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Preliminary isoseismal map for the Northeastern  
Ohio earthquake of January 31, 1986

by

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

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INTRODUCTION

The January 31, 1986 Northeastern Ohio earthquake was felt over a contiguous area of approximately 122,000 mi<sup>2</sup> of Canada and the United States and had a maximum Modified Mercalli intensity (MMI) of VI. The hypocenter was located at 41.650°N., 81.162°W., a fixed depth of 10 km, origin time 16h46m43.33s UTC (J. Dewey, USGS, personal communication), a location about 10 km southeast of Painesville, Ohio. The magnitude was computed at 5.0mb by the USGS, National Earthquake Information Center (NEIC). Seventeen people received medical treatment for injuries from falls during the evacuation of buildings, cuts from flying broken glass, bruises from falling objects, and exposure due to extended periods in the cold weather while buildings were being examined for damage.

This is only the second earthquake to cause damage in northeastern Ohio; the other was an earthquake centered near Berea (about 20 km southwest of Cleveland) on April 9, 1900. It caused chimney damage (MMI=VI) at Berea. Besides the 1900 event, 10 earthquakes before 1986 have caused damage in Ohio. Seven were in the Anna region of western Ohio (maximum MMI=VIII) during the period 1875-1977 (Stover and others, 1984), the other three were in southeastern Ohio. Two of the three occurred south of Zanesville in 1776 and 1952 (MMI=VI), the other was near Pomeroy on the Ohio River (MMI=VI).

The seismicity of northeastern Ohio for earthquakes with magnitudes 2.5 and larger or shocks that were felt is shown in figure 1 and listed in table 1. These data were taken from Stover and others (1984); USGS/NEIC, Preliminary Determination of Epicenters, Monthly Listing; and publications of the Geophysics Division, Geological Survey of Canada. Figure 1 shows the 1986 earthquake epicenter (plotted as a star) located within a seismic zone that generally extends along the south coast of Lake Erie. It has the largest instrumental magnitude of those listed in table 1; however, the MMI=VI event in 1900 has no instrumental magnitude available for comparison. Six aftershocks of the January 31, 1986 earthquake (only one is listed in table 1) were recorded in the period February 2-10, 1986. The magnitudes ranged from -0.5 to 2.5; all of the aftershocks were located very near the epicenter of the main shock (Borcherdt, R. D., 1986).

The felt area for the 1986 Northeastern Ohio earthquake appears to be consistent with other earthquakes in this region for shocks of comparable magnitude although the maximum intensity is much lower. The 1986 earthquake (magnitude 5.0) occurred about midway between the two largest magnitudes events located in the Ohio-Lake Erie region. These two events were the August 12, 1929, Attica, New York earthquake located at 42.91°N., 78.40°W., magnitude 5.2, MMI=VIII; and the March 9, 1937 Anna, Ohio earthquake located at 40.47°N., 84.28°W., magnitude 4.9, MMI=VIII. The felt areas of all these

earthquakes are also comparable; 122,000 square miles for the 1986 Northeastern Ohio event, estimates by various authors from 50,000 to 125,000 square miles for the 1929 Attica, New York event, and from 110,000 to 150,000 square miles for the 1937 Anna, Ohio event. Even though the 1929 New York and 1937 Ohio earthquakes are of comparable magnitude and felt area with the January 31, 1986 Ohio earthquake they both caused much more damage resulting in a MMI=VIII versus MMI=VI for the one in 1986.

#### ISOSEISMAL MAP

Figure 2 shows the areal distribution of intensity. This isoseismal map was compiled from data obtained through a USGS questionnaire canvass of postmasters located within a radius of 800 km of the epicenter and police departments within a 100 km radius. This canvass was supplemented by data from a survey in the epicentral region by Weston Geophysical Corporation, Westboro, Mass. and by numerous press reports. The intensities for localities in Canada were furnished by R. J. Wetmiller, Geophysics Division, Geological Survey of Canada, Ottawa, or interpreted from press reports. The data used for the map compilation consisted of 3483 reports in the United States and Canada, 1528 of them were assigned intensities and the remainder were reported as not felt. All intensities were rated using the Modified Mercalli Intensity Scale of 1931 (Wood and Neumann, 1931). It should be emphasized that all the intensity ratings are preliminary and may be revised with later analysis or from the addition of new data.

