andreanof Islands, Aleutian Islands
Origin time: 03 55 54.0
Epicenter: 52.290N., 176.889W.
Depth: 130 km
Magnitude: 5.0mb(GS)
Felt: Adak Island (PM).

15 July (GM) Southeastern Alaska
Origin time: 07 49 00.1
Epicenter: 60.240N., 140.883W.
Depth: 14 km
Magnitude: 5.1mb(GS), 4.1MS(GS), 4.6ML(PM), 3.7MD(GM)
Intensity III: Yakutat.

15 July (GS) Southeastern Alaska
Origin time: 11 42 57.2
Epicenter: 60.056N., 141.001W.
Depth: 12 km
Magnitude: 3.6ML(PM)
Felt: Yakutat.

21 July (GM) Kodiak Island region
Origin time: 17 35 16.6
Epicenter: 58.077N., 152.940 W.
Depth: 99 km
Magnitude: 4.9mb(GS), 4.6ML(PM), 4.3MD(GM)
Intensity III: Kodiak.
Felt: Afognak Island (PM).

4 August (GS) Southern Alaska
Origin time: 04 07 18.9
Epicenter: 60.870N., 147.349W.
Depth: Normal
Magnitude: 4.4mb(GS), 3.6MS(GS), 4.0ML(PM)
Felt: Palmer and Valdez (PM).

5 August (GS) Northern Alaska
Origin time: 03 10 43.4
Epicenter: 67.107N., 155.478W.
Depth: Normal
Magnitude: 3.2ML(PM)
Felt: Indian Mountain (PM).

5 August (GM) Southern Alaska
Origin time: 21 23 38.7

Epicenter: 61.728N., 147.468W.
Depth: 35 km
Magnitude: 4.2mb(GS), 4.5ML(PM), 3.7MD(GM)
Intensity IV: Copper Center, Sutton.
Felt: Anchorage, Palmer, and Talkeetna (PM).

6 August (GM) Southern Alaska
Origin time: 16 34 00.5
Epicenter: 60.400N., 152.892W.
Depth: 129 km
Magnitude: 5.4mb(GS), 4.7MD(GM)
Intensity IV: Clam Gulch, Homer, Kasilof (one foundation reported cracked), Soldotna.
Intensity III: Anchorage, Cooper Landing, Kenai, Ninilchik, Seldovia (PM), Skwentna, Tyonek.

19 August (GM) Southern Alaska
Origin time: 04 59 32.7
Epicenter: 60.138N., 152.807W.
Depth: 98 km
Magnitude: 4.7mb(GS), 4.2MD(GM)
Intensity III: Anchorage, Homer, and Kenai (PM).
Intensity II: Palmer (PM).

19 August (GS) Southern Alaska
Origin time: 08 07 21.4
Epicenter: 60.641N., 149.955W.
Depth: 25 km
Magnitude: 3.5ML(PM)
Intensity II: Palmer (PM).

19 August (GS) Southern Alaska
Origin time: 19 05 20.6
Epicenter: 62.789N., 148.997W.
Depth: 92 km
Magnitude: 4.4mb(GS)
Intensity II: Palmer (PM).

22 August (GS) Cook Inlet area
Origin time: 10 53 55.2
Epicenter: 60.084N., 152.585W.
Depth: 116 km
Magnitude: None computed
Felt: Homer (PM).

25 August (GS) Southern Alaska
Origin time: 11 59 22.6
Epicenter: 61.655N., 149.723W.
Depth: 42 km
Magnitude: 2.8ML(PM)
Felt: Palmer (PM).

7 September (GM) Prince William Sound
Origin time: 19 22 05.0
Epicenter: 60.978N., 147.320W.
Depth: 30 km
Magnitude: 6.2mb(GS), 6.2MS(GS), 6.2MS(BK), 6.3mb(BK), 6.4mb(PS)

This event is located in the same epicentral area as the March 27, 1964, magnitude 8.3(MS), earthquake.

Intensity VI:
Gakona— Many merchandise items were thrown from store shelves; a few dishes or glassware broke; many small objects overturned or fell; moving vehicles rocked slightly; uncased water wells collapsed; flow was disturbed in water wells; there were small landslides and slumping of road fill.
Valdez— Chimneys and foundations cracked; hairline cracks appeared in interior walls; moving vehicles rocked slightly; a few items were thrown from store shelves; light furniture or small appliances overturned; a few windows cracked; hanging pictures fell; a few dishes or glassware broke; a few small objects overturned or fell; felt by all.
Intensity V: The most common effects at the places listed below were a few small objects overturned or fell, a few items thrown off store shelves, trees and bushes shook slightly to moderately, standing vehicles shook slightly, shaking described as moderate to strong, felt by many or all.
Anchorage— Hanging pictures swung out of place; hairline cracks appeared in drywall partitions along the stairwells of the Resolution Tower building at Fourth Avenue and L Street and the Federal Building at 701 C Street; some ceiling tiles and modular bookcases fell in the Federal Building; a few hairline cracks appeared in the tunnel between the Federal Building and an annex.
Chitina— Buildings shook strongly.
Chugiak.
Cooper Landing— People had difficulty walking; hairline cracks appeared in interior walls; well water muddied.
Copper Center.
Homer— The shaking was strongest on Homer Spit.
Hope— Standing vehicles rocked moderately.
Moose Pass.
Palmer.
Soldotna— A few dishes or glassware broke.
Sterling.
Sutton— Hairline cracks appeared in plaster walls; moving vehicles rocked slightly.
Wasilla— Hanging pictures swung out of place; moving vehicles rocked slightly.
Willow.
Intensity IV: Clam Gulch, Cordova (PM), Glennallen, Gulkana, Kenai, Ninilchik, Seward (PM), Sleetmute, Tyonek, Whittier.
Intensity III: Anchor Point, Dot Lake, Fairbanks (PM).

7 September (GM) Prince William Sound
Origin time: 22 22 10.6
Epicenter: 61.010N., 147.307W.
Depth: 27 km
Magnitude: 5.0mb(GS), 4.6ML(PM), 4.0MD(GM)
Felt: Anchorage, Palmer, Valdez, and Wasilla (PM).

12 September (GS) Prince William Sound.
Origin time: 14 28 19.8
Epicenter: 60.896N., 147.300W.
Depth: Normal
Magnitude: 3.5ML(PM)
Felt: Anchorage, Palmer, and Valdez (PM).

14 September (GM) Prince William Sound
Origin time: 02 35 10.8
Epicenter: 60.960N., 147.267W.
Depth: 30 km

Magnitude: 4.9mb(GS), 4.6ML(PM), 3.7MD(GM)
Felt: Anchorage, Palmer, and Valdez (PM).

