

Times Standard

Not My Fault: A Day for Earthquakes: M5.6 Surprise in Mendocino County and Catastrophic M7.2 and 7.5 Quakes in Venezuela

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Two earthquake sequences last Wednesday had very different impacts. On the left, the arrow points to the M5.6 earthquake near Willits. Inset shows toppled shelves and books at The Book Juggler bookstore in Willits. The arrow on the right points to the epicenter of the Venezuela earthquakes with inset showing one of more than 100 buildings in the Caracas area that collapsed (Jesus Vargas photo).

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Last Wednesday was earthquake day and it started fairly early for me. I was with my morning dog walking group on the trail from Vista Point to the beach near the airport when my phone squawked at 8:20 AM. I've heard the tone enough times that I know what it means – a ShakeAlert. The text on the phone said expect shaking from an earthquake in Mendocino County with a magnitude of 6.0.

ShakeAlert means that seismometers have detected a tremor of sufficient magnitude and in a location where I might feel shaking. It's not earthquake prediction. Once several seismographs have recorded seismic waves, an automated algorithm determines the epicenter, magnitude, and areas where the shaking strength is likely to be noticeable. All of this happens in the first 5 to 15 seconds after the earthquake rupture begins. If the magnitude estimate is in the M5 or larger range, alerts are sent to cell phones where shaking is expected to be intensity III (noticeable while sitting indoors), or stronger. The system continues updating its shaking

forecast over the next minute or so, expanding the notification area if the magnitude estimate increases. No person ever reviews the data during this process.

The ShakeAlert system went live in California in 2019, expanded to Oregon and Washington in 2021, and instruments are currently being installed to cover Nevada. The USGS hopes that ShakeAlert will eventually cover the entire country, but that is years away and dependent upon considerable additional funding. It should be no surprise to North Coast residents, that more ShakeAlerts have been issued in our area than any other region because we have had more M5 and larger earthquakes since 2019 than elsewhere.

How did I react last Wednesday morning? A M6 earthquake in Mendocino County is unlikely to produce strong shaking in Humboldt but I am always cautious because the automated magnitude might be too low. Our group was standing in an open area where nothing could fall, so we just stood and waited. Seismic waves travel at speeds of several miles per second, and we would have felt something only seconds after the alert had the earthquake been strong enough. No one felt anything.

My second thought after the threat of shaking passed was tsunami. We were standing well above the tsunami hazard zone but were headed to the beach. A magnitude 6 is far too small to produce a tsunami, but it was reassuring when a text from the National Tsunami Warning Center hit my phone confirming that no tsunami was expected. A reviewed USGS location popped up a few minutes later with a revised magnitude of 5.6 and a location 7.5 miles southeast of Willits.

It was clear that my location was safe from shaking or tsunami. We continued the walk with me taking frequent peeks at my phone for updates and when I got home it was time for a deeper dive into Willits earthquake. Cape Mendocino marks a great divide in California tectonics: the northern termination of the San Andreas transform system and the southern end of the Cascadia subduction zone. It also separates the intense seismic activity near the Mendocino triple junction and the historically much quieter area to the south. Since 1950, twenty-seven earthquakes in the M6 and larger range have been noted in and offshore of Humboldt County and none in Mendocino or Sonoma Counties.

Lack of big earthquakes in the recent past does not mean zero earthquake threat. There are mapped faults in Mendocino County. The San Andreas cuts through the southern part of the County, heading offshore at Point Arena and runs within ten miles of the coast. The most prominent fault inland is the Maacama, slicing from northern Sonoma County to Laytonville. It's a major fault, cutting the landscape, offsetting valleys and river channels. Its trace is well mapped in Willits where the two sides of the fault are slowly creeping past one another causing fresh cracks to appear in parking lots and roads almost as quickly as they are tarred over.

