Times-Standard
Times-Standard / Humboldt Beacon

Not My Fault: Episodic tremor and slip, the silent earthquake you can't feel

Lori Dengler/For the Times-Standard
Posted August 29, 2019

The KIRO-TV headline (8/21) was a little obscure: "Seismologists: Seismic event underway that could increase risk of large earthquake in region." KIRO is the CBS affiliate in the Seattle area and they were talking about the Episodic Tremor and Slip event or ETS that began on August 11th.

ETS is what seismologists call a process that has been observed in some fault zones. First noted in Japan in 2002, it involves repeated episodes of slow sliding, one plate against the other, accompanied by energetic seismic noise called tremor. Over the period of a few weeks, the slip and tremor area grows, eventually extending over an area of several hundred square miles, and releasing the energy equivalent to a magnitude 6.5 to 7 earthquake. But you won't feel a thing because the slip occurs so slowly and the individual earthquakes are all very small.

ETS was first observed in subduction zones, where one slab or plate is pulled by gravity beneath another plate. The pull is constant and the subducting plate moves continuously like a conveyor belt, regardless of what happens above or below it. Near the surface, where the subducting plate is relatively cool, friction is large and the two plates are locked together. It's this upper stuck zone above 20 miles in depth that gives rise to great earthquakes when the pull finally overwhelms the strength of the interface and the two sides suddenly move. The plates may be locked for hundreds of years and all of the stored energy is released in a few minutes. Shaking is very strong and the impacts are significant.

But deeper down, the rock becomes warmer and warmer. By the time the subducting slab reaches a depth of 30 to 40 miles, friction is much less and the two plates slide past each other. No energy is stored along the interface and great earthquakes can't happen here*. It's the transition area between the locked zone and the stable sliding area where ETS events occur.

The best studied ETS area in the world is beneath our feet, the Cascadia subduction zone. In the late 1990s and early 2000s, Global Positioning Satellite systems were installed in Washington State and Southern British Columbia. These instruments continuously monitored position and, unlike the GPS in your car, were capable of measuring location changes as small as an inch.

When scientists from Geological Survey of Canada looked at the first data results, they saw what they expected over the locked portion of the subduction zone. The west coast of Vancouver Island was slowly and steadily moving to the Northeast as the subducting Juan de Fuca plate pulled it along. And further east, on the British Columbia mainland, the data also confirmed their models. There was no NE movement because the two plates could slide relative to each other.

But there was a surprise. I don't know what they expected to see in the transition zone - perhaps a gradual and steady diminishing of the deformation until there was none to see. Instead there were a step-like series of jerks. For a year or so the motion was very similar to the locked zone, steady NE movement. Then, over a period of a few weeks, the motion reversed and this part of the overlying plate began to move to the southwest. This pattern repeated year after year. About 14 months would pass with steady movement in one direction then slip in the opposite direction.

Sensitive seismograph arrays found that the slip events weren't completely silent. They were accompanied by a burst of very tiny earthquakes, most less than magnitude 1. As the slip event continued, the epicenters slowly moved – sometimes to the south and sometimes to the north. By calculating the area and summing the total slip, the displacement released energy equivalent to a M7 earthquake.

The scientists called the phenomenon Episodic Tremor and Slip (ETS), tremor referred to the small earthquakes and slip, the GPS observed movement. After much discussion and some head scratching, a model was proposed. Think of the subduction zone as a ramp gently dipping down into the earth. Where it first begins to descent, the overlying plate has great grip and the two plates are stuck and move together. But in the transition zone, the grip isn't as strong. Several processes are at play including heat and water. The overlying plate can hang on for a year or so and move with the subducting plate, but then loses traction and begins to slide in the opposite direction for a couple of weeks before it grabs on again.

The ETS itself poses no risk to our built environment or us. There is a "but." Soon after ETS was first observed, some suggested they might increase the likelihood of a great earthquake. The thinking went like this – during ETS sliding, a small additional push is exerted on the overlying plate near the bottom of the locked zone. Whether this tiny nudge is enough to initiate rupture is unknown.

Since the most recent ETS began two weeks ago, more than 4000 tiny quakes have been detected, their epicenters migrating to the south as the slip patch grows. I'm not worried. Since ETS was first discovered, we've learned that there are four separate zones of slow slip in Cascadia, all with their own regular pattern of sliding events and that any additional ETS tug is extremely small. ETS has been observed in Japan, New Zealand and Central America but so far not a single significant earthquake has occurred during an ETS episode.

We will have a major Cascadia earthquake and it could occur this afternoon, tomorrow, or decades from now. It is important to prepare our communities and ourselves. But don't lose any sleep because an ETS is in progress.

Note: * Deeper earthquakes do occur in some subduction zones. The largest earthquake in 2018 was more than 370 miles deep. But these very deep quakes are not on the interface and have a different cause unrelated to locked zones. The recent KIRO news story is at https://www.kiro7.com/news/local/seismologists-seismic-event-underway-that-could-increase-risk-of-large-earthquake-in-region/978035722 The Pacific Northwest Seismic Network provides an ETS overview and archive of events at https://pnsn.org/tremor/overview .

Lori Dengler is an emeritus professor of geology at Humboldt State University, an expert in tsunami and earthquake hazards. Questions or comments about this column, or want a free copy of the preparedness magazine "Living on Shaky Ground"? Leave a message at (707) 826-6019 or email Kamome@humboldt.edu

https://www.times-standard.com/2019/08/29/lori-dengler-episodic-tremor-and-slip-the-silent-quake-you-cant-feel/