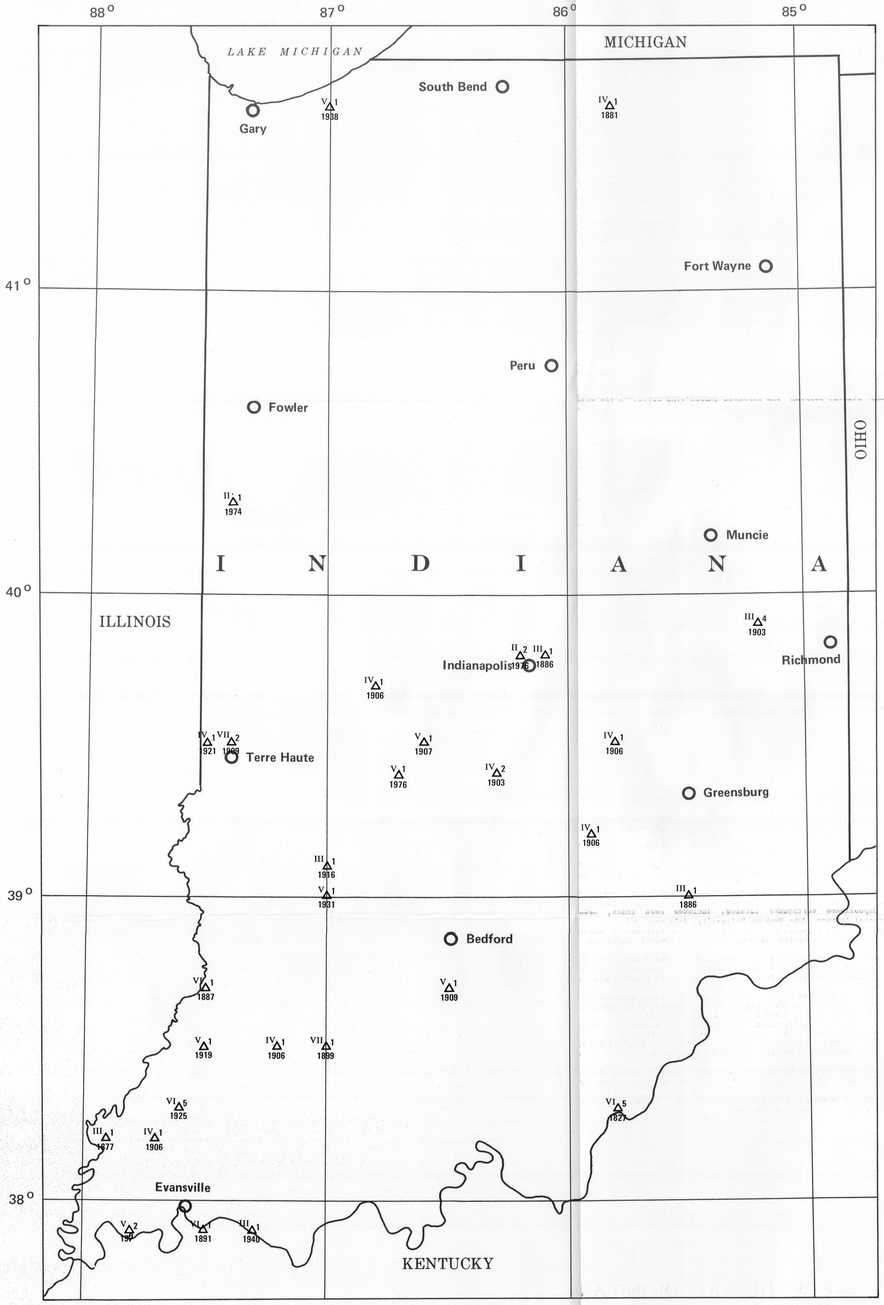
DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF—1974



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 boundaries of Indiana, even though earthquakes in nearby states may have been felt or may have caused damage in Indiana.

