Times Standard

Not My Fault: An earthquake enigma: where was the 1954 earthquake located?

Lori Dengler for the Times-Standard

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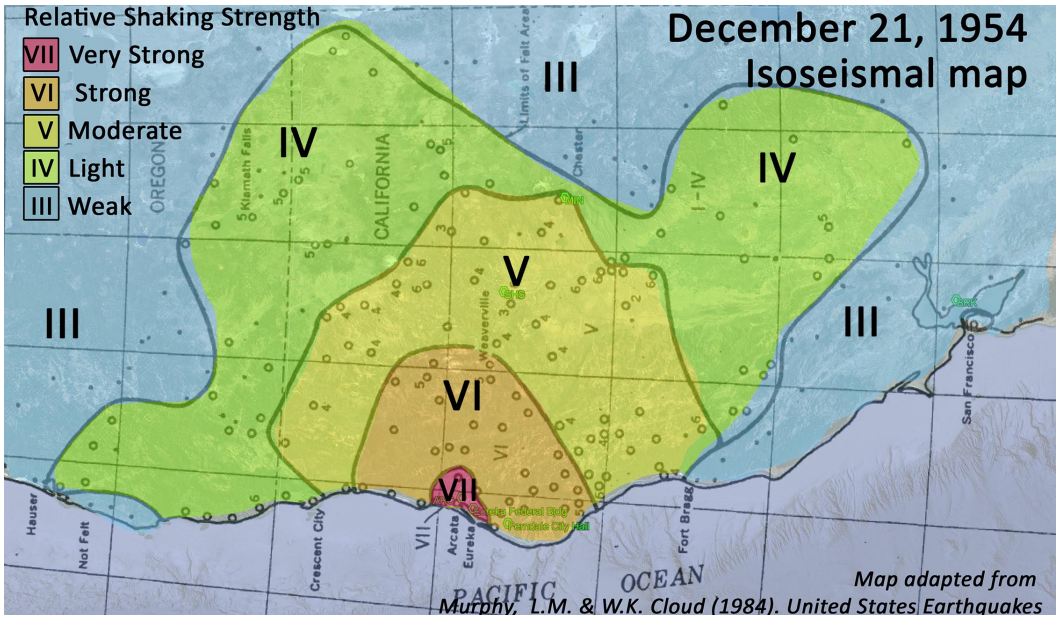

The USGS shaking map published after the 1954 earthquake based on reports and observations of shaking effects and damage (small squares).

The North Coast is a shaky place. The USGS catalog lists 28 earthquake of magnitude 6 or larger in the coastal areas of North Coast California and the adjacent offshore area since 1950, outstripping the rest of the State by far. Eight were centered in the triple junction region within 25 miles of Cape Mendocino. Thirteen were in the Gorda plate offshore of Humboldt and Del Norte Counties. Six were Mendocino fault quakes, on the plate boundary that marks the southern edge of the Gorda plate.

There is one enigma. On December 21, 1954, at 11:56 AM a magnitude 6.5 earthquake rocked Humboldt County. The magnitude value is probably pretty good as it can be estimated from seismic stations far away. We can constrain the epicenter to somewhere between Dinsmore, Eureka, and Arcata, but exactly where and how deep is still a mystery.

Why is an earthquake that occurred nearly seventy years ago of any interest? Because it is the only earthquake in the instrumental catalog that may have been shallow and centered on one of our many mapped surface faults.

There are few places on the planet with such a complex layering of potential seismic sources than the North Coast. What we see on the surface doesn't reflect what is causing most of our earthquakes. We can blame the subduction zone and the triple junction for our crazy juxtaposition of faults.

Explaining what is going on requires imagination and 3-D visualization. Subduction zones are Nature's ultimate recycling centers where one plate (the outer layer of the earth's surface) is pulled by gravity beneath another plate. The Cascadia subduction zone, extending from Cape Mendocino to Vancouver Island, Canada is one of these places.

Subduction zones not only produce earthquake, they also squeeze and rumple the ground surface. This deformation is most pronounced near the leading edge of the subduction zone where the overlying plate is thin. The amount of compression is enormous. It bends the rock into gentle folds. Rocks don't bend very easily, and the folds eventually break with one slab pushed over another.

