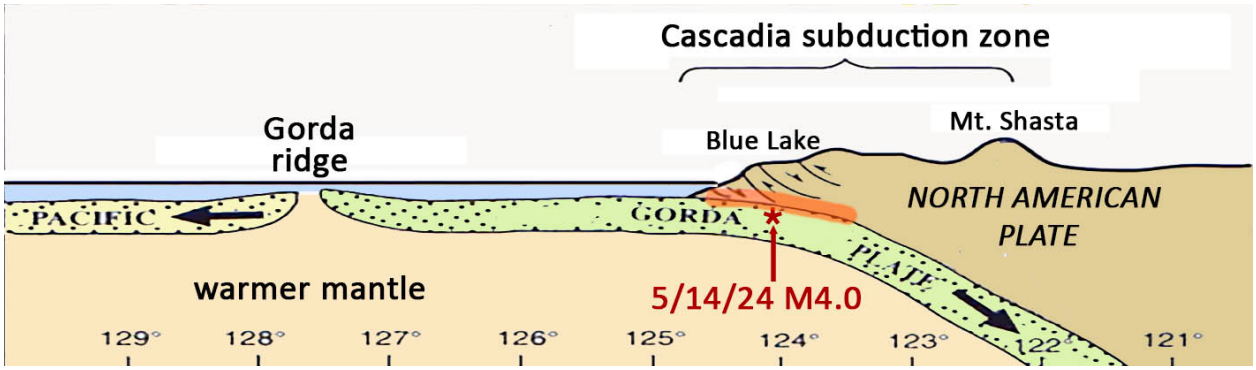
Times Standard

Not My Fault: Not all North Coast quakes are at the coast or offshore

Lori Dengler for the Times-Standard
Posted May 18, 2024
https://www.times-standard.com/2024/05/18/lori-dengler-not-all-north-coast-quakes-are-at-the-coast-or-offshore/



Cartoon cross section showing approximate locations of the plates and the focus of the May 14 M4.0 earthquake. Orange area represents the locked portion of the Cascadia subduction zone and arrow shows the gravitational tug on the Gorda plate. Elevations are highly exaggerated.

Even modest temblors can give a psychic jolt – especially at night. Tuesday's 11:39 PM earthquake was felt by many in the Humboldt Bay region and by a few as far away as Willits and Del Norte County. It was alarming to people traumatized by strong shaking in previous earthquakes.

My husband felt a slight jiggle and heard my phone vibrating; I slept straight through. By the time I checked my computer in the morning, all the particulars were listed. The earthquake had a magnitude of 4.0 and was centered 6 miles southeast of Blue Lake at a depth of 16 miles. It was on a north – south oriented normal fault. That means stretching in an east – west direction.

You couldn't tell any of this from what you felt. But you should have recognized it was not a big earthquake. The shaking may have been over before you registered it as an earthquake. A few of you may have thought there were two earthquakes – a relatively weak vibration followed a few seconds later by a slightly stronger jolt. You experienced only one quake, but were able to discern two different types of wave energy (phases), produced by the fault rupture.

The process of fracturing rock always generates several different types of seismic waves. They all start at the same time when the rupture begins but some waves are faster than others and get to you more quickly. The fastest is always a P-wave, essentially a sound wave in the ground. It typically travels between 3 and 4 miles per second in crustal rock. If

the earthquake were 20 miles away from you, it would take less than 6 seconds to reach you.

The S-wave is a bit slower. S stands for secondary as it can never arrive before P. It is still zipping along at just over 2 miles per second but would arrive roughly 3 seconds after P if you were 20 miles away from the source. Closer to the source, P and S will be closer together and further away, longer.

The P-wave is weaker than S and many of you likely didn't feel it last Tuesday night. But your pets might have. Animals are much more sensitive to ground shaking than people are, and I've heard many stories of how dogs, cats, and birds became agitated a few seconds before their people felt anything. They weren't predicting the quake, just much better at sensing the smaller signals.