The isoseismal defining the limit of perceptibility in figure 2 (the II-III isoseismal) is drawn to enclose all contiguous localities that felt the earthquake. This contiguous area covers most of Ohio and parts of Illinois, Indiana, Kentucky, Michigan, New York, Pennsylvania, West Virginia, and Ontario, Canada. Three anomalous areas in eastern Pennsylvania outline three or more localities in close proximity that reported feeling the earthquake. A number of isolated localities outside the contiguous felt area also reported feeling this earthquake. These localities are in the states of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, New York, Pennsylvania, Virginia, and West Virginia. These isolated felt reports are not plotted in figure 2. They are widely scattered and include Baltimore, Md. (MMI=2), Washington, D. C. (MMI=2), Richmond, Va. (MMI=3), Madisonville, Ky. (MMI=3), and Des Plaines, Ill. (MMI=2). Most of the isolated felt reports originated from persons located on upper floors of multi-story buildings.

There are also anomalies within the contiguous felt area. A MMI=IV anomaly is shown south and east of Cleveland within the area defined by the MMI=V isoseismal; two MMI=V anomalies near Detroit, Mi. and a MMI=III anomaly in eastern Ohio are within the MMI=IV isoseismal; and a MMI=IV-VI anomaly in northwestern Ohio and a IV-V one in eastern Michigan are within the MMI=II-III isoseismal.

The isoseismals are drawn to represent the general consensus of the data and do not define each intensity value. For example, a V isoseismal may enclose a few localities with higher or lower intensity but most of the data within an isoseismal was assigned an intensity of V.

## INTENSITY DISTRIBUTION

Only minor damage resulted from this earthquake even though it was felt over a large area of the United States and Canada. The epicenter of the January 31 earthquake locates near the county-line between Lake and Geauga Counties and most of the damage occurred in these two Counties. The damage to buildings consisted mostly of cracked chimneys, brick walls, and plastered walls. Other types of damage were broken glassware and windows in homes and businesses. The glassware breakage occurred when glass items were thrown off shelves and from china being knocked about in china closets or kitchen cabinets. The damage at locations rated MMI=VI are listed below:

### OHIO

Bainbridge, Geauga Co.-- A chimney shifted and several walls were cracked at the Kenston Intermediate School.

Bowling Green, Wood Co.--

Wood County Office Building-- cracked marble in the front entranceway, damage to the Law Library ceiling, cracked and fallen plaster in the Sheriff's entry to the parking garage, damage to tiles in front of several parking garage spaces, about 10-ft-long cracks in the ceramic wall tiles in four restrooms on the 1st and 2nd floors, a 1/2 in. wide crack between floor and wall of the men's restroom on the 1st floor, some mortar joints split in the stairwell on the 1st, 2nd, and 5th floors.

Chardon, Geauga Co.-- plaster fell in three offices on the 3rd floor of the courthouse annex, chimneys were cracked, building foundations were cracked, a double plate glass picture window in a home on Water Street was broken, many items were thrown off store shelves. Glass items were broken.

Geneva, Ashtabula Co.-- floor to ceiling cracks in the high school gymnasium and hairline cracks at expansion joints, cracks in the plaster at the elementary school, chimneys and foundations were cracked, many glass items were broken.

Grand River, Lake Co.-- a 6 in. water main was broken at a joint; wood panels came loose and cracks enlarged at Western Reserve Montessori School, other reports of cracked plaster, and merchandise thrown off store shelves.

Huntsburg, Geauga Co.-- Several cracks in the exterior brick walls and the interior walls and ceilings of the Opera House section of the 78-year-old Town Hall, a portion of the chimney at the newly-renovated park pavilion moved several inches, a newly poured concrete floor cracked, chimneys and brick walls were cracked, and several cement-block basement walls were cracked.

Kirtland, Geauga Co.-- chimneys, basement floors, and cement-block basement walls were cracked; several pieces of plaster fell from the walls and ceiling of the Kirtland Temple Visitor Center; a suspended ceiling fell on the 3rd floor of Lakeland Community College.

Leroy, Geauga Co.-- a cracked wall and broken windows at the Leroy Elementary School, several cracked chimneys and one fireplace, and bricks fell from one chimney.

Madison, Lake Co.-- in Madison High School the cement-block walls were cracked and ceiling tiles fell, other damage included cracked chimneys with bricks falling from some, and cracks in basement floors.

Mentor, Lake Co.-- cracked walls at Center Street and Garfield Elementary Schools and at Memorial Junior High School, several ceiling tiles fell and many merchandise were thrown off shelves in Heinen's Supermarket, ceiling tiles also fell at the Great Lakes Mall, one window was broken and six cracked at St. Bede's Catholic Church, the press reported 15 buildings damaged.

Metals Park, Geauga Co. (west of Newburg)-- cracks in the stairs of the American Society of Metals building, cracked chimneys, small sidewalk cracks, and hairline plaster cracks.