14 September (GS) Cook Inlet area
Origin time: 11 25 02.7
Epicenter: 59.969N., 152.868W.
Depth: 185 km
Magnitude: 4.0mb(GS)
Felt: Anchorage and Homer (PM).

15 September (GS) Southern Alaska
Origin time: 22 52 57.2
Epicenter: 60.572N., 149.821W.
Depth: 63 km
Magnitude: 3.5ML(PM)
Felt: Anchorage and Whittier (PM).

21 September (GM) Southern Alaska
Origin time: 22 50 48.2
Epicenter: 60.252N., 152.468W.
Depth: 103 km
Magnitude: 4.8mb(GS), 4.1MD(GM)
Intensity IV: Cooper Landing, Homer, Seward, Skwentna.
Intensity III: Chugiak, Sterling, Sutton, Willow.
Felt: Anchorage, Clam Gulch, and Kenai (PM).

6 October (GM) Southern Alaska
Origin time: 11 10 12.8
Epicenter: 62.355N., 151.193W.
Depth: 97 km
Magnitude: 5.4mb(GS), 4.7MD(GM)
Intensity IV: Anchorage, Chugiak, Eagle River, Talkeetna (press report) Tyonek, Willow.
Intensity III: Fairbanks International Airport.

12 October (GS) Southern Alaska
Origin time: 21 00 54.0
Epicenter: 61.029N., 147.879W.
Depth: 38 km
Magnitude: 3.7mb(GS), 4.3ML(PM)
Intensity III: Anchorage and Chugiak (PM).
Intensity II: Palmer (PM).

13 October (GM) Cook Inlet area
Origin time: 04 30 17.4
Epicenter: 59.630N., 152.077W.
Depth: 63 km
Magnitude: 4.6mb(GS), 3.7MD(GM)
Intensity V: Homer— Small objects overturned or fell; buildings shook strongly; an observer was almost shaken off his feet; felt by many.
Felt: Seldovia.

14 October (GM) Southern Alaska
Origin time: 17 26 38.9
Epicenter: 61.850., 149.525W.
Depth: 38 km
Magnitude: 4.8mb(GS), 4.3ML(PM), 3.4MD(GM)
Intensity III: Willow.
Intensity II: Anchorage (PM), Elmendorf Air Force Base, Palmer, and Talkeetna (PM).

18 October (GS) Prince William Sound area
Origin time: 12 25 47.3
Epicenter: 61.425N., 146.645W.
Depth: 51 km
Magnitude: 4.2mb(GS), 4.4ML(PM)
Intensity II: Anchorage and Valdez (PM).

24 October (GS) Fox Islands, Aleutian Islands
Origin time: 13 54 08.8
Epicenter: 52.510N., 168.441W.
Depth: Normal
Magnitude: 4.5ML(PM)
Intensity III: Nikolski (PM).

31 October (GS) Southern Alaska
Origin time: 01 20 11.9
Epicenter: 62.118 N., 150.701 W.
Depth: 94 km
Magnitude: None computed.
Felt: Anchorage and Valdez (PM).

3 November (GS) Northern Alaska
Origin time: 13 07 30.6
Epicenter: 67.302N., 149.714W.
Depth: Normal
Magnitude: 3.2ML(PM)
Intensity III: Wiseman.

4 November (GS) Seward Peninsula
Origin time: 05 41 20.5
Epicenter: 65.739N., 167.785W.
Depth: Normal
Magnitude: 3.7ML(PM)
Intensity III: Tin City Air Force Base (telegram).

4 November (GS) Seward Peninsula
Origin time: 07 55 15.7
Epicenter: 65.725N., 167.941W.
Depth: Normal
Magnitude: 4.2ML(PM)
Intensity IV: Tin City Air Force Base (telegram).

12 November (GS) Central Alaska
Origin time: 07 40 37.5
Epicenter: 64.536N., 147.206W.
Depth: 5 km
Magnitude: 3.7ML(PM)
Felt: Fairbanks, North Pole, and Salcha (PM).

14 November (GS) Central Alaska
Origin time: 18 42 34.7
Epicenter: 64.783N., 147.322W.
Depth: Normal
Magnitude: 2.7ML(PM)
Felt: College Observatory (PM).

17 November (GS) Andreanof Islands, Aleutian Islands
Origin time: 09 36 29.5
Epicenter: 51.649N., 176.805W.
Depth: 59 km
Magnitude: 4.6mb(GS)
Intensity III: Adak (PM).

24 November (GS) Kodiak Island Region
Origin time: 06 50 33.5
Epicenter: 56.386N., 152.189W.
Depth: Normal
Magnitude: 5.0mb(GS), 4.7ML(PM)

Intensity III: Old Harbor and Akhiok (PM).
Intensity II: Karluk (PM).

24 November (GS) Kodiak Island Region
Origin time: 06 56 48.4
Epicenter: 56.429N., 152.498W.
Depth: Normal
Magnitude: 5.1mb(GS), 4.7ML(PM)
Intensity III: Old Harbor and Akhiok (PM).
Intensity II: Karluk (PM).

26 November (GS) Southern Alaska
Origin time: 06 40 41.0
Epicenter: 60.825N., 149.461W.
Depth: Normal
Magnitude: 3.1ML(PM)
Felt: Anchorage (PM).

26 November (GS) Alaska Peninsula
Origin time: 15 51 49.7
Epicenter: 56.768N., 155.344W.
Depth: Normal
Magnitude: 5.3mb(GS), 4.6MS(GS), 5.1ML(PM)
Intensity IV: Larsen Bay.

6 December (GS) Andreanof Islands, Aleutian Islands
Origin time: 20 28 57.4
Epicenter: 51.361N., 176.788W.
Depth: Normal
Magnitude: 3.9mb(GS), 4.9ML(PM)
Intensity III: Adak (PM).

26 December (GS) Near Islands, Aleutian Islands
Origin time: 11 07 39.7
Epicenter: 52.652N., 174.467E.
Depth: 82 km
Magnitude: 4.9mb(GS)
Felt: Shemya Island (PM).

26 December (LD) Alaska Peninsula
Origin time: 19 39 24.4
Epicenter: 55.939N., 160.701W.
Depth: 159 km
Magnitude: 5.0mb(GS)
Felt: Sand Point (PM).

27 December (LD) Unimak Island Region
Origin time: 23 05 52.9
Epicenter: 53.586N., 164.376W.
Depth: 40 km
Magnitude: 5.6mb(GS), 5.3MS(GS), 6.1mb(PS), 5.4MS(PS), 6.0mb(BRK), 5.8ML(LD)
Intensity V: False Pass (PM), King Cove (a few small objects fell, people had difficulty in standing or walking, standing vehicles rocked moderately).
Intensity IV: Akutan, Chignik (PM), Cold Bay, Sand Point (PM).
Intensity III: Chignik Lagoon, Unalaska.

