

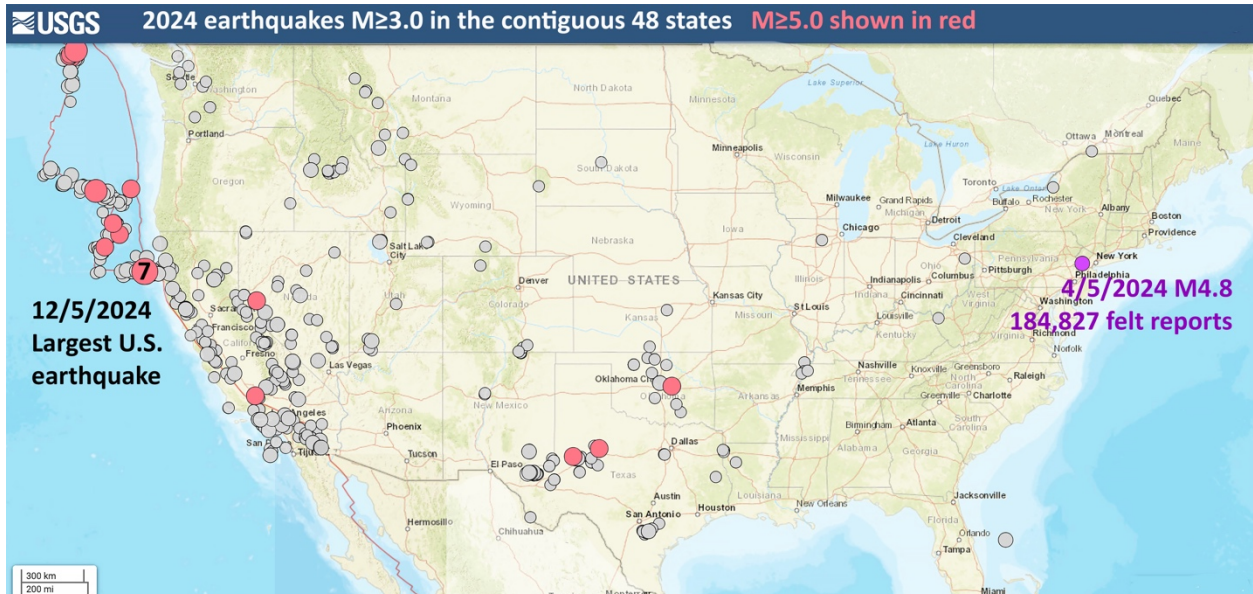
# Times Standard

## Not My Fault: The 2024 earthquake report for the United States

Lori Dengler for the Times-Standard

Posted January 11, 2025

<https://www.times-standard.com/2025/01/11/lori-dengler-the-2024-earthquake-report-for-the-united-states/>



2024 earthquakes of magnitude 3 and larger in the lower 48 states. Earthquakes of M5 and larger shown in pink. The largest 2024 earthquake anywhere in the U.S. was the December 5 M7.0 offshore of Cape Mendocino. Shown in purple is the April 5 M4.8 New Jersey earthquake that set the all-time "Did You Feel It?" record with over 180,000 felt reports.

The good news for 2024 U.S. quakes – no casualties and little damage. On the other side of the scale, induced earthquake activity remains high and our response to tsunami warnings leaves much room for improvement.

Earthquakes occurred in all the usual places in 2024. It's never a surprise that Alaska leads the pack with the largest totals. At least 2,237 magnitude 3 or larger earthquakes were tallied in Alaska and the Aleutian Island region, similar to last year but well below the over 5,200 count of 2018. Alaska features one of the longest subduction zones in the world and will always lead the U.S. earthquake count.

Alaska didn't win the largest U.S. quake of the year nod. Only five Alaska quakes made it into the magnitude 6 category last year and the largest were two M6.3s on December 8. It was the lowest total since 2004 when only two M6s occurred. The largest U.S. quake was in our own backyard, the M7.0 Mendocino fault earthquake on December 5<sup>th</sup>.

A magnitude 7 earthquake is quite capable of producing major damage depending on its location, the exposed population, and the nature of construction in the area. We were

fortunate in all of these categories. The earthquake struck about 40 miles offshore, strongest shaking was in less-populated areas, and our buildings are predominantly wood frame and resistant to side-to-side shaking.

This was in sharp contrast to last week's similar-sized earthquake in Tibet. A magnitude 7.1 earthquake occurred just north of the Nepal border on January 6<sup>th</sup>. The death toll in the currently stands at 126, 350 injuries, and an unknown number of people still unaccounted for. Ground motion estimates show similar peak ground accelerations for both quakes. Tibet is a more populated area with roughly three times as many people exposed to strong shaking, but the primary difference in impacts was construction. Many homes in Tibet are built of stone with no reinforcement to resist earthquake shaking. No injuries were reported in our earthquake and only a few structures compromised.

