

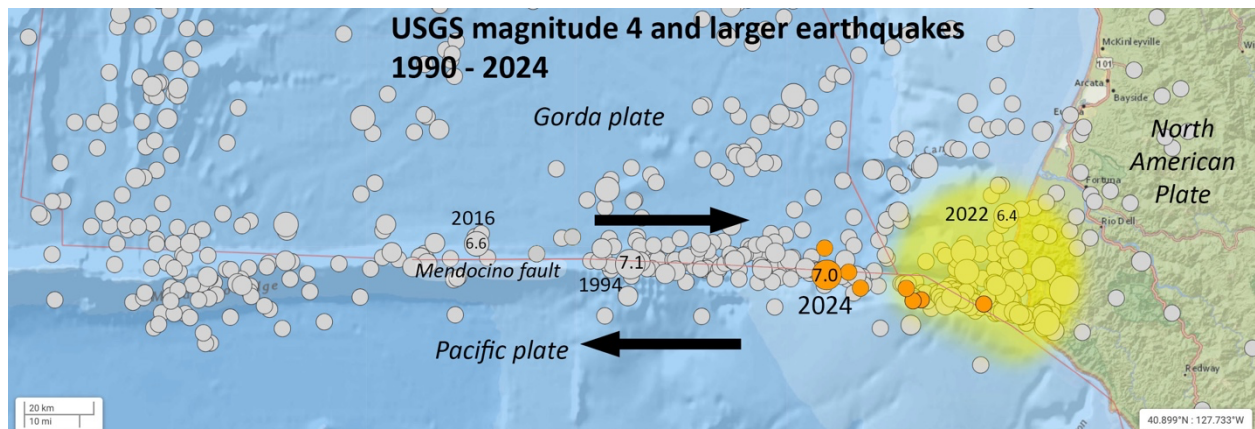
Times Standard

Not My Fault: Ready for the Big One? Thursday's quake shows we have a long way to go

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Magnitude 4 and larger earthquakes near the Mendocino fault (MF) since 1990. Yellow highlighted area is the Mendocino triple junction where the Mendocino fault meets the San Andreas fault to the south and the Cascadia subduction zone to the north. Black arrows show the relative movement between the Gorda and Pacific plates. Thursday's M7.0 and larger aftershocks are shown in orange. Locations of the 2022 Ferndale earthquake and the two most recent large earthquakes on the MF are labeled. USGS data and basemap.

How did we do on Thursday morning December 5th? It's still early in the assessment process, but I would say we have much room for improvement. The good news is that the North Coast escaped major damage, casualties, and significant damage. The not-so-good news is that many people are still bolting for the door when shaking starts and our tsunami response was pretty abysmal.

I was at my desk Thursday morning working to get this column completed before family arrived. At 10:44 AM, while deep in thought about the 1955 floods, my phone announces "EARTHQUAKE! Expect Shaking Soon. Drop, Cover, and Hold On." It was the USGS ShakeAlert alarm. This was my seventh early warning alert since the system went statewide in 2020. I've become somewhat accustomed to the squawking tone on my phone and was instantly attuned to any vibration. As the message was ending, I felt gentle vibrations that continued for six to seven seconds and then became stronger.

I live in McKinleyville and at my house, the shaking never exceeded a moderate level. I heard nothing more than a gentle rattle, nothing fell. Even the pictures on the wall stayed put. Our dogs didn't like it much. Throughout the earthquake I remained seated in my chair. I've had two knees replaced and getting on the floor under my desk is not an option.

But I can still bend over and cover the back of my neck with my arm and as long as I stay put, I am unlikely to be injured. From the length of shaking and the relatively gentle roll at my home, I estimated something in the upper magnitude 6 range at least 50 miles away most likely near the triple junction, on the Mendocino fault, or offshore in the Gorda plate.

The minutes after a significant earthquake are very busy – trying to find out location, size, and tsunami potential, updating our earthquake hotline and Facebook posts and responding to media inquiries. This earthquake kept jumping around. The first USGS estimate was M6.0 near Scotia, then it moved offshore and was upped to a 6.6. A few minutes later it was even further offshore and upgraded to 7.0. The M7.0 has stuck but the location changed one more time, to 39 miles west of Petrolia.

Lauren Schmitt at KMUD radio news is very on top of North Coast happenings and we were doing a live interview within minutes of the ground quieting down. I had to keep changing my assessment of the earthquake as the USGS location was updated. When it was a 6.0 near Scotia, I was confident there was no tsunami potential. As it became larger and moved offshore, a tsunami alert became a possibility.

Why so much confusion about the location and magnitude? Earthquake location is straightforward on land when seismic stations surround potential earthquake zones. It's a triangulation problem, and modern instruments and algorithms can quickly center in on a reasonable location even without detailed inspection by seismologists. With a location determined, magnitude soon follows.

Offshore quakes are more problematic. We've got seismic coverage to the north, east and south. There are no ocean bottom instruments to the west. A larger magnitude further offshore can fit the onshore seismic data just as easily as a smaller earthquake closer to shore. It is harder to constrain the depth as well. There are ways to pin down the location using more complex analyses, but these take the eyes of experts and more time.

How quickly the size/location is determined is not critical to your response to shaking. Regardless of where and how big an earthquake is, you need to know what to do to protect yourself. What causes most injuries in California earthquakes? The more you move while the ground is shaking, the more likely you are to be hurt. Running from indoors to outside is the worst thing to do, exposing yourself to debris toppling off roofs. It is best FREEZE IN ONE SPOT and get under a desk or table if one is nearby. And you are physically able.

