

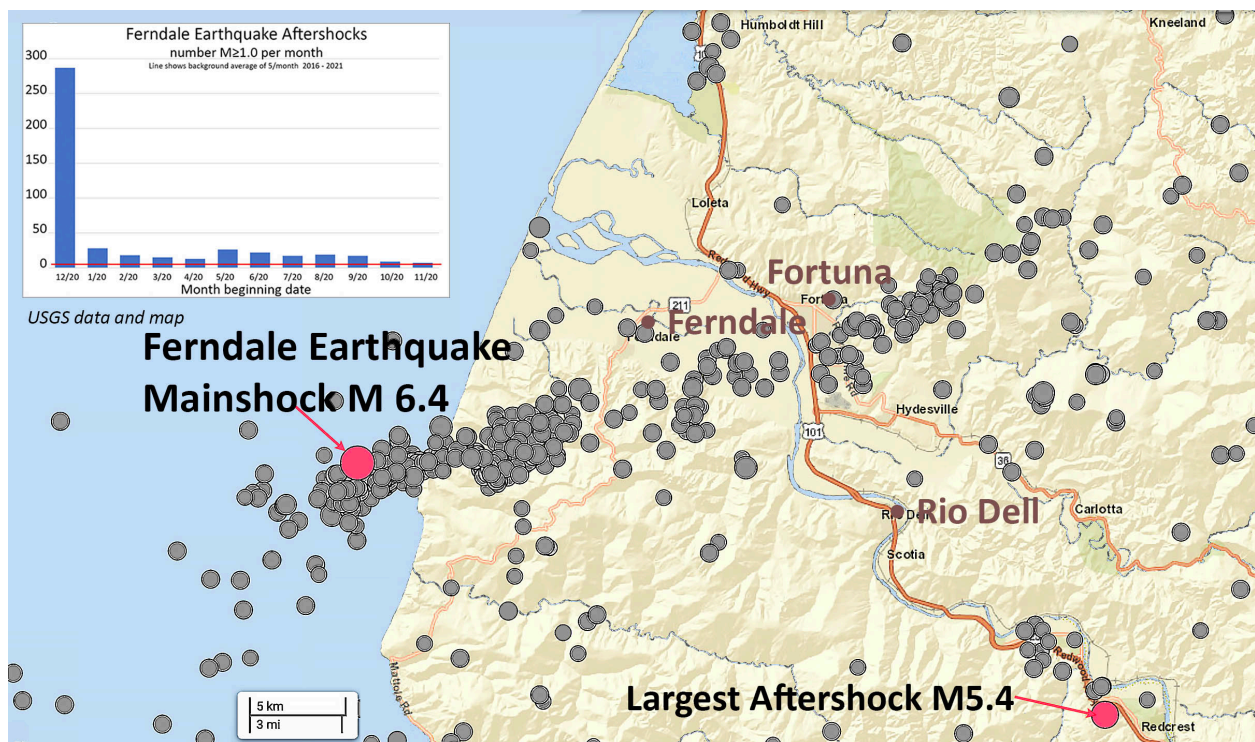
Times Standard

Not My Fault: The December 20, 2022 Ferndale Earthquake – a one-year report card

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USGS epicenter map for earthquakes of magnitude 1 and larger, December 20, 2022 through December 15, 2023. Inset shows number of aftershocks per month; red line is the long-term background monthly average.

Last December 19th, my husband and I were in Sacramento picking up a new car. We spent the night in Sacramento to avoid a night drive home. The MyShake App on my phone loudly awoke us at 2:34 AM blaring “Earthquake detected! Drop Cover and Hold On.” I braced myself in bed for the shaking that never came.

Back in Humboldt, the experience was very different. It was the most damaging North Coast earthquake since a magnitude 6.5 struck offshore of Eureka in January 2010. For Rio Dell, it was a catastrophe, damaging nearly a quarter of the city’s building stock. Damage was also reported in Fortuna, Ferndale, Eureka, Arcata, and as far away as Willow Creek where a water line was broken. Total losses in the County exceeded \$32 million.

This is the time to look back on what happened, what was learned, and think about preparing for our inevitable next strong earthquake.

Shaking in the night is a rude shock but the location of the Ferndale earthquake was not a surprise. There have been nine earthquakes of magnitude 6 or larger within 35 miles of the epicenter since 1980, more in this timespan than any similar-sized region of the lower 48 states. USGS seismologists named it the Ferndale earthquake because it was the closest city to the epicenter.

The earthquake ruptured a vertical strike-slip fault (horizontal fault slip) within the Gorda plate. The Gorda plate has been the source of most of our large earthquakes for the past century including the 2010 M6.5 offshore of Eureka and the 1980 M7.2 near Trinidad. What is different - the Ferndale epicenter was closer to the coast and ruptured towards land rather than away from it.