Middlefield, Geauga Co.-- cracked chimneys, a cracked re-inforced concrete wall, hairline cracks in plaster walls, cracked windows, and a report of visible waves on the ground.

Painesville, Lake Co.-- at Lake Erie College, 19 windows were cracked or broken and a large crack opened in the stairwell of the Commons (dining facility), cracks in the walls and ceilings of Thomas W. Harvey High School, tiles fell from the ceiling at Lake East Hospital, other damage included damaged chimneys, cracked plaster, cracked basement walls and a fireplace front.

Perry, Lake Co.-- at one residence a garage ceiling cracked with the crack extending part-way down the wall, baseboards separated from the wall in several rooms, bathroom walls separated from the ceiling leaving a 3/16 in. crack, broke dishes in a china closet, broke windows, and cracked a basement floor.

Perry Nuclear Power Plant, Lake Co.-- hairline floor and wall cracks and several minor leaks in non-safety piping.

Thompson, Geauga Co.-- cracks in a gymnasium wall of the Lodgemont Elementary and Junior High School, cracks in walls and basement floors, cracked chimneys, and glassware broken.

Warren, Trumbull Co.-- Warren Western Reserve High School had some cracked walls.

Willoughby, Lake Co.-- some broken windows, cracks in plaster board walls, cracked cement-block foundation, few broken glassware, many merchandise thrown off store shelves, and cracks in the street.

#### **PENNSYLVANIA**

Albion, Erie Co.-- many large cracks in plaster/plaster board walls; cracked chimneys, foundations, and exterior brick walls; a few cracked windows; and a few glassware broken.

Linesville, Crawford Co.-- cracked chimneys and a foundation, hairline plaster cracks, a few glassware broken, and a few cracked windows.

#### **REFERENCES CITED**

- Borcherdt, R. D., Ed., 1986, Preliminary report on aftershock sequence for earthquake of January 31, 1986 near Painesville, Ohio: U.S. Geological Survey Open-File Report 86-181, p. 12-15.
- Stover, C. W., Reagor, B. G., and Algermissen, S. T., 1984, United States earthquake data file: U.S. Geological Survey Open-File Report 84-225, 123p.
- 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.