The data in table 1 were used to compile the seismicity map; these data are a corrected, expanded, and updated (through 1983) 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 intensities were assigned where none had been before. Many earthquakes were added to the original list from new data sources as well as from some old data sources that had not been previously used. The data in table 1 represent best estimates of the location of the epicenter, magnitude, and intensity of each earthquake on the basis of historical and current information. Some of the aftershocks from large earthquakes are listed, but not all, especially for earthquakes that occurred before seismic instruments were universally used.

The latitude and longitude coordinates of each epicenter were rounded to the nearest tenth of a degree and sorted so that all identical locations were grouped and 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 arabic number to the right of the triangle. A Roman numeral to the left of a triangle is the maximum Modified Mercalli intensity (Wood and Neumann, 1931) of all earthquakes at that geographic location. The absence of an intensity value indicates that 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 TABLES

The data in table 1 are listed chronologically in the following categories: date, origin time in Coordinated Universal Time (UTC), N. latitude, W. longitude, depth, hypocenter quality and reference, magnitude, intensity (Modified Mercalli), and intensity reference. The letter F is recorded in the intensity column if an earthquake was felt but not enough information was available to assign an intensity. Table 1 also has some basic limitations in terms of the size (magnitude or intensity) of the earthquakes listed. All felt earthquakes or those with computed magnitudes greater than 2.5 are listed. If no magnitude was computed and the earthquake was felt or an epicenter published, it was included in the earthquake list. The low-magnitude events located in recent years with data from dense seismograph networks have not been included.

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

1. Leaders (..) indicate information not available.
2. Latitude and longitude are listed to a hundredth of a degree if they have been published with that degree of accuracy or greater; however, most historical events have assigned locations based on felt or damage information and are listed in table 1 only to the nearest degree or tenth of a degree. An asterisk (*) to the right of the longitude indicates that the latitude and longitude were not given in the source reference but were assigned by the compilers of the data file. An x to the right of the longitude indicates that the event is an explosion, a suspected explosion, a rockburst, or some other nontectonic event; these have not been plotted on the map. A question mark (?) to the right of the longitude indicates that published descriptions of the event are inconclusive and it may or may not be an earthquake.
3. The letter code in the HYPOCENTER, QUAL column is defined below:
   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:

A	0.0°-0.1°
B	0.1°-0.2°
C	0.2°-0.5°
D	0.5°-1.0°
E	1.0° or larger

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

F	0.0°-0.5°
G	0.5°-1.0°
H	1.0°-2.0°
I	2.0° or larger

4. The reference identification numbers in the HYPOCENTER, REF and INTENSITY, REF columns indicate the sources of the hypocenter and intensity data. They are listed in numerical order in the list of data sources.
5. The magnitudes listed under USGS are mb (modified from Gutenberg and Richter, 1956) or Ms (Bath, 1966) values published in the Preliminary Determination of Epicenters (PDE) by the National Earthquake Information Center, U. S. Geological Survey and predecessor organizations. Associated with the magnitude values listed under OTHER are the source code and type. Type is defined by Mfa (magnitude based on felt areas or attenuation), Mn (Nuttli, 1973). Magnitudes computed solely from epicentral intensity have not been included. Moment magnitudes (Mw) are listed by value and source. The value was computed using the formula by Hanks and Kanamori (1979). The source codes are listed below:

BAR - Barstow, N. L., Brill, K. G., Nuttli, O. W., and Pomeroy, P. W., 1981, An approach to seismic zonation for siting nuclear electric power generating for facilities in the eastern United States, NUREG/CR-1577, Washington, D. C.
GS - National Earthquake Information Center (and predecessor organizations), U. S. Geological Survey, Golden, Colo.
SLM - St. Louis University, St. Louis, Mo.