28 December (GS) Andreanof Islands, Aluetian Islands
Origin time: 00 16 34.8
Epicenter: 52.077N., 177.801W.
Depth: 111 km
Magnitude: 5.1mb(GS)
Intensity IV: Adak Island (PM).

29 December (GS) Kenai Peninsula
Origin time: 20 14 54.2
Epicenter: 59.532N., 151.670W.
Depth: Normal
Magnitude: 3.8ML(PM)
Intensity III: Homer.

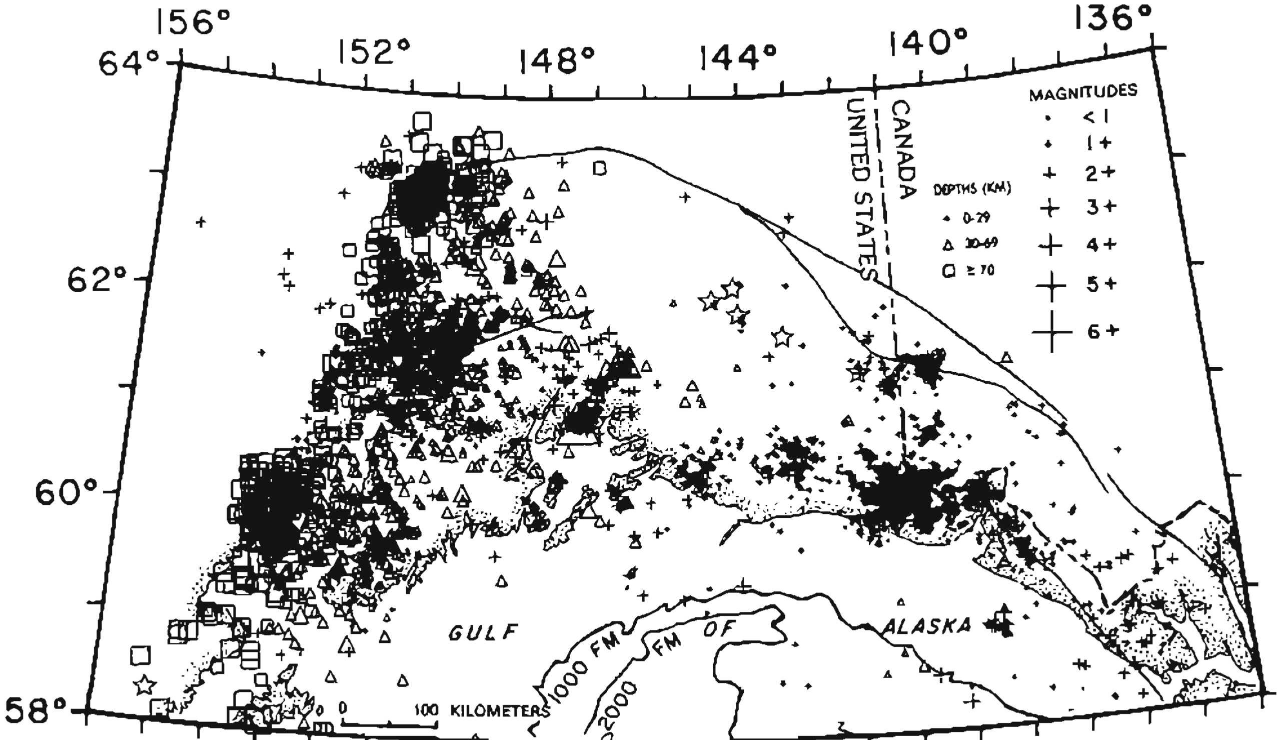

Figure 48. Hypocenters of 4642 earthquakes located by the USGS regional seismograph network in southern Alaska for 1983. The magnitude threshold for completeness varies across the network. West of longitude 145°W. all shallow (0–40 km depth) events of coda-duration magnitude 2.0 and larger are routinely located, but the threshold for completeness increases with depth and is about magnitude 3.0 at 150 km depth. Concentrations of shallow events beneath the southern Kenai Peninsula, near Anchorage, and along the volcanic arc west of Cook Inlet are a result of emphasis placed on locating events smaller than magnitude 2.0 in these areas. East of Prince William Sound the relative rate of activity is much lower and earthquakes as small as magnitude 1.0 are routinely located. The phase data used to locate the earthquakes includes P- and S-times from stations operated by the Alaska Tsunami Warning Center, the University of Alaska, and the Department of Energy, Mines and Resources, Canada. Stars indicate volcanoes.

NETWORK OPERATIONS

Alaska Earthquakes, 1983

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During 1983, the Geophysical Institute located over 3,000 Alaska earthquakes which occurred within the areas covered by the existing seismographic networks. Of these, 389 were of magnitude (ML) 3.0 or greater (fig. 40), and 91 were of magnitude 3.5 or greater (fig. 41).

Seismological investigations during 1983 depended on a network configuration comprising two subsets of stations. The northernmost of these consisted of 18 stations ranging from Barrow (BRV) in the north to Anvil Mountain (AVN) at Nome in the west. However, most installations lay within a radius of 400 km from Fairbanks (FB2), where the signals were recorded.

The other subset was made up of 21 stations which were operated around Cook Inlet in south-central Alaska (fig. 42). Stations for this group included remote installations on Kodiak Island and the Alaska Peninsula. Signals were telemetered to Homer (HOM) on the Kenai Peninsula, where recording was done.

This configuration of stations does not permit the accurate location of earthquakes in the highly active areas of the Aleutians or the southeast panhandle of Alaska. Data for the latter area are largely provided by network operations of the USGS at Menlo Park, while the NOAA Alaska Tsunami Warning Center at Palmer bears the primary responsibility for fast locations in the Aleutians.

Geophysical Institute capabilities are therefore largely concentrated on the more heavily populated area of central and south-central Alaska. During 1983, the more significant earthquakes to have occurred within these areas were the following:

Date UTC	Time	Lat N	Long W	H(km)	Mag(ML)	Remarks
			Northern sub-net			
15 Apr 83	1830	64.75	147.53	7	5.0	Slight damage at Fairbanks.
			Southern sub-net			
05 Aug 83	1833	60.42	152.94	149	5.4	Felt throughout Kenai Peninsula.
26 Sep 83	2352	57.54	156.00	87	5.4	Alaska Peninsula.
			Combined nets			
12 Jul 83	1510	61.04	147.19	25	6.4	Damage at Valdez.
07 Sep 83	1922	60.94	147.26	18	6.2	Slight damage at Valdez.
08 Oct 83	1110	62.46	151.21	94	5.4	Felt throughout Matanuska Valley.