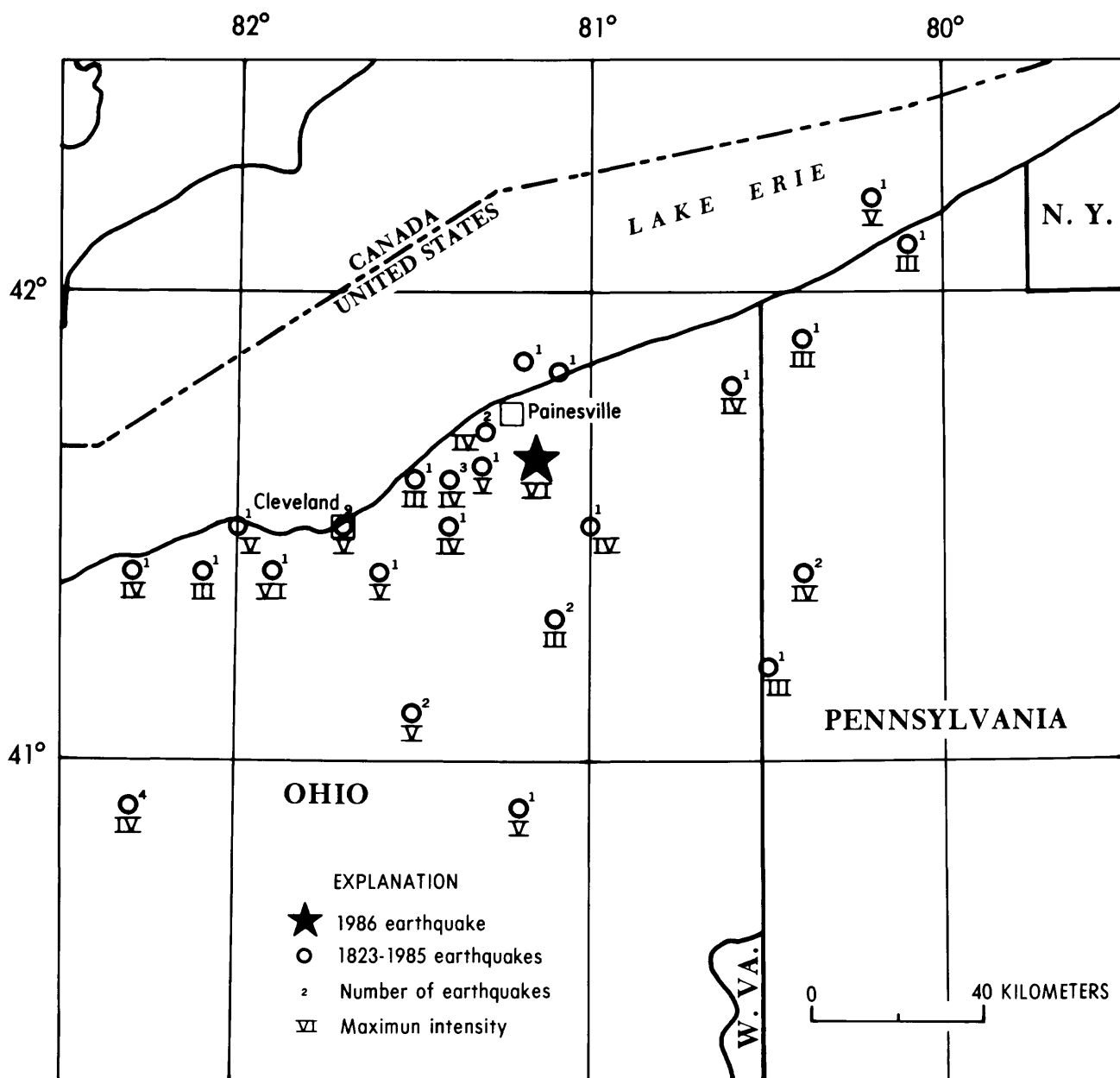
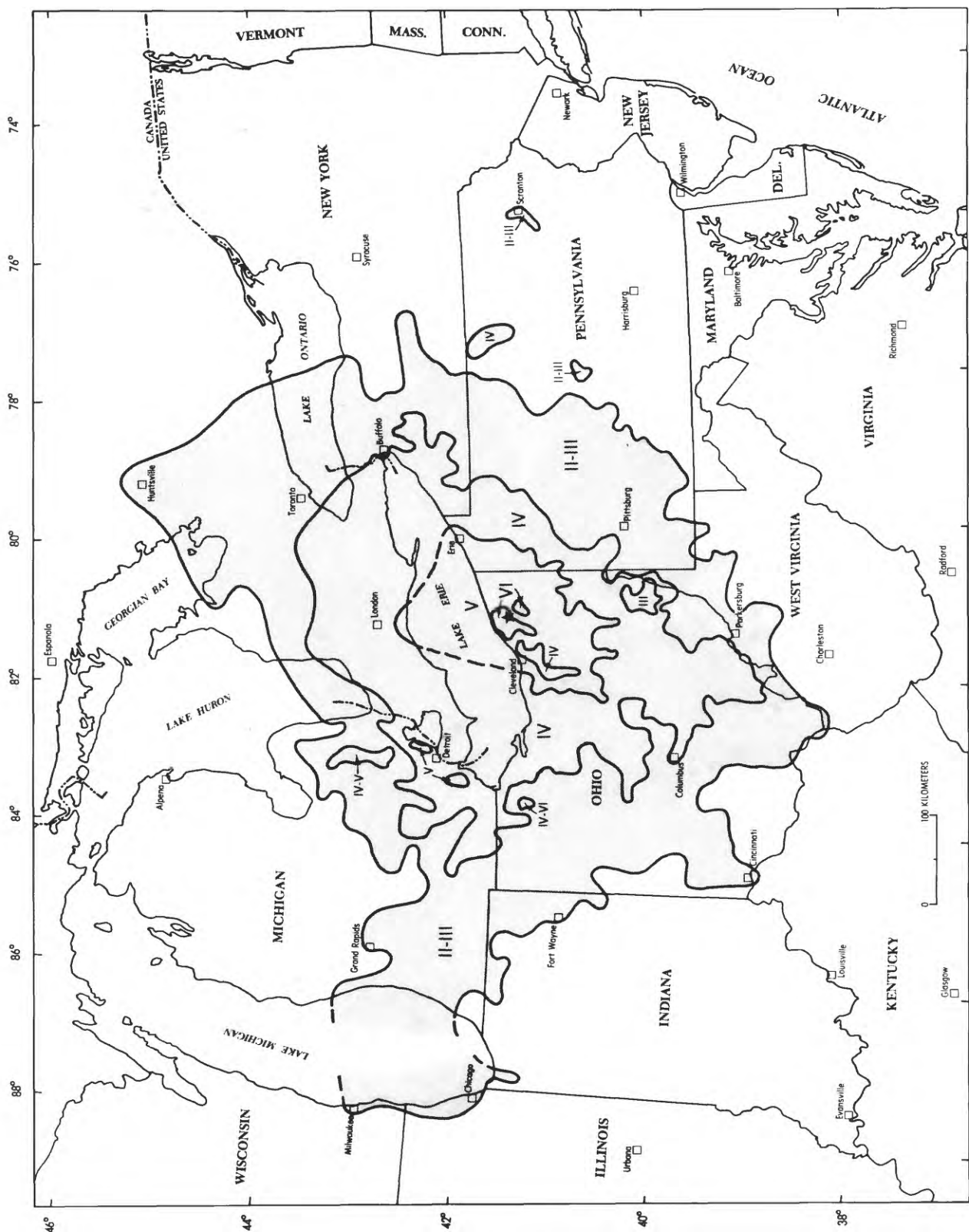