6. An asterisk (*) in the INTENSITY, MM 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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Nuttli, O. W., 1973, Seismic wave attenuation and magnitude relations for eastern North America: Journal of Geophysical Research, v. 78, no. 5, p. 876-885.
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Table 1.—Chronological listing of earthquakes for the State of Indiana

DATE YEAR	MONTH	DAY	ORIGIN TIME (UTC) H	M	S	LAT.		LONG.		DEPTH (KM)	HYPOCENTER QUAL	HYPOCENTER REF	MAGNITUDE USGS (mb)	MAGNITUDE USGS (Ms)	MAGNITUDE OTHER	MAGNITUDE MOMENT (Mw)	INTENSITY MM	INTENSITY REF
1827	JUL	05	11	30	..	38.3	N.	85.8	W.	..	G	105	..	..	4.8Mfa BAR	..	VI	38
1827	AUG	07	04	30	..	38.3	N.	85.8	W.	..	G	38	..	..	..	..	VI	38
1827	AUG	07	07	..	..	38.3	N.	85.8	W.	..	G	38	..	..	..	..	VI	38
New Albany, Indiana. These two earthquakes on August 7 at 04:30 and 07 were described as "strong shocks". H.F. Reid, unpublished notes, described the earlier shock as "light" (Ref. 105).																		
1877	MAY	26	21	..	..	38.2	N.	87.9	W.	..	G	105	..	..	..	..	III	105
1881	APR	20	..	..	..	41.6	N.	85.8	W.	..	G	105	..	..	..	..	IV	105
1886	MAR	01	16	..	..	39.0	N.	85.5	W.	..	G	105	..	..	..	..	III	105
1886	AUG	13	..	..	..	39.8	N.	86.1	W.	..	G	105	..	..	..	..	III	105
1887	FEB	06	22	15	..	38.7	N.	87.5	W.	..	G	38	..	..	4.7Mfa BAR	..	VI	38
Near Vincennes, Indiana. Felt most distinctly in southwestern Indiana and southeastern Illinois. Estimates of the felt area range between 25,000 and 75,000 sq mi (Ref. 105).																		
1891	JUL	27	02	28	..	37.9	N.	87.5	W.	..	G	38	..	..	..	..	VI	38
Evansville, Indiana. A strong shock frighten people in several churches and damaged property.																		
1899	APR	30	02	05	..	38.5	N.	87.0	W.	..	G	38	..	..	4.6Mfa BAR	..	VII	38
Near Vincennes, Indiana. Brick walls were cracked and a few chimneys fell. Felt area was estimated at 40,000 sq mi (Ref. 105).																		
1902	MAR	10	06	..	..	39.9	N.	85.2	W.	..	G	105	..	..	..	..	III	105
1902	MAR	10	11	30	..	39.9	N.	85.2	W.	..	G	105	..	..	..	..	III	105
1903	JAN	01	18	30	..	39.9	N.	85.2	W.	..	G	105	..	..	..	..	III	105
1903	JAN	01	23	45	..	39.9	N.	85.2	W.	..	G	105	..	..	..	..	III	105
1903	SEP	20	..	..	..	39.4	N.	86.3	W.	..	G	105	..	..	..	..	IV	105
1903	NOV	20	..	..	..	39.4	N.	86.3	W.	..	G	105	..	..	..	..	III*	105
1906	MAY	08	06	58	..	39.5	N.	85.8	W.	..	G	105	..	..	3.8Mfa BAR	..	IV	105
1906	MAY	09	06	38	..	39.2	N.	85.9	W.	..	G	105	..	..	..	..	IV	105
1906	MAY	11	06	15	..	38.5	N.	87.2	W.	..	G	38	..	..	3.8Mfa BAR	..	IV	105
1906	AUG	13	13	19	..	39.7	N.	86.8	W.	..	G	105	..	..	..	..	IV	105
1906	SEP	07	16	33	..	38.2	N.	87.7	W.	..	G	105	..	..	..	..	IV	105
1907	JAN	29	..	..	..	39.5	N.	86.6	W.	..	G	105	..	..	..	..	V	105
1909	SEP	22	..	..	..	38.7	N.	86.1	W.	..	G	38	..	..	3.9Mfa BAR	..	V	38