We call this deformed region the accretionary fold and thrust belt. In most subduction zones, it is offshore, hidden beneath the ocean. Humboldt County is unique because many of these folds and faults are exposed on land. Big Lagoon and Arcata Bay are gentle folds where the center drops down. The opposite type of fold that pushes the ground up runs beneath Eureka, producing the islands and the narrowest part of the Bay.

There are plenty of faults to see on the surface as well. You drive over two strands of the Fickle Hill Fault on G and H Street in Arcata. Wildberries sits on top of the larger scarp. A more subtle feature cuts through the Jacoby Storehouse. The Little Salmon fault runs through the College of the Redwoods campus and there are a number of parallel fault strands in the Mad River fault zone exposed in Blue Lake, McKinleyville, and Trinidad.

These faults all trend to the northwest parallel to the river and mountain ridges. They are considered active (evidence of rupture in the past 10,000 years). Yet none of those 28 magnitude 6 and larger North Coast earthquakes in the past 75 years have occurred on these mapped surface faults except for perhaps 1954.

There have been at least ten different attempts to locate the '54 quake, and they all differ. Locating earthquakes is a triangulation problem. You carefully notate the arrival times of the seismic waves at each seismic station and find the best fit for all the data. It may sound straightforward but there are challenges.

There were only two continuously operating seismic stations in Humboldt County in 1954, one in the campus vault in Founders Hall and the other an ancient (even by 1954 standards) smoked drum recorder at the Ferndale Fire Hall. Strong motion instruments (activated by shaking) in Eureka and Ferndale were also triggered by the event. Many more distant seismic stations also recorded this earthquake, but the nearby stations are most useful for constraining location and depth.

Timing is of tantamount importance in seismology. The most beautiful seismic record is of little use if you don't have a good clock. Nowadays we use GPS signals from satellites to

synchronize the local instrument clock. In 1954, a radio signal was sent, embedding a Greenwich Mean Time code on the record two times a day.

Seismic waves are incredibly fast zipping along at miles per second. Reading both the seismic signals and the timing corrections inaccurately will produce errors on the order of several tens of miles. Even the thickness of the pen can pose problems. Consistent "P picking" – where you note the first P-wave arrival – is essential.

Seismic velocity depends on rock type. The subduction process has churned the North Coast bedrock for well over a hundred million years. Developing accurate "community velocity models," a 3-D picture of regional structure and seismic velocities is still a research priority today. The models used in 1954 were simplistic and used a broad brush to paint all of California in roughly the same colors.

Three years ago, we began to talk about revisiting the 1954 earthquake. Step one was to collect the original recordings, digitize the signals, and apply the most recent cutting-edge techniques to relocate the event and analyze the source mechanism. Peggy Hellweg, recently retired from running Berkeley's seismographic network, has led the effort, uncovering many original paper records from the Berkeley archives.

Our group has narrowed down the possibilities, but we still don't have a lock on the depth. Depth is key to whether 1954 was on a shallow surface fault or on a deeper buried fault below the subduction zone interface. YOU might be able to help resolve the issue.

This is a plea for accounts of the 1954 earthquake. Your story can tell us a lot about how strong the shaking was and how quickly it weakened away from the source. Shallow earthquakes tend to be very strong in the epicentral area but the strength decays rapidly with distance. Deep earthquakes lose shaking strength more gradually.

Even small observations are useful. The steelhead fisherman on the Mad River who observed the current briefly flow backwards or the girl who found herself unable to pedal a bicycle in Eureka provide important data points. Maybe you have no memories of 1954, but did your parents? Did someone in your family leave a diary or letters?

I am interested in any and all recollections but with a particular request for the more rural areas such as Maple Creek, Davis Creek, Angel Ranch, and Upper Fickle Hill. These are areas that are sparsely occupied, but with long lived families that may remember something. Shaking maps have traditionally relied on damage to built structures to indicate the strongest ground motions. This puts rural areas like ours at a disadvantage.

You can get your stories to me in many ways. Note the message phone line and email address below. If you prefer to talk face to face, leave me a message on how to connect. You can also input information on the USGS "Did You Feel It?" page for this earthquake at https://earthquake.usgs.gov/earthquakes/eventpage/cdmg19541221195629000/tellus Note that the survey form is lengthy, and you can skip any question that doesn't pertain.

I promise to share what we learn in a future column.

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 copies of the preparedness magazine "Living on Shaky Ground." Digital copies are at https://rctwg.humboldt.edu/prepare/shaky-ground.