Ridgecrest faults increasingly sensitive to solid Earth tides before earthquakes

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Credit: Pixabay/CC0 Public Domain

Faults in the Ridgecrest, California area were very sensitive to solid earth tidal stresses in the year and a half before the July 2019 Ridgecrest earthquake sequence, researchers reported at the Seismological Society

of America (SSA)'s 2023 Annual Meeting.

"The signal of tidal modulation becomes extremely strong" after 2018, said Eric Beauce of Lamont-Doherty Earth Observatory, who noted that the signal was identified with seismicity that occurred around the faults that broke in the 2019 magnitude 7.1 earthquake.

The link does not mean that tidal stresses—which are very small compared to other tectonic stresses—triggered the earthquake, however.

"We don't know if something started to happen in the fault zone, something that is an indicator of the upcoming earthquake," Beauce said. "Maybe that process changed the properties of the crust in a way that made the crust be more sensitive to tidal stresses."

Pulled by the same gravitational forces of sun and moon that create ocean tides, the solid earth also deforms in the same periodic way. People can't feel the changes, but the ground deforms between 10 to 20 centimeters a day.

These solid tides "induce very, very small stress changes in the crust," Beauce explains, "which can induce stress changes in all the faults within the crust."

Although researchers have known about these tiny stress changes for more than a century, it has been difficult to extract their signal from the seismic record, and to determine whether they modulate seismicity.

In the past ten years, however, better earthquake detection and analysis techniques have made it possible to search through earthquake catalogs to find the signal of tidal stresses, Beauce said.

He and his colleagues built a rich, high-resolution earthquake catalog,

using machine learning algorithms along with other techniques, for the past decade of microseismicity in the Ridgecrest area. (Microseismicity usually refers to earthquakes of magnitude 2.0 or smaller).

They found that "there is suggestive evidence that peak seismicity happens when tidal stresses are maximum," Beauce said, "but this modulation is weak, and because it is weak, it is only suggested."

Other researchers looking at the 2004 Indian Ocean and 2011 Tohoku megathrust earthquakes have detected an increase in modulation of seismicity connected to tidal stresses, decades before the earthquakes, said Beauce. And some scientists have been able to generate similar results in lab-created earthquake experiments.

The tidal findings do not have direct implications for earthquake forecasting, "as we do not know if we are looking at a general phenomenon or one specific to the Ridgecrest earthquake only, said Beauce, "but I see it as a way of getting new observational constraints on the physics of earthquakes, possibly the preparation and nucleation of earthquakes."

More information: meetings.seismosoc.org

Provided by Seismological Society of America

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