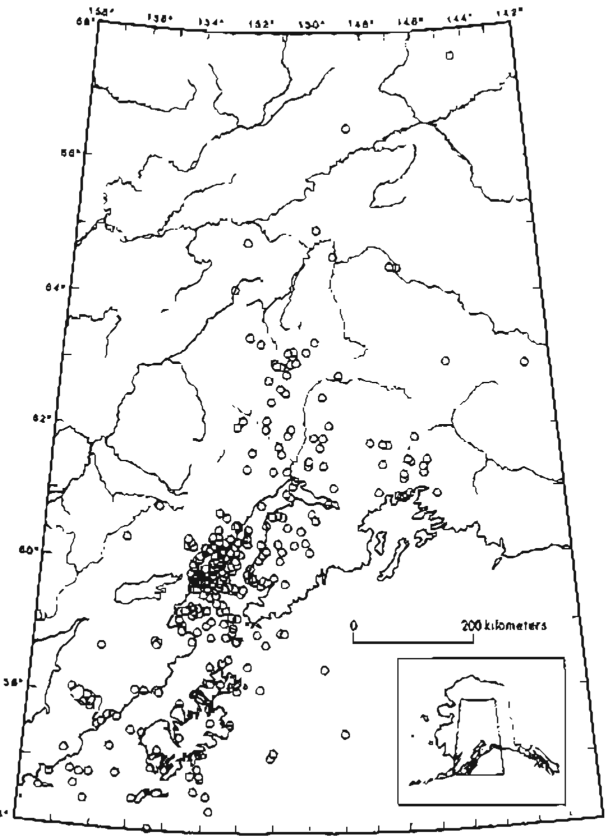

Figure 40. Alaska earthquakes of magnitude 3.0 or greater located by the University of Alaska seismic network in 1983. Open circles represent earthquake epicenters.

The Geophysical Institute, in cooperation with the Alaska State Division of Geological and Geophysical Surveys, is currently publishing a quarterly bulletin to list the parameters of all earthquakes located with the present networks.

Earthquake Monitoring in the Shumagin Seismic Gap and Eastern Aleutians, Alaska, 1983

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Lamont-Doherty Geological Observatory of
Columbia University
Palisades, NY 10964

Since 1973, Lamont-Doherty Geological Observatory (L-DGO) has operated a short-period high-gain seismic network in the Shumagin Islands region of the eastern Aleutians. The Shumagin network consists of 14 stations

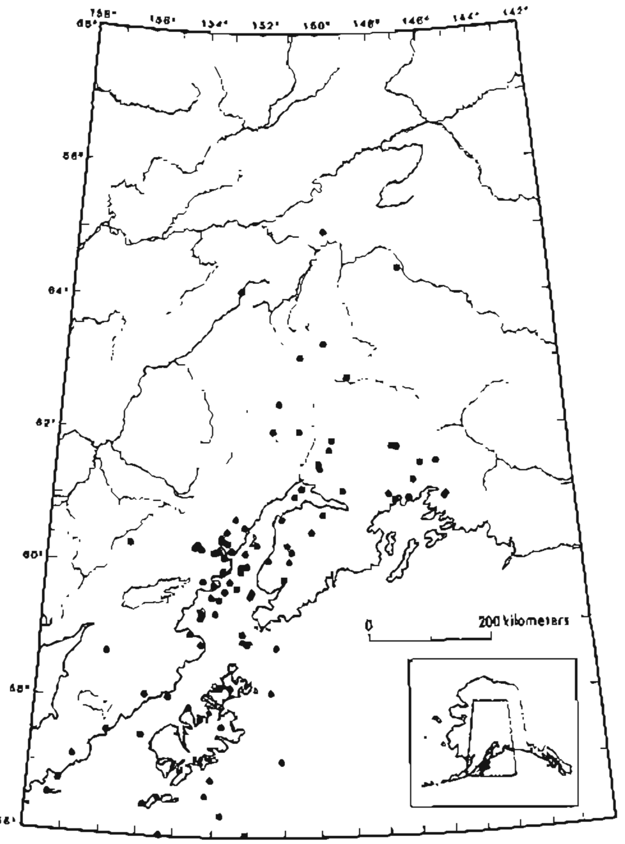

Figure 41. Alaska earthquakes of magnitude 3.5 or greater located by the University of Alaska seismic network in 1983. Solid circles represent earthquake epicenters.

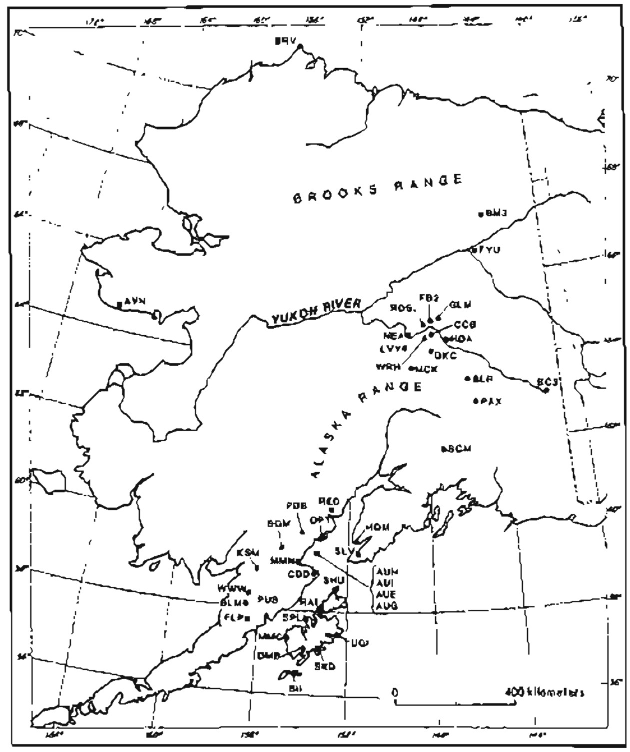

Figure 42. Telemetered seismographic network operated by the University of Alaska during 1983. Solid circles represent geographic locations of the stations; the three letter code represents each station name abbreviation.

plus four stations in the Pavlov volcano subarray (fig. 43). The stations consist of single short-period vertical seismometers, except for five short-period three-component stations, one intermediate-period three-component station, and one three-component force balance accelerometer. The analog signals from the high gain remote stations are transmitted via radio links to a central recording site in Sand Point. The seismic signals are digitized at 100 samples per second and are event detected using 12 of the 32 recorded channels. The event detector parameters can be adjusted from L-DGO via modem. An analog tape recorder with a separate event detection algorithm works in parallel with the digital system and acts as the backup system.