It's this difference between the speed of P and S that is the basis of ShakeAlert® and earthquake early warning. Seismographs close to the epicenter detect the P-waves, locate the quake and algorithms forecast the likely magnitude and strength of shaking all with about 5 seconds of the earthquake beginning. If the earthquake is large enough and shaking is expected to be noticeable, alerts are sent via cell phones and other systems and will hopefully reach you before the stronger S waves arrive. Why no message last Tuesday? The earthquake didn't make the magnitude 4.5 cutoff.

Whenever you feel an earthquake in Humboldt County, think tsunami. Be aware if you are in a tsunami zone at home, at work, school, or play. It's easy to find out – look for the Entering and Leaving tsunami zone signs, pick up a community tsunami brochure from the weather service, or look at our on-line repository of tsunami maps at https://rctwg.humboldt.edu/tsunami-hazard-maps. The signs and maps are all based on the greatest tsunami threat, the areas that should be evacuated if a magnitude 9 earthquake occurs on the Cascadia subduction zone.

If the earthquake is short like Tuesday's 4.0, no sweat. The earthquake wasn't large enough to deform the sea floor and generate a tsunami, stay where you are and go back to sleep. It's the shaking that feels like it lasts forever that is the natural warning a tsunami could be coming, and you should quickly head to a safe spot inland or on higher ground. Not sure if it's long enough or not? Treat it like the real thing until you get confirmation that there is or isn't a tsunami threat. The National Tsunami Warning Center usually issues a statement within five minutes if it's clear the quake poses no risk. We are working on more ways to get that "No Tsunami" message out quickly. KMUD does a good job of broadcasting this information and you can always check tsunami.gov on your cell phone as you are heading to safer areas.

Was the 4.0 another aftershock of the December 2022 M6.4? No. It was a different type of earthquake and unrelated to the Mendocino triple junction. With earthquakes in our area, think in three dimensions. Depth is important because it tells what tectonic zone it was in. This earthquake was not on the subduction zone interface between the North American and Gorda plates. That's the big fault structure we call the megathrust. It was also not on one of the many mapped faults in the North American plate. It was within the Gorda plate, roughly 7 miles below the megathrust.

The overwhelming majority of felt earthquakes in historic times have been centered in the Gorda plate including the 1980 M7.2 offshore of Trinidad and the 2022 M6.4 Ferndale eathquakes. Both of those earthquakes were related to the squeezing of the Gorda plate in the offshore and near coastal area where the triple junction plays a role. But further inland east of the triple junction other stresses are more important.

A cross section is a good way to visualize what is happening. The Gorda plate is pulled by gravity as it sinks beneath North America. For the past 100 million plus years, a giant conveyor belt has been operating along the west coast tugging constantly at the toe of the sinking plate. If the interface between Gorda and North America were nicely lubricated, the process would go smoothly with only some small earthquakes and no great buildup of strain.

But Cascadia is what we call a locked subduction zone. The upper fifty or so miles of the interface are tightly stuck together. The friction is so great that subduction is causing the North American plate to slowly bulge upward. The Gorda plate is stuck at the upper end and being pulled from below. The result is stretching. The 4.0 was on a north - south normal fault which means tension in an east-west direction.

Local seismologist Bob McPherson first identified these types of quakes in his thesis work in the 1980s and dubbed them “slab pull” earthquakes. Although usually small in magnitude, the USGS has recorded two similar quakes in the M5 range in the 2000s - a 5.4 near Burnt Ranch in 2008 and a 5.6 NW of Willow Creek in 2012. We don’t know for sure how large these earthquakes could be in the future. It’s possible that the December 21, 1954, M6.5 fell into this category, but the quality and distribution of instruments at the time makes it impossible for a definitive conclusion.

It's unlikely that the Blue Lake 4.0 means much in terms of hazard. These deeper slab pull quakes produce few aftershocks and probably don’t influence what is happening along the locked megathrust interface. They are a reminder that the interface is locked and will eventually produce a much larger earthquake and that it’s not just offshore areas or the triple junction region that can wake us up in the night.

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/taxonomy/term/5 and may be reused for educational purposes. Leave a message at (707) 826-6019 or email Kamome@humboldt.edu for questions and comments about this column or to request a copy of the new edition of the preparedness magazine “Living on Shaky Ground.” An electronic version is posted at https://rctwg.humboldt.edu/prepare/shaky-ground.