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Preliminary isoseismal map and intensity distribution for the Laramie
Mountains, Wyoming, earthquake of October 18, 1984

by

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This report is preliminary and has not been reviewed for conformity with U.S.
Geological Survey editorial standards and stratigraphic nomenclature.

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INTRODUCTION

The October 18, 1984 earthquake that occurred in the Laramie Mountains, south of Douglas, Wyoming was felt over an area of approximately 287,000 km² of Wyoming, Colorado, South Dakota, Nebraska, Kansas, Montana, and Utah. The hypocenter was located by the U.S. Geological Survey at 42.364°N., 105.692°W., fixed depth of 33 km, origin time 15h30m23.1s UTC. The magnitude was computed at 5.3mb, 5.1MS, and 5.5ML. Even though this earthquake was felt over a large area it caused very little damage.

The Laramie Mountains earthquake, maximum intensity VI, may be the largest event recorded in eastern Wyoming. Only one pre-1984 earthquake located within the region shown in figure 1 caused damaged (intensity VI); it occurred on November 14, 1897 near Casper. The November 3, 1984 earthquake (see table 1) near Lander has a preliminary maximum intensity of VI based on minor damage reports at Lander, which would make it only the third damaging event in this area. Only within the past two decades have magnitudes been computed for eastern Wyoming earthquakes and within this period the Laramie Mountains event has the largest magnitude. The 1984 Lander event had a magnitude of 5.0mb.

The historical seismicity of eastern Wyoming is shown in figure 1. The data were taken from Reagor and others (1985) and the Preliminary Determination of Epicenters listing of the U.S. Geological Survey. The 1984 epicenters, shown as solid circles in figure 1, fall within the historical distribution of seismicity for the region; however, they are the only earthquakes that have a computed magnitude of 5.0 or larger. The 1984 hypocenters are listed in table 1.

Isoseismal Map

Figure 4 shows the areal distribution of intensities for the Laramie Mountains earthquake. The isoseismal map was compiled from data obtained in a questionnaire convass of postmasters and police departments (within 400 kilometers of the epicenter), supplemented by a selected convass of fire departments and by information from numerous press reports. Intensities were rated using the Modified Mercalli Intensity Scale of 1931 (Wood and Neumann, 1931).

The isoseismal defining the limit of perceptibility in figure 4 is drawn to enclose all contiguous localities that felt the earthquake. Six anomolous areas east to south of the epicenter in South Dakota, Nebraska, Kansas, and Colorado outline two or more localities that reported feeling the earthquake. A few isolated felt reports from communities at large distances

from the epicenter are noted on the map. Most of these were reports from the upper floors of tall buildings and are not enclosed within an isoseismal.

Isoseismal maps for the May 29, September 8, and October 18, 1984, earthquakes are shown in figures 2, 3, and 4 respectively. The three maps have the same scale and therefore the relative size of the felt areas can be compared by inspection. The important factor to note is that these three events all occur in eastern Wyoming with comparable magnitudes of 5.0, 5.1, and 5.3mb, but have vastly different felt areas. The May 29 event had a felt area of about 56,000 km²; the September 8 event was felt over about 68,000 km²; while the October 18 event was felt over about 287,000 km² of seven states. Another comparison was made with published isoseismal maps from nearby states, in this case, one earthquake in Nebraska and two in Colorado. These earthquakes were selected because the magnitudes are comparable with the Laramie Mountains event. The Nebraska earthquake of March 28, 1964 had a magnitude of 5.1 mb; the two Colorado events, on August 9 and November 27, 1967, had magnitudes of 5.3 mb and 5.2 mb respectively. The felt area for these three earthquakes were computed by the author using the same method that was used for the 1984 Wyoming earthquakes. The resulting areas from the isoseismal maps published in United States Earthquakes were 134,000 km² for the 1964 Nebraska earthquake, 52,000 km² for the first Colorado event, and 64,000 km² for the second Colorado event. Docekal (1970) also published an isoseismal map for the 1964 Nebraska earthquake that had a larger felt area of 160,000 km². These comparisons show that the Laramie Mountains earthquake has from 2 to 5 times the felt area of other events in this seismic region for earthquakes of about the same magnitude.

