EARTHQUAKES

IN NEBRASKA

R. R. Burchett

Educational Circular No. 4a

Conservation and Survey Division
Institute of Agriculture and Natural Resources
The University of Nebraska-Lincoln

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Contents

Illustrations

Tables

Introduction

An earthquake is the result of an adjustment of the surface of the earth caused by a release of energy in the earth's crust. Faulting is one of many causes of earthquakes. A fault or fracture normally occurs when the earth's crust bends and then breaks, forming blocks. These blocks can slip past one another either horizontally or vertically. When the movement of two blocks is nearly horizontal, the fault produced is called a strike-slip fault (fig. 1). When the movement of the blocks is nearly vertical, the fault produced is called a dip-slip fault (fig. 2). Along many faults the movement is in a combination of directions. Weaknesses in the earth's crust are reflected by these faults, and many earthquakes are centered in these zones of weaknesses.

Another cause of earthquakes may be injections of fluids under pressure into subsurface rocks. The earthquakes caused by injecting fluids into deep wells at Rocky Flats near Denver, Colorado, are an example of this.

Earthquakes cause seismic vibrations (fig. 3) of two types: (a) surface waves that travel along the earth's surface and (b) body waves that travel through the earth. Body waves are either compressional waves or shear waves. Compressional waves, traveling at great speeds, reach the surface of the earth first and are called primary or "P" waves. Shear waves reach the surface of the earth later and are called secondary or "S" waves.

Seismic vibrations produced by an earthquake are recorded by an instrument called a seismograph, which generally consists of a recording unit (fig. 4) and a seismometer (fig. 5). The seismometer is an instrument housing a mass suspended on a spring. This mass vibrates when an earthquake takes place, and the vibrations are then sent to the recorder, where they are inscribed on a rotating drum, producing a record called a seismogram (fig. 6). Data from the seismograms can then be used to pinpoint an earthquake's time, focal point, epicenter, depth, and energy released.

The strength of an earthquake can be indicated by either intensity or magnitude. Intensity describes the effect of an earthquake on a human being, on human structures, or on the earth's surface and is measured or rated on an intensity scale such as the Modified Mercalli (MM) Scale of 1931. Magnitude is a measure of the quantity of energy released by an earthquake and is expressed by the Richter Scale. The approximate relationships of Mercalli to Richter scales is shown in figure 7. Most earthquakes having a Richter Scale reading of 2 or less are not felt by humans. A reading of 7 or more on the scale signals the occurrence of a major earthquake. The largest earthquake in the world recorded a magnitude of 9.6 in Chile during 1960.

Earthquakes occur in concentrated zones along the margins of the earth's crustal plates (fig. 8). Approximately 98 percent of all earthquakes occur near the edges of these plates.

When an earthquake occurs, the National Earthquake Information Service sends an earthquake questionnaire to the area surrounding the epicenter (fig. 9).

A seismic risk map (fig. 10) for the United States was compiled by Algermissen (1969). The U.S. Uniform Building Code, which determines earthquake-resistant design of structures, is based on this map. Most of Nebraska is in seismic risk zone 1. Seismic risk zone 2—which lies across parts of eastern Nebraska, Kansas, and Oklahoma—is a region delineated on the basis of data from the felt areas of several Modified Mercalli VII-VIII earthquakes that have occurred in the past. Seismic risk zone 2 is an area in which moderate damage is predicted when a major earthquake occurs in the region.

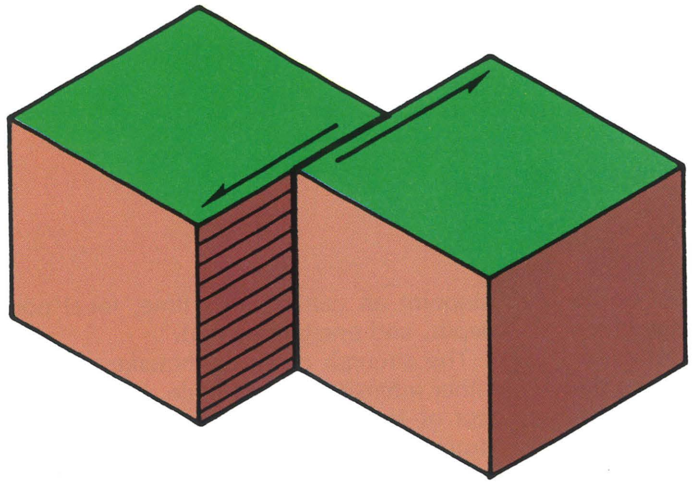

Fig. 1. Strike-slip fault

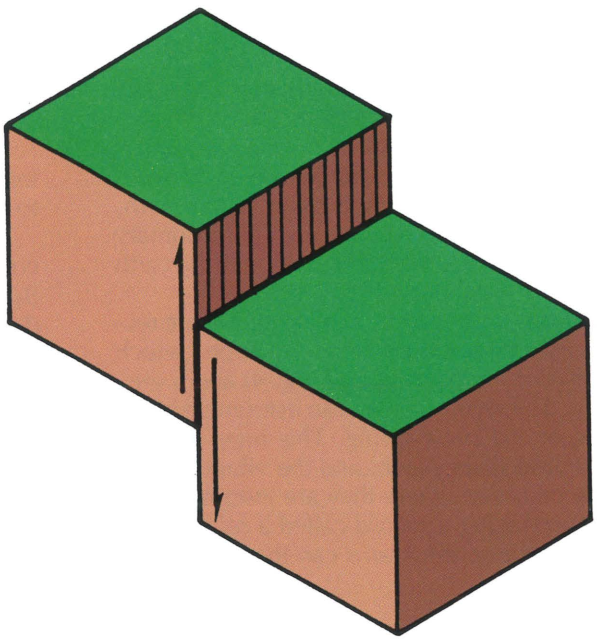

Fig. 2. Dip-slip fault

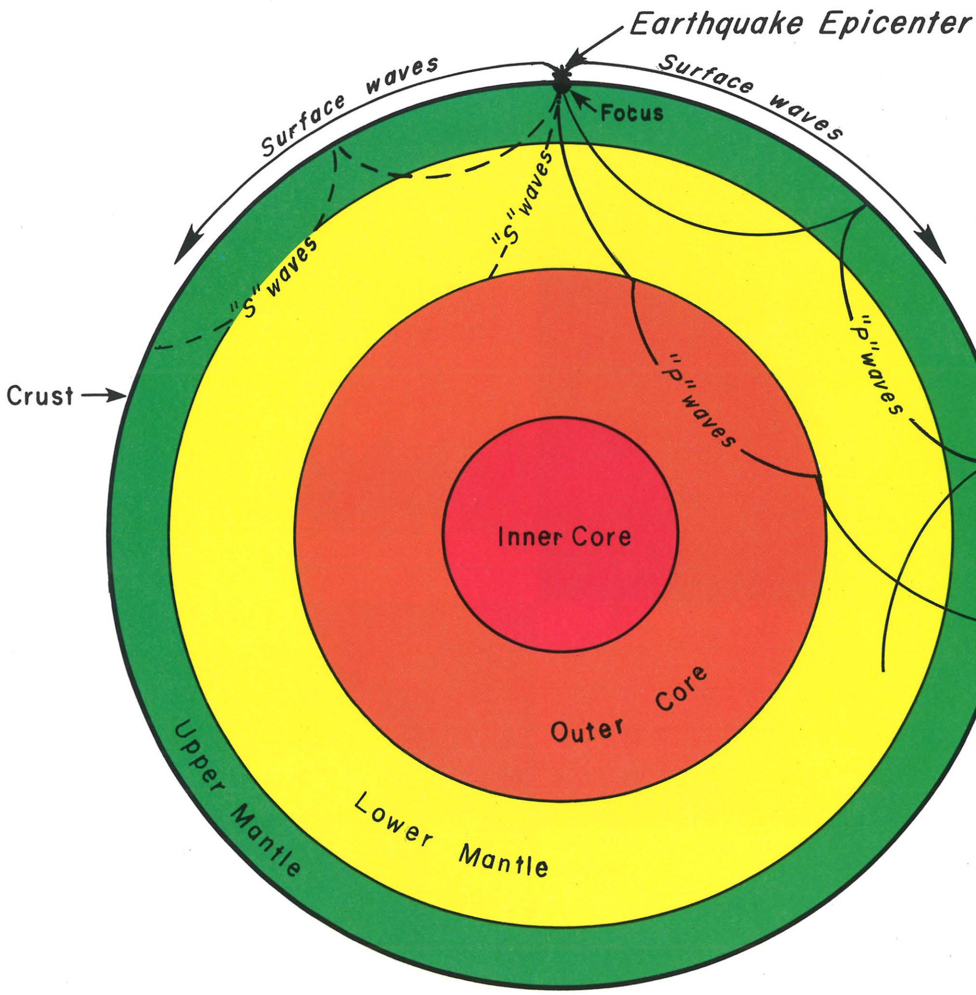

Fig. 3. Cross section of the earth showing various types of waves generated by earthquakes.

