Times Standard

Not My Fault: I learned something new about North Coast earthquakes

Lori Dengler for the Times-Standard

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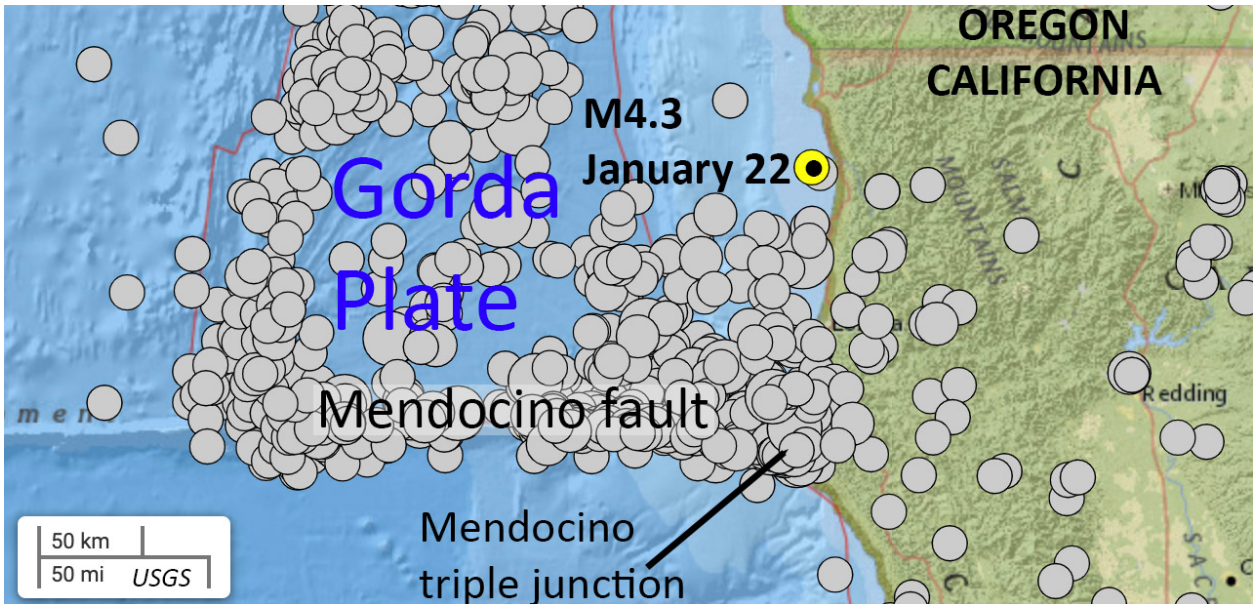

The magnitude 4.3 January 22 earthquake was centered in an area that has had very few earthquakes compared to other areas of the Gorda plate (USGS seismicity map).

Last Monday, a modest earthquake occurred off the coast of the Klamath River mouth. At a magnitude of 4.3, the USGS described it as 'light,' just above the 'small' magnitude 2s and 3s, and below the 'moderate' M 5s. It was felt by many in northern Humboldt and Del Norte County. Light earthquakes are common on the North Coast and adjacent offshore areas – we've had 16 in the past year alone. But this one was a bit different.

I've spent 45 years studying earthquake activity in our area. When I arrived as a fresh Ph.D. from Berkeley, I knew little about the Mendocino triple junction and had never heard of the Gorda plate. It would be another eight years before someone applied the name "Cascadia subduction zone" to what we know now as our greatest regional threat.

I felt my first earthquake only months after arriving (a 4.6 near Ferndale) but the real jolt of awareness was November 8, 1980 when we awoke at 2:27 AM to our screaming house during the M7.2 Trinidad earthquake. Our home was only ten miles from the epicenter and every board groaned and window rattled. It ended in a crescendo as an antique clock smashed on the floor.

Suddenly I had so many questions about earthquakes in this area. What fault was it on? Had there been quakes like this before? How do I keep things from falling over? As the geophysicist in the Geology Department, I needed to quickly get atop the game. Fortunately, I was surrounded by great colleagues. It was the beginning of a golden era for my Department and the dawn of our graduate program.

My first graduate student was Bob McPherson. Bob was running the Humboldt Seismic Network for Tera Corporation as part of the seismic safety assessments for the nuclear power plant at King Salmon. He had the richest data set ever compiled on regional earthquake activity and wanted to turn it into a thesis.