The explanation for the large felt area resulting from the Laramie Mountains earthquake is not certain; however, a possible explanation may lie with the focal depth. It has been shown that an earthquake with a deeper focal depth is felt over a wider area than one of comparable magnitude with a shallow focus (Steinbrugge, 1982). Thus, if the Laramie Mountains earthquake is shown to have a larger felt area than shallower earthquakes in the same region with similar magnitudes, then the focal depth must be a contributing factor.

Accurate focal depths in eastern Wyoming are not available even though focal depths have been published here since 1961. The two 1984 Gillette, Wyoming earthquakes were published at depths of 18 and 20 km (see table 1); but, there is some uncertainty as to the true depth. Gordon, D. W. (personal communication), who computed the May 29 hypocenter listed in table 1, estimated the accuracy of the focal depth at 18 ± 15 km; thus, the actual depth may be much shallower than that published. Accurate focal depths for aftershocks of the Laramie Mountains earthquake have been determined by Langer and others (1985) to range from about 20 to 25.5 km. The focal depth of the main shock is also estimated to fall within this range. Also, reasonably accurate depths for the 1967 Colorado earthquakes were determined by Herrmann and others (1981) to be about 3-5 km.

If the Gillette, Wyoming earthquakes are assumed to be of shallow focus, about 5 km, their felt areas of 52,000 km² and 64,000 km² compare favorably with the 1967 Denver, Colorado earthquakes felt area of 56,000 km² and 68,000 km² which had depths of 3-5 km. The 1964 Nebraska earthquake does not compare with these events as its felt area is larger by a factor of 2 or 3 times.

Gordon (1983) computed a focal depth of about 30 km for the Nebraska event, but did not consider it reliable; however, the large felt area of 134,000 km² (160,000 km²; Docekal, 1970) (table 1) may indicate that this event could be deeper than the earthquakes in the Denver, Colorado and Gillette, Wyoming areas.

Intensity Distribution

No major damage resulted from this earthquake even though it was felt over a wide area. The most severe damage reported was cracks in the exterior brick walls of the Douglas City Hall and the public school in Medicine Bow. Other reported damage were cracked chimneys at Casper, Douglas, Guernsey, Lusk, and Rock River; broken underground pipes at Casper and Shirley Basin; and cracked exterior brick or cinderblock walls and foundations at Casper, Guernsey, Hanna, Lusk, McFadden, Rock River, and Shirley Basin.

An unusual report of damage caused by this earthquake was from Golden, Colorado; about 300 km south of the epicenter. Damage occurred in two five-story buildings which were part of a 10 building complex of the Golden Ridge Condominiums located near the juncture of U.S. highway 6 and Colorado state highway 93. The damage consisted of some foundation failure, numerous wall cracks and a gas leak in one of the buildings. All of the damage may not be attributed to the earthquake; some of it may be due to construction methods or soil conditions and may have existed prior to the earthquake.

Some common effects at the localities enclosed within the intensity V isoseismal on figure 4 were a few broken dishes or glassware, small objects overturned or fell, a few items of merchandise fell from store shelves, hair-line cracks in walls, trees and bushes were shaken slightly, standing vehicles were rocked slightly, and it was felt by many.

REFERENCES CITED

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- Herrmann, R. B., Park Sam-Kuen, and Wang Chien-Jing, 1981, the Denver earthquakes of 1967-1968: Seismological Society of America Bulletin, v. 71, no. 3, p. 731-745.
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- Wood, H. O., and Neumann, Frank, 1931, Modified Mercalli Intensity Scale of 1931: Seismological Society of America Bulletin, v. 21, no. 4, p. 277-283.

TABLE 1.--List of earthquakes cited in the text.