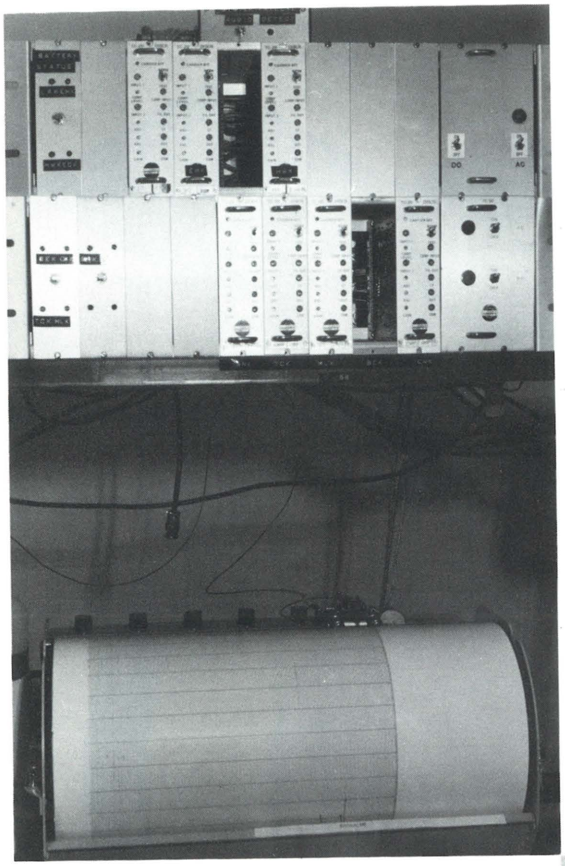

Fig. 4. Earthquake recording unit.

Fig. 5. Seismometer.

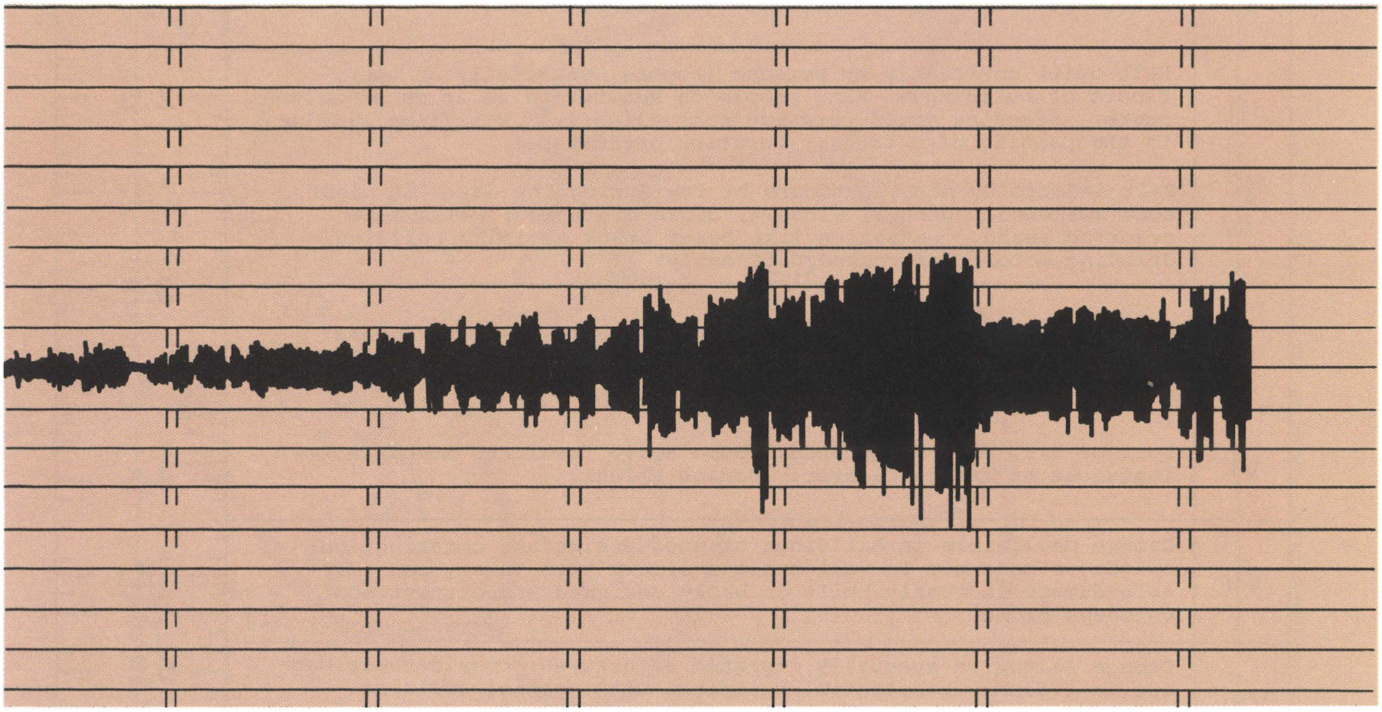

Fig. 6. Seismogram.

MODIFIED MERCALLI SCALE		RICHTER SCALE: MAGNITUDE
INTENSITY	EFFECT	
I	Not felt except by a very few under especially favorable conditions.	1.5
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.	2
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration similar to the passing of a truck. Duration estimated.	2.5
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.	3
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.	3.5 4
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.	4.5
VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.	5
VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.	5.5
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.	6 6.5
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.	7
XI	Few, if any, (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.	7.5
XII	Damage total. Lines of sight and level are distorted. Objects thrown into the air.	8

Fig. 7. Comparison of Modified Mercalli and Richter scales.

