

Not My Fault: A Shaky Start to 2023

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New Year's Day 2023. Normally I would be compiling my annual summary of 2022 earthquakes, but Mother Nature had other ideas. I had just finished updating the Humboldt Earthquake Hotline (707) 826-6020 when my phone announced, "EARTHQUAKE EARTHQUAKE DROP COVER AND HOLD ON." The words were barely done when the first jiggle hit, not very strong but I would have noticed even if my phone hadn't alerted me. After a few more seconds, the shaking got a little stronger but not enough to knock pictures askew. It was over in less than five seconds.

It took another minute or two before the preliminary magnitude and location popped up on my phone. First a 5.1, then 4.9, and finally a 5.4. No these weren't three different earthquakes and there were no errors involved. The first magnitudes were estimates made by computers looking at limited station data. We want info about size and location fast and computer estimates are the best way to get preliminary values.

Computers have gotten much better at picking seismic arrivals, but these early quick locations are often off by a few tenths of a magnitude unit. It is more problematic on the North Coast where we have no offshore instruments and constraining the location requires a trained eye. If you are a visitor to the USGS Latest Earthquakes page, scroll down to the Origin box on their earthquake page and look at the Review Status. It takes a few minutes for a seismologist to bring up the data and review the computer analysis. It is not unusual for a few adjustments to be made.

Larger earthquakes or multiple overlapping quakes can be even more challenging. In December 2021, it took two weeks for the final determination of size and location to be agreed to. It turned out we had two earthquakes – a 5.7 followed by a 6.2 18 miles and 11 seconds apart. Some seismologists are still arguing the magnitudes need a little adjustment.

It didn't take me long to realize that the January 1 M5.4 was different than the December 20th M6.4 is several ways. It was almost twice as deep and oriented in a

different direction. The 6.4 rupture was roughly 8 to 10 miles long and motion was left-lateral strike slip, the rock on the northern or Fortuna side of the fault lurched to west and the rock on the Rio Dell and Ferndale side moved to the east, the slip horizontal like cars on an American highway.

The M5.4 was 10 miles south of the M6.4 fault plane and on a different fault. This fault was also strike-slip but oriented in a NW – SE direction. Motion was akin to a British highway with the rock on the eastern side being pushed towards Ruth Lake and the western side being shoved in the direction of Ferndale. We call this right-lateral slip.

Have I lost you? Our North Coast tectonics confuse many people, even geoscientists that aren't familiar with the wild world of the Mendocino triple junction. I can't tell you how many journalists have asked me to name the fault that causes our earthquakes. Not just one fault - we have so many that only the ones large enough to break the surface have names.

Some of the more informed journalists like to pull up a USGS fault map and point to one of the named faults that seem close to the epicenter. Nope – that won't work. Very few of our historic faults are on the ones that are mapped on the surface. Both the December 20th 6.4 and New Year's Day 5.4 were in the Gorda plate, well below the interface that separates it from the North American plate and all of the faults we can see.

I like jigsaw puzzles. Let's say I finish a 500-piece puzzle and then decide to construct another different puzzle right on top of it. The top puzzle pieces are different in size and shape. When I am done, I can't see the detailed structure of the bottom one. I can't use the upper puzzle to predict what lies below.

The Mendocino triple junction region is even more complex than my two puzzles. Most of the action takes place in the bottom puzzle and stresses have mixed and squeezed parts of the puzzles together. Like the puzzles, if I push on one piece it can affect a neighbor. That's what is happening in the Southern Humboldt region right now.

If an earthquake is on a different fault, can it still be an aftershock? Yes, if it is on a nearby closely related fault and in the time of elevated seismicity following the first earthquake. We've had nearly 300 aftershocks to date, about 220 close to the mainshock fault rupture, 44 in a shotgun pattern around the eastern end of the rupture and a smattering of others, like January 1, north or south of the

main rupture zone. If the 5.4 occurred two years from now after earthquake activity returned to background levels, I'd call it a separate quake.

I received MyShake alerts for both the 6.4 and 5.4 and was glad to get them. I know many of you were frustrated that the alerts didn't give you much, if any, heads up. How does MyShake work and why did I get only a second's notice last Sunday?

MyShake is California's earthquake alert system. Oregon and Washington have a similar program, called ShakeAlert. For large earthquakes, you might also get Wireless Emergency Alerts (WEA) via your phone. All of these alerts are based on the same principle: detect the earthquake rupture in the first few seconds AFTER it has already begun. There is no prediction going on here, and, when enough seismic stations record those early signals, it can be very accurate.

After at least four stations have "picked" a signal (seismospeak for seismic wave arrival time), an algorithm takes over estimating epicenter and magnitude, and forecasting likely shaking in the region. If the magnitude is at least 4.5 (5 for WEA alerts) and the expected shaking reaches the Intensity III threshold (moderate shaking), alerts are sent to everyone in the III and stronger shaking area via cell phones and, in some cases, computers. On December 20th, it took 5.5 seconds for the first alert to be sent following the 6.4. The New Year's Day M5.4 temblor took 8 seconds.

Here lies the rub in earthquake early warning. Seismic waves are very fast and in 7 to 8 seconds the primary or P-wave can travel about 35 miles. That means everyone within 35 miles of the epicenter won't get an alert because it hasn't even been issued yet. On January 1, the alert arrived at my phone less than a second before I felt it. I live in McKinleyville, 36 miles from the Jan 1 epicenter.

Can MyShake do better? Yes, and it is improving. The density of seismic networks is the most important factor. We have many more stations on the North Coast now than a decade ago and more are being installed all the time. Algorithms are tested and improved with each real event. But until we have offshore detections systems, many of our earthquake alerts will arrive at about the same time as the shaking. And there is no way you will get a 20-30 second warning unless you are fairly far from the epicenter.

Don't confuse these earthquake early warning alerts with your county emergency notification system. Almost all California counties have a system to notify you when

hazardous conditions exist. It is used to let you know when a tsunami warning has been issued in our area and other conditions that warrant your action. A Humboldt Alert was issued on January 3 to tell us about the storm conditions and curtail nonessential driving. County notifications do not broadcast earthquake early warnings.

I don't know when this sequence will end. Seismicity has been relatively low in the aftershock zone for the past day. But I doubt if it's over yet.

Lori Dengler is an emeritus professor of geology at Cal Poly Humboldt and 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."