

Fingerprinting slow earthquakes (w/Podcast)

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This USGS image shows Earth's tectonic plates. Image courtesy USGS

(PhysOrg.com) -- The most powerful earthquakes happen at the junction of two converging tectonic plates, where one plate is sliding (or subducting) beneath the other. Now a team of researchers, led by Teh-Ru Alex Song of the Carnegie Institution's Department of Terrestrial Magnetism, has found that an anomalous layer at the top of a subducting plate coincides with the locations of slow earthquakes and non-volcanic tremors. The presence of such a layer in similar settings elsewhere could point to other regions of slow quakes. Slow earthquakes, also called silent earthquakes, take days, weeks, or even months to release pent-up energy instead of seconds or minutes as in normal earthquakes. The research is published in the April 24th issue of *Science*.

The scientists analyzed 20 years of seismic data for southern Mexico, where the Cocos plate is slipping beneath the North American plate.

"We can tell a lot about the material inside the Earth by the speed, strength, and interferences of different seismic waves," explained Song. "Typically, P-waves are the fastest, followed by scattered waves associated with variations in [seismic wave](#) speed within the medium. We used local observations recorded within 100 to 150 miles to map the structures at the top of the subducting plate."

From observations and modeling, the researchers found that 30 events had similar waveforms and thus provided reinforcing information on structural details in the source region. In particular, they found a [layer](#) on top of the subducted plate where the speed of S-waves—which do not travel through liquids and are slower than P-waves—was some 30% to 50% slower than typical water-laden [oceanic crust](#). The anomalous layer, dubbed the ultra-slow-velocity layer by the researchers, is found at depths of 15 to 30 miles (25 to 50 kilometers), somewhat deeper than the portion of the plate interface zone that is strongly coupled and is the site of great earthquakes in this region. The spatial distribution of such a structure is also confirmed by observations recorded by stations located more than 3,000 miles away in Canada.

The scientists also examined the locations where slow earthquakes and non-volcanic tremors have occurred. They found that slow [earthquake](#) areas and the ultra-slow-velocity layers cluster together, and that regions of non-volcanic tremors are adjacent to those clusters.

But what is this layer and what does it have to do with these seismic events? Song and team believe that it may be subducted oceanic crust at unusually high levels of water saturation. The cause of such anomalously high pore pressures is unknown, but a clue might come from the fact that non-volcanic tremors are concentrated in areas with temperatures around 840°F (450°C). The researchers think that at such temperature and under ambient pressures a combination of fluid release and reduction in permeability may give rise both to the high pore pressures and the

stimulation of tremor activities.

"The ultra-slow-velocity layer may be the fingerprint that shows us where these slow quakes are active elsewhere in the world," remarked Song. "It is extremely important to learn more about slow quakes and how they are temporally and spatially associated with more powerful and destructive earthquakes. Mapping these structures is a first step toward this goal, and the study provides observational data that can be used in numerical simulations on stress interactions between slow earthquakes and megathrust earthquakes."

Source: Carnegie Institution

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