The Tera network data allowed better detection of smaller quakes and far more precise locations than Berkeley's two regional stations could determine. It also allowed Bob to determine what kind of earthquakes they were and how the faults had moved. By painstakingly plotting the first motions on stereonets, he could determine if the earthquakes were caused by tension, compression, or shear.

It was the first clear three-dimensional view of the complex terrain beneath our feet and gave Bob the tools to group earthquake behavior by depth and location. In 1992, Bob and I joined with Gary Carver in writing a summary paper on the sources of North Coast Seismicity. Bob's thesis work provided much of the framework.

We described the regional earthquake activity in terms of location, type of faulting, plate tectonic setting, and potential to cause major quakes. We recognized five areas that could generate significant earthquakes: the fault systems that join in the Mendocino triple junction area (Cascadia subduction zone, San Andreas, Mendocino), offshore earthquakes within the Gorda plate, and shallow onshore earthquakes on mapped surface fault systems.

This framework still holds up pretty well today, but I'd make a few additions. We now know that Gorda plate faults like the one that produced my rude awakening in 1980 extend eastward beneath Humboldt County. I'd call the December 20, 2022 M6.4 an offshore-onshore earthquake. It started offshore of False Cape west of Ferndale and then ruptured about ten miles towards Hydesville.

The complex web of Gorda plate faults is not only offshore but deeply buried onshore as well. Likely created millions of years ago when this part of the plate was still offshore, these planes of weakness were carried within the Gorda plate as it was pulled beneath the North American plate where all of us on the North Coast live. We can't see these faults on the surface as they all lie at depths of ten or more miles.

Where does last Monday's quake fit? Not into our 1992 paper. A quick glance at a North Coast earthquake epicenter map shows clustering of earthquakes in the vicinity of the Mendocino fault, Mendocino triple junction, and offshore in the Gorda plate. The number of Gorda plate earthquakes decreases in the central part of the plate and nearly vanish in the north. Some seismologists sketch in a boundary between the seismic and aseismic areas and say the southern Gorda isn't a plate at all and call it a deformation zone.

Monday's earthquake falls into this aseismic region. Its location is not the only thing unusual. Offshore Gorda plate earthquakes are all on strike-slip faults, or at least we thought they were. The 1980 quake that destroyed our clock is a classic example. It ruptured a 100-mile-long vertical fault to the southwest displacing rock on the northern side several feet to the west relative to rock on the south. We think these faults are in response to the squeezing of the Gorda plate from plate motions to the north and south.

The 4.3 on Monday was on a north – south oriented normal fault. Normal faults are the result of pulling or extension. For this earthquake to happen, there had to be east – west stretching. This may seem very puzzling. On the map, the epicenter looks like it's in the Cascadia subduction zone margin. If you've been reading this column, a bell should ring screaming big time compression. How on earth do you get stretching where the main stress regime is pushing things together?

In subduction zones both pushing and pulling happens at the same time. Gravity drives the subduction process and is constantly pulling the Gorda plate down. Friction sticks the Gorda plate to the North American plate so most of the time the interface between the two is stuck. We expect to see "down slab pull" to the east of the stuck zone. Bob recognized this down slab pull back in the 1980s in his thesis work. But his tension quakes were all located further south of the 4.3 and onshore.

It's easy for me to wave my hands and speculate on what the 4.3 means. It's harder to say if this earthquake portends another source of larger North Coast earthquakes. We had a 5.4 in 2008 near Burnt Ranch and a 5.6 in 2012 north of Willow Creek on similar faults and I couldn't rule out quakes of this type in the M 6 range. But I'm not convinced that the 4.3 falls into the same category because of its location and depth.

I got into earth science because I love puzzles. Over my half century in the field, I've seen many puzzles answered but there are always new ones to ponder. Every earthquake is a reminder that on the North Coast earthquakes can a do happen anywhere, not just near the triple junction. And I have learned to restrain antique clocks and bolt cabinets to the wall.

Note: You can find our 1992 paper, Sources of North Coast Seismicity at https://kamome.humboldt.edu/sites/default/files/Sources%20of%20North%20Coast%20Seismicity.pdf

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