



EARTHQUAKES AND SEISMIC RISK IN OHIO

Although most people do not think of Ohio as an earthquake-prone state, at least 200 earthquakes above 2.0 magnitude have occurred within the state since 1776. In addition, a number of earthquakes with origins outside Ohio have been felt in the state. Most of these earthquakes have been felt only locally and have caused no damage or injuries.

However, at least 15 earthquakes have caused minor to moderate damage in Ohio. Fortunately, no deaths and only a few minor injuries have been recorded for these events.

Ohio is on the periphery of the New Madrid Seismic Zone, an area in Missouri and adjacent states that was the site of the largest earthquake sequence to occur in historical times in the continental United States. Four great earthquakes were part of a series at New Madrid in 1811 and 1812. These events were felt throughout the eastern United States and were of sufficient intensity to topple chimneys in Cincinnati. Some estimates suggest that these earthquakes had magnitudes in the range of 8.0.

A major earthquake centered near Charleston, South Carolina, in 1886 was strongly felt in Ohio. More recently, an earthquake with a Richter magnitude of 5.3 centered at Sharpsburg, Kentucky, in 1980 was strongly felt throughout Ohio and caused minor to moderate damage in communities near the Ohio River in southwestern Ohio. In 1998 a 5.2-magnitude earthquake occurred in western Pennsylvania, just east of Ohio, and caused some damage in the epicentral area.

EARTHQUAKE REGIONS

Three areas of the state appear to be particularly susceptible to seismic activity (see map on reverse).

Shelby County and surrounding counties in western Ohio have experienced more earthquakes than any other area of the state. At least 40 felt earthquakes have occurred in this area since 1875. Although most of these events have caused little or no damage, earthquakes in 1875, 1930, 1931, and 1937 caused minor to moderate damage. Two earthquakes in 1937, on March 2 and March 9, caused significant damage in the Shelby County community of Anna. The damage included toppled chimneys, cracked plaster, broken windows, and structural damage to buildings. The community school, of brick construction, was razed because of structural damage.

Northeastern Ohio has experienced approximately 80 felt earthquakes since 1836. Most of these events were small and caused little or no damage. However, an earthquake on January 31, 1986, strongly shook Ohio and was felt in 10 other states and southern Canada. This event had a magnitude of 5.0 and caused minor to moderate damage, including broken windows and cracked plaster, in the epicentral area of Lake and Geauga Counties.

Southeastern Ohio has been the site of at least 10 felt earthquakes with epicenters in the state since 1776. The 1776 event, recorded by a Moravian missionary, has a very uncertain location. Earthquakes in 1901 near Portsmouth (Scioto County), in 1926 near Pomeroy (Meigs County), and in 1952 near Crooksville (Perry County) caused minor to moderate damage.

CAUSES OF OHIO EARTHQUAKES

The origins of Ohio earthquakes, as with earthquakes throughout the eastern United States, are poorly understood at this time. Those in Ohio appear to be associated with ancient zones of weakness in the Earth's crust that formed during continental rifting and collision events about a billion years ago. These zones are characterized by deeply buried and poorly known faults, some of which serve as the sites for periodic release of strain that is constantly building up in the North American continental plate due to continuous movement of the tectonic plates that make up the Earth's crust.

SEISMIC RISK

Seismic risk in Ohio, and the eastern United States in general, is difficult to evaluate because earthquakes are generally infrequent in comparison to plate-margin areas such as California. Also, active faults do not reach the surface in Ohio and therefore cannot be mapped without the aid of expensive subsurface techniques.

A great difficulty in predicting large earthquakes in the eastern United States is that the recurrence interval—the time between large earthquakes—is commonly very long, on the order of hundreds or even thousands of years. As the historic record in most areas, including Ohio, is only on the order of about 200 years—an instant, geologically speaking—it is nearly impossible to estimate either the maximum magnitude or the frequency of earthquakes at any particular site.

Earthquake risk in the eastern United States is further compounded by the fact that seismic waves tend to travel for very long distances. The relatively brittle and flat-lying sedimentary rocks of this region tend to carry these waves throughout an area of thousands of square miles for even a moderate-size earthquake. Damaging ground motion would occur in an area about 10 times larger than for a California earthquake of comparable intensity.