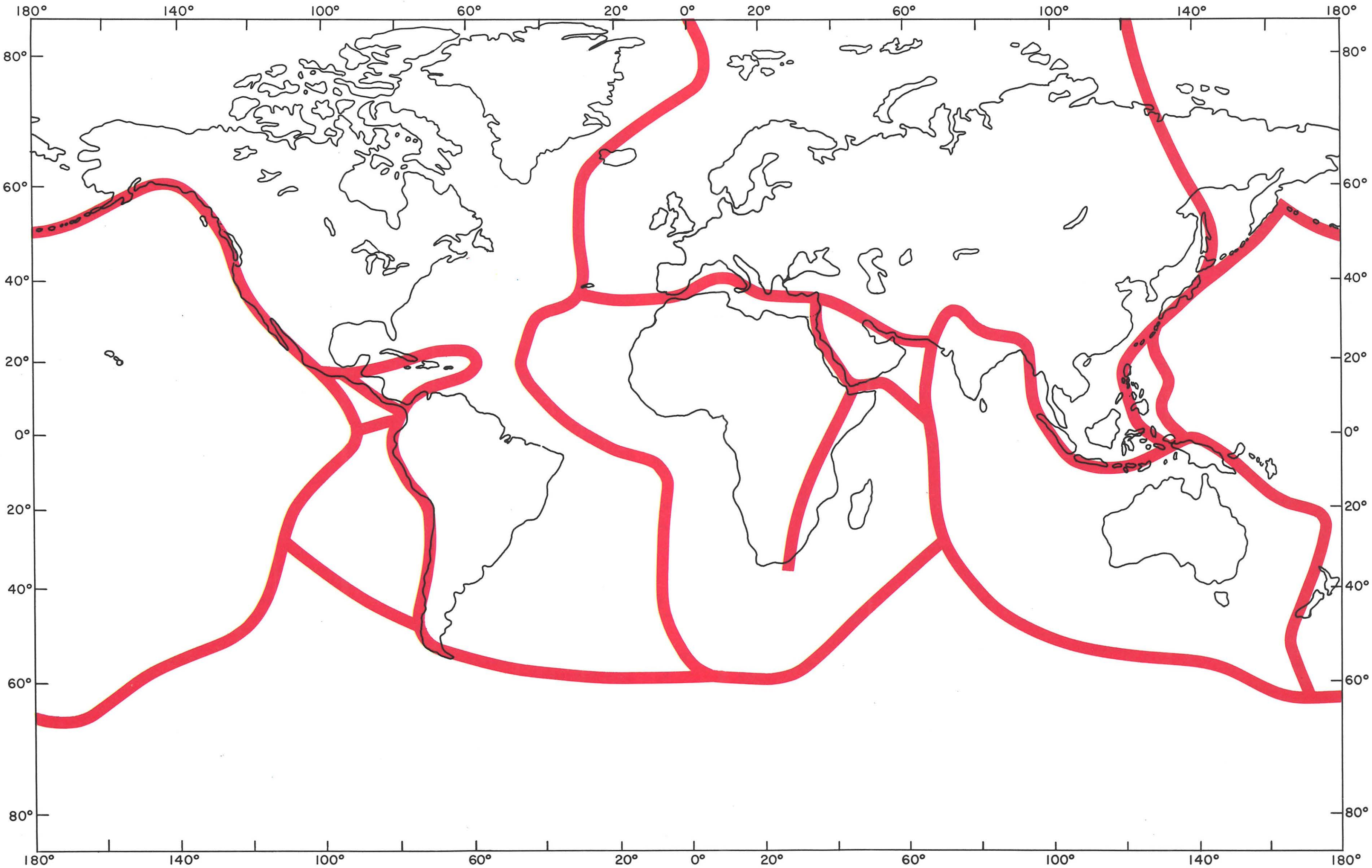

Fig. 8. Where earthquakes occur—along the margins of crustal plates.

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
EARTHQUAKE REPORT

Form Approved
OMB No. 42-R1700

Please answer this questionnaire carefully and return as soon as possible.

1. Was an earthquake felt by anyone in your town or zip code area recently?
   ☐ Not felt: Please refold and tape for return mail.
   ☐ Felt: Date________ Time________ ☐ AM ☐ PM ☐ Standard time ☐ Daylight time

Name of person filling out form ________
Address________
City________ County________
State________ Zip code________

If you felt the earthquake, complete the following section. If others felt the earthquake but you did not, skip the personal report and complete the community report.

PERSONAL REPORT

2a. Did you personally feel the earthquake? 1☐ Yes ☐ No
b. Were you awakened by the earthquake? 2☐ Yes ☐ No
c. Were you frightened by the earthquake? 3☐ Yes ☐ No
d. Were you at 4☐ Home 5☐ Work 6☐ Other?
e. Town and zip code of your location at time of earthquake ________

f. Check your activity when the earthquake occurred:
7☐ Walking 8☐ Sleeping 9☐ Lying down 10☐ Standing
11☐ Driving (car in motion) 12☐ Sitting 13☐ Other
g. Were you 14☐ Inside or 15☐ Outside?
h. If inside, on what floor were you? 16☐☐
Continue on to next section which should include personal as well as reported observations.

COMMUNITY REPORT

Check one box for each question that is applicable.
3a. The earthquake was felt by ☐ No one 17☐ Few 18☐ Several 19☐ Many 20☐ All?
b. This earthquake awakened ☐ No one 21☐ Few 22☐ Several 23☐ Many 24☐ All?
c. This earthquake frightened ☐ No one 25☐ Few 26☐ Several 27☐ Many 28☐ All?

4. What outdoor physical effects were noted in your community?

Parapets or cornices fallen	29☐ Yes	☐ No	
Trees and bushes shaken	30☐ Slightly	31☐ Moderately	32☐ Strongly
Standing vehicles rocked	33☐ Slightly	34☐ Moderately	35☐ Strongly
Moving vehicles rocked	36☐ Slightly	37☐ Moderately	38☐ Strongly
Ground cracks	39☐ Wet ground	40☐ Steep slopes	41☐ Dry and level ground
Landslides	42☐ Small	43☐ Large	
Underground pipes	44☐ Broken	45☐ Out of service	
Water splashed onto sides of lakes, ponds, swimming pools	46☐ Yes	☐ No	
Elevated water tanks	47☐ Cracked	48☐ Twisted	49☐ Fallen (thrown down)
Air coolers	50☐ Displaced	51☐ Rotated	52☐ Fallen
Railroad tracks bent	53☐ Slightly	54☐ Greatly	
Stone or brick fences	55☐ Cracked	56☐ Fallen	57☐ Destroyed
Tombstones	58☐ Displaced 61☐ Fallen	59☐ Cracked	60☐ Rotated
Chimneys	62☐ Cracked 65☐ Broken at roof line	63☐ Twisted	64☐ Fallen 66☐ Bricks fallen
Highways or streets	67☐ Cracked slightly	68☐ Large cracks	69☐ Displaced
Sidewalks	70☐ Cracked slightly	71☐ Large cracks	72☐ Displaced

Continued on the reverse side

5. What indoor physical effects were noted in your community?

Windows, doors, dishes rattled	73☐ Yes	☐ No	
Buildings creaked	74☐ Yes	☐ No	
Building trembled (shook)	75☐ Yes	☐ No	
Hanging pictures	76☐ Swung	77☐ Out of place	78☐ Fallen
Water in small containers	79☐ Spilled	80☐ Slightly disturbed	
Windows	81☐ Few cracked	82☐ Some broken	83☐ Many broken

6a. Did hanging objects, doors swing? ☐ No 84☐ Slightly 85☐ Moderately 86☐ Violently
b. Can you estimate direction? ☐ No 87☐ North/South 88☐ East/West 89☐ Other

7a. Were small objects (dishes, knick-knacks, pictures) ☐ Unmoved 90☐ Shifted 91☐ Overturned 92☐ Fallen, not broken 93☐ Broken?
b. Was light furniture ☐ Unmoved 94☐ Shifted 95☐ Overturned 96☐ Fallen, not broken 97☐ Broken?
c. Were heavy furniture or appliances ☐ Unmoved 98☐ Overturned 99☐ Shifted 100☐ Broken?

8. Indicate effects of the following types to interior walls if any:
Plaster 101☐ Cracked 102☐ Fell
Dry wall 103☐ Cracked 104☐ Fell
Ceiling tiles 105☐ Cracked 106☐ Fell

9a. Check below any damage to buildings or structures.
Foundation 107☐ Cracked 108☐ Destroyed
Interior walls 109☐ Split 110☐ Fallen 111☐ Separated from ceiling or floor
Exterior walls 112☐ Hairline cracks 113☐ Large cracks 114☐ Bulged outward 115☐ Partial collapse 116☐ Total collapse
Building 117☐ Moved on foundation 118☐ Shifted off foundation
b. What type of construction was the building that showed this damage?
119☐ Wood 120☐ Stone 121☐ Brick veneer 122☐ Other
123☐ Brick 124☐ Cinderblock 125☐ Reinforced concrete
c. What was the type of ground under the building?
126☐ Don't know 127☐ Sandy soil 128☐ Marshy 129☐ Fill
130☐ Hard rock 131☐ Clay soil 132☐ Sandstone, limestone, shale
d. Was the ground: 133☐ Level 134☐ Sloping 135☐ Steep?
e. Check the approximate age of the building:
136☐ Built before 1935 137☐ Built 1935-65 138☐ Built after 1965

10a. What percentage of buildings were damaged?
Within 2 city blocks of your location ☐ None 139☐ Few (about 5%) 140☐ Many (about 50%) 141☐ Most (about 75%)
b. In area covered by your zip code ☐ None 142☐ Few (about 5%) 143☐ Many (about 50%) 144☐ Most (about 75%)

11a. Were springs or well water disturbed? 145☐ Level changed 146☐ Flow disturbed 147☐ Muddied ☐ Don't know
b. Were rivers or lakes changed? 148☐ Yes ☐ No ☐ Don't know

12a. Was there earth noise? ☐ No 149☐ Faint 150☐ Moderate 151☐ Loud
b. Direction of noise 152☐ North 153☐ South 154☐ East 155☐ West
c. Estimated duration of shaking 156☐ Sudden, sharp (less than 10 secs) 157☐ Long (30-60 secs) 158☐ Short (10-30 secs) 159☐ Other

13. What is the approximate population of your city/town? Or are you in a
160☐ Less than 1,000 161☐ 10,000 to 100,000 164☐ Rural area?
162☐ 1,000 to 10,000 163☐ Over 100,000
This community report is associated with what town or zip code? ________

Thank you for your time and information. Refold this card and tape for return mail.