Within the region of the Shumagin network there are also 12 strong-motion accelerographs (Kinemetrics SMA-1, 1g) 10 of which are colocated with seismic stations. These 10 SMA's are connected to the telemetry system so that a trigger signal is sent to the central recording site allowing us to know the exact time at which an SMA began recording a given earthquake.

The most significant activity in the Shumagin region in 1983 was an earthquake sequence that included two moderate (M_S = 6.3 and 5.6) thrust events and at least 50 smaller events with magnitudes up to 4.0 M_L. The cluster is visible in figure 44 near 55° N., 159° W. The main events occurred on February 14 and were separated by 5 hours. The events were located on the shallowly dipping subduction zone interface between the Pacific and North American plates. They lie about 1/3 of the distance between the downdip end of this main thrust zone and the offshore trench. These were the largest events to occur within the Shumagin gap since 1979 and both were felt in Sand Point and nearby villages. The events occurred on the eastern edge of the seismic gap and the rupture direction was updip and away from the gap. This may explain why the shocks did not initiate the expected great earthquake in the region. The only other felt event in 1983 had a local magnitude of 5.8 and occurred on December 27 at 2305. It was located about 140 km west of the network, near the probable western boundary of the Shumagin seismic gap.

Otherwise, seismicity within the region was similar to previous years. There were 565 events located by the network, as shown in map view in figure 44 and in cross section in figure 45. There is relatively little activity along the shallow part of the main thrust zone, but there is a cluster of events at the lower end of this locked zone. Below 40 km there is a clear double Benioff zone, with most of the events occurring in the upper plane. The apparent bend in the slab at about 130 km is due mainly to mislocations arising from the relatively high velocity of the descending slab.

The upper crustal seismicity is also concentrated above the lower edge of the main thrust zone. This forms a band of seismicity parallel to the mainland and about 100 km offshore. There is very little shallow seismicity on the mainland itself. Further west, in the area of the magnitude 5.8 event, the rate of seismicity increases and

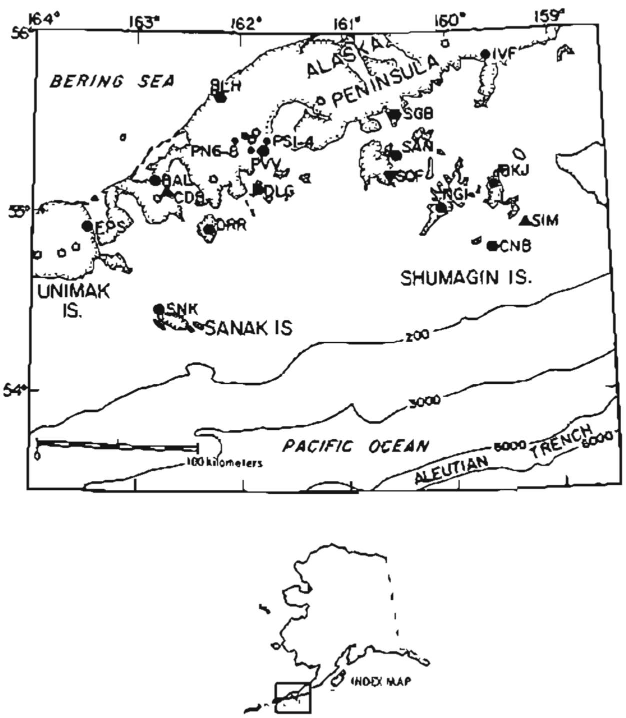

Figure 43. The Shumagin seismic network, in 1983. Solid circles are short-period vertical seismic stations. The hexagons are short-period three-component stations. The inverted triangle (SQF) indicates a low-gain site with a three-component force balance accelerometer. Strong motion accelerographs (SMA-1) are located at the seismic stations SNK, DRR, DLG, SGB, SAN, NGI, BKJ, IVF, and CNB and at upward pointing triangles. Instrumentation at SAN also includes a digitally recording PDR-1 strong motion recorder with FBA sensors.

the events are spread over a larger portion of the distance between the volcanic arc and the offshore trench.

Explanation of table 2

DATE Year, month, and day of the event.
ORIGIN Origin time in hours, minutes and seconds.
LAT North latitude, in degrees and minutes.
LON West longitude in degrees and minutes.
DEPTH Depth in km.
XMAG Average amplitude or local magnitude.
NWR Number if readings (P and S), with weights greater than 0.1.
GAP The largest azimuthal gap between azimuthally adjacent stations.
DMIN Distance to the nearest station reporting an arrival with weight greater than 0.1.
RMS The root-mean-square travel time residual, computed after residual weighting.
ERH The horizontal error in km, defined as the greatest length of the horizontal projections of the three standard errors.
ERZ The vertical error in km, defined as the greatest length of the vertical projections of the three standard errors.
A * after ERZ means that one of the parameters was held fixed in the final solution (usually depth).

Table 2. *Magnitude 3.5 or larger earthquakes located by the Shumagin network in 1983*

DATE	ORIGIN	LAT	LON	DEPTH	XMAG	NWR	GAP	DMIN	RMS	ERH	ERZ
830101	0603 20.93	53 16.80	163 55.81	004.55	4.1	11	328	271	0.14	01.17	31.61*
830109	2805 29.82	53 30.31	165 26.11	094.18	3.5	26	330	205	0.19	01.90	03.75
830110	2152 03.59	53 41.17	163 48.01	001.89	3.7	27	303	109	0.35	03.18	03.29
830120	1410 10.76	54 38.72	159 28.21	029.00	3.9	23	298	021	0.51	02.72	02.84
830214	0320 03.71	54 48.51	159 06.48	016.11	5.6	25	308	031	0.64	02.24	01.20
830214	0329 28.72	54 54.87	158 54.11	004.29	3.5	22	311	045	0.28	01.03	01.19
830214	0603 35.38	54 42.71	158 44.06	007.15	3.5	21	314	056	0.32	02.03	02.43
830214	0810 02.72	54 51.75	158 52.48	014.02	6.0	24	313	046	0.34	01.94	00.97
830214	1748 51.92	54 42.99	158 56.08	012.11	3.5	20	310	043	0.33	01.69	01.04
830215	1853 51.99	54 51.67	158 48.09	006.12	3.8	25	262	049	0.37	02.04	01.04
830221	1840 27.10	54 17.28	161 27.31	003.51	3.7	28	221	088	0.33	01.06	02.04
830227	1555 31.92	54 53.50	158 58.63	001.37	4.0	26	277	109	0.35	02.85	01.52
830601	2249 03.90	54 34.16	159 42.35	031.61	3.5	13	288	079	0.33	02.48	02.77
830512	0554 10.67	54 38.50	159 35.70	028.98	3.7	12	300	020	0.38	03.83	02.40
830525	0644 18.18	52 50.65	165 46.78	080.14	4.1	24	331	268	0.72	06.91	31.61*
830808	0437 37.81	54 48.35	159 40.17	011.38	4.3	25	188	005	0.45	01.37	01.52
830819	2050 57.37	54 02.14	161 05.39	011.29	3.6	30	246	120	0.48	03.19	07.57
830828	1205 10.09	53 30.55	162 18.71	019.93	3.9	21	299	113	0.43	08.94	17.01
830906	0401 52.15	53 49.84	163 53.17	001.45	5.0	23	304	107	0.34	05.71	02.84
830912	0720 28.74	55 16.97	163 23.19	003.91	3.3	28	304	138	0.48	11.48	14.82
830914	0021 57.28	54 38.43	159 56.77	033.93	3.7	32	217	030	0.40	01.70	02.91
830923	1515 67.98	52 58.09	165 28.63	010.52	3.5	22	329	244	0.52	05.51	31.81*
830924	1620 03.58	53 15.66	163 38.91	016.29	3.9	31	307	147	0.46	07.17	12.44
831022	0454 59.33	55 04.50	180 26.34	054.69	3.8	31	129	018	0.37	01.28	02.08
831107	2206 19.29	53 02.77	161 46.36	008.23	3.9	31	298	172	0.50	10.38	12.84
831109	1602 32.17	54 32.51	160 43.49	003.72	4.0	31	200	069	0.42	01.47	03.59