Epicenters mark the point on the ground surface above the real focus at depth where rupture began. Last December 20th, the focus was 11 miles deep and grew for about 10 miles, primarily inland towards Fortuna. It took about 12 seconds to break, moving rocks on the north side to the west relative to rocks on the south. Slip is never uniform; the maximum displacement was a little more than a foot, but far less at the ends of rupture zone. The entire fault slip occurred at depths of 7 to 16 miles and never reached the surface.

The characteristics of the fault rupture (location, speed, direction, fault strength) combined with the local and regional geology determined how strongly the ground shook at any one location. Petrolia and Rio Dell were both 11 miles away from the epicenter yet had very different earthquake experiences. The strongest accelerations in Rio Dell were 1.4g (gravity), the third highest ever recorded in a California earthquake and large enough to make you feel momentarily weightless before being slammed in the opposite direction at more than twice your weight. At Petrolia, they were less than a tenth as strong and shaking perceived as moderate and rolling.

We have an idea why Rio Dell and Petrolia had such different experiences. They were similar distances from the epicenter, but Rio Dell was closer to the fault rupture zone. The type of fault and its rupture direction focused the stronger secondary (S) waves towards Rio Dell. Rio Dell is also at the south edge of the Eel River basin where thick sediments meet firmer bedrock creating further amplification.

The shaking didn't stop at 2:34 AM. Like all large earthquakes, the December 20th quake produced aftershocks, 180 in the first 24 hours alone. Nearly 500 earthquakes of magnitude 1 or larger have been recorded on or near the main rupture fault zone in the past year, dozens large enough to be felt.

The largest was a magnitude 5.4 last New Year's Day. It was centered 9 miles SSE of Rio Dell and 15 miles south of the main rupture zone on a different fault. For some in Rio Dell it produced more damage than the mainshock. All aftershocks are earthquakes in their own right – caused by fault rupture and capable of producing strong seismic waves if large enough.

Aftershocks are nature's way of adjusting to the regional stress changes after fault slip. The larger the earthquake, fault size and slip, the longer it takes to readjust to a new normal. The majority occur soon after the earthquake and slowly decay over time. Before the Ferndale

earthquake, typical background activity was about 5 small quakes a month. Afterwards, activity remained elevated until October. The last month only 7 were detected and none large enough to be felt. This aftershock sequence appears to be over.

While the aftershocks seem to be finished, the recovery is not. In Rio Dell, 79 of the 91 red tagged structures (deemed by engineers to be unsafe to live in) have been repaired. But the majority of yellow tagged (part of structure off limits), and most green tagged (structurally safe but some damage) are still unrepaired.

Why so slow? In part because of the structure of recovery assistance in the United States. The \$32 million in losses were large enough to earn a State of Emergency declaration from California. That meant public structures like roads and could be repaired with State funds. Fernbridge is solid once again thanks to State funding – and new seismically triggered gates will soon be installed to restrict access if shaking reaches a preset threshold. But a State of Emergency provides almost no support for individuals and the Ferndale earthquake didn't meet the bar for a Presidential Disaster Declaration.

There was no federal disaster declaration for the Ferndale earthquake because the financial loss threshold depends on the size of a state's economy. The losses in Humboldt County needed to be roughly twice as high for consideration. An assumption is made at the federal level that larger states can afford to support recovery themselves, but this is erroneous thinking. There are no mechanisms within states to support individual or business recovery. These regulations discriminate against all Californians who live in smaller, rural communities.

The City of Rio Dell, Humboldt County, State agencies, and other organizations have cobbled together mechanisms to support recovery. The County allocated \$1 million for an Earthquake Recover & Assistance Program, over a third has already been spent on temporary shelters. The County and local nonprofits are coordinating services for displaced residents. Habitat for Humanity will be assisting Rio Dell residents in repairing some structures.

For many in Rio Dell, it has been an extremely frustrating experience. I've attended community preparedness events and have listened to people recount stories of being shuffled from location to location with no certainty of clear recovery paths. But I've also been impressed with the incredible spirit of community in Rio Dell. It's neighbors helping neighbors at the most fundamental level, organizing food and clothing drives, and conducting regular welfare checks.

The community is also going further to develop local response capabilities. Last April, about 30 residents participated in Community Emergency Response Training (CERT) and next March Rio Dell will take part in further training through the Emergency Preparedness Academy at the blue Lake Rancheria. "It's a beautiful thing to witness the community pulling together", said Rio Dell Mayor Debra Garnes.

It's become a common playground activity for Rio Dell students to countdown to the next earthquake. But I'm going to stick my neck out and say you don't need to hold your breath or leave town this Wednesday. The USGS estimates about a 1 in 5000 chance we will be hit with another 6.4 earthquake on that date. But eventually, there will be another earthquake – maybe next year or the year after. And it probably won't nail Rio Dell, but maybe Eureka or Arcata.

Everywhere on the North Coast is earthquake country. The Rio Dell experience could be yours next time.

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. Downloadable copies of the North Coast preparedness magazine "Living on Shaky Ground" are posted at <https://rctwg.humboldt.edu/prepare/shaky-ground>.