Fig. 9. Earthquake questionnaire used by the National Earthquake Information Service of the U.S. Geological Survey.

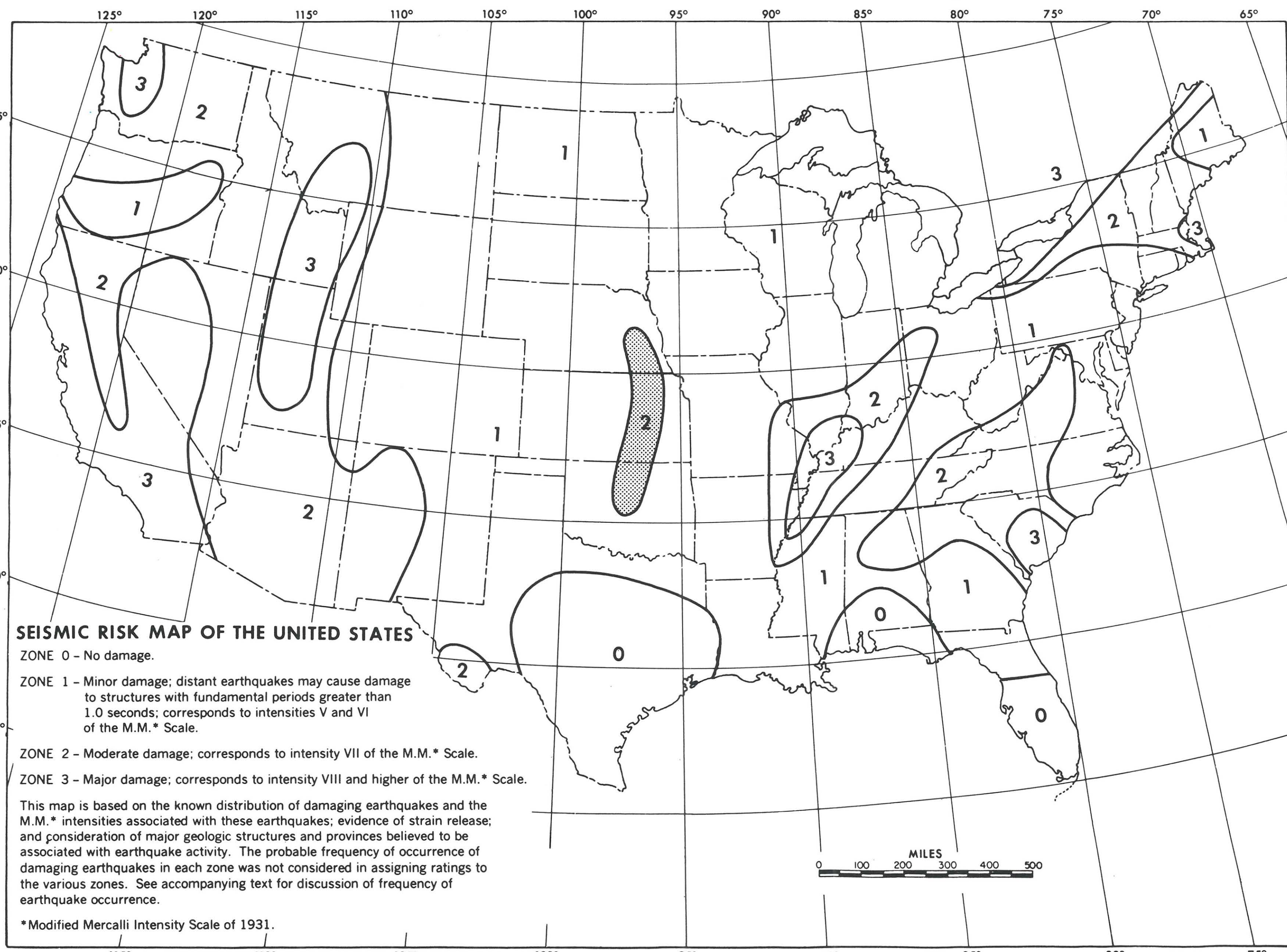

Fig. 10. Seismic risk map of the United States (Algermissen, 1969).

Earthquakes in Nebraska

Since 1866, at least 51 earthquakes having their epicenter in Nebraska were felt by some residents of the state. The time of occurrence, epicenter location, and strength of each are given in table 1; the location of each is shown in figure 11. Earthquake histories in Nebraska have been reported by Docekal (1970) and von Hake (1974). The earliest recorded event occurred on April 28, 1867, in Nebraska City with an intensity of IV on the Modified Mercalli scale. Since then at least 10 earthquakes of intensity IV-V or greater have occurred within Nebraska's boundaries. Newspaper and other reports of these earthquakes are summarized below. All quotations not otherwise identified are from Docekal (1970).

On October 9, 1872, an intensity V earthquake occurred near Maskell in Dixon County. Rockford (1873) described it as follows: "A severe shock lasting 20-30 seconds shook northeastern Nebraska. The most severe reports in South Dakota came from Fort Randall. Yankton and Sioux City experienced a severe shock; at White Swan thunderous sounds were heard. The earthquake was most noticeable on low ground, and to a lesser extent on the bluffs."

Probably the strongest earthquake having a Nebraska epicenter occurred on November 15, 1877, near Garland in northeastern Seward County. It had an intensity of VII.

"Most damage seemed to be at Columbus where a severe shock lasting 30 seconds split the courthouse walls in nine places and schoolhouse walls were badly damaged, giving rise to panic. At Omaha three strong shocks over 45 seconds shook buildings. The motion seemed to come from the east. Lincoln experienced two shocks 10 seconds apart which rocked buildings and people reported sickening sensations. At Council Bluffs, Iowa, severe, quick, successive shocks lasting 2 minutes threatened a brick building, causing people to dash into the street for safety. At Fremont, Nebraska, a severe shock rocked the courthouse and hotel perceptibly, while at Clarks, buildings rocked for nearly a minute. At West Point, Nebraska, two shocks swayed buildings and rattled windows. North Platte experienced two severe shocks lasting 40 seconds which cracked walls and overturned printing cases.

"Southeastern South Dakota was strongly shaken. At Yankton the shock was severe in the valley, lasting 20 seconds. Buildings rocked and some glass broke. At Sioux City, Iowa, severe shocks lasting 15 seconds caused panic in a church and in a high school building where one wall cracked.

"Other reports received include: Paxton (Alkali), Big Springs, De Sota, Fort Hartsuff, Fort McPherson, Genoa, Grand Island, Kearney Junction, Ogallala, Plattsmouth, Potter, Sidney, Sutton, and Wisner, Nebraska; Boone, Boonesboro, Denison, Logan, Ogden, and Tabor, Iowa; Atchinson, Kansas City, Lawrence, and Topeka, Kansas; Fort Randall, Olivet, and Springfield, South Dakota; Albert Lea, and Winnebago City, Minnesota; and at St. Joseph, Missouri. Outlying reports are also received from Dubuque, Iowa City, and Monticello, Iowa; and from La Crosse, Wisconsin. Reid (unpublished) estimated the felt area at 140,000 square miles."

