Tremors between slip events: More evidence of great quake danger to Seattle

December 15 2009, by Vince Stricherz

(PhysOrg.com) -- For most of a decade, scientists have documented unfelt and slow-moving seismic events, called episodic tremor and slip, showing up in regular cycles under the Olympic Peninsula of Washington state and Vancouver Island in British Columbia. They last three weeks on average and release as much energy as a magnitude 6.5 earthquake.

Now scientists have discovered more small events, lasting one to 70 hours, which occur in somewhat regular patterns during the 15-month intervals between episodic tremor and slip events.

"There appear to be tremor swarms that repeat, both in terms of their duration and in where they are. We haven't seen enough yet to say whether they repeat in regular time intervals," said Kenneth Creager, a University of Washington professor of Earth and space sciences.

"This continues to paint the picture of the possibility that a megathrust earthquake can occur closer to the Puget Sound region than was thought just a few years ago," he said.

The phenomenon, which Creager will discuss today (Dec. 15) during a presentation at the annual meeting of the American Geophysical Union, is the latest piece of evidence as scientists puzzle out exactly what is happening deep below the surface near Washington state's populous Interstate 5 corridor. He noted that the work shows that tremor swarms follow a size distribution similar to earthquakes, with larger events

occurring much less frequently than small events.

The Cascadia subduction zone, where the Juan de Fuca tectonic plate dips beneath the North American plate, runs just off the Pacific coast from northern California to the northern edge of Vancouver Island in British Columbia. It can be the source of massive megathrust earthquakes on the order of magnitude 9 about every 500 years. The last one occurred in 1700.

The fault along the central Washington coast, where the Pacific and Juan de Fuca plates are locked together most of the time but break apart from each other during a powerful megathrust earthquake, was believed to lie 80 miles or more from the Seattle area. But research has shown that the locked zone extends deeper and farther east than previously thought, bringing the edge of the rupture zone beneath the Olympic Mountains, perhaps 40 miles closer to the Seattle area. It is this locked area that can rupture to produce a megathrust earthquake that causes widespread heavy damage, comparable to the 2004 Indian Ocean earthquake or the great Alaska quake of 1964.

Episodic tremor and slip events appear to occur at the interface of the plates as they gradually descend beneath the surface, at depths of about 19 to 28 miles. The smaller tremors between slip episodes, what Creager refers to as inter-episodic tremor and slip events, appear to occur at the interface of the plates a little farther east and a few miles deeper.

"There's a whole range of events that take place on or near the plate interface. Each improvement in data collection and processing reveals new discoveries," Creager said.

Episodic tremor and slip events often begin in the area of Olympia, Wash., and move northward to southern Vancouver Island over a three-week period, but scientists have yet to pin down such patterns among the

smaller tremors that occur between the slip events.

Because the two tectonic plates are locked together, stress builds at their interface as they collide with each other at a rate of about 4 centimeters (1.6 inches) a year. The slip events and smaller tremors ease some of that stress locally, Creager said, but they don't appear to account for all of it.

"Each one of these slip events puts more stress on the area of the plate boundary where megathrust earthquakes occur, which is shallower and farther to the west, bringing you closer to the next big event," he said. "There's nothing to tell you which one will be the trigger."

Since the slip events and intervening small tremors don't accommodate all of the stress built up on the fault, scientists are getting a better idea of just what the hazard from a megathrust earthquake is in the Seattle area. One benefit from that is the ability to revise building codes so structures will be better able to withstand the immense shaking from a great quake, particularly if the source is substantially closer to the city than it was previously expected to be.

"We'd like to go back and see how much slip has occurred in these slip events, compared to how much should have occurred," Creager said. "Then we'll know how much of that slip will have to be accommodated in a megathrust earthquake, or through other processes."

Provided by University of Washington

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