An additional factor in earthquake risk is the nature of the geologic materials upon which a structure is built. Ground motion from seismic waves tends to be magnified by unconsolidated sediments such as thick deposits of clay or sand and gravel. Such deposits are extensive in Ohio. Buildings constructed on bedrock tend to experience much less ground motion, and therefore less damage. Geologic maps, such as those prepared by the Ohio Division of Geological Survey, delineate and characterize these deposits. Geologic mapping programs in the state geological surveys and the U.S. Geological Survey are therefore critical to public safety.

The brief historic record of Ohio earthquakes suggests a risk of moderately damaging earthquakes in the western, northeastern, and southeastern parts of the state. Whether these areas might produce larger, more damaging earthquakes is currently unknown, but detailed geologic mapping, subsurface investigations, and seismic monitoring will greatly help in assessing the risk.

EARTHQUAKE PREPAREDNESS

Large earthquakes are so infrequent in the eastern United States that most people do not perceive a risk and are therefore unprepared for a damaging event. Simple precautions such as bolting bookcases to the wall, strapping water heaters to the wall, putting latches or bolts on cabinet doors, and maintaining an emergency supply of canned food, drinking water, and other essentials can prevent both loss and hardship. Brochures on earthquake preparedness are available from disaster services agencies and the American Red Cross.

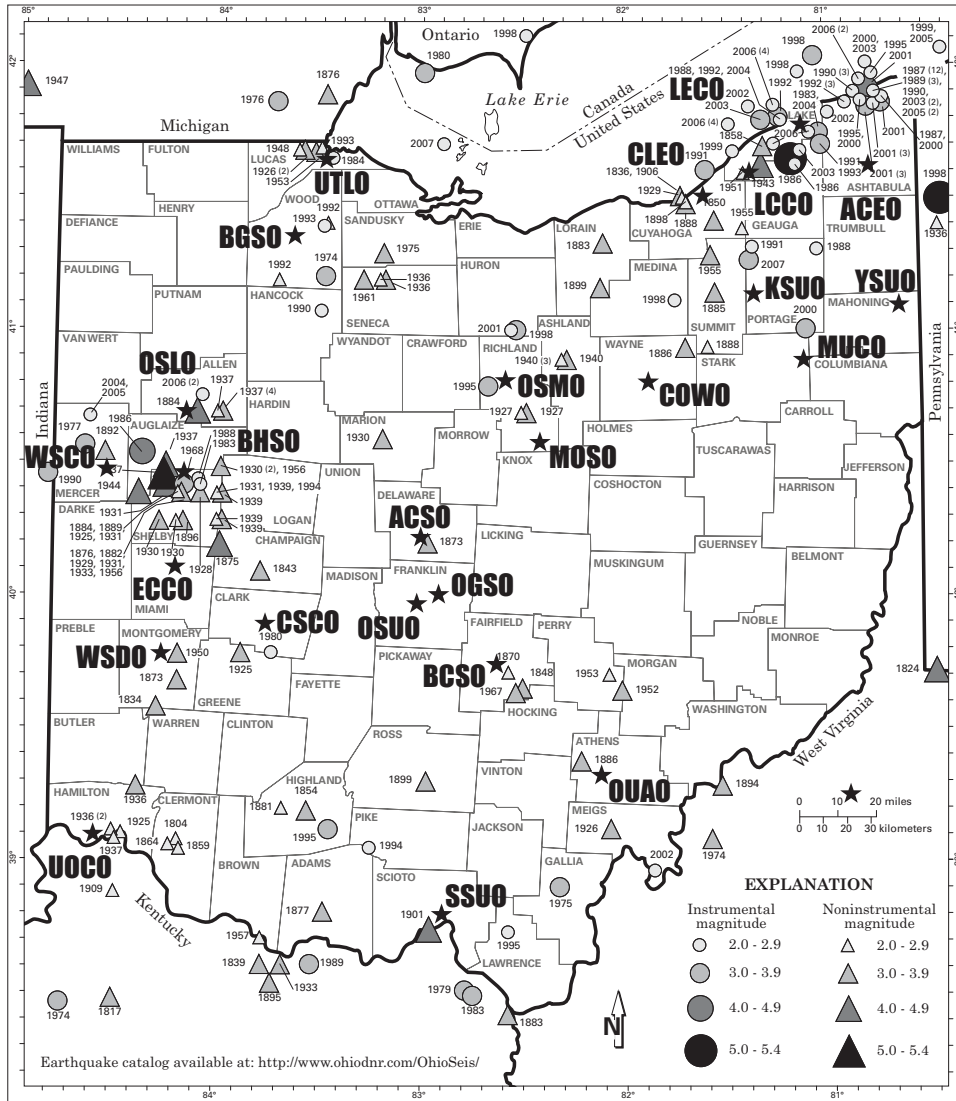
Earthquake insurance is commonly available in Ohio for a nominal additional fee on most homeowner policies. Such a policy might be a consideration, particularly for individuals who live in areas of Ohio that have previously experienced damaging earthquakes.

