Researchers find link between amount of silica in subduction zones and frequency of 'slow' earthquakes

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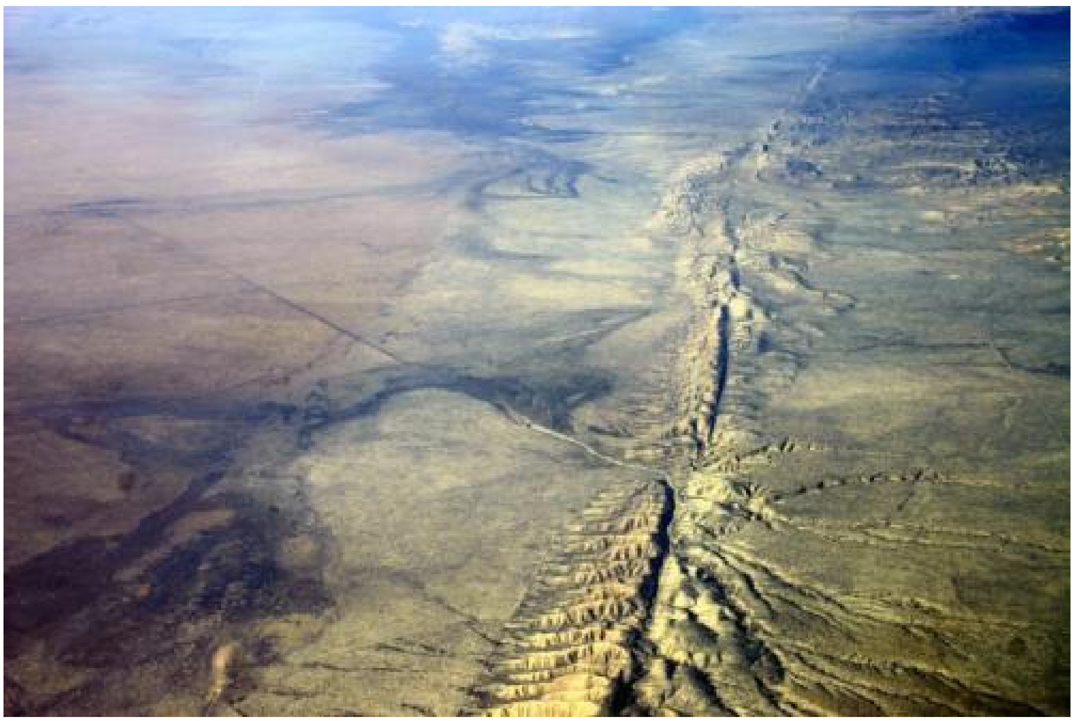

Aerial photo of the San Andreas Fault in the Carrizo Plain, northwest of Los Angeles. Credit: Wikipedia.

(Phys.org) —A pair of researchers, Pascal Audet and Roland Burgmann of the Universities of Ottawa and California, respectively, has found a connection between the amount of silica rich quartz above subduction zones and the frequency rate of "slow" earthquakes. In their paper published in the journal *Nature*, the two describe how they measured quartz amounts in the Cascadia subduction zone using seismic waves, and how it relates to slow earthquakes.

Scientists have only known about slow earthquakes for a few years—since they can't be felt, there was no real indication that they were occurring. They happen when silica rich sediment is pushed from below when one plate pushes beneath another. The fluid is trapped causing pressure to build—eventually that pressure is released by slow sliding (due to lubrication provided by the silica), rather than the jolt associated with surface quakes. After the sliding stops, the pressure begins to build up again and the whole process is repeated. Such quakes can occur over days or even weeks, releasing energy equivalent to large surface quakes. Scientists now know that such quakes occur off the coast of Japan, New Zealand, the United States and Canada, but, they all have a different frequency rate. They happen every two years in New Zealand, every six months in Japan and every 14 months beneath Canada's Vancouver Island. The difference in rates, the researchers have found, is due to the amount of silica in the fluid—there more there is, the faster faults knit together after the sliding has stopped.

The pair of researchers note that much more study needs to be done before it can be determined if slow earthquakes can be used to help predict surface quakes. In their experiments, they found the crust to be 5 to 15 percent quartz above the plates in the Cascadia subduction zone, an area that experienced a magnitude 9 quake in 1700. Scientists believe a major quake will likely occur again there sometime over the next 200 years. If slow earthquakes are found to portend larger ones, perhaps enough warning time can be given to save lives in the heavily populated area.

More information: Possible control of subduction zone slow-earthquake periodicity by silica enrichment, *Nature* 510, 389–392 (19

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Abstract
Seismic and geodetic observations in subduction zone forearcs indicate that slow earthquakes, including episodic tremor and slip, recur at intervals of less than six months to more than two years. In Cascadia, slow slip is segmented along strike and tremor data show a gradation from large, infrequent slip episodes to small, frequent slip events with increasing depth of the plate interface. Observations and models of slow slip and tremor require the presence of near-lithostatic pore-fluid pressures in slow-earthquake source regions; however, direct evidence of factors controlling the variability in recurrence times is elusive. Here we compile seismic data from subduction zone forearcs exhibiting recurring slow earthquakes and show that the average ratio of compressional (P)-wave velocity to shear (S)-wave velocity (vP/vS) of the overlying forearc crust ranges between 1.6 and 2.0 and is linearly related to the average recurrence time of slow earthquakes. In northern Cascadia, forearc vP/vS values decrease with increasing depth of the plate interface and with decreasing tremor-episode recurrence intervals. Low vP/vS values require a large addition of quartz in a mostly mafic forearc environment. We propose that silica enrichment varying from 5 per cent to 15 per cent by volume from slab-derived fluids and upward mineralization in quartz veins can explain the range of observed vP/vS values as well as the downdip decrease in vP/vS. The solubility of silica depends on temperature, and deposition prevails near the base of the forearc crust. We further propose that the strong temperature dependence of healing and permeability reduction in silica-rich fault gouge via dissolution–precipitation creep can explain the reduction in tremor recurrence time with progressive silica enrichment. Lower gouge permeability at higher temperatures leads to faster fluid overpressure development and low effective fault-normal stress, and therefore shorter recurrence times. Our results also agree with numerical models of slip stabilization under fault zone dilatancy strengthening15 caused by

decreasing fluid pressure as pore space increases. This implies that temperature-dependent silica deposition, permeability reduction and fluid overpressure development control dilatancy and slow-earthquake behaviour.