DATE	ORIGIN TIME h m s	LATITUDE (o)	LONGITUDE (o)	PUBLISHED depth(km)	Mb Mag.	MAX Intensity	FELT Area(km ²)	LOCALITY
Mar. 28, 1964	10 08 46.5	42.997 N.	101.798 W.	30	5.1	VI-VII	134,000 (160,000)	Merriman, Nebraska
Aug. 9, 1967	13 27 06.2	39.000 N.	104.700 W	5	5.3	VII	52,000	Denver, Colorado
Nov. 27, 1967	05 09 24.6	39.870 N.	104.880 W.	5	5.2	VI	64,000	Denver, Colorado
May 29, 1984	20 18 32.6	44.232 N.	105.965 W.	18	5.0	V	56,000	Gillette, Wyoming
Sept. 8, 1984	00 59 31.1	44.240 N.	106.019 W.	20	5.1	V	68,000	Gillette, Wyoming
Oct. 18, 1984	15 30 23.1	42.364 N.	105.692 W.	33	5.3	VI	287,000	Laramie Mtns., Wyoming
Nov. 3, 1984	09 30 08.6	42.544	108.866 W.	5	5.0	VI	---	Lander, Wyoming

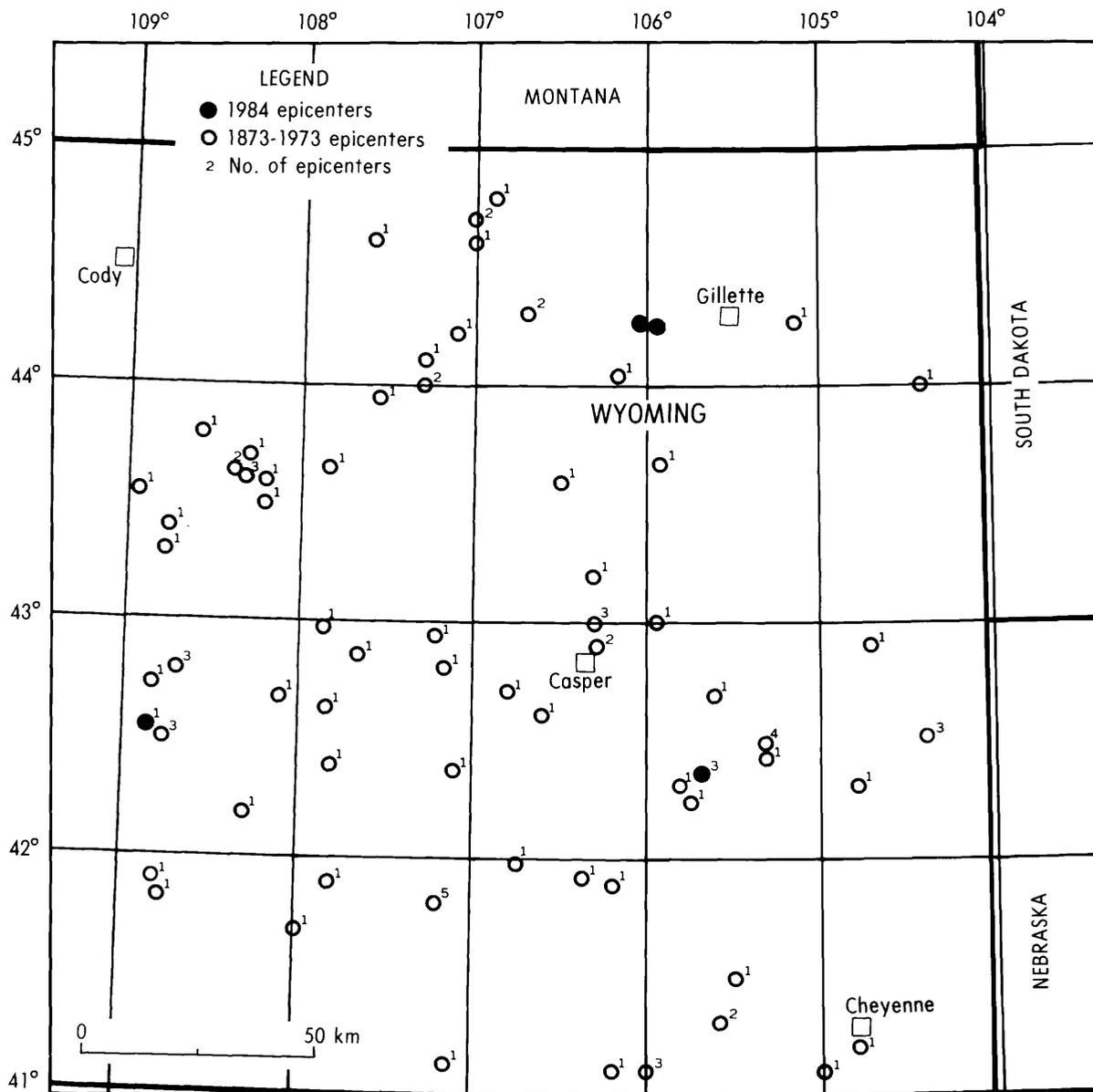


FIGURE 1.--Seismicity of Eastern Wyoming 1873-1984 east of 109° W. longitude.