For additional information concerning earthquakes, contact:

Ohio Department of Natural Resources
Division of Geological Survey
2045 Morse Rd., Bldg. C-1
Columbus, OH 43229-6693
Telephone: 614-265-6576

THE OHIO SEISMIC NETWORK

In early 1999, the first statewide cooperative seismic network, OhioSeis, became operational. This network uses broadband seismometers to digitally record earthquakes in Ohio and from throughout the world. The network was established with the primary purpose of detecting, locating, and determining magnitude for earthquakes in the state. These data not only provide information to the public after an earthquake but, after a long period of monitoring, will more clearly define zones of highest seismic risk in the state and help to identify deeply buried faults and other earthquake-generating structures. The Ohio Seismic Network was funded in part by the Federal Emergency Management Agency (FEMA) through the Ohio Emergency Management Agency as part of the National Earthquake Hazards Reduction Program (NEHRP). The stations are operated independently by volunteers as part of a cooperative agreement.



Modified Mercalli Scale		Magnitude Scale
I	Detected only by sensitive instruments	1.5
II	Felt by few persons at rest, especially on upper floors; delicately suspended objects may swing	2
III	Felt noticeably indoors, but not always recognized as earthquake; standing autos rock slightly, vibrations like passing truck	2.5
IV	Felt indoors by many, outdoors by few, at night some awaken; dishes, windows, doors disturbed; standing autos rock noticeably	3
V	Felt by most people; some breakage of dishes, windows, and plaster; disturbance of tall objects	3.5
VI	Felt by all, many frightened and run outdoors; falling plaster and chimneys, damage small	4
VII	Everybody runs outdoors; damage to buildings varies depending on quality of construction; noticed by drivers of autos	4.5
VIII	Panel walls thrown out of frames; walls, monuments, chimneys fall; sand and mud ejected; drivers of autos disturbed	5
IX	Buildings shifted off foundations, cracked, thrown out of plumb; ground cracked; underground pipes broken	5.5
X	Most masonry and frame structures destroyed; ground cracked, rails bent, landslides	6
XI	Few structures remain standing; bridges destroyed, fissures in ground, pipes broken, landslides, rails bent	6.5
XII	Damage total; waves seen on ground surface, lines of sight and level distorted, objects thrown up into air	7.5

General relationship between epicentral Modified Mercalli intensities and magnitude. Intensities can be highly variable, depending on local geologic conditions (modified from D.W. Steeples, 1978, Earthquakes: Kansas Geological Survey pamphlet).

- ACSO** Alum Creek (Ohio Earthquake Information Center)
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| OGSO Ohio Geological Survey | MOSO Mohican Outdoor School |
| ACEO Ashtabula EMA | MUCO Mount Union College |
| BCSO Bloom-Carroll Schools | OSUO Ohio State University |
| BHSO Botkins High School | OSLO Ohio State University-Lima |
| BGSO Bowling Green State University | OSMO Ohio State University-Mansfield |
| CSCO Clark State Community College | OUAO Ohio University |
| CLEO Cleveland Museum of Natural History | SSUO Shawnee State University |
| COWO College of Wooster | UOCO University of Cincinnati |
| ECCO Edison Community College | UTLO University of Toledo |
| KSUO Kent State University | WSUO Wright State University-Celina |
| LECO Lake Erie College | WSDO Wright State University-Dayton |
| LCCO Lakeland Community College | YSUO Youngstown State University |

Earthquake epicenters in Ohio and border areas and locations of OhioSeis seismograph stations. Locations and intensities of historic earthquakes are represented by symbols according to maximum epicentral Modified Mercalli intensities. Solid symbols indicate the event was located by instruments. Noninstrumental locations may be in error by a considerable distance, especially for early events.

• This GeoFacts compiled by Michael C. Hansen • April 2007 •

The Division of Geological Survey GeoFacts Series is available on the World Wide Web: <http://www.ohiodnr.com/geosurvey/>
The Ohio Seismic Network provides earthquake information on the World Wide Web: <http://www.ohiodnr.com/ohioseis/>

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