On July 28, 1902, an earthquake having an intensity of V-VI occurred in Madison County. "It was felt more strongly at Battle Creek, Nebraska, where it lasted for 30 seconds, spilling water from buckets. At Tilden, Nebraska, dishes fell from shelves, plaster cracked, one chimney was destroyed and rumbling was heard. Elgin, Nebraska, reported dishes fell from shelves and windows rattled, frightening residents. A shock lasting 12 seconds and accompanied by rumbling and rattling of dishes was strongly felt at Yankton, South Dakota. Rattling of dishes or windows was reported from Santee, Oakdale, and Carroll, Nebraska. O'Neill did not feel the shock, but Petersburg, Pierce, Plainview, Norfolk, Neligh, and Creighton, Nebraska, did. Chicago, Illinois, barely felt the shock. Heck (1938) estimated the felt area at 35,000 square miles."

An earthquake of intensity VI occurred on May 9, 1906. Lasting 8 seconds, it centered near the South Dakota-Nebraska border. "It was reported all along the Niobrara Valley from Rushville to Valentine, Nebraska, and at Rosebud, South Dakota. Reid (unpublished) felt it was centered in eastern Washabaugh County, South Dakota, and estimated the felt area at 7,000-8,000 square miles. At Cody, Nebraska, plants fell from a window sill and towns for 60 miles in all directions felt the shock. Agnew and Tullis (1962) give the coordinates used here for the location of the epicenter."

On January 26, 1909, an earthquake of intensity IV-V occurred near Plainview in Pierce County. "A violent shock through Pierce and Knox counties, Nebraska, shook the schoolhouse at Plainview perceptibly."

An earthquake of intensity IV-V occurred on February 26, 1910, in Platte County. "Houses were shaken by several local shocks at Columbus, Nebraska."

"An earthquake [intensity IV-V] centered near Scottsbluff, Nebraska, shook buildings over a wide area of western Nebraska and eastern Wyoming (on August 8, 1933). Henry, Nebraska, reported a loud explosion."

On July 30, 1934, "A fairly strong earthquake [intensity VI] centered near Chadron, Nebraska, was felt throughout western Nebraska and adjacent portions of Wyoming and South Dakota. Chimneys were damaged, plaster fell, objects toppled from shelves, and guests were ordered from a hotel. Heck (1938) estimated the felt area at 23,000 square miles."

"A strong earthquake [intensity VII] had its epicenter at Tecumseh, Nebraska [on March 1, 1935]. Two shocks about 4 minutes apart were felt. The first was strong and the second weak. Many chimneys were reported cracked

Table 1
EARTHQUAKES IN NEBRASKA

[Source: A-Docekal 1970; B-Zollweg 1974; C-National Earthquake Information Service; D-Kansas Geological Survey]

Ref. No.	Date	Origin Time[1] (UTC)	Locality	Latitude Degrees North	Longitude Degrees West	Modified Mercalli (MM) Intensity	Source
1	1867 Apr 28	——	Nebraska City	40.683	95.833	IV	A
2	1872 Oct 09	16:00	Maskell	42.700	97.000	V	A
3	1875 Dec 09	09:00	Nebraska City	40.683	95.850	III	A
4	1877 Nov 15	17:45	Garland	41.000	97.000	VII	A
5	1877 Nov 15	18:30	Garland	41.000	97.000		A
6	1884 Mar 17	20:00	North Platte	41.133	100.750	IV	A
7	1896 Feb 04	11:45	Hartington	42.617	97.300	III	A
8	1898 Sep 16	09:59	Hartington	42.617	97.300	IV	A
9	1902 Jul 28	18:00	Battle Creek	42.000	97.600	V-VI	A
10	1904 Dec 01	09:00	West Point	41.833	96.733	III	A
11	1906 May 10	00:27	South Dak.— Neb. Border	43.000	101.300	VI	A
12	1909 Jan 26	20:15	Plainview	42.350	97.767	IV-V	A
13	1910 Feb 26	08:00	Columbus	41.433	97.383	IV-V	A
14	1915 Sep 16	19:00	Kirkwood	42.800	99.300	III-IV	A
15	1916 Dec	——	Stapleton	41.550	100.467	II-III	A
16	1923 Sep 10	06:30	Tekamah	41.733	96.200	III-IV	A
17	1924 Sep 24	11:00	Gothenburg	40:950	100.133	IV	A
18	1927 Oct 14	16:10	Ord	41.600	98.900	IV	A
19	1933 Aug 08	——	Scottsbluff	41.867	103.667	IV-V	A
t20	1934 May 11	10:40	North Loup	41.533	98.750	IV	A
21	1934 Jul 30	07:20	Chadron	42.850	103.000	VI	A
22	1934 Nov 08	04:45	Wood Lake	42.600	100.233	III	A
23	1935 Mar 01	11:00	Tecumseh	40.350	96.150	VII	A
24	1935 Mar 01	11:04	Tecumseh	40.350	96.150		A
25	1935 Mar 22	22:45	Tecumseh	40.350	96.150	IV	A
26	1938 Mar 24	13:11	Fort Robinson	42.683	103.417	IV	A
27	1948 Apr 07	——	Broken Bow	41.400	99.617	II-III	A
28	1949 May 13	04:15	Atkinson	42.517	98.967	IV	A
29	1955 Feb 25	01:45	Cotesfield	41.350	98.633	IV	A
30	1963 Mar 09	15:25	Chadron	42.850	103.000	II-III	A
31	1963 Jun 06	02:47	Syracuse	40.700	96.200	III	B
32	1964 Mar 28	10:21	Merriman	42.800	101.667	VII	A
33	1966 Sep 09	09:51		41.30	98.81	IIE	C
34	1972 Oct 16	05:48	Bassett	42.340	99.590	V	C
35	1975 May 13	07:54	Bartlett	42.120	98.450	VI	C
36	1975 Aug 25	10:01		42.57	101.55	IIE	C
37	1977 Aug 18	10:34		41.42	98.47	IIE	C
38	1977 Dec 01	13:05	NE Red W. Co.	40.31	100.37	III	D
39	1977 Dec 01	13:23	NE Red W. Co.	40.21	100.30	III	D
40	1978 May 07	16:06	SW Cherry Co.	42.26	101.95	V	C
41	1978 May 20	01:54		40.11	100.32	IIE	C
42	1979 Jun 06	16:16	E Red W. Co.	40.14	100.35	III	D
43	1979 Jul 16	00:04	E Red W. Co.	40.17	100.29	III	D
44	1979 Aug 02	04:16	SE Red W. Co.	40.17	100.36	III	D
45	1979 Aug 31	08:00	SE Red W. Co.	40.14	100.23	IV	D
46	1981 Sep 07	00:38	NE Cherry Co.	42.90	100.60	IV	C
47	1982 Jun 03	14:21	Wymore	40.19	96.58	II	D
48	1983 May 06	06:15	NE Sheridan Co.	42.96	102.20	III	C
49	1983 Jun 26	12:43	Dunbar	40.70	96.05	IV	D
50	1987 Jan 01	08:02	Crawford	42.79	103.48	III	C
51	1989 Feb 08	05:16	Merriman	42.80	101.60	IV	C

[1](UTC) Coordinated Universal Time—Subtract 6 hours for Central Standard Time.
E = Estimated intensity

