DEPARTMENT OF THE INTERIOR
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MISCELLANEOUS FIELD STUDIES
MAP MF-1819
SHEET 2 OF 2

SEISMICITY MAP OF THE STATE OF MONTANA

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INTRODUCTION

This map is one of a series of seismicity maps produced by the U. S. Geological Survey that show earthquake data of individual states or groups of states at the scale of 1:1,000,000. This map shows only those earthquakes with epicenters located within the State of Montana. Earthquakes originating in adjacent bordering states or countries may have been felt or may have caused damage in Montana.

The data in table 1 were used to compile the seismicity map; these data are a corrected, expanded, and updated (through 1981) version of the data used by Algermissen (1969) for a study of seismic risk in the United States. The locations and intensities of some earthquakes were revised and relocated epicenters were assigned where none had been before. Many earthquakes were added to the original list from new data sources as well as from careful restudy of macroseismic data from earthquakes in the historical period. The magnitudes (see table 1) were recalculated for events in Montana during 1981. The data in table 1 represent best estimates of the location of the epicenter, magnitude, and intensity of each earthquake. The data are not complete, however, because of the lack of information from large earthquakes that occurred before seismic instruments were universally used.

Specific criteria used in compiling this list of earthquakes in the State of Montana include the following: (1) All earthquakes with epicenters along the Montana-Wyoming border from the 1925 Hebgen Lake earthquake to the present; (2) all events of the 1925 and 1935 earthquakes were assigned new epicenters based on macroseismic data; (3) all instrumental epicenters for the 1959 Hebgen Lake earthquake and its aftershocks were located in Montana, Montana, and Wyoming; only the ones located in Montana are included on this map. All noninstrumental locations were given the location of the main shock with an accuracy code that includes the uncertainty in assigning the intensity center.

The latitude and longitude coordinates of each epicenter were rounded to the nearest tenth of a degree, and earthquakes that fell on the same point were counted. These locations are represented on the map by a triangle. The number of earthquakes at each location is shown on the map by the number to the right of the triangle. Only the largest event is listed if more than one earthquake occurred during the same day and had the same epicenter grouping. If all earthquakes at the same epicenter have the same intensities, the largest event is listed. If no intensities have been assigned to earthquakes at that location, the year shown below each triangle is the latest year for which the maximum intensity was recorded.

EXPLANATION OF THE TABLE

The data are listed chronologically in table 1 with the following categories: date, origin time in Coordinated Universal Time (UTC), N. latitude, W. longitude, depth, magnitude, intensity, and felt area. Earthquakes that occurred before 1925 are listed by Modified Mercalli intensity values only. The location of the epicenter listed in table 1, column 10 an earthquake was felt but not enough information was available to assign an intensity value. The letter "F" is used to indicate that the event was felt (column 11) or was felt in adjacent states (column 12). All felt earthquakes of magnitude greater than 2.5 are listed. If no magnitude was computed and the earthquake was felt, the epicenter grouping is listed in column 12. Only the most significant events located in recent years with data from dense seismograph networks have no magnitudes.

Listed below is an explanation of the symbols and codes used in table 1:

1. Leaders (--) indicate unknown data.
2. Latitude and longitude are listed to a hundredth of a degree if they have been determined by a seismograph network. Otherwise, they are rounded to the nearest tenth of a degree. Earthquakes that fell on degree lines are assigned to the nearest even degree (i.e., only to the nearest degree or tenth of a degree). An asterisk (*) to the right of the longitude indicates that the event is an explosion, a suspected explosion, or a suspected nonexplosion; see column 12. A second asterisk (**) to the right of the longitudes indicates that published epicenters have been moved to reflect new information.
3. The letter code in column 5 indicates the method used to locate the earthquake:
   a. Determinations of instrumental hypocenters are estimated to be accurate within the ranges of latitude and longitude listed below; each range is letter coded as indicated:

Code	Range
A	0.0°–0.1°
B	0.2°–0.3°
C	0.4°–0.5°
D	0.6°–1.0°
E	1.1°–2.0°
F	2.1°–3.0°
G	3.0° or larger

   b. Determinations of noninstrumental epicenters that fell data are estimated to be accurate within the ranges of latitude and longitude listed below; each range is letter coded as indicated:

Code	Range
A	0.0°–0.1°
B	0.2°–0.3°
C	0.4°–0.5°
D	0.6°–1.0°
E	1.1°–2.0°
F	2.1°–3.0°
G	3.0° or larger

4. The reference identification numbers in column 6 refer to the MAG and INTENSITY, REF columns indicate the source of the magnitude and intensity. They are listed in numerical order in the list of data sources.
5. Depths are in kilometers. Depths from 1961 through Coatsworth and Richter, 1976) published in the Preliminary Determination of Epicenters by the National Earthquake Information Center, U. S. Geological Survey and predecessor organizations. Depths for 1977 and 1978 are from Engdahl and Gunst (1978) and the source code are (see p. 5): 1 = NI (Engdahl, Gunst, and Flinn, 1973), 2 = WQ (Smith, 1966 or Gutenberg, 1963), 3 = WC (Smith, 1966 or Gutenberg, 1963), 4 = WG (Smith, 1966 or Gutenberg, 1963), 5 = WS (Smith, 1966 or Gutenberg, 1963), 6 = WW (Smith, 1966 or Gutenberg, 1963), 7 = WO (Smith, 1966 or Gutenberg, 1963), 8 = WE (Smith, 1966 or Gutenberg, 1963), 9 = WB (Smith, 1966 or Gutenberg, 1963), 0 = WU (Smith, 1966 or Gutenberg, 1963), and 9 = unknown. Magnitudes are listed to the nearest tenth of a magnitude unit. Magnitude source codes are listed below:

Code	Source
BRE	Seismograph Station, University of California, Berkeley, Calif.
CD	Defense Nuclear Agency, Albuquerque Seismological Laboratory and Development Administration and Atomic Energy Commission)
GS	National Earthquake Information Center (and predecessor organizations), U. S. Geological Survey, Golden, Colo.
MSC	Montana College of Mineral Sciences and Technology, Butte, Mont.
MSU	University of Montana, Missoula, Mt.
OTT	Seismological Service of Canada, Ottawa.
PAS	Seismological Laboratory, California Institute of Technology, Pasadena, Calif.
SSB	Stover, C. W., 1976, Seismological Society of America Bulletin, v. 66, no. 2, p. 543.
USC	Seismograph Station, University of Southern Calif.

6. An asterisk (*) in the INTENSITY, MAG column indicates that the intensity was assigned by the compiler on the basis of the available data at the time the catalog was compiled.

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MODIFIED MERCALLI INTENSITY SCALE OF 1931

Adapted from Sieberg's Mercalli–Cancani scale,
modified and condensed (Wood and Neumann, 1931)

I. Not felt – or, except rarely under especially favorable circumstances. Under certain conditions, at most outside the boundary of the area in which a great shock is felt, guerilla bids, animals, reported uneasy or disturbed; clocks may stop, sensitive persons may sense; 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 to grade I, but often more noticeably: sometimes hanging objects may swing, especially when their suspension is long; 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 many, outdoors rarely—many people recognize 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 heavy traffic, but sharper or more rhythmic; sometimes like a jolt without any following vibrations; sometimes hanging objects may swing slightly. Movements may be appreciable on upper levels of tall structures. Rocked see