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Not My Fault: When it comes to Cascadia, not all parts are equal

Lori Dengler/For the Times-Standard
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At some point in the next 15 million years, the Cascadia subduction zone (CSZ) will no long pose an earthquake threat to Northern California and the Pacific Northwest. That's not a long time geologically speaking, but from a human perspective it means that in the foreseeable future, the CSZ threat is real.

The CSZ marks the convergent boundary between the Juan de Fuca plate system and the North American plate. It extends from Cape Mendocino to Vancouver Island and west to the Gorda, Juan de Fuca and Explorer ridges. The ridges are offset by transform faults, giving the western boundary of this plate system a jagged appearance. These transforms also divide the Juan de Fuca into three distinct geographic regions: Gorda (in the south), Juan de Fuca (the central and largest region), and the Explorer (the smallest segment offshore of Canada).

I was recently asked if researchers still work on the CSZ and the Juan de Fuca plate system. YES. I recently participated in a workshop focused on the Gorda region in Northern California and Southern Oregon. About thirty scientists attended with a wide range of backgrounds including seismology, paleoseismology, geology, engineering, and geodesy. The purpose was to summarize what we know, where we agree/disagree and the top priorities for future research.

There is nothing wrong about disagreements in science. Without disagreement, we would never question or test ideas and science would advance very slowly. Awareness of the Cascadia subduction zone and the potential for great earthquakes is less than four decades old. The last Cascadia earthquake was more than three centuries ago and our information about that event is incomplete. We have tantalizing pieces of data from tsunami sediment deposits, offshore and onshore geology, oral accounts from Native Peoples, and modeling studies. But just like a person attempting to describe an elephant when limited to a small area, it is difficult to build a complete picture of the beast.

There were many areas of agreement. The central or Juan de Fuca region offshore of Oregon and Washington is the only part that is behaving like a classic plate with earthquakes concentrated on the boundaries and a quake-free interior. The Gorda and Explorer regions are riddled with intraplate earthquakes. Since 2000, over 200 earthquakes of magnitude 4 and larger have occurred within the Explorer plate, including nine in the M6 range. The Gorda plate is likewise earthquake prone. More than 130 M4 and larger earthquakes have occurred with the plate's interior including a 7.2 and three in the M6 range since 2000. Two 5.9s were recorded only three weeks ago far offshore of the CA-OR border. In contrast, only nine M≥4 intraplate quakes were recorded within the central Juan de Fuca plate in this same time period.

The rate of intraplate earthquake activity in the Gorda and Explorer interiors have led some scientists to argue they shouldn't be called 'plates' and that 'deformation zone' is a more apt lable. But here is where some big questions and a few disagreements lie. How do the earthquakes within the plates affect what will happen in the next Great Cascadia earthquake?

Like most of you reading this column, the southern CSZ is what most concerns me. I live right on top of the CSZ interface. It's only eight miles beneath my house. This is the interface that will break in the next Cascadia earthquake. I'd like to know how strong the shaking will be, how big a tsunami can we expect, and what will happen to our infrastructure.

The answers to the thirst two questions lie in the stress accumulation and the properties of underlying rocks and rock structures. That is what determines the characteristics of rupture and how much of slip occurs beneath the sea floor. We can't measure those variables directly, but we can measure surface deformation and estimate subsurface structure from geophysical studies.

I'm in the camp that believes the Gorda region differs from the Juan de Fuca in Oregon and Washington in several important ways. The CSZ fault plane is a gently dipping surface extending from the continental shelf offshore for 60 to 80 miles. In Humboldt County, perhaps a third of that fault plane is beneath land. By Central Oregon, it is entirely offshore. Second, the rate of plate convergence along the Southern Cascadia margin is less than further north. There is also evidence that this area experiences more partial ruptures (~M8 – 8.5) than areas further north. Partial ruptures and slower convergence to my mind suggests less slip in the next earthquake.

Everyone at the workshop agreed that Cascadia tsunamis reach our coast more quickly than in Central Oregon and Washington. Tsunamis are caused by slip beneath the seafloor, and we are just closer to the source zone. First tsunami surges could reach Humboldt, Del Norte and Curry County Oregon coasts in as little as ten minutes after the earthquake. We also agreed that this area will experience stronger ground shaking because some of the rupture zone is beneath populated areas.

Determining the likely height of a future tsunami is more difficult. Paleotsunami studies that map out the extent of previous CSZ tsunamis are the only direct measurement of what has happened in the past. But such studies require preservation of deposits that can easily be eroded on a dynamic landscape. The relative paucity of tsunami sands in Humboldt County and especially the lack of any deposits in the Mad River slough convinces me that tsunami heights here are likely to be less than along the Oregon and Washington coasts.

We all agreed that learning more about our offshore environment, and particularly how the sea floor is deforming could be one of the best routes to getting a better handle on strain accumulation. So that is an avenue I will loudly lobby for. We also agreed that all of the jurisdictions along the Cascadia margin are working hard to update hazard information based on the best currently available science and that the best way to survive the shaking and the tsunami is to keep informed and prepare now.

Lori Dengler is an emeritus professor of geology at Humboldt State University, an expert in tsunami and earthquake hazards. The opinions expressed are hers and not the Times-Standard's. All Not My Fault columns are archived online at https://kamome.humboldt.edu/resources and may be reused for educational purposes. Leave a message at (707) 826-6019 or email rctwg@humboldt.edu for questions and comments about this column, or to request a free copy of the North Coast preparedness magazine "Living on Shaky Ground."