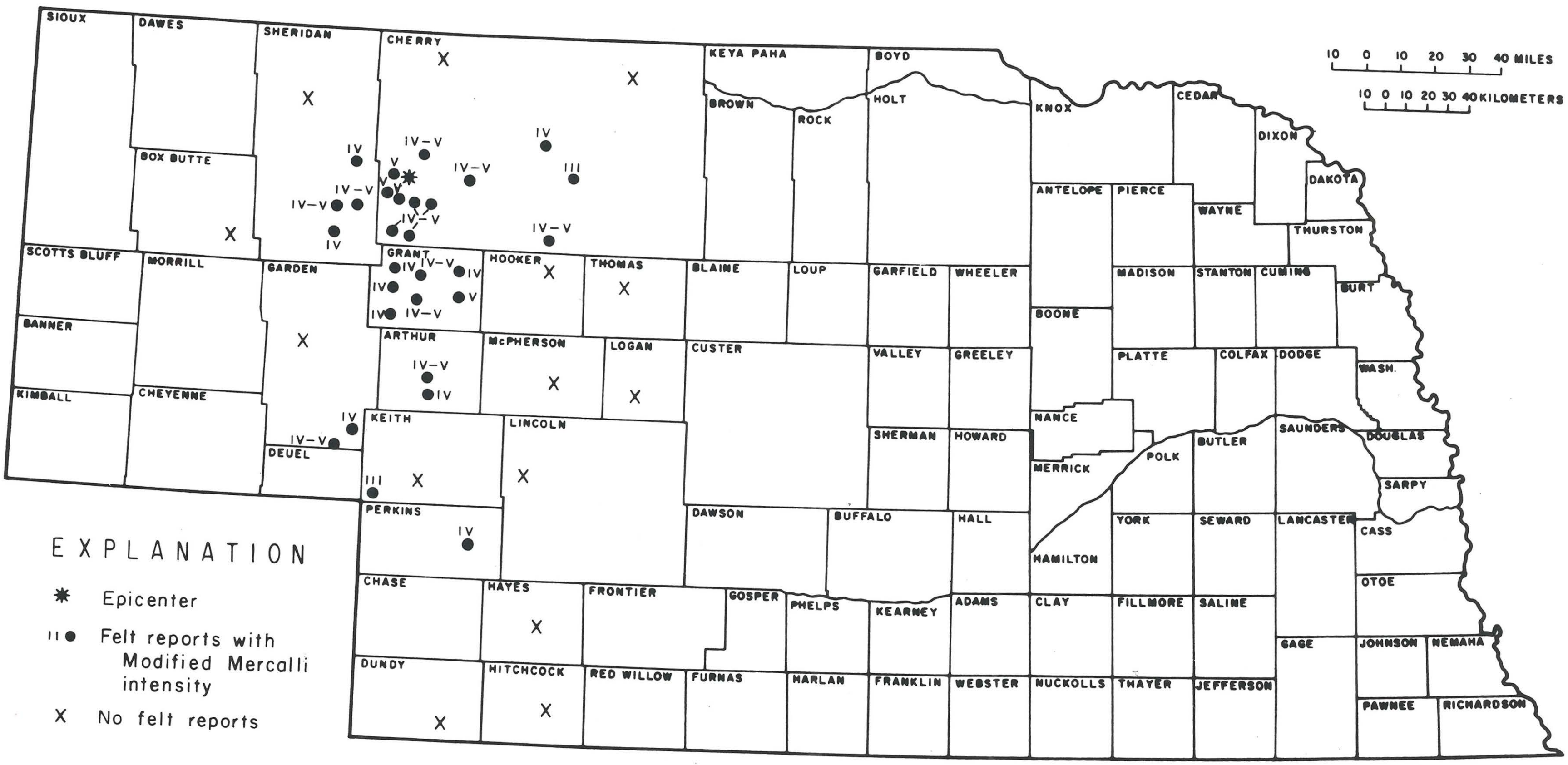

Fig. 12. Area affected by the May 7, 1978, earthquake.

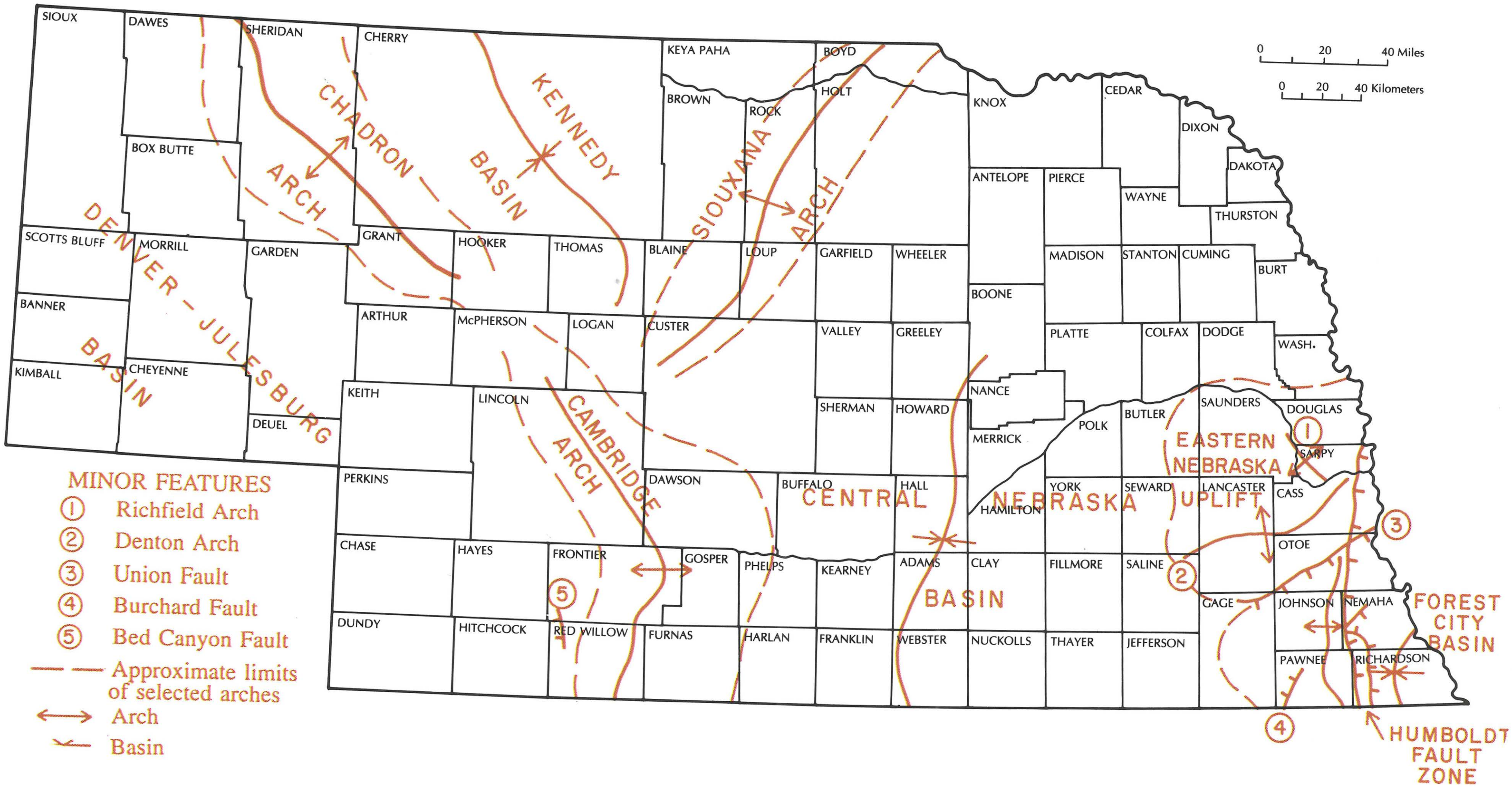

Fig. 13. Principal structural features of Nebraska.