1909	SEP	27	09	45	..	39.5	N.	87.4	W.	..	G	105	..	..	4.8Mfa BAR	..	VII	38
Centered in the Wabash Valley between Terre Haute and Vincennes, Indiana. At Terre Haute a few chimneys were thrown down, plaster cracked, and pictures shaken from walls. A few chimneys were shaken down and windows were broken at Covington, Indiana. Dishes were broken at Vincennes. The felt area was estimated at 30,000 sq mi (Ref. 105).																		
1909	SEP	27	12	00	..	39.5	N.	87.4	W.	* ..	G	109	..	..	..	..	III*	109
1916	JAN	07	19	45	..	39.1	N.	87.0	W.	..	G	58	..	..	3.8Mfa BAR	..	III	105
1919	MAY	25	09	45	..	38.5	N.	87.5	W.	..	G	38	..	..	4.4Mfa BAR	..	V	38
1921	MAR	14	12	15	..	39.5	N.	87.5	W.	..	F	113	..	..	4.4Mfa BAR	..	IV	105
1921	MAR	31	20	03	..	37.9	N.	87.8	W.	..	G	105	..	..	..	..	IV	105
1922	JAN	11	13	42	..	37.9	N.	87.5	W.	..	G	105	..	..	4.2Mfa BAR	..	V	84
1925	APR	27	04	05	..	38.3	N.	87.6	W.	..	G	105	..	..	4.8Mfa BAR	..	VI	67
Centered in the Wabash Valley near Princeton, Indiana. In the epicentral area chimneys were shaken down and crockery was broken. The felt area was listed at 100,000 sq mi (Ref. 105).																		
1925	APR	27	04	14	..	38.3	N.	87.6	W.	* ..	G	125	..	..	..	..	F	125
1925	APR	27	04	30	..	38.3	N.	87.6	W.	* ..	G	125	..	..	..	..	F	125
1926	OCT	04	02	20	..	38.3	N.	87.6	W.	..	G	105	..	..	..	..	III	105
1929	FEB	14	20	12	..	38.3	N.	87.6	W.	..	H	2	..	..	3.6Mfa BAR	..	IV	105
1931	JAN	06	02	57	..	39.0	N.	87.0	W.	..	H	38	..	..	3.5Mfa BAR	..	V	38
1931	DEC	31	..	..	..	38.5	N.	87.2	W.	x ..	H	105	..	..	..	..	II*	105
1938	FEB	12	06	27	..	41.6	N.	87.0	W.	..	G	105	..	..	4.0Mfa BAR	..	V	105
1940	JAN	08	20	05	..	38.3	N.	85.8	W.	..	G	105	..	..	..	..	III	105
1940	DEC	29	02	30	..	37.9	N.	87.3	W.	..	G	105	..	..	3.6Mfa BAR	..	III	105
1954	AUG	09	..	..	..	38.5	N.	87.3	W.	x ..	H	105	..	..	..	..	IV	105
1968	DEC	11	16	00	..	38.3	N.	85.8	W.	..	F	116	..	..	..	..	V	41
1974	NOV	25	23	34	05.1	40.3	N.	87.4	W.	005	B	47	..	..	2.4Mn	SLM	II	47
1976	APR	08	07	38	53.0	39.35	N.	86.68	W.	020	B	49	..	..	3.0Mn	GS	V	49
1976	JUN	13	18	55	18.5	39.75	N.	86.17	W.	* ..	F	49	..	..	..	..	II	49
1976	JUN	13	18	58	28.5	39.75	N.	86.17	W.	* ..	F	49	..	..	..	..	II	49

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 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 experiences. 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, 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, 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 or 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, some collapse in large part; or wholly shifted frame buildings off foundations, racked frames, serious to reservoirs; underground pipes sometime 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 and level. Threw objects upward into the air.

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SEISMICITY MAP OF THE STATE OF INDIANA

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