Times Standard

Not My Fault: June earthquakes are a reminder that North Coast earthquakes come from different sources

Lori Dengler for the Times-Standard

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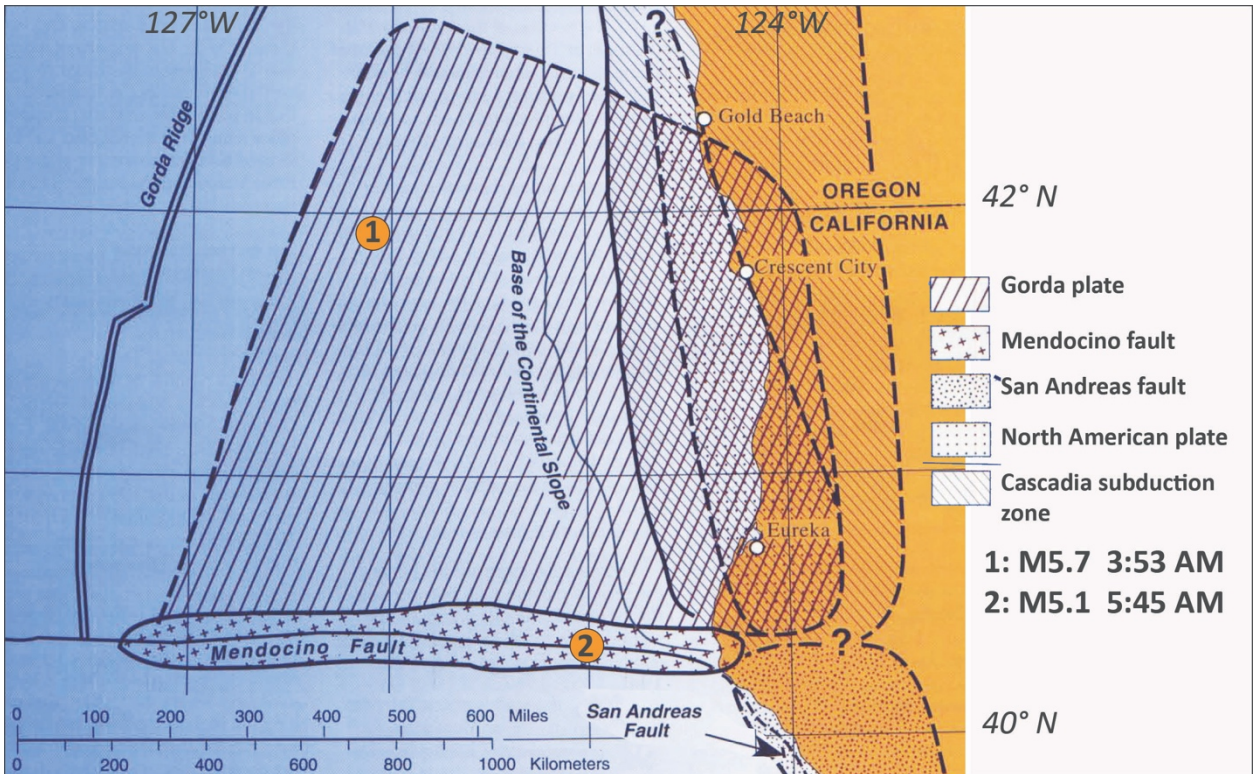

June 3 earthquakes (orange circles) superimposed on a map of different sources of strong earthquakes in the North Coast region from a paper by Dengler, Carver, and McPherson published in 1992. The M5.7 earthquake was on a fault within the Gorda plate far offshore of Del Norte County. The M5.1 was on the Mendocino fault and likely an aftershock of a December 5, 2024, M7.0 quake.

Early Wednesday morning June 3, several earthquakes struck the North Coast region. I didn't feel them, but others did. A M5.7 far struck far offshore of the CA – OR border a little before 4 AM and a M5.1 offshore of Cape Mendocino occurred a little under two hours later. The earthquakes were not large enough and too remote to cause any damage but are a reminder that we live in earthquake country and have numerous fault sources that can cause potentially damaging earthquakes.

The first earthquake occurred at 3:53 AM PDT and was centered 104 miles WNW of Crescent City. It was a shallow earthquake, less than 10 miles beneath the sea floor on a strike slip fault within the Gorda plate. The Gorda plate is the southernmost part of the Juan de Fuca plate

system and the source of many of our strongly felt earthquakes. The slip on the fault was entirely horizontal and likely oriented in a NE – SW direction.

The USGS issued a ShakeAlert 29 seconds after the earthquake with an initial magnitude estimate of 5.2. ShakeAlert currently operates in the three West Coast states and is being expanded into Nevada. Utilizing a dense network of on shore seismic stations, it automatically locates, estimates magnitude, and forecasts likely shaking strength within seconds of the fault rupture initiation. The offshore location and moderate magnitude showed no coastal areas likely to feel moderate shaking, so the alert was not sent to cell phones through the Wireless Emergency Alert (WEA) system.

Five minutes after the earthquake, the National Tsunami Warning Center (NTWC) in Palmer Alaska sent out a Tsunami Information Statement that the earthquake was too small to cause a noticeable tsunami. Their magnitude estimate was 5.7, identical to the final USGS magnitude that was confirmed a few minutes later. Information statements are the most common bulletins issued by NTWC, usually explaining that an earthquake has occurred, may have been felt, but was either too small or too deep to produce a noticeable tsunami.

