California earthquakes discovered much deeper than originally believed

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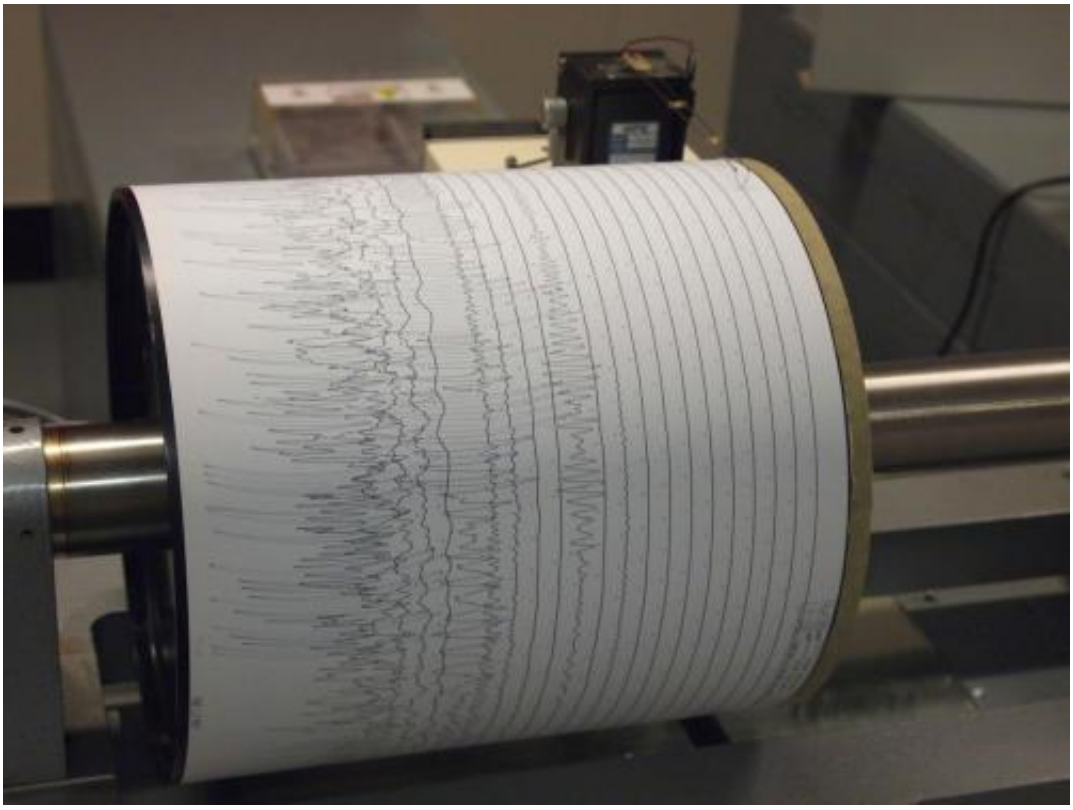

Seismogram being recorded by a seismograph at the Weston Observatory in Massachusetts, USA. Credit: Wikipedia

Scientists in California have found that earthquakes can occur much deeper below the Earth's surface than originally believed, a discovery that alters their understanding of seismic behavior and potential risks.

Seismologists have long believed that earthquakes occur less than 12 to 15 miles underground. But the new research found evidence of quakes deeper than 15 miles, below the Earth's crust and in the mantle.

Three scientists at the California Institute of Technology in Pasadena studied data from state-of-the-art sensors installed in Long Beach atop the Newport-Inglewood fault, one of the most dangerous in the Los Angeles Basin and which caused the magnitude 6.4 Long Beach earthquake of 1933.

After analyzing the data collected over six months by 5,000 sensors, scientists found quakes were occurring deep into the upper mantle, an area where the rock is so hot that it is no longer brittle like it is at the surface, but creeps, moving around like an extremely hard honey.

It appeared that the Newport-Inglewood fault extended even into the mantle - past the uppermost layer of the Earth, the crust, where earthquakes long have been observed. Until now, researchers didn't think earthquakes were possible there, said Caltech seismology professor Jean Paul Ampuero, one of three authors of the study, published Thursday in the journal *Science*.

Ampuero said the research raised the possibility that the Newport-Inglewood and others, like the San Andreas, could see even more powerful earthquakes than expected. The earthquakes he and his colleagues studied were so deep that they were not felt at the surface by conventional seismic sensors.

The new study indicates that a quake much closer to the surface could travel much deeper into the Earth, producing a stronger, more damaging, rupture than previously believed was possible.

"That got us thinking - that if earthquakes want to get big, one way of

achieving that is by penetrating deep," Ampuero said. "The big question is: If the next, larger earthquake happens, if it manages to penetrate deeper than we think, it may be bigger than we expect."

It's an idea that was first raised in 2012, also by Ampuero and several colleagues in the journal Science, when a magnitude 8.6 earthquake struck the Indian Ocean.

That was the largest quake of its kind "that has ever happened," Ampuero said. It happened on a fault known as a "strike-slip," the same kind of fault as Newport-Inglewood and California's mighty San Andreas, the state's longest fault.

But that Indian Ocean earthquake was so large, it was impossible to explain how it happened with existing science.

So answering the question of how an 8.6 earthquake occurred required a new explanation - that perhaps the quake centered on a fault that not only ruptured the crust, but went deeper into the mantle.

If deep earthquakes can occur on the Newport-Inglewood fault, then it's possible Southern Californians could see earthquakes along this fault at an even greater magnitude than what is projected. According to Caltech, the probable magnitude of a large quake on the Newport-Inglewood fault ranges from 6.0 to 7.4.

But there's a lot more study that needs to be done.

The deep quakes Caltech scientists detected were only microquakes - topping out at about a magnitude 2.

Therefore, one alternate - and more comforting - possibility is that these deep earthquakes remain small and don't help a large earthquake become

stronger. With this theory, earthquakes in this deep zone occur in small pockets far away from each other and don't link in a way that forces a big earthquake to get stronger.

"This could be good news, in a way, because if they never break together, that means they can break in tiny earthquakes, but they cannot break in large ones," Ampuero said. "So several questions are still open. I wouldn't say that this is cause for alarm at this point. These are very interesting questions that we need to pursue."

Another thing to consider: The deep earthquakes were found in a 9-square-mile area underneath Long Beach, recorded over six months. When researchers looked farther northwest - over a shorter time period, only four weeks - they did not find deep earthquakes there.

So it's possible that deep earthquakes don't exist everywhere on the Newport-Inglewood fault. But it's also possible that scientists didn't record any, and could catch some if they continue monitoring the area for a longer period.

There's a possibility that Long Beach is simply peculiar, and what's found there isn't found elsewhere. In Long Beach, scientists found evidence that there are some liquids flowing from the mantle up to the surface - an observation that was not found in another location on the Newport-Inglewood fault.

The scientists obtained the data from a group who installed sensors to better understand the oil fields of the area. Once they collected it, the scientists had to design a program to process the massive amounts of data collected to understand what was going on miles underground, and invisible to conventional seismic sensing equipment.

In addition to Ampuero, the other authors of the study are Asaf Inbal

and Robert Clayton.

More information: "Localized seismic deformation in the upper mantle revealed by dense seismic arrays," *Science* science.sciencemag.org/cgi/doi … 1126/science.aaf1370