

# Times Standard

## **Not My Fault: A 1954 cold case seismic mystery solved – maybe**

Lori Dengler for the Times-Standard

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*Downtown Eureka near 4th and F St suffered damage in the Dec. 21, 1954 earthquake. The Daly's building, at left, is now home to the Arkley Center for the Performing Arts (Times-Standard file photo.)*

Where was the 1954 earthquake located? A paper published this week in the Bulletin of the Seismological Society of America (BSSA) has some answers about one of the most damaging historic earthquakes on the North Coast. “Revisiting an Enigma on California’s North Coast: The 6.5 Fickle Hill Earthquake of 21 December 1954,” re-examines old records using modern techniques, and current tectonic perspective. I was part of this ten-member ‘cold case’ scientific team.

This study had its genesis a half century ago when Tenekron Energy Resource Analysts (TERA Corporation) established the first permanent seismic network in our region. The Atomic Energy Commission had directed all nuclear power facilities in the U.S. to evaluate seismic safety in the wake of the 1971 San Fernando earthquake and the recognition of surface fault hazards. TERA installed 16 seismic stations that operated between 1974 and 1986.

In 1977, TERA wrote a report on large historic earthquakes in the region. It mentions 1906 of course, the most widely felt and damaging earthquake in our area that leveled many buildings in southern Humboldt and the Eel River Valley. There were many strong quakes in the Mendocino triple junction area and adjacent offshore including M7s in 1922 and 1923. No surprise there are no brick chimneys in Petrolia as every five or so years the reports describe “chimneys down in Petrolia.” After 1906, the two most damaging earthquakes were magnitude

6.5s in 1932 and 1934. They are the only historic earthquakes in Humboldt County to cause deaths directly linked to strong shaking.

The 1932 earthquake was centered near Arcata. There were no regional seismographs in the area at that time, so it's not a good candidate for re-analysis. But it was well-recorded on distant instruments, and all the evidence points to being relatively deep, similar to the 2022 quake near Rio Dell and within the subducted Gorda plate. The earthquake caused chimneys to topple in the Eureka and Arcata areas and unfortunately, one of those chimneys fell through the roof of a home in Eureka, killing a woman in her kitchen.

According to TERA's report, the 1954 M6.5 was located near Blue Lake, causing chimneys to fall in Blue Lake, Arcata, and Eureka. It also triggered the collapse of a log deck in Korb knocking an employee into a log pond killing him. This earthquake had made it into earthquake catalogs at Berkeley and the U.S. Department of Commerce, but TERA was the only one to estimate a depth. Based on three seismic records in Humboldt County, they estimated a depth of only a few miles beneath the surface. Shallow means it couldn't be in the Gorda plate.

1954 had been rolling around in the back of my head since the 1980s when my first grad student Bob McPherson introduced me to the seismic complexities of our area. Bob had run the TERA network and decided to turn the data into a masters' thesis. The suspected shallow depth earned this quake special mention in our 1992 paper "Sources of North Coast Seismicity" as possibly being centered on a mapped surface fault.

We didn't have the means to explore the earthquake any further at the time. This was long before the digital era and what records remained were languishing in basements and warehouses. But I would frequently query colleagues about how we might learn more about this quake and three years ago, one of them took me up on it.

I wrote about this quest a year ago (Not My Fault 7/27/24) and how Peggy Hellweg, recently retired from running UC Berkeley's Seismological Laboratory had become interested in North Coast tectonics in general and 1954 in particular. Peggy is a whiz at seismic data analysis and knows how to find archived seismic data. She also has connections with experts all over the world and pulled together a team to relocate and examine every aspect of the 1954 earthquake.

In my 2024 column, I saw the quest as a search for two possibilities – was it shallow and centered on one of the mapped faults on land within the North American plate or was it deeper, within the subducted Gorda plate? There was always a third possibility – it might have been on the Cascadia subduction zone (CSZ) interface between the North American plate and the Gorda plate beneath. But in 2024, I considered that to be such a remote likelihood, I didn't even mention it.

Fast forward to this week and the results are in. Peggy was able to find a number of original records and digitize them. She enlisted Anthony Lomax to run his nonlinear location algorithms using current velocity models and a suite of possible travel times to constrain the probability of its location. Before this study, I referred to this earthquake as near Blue Lake. Then we switched the name to Korb, in part because of the fatality there. But Anthony's relocation has caused us to change the name again because the most likely location is between Arcata and Blue Lake, beneath Fickle Hill at a depth of about 7 miles beneath the surface.

There are uncertainties with Anthony's locations, on the order of seven miles horizontally and nine miles vertically. It was important to look at other factors to see how credible this location was. Doug Dreger is a master at earthquake focal mechanisms. By examining seismograms, it's possible to determine the orientation, direction, and amount of slip on a fault. In our times, this is done routinely within hours of any large earthquake by analyzing digital records.

It's a bit harder with 1954 records. But the team was able to look at the first motions on seismograms, whether the initial waves pushed the ground up or down, and examine accelerograms from stations in Eureka and Ferndale. If you had asked me five years ago what I thought the fault mechanism would be, I would have guessed strike-slip where the fault is vertical, and the motion of the two sides is horizontal. But the 1954 quake surprised me once again. It's a thrust event, the fault dipping at an angle of about 10° relative to the surface and it's oriented nearly north south.

This mechanism rules out a Gorda plate location. We just don't have thrust earthquakes in Gorda. But the location and orientation also suggest it's not on one of the mapped surface faults. All of the exposed surface faults are oriented in a northwest direction and likely dip at an angle steeper than 10°. This all points to the CSZ interface as being the most likely causative fault. The depth is right, the type of faulting is right, and the fault orientation is right.

Wow! 1954 now appears to be on the CSZ interface. It only caused a small patch on the order of ten miles to rupture, but that rupture caused damage, injuries and a fatality. The most important take home messages:

- Scientific and media interest in Cascadia has focused almost entirely on the monster events – earthquakes in the upper magnitude 8 to 9 range. 1954 suggests interface events can be more modest yet still damaging.
- 1954 did not lead to a larger CSZ rupture. It's quite possible that a full-scale rupture will be preceded by foreshocks, but this event did not lead to a bigger quake.
- The triple junction area is not the only Humboldt County location to produce large damaging earthquakes.
- What happened in 1954 could be repeated anywhere in California and most areas of the Western U.S. It's a reminder that faults capable of M6.5 quakes are ubiquitous, and they deserve as much attention as larger ones.
- This earthquake in no way changes the likelihood of great earthquakes on the Cascadia subduction zone. It does suggest that small patch events are possible elsewhere on the Cascadia interface, but they are still exceedingly rare.
- Old data is valuable. There are many other earthquakes in the pre-digital age that may benefit from a similar analysis.
- Science is really fun. We tested ideas and hypotheses, found old data and new ways to look at it and the answer didn't pop out until the end.

I have no room today to squeeze in another important part of the study, reports on people's perceptions of the shaking and how it fits into the source story. Stay tuned next week.

For links to the paper, visit <https://www.seismosoc.org/news/mysterious-fickle-hill-earthquake-in-northern-california-may-have-unexpected-source/>.

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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/taxonomy/term/5> and may be reused for educational purposes. Leave a message at (707) 826-6019 or email [Kamome@humboldt.edu](mailto:Kamome@humboldt.edu) for questions and comments about this column or to request copies of the preparedness magazine "Living on Shaky Ground."