Southern Alaska Seismicity, 1983

C. D. Stephens, R. A. Page, K. A. Fogleman, and J. C. Lahr, U. S. Geological Survey
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Two of the most significant earthquakes in southern Alaska in recent years occurred beneath Columbia Bay north of Prince William Sound on July 12 and September 7, 1983 (fig. 46 and table 3). These shocks, with magnitudes of 6.1 m_b (6.4 M_S) and 6.2 m_b (6.2 M_S), are the largest events to occur in the Prince William Sound region since the 1964 Alaska earthquake (9.2 M_W, 8.4 M_S), and the largest events to occur within the USGS regional seismograph network since the 1979 St. Elias earthquake (7.1 M_S) north of Icy Bay. Both of the Columbia Bay shocks were felt throughout south-central Alaska, and a peak horizontal acceleration of 0.32 g at Valdez produced by the July shock is the strongest ground acceleration recorded for an Alaskan earthquake (Maley and Ellis, 1984). Both mainshocks were located at a depth of 30 km by the regional network using travel-time corrections calibrated by well-located aftershocks recorded by temporary seismographs deployed in the epicentral area following the mainshocks (Page and others, 1985). The July shock occurred about 45 km west of Valdez, 145 km east of Anchorage, and about 25 km east of the epicenter of the 1964 earthquake. Aftershocks of the July shock (fig. 47) define a steeply northwest-dipping planar zone about 27 km long ranging in depth from 22 to 32 km. The September shock occurred about 10 km southwest of the July shock at the southwest end of the July aftershock zone. Aftershocks from the later event define a cluster 6 to 9 km in diameter ranging in depth from 26 to 35 km which does not significantly overlap the July aftershock zone. Preliminary focal mechanisms for the two mainshocks determined from regional and teleseismic P-wave polarities are nearly identical and indicate predominantly

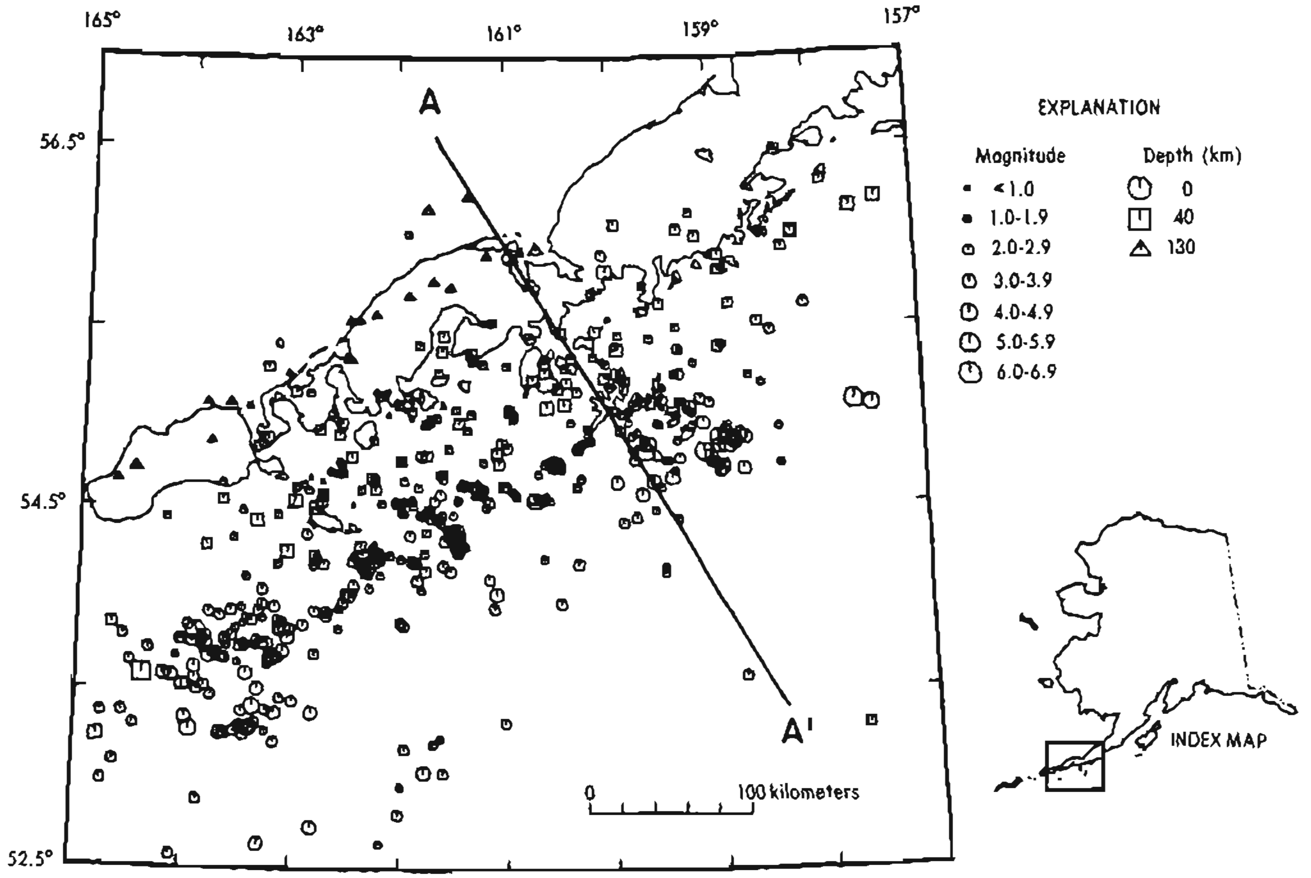

Figure 44. Hypocenters located by the Shumagin network in 1983. Events less than 40 km deep are plotted as octagons, those between 40 and 130 km as squares, and those greater than 130 km as triangles.