Figure 1. Earthquakes in Northeastern Ohio and Northwestern Pennsylvania, 1823-1986.



**Figure 2.**— Isoseismal map for Northeastern Ohio earthquake of January 31, 1986. The solid star represents the epicenter.

Table 1.-- List of earthquakes shown in Figure 2.

DATE	TIME	LAT(°)	Lon(°)	DEP(km)	MAG	INTENSITY
05 30 1823	-- -- --	41.500N	81.000W	--	--	IV
07 08 1836	-- -- --	41.500N	81.700W	--	--	IV
10 01 1850	-- -- --	41.400N	82.300W	--	--	IV
03 01 1857	01 40 00	41.800N	80.600W	--	--	IV
04 16 1858	12 00 00	41.700N	81.300W	--	--	IV
01 13 1867	-- -- --	41.500N	81.700W	--	--	III
07 23 1872	-- -- --	41.400N	82.100W	--	--	III
08 17 1873	14 00 00	41.200N	80.500W	--	--	III
01 18 1885	11 30 00	41.300N	81.100W	--	--	III
08 15 1885	05 05 00	41.300N	81.100W	--	--	III
10 23 1898	-- -- --	41.500N	81.700W	--	--	III
04 09 1900	14 00 00	41.400N	81.900W	--	--	VI
04 20 1906	18 30 00	41.500N	81.700W	--	--	IV
06 27 1906	21 10 00	41.400N	81.600W	--	4.0ML	V
04 12 1907	19 28 00	41.500N	81.700W	--	--	III
09 27 1921	04 32 00	42.100N	80.100W	--	3.0ML	III
01 29 1927	-- -- --	40.900N	81.200W	--	--	V
09 09 1928	21 00 00	41.500N	82.000W	--	3.7ML	V
06 10 1929	-- -- --	41.500N	81.700W	--	--	III
09 17 1929	19 16 00	41.600N	81.500W	--	--	III
01 21 1932	-- -- --	41.100N	81.500W	--	3.7ML	V
10 29 1934	20 07 00	42.200N	80.200W	--	4.0ML	V
11 05 1934	20 00 00	41.900N	80.400W	--	--	III
05 26 1935	-- -- --	41.500N	81.400W	--	--	IV
08 26 1936	09 00 00	41.400N	80.400W	--	3.0ML	III
08 26 1936	09 55 00	41.400N	80.400W	--	--	IV
05 31 1940	17 00 00	41.100N	81.500W	--	--	II
06 16 1940	02 30 00	40.900N	82.300W	--	3.0ML	IV
07 28 1940	09 30 00	40.900N	82.300W	--	--	III
08 15 1940	10 35 00	40.900N	82.300W	--	--	III
08 19 1940	03 30 00	40.900N	82.300W	--	--	III
03 09 1943	03 25 24.9	41.628N	81.309W	07	4.5Mn	V
12 03 1951	07 02 00	41.600N	81.400W	--	3.2ML	IV
12 07 1951	21 00 00	41.600N	81.400W	--	--	II
12 21 1951	12 00 00	41.600N	81.400W	--	--	II
05 26 1955	18 09 00	41.500N	81.700W	--	4.0ML	V
06 29 1955	01 15 33	41.500N	81.700W	--	3.6ML	V
05 01 1958	22 46 31	41.500N	81.700W	--	4.3ML	V
01 22 1983	07 46 57.9	41.854N	81.191W	05	2.7Mn	--
11 19 1983	16 22 20.0	41.830N	81.090W	18	2.5Mn	--
01 31 1986	16 46 43.3	41.650N	81.162W	10	5.0mb	VI
02 07 1986	18 36 22.3	41.645N	81.157W	06	2.5Mn	FELT