GIP 118

Bicentennial of the 1811–1812 New Madrid Earthquake Sequence

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New Madrid Earthquake Sequence

A series of earthquakes hit the New Madrid seismic zone (NMSZ) of southeastern Missouri, northeastern Arkansas, and adjacent parts of Tennessee and Kentucky, in December 1811 to February 1812. Three earthquakes had a magnitude of 7.0 or greater. The first earthquake occurred December 16, 1811, at 2:15 a.m.; the second 9 a.m. on January 23, 1812; and the third on February 7, 1812, at 3:45 a.m. These three earthquakes were among the largest to strike North America since European settlement. The main shocks were followed by many hundreds of aftershocks that lasted for decades. Many of the aftershocks were major earthquakes themselves. The area that was strongly shaken by the three main shocks was 2–3 times as large as the strongly shaken area of the 1964 M9.2 Alaskan earthquake, and 10 times as large as that of the 1906 M7.8 San Francisco earthquake.

The New Madrid earthquakes occurred along the western frontier of the young United States. They were felt in all settled parts of the central and eastern United States, as well as in Toronto, Canada. They caused general alarm from Detroit, Mich., to New Orleans, La. Chimneys were knocked down as far away as Cincinnati, Ohio, 560 kilometers (km) [350 miles (mi)] away. Closer to the earthquakes, Memphis, Tenn. was not yet established, but in St. Louis, Mo., many homes were damaged. The thriving frontier trading town of New Madrid, Mo., was damaged severely and temporarily evacuated. About 45 km (30 mi) south of New Madrid, Little Prairie, Mo., was destroyed. During the earthquake the ground rose, fell, and cracked; trees snapped and were uprooted; large landslides were abundant on steep ground from the future site of Memphis, Tenn., to southernmost Illinois. Large areas rose permanently, and some of them dammed rivers to create or enlarge lakes that remain (Reelfoot Lake, Tenn.). Other large areas sank and were flooded by streams and enormous volumes of water and sand that erupted from thousands of fissures over a region about 240 km (150 mi) long and 80 km (50 mi) wide. Great waves on the Mississippi River and collapsed banks and sand bars destroyed some boats and washed others ashore. A sudden uplift beneath the river caused it to overflow its banks, briefly flow upstream, and form two large rapids.

There is broad agreement in the scientific community that a continuing concern exists for a major destructive earthquake in the New Madrid seismic zone. The geologic record of pre-1811 earthquakes also reveals that the New Madrid seismic zone repeatedly produced sequences of major earthquakes, including several of magnitude 7 to 8, during the past 4,500 years. The preponderance of evidence leads scientists to conclude that earthquakes can be expected in the future as frequently and as severely as in the past 4,500 years. Such high hazard requires prudent measures such as adequate building codes to protect public safety and ensure the social and economic resilience of the region to future earthquakes.

The U.S. Geological Survey and the Center for Earthquake Research and Information of the University of Memphis estimate that similar NMSZ earthquakes have a 7–10 percent chance of reoccurring within the next 50 years (U.S. Geological Survey Fact Sheet 2006–3125).

Personal Accounts from the 1811−1812 New Madrid Earthquakes

Little Prairie, Missouri
"I have heard accounts of the earthquake, on the other side of Mississippi, a great deal of the country in the neighborhood of Little Prairie is said to be much injured. Cracks are yet in the earth in place 18 feet wide...such large quantities of white sand have been thrown up that in many places that was formerly rich land looks like a sand beach – from all these stories I conclude that the shock has been severe, and that the country has sustained some injury. It is certainly true that many people are removing from it. I saw a gentleman who told me that he was in the barge twelve miles above New Madrid when the first shock we experienced took place – that in the morning during the shock he saw the water in the river at some places boil[ed] up 12 or 15 feet higher than the surface of the surrounding river, that in those places large quantities of leaves, dirt, and as he supposed, stone-coal were thrown up; that the shock was so violent, that he saw cotton-wood trees 18 or 24 inches through snapped off; and that he thinks, at least, two hundred acres of land along the margin of the river, fell in."
—Extraction of a letter written by a gentleman from west Tennessee to his friend in Knoxville, January 25, 1812, Knoxville Gazette, February 10, 1812

Artists' concepts of public reaction to the powerful New Madrid earthquakes 1811–1812. (19th Century illustrations used by permission of State Historical Society of Missouri, Columbia)