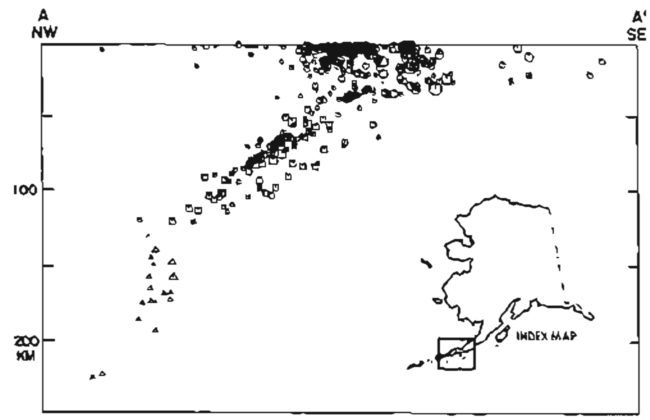

Figure 45. Cross section along A-A' in figure 44. Events that required fixed depths are excluded.

normal faulting with a subhorizontal least compressive stress axis dipping gently to the northwest. In each case, one of the nodal planes closely corresponds to the steeply dipping fault plane defined by the aftershock distribution. The depth to the subducted Pacific plate beneath the Prince William Sound region is difficult to ascertain because of the sparce distribution of seismicity and generally poor depth control; but on the basis of the distribution of Benioff-Wadati zone seismicity in adjacent regions, the Columbia Bay events are surmised to have occurred within the upper part of the subducted plate (Page and others, 1985).

On January 1, a magnitude 5.4 m_b (4.8 M_s) shock occurred at a depth of 38 km near the southern end of a southwest-northeast-trending zone of seismicity about 40 km north of the Columbia Bay aftershock zone. In October, a magnitude 4.2 m_b shock occurred at a 43 km depth near the northern end of the zone. Activity within this zone has persisted since at least 1971 when the network was established. Preliminary focal mechanisms for the two recent events determined from P-wave polarities at regional stations indicate normal faulting on northeast-striking planes similar to the mechanisms found for the Columbia Bay shocks, suggesting that these events also may have occurred within the subducted Pacific plate. However, the northern zone of seismicity is offset from and rotated counter clockwise with respect to the Columbia Bay aftershock zone, suggesting that the seismicity in these two zones probably occurs on different structures.

On June 28, a 6.0 m_b shock occurred at 15 km depth north of Icy Bay and within the aftershock zone of the St. Elias earthquake. A focal mechanism for the June event determined from regional P-wave first motions is compatible with predominantly low-angle thrusting on a northward-dipping plane, consistent with the teleseismic solution published by NEIC, and similar to the low-angle

Table 3. *Earthquakes in southern Alaska with magnitude 4.5 mb or larger, or MM intensity IV or higher*

Date (1983)	Origin time (UTC) hr mn sec	Lat N deg min	Long W deg min	Depth km	mb	MS	ML	Int MM	Region
JAN [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NORTH OF PRINCE WILLIAM SOUND
FEB [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	COOK INLET BENIOFF ZONE
MAR [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] COOK INLET BENIOFF ZONE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] COOK INLET BENIOFF ZONE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] COOK INLET BENIOFF ZONE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	CONTINENTAL MARGIN, S. OF YAKUTAT BAY
30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	DUKE RIVER FAULT - YUKON TERR.
APR [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] COOK INLET BENIOFF ZONE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	CONTINENTAL MARGIN, S. OF YAKUTAT BAY
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	COOK INLET BENIOFF ZONE
JUN [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	WESTERN PRINCE WILLIAM SOUND
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] COOK INLET BENIOFF ZONE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	COOK INLET BENIOFF ZONE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	COOK INLET BENIOFF ZONE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	ST. ELIAS AFTERSHOCK ZONE
JUL [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	COLUMBIA BAY
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	ST. ELIAS AFTERSHOCK ZONE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	KODIAK ISLAND
AUG [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NORTH OF PRINCE WILLIAM SOUND
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	COOK INLET BENIOFF ZONE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	MONTAGUE ISLAND
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	COOK INLET BENIOFF ZONE
SEP [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	COLUMBIA BAY
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	COLUMBIA BAY
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	COLUMBIA BAY
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	COOK INLET BENIOFF ZONE
OCT [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] COOK INLET BENIOFF ZONE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	ST. ELIAS AFTERSHOCK ZONE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	COOK INLET BENIOFF ZONE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] COOK INLET
NOV [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	ST. ELIAS AFTERSHOCK ZONE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] COOK INLET BENIOFF ZONE
DEC [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] COOK INLET BENIOFF ZONE

thrusting inferred for the St. Elias mainshock (Hasegawa and others, 1980). The June event occurred at the southwest edge of a zone characterized by a relatively high rate of continuous aftershock activity since the St. Elias mainshock. This event and other shocks of magnitude 5.0 and larger that have occurred nearby within the zone generally have not triggered strong secondary aftershock activity; only 43 shocks of coda-duration magnitude 1.0 and larger occurred within three days and 10 km of the June 1983 shock. Similarly, a magnitude 5.1 m_b shock in July 1983 occurred within the zone of high activity about 20 km east of the June event and did not trigger a strong secondary aftershock sequence. In contrast, a magnitude 5.0 m_b shock that occurred in May 1982 and was located within the St. Elias aftershock zone about 20 km south of the June 1983 event had 324 aftershocks of magnitude 1.0 and larger within three days and 10 km (Stephens and others, 1984b).

A magnitude 5.4 m_b (4.8 M_S) shock occurred on March 30 and was located at crustal depth near the western end of the Duke River fault system in Canada. This event had a pronounced aftershock sequence, but the distribution of the aftershocks is not well constrained due to a lack of nearby seismographs to record the events.