The Great ShakeOut earthquake drill held every October is the time we try our best to hammer this message home. Most schools eagerly adopted ShakeOut and students starting in kindergarten learn to quickly scramble under their desks and hold onto them. The January 2010 offshore M6.5 earthquake shook Eureka strongly and panicked response caused many injuries. Nicole Bowles, a Fortuna high school student was in the Bayshore Mall at the time and wrote a letter to this paper describing her horror as adults raced to exits while she and her friend crouched safely under a table. Eight people received injuries severe enough to require ambulance response and more than 400 injuries were reported.

Saturday morning, I received an email from Arnold King, Principal of three schools in southern Humboldt, "Students, from littles to high schoolers, by and large responded

appropriately and calmly: drop, covering, and holding on, and then following directions.” He praised the ShakeOut Drill for creating an orderly environment where everyone could feel safe. I hope staff from other schools can send me their accounts.

Sadly, many adults are still not as well-trained as children. On Thursday, people ran out of shops and buildings just like 2010. I had hoped the lesson of December 2022 had sunk in. Peak accelerations in 2022 were more than five times stronger than 2010 and many more buildings severely damaged yet only 17 injuries were the result. The reason? Most people were in bed and unable to bolt. They had no choice but to stay in one place.

On Thursday, the peak shaking was mild compared to 2022 and fortunately none of the panicked evacuees were injured. But slight differences in the size and location of the earthquake might have meant a very different story and would have been exacerbated by the other side of Thursday’s 7.0 – the tsunami warning.

Determining an accurate location and magnitude quickly is critical to effective tsunami warnings. The National Tsunami Warning Center in Palmer Alaska is responsible for issuing alerts to the U.S. West Coast. Over the past decades they have developed protocols for how to respond to any earthquake located in the Pacific that might send a tsunami headed our way. When earthquakes are far away, there is some time to fully assess the likely tsunami potential for a particular earthquake.

Thursday’s M7.0 was not far away. The first tsunami surges would reach our coast in less than 30 minutes, before any surges could pass over the deep ocean sensors that would give an accurate assessment of whether a tsunami had been generated. The NTWC preliminary magnitude estimate was 7.3 centered on 45 miles SW of Eureka. That size and location put the earthquake into the immediate WARNING category.

The tsunami warning was issued five minutes after the earthquake. But it didn’t just include the Mendocino, Humboldt, and Del Norte County coasts closest to the epicenter. The National Weather Service uses a break point system to issue weather and tsunami alerts. There are seven break points on the U.S. West coast from the Baja to Canada border. The system has no ability to nuance the forecast for areas in between break points. The result of this structural impediment in the system was that a very large section of coastline from Santa Cruz to central Oregon was placed in the tsunami warning, including all coastlines within San Francisco Bay.

There are three reasons why this warning resulted in confusion, inappropriate response, traffic jams, and considerable chaos. First, the short time fuse. When warnings are issued for earthquakes far away, there is time both to assess the hazard and to include the emergency managers of coastal counties and cities in on the dialog allowing them to understand and communicate the threat locally and put assets in place to coordinate evacuations. These folks were all blindsided on Thursday and had no ability to control messaging or an orderly evacuation.

Second, there was no sense of the scale of the tsunami. In California all of our tsunami maps show the worst-case tsunami event. For our area, that’s a magnitude 9 on the Cascadia subduction zone. There’s a good reason – the Cascadia earthquake will likely

disrupt communications and infrastructure and prevent any official tsunami warning reaching people in harm's way. We all need to know our tsunami zone and self-evacuate without any guidance. There was never any question on Thursday that our 7.0 would produce anything larger than a few foot-high tsunami. I tried to convey this on my KMUD interviews – get off the beach and stay away from harbors, but otherwise there is nothing to worry about. You certainly don't need to get in your car and drive up Humboldt Hill or head to Kneeland.

Third and perhaps most egregious was the first ever use of the Wireless Emergency Alert system (WEA) in blasting out the tsunami warning. Private cell phone companies have an agreement with the NWS to send out alerts for hurricanes, tornadoes, floods, and now tsunamis if an official warning is issued. Unfortunately, these warnings have no information on what to do or the scale of the tsunami hazard. Imagine you are in Contra Costa County and suddenly you get an alert on your phone saying tsunami coming, head to high ground. Millions of people were simultaneously thrown into a state of confusion and fear.

In Humboldt County, like other areas, it resulted in massive traffic jams. Had there been any injuries in the 7.0, ambulances would have been hard pressed to get to the injured or transport them to hospitals. Had there been fires, response personnel couldn't fight them in a timely manner.

The tsunami warning was canceled a little more than an hour after the earthquake. A 3.5-inch-high tsunami was observed at Point Arena, and we are studying small oscillations in Humboldt Bay that may have been triggered by the earthquake. Unfortunately, WEA does not send out tsunami cancellation notices so getting the "the threat is over" message out fell on the shoulders of the already stressed local and state response organizations.

It is early days post 2024 Mendocino fault earthquake. and there is much to learn. It is time to seize hold of this moment to improve what we do during shaking, tsunami threat assessment, dissemination of tsunami messages, and people's understanding of what they mean. No major shaking damage or tsunami this time doesn't mean we will be as lucky in the future.

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."