

Not My Fault: Human-caused earthquakes in the Midwest – two new hotspots

Lori Dengler/For the Times-Standard

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This week, the central time zone was the most seismically active area of the lower 48 states, chalking up 48 earthquakes of magnitude 2.5 or larger. I can usually bet on California to take the lead, but this week, states in the middle part of the country accounted for the majority, including two M4s in West Texas and one in Kansas.

None of these earthquakes were damaging, but M 4s in Texas and Kansas would have been highly unusual two decades ago. The national network of seismic stations in the United States is dense enough that no magnitude 4 or larger quakes would have been missed going at least as far back as 1980. It's easy for anyone to do a search (click the latest earthquakes link at <https://earthquake.usgs.gov/> at select Search Catalog from the menu).

In the thirty-year window from 1980 to 2010, 58 M \geq 4 earthquakes occurred in the central US between the longitude bands corresponding to Western Wyoming and Eastern Oklahoma, a rough average of two per year. Most of these earthquakes are within the mountain areas of Montana, Wyoming, Colorado, and New Mexico. Only three were located in Oklahoma, one in Kansas and eight in West Texas. This is probably a good picture of the natural background activity of the region.

A search of earthquakes in the eleven years since 2010 shows a different picture. 165 earthquakes of 4 or larger were located in this same region, an average of 15 per year. Activity in the mountain states is similar; the big increase is in the Midwest. The largest contributor is Oklahoma with 94. Prior to 2010, Oklahoma experienced a magnitude 4 or larger earthquake about once every ten years. In 2015 alone, thirty M4s were recorded.

Earthquake activity can considerably from year to year. In the three years between 2016 – 2019, only 31 earthquakes of 4 or larger were located in Eastern California and Nevada. Since 2019, that number climbed to 228. It's easy to explain what is happening - a series of big earthquakes and their aftershocks. The Ridgecrest sequence with its 6.5

and 7.1 on July 4th and 5th, 2019 started the activity that continued with the M6.5 Monte Cristo earthquake in Western Nevada in May 2020 and earthquakes in the Owens Valley and Antelope Valley.

The recent earthquakes in California and Nevada are classic tectonic earthquakes – caused by regional stresses driven by the heat within the earth. Human activity has nothing to do with their occurrence. These earthquakes occur on faults that may remain quiet for decades or centuries and then reawaken with one or several large earthquakes followed by years of smaller aftershocks.

Could a similar reason explain the increase in earthquake activity in the Midwest? Highly unlikely. These aren't typical tectonic sequences with a larger quake followed by smaller ones that slowly decrease in frequency as time passes. Most of the Midwest earthquakes are small and clustered in narrow zones. Volcanic areas and geothermal zones like the Salton Sea area of Southern California are notable for swarm activity with numerous nearly equal-sized quakes occurring over days and weeks. These swarms are related to the natural movement of hot fluids and magma, definitely not likely in the Midwest.

But fluids are likely a big part of the Midwest earthquake story. It's the source of the fluids that make these quakes very different from tectonic, volcanic, or geothermal events. The sudden increase in earthquake activity corresponds to a regulatory event. In 2008, the US prohibited the disposal of waste fluids from drilling operations into surface reservoirs because of concerns for ground water contamination and pollution. Oil drilling operations were required to inject waste fluids in deep wells, often more the 10,000 feet below the surface.

The Environmental Protection Agency designates Class II wells for the disposal fluids associated with natural gas and oil exploration and estimates 180,000 such wells are currently operating in the United States. EPA estimates over two billion gallons of brine and other wastes are injected into these wells every day.

The overwhelming majority of the Class II wells have absorbed these fluid wastes with no noticeable effects. But the exceptions are interesting and pose a potential seismic threat. The problem first became noticeable in Oklahoma with a rapid increase in seismic activity. It was difficult to directly pin the earthquake activity on injection as the location, rates and volumes of fluids are proprietary in most states, but a damaging 5.7 in 2011 brought national attention.

By 2015, the extraordinary increase in Oklahoma earthquake activity became a concern for insurers (<https://www.reuters.com/article/us-usa-oklahoma-earthquakes/insurers-shun-risk-as-oil-linked-quakes-soar-in-oklahoma-idUSKCN0Y30DC>). Oklahoma State legislators enacted legislation in 2015 to control the volume and rate of fluid injection and the number of earthquakes swiftly declined. Only four Oklahoma earthquakes have made it into the magnitude 4 range since 2019.

As Oklahoma induced activity declined, increases are occurring in other areas. The earthquake activity of the last week highlights two new hotspots. The Chihuahua Desert east of El Paso has become one of the shakiest spots in the nation (<https://www.eenews.net/articles/earthquakes-linked-to-drilling-are-messing-with-texas/>), with thirteen $M \geq 4$ earthquakes in 2021. The area is remote, the earthquakes have caused no damage, and few have felt them. But the concern is the potential for stronger earthquakes and ironically, it's the oil and gas industry that has the most to lose if shaking disrupts pipelines and production facilities. This month State regulators have requested operators to develop plans to reduce earthquake activity.

The second hotspot is Kansas. Both the December 8 M4.3 and December 15 4.0 earthquakes near the city of Salina, Kansas were felt by hundreds of people over much of the State and by a few as far away as Kansas City, Missouri and Omaha, Nebraska. Kansas legislators have yet to pass regulations on injection activity (<https://www.kcur.org/economy/2018-02-15/environmentalists-duel-with-drillers-over-kansas-earthquake-legislation>). Keep your eyes peeled – a few more or stronger earthquakes could nudge them in the same direction as Texas.

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