The Maacama is part of the San Andreas transform system responding to the movement between the Pacific and North American plates. The main strand of the San Andreas took a big bite of this relative displacement in 1906 when measured offset at Point Arena exceeded 16 feet. But the Maacama in historic times has been relatively quiet. The fault zone is well defined by small earthquakes but no large ones. Prior to Wednesday, only one earthquake had made it into the M5 range, a 5.2 near Ukiah in 1962.

So perhaps creep and the small quakes are taking up all the stress on the fault? Numerous trenches have been dug across the Maacama with ample evidence that is not the case. Offsets are consistent with past earthquakes in the M6.5 to M7 range and perhaps larger as recently as ~500 years ago. The USGS classifies the Maacama as a 'Class A Quaternary fault' with a maximum credible earthquake magnitude of 7.4 to 7.5.

Wednesday's M5.6 is now the largest earthquake on the Maacama fault in written historic times. It has been followed by aftershocks, just under a 100 the last time I looked. Only 23 made it into the M2 range, the largest to date a 2.8 that occurred nearly eight hours after the M5.6. Aftershocks will continue, and there is still a chance of aftershocks large enough to be felt in the next weeks and months. Mendocino County is still compiling losses. Some minor injuries were reported and many markets reported items knocked from shelves in the Willits to Ukiah area, but at this time the numbers appear relatively minor.

There is nothing about the current sequence that suggests a heightened risk of a larger earthquake soon, but it is a threat that everyone should be prepared for. The Maacama is the northern branch of three major faults that are likely interconnected. The Rogers Creek fault is only a few miles to the west of the southern Maacama and extends to San Pablo Bay where it steps again to the west onto the Hayward fault that runs through the East Bay Area. Recent sequences like the 2016 Kaikoura earthquake in New Zealand suggest that ruptures on stepping faults occasionally jump from one strand to another, creating a much larger earthquake than any one piece alone may produce.

While I was focused on the earthquake in Mendocino, a much more major earthquake sequence was unfolding in Venezuela. A M7.2 occurred a 3:04 PM PDT followed 38 seconds later by a 7.5. Both earthquakes were located near the coast in western Venezuela's Yaracuy State. This coastal region is heavily populated and the USGS estimates that nearly 8 million people experienced very strong to violent shaking.

It's too early for a clear estimate of losses, but many of you have seen the video footage of buildings collapsing in the capital Caracas over 100 miles away and know numbers are likely to be grim. The USGS PAGER loss estimation tool projects that casualties may exceed 10,000 and financial losses of more than a ten billion (US \$) are likely. As I write, the official death toll stands at 920, but more than 50,000 people are unaccounted for.

The Venezuela quakes bring up many questions. Teams of international scientists and engineers are being assembled for onsite investigations of fault rupture and structural collapse, and it will be weeks and months before a full picture is seen. I will be surprised if substandard construction methods exacerbated by years of corruption aren't a big part of the story. Engineers will be playing particularly close attention to whether the extremely long duration of shaking caused by the twin seismic events caused some otherwise sound structures to collapse.

How unusual is it for two earthquakes to be so close together in time? The current USGS epicenters put them about four miles apart. This is the plate boundary region between the Caribbean and South American plates, where motion is accommodated by numerous faults. It's not clear if these two quakes were on the same or nearby faults. Very big earthquakes often rupture in pulses, one section of the fault slipping before another piece moves. The 1985 M8.0 Mexico earthquake involved two main pulses of slip about 27 seconds apart. Some people are

debating whether Venezuela was one earthquake or two. What is clear is that the ground was still shaking from the 7.2 when the 7.5 occurred. Structures become weaker as the cycling of earthquake motions move them in different directions. The more cycles and longer duration, the greater the likelihood of structural elements failing. This will be one of the key areas that structural engineers will be looking.

Was there any relation between the Willits 5.6 and Venezuela? Highly unlikely. While the earlier quake felt very strong in Willits and Ukiah, it's energy decayed quickly with distance and wouldn't have had any noticeable effect in Venezuela 4000 miles away.

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."