Earthquakes actually aftershocks of 19th century quakes

November 4 2009

An aerial view of the San Andreas fault in the Carrizo Plain, Central California. Image: USGS, Wikimedia Commons.

(PhysOrg.com) -- When small earthquakes shake the central U.S., citizens often fear the rumbles are signs a big earthquake is coming. Fortunately, new research instead shows that most of these earthquakes are aftershocks of big earthquakes (magnitude 7) in the New Madrid seismic zone that struck the Midwest almost 200 years ago.

The study, conducted by researchers from Northwestern University and

the University of Missouri-Columbia, will be published in the Nov. 5 issue of the journal *Nature*.

"This sounds strange at first," said the study's lead author, Seth Stein, the William Deering Professor of Geological Sciences in the Weinberg College of Arts and Sciences at Northwestern. "On the San Andreas fault in California, aftershocks only continue for about 10 years. But in the middle of a continent, they go on much longer."

There is a good reason, explains co-investigator Mian Liu, professor of geological sciences at Missouri. "Aftershocks happen after a big earthquake because the movement on the fault changed the forces in the earth that act on the fault itself and nearby. Aftershocks go on until the fault recovers, which takes much longer in the middle of a continent."

The difference, Stein explains, is that the two sides of the San Andreas fault move past each other at a speed of about one and a half inches in a year -- which is fast on a geologic time scale. This motion "reloads" the fault by swamping the small changes caused by the last big earthquake, so aftershocks are suppressed after about 10 years. The New Madrid faults, however, move more than 100 times more slowly, so it takes hundreds of years to swamp the effects of a big earthquake.

"A number of us had suspected this," Liu said, "because many of the earthquakes we see today in the Midwest have patterns that look like aftershocks. They happen on the faults we think caused the big earthquakes in 1811 and 1812, and they've been getting smaller with time."

To test this idea, Stein and Liu used results from lab experiments on how faults in rocks work to predict that aftershocks would extend much longer on slower moving faults. They then looked at data from faults around the world and found the expected pattern. For example,

aftershocks continue today from the magnitude 7.2 Hebgen Lake earthquake that shook Montana, Idaho and Wyoming 50 years ago.

"This makes sense because the Hebgen Lake fault moves faster than the New Madrid faults but slower than the San Andreas," Stein noted. "The observations and theory came together the way we like but don't always get."

Aftershocks go on for long times in other places inside continents, Stein said. It even looks like we see small earthquakes today in the area along Canada's Saint Lawrence valley where a large earthquake occurred in 1663.

The new results will help investigators in both understanding earthquakes in continents and trying to assess earthquake hazards there. "Until now," Liu observed, "we've mostly tried to tell where large earthquakes will happen by looking at where small ones do." That's why many scientists were surprised by the disastrous May 2008 magnitude 7.9 earthquake in Sichuan, China -- a place where there hadn't been many earthquakes in the past few hundred years.

"Predicting big quakes based on small quakes is like the 'Whack-a-mole' game -- you wait for the mole to come up where it went down," Stein said. "But we now know the big earthquakes can pop up somewhere else. Instead of just focusing on where small earthquakes happen, we need to use methods like GPS satellites and computer modeling to look for places where the earth is storing up energy for a large future earthquake. We don't see that in the Midwest today, but we want to keep looking."

More information: The *Nature* paper is titled "Long Aftershock Sequences within Continents and Implications for Earthquake Hazard Assessment."

Source: Northwestern University (news : web)