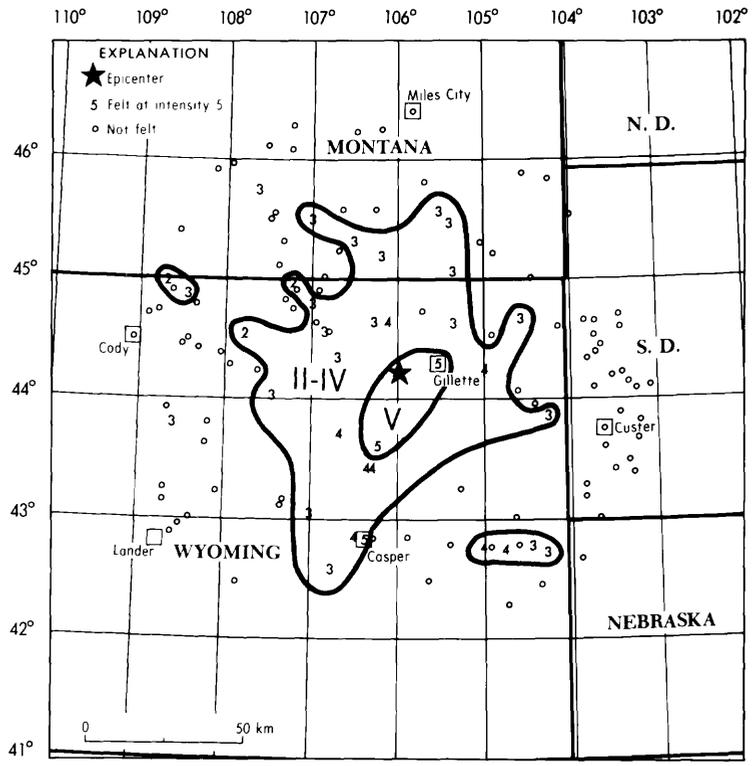


FIGURE 2.--Isoseismal map for the May 29, 1984 Gillette, Wyoming earthquake.

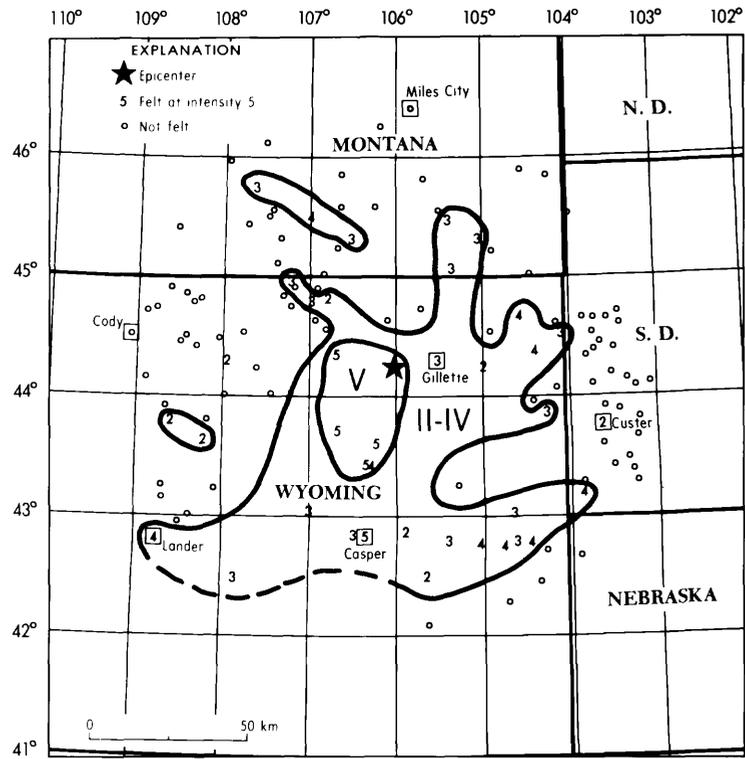


FIGURE 3.--Isoseismal map for the September 8, 1984 Gillette, Wyoming earthquake.