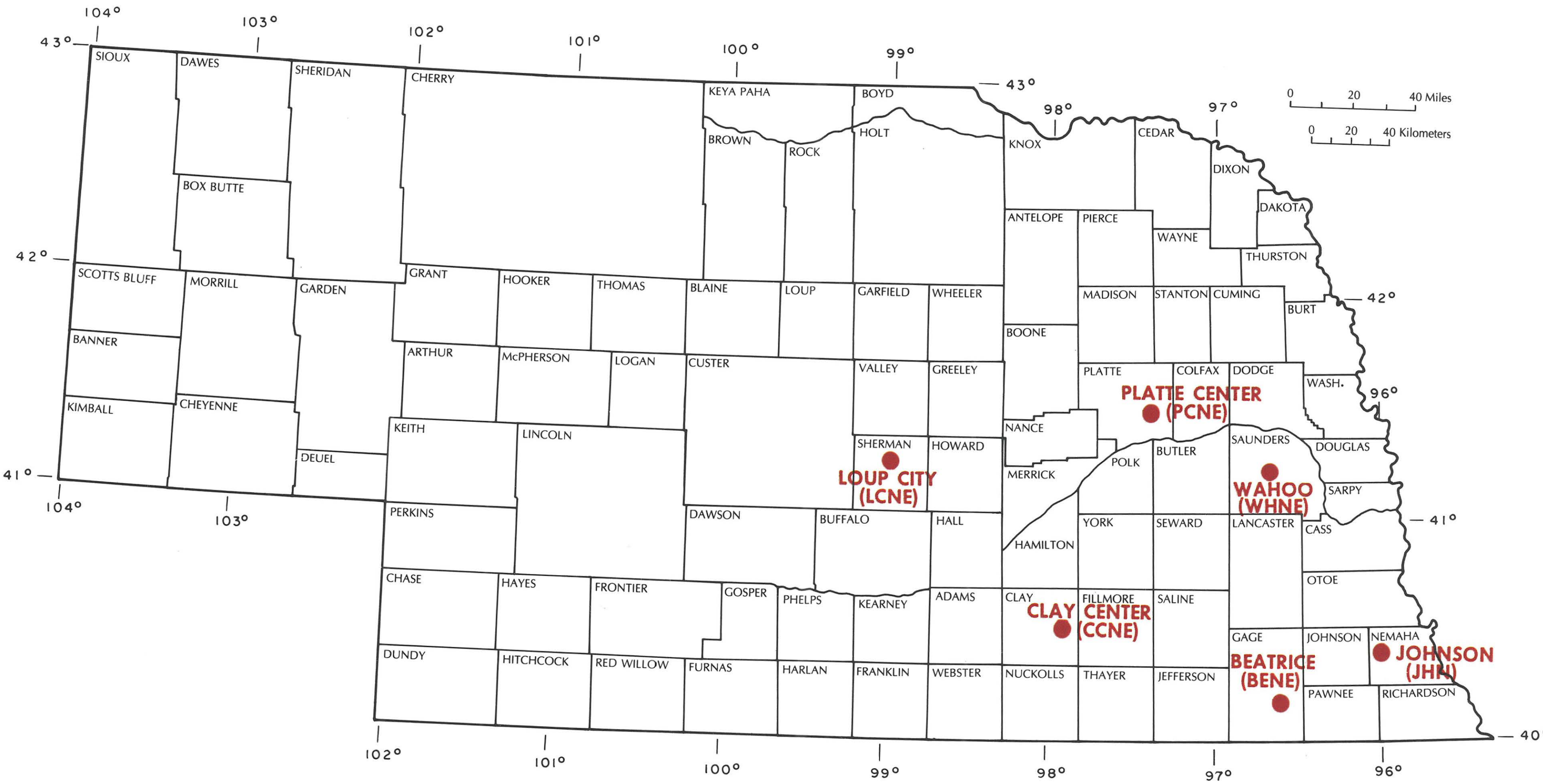

Fig. 14. Location of earthquake-monitoring stations in Nebraska.

Table 2
MICROEARTHQUAKES IN NEBRASKA

Ref. No.	Date	Origin Time (UTC)[1] (h)(m)(s)	Latitude Degrees North	Longitude Degrees West	Depth[2] (km)	Magnitude[3]
1	1977 Aug 18	10:34:25.21	41:24.90	98:28.07	5.00	2.5
2	1977 Dec 1	13:04:34.20	40:18.53	100:22.00	5.00	2.3
3	1977 Dec 1	13:22:38.57	40:12.52	100:17.87	5.00	2.4
4	1978 Jan 13	20:15:33.39	40:05.58	95:42.00	5.00	1.7
5	1978 Feb 3	0:25:47.62	40:01.92	100:20.00	5.00	2.4
6	1978 Sep 14	8:06:18.59	40:53.76	100:22.00	5.00	2.2
7	1979 Apr 8	22:46:10.41	40:58.12	98:33.83	0.67	2.4
8	1979 Jun 6	16:16:21.91	40:08.61	100:20.88	1.00	2.5
9	1979 Jun 12	11:13:11.88	40:24.33	96:03.26	2.07	1.8
10	1979 Jul 16	0:03:48.18	40:10.07	100:17.22	5.00	2.7
11	1979 Jul 16	1:34:20.32	40:11.59	100:20.70	5.00	2.5
12	1979 Jul 16	5:27:01.42	40:11.45	100:20.00	9.08	1.3
13	1979 Jul 16	6:08:09.89	40:11.32	100:20.73	11.09	1.5
14	1979 Jul 16	7:05:56.02	40:12.00	100:19.90	7.08	1.1
15	1979 Jul 24	4:16:46.09	40:12.47	100:26.00	0.88	2.2
16	1979 Jul 24	8:04:46.26	40:27.94	99:37.38	0.87	1.9
17	1979 Aug 2	4:16:21.66	40:10.34	100:21.44	0.84	2.5
18	1979 Aug 13	11:09:47.65	40:06.80	100:30.10	1.50	1.7
19	1979 Aug 14	23:59:31.37	40:10.39	100:20.58	1.76	1.5
20	1979 Aug 15	6:45:53.87	40:08.68	100:20.34	1.51	1.5
21	1979 Aug 15	16:07:07.14	40:08.49	100:26.43	1.23	1.3
22	1979 Aug 31	8:00:11.70	40:08.31	100:20.22	1.53	2.2
23	1979 Nov 19	4:58:43.40	40:14.86	100:02.77	13.57	1.5
24	1979 Nov 29	22:02:31.21	40:09.80	100:21.64	3.15	1.9
25	1980 Apr 26	14:21:48.50	40:43.99	99:43.91	5.00	2.3
26	1980 Aug 13	5:50:11.83	41:53.59	97:06.01	9.90	2.1
27	1981 Mar 13	12:42:16.68	40:53.44	99:41.67	5.00	2.4
28	1981 Mar 20	5:09:48.17	40:10.31	100:19.60	1.75	1.9
29	1981 Apr 20	18:18:13.48	41:02.14	97:49.68	5.00	2.4
30	1981 Jun 26	18:55:02.20	41:31.02	97:37.95	4.21	2.7
31	1981 Jul 17	12:41:57.77	41:34.06	97:18.80	5.00	1.9
32	1981 Oct 9	21:54:25.58	41:15.83	98:41.88	5.00	2.5
33	1981 Dec 8	6:20:42.00	40:26.84	99:44.61	5.00	2.2
34	1982 Apr 1	22:33:55.05	40:09.45	100:23.16	2.57	1.7
35	1982 Apr 3	19:31:00.09	40:10.97	100:21.20	1.99	1.3
36	1982 Apr 5	01:44:59.30	40:10.85	100:19.04	3.49	1.0
37	1982 Apr 8	15:00:32.63	40:10.54	100:21.57	4.92	0.9
38	1982 Apr 11	21:05:59.18	40:09.37	100:22.84	3.82	1.0
39	1982 Apr 13	11:51:04.14	40:10.01	100:22.81	2.54	0.7
40	1982 Apr 13	13:14:43.62	40:10.01	100:24.24	5.00	0.7
41	1982 Apr 15	11:04:41.57	40:11.40	100:21.39	3.05	——
42	1982 Apr 21	13:49:49.31	40:07.85	100:25.25	4.06	0.8
43	1982 Apr 21	18:45:17.05	40:09.26	100:24.01	0.57	1.1
44	1982 Apr 21	18:46:50.82	40:09.01	100:24.67	5.00	0.8
45	1982 Apr 22	04:25:14.20	40:10.35	100:20.99	1.23	0.5
46	1982 Apr 22	11:47:47.68	40:10.75	100:23.11	1.85	0.5
47	1982 May 5	18:27:30.71	40:10.01	100:24.36	5.00	0.0
48	1982 May 5	18:57:35.34	40:08.91	100:23.16	4.46	0.3
49	1982 May 9	10:26:46.23	40:10.01	100:22.21	3.16	0.7
50	1982 Jun 3	14:20:50.20	40:10.91	96:35.12	4.68	2.2
51	1982 Aug 27	14:19:25.39	40:05.67	95:57.96	5.00	1.6
52	1982 Dec 23	02:22:00.79	40:49.06	99:32.98	5.00	2.5
53	1983 Feb 12	16:24:03.22	41:23.84	99:17.52	8.88	1.8
54	1983 Feb 26	06:24:58.34	41:22.45	98:43.12	5.00	1.8
55	1983 Jun 20	02:22:36.31	41:28.30	97:42.42	5.00	1.7
56	1983 Aug 2	06:49:43.18	40:20.81	95:56.89	5.00	1.4
57	1983 Oct 29	10:38:56.18	40:04.92	96:04.76	5.00	1.6
58	1983 Nov 16	05:47:45.55	42:40.86	100:36.76	5.00	2.2
59	1983 Dec 1	11:23:50.53	41:13.90	100:06.71	5.00	2.3
60	1984 Jan 7	19:45:34.90	40:03.99	97:49.64	5.00	1.8
61	1984 Jan 27	03:33:28.12	41:00.60	98:28.52	9.53	1.7
62	1984 Dec 18	16:12:47.70	41:33.57	97:11.01	5.00	1.8
63	1985 Feb 8	09:13:55.43	40:22.84	95:56.58	5.00	1.6
64	1985 Apr 15	14:29:21.51	40:26.24	98:06.66	8.64	1.9

Table 2 (cont.)

