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Not My Fault: Is there a coronavirus – oil price – earthquake connection?

Lori Dengler/For the Times-Standard
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An unplanned experiment is occurring right now in the central part of the country. It is the latest chapter that began in 2008 when the Environmental Protection Agency mandated that waste fluids associated with the extraction of oil and gas be injected into disposal wells deep beneath the surface.

There were good reasons for the 2008 regulations. It was to protect underground sources of drinking water from contamination by the nasty effluent from both conventional oil drilling and hydrofracturing operations. Oil extraction produces a high volume of waste products including mud, hydraulic fracturing compounds, well cleaning acids and lots of brine-rich water.

Known as class II injection wells, the majority is located in Oklahoma, Texas, California and Kansas but wells can be found from the Gulf coast to the Canadian border and as far east as Ohio and West Virginia. According to the EPA, 180,000 class II wells were operating in the US in 2019, disposing of about 2 billion gallons of fluid every day. The depths of the wells vary, but regulations require they reach below an impermeable rock layer so that the fluids can't work their way back up to the surface. Many of the wells are 10,000 feet or deeper.

It sounds like the perfect solution to an environmental issue. There is a potential problem. We have known that occasionally injecting fluids triggers earthquakes. The first inklings of the connection came in the early 1960s from Colorado's Rocky Mountain Arsenal (RMA). After decades of a low background incidence of earthquakes, a sudden spurt of earthquakes began in April of 1962. Over the next 18 months, more than 700 earthquakes were detected, many large enough to be felt. Not only was the abrupt onset of activity unusual, but the earthquakes were clustered tightly in a five-mile radius of RMA.

RMA was a chemical weapons manufacturing center that operated from the 1940s until its closure in 1992. In 1961, a 12,000-foot well was constructed to dispose of the contaminated fluid by-products of the manufacturing process. The earthquake activity abruptly started about a month after the fluid injection began and for the next several years, correlated with the rate and volume of fluid injection. Disposal was halted in 1966 after public outcry over the earthquakes, the largest of which was a 4.3 and felt as far away as Denver.

In 1969, the USGS initiated a study of fluid injection and earthquakes. They chose Rangely Oil Field, 210 miles to the west of RMA. It is one of the oldest and largest oil fields in the state and allowed the USGS to use several wells for a controlled injection experiment. Over the next four years, fluid was injected or withdrawn at different pressures and the corresponding earthquake activity mapped. When the fluid pressure reached a threshold level, activity increased and when the pressure dropped it ceased. The Rangely study remains one of the best cases for injection-induced seismicity.

Fast forward to 2008. When EPA regulations were put in place, US oil production was about 5000 barrels a day, a 40-year low. With the oil shale boom, it rapidly increased, reaching a peak of 13,000 barrels a day in 2018. With the experience in Colorado, you might expect a sudden increase in earthquake activity in all the oil production areas in the country. Such was not the case. Of the 180,000 injection sites only about a dozen showed earthquake increases. The overwhelming majority, including wells in California, quietly absorbed the volumes of injected fluids with no seismic effects.

The exceptions were noteworthy. I did a simple exercise tallying earthquakes of magnitude 3 and larger in the central part of the state - from Texas to Nebraska and from Colorado to Missouri - and counted earthquakes of magnitude 3 and larger. Between 1980 and 2008, about ten earthquakes ≥M3s happened per year. This activity represents the normal tectonic background level.

In 2009, 39 earthquakes occurred and the number increased each subsequent year until 2015 when the number hit 984. Activity clustered in a handful of hotspots – Oklahoma, West Texas, the Dallas-Fort Worth area, and Southern Kansas.

The poster child for induced earthquakes was Oklahoma, where not only the total number of earthquakes increased but the size as well. A magnitude 5.7 in 2011 and a 5.8 in 2016 were felt not only in Oklahoma, but neighboring states as well and caused moderate damage (https://www.nytimes.com/2016/03/29/us/earthquake-risk-in-oklahoma-and-kansas-comparable-to-california.html)

Threats from insurance companies of legal action to the oil industry finally led to regulations in May of 2015 when Oklahoma restricted both the volume and injection rate. After the 2015 peak, activity slowed by a third in 2016 and for the past three years has averaged about 170, still substantially higher than the pre-injection era but below the 2015 peak.

Where does COVID-19 come into this story? That remains to be seen. Oil prices have been in free fall with the economic shutdown caused by the virus. West Texas Intermediate Crude, the benchmark value for oil prices, is just below $25 a barrel as I write. That's above the brief foray into negative territory of a few weeks ago but substantially below the $60 a barrel average over the year before the pandemic struck.

It's difficult to turn off an oil well spigot. Today's oil fields are carefully managed in order to optimize production. As of the beginning of this month, US oil production was at 11,900,000 barrels per day, still close to the thirty-year high. According to the US Energy Information Administration, production is expected to drop by more than a million barrels a day into 2021. Over the next months, slowing production should mean less fluid injection. I will be watching to see if earthquake activity in the central part of the country takes a corresponding drop.

Note: The overwhelming majority of earthquakes since 2008 are natural tectonic earthquakes. Oklahoma and West Texas are the exceptions. See https://blogs.agu.org/terracentral/2013/07/ for a scientist's discussion of deep injection wells. Bruce Bolt's book "Earthquakes" includes a good overview of induced seismicity and the Rocky Mountain Arsenal and Rangely, Colorado study.

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