The Mendocino fault quake is also in large part responsible for a steep jump in California earthquakes over 2023. 366 magnitude 3 and larger earthquakes were reported in California last year, about 150 more than last year. Our North Coast M7 aftershock sequence can explain more than 100 of this surplus. The remainder is due to an uptick in seismic activity in southern California.

Our M7 has produced a rich aftershock sequence, and a bit more robust than that produced by past large earthquakes on the Mendocino fault. The 1994 M7.1 earthquake was about 30 miles west of the 2024 rupture. It produced only 45 aftershocks in the magnitude 3 or larger range in the two months following the earthquake, only about a third as many as the December 5<sup>th</sup> quake has pumped out in only one month. Why the difference? No clear answers but the recent quake's closer proximity to the triple junction and the earthquakes of 2021 and 2022 may have "primed the pump" so to speak. The 2024 quake has produced a much larger spike of events in the triple junction region than what happened in 1994.

We are only one month into our aftershock phase, and it is by no means over. So far, the sequence has been "well-behaved" in the sense that the daily number and peak size has diminished in a predictable way. We are now in a relatively stable period with two to three aftershocks detected most days, occasionally skipping a day, and sometimes a few more. This should continue for at least the next few months. But don't rule out a few more 4s or even another magnitude 5. The USGS estimates a 10% chance of another M5 in the next month and an over 40% likelihood in the next year. And of course we have many other faults quite capable of starting a new sequence.

December 5<sup>th</sup> may have been the largest U.S. quake of the year, but it was by no means the most widely felt. Over 16,000 people filed reports on the USGS "Did You Feel It?" site, putting it only 9<sup>th</sup> on the list of 2024 earthquake responses. The surprising winner? The April 5<sup>th</sup> Tewksbury, New Jersey earthquake with a mighty magnitude of 4.8! To be fair, most of these responses were only "light" or "moderate" shaking, compared to many "strong" reports from our earthquake, but there is no denying that footprint of that modest New Jersey quake was much larger.

At 184,827 reports, the New Jersey earthquake is now the all-time winner of "Did You Feel It?" reports since the web site was activated in the 2000s. There have been plenty of larger and more damaging earthquakes in this time period, but no other quake has garnered near the

response. In second place at just over 131,000 is another east coast quake, the M5.8 in August 2011 near Washington D.C. Only 40,000 responses were filed after the previous M7.0 California quake (Ridgecrest in 2019).

Maybe Californians are just more blasé about feeling earthquakes and not as likely to respond? Sue Hough at the USGS has looked at “Did You Feel It?” responses in a systematic way and finds no evidence that we are less likely to fill out felt reports. When adjusted for population density, we are just as likely to report moderate shaking than folks in the east. There is a real, physical, difference for the response differential.

The December 5<sup>th</sup> quake was felt as far away as Boise, Idaho, 520 miles away from the epicenter. The 2019 Northridge quake was felt as far away as west Texas about 920 miles distance. The New Jersey quake produced reliable felt reports from New Brunswick to Minneapolis and Louisiana. The people who felt it in New Orleans were 1,145 miles away from the epicenter.

How did a quake with less than 1000 times the amount of energy of California’s two M7s make itself felt over such a large area? It’s all about geology. The western third of the U.S. is much more tectonically active than the Midwest or the East. Tectonics means mountain building, active faults, and hot springs, and in a few spots, volcanoes. These are all manifestations of higher heat flow and warmer crust means less efficient transmission of seismic waves. The December 1811 New Madrid earthquake in southern Missouri was strong enough to ring church bells in Washington DC and be felt by many in Maine. It was probably smaller than the 1906 M7.9 San Francisco earthquake that was felt over an area less than half the size.

Not all of the 2024 U.S. earthquakes were tectonic in origin. Induced earthquakes related to hydrocarbon production and waste disposal remains prevalent in many areas of the Midwest, most frequently in Texas, Oklahoma, New Mexico and southern Colorado. Texas continues to lead the pack with nearly the same number of M4s in 2024 as in 2023. Two Texas quakes made it into the M5 range, causing minor damage and triggering restrictions on the volume and rate of waste fluid disposal in deep wells. After years of declining induced earthquake activity in Oklahoma experienced an increase nearly doubling the number of M3 and larger quakes in 2024 over the previous year and producing the first earthquake to reach M5 since 2016.

Perhaps the biggest earthquake lesson for the U.S. in 2024 is not a shaking one at all. Large earthquakes offshore or near the coast have the potential to produce damaging tsunamis. It is not just a Pacific problem – states and territories bordering the Gulf of Mexico, the Atlantic or in the Caribbean are all at similar threat. The December 5<sup>th</sup> earthquake illustrates how poorly this threat is understood and behooves us to do much better to communicate the hazard. The next time might not be so benign.

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