Research links seismic slip and tremor, with implications for subduction zone

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(PhysOrg.com) -- In the last decade, scientists have recorded regular episodes of tectonic plates slowly, quietly slipping past each other in western Washington and British Columbia over periods of two weeks or more, releasing as much energy as a magnitude 6 earthquake.

The slip events coincide with regular occurrences of what scientists call nonvolcanic tremor, which showed up clearly on seismometers but for which the origins were uncertain.

Now researchers from Italy and the University of Washington have concluded that both phenomena are signs of the same processes taking place about 25 miles deep at what is believed to be the interface between the Juan de Fuca and North American tectonic plates.

"We are now more confident that the tremor and the slip are both products of the same slip process," said Kenneth Creager, a UW professor of Earth and space sciences and a co-author of a paper describing the research being published Jan. 30 in *Science*.

The findings could have major implications for megathrust earthquakes in the Cascadia subduction zone, an area along the West Coast from northern California to southern British Columbia. Megathrust events are huge earthquakes, often in the range of magnitude 9, that occur in areas where one tectonic plate is forced beneath another.

The slow slip events appear to be building stress on the megathrust fault, where the Juan de Fuca plate is sliding beneath the North American plate, with the two locked together most of the time. That pressure is relieved when the plates slip during megathrust earthquakes such as one determined to have occurred off the coast of Washington on Jan. 26, 1700, estimated at magnitude 9.2. That quake was similar to the great Sumatra-Andaman Islands earthquake the day after Christmas in 2004, which also measured 9.2 and triggered a devastating Indian Ocean tsunami.

In such events, the plates are locked together for hundreds of years and then slip past each other by sliding 50 feet or more during a megathrust earthquake.

"The same amount of slip must also occur onshore along the Washington coast," Creager said. "While megathrust earthquakes account for most of the plate motion offshore, and perhaps slightly onshore, episodic tremor and slip harmlessly accommodates much of the plate motion that is taking place on plate interface just west of the Puget Sound region's major population centers."

The paper's lead author is Mario La Rocca of Italy's National Institute of Geophysics and Volcanology Vesuvius Observatory. Other authors are Danilo Galluzzo, also of Italy's geophysics and volcanology institute, and Steve Malone, John Vidale, Justin Sweet and Aaron Wech of the UW.

Slip events occur on the interface between tectonic plates, but previous research has suggested that nonvolcanic tremor occurs in a broad range of depths from the plate boundary to 15 miles above it. The new research indicates the tremor is at the plate boundary, in essentially the same place as the slip.

The researchers used seismometer arrays at Sequim and Lopez Island in Washington state and at Sooke on the southern edge of Canada's Vancouver Island to record an episodic tremor and slip event in 2004. La Rocca devised a novel method using the different times that specific waves generated by the tremor were detected by seismometers, and the data helped the scientists pinpoint the depth of the tremor. At the same time, GPS measurements recorded the slow plate slippage.

Since they were discovered in the last decade, slow slip and tremor events in western Washington and British Columbia have been recorded on a regular basis about every 15 months. GPS signals indicate slip of about 1 inch during an average episode.

"We are quite confident that each episodic tremor and slip event will increase the stress on the megathrust fault," Creager said. "If a megathrust earthquake were to begin off the Washington coast, one might expect it to occur during one of these slow slip events."

But he said the findings demonstrate that much research remains to be done.

"We're just scratching the surface in understanding how all of this works."

Provided by University of Washington