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NORTHERN CALIFORNIA'S LARGEST NEWSPAPER

Quakes, injection disposal of fracking water linked

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America's boom in oil and natural gas production may have triggered an unwelcome side effect - earthquakes.

A new study in the journal Science finds that the number of temblors shaking the central and eastern United States has soared in recent years, even as the controversial practice of hydraulic fracturing has opened up those regions to oil and gas drilling.

More than 300 earthquakes stronger than magnitude 3 struck in the last three years, according to the study. In the past, the central and eastern states experienced an average of 21 similarly sized quakes each year.

The problem does not appear to be hydraulic fracturing - or fracking - itself. Instead, many of the quakes erupt near wells where the dirty water left over from fracking, or other oil and gas operations, is injected deep underground for permanent disposal.

"The people in the industry I've talked to, they're very cognizant of this problem, and they're concerned about it," said study author William Ellsworth, a geophysicist with the U.S. Geological Survey.

The use of fracking is on the rise in seismically active California. If the practice takes off, it could lead to more deep injection wells. California regulations do not prevent companies from drilling injection wells near faults, although the rules do limit injection pressure.

The state already has about 2,300 injection wells, according to Ellsworth's study. But few of them are in areas with high seismicity. The potential link he sees between wells and quakes in states such as Arkansas and Oklahoma doesn't seem to be happening here.

"Rather than be worried, we should be informed," Ellsworth said. "We should ensure that better monitoring is done at injection sites. If we see changes in (seismic) behavior, they could be a warning that things are going to get worse."

California has been one of the nation's top oil-producing states for more than a century. But the increased use of fracking has touched off a bitter fight in Sacramento, with environmentalists and their political allies pushing to regulate the practice or stop it altogether. Oil companies have turned to fracking as a way to unlock the Monterey Shale, a vast geologic formation that could hold an estimated 15 billion barrels of oil.

Need for information

The possibility of triggering more earthquakes in a state that has, at times, been devastated by temblors has become part of the fracking debate. A bill from state Sen.

Fran Pavley, D-Agoura Hills (Los Angeles County), would launch an extensive study of fracking's pros, cons and risks - including seismicity. The bill would halt all fracking in the state unless the study is completed by 2015.

"This underscores how little we know about the risks of fracking," Patrick Sullivan of the Center for Biological Diversity, an environmental group that wants a fracking ban, said of the new study. "The state needs to go back to the beginning and rethink the whole regulatory framework around fracking."

The oil and gas industry considers seismicity near injection wells a relatively minor problem, one that can be managed by siting the wells correctly and monitoring their pressure. Steve Everley, a spokesman for an industry-funded advocacy project called Energy in Depth, noted that the vast majority of the nation's deep injection wells have not been linked to earthquakes.

"It's a well-known thing," he said. "It's also an exceedingly rare thing. It's one of the risks that you try to manage."

Water, sand, chemicals

Hydraulic fracturing involves pumping a mix of water, sand and chemicals into wells at high pressure to crack subterranean rocks that contain oil or natural gas. The process itself can trigger quakes, but they tend to be too small for people to notice, Ellsworth said. The largest quake directly linked to fracking was a 3.6-magnitude temblor in British Columbia's Horn River Basin in 2009, he said.

Deep injection wells have been used for years in oil and gas drilling operations. Oil reservoirs often contain large amounts of non-drinkable water that must be separated from the oil. Injection wells return that water underground. Other injection wells dispose of the chemical-laced water used in fracking, although many fracking companies are now recycling that water.

Change in pressure

While fracking is a temporary event, deep injection wells alter the pressure inside rock formations over time. That can be a problem in the presence of a fault. The steady accumulation of fluid can change the pressure on the fault, allowing rocks locked together to slip suddenly.

A second study in the same issue of Science argues that injection wells have contributed to some U.S. quakes that were triggered by much larger quakes elsewhere on the globe. In those cases, the changed pressure in the rocks primed faults to slip, said Nicholas van der Elst, the report's lead author. Seismic waves from the distant quakes - waves that can travel all the way around the world - provided the final push.

"The remote triggering of earthquakes only happens if the faults are already very near failure," said van der Elst, a postdoctoral researcher at Columbia University's Lamont-Doherty Earth Observatory. "The faults have to be near the tipping point."

Pinning down the source

While the idea that human activity can trigger earthquakes has been accepted among geologists for decades, blaming a specific quake on a nearby well can be difficult. Ellsworth notes, for example, that geologists still disagree about a 5.6 magnitude quake that hit central Okla-

homa on Nov. 5, 2011 - the largest quake in the state's history. Some blame it on injecting oilfield wastewater deep underground, while others insist the causes were natural.

Ellsworth wants government regulators to pay more attention to the issue and develop clear guidelines for oil companies to address seismicity around wells. If injection appears to be triggering quakes, he said, the companies have options.

"Maybe we don't inject as much fluid," Ellsworth said. "Maybe we reduce the pressure it's being injected under. If we continue to see increased seismicity, maybe we decide to close that well."