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DO EARTHQUAKES CAUSE FAULTS?

"RADICAL" NEW THEORY BLAMES SOME QUAKES ON FLUIDS MOVING WITHIN EARTH'S CRUST

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A scientist at the Georgia Institute of Technology has proposed a "radical" new theory which blames the earthquakes which occur in the Eastern United States on the upward movement of fluids deep within the earth's crust.

Those fluids -- which may be molten lava or water -- fracture and weaken the crust, allowing existing stress to trigger earthquakes, suggests Dr. Timothy Long, professor of Earth and Atmospheric Sciences. He believes the theory offers a comprehensive explanation for earthquakes which occur in regions lacking known active earthquake faults.

Long bases his theory on long-term study of seismic activity in two areas: New Madrid, Missouri, the scene of severe quakes in the early 1800s, and Southeastern Tennessee, which he fears may be building toward a future quake.

For the U.S. East Coast, Long's theory offers both good and bad news. He believes the stresses which cause earthquakes are transient, meaning areas which suffered quakes in the past will not necessarily suffer them again. But that also means areas with no known earthquake history may be vulnerable in the future.

"Most of the theories to explain Eastern U.S. earthquakes or any continental earthquakes look for a fault that breaks through the surface," he said. "In contrast, I suggest a mechanism that creates its own faults. It doesn't rely on existing faults to trigger seismic activity."

Geologists explain most earthquakes with the "Plate Tectonics" theory, which suggests that the Earth's crust is composed of rigid plates which float on a mantle of virtually fluid rock. When the plates collide and push against each other, the result is earthquakes, volcanoes -- and the building of mountain ranges. These collision zones are often marked by faults, unstable areas which shift with alternating pressure.

But the Eastern United States lies within a plate, having no boundaries and no known active faults. Plate Tectonics cannot adequately explain earthquakes which occur within plates, a serious weakness for geologists studying East Coast activity.

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Long believes geologists should look for other ways to explain seismic activity within plates. The explanation must incorporate the transient behavior observed in mid-plate seismicity and the short lengths of faults in plate interiors. He proposes a five-step sequence leading to an earthquake:

Step 1. Fluids -- possibly molten lava or other liquids squeezed from rocks under high pressure -- are released into the crust at depths exceeding 20 kilometers. Such events on a larger scale create volcanos and lava flows when they reach the surface, but Long suggests a great many smaller events never reach the surface.

"It is not inconceivable that a smaller unit of lava would come up and stop in the base of the crust and be a trigger mechanism," he said. "And when you look into the lower part of the crust, a lot of the features tend to be horizontal, which suggests some horizontal shearing or the intrusion of sills containing fluid."

Step 2. The movement of this fluid weakens rock structures perhaps already softened by high temperatures and stressed by the horizontal forces of Plate Tectonics.

"These fluids have a tremendous ability to weaken the rock," he explained. "The fluids start to move and expand the area that has been weakened. If that area is already under compressive stress, you have a small area which is being squeezed. The squeezing of those areas begins to generate some small seismic events."

Step 3. The weakened rock begins to shift slightly under the compressive stress, triggering small seismic events: barely noticeable earthquakes of magnitude 2 or 3.

Step 4. The stresses build until a major earthquake occurs, splitting the crust and releasing the stress.

Step 5. Aftershocks follow as the fluids disperse. Long believes the aftershock period may last for hundreds of years until the fluids finally dissipate. The crust then returns to its previous state, with no lasting weaknesses or fault structures.

Seismic activity in the New Madrid area now shows evidence of that decay, Long postulates. Similar activity in Southeastern Tennessee, however, may indicate a build-up of stress in Stage 2 -- or alternatively, it may show a more advanced decay phase from a quake that may have occurred long ago.

Other geologists have suggested that seismic activity is caused by fluid pressure from the surface down. While acknowledging that such fluids may account for shallow earthquakes -- particularly those that occur near large reservoirs -- Long believes only the upward movement of fluids can account for deep activity which causes severe quakes.

If Long's theory is accepted and developed, it may give geologists a way to predict continental earthquakes years ahead of time, though the precise timetable may be difficult to determine. It will also give them a mechanism to test by various seismic techniques.

Long's theories were published in Seismological Research Letters. He has also submitted a paper to Tectonophysics.

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