Earthquake
"On Monday morning last, about a quarter past two, St. Louis and the surrounding country, was visited by one of the most violent shocks of earthquake that has been recorded since the discovery of our country. As we were all wrapt in sleep, each tells his story in his own way. I will also relate my simple tale. At the period above mentioned, I was roused from sleep by the clamor of windows, doors and furniture in tremulous motion, with a distant rumbling noise, resembling a number of carriages passing over pavement – in a few seconds the motion and subterraneous thunder increased more and more: believing the noise to proceed from N. or N.W. and expecting the earth to be relieved by a volcanic eruption, I went out of doors & looked for the dreadful phenomenon. The agitation had now reached its utmost violence. I entered the house to snatch my family from its expected ruins, but before I could put my design in execution the shock had ceased, having lasted about one and three fourth minutes. The sky was obscured by a thick hazy fog, without a breath of air. Fahrenheit thermometer might have stood at this time at about 35 or 40°. At forty seven minutes past two, another shock was felt without any rumbling noise and much less violent than the first, it lasted near two minutes. At thirty four minutes past three, a third shock nearly as tremulous as the first, but without as much noise, it lasted about fifty seconds, and a slight trembling continued at intervals for some time after. A little after day light, a fourth shock was felt, but with less violence than any of the others, it lasted nearly one minute. About 8 o'clock, a fifth shock was felt; this was almost as violent as the first, accompanied with the usual noise, it lasted about half a minute: this morning was very hazy and unusually warm for the season, the houses and fences appeared covered with a white frost, but on examination it was found to be vapour, not possessing the chilling cold of frost: indeed the moon was enshrouded in awful gloom. At half past eleven, a slight shock was felt, and about the same hour on Tuesday last, a smart shock was felt – several gentlemen declare, they felt shocks at other intervals."
—Street, R., 1984, The historical seismicity of the central United States: 1811–1928: Final Report, contract 14-08-0001-21251, U.S. Geological Survey, Appendix A., 316 p.

New Madrid, Missouri
"On the 16th of December, 1811, about two o'clock, A.M., we were visited by a violent shock of an earthquake, accompanied by a very awful noise resembling loud but distant thunder, but more hoarse and vibrating, which was followed in a few minutes by the complete saturation of the atmosphere, with sulphurious vapor, causing total darkness. The screams of the affrighted inhabitants running to and fro, not knowing where to go, or what to do – the cries of the fowls and beasts of every species – the cracking of trees falling, and the roaring of the Mississippi – the current of which was retrograde for a few minutes, owing as is supposed, to an irruption in its bed – formed a scene truly horrible. From that time until about sunrise, a number of lighter shocks occurred; at which time one still more violent than the first took place, with the same accompaniments as the first, and the terror which had been excited in everyone, and indeed in all animal nature, was now, if possible doubled."
—1816 letter from Eliza Bryan, New Madrid resident, to her friend Lorenzo Dow, who later published the letter in his biography: History of Cosmopolite

Artists' concepts of public reaction to the powerful New Madrid earthquakes 1811–1812. (19th Century illustrations used by permission of State Historical Society of Missouri, Columbia)

Mississippi River, Downstream from New Madrid, Missouri
"I resolved to wait until the morning, and caused the boat to be moored to a small island, about 500 yards above the entrance into the channel. After supper we went to sleep as usual; about ten o'clock, and in the night, I was awakened by a most tremendous noise, accompanied by so violent agitation of the boat that it appeared in danger of upsetting. Before I could quit the bed, or rather the skin, upon which I lay, the four men who slept in the other cabin rushed in, and cried out in the greatest terror....I passed them with some difficulty, and ran to the door of the cabin, where I could distinctly see the river agitated as if by a storm....I could distinctly hear the crash of falling trees, and the screaming of the wild fowl on the river, but found that the boat was still safe at her moorings. I was followed by the men and the patron, who, in accents of terror, were still enquiring what it was....At day-light we had counted twenty-seven shocks during our stay on the island, but still found the chasm so that it might be passed. The river was covered with foam and drift timber, and had risen considerably, but our boat was safe."
—John Bradbury (1819), travels in the interior of North America, 1809 through 1811

The following description of the earthquake from a gentleman who was in a large barge and lay at anchor in the Mississippi River a few leagues below New Madrid, on the night of December 15: "At 2 o'clock all hands were awakened by the first shock. The impression was that the barge had dragged her anchor and was grounding on gravel. Such were the feeling for 65 or 80 seconds, when the shock started. The crew were so fully persuaded of the fact of their being aground, that they put out their poles, but found water enough. At seven the next morning a second and very severe shock took place, – the barge was underway, – the river rose several feet; the trees on the shore shook; the banks in the large columns tumbled in; hundreds of old trees that had lain perhaps half a century at the bottom of the river, appeared on the surface of the water, the feathered race took the wing, the canopy was covered with geese and ducks and various other kinds of fowl; very little wind; the air was tainted with a nitrous and sulphurous smell; and everything was truely alarming for several minutes. The shocks continued to the 21st Dec. During that time, perhaps a hundred were distinctly felt."
—Knoxville Gazette, February 10, 1812

Reelfoot Lake, Tennessee drawing by Jeff Dietterle

Landslide trench and tilted tree trunks along ridge in the Chickasaw Bluffs east of Reelfoot Lake, Tennessee, resulting from the 1811−12 New Madrid earthquakes. (USGS photograph from Fuller, 1912).