Aside from aftershocks associated with some of the larger events, the distribution of microearthquakes located by the USGS regional network for 1983 is similar to that observed over the past several years (fig. 48). West of Prince William Sound the distribution is dominated by earthquakes that occur within the Aleutian Benioff-Wadati zone of the subducted Pacific plate which dips northwestward at a low angle beneath the Kenai Peninsula and more steeply beneath the volcanic arc west of

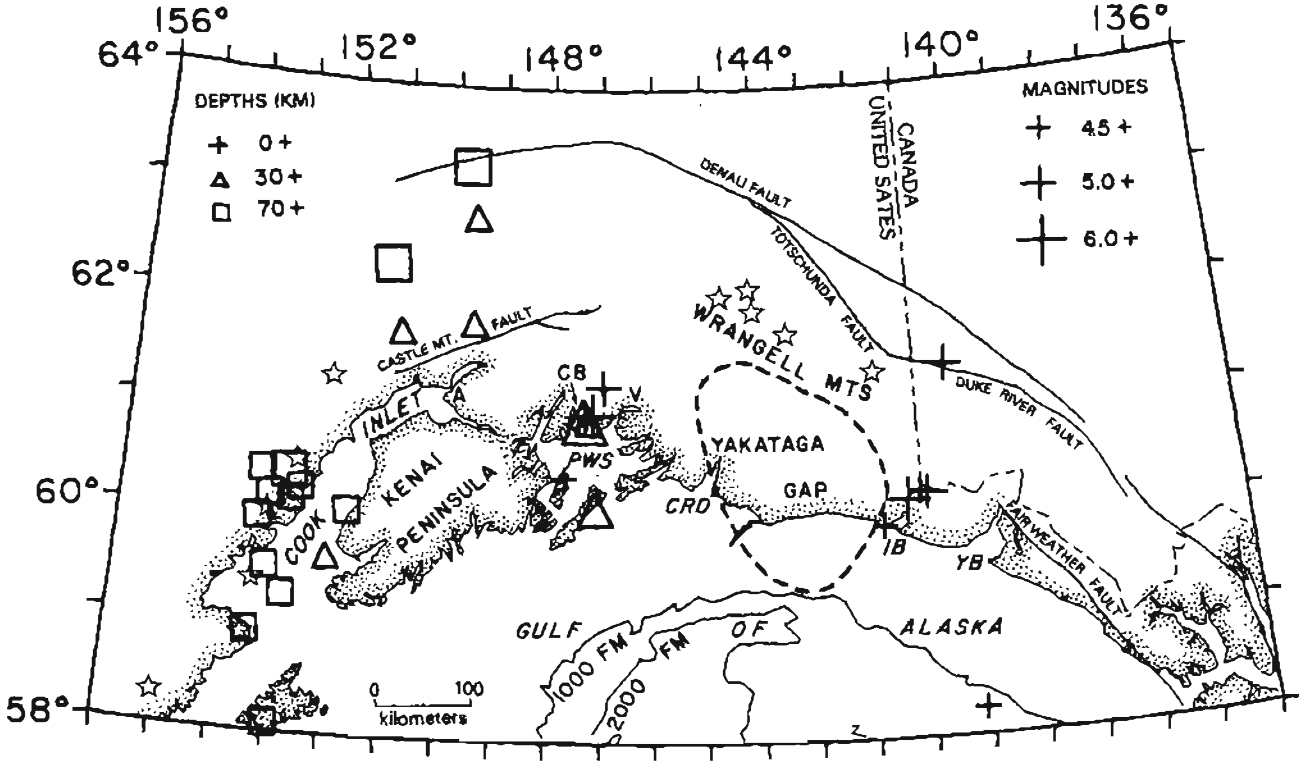

Figure 46. Hypocenters of magnitude 4.5 m_b and larger earthquakes determined by the USGS regional seismograph network in southern Alaska for 1983. A - Anchorage, CB - Columbia Bay, CRD - Copper River Delta, IB - Icy Bay, PWS - Prince William Sound, V - Valdez, YB - Yakutat Bay. Stars indicate volcanoes.

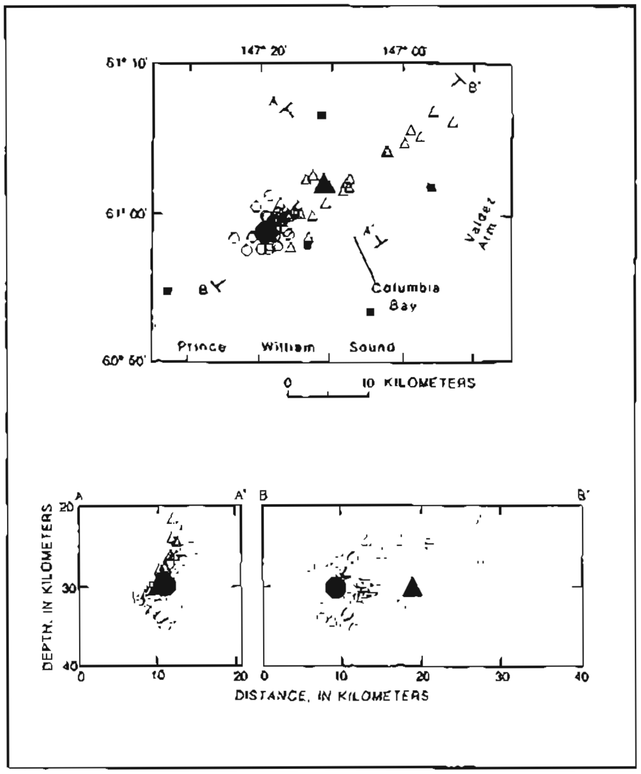

Figure 47. (Top) Epicenters of Columbia Bay main shocks (large solid symbols) and well-located aftershocks. All aftershocks were recorded by local temporary seismographs (solid squares) as well as more distant reional stations. Triangles shocks from July 16-24; octagons, shocks from September 12-14. Aftershock magnitudes, determined from duration of signal codas at regional stations, range from 1.6 to 3.8. Westernmost seismograph operated in September only, others in both July and September. AA' and BB' indicate line of cross-sections shown in lower part of figure. (Bottom) Vertical cross sections of Columbia Bay main shocks and well-located aftershocks. Data and symbols as in map view. Left section is view looking to northeast along strike of aftershock zone. Right section is view looking to northwest in dip direction of aftershock zone. Figure modified from Page and others (1985).

Cook Inlet. The rate of seismicity in the overthrust plate is relatively low; concentrations of small (magnitude less than 1.0) shallow earthquakes along the Cook Inlet section of the volcanic arc are due at least in part to an emphasis placed on locating smaller events in this area. East of Prince William Sound the seismicity is concentrated at depths shallower than about 35 km, although a few deeper shocks occur within the northeast-dipping Wrangell Benioff-Wadati zone south of the Wrangell volcanoes (Stephens and others, 1984a). Salient features in the distribution of hypocenters include continuing aftershock activity from the St. Elias earthquake, concentrations of events beneath the Copper River Delta and beneath Waxell Ridge near the center of the Yakataga seismic gap, and diffuse clusters of events along the northern section of the Fairweather fault, off-shore south of Yakutat Bay, and along the Denali fault system north of the St. Elias rupture zone.