Shock Waves

By Kirsten Weir

A new theory explains a surprise series of earthquakes.

Beds shook suddenly across New York City the night of Dec. 16, 1811, rousing people from their sleep. The cause of the rude awakening was an earthquake whose *epicenter* (point of origin) was halfway across the country near New Madrid, MO.

The earthquake was one of a series in 1811 and 1812 that uprooted trees, triggered landslides, and toppled log cabins across the Midwest. Scientists have evidence that huge quakes also hit the same region around the years 1450 and 900. The cause of the New Madrid earthquakes has long mystified scientists. Have they now found an answer?

The Granger Collection; Waves: Shutterstock
These old illustrations of thrashing waves and a ruined building depict the destruction caused by the 1811 and 1812 New Madrid earthquakes.

Puzzle Pieces

Most earthquakes happen at the boundaries of *tectonic plates.* Tectonic plates are enormous pieces of Earth's crust and upper mantle that fit together like pieces in a jigsaw puzzle. Wherever two plates meet, they either pull apart, press together, or slide past each other. Those movements cause large *faults* (cracks) to appear in the crust near the plate boundary.

The ground on either side of a fault moves very gradually. But sometimes the two sides get hung up on each other, unable to move. Stress builds to a point at which the two sides eventually snap apart, sending shock waves through the ground. Those shock waves are better known as earthquakes.

North Wind Picture Archives

California is the country's most quake-prone state. It lies atop a boundary where the Pacific Plate meets the North American Plate. Those plates are sliding past each other in opposite directions. That movement has created a lot of faults.

The New Madrid faults are different. They lie in the center of the North American Plate, far from any plate boundary. Why would huge earthquakes occur there? Earth scientists have been asking that question since 1812. Now a team of researchers that includes Andrew Freed, a professor of earth sciences at Purdue University, has a theory.

Losing Weight

The New Madrid faults lie atop the *Reelfoot Rift.* A rift is a region where Earth's crust is being pulled apart by the slow movement of tectonic plates. Hundreds of millions of years ago, tectonic forces almost pulled the North American Plate in two. For some reason, Freed says, that action stopped. The North American Plate is no longer cracking apart. But the Reelfoot Rift remains as evidence of that ancient upheaval. It's a "dead rift," says Freed, "a zone of weakness."

The New Madrid faults lie along that weak zone in the crust. But the presence of a weak zone doesn't fully explain the New Madrid quakes. In California, stress builds up in the rocks because the two tectonic plates there are constantly in motion. How could so much stress build up such a long way from any plate boundaries?

To find out, Freed and his colleagues studied the New Madrid faults for 10 years. They used Global Positioning System (GPS) sensors to track any tiny movements of the Earth's crust. "It's just like the GPS in your car or in your cell phone, but it's a much more precise measurement," Freed says.

They expected to see the ground slowly twisting and turning, causing stress to build up in the rocks. That's not what they found. "After 10 years, we realized there's nothing happening," he says. "No force is building up. So why do you get earthquakes?"

The stress, Freed now believes, must have been left from geological processes that happened long ago. It had probably been stored underground for millions of years—until something let it out.

Freed and his colleagues have an idea what that "something" was. During the last Ice Age, the northern half of North America was covered by an enormous ice sheet. Between 16,000 and 10,000 years ago that ice sheet melted, sending torrents of water down the Mississippi River. The river has carried bits of rock with it ever since. In time, says Freed, "it removed a lot of rock from the surface."

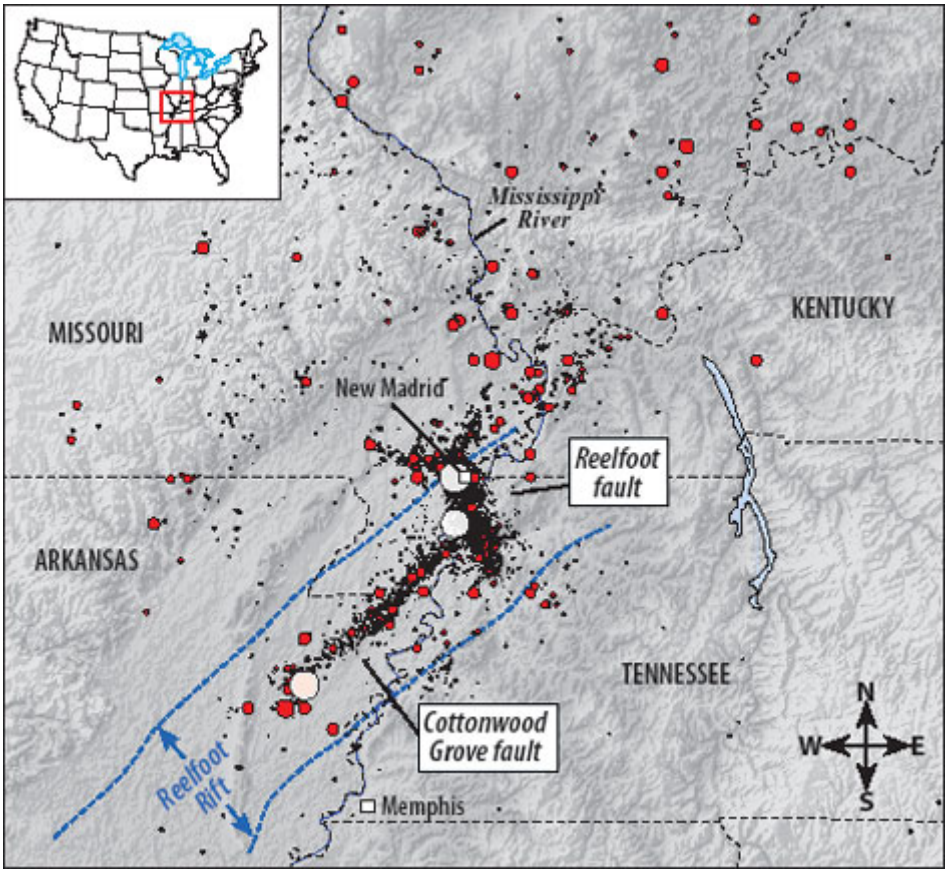
That removal was significant, he says, because the Reelfoot Rift lies right below the Mississippi River. The weight of the ground above the rift had been pressing down on the New Madrid faults, holding back the stored-up stress for millions of years. As the river washed away the ground, a huge weight was lifted from Earth's crust. As that pressure eased, the faults slipped several times, triggering the New Madrid quakes.

High-Risk Zones

Finding solid proof for that theory is difficult, Freed says. Still, the theory goes a long way toward explaining earthquakes that happen in the middle of North America.

There's good reason to understand such a system. For one thing, Freed says, the Mississippi is still changing Earth's crust. More earthquakes could strike the New Madrid area as more age-old stresses are released. Similar changes could be happening elsewhere. "We know there are other rifts under other river valleys around the country," he says.

Many of those places haven't experienced earthquakes in recent history. If Freed's theory is correct, other faults may be lying quietly, getting ready to rock.



Andrew Freed/Purdue University

The major earthquakes that have rattled the Midwest several times in history can be traced to a region, the Reelfoot Rift, where the ground is weak and riven by large *faults* (cracks). Sudden movements of those faults have triggered many small quakes over the years. The epicenters of those quakes are indicated by the black and red dots on the map. The big white dots indicate the epicenters of the monster quakes that happened in 1811 and 1812.