The M5.7 was noticed by some people on the Northern California and Southern Oregon coast. Thirty-five people filed felt reports on the USGS "Did You Feel It?" web site, most between Crescent City and Reedsport. I'm suspicious of a few of them, it's highly unlikely that it was felt by anyone in Fresno, and I think a few of the reports from the Humboldt County were likely confused with the second earthquake that occurred just under two hours later. No aftershocks have been recorded to date, although the USGS still estimates a one in five chance of an M3 event in the next week.

There is nothing unusual about the 5.7. Eight earthquakes in the magnitude 5 range have occurred in this part of the Gorda plate in the past five years and 35 since 1980, the largest a 7.0 in August 1991. Our largest North Coast quake of 2025 was a 5.7 50 miles NW of Wednesday's tremor. Although not as common as earthquakes in the southern part of the Gorda plate, they are not infrequent, and we can expect them to continue in the future. Their remote offshore location makes them unlikely to be felt by many or cause damage, but a repeat of the 1991 M7.0, especially if nearer to the coast, could cause damage in Del Norte County and would likely trigger a tsunami warning for the region, even though the tsunami potential of strike-slip earthquakes is small.

Earthquakes in the Gorda plate are driven by regional tectonic stresses. To the north, the main part of the Juan de Fuca plate is slowly spreading out from the Juan de Fuca ridge and moving in in a southeast direction relative to the Pacific plate, exerting a very large force on the much smaller Gorda plate. The Gorda plate can't move out of the way because it is constrained by the enormous buttress of the older, colder Pacific plate south of the Mendocino fault and the North American continent to the east. The only response is to "crack" under the pressure, resulting in the numerous faults and moderate to large earthquakes in the interior of the plate.

An hour and fifty-two minutes after the Gorda plate 5.7, an earthquake occurred on the Mendocino fault, 120 miles SSE of the earlier earthquake. ShakeAlert issued a message 14 seconds after the earthquake with an initial magnitude of 4.2, not large enough to trigger WEA alerts to cell phones. The NTWC issued a tsunami statement six minutes after the earthquake

notifying us that a M4.9 had occurred, and no tsunami would be generated. A few minutes later, the USGS updated the magnitude to 5.1 with a location on the Mendocino fault, 39 miles west of Petrolia. Fault analysis shows purely E-W horizontal slip, consistent with the orientation of the Mendocino fault.

The 5.1 was felt more widely than the earlier M5.7. The USGS "Did You Feel It?" site includes 121 credible felt reports from Westport in northern Mendocino County to McKinleyville. No one reported any damage. Seven aftershocks have been recorded to date, including a 4.5 at 6:11 AM, a 4.0 at 8:51 AM and a 4.5 at 7:36 PM all on June 3 and reported felt lightly. The USGS gives a 28% likelihood of more aftershocks in the M3 range over the next week.

Earthquakes are common on the Mendocino fault, the transform plate boundary between the Gorda plate to the north and the Pacific plate to the south. It is one of the most active fault systems in the lower 48 states in terms of earthquake production. Wednesday's 5.1 was centered almost on top of the epicenter of the December 5, 2024, M7.0 and is likely an aftershock of that event. Seismic activity in the aftershock zone had quieted over the past six months, but it's not unusual for spurts of activity to occur years after earthquake of this size. The USGS aftershock forecast of the 2024 quake still gives a 14% likelihood of another M5 in the next year.

Two earthquakes less than two hours apart might make you think they are related, and they are, but only in the general way of responding to the regional tectonic stresses. The offshore Crescent City and the Cape Mendocino earthquakes have no direct relationship. They were in distinctly different tectonic environments, and it was only coincidence that they occurred so closely together in time.

This isn't the first time we've seen different source areas in our area set off quakes so close together. On August 16, 1991, a M6.1 earthquake occurred in the Gorda plate 24 miles SE of Wednesday's 5.7. Twenty-one hours later, a M6.0 occurred in Honeydew 130 miles away. Three hours after the Honeydew earthquake, a M7 occurred near the location of the 6.1. No question that the 6.1 and 7.0 were related. They were centered only two miles apart and had the same type of fault orientation and slip. But Honeydew was a thrust earthquake in the triple junction area and likely related to the Cascadia subduction zone. It was pure coincidence that these two different areas had earthquakes at the same time.

I've been thinking about source areas of North Coast earthquakes for a long time. In 1992, along with co-authors Gary Carver and Bob McPherson, we summarized our thoughts on all of the different potential fault systems and tectonic regimes that could cause large earthquakes. We came up with five distinctly different regions: the Gorda plate and the Mendocino fault active this week, the San Andreas fault, shallow faults in the North American plate, and the Cascadia subduction zone.

Our 1992 paper still holds up pretty well, and those five regions are still our primary source candidates. But it's time to update that paper with everything new we've learned in the 34 years since it was published. At the time, we thought the 1954 Fickle Hill earthquake might have been on a North American plate fault. A re-examination surprised us all by likely putting it on the subduction zone interface, so we still have no recent examples of an earthquake on any of our mapped surface faults. We will add a "downslab tension" region just inland of the coast

on north-south oriented normal faults. Two moderately deep mid M5 earthquakes in the early 2000s range likely caused by stretching of the subducting slab. We knew about these earthquake before, but they had all been smaller. And we need to expand our Gorda plate seismicity zone all the way west to the Gorda ridge as the whole Gorda plate is capable of producing earthquakes.

My big project for the next year is to update the '92 paper and call on better brains than mine to rethink how these regions are interconnected.

Note: Our 1992 Sources of North Coast Seismicity paper is at https://kamome.humboldt.edu/sites/default/files/Sources%20of%20North%20Coast%20Seismicity.pdf

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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 for questions and comments about this column or to request copies of the preparedness magazine "Living on Shaky Ground."