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Not My Fault: More lessons from The Geysers

Lori Dengler/For the Times-Standard
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Most important things first. Tragedy hit the North Coast last week when two people were struck by waves on the north jetty. One was able to cling onto the rocks and survive; the other was swept into the water and perished. Another family barely escaped when caught by a sneaker wave near the mouth of the Mad River in late November. A four-year old was swept into the water but fortunately a passerby was able to grab the child.

Unexpected waves can strike at any time of the year but are particularly common from now until April. The set behavior of waves can fool anyone, but especially visitors to our area who aren't aware that the wave behavior you see when you arrive at the beach or jetty could abruptly change in only a few minutes. No matter how long you have lived here, please have that talk with your family about beach and water safety. And if you have holiday visitors, keep safely distant and emphasize that our beautiful coast requires respect at all times.

I promised to tackle a question from two weeks ago. Is the earthquake activity at The Geysers similar to what has been observed in Oklahoma, Texas and other locations where hydraulic fracturing (fracking) is occurring? The answer is – similar yes but some clarification is needed.

I've written about induced seismicity associated with hydrocarbon resource extraction before (see 5/20/20 and 12/13/17). Earthquake activity began to increase about a decade ago in places like Oklahoma that had previously been seismically quiet. The activity corresponded to an increase But don't jump to the conclusion that fracking caused the earthquakes.

There is a connection, but it's mainly a secondary effect. Hydraulic fracturing involves injecting a highly pressurized propellant solution into a horizontal well bore to create a network of cracks in the reservoir rock formation. It is most often used in shale formations that have very low permeability. The cracks make it easier to extract oil and natural gas. The actual hydraulic fracturing doesn't take very long and is typically only done one or two times in a particular rock unit. There have been a few reports of very small earthquakes (magnitude 1 and smaller) directly associated with the process, but the general scientific consensus is that fracking is not the primary cause of the seismicity increase.

Hydraulic fracturing involves a lot of fluid and, after injection is completed, the fluids need to be disposed of. The process of well drilling and convention oil wells also involves fluids. They vary considerably in composition. Some can be readily cleaned and reused or released into surface waters. Others are nasty concoctions of water, drilling muds and an assortment of chemicals that require careful handling. In 2008, the EPA required that waste fluids couldn't be released into reservoirs or waterways. The solution was deep disposal wells (called Class II Wells), typically 10,000 or more feet beneath the surface. In 2015, 144,000 Class II wells were listed as operational, located primarily in OK, TX, CA and KS. Unlike fracking operations, the same disposal wells operate over many years.

There are challenges in studying the link between Class II wells and earthquakes. The earthquake information is available on the USGS web site and accessible to anyone. The wells, however, are on private land and information about their location and disposal history (rates and volume) are proprietary. What is clear is that the overwhelming majority of Class II wells have not triggered earthquake activity. The interesting question is why there are a handful that have.

This is where The Geysers can help. Studies on induced seismicity at the Geysers and at Cooper Basin, a geothermal energy test site in Australia, provide data to examine the relation between injection history and earthquakes that is not accessible in oil shale country. Calpine, who operates The Geysers, has been open to research efforts. The history of the wells at The Geysers can be readily accessed. There have been studies not only of earthquakes and injection history, but also GPS examination of surface deformation related to injection.

What has been learned is that injection rate is the best determinant of earthquake activity and that the relationship is complex. Several processes are occurring simultaneously: extraction of mass (steam), injection of waste fluids, and tectonic forces from volcanism and faulting. The injection rate has stood out as a primary factor in affecting earthquake activity but it is not instantaneous. There are seasonal changes in the shape and spatial extent of the seismicity pattern, related to yearly changes in energy requirements and injection rates, but the pattern varies from year to year. At The Geysers, the largest earthquakes have been centered near

the two injection wells, and surface deformation measured by GPS seems to lag as much as a month behind variations in injection.

The biggest question from a human perspective is how does injection affect seismic hazard. For the overwhelming majority of Class II wells, there appears to be no change. But for a small subset of disposal wells in Oklahoma, Kansas, Texas and New Mexico, the USGS estimates that the Class II wells have made these areas more seismically risky. This hazard now shows up on the latest USGS national seismic hazard maps and the agency estimates that the disposal wells have elevated the seismic threat to near-California levels for nearly 8 million people. As to The Geysers, The increase in seismicity pre and post injection hasn't been nearly as dramatic as in Oklahoma. The largest magnitude earthquakes are no bigger than they were in the 1950s and 60s. The earthquake threat in Lake and Mendocino Counties is dominated by potential earthquakes in the San Andreas system and there is no evidence that injection or geothermal production at The Geysers has had any impact on the nearby Maacama of Healdsburg faults.

Note: more on how injection has changed USGS seismic hazard estimates at https://www.usgs.gov/natural-hazards/earthquake-hazards/induced-earthquakes?qt-science_support_page_related_con=4#qt-science_support_page_related_con

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Lori Dengler is an emeritus professor of geology at Humboldt State University, an expert in tsunami and earthquake hazards. All Not My Fault columns are archived at https://www2.humboldt.edu/kamome/resources and may be reused for educational purposes. Leave a message at (707) 826-6019 or email Kamome@humboldt.edu for questions/comments about this column, or to request a free copy of the North Coast preparedness magazine "Living on Shaky Ground."

https://www.times-standard.com/2020/12/13/lori-dengler-more-lessons-the-geysers-can-teach-us/