Major quakes can weaken seismic faults far away, scientists say

September 30 2009

This is the San Andreas Fault. Credit: Wikipedia

(PhysOrg.com) -- U.S. seismologists have found evidence that the massive 2004 earthquake that triggered killer tsunamis throughout the Indian Ocean weakened at least a portion of California's famed San Andreas Fault. The results, which appear this week in the journal *Nature*, suggest that the Earth's largest earthquakes can weaken fault zones worldwide and may trigger periods of increased global seismic activity.

"An unusually high number of magnitude 8 earthquakes occurred worldwide in 2005 and 2006," said study co-author Fenglin Niu, associate professor of Earth science at Rice University. "There has been speculation that these were somehow triggered by the Sumatran-Andaman earthquake that occurred on Dec. 26, 2004, but this is the first direct evidence that the quake could change fault strength of a fault

remotely."

Earthquakes are caused when a fault fails, either because of the buildup of stress or because of the weakening of the fault. The latter is more difficult to measure.

The magnitude 9 earthquake in 2004 occurred beneath the ocean west of Sumatra and was the second-largest quake ever measured by seismograph. The temblor spawned tsunamis as large as 100 feet that killed an estimated 230,000, mostly in Indonesia, Sri Lanka, India and Thailand.

In the new study, Niu and co-authors Taka'aki Taira and Paul Silver, both of the Carnegie Institution of Science in Washington, D.C., and Robert Nadeau of the University of California, Berkeley, examined more than 20 years of seismic records from Parkfield, Calif., which sits astride the San Andreas Fault.

The team zeroed in on a set of repeating microearthquakes that occurred near Parkfield over two decades. Each of these tiny quakes originated in almost exactly the same location. By closely comparing seismic readings from these quakes, the team was able to determine the "fault strength" -- the shear stress level required to cause the fault to slip -- at Parkfield between 1987 and 2008.

The team found fault strength changed markedly at three times during the 20-year period. The authors surmised that the 1992 Landers earthquake, a magnitude 7 quake north of Palm Springs, Calif. -- about 200 miles from Parkfield -- caused the first of these changes. The study found the Landers quake destabilized the fault near Parkfield, causing a series of magnitude 4 quakes and a notable "aseismic" event -- a movement of the fault that played out over several months -- in 1993.

The second change in fault strength occurred in conjunction with a magnitude 6 earthquake at Parkfield in September 2004. The team found another change at Parkfield later that year that could not be accounted for by the September quake alone. Eventually, they were able to narrow the onset of this third shift to a five-day window in late December during which the Sumatran quake occurred.

"The long-range influence of the 2004 Sumatran-Andaman earthquake on this patch of the San Andreas suggests that the quake may have affected other faults, bringing a significant fraction of them closer to failure," said Taira. "This hypothesis appears to be borne out by the unusually high number of large earthquakes that occurred in the three years after the Sumatran-Andaman quake."

Source: Rice University