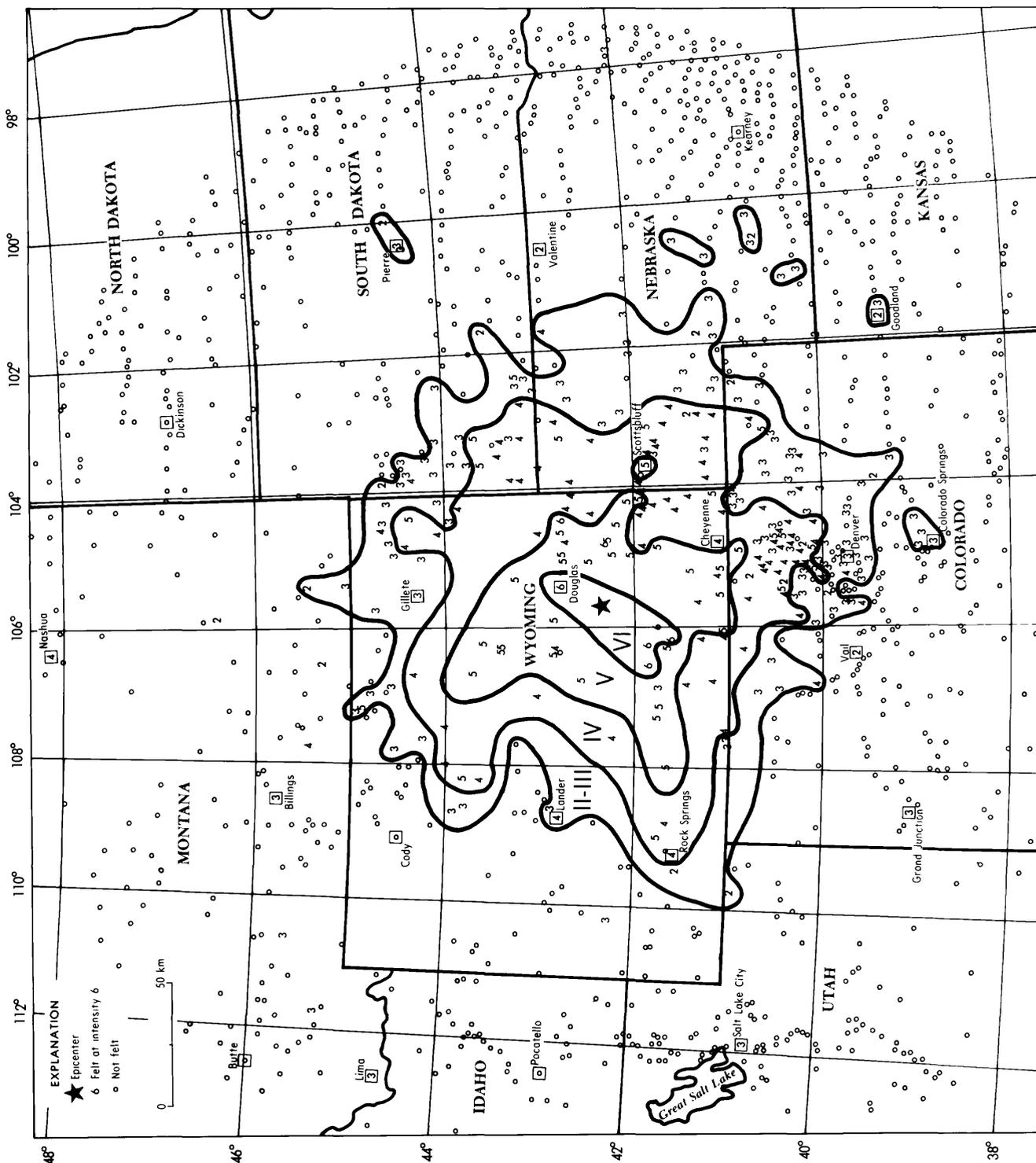


FIGURE 4.--Isoseismal map for the October 18, 1984 Laramie Mountains earthquake.