Study results suggest slower seismic waves due to quakes may signal weak spots in crust

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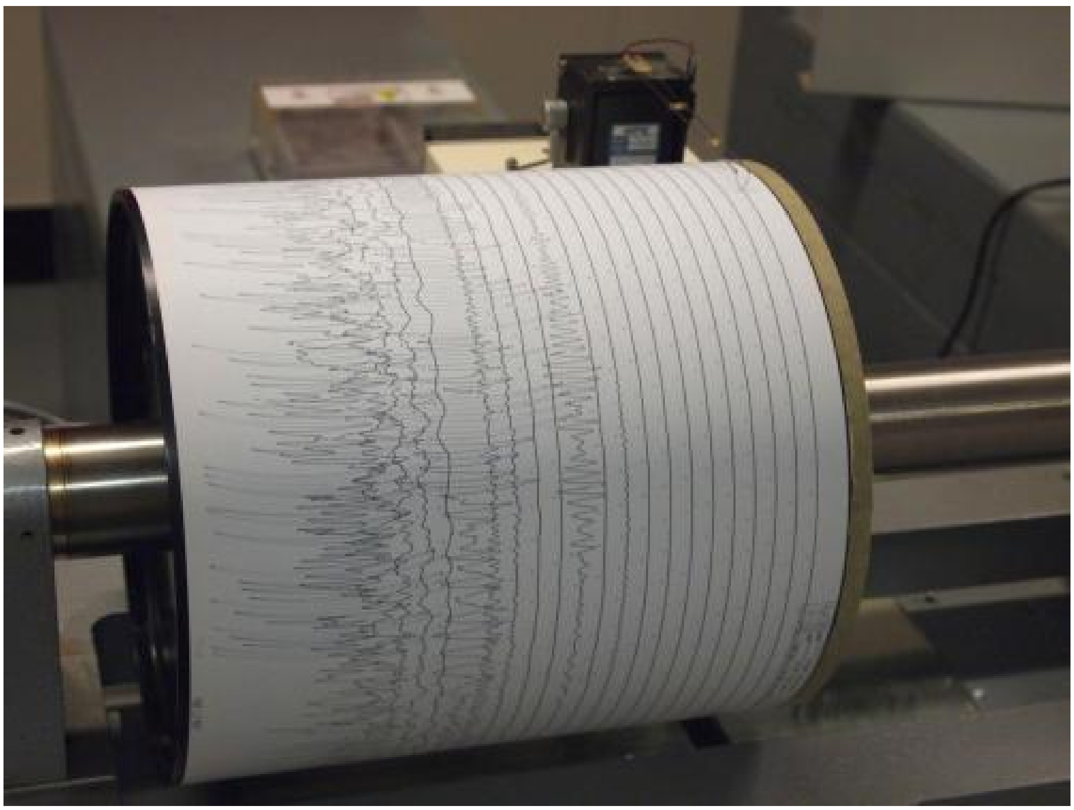

Seismogram being recorded by a seismograph at the Weston Observatory in Massachusetts, USA. Credit: Wikipedia

(Phys.org)—A pair or researchers, both with the University of California, Santa Cruz has found via field study that seismic waves passing through rock can be slowed down due to cracking by an earthquake. In their paper published in the journal *Science Advances*, Esteban Chaves and Susan Schwartz suggest that their findings may indicate that it is possible to identify weakened places in the crust following earthquakes that may make other places more vulnerable to a future quake.

Figuring out how to predict when and where major earth quakes may strike is an ongoing process—scientists have learned a lot, but they still cannot say with any degree of accuracy when a major quake might strike a given area. In this new effort, the research pair believes they have uncovered another geological clue that might help predict future quakes.

Recognizing that earthquakes generate powerful seismic waves that travel through underground rock, the researchers wondered if it might be possible to figure out if and where such seismic waves cause underground damage that could cause another area to be more susceptible to a quake. They focused their attention on Nicoya Peninsula, which is located on the Pacifica coast of Costa Rica, for two reasons. The first was because the area experienced a major earthquake just three years ago; the other was because seismic wave speed tests had been conducted in the area before the quake struck. They ran similar speed tests after the quake to see if there might be any difference—if so, this would suggest that damage had occurred to the rock, causing breaks, which would slow the speed of seismic waves passing through. And if that were the case, it would suggest that the rock in that location was weaker than it had been, and thus the area would be more likely to experience a quake of its own.

In conducting seismic tests in the area, the research pair found places where the waves traveled approximately 0.6 percent slower after the big quake, than they had before it occurred. Their finding also added credence to a theory that suggests that fluids underground can make rock more susceptible to fracturing when a nearby earthquake occurs. Prior research had shown that there was highly pressurized fluid under the peninsula, which the new researchers propose, contributed to fracturing and slowed seismic wave speed. The researchers suggest this means that an earthquake is likely to happen sooner in those areas than it would have prior to the impact of the 2012 earthquake.

More information: E. J. Chaves et al. Monitoring transient changes within overpressured regions of subduction zones using ambient seismic noise, *Science Advances* (2016). DOI: 10.1126/sciadv.1501289

Abstract
In subduction zones, elevated pore fluid pressure, generally linked to metamorphic dehydration reactions, has a profound influence on the mechanical behavior of the plate interface and forearc crust through its control on effective stress. We use seismic noise–based monitoring to characterize seismic velocity variations following the 2012 Nicoya Peninsula, Costa Rica earthquake [Mw (moment magnitude) 7.6] that we attribute to the presence of pressurized pore fluids. Our study reveals a strong velocity reduction (~0.6%) in a region where previous work identified high forearc pore fluid pressure. The depth of this velocity reduction is constrained to be below 5 km and therefore not the result of near-surface damage due to strong ground motions; rather, we posit that it is caused by fracturing of the fluid-pressurized weakened crust due to dynamic stresses. Although pressurized fluids have been implicated in causing coseismic velocity reductions beneath the Japanese volcanic arc, this is the first report of a similar phenomenon in a subduction zone setting. It demonstrates the potential to identify pressurized fluids in subduction zones using temporal variations of seismic velocity inferred from ambient seismic noise correlations.