Ref. No.	Date	Origin Time (UTC)[1] (h)(m)(s)	Latitude Degrees North	Longitude Degrees West	Depth[2] (km)	Magnitude[3]
65	1985 Jun 3	09:13:59.21	40:14.47	100:08.11	5.00	1.8
66	1985 Jul 18	15:53:49.01	41:24.66	97:34.95	0.25	1.4
67	1985 Jul 20	11:51:32.54	41:28.12	98:50.27	1.50	2.3
68	1985 Jul 22	14:05:44.33	41:26.04	97:39.53	5.00	1.4
69	1985 Sep 14	17:32:35.47	41:11.84	96:43.25	19.48	2.3
70	1985 Oct 1	03:29:14.62	41:04.33	96:47.28	5.00	1.7
71	1985 Dec 26	00:13:48.64	41:15.53	98:22.58	2.97	1.5
72	1986 Feb 2	11:04:45.87	41:24.76	98:32.62	9.94	1.9
73	1986 Sep 24	07:34:58.52	40:37.80	95:54.09	5.00	2.0
74	1987 Jan 24	10:35:24.03	41:41.37	98:09.45	6.78	2.2
75	1987 Feb 2	09:01:25.13	41:07.71	98:49.92	3.11	2.2
76	1987 Feb 16	02:29:34.67	41:24.16	97:47.32	5.00	1.5
77	1987 Mar 15	17:32:35.18	42:00.44	98:27.73	5.00	1.6
78	1987 Jul 12	17:32:06.12	41:32.25	100:35.82	5.00	2.5
79	1987 Aug 10	14:05:48.37	40:01.21	96:01.21	14.46	1.4
80	1987 Nov 29	03:39:03.55	41:16.89	98:41.06	5.00	1.7
81	1988 Jan 18	13:47:24.66	41:20.69	98:43.63	0.75	1.97
82	1988 Jun 21	19:38:19.20	40:01.68	96:02.80	6.07	1.53
83	1988 Aug 8	17:49:04.96	40:34.79	95:56.55	5.00	1.15
84	1988 Oct 15	19:43:00.65	41:31.06	99:05.59	1.23	1.7
85	1988 Oct 16	11:18:27.88	42:27.63	97:50.57	0.82	2.2
86	1989 Feb 8	05:15:47.84	42:34.20	101:54.54	9.97	4.0
87	1989 Feb 23	23:39:29.20	40:04.08	96:00.60	5.00	1.7
88	1989 Mar 14	19:35:10.99	40:04.05	96:06.67	9.38	2.2
89	1989 May 2	22:35:07.59	40:02.19	96:02.72	10.73	1.8
90	1989 May 8	18:51:19.82	40:02.25	96:04.95	22.31	2.1
91	1989 May 10	19:48:55.63	40:01.07	96:01.46	5.00	2.0

[1](UTC) Coordinated Universal Time.—Subtract 6 hours for Central Standard Time.
[2]Depth calculated in kilometers or fixed at 5.00 km.
[3]Duration magnitude calculated from equation derived by Oklahoma Geological Observatory.

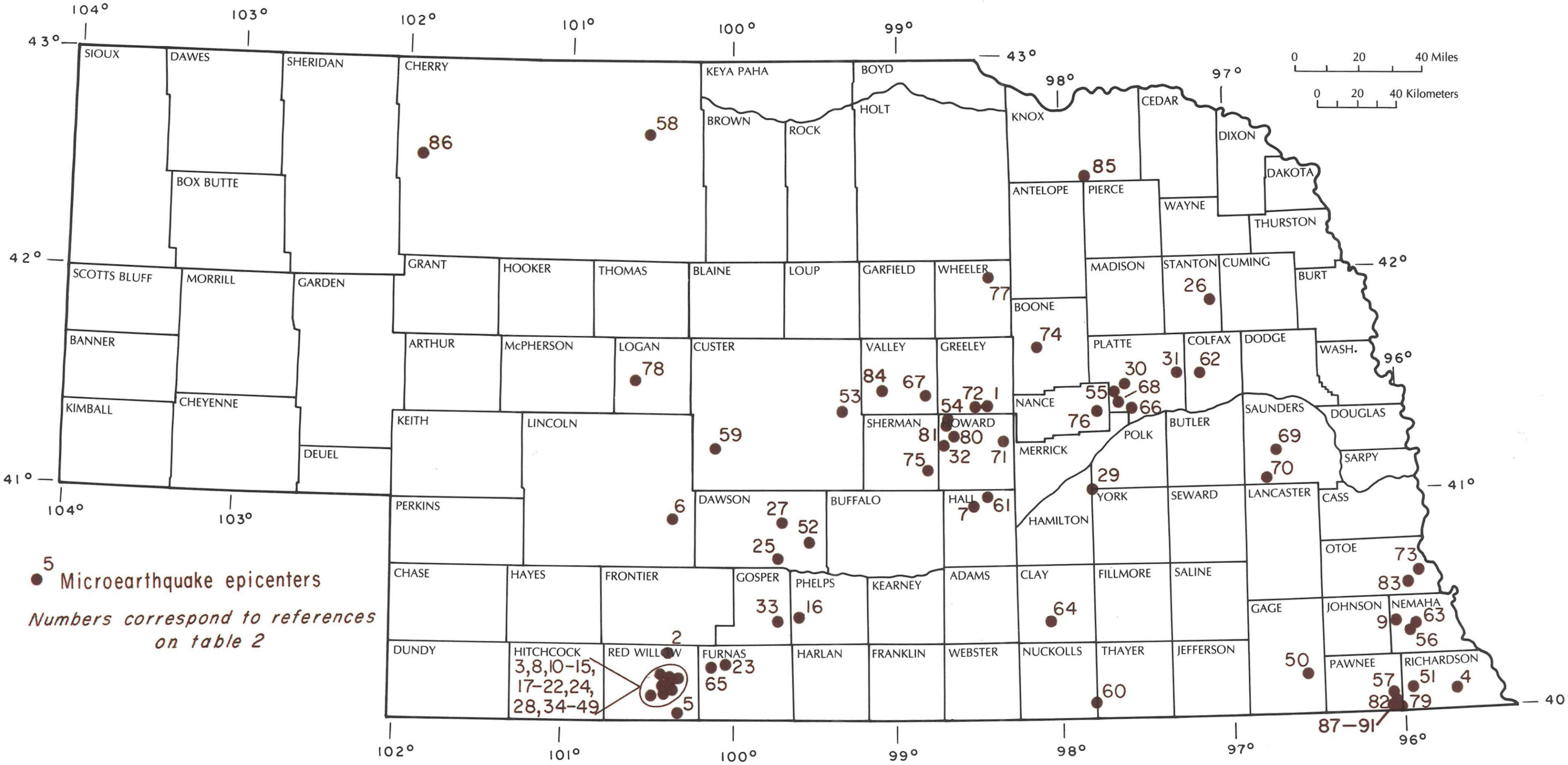

Fig. 15. Microearthquakes in Nebraska.

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