Upper Blue Basin, Reelfoot Lake, Tennessee. (Photograph used by permission of Nancy Moore).

Nelson, Kentucky
"What are we gonna do? You cannot fight it cause you do not know how. It is not something that you can see. In a storm you can see the sky and it shows dark clouds and you know that you might get strong winds but this you can not see anything but a house that just lays in a pile on the ground – not scattered around and trees that just falls over with the roots still on it. The earth quake or what ever it is come again today. It was as bad or worse than the one in December. We lost our Amandy Jane in this one – a log fell on her. We will bury her upon the hill under a clump of trees where Besys Ma and Pa is buried. A lot of people thinks that the devil has come here. Some thinks that this is the beginning of the world coming to a end."
—George Heinrich Crist, January 23, 1812

Washington, D.C.
"The re-iteration of earthquakes continues the uproar from certain quarters. They have slightly reached the state of N. Y. and have been severely felt W. & S. Westwardly. There was one here this morning at 5 or 6 minutes after 4 o'C. It was rather stronger than any preceeding one, & lasted several minutes, with sensible tho very slight repetitions throughout the succeeding hour."
—James Madison, U.S. President, February 7, 1812 letter to Thomas Jefferson (Library of Congress)

Nashville, Tennessee
"An alarming earthquake was felt in this town and the adjoining country as far as we have heard, about 15 m past two o'clock yesterday morning. The shocks, which continued (until) after day, were some of them very severe – so much so that the heaviest houses seemed to be racked to pieces, however we have heard of no real injury sustained, except the fall of some chimneys in the country..."
—Account of the December 16, 1811, main shock, The Clarion & Tennessee Gazette, December 17, 1812

Charleston, South Carolina
"Another severe shock of an earthquake was felt in this city yesterday morning at four o'clock. Its duration was much longer than any that has preceded it. A gentleman who was up at the time ascertained it to exceed three minutes. Its undulatory motion was much shorter and quicker than any we have before experienced. Books and other articles were thrown from shelves, and chairs and other furniture standing against walls, made a rattling noise at the time. It was nearly calm and cloudy. Thermometer at eight o'clock A.M. stood at 52."
—Anonymous, Charleston, South Carolina, February 8,1812

Further Reading
More eyewitness accounts of the New Madrid earthquake sequence are available at http://www.ceri.memphis.edu/compendium/.

Disaster Relief Act

In 1814, Missouri Territorial Governor, William Clark (of the Lewis & Clark Expedition) asked for federal relief for the "inhabitants of New Madrid County." In response, Congress allocated $50,000 in 1815 for recovery. This was the first United States disaster relief act.

Image of the 1814 request, signed by Missouri Territorial Governor, William Clark.

Seismicity of the Central United States

This isoseismal map (left) is an interpretation of the extent and intensity of ground shaking for the December 16, 1811 earthquake, as recorded in the accounts of people who experienced the shaking. The

map is not colored west of the Mississippi River because few people lived in that region, and no first-hand accounts of earthquake effects exist there. Though no accounts are available, scientists are confident that ground shaking effects were similar to those east of the Mississippi River. An earthquake's magnitude is a measure of the total energy released and intensity is a measure of the severity of ground shaking. Isoseismal maps, like the one shown at left, show the distribution of intensity values. Although the magnitude of an earthquake is characterized by a single number, intensity is expressed as a range of values based on varying levels of shaking over the felt area and is notated in Roman numerals.

Typically, ground shaking will decrease from a maximum near the earthquake's epicenter to its lowest levels near the edge of the felt area. Intensity values are determined using the written accounts (letters, journals, and diaries) and the published records (newspapers and official reports) of the ground shaking effects on people, buildings, and the landscape. These accounts are codified in the Modified Mercalli Intensity Scale; a range of values from I (barely felt or not felt) to XII (total destruction).

The earthquake epicenters shown on this map (right) include the 1811–1812 New Madrid earthquake main shocks (red bull's-eyes) and selected historical and other instrumental events above magnitude 3.0 recorded from 1974 to early 2010.

Current National Park Service sites are within the area that experienced moderate to strong ground shaking during the 1811–1812 earthquakes. A nearly 3-year old Abraham Lincoln growing up in west-central Kentucky, not far from Mammoth Cave National Park, likely would have experienced Intensity VI ground shaking during the New Madrid earthquake sequence.

Reprinted letters and quotations on this poster contain errant and variant spellings that are reproduced as written.

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