Natural or manmade quakes? New technique can tell the difference

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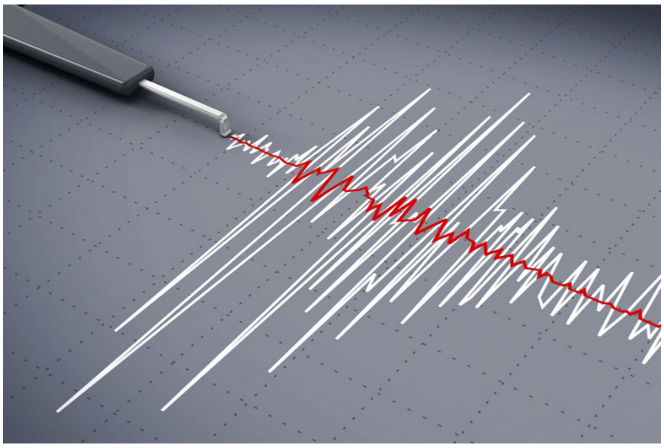

A study by Stanford researchers found that the likelihood of large-magnitude manmade earthquakes increases over time, independent of the previous seismicity rate. Credit: cigden/Shutterstock.com

A new study by Stanford researchers suggests that earthquakes triggered by human activity follow several indicative patterns that could help scientists distinguish them from naturally occurring temblors.

The findings were presented this week at the American Geophysical Union's fall meeting in San Francisco.

Jenny Suckale, an assistant professor of geophysics at Stanford's School of Earth, Energy & Environmental Sciences, and her postdoctoral researcher David Dempsey analyzed a sequence of earthquakes on an unmapped basement fault near the town of Guy, Arkansas, from 2010 to 2011.

In geology, "basement" refers to rock located beneath a sedimentary cover that may contain oil and other gas reserves that can be exploited through drilling or hydraulic fracturing, also known as "fracking." Scientists suspected that the Arkansas quakes were triggered by the injection of roughly 94.5 million gallons of wastewater into two nearby wells that extend into the basement layer during a nine-month span. The injected water increases the pore pressure in the basement layer, adding more stress to already stressed faults until one slips and releases seismic waves, triggering an earthquake.

One of the study's main conclusions is that the likelihood of large-magnitude manmade, or "induced," earthquakes increases over time, independent of the previous seismicity rate. A reservoir simulation model that Suckale and Dempsey developed found a linear relationship between frequency and magnitude for induced quakes, with magnitude increasing the longer wastewater is pumped into a well.

"It's an indication that even if the number of earthquakes you experience each month is not changing, as you go further along in time you should expect to see larger magnitude events," said Dempsey, who is now at the University of Auckland in New Zealand.

This trend doesn't continue indefinitely, however. The research shows that induced quakes begin to fall off after reaching some maximum magnitude as the triggered faults release more of their stress as seismic waves.

While energy companies might welcome the notion that there are upper limits to how strong an induced quake on a particular fault can be, it's difficult to know what that ceiling will be.

"The question becomes, Does it taper off at magnitude 3 or a more dangerous magnitude 6.5?" Suckale said.

Other studies have found that the rate of wastewater injection into a well is more important than the total volume injected for triggering earthquakes. But the Stanford study found that, given similar rates of wastewater injection, there is a direct correlation between the volume injected and the incidence of earthquakes. Of the two wells studied near Guy, Well 1 received four times the wastewater volume as Well 5, and induced four times as many earthquakes.

"There's a scaling there in terms of the volume injected," Dempsey said.

The study's findings could have implications for both the oil and natural gas industry and for government regulators. Under current practices, extraction activities typically shut down in an area if a high-magnitude earthquake occurs. But according to Suckale, a better approach might be to limit production before a large quake occurs.

"Very often with these faults, once you have a big earthquake, you might not have one for a while because you just released all the stress," Suckale said.

Provided by Stanford University