

#### 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 North Carolina, even though earthquakes in nearby states may have been felt or may have caused damage in North Carolina.

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 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.

indicated:

was compiled.

- 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
- 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

A 0.0°-0.1° B 0.1°-0.2° C 0.2°-0.5 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:

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 MD (duration or coda length), Mfa (magnitude based on felt areas or attenuation), Mn (Nuttli, 1973), Mnx (modified Mn). 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. BLA - Virginia Polytechnic Institute and State University, Blacksburg, Va.
  - DG Dewey, J. W., and Gordon, D. W., 1984, U. S. Geological Survey, Miscellaneous Field Studies Map MF-1699 Pamphlet, 39 p. GB - Bollinger, G. A., 1979, Seismological Society of America Bulletin,
  - v. 69, no. 1, p. 45-63. GS - National Earthquake Information Center (and predecessor organizations), U. S. Geological Survey, Golden, Colo.
  - JLM Jones, F. B., Long, L. T., and McKee, J. H., 1977, Seismological Society of America Bulletin, v. 67, no. 6, p. 1503-1513. TAR - Tarr, A. C., Talwani, Pradeep, Rhea, Susan, Carver, David, and
  - Amick, David, 1981, Seismological Society of America Bulletin, v. 71, no. 6, p. 1883-1902. TEC - Tennessee Earthquake Information Center, Memphis State University,
- Memphis, Tenn. 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

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Algermissen, S. T., 1969, Seismic risk studies in the United States: Fourth World Conference on Earthquake Engineering, Santiago, Chile, January 13-18, 1969, Proceedings, v. 1, p. 14-27. Bath, Markus, 1966, Earthquake energy and magnitude, in Physics and chemistry of the Earth, v. 7: New York, Pergamon Press, p. 115-165. Gutenberg, Beno, and Richter, C. F., 1956, Magnitude and energy of earthquakes: Annali di Geofisica, v. 9, no. 1, p. 1-15. Hanks, T. C., and Kanamori, Hiroo, 1979, A moment magnitude scale: Journal of Geophysical Research, v. 84, no. B5, p. 2348-2350. Nuttli, 0. W., 1973, Seismic wave attenuation and magnitude relations for eastern North America: Journal of Geophysical Research, v. 78, no. 5, p. 876-885. 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 .-- Chronological listing of earthquakes for the State of North Carolina

_	A T E	DAY	ORIGI H M (UT		E LAT	•	LONG.		DEPTH (KM)	HYPO QUAL	CENTER REF	US (mb)	GS		I T U	MO	MENT Mw)	INTEN MM	SITY REF
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811 823 826 827 829	NOV AUG NOV MAY	27 23 11 11	08	::	36.1 36.1 36.1 36.1 35.2	N. N. N. N.	80.2 80.2 80.2 81.2 83.8	W. W. W. W.	* * *	G G G G	71 71 71 156 71	::	••	• • •		••	•••	IV* III* III* F	71 71 71 156 71
834 844 848 850 851	NOV JUN  MAR AUG	29  30 11	15 01 55		36.1 35.3 35.7 35.4 35.6	N. N. N. N.	80.2 83.3 82.1 78.0 82.6	W. W. W. W.	* * * *	G G G G	71 71 165 156 156				:	••	•••	III*     F     F     V*     V*	71 71 165 156 156
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1874 1874 1874 1874 1876	MAR MAR APR APR JAN	17 26 14 17 23		::	35.7 35.7 35.7 35.7 35.7	N. N. N. N.	82.1 82.1 82.1 82.1 82.1	W. W. W. W.	*	G G G G	71 71 71 71 165	••		••••			•••	IV* IV* IV* F	71 71 71 71 165
1877 1877 1878 1879 1879	APR OCT NOV DEC DEC	26 09 23 13	22 00 01 15 00 00 07	•••	35.2 35.0 35.1 35.2 35.2	N. N. N.	83.4 82.7 84.0 80.8 80.8	W. W. W. W.	x * *	G G G G	103 156 71 71 71	••		••••			•••	III* III* IV*	71 71 71 71
1880 1880 1880 1882 1882	JAN JAN FEB JAN OCT	28 29 10 08 15	22 10 17 30		35.7 35.7 35.7 34.6 35.1	N. N. N.	82.1 82.1 82.1 76.5 84.0	W. W. W.	* * *	G G G G	71 71 71 103 103	•••		•••				III* III* IV* III*	71 71 71 71 71
1882 1883 1884 1884	OCT SEP JAN JAN APR	23 21 18 18 30	12 00 11 45 13 13 02 11 46		35.1 36.1 34.3 34.3 35.1	N. N. N.	77.0 79.8 78.0 78.0 84.1	W. W. W.	*	G G G G	71 103 103 71 71			•••			•••	IV* V V IV*	71 71 103 71 66
1884 1884 1885 1895 1896	JUL AUG OCT FEB	06 07 11	13 00 04 30 01 45		35.7 36.2 35.9 36.3	N. N. N.	82.5 81.6 77.5 78.6	W. W. W.	*	G G G	71 71 156 71	••		••••		••	•••	III* V* V* IV*	71 71 156 71
1898 1915 1915 1916	OCT OCT FEB	29 29 21	04 30 05 23 05 25 22 39				78.6 82.7 82.7 82.5			G G G	71 71 71 71	••	••			::		III*  IV*  V VII	71 71 67 67
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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 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, expecially 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, or 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 is 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
- 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

# SEISMICITY MAP OF THE STATE OF NORTH CAROLINA

upward into the air.

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