Thanks To Fracking, Earthquake Hazards In Parts Of Oklahoma Now Comparable To California

Forbes

A magnitude 5.6 earthquake shook Oklahoma on Saturday, tied for the strongest quake ever recorded in the state. Odds are it was triggered by fracking operations, specifically the subsurface injection of fracking wastewater.

There is a direct connection between fracking and earthquakes in the central and eastern United States Figure 1). But the earthquakes are not a result of fracking itself. They mostly result from the injection of fracking wastewater at depths well-below the fracking horizon. The larger the volumes of wastewater injected into the subsurface, the larger the earthquakes can be.

The United States Geological Survey just produced a seismic hazard forecast for 2016 for the central and eastern United States that includes both induced and natural earthquakes. While almost all of the fracking-induced or triggered earthquakes are small — less than magnitude 3, which can't be felt by most people — enough are above 3 that the USGS predicted a 5% to 17% chance of significant damage to homes and structures in just the year 2016 for areas of north-central Oklahoma and southern Kansas where fracking occurs. Presumably, this will continue each year as long as fracking continues close to the present rate.

In cases when injection of fracking wastewater induces earthquakes of larger magnitudes, the earthquakes are most likely the result of reactivation of nearby pre-existing faults by upsetting the subsurface pressure regimes that keep the fault closed.

Invented in 1947, hydraulic fracturing, or fracking, is a technique that improves the production of oil and

gas from wells by increasing the number of fractures in the formation through which oil and gas can flow, and extending the reach of fluid pathways, i.e., fractures, between the formation and the well. Injecting water, plus some specific chemicals, at high pressure into low-permeability, or tight, rocks, fractures the rocks or stimulates slip across pre-existing faults and fractures, allowing for more oil and gas to be accessed by the well. A propping agent, usually sand particles, is also injected to keep the new fractures open.

Fracking takes a few hours to a few days, followed by a period where the fracking fluid is allowed to flow back to the surface where it is collected for disposal, treatment, or reuse. It is the disposal of this fluid by injection into deep wells that causes the earthquakes.

The dramatic increase in fracking for oil and gas in America since 2006 Figure 2) has caused some regions to experience frequent earthquakes, regions that have not had many in the past. In fact, some areas in north-central Oklahoma and southern Kansas now have hazards from fracking-related induced earthquakes that are similar to parts of California where earthquakes are caused by natural tectonic forces like plate collisions and volcanism Figure 3).

On the other hand, the fracking craze is responsible for the dramatic drop in carbon emissions in America because it has provided enough gas at cheap prices for natural gas to replace coal. Our emissions are now at a 27-year low.

Just another human-environmental conundrum that makes policy decisions difficult.

It’s important to understand what fracking does and does not do:

– Fracking is generally NOT the cause of induced earthquakes. Wastewater disposal is the primary cause of the recent increase in earthquakes in the central United States associated with fracking

– Not all wastewater injection wells induce earthquakes

– Wastewater is produced at all wells, not just fracking sites

– Induced earthquakes can occur at significant distances from injection wells and at different depths

The injected fluids change the subsurface dynamics of pressure and friction, allowing things to move that wouldn't ordinarily move or that wouldn't move so often. The wastewater is injected into a different rock formation than where the oil or gas is, usually below the production zone.

Fracking itself, and subsequent enhanced recovery operations, inject water into rocks where oil or gas is being removed or where they have already been removed, which doesn't increase the pressure that much.

However, wastewater injection wells usually inject into pristine rocks, so injection increases pressures much more and makes induced earthquakes more likely. Where there are faults, the increased fluid pressure can push back against the pressure holding the fault closed, thereby allowing the fault to move.

Since wastewater disposal wells typically operate for much longer times than the fracking wells, they tend to inject much more fluid than the fracking operations. Injections responsible for earthquakes above magnitude 3 involve hundreds of thousands of barrels.

Fortunately, most fracking and wastewater injection operations do not induce earthquakes. Either they don't have high enough injection rates and total water volumes to change the pressures, or they are not close enough, or connected by subsurface fluid pathways, to sufficiently large faults. Because of the complexity of the subsurface geology, earthquakes can be induced 10 miles or more away from the injection point and at greater depths than the injection points.

A similar, but reversed, situation has occurred in southern California. Work by Dr. Kerry Sieh in the 1970s showed that over the last 15,000 years, great earthquakes M>8) on the southern portion of the San Andreas fault occurred in a regular manner, easily dated to within about ±5 years. The time period varied in a regular and reproducible way. The last great earthquake occurred in 1857, and the work showed that the next "Big One" should have been in 1947.

But we are still waiting for it. Beginning at about 1900, extensive drilling for oil occurred in the Los Angeles Basin and surroundings. At the same time, the population began to rapidly grow and we began extracting groundwater at an amazing rate. We extracted so much oil and water that we completely changed the subsurface dynamics of the San Andreas fault system and rendered useless our knowledge of the previous earthquake frequency. We now have no idea when the "Big One" will occur. Or how big it

will be, considering that we have locked it up tighter than it ever was.

There really are consequences to human activities.

And more than just physical consequences. Fracking-induced earthquakes are a real grey area in home insurance. Amy Bach, executive director of United Policyholders, says man-made quakes are “new territory” in insurance coverage, and the home-owner should ask directly whether fracking is covered as a cause. Only 15% of homeowners in Oklahoma carry earthquake insurance, but that’s up 500% from just a five years ago in 2011 when the strongest earthquake in that state’s history damaged over a dozen homes.

With this latest quake, expect that number to jump again.

With respect to fracking, there are other instances where fracking itself has been painted with issues that actually relate to other processes. Fugitive methane emissions come more from a poor cement job during sealing of the wells, than from fracking itself. EPA considers emissions from natural gas systems to be fairly low, even compared to agriculture and organic digesters Duke University; Forbes Opinion). And other toxic organics coming from fracking sites, like benzene, toluene, ethyl benzene, and xylene, are also not from fracking but from other activities like gas flaring units, condensate tanks, compressor units, and hydrogen sulfide scavengers. Mechanical inefficiencies in these systems, not the fracking process itself, cause the majority of toxic emissions from fracking sites.

So if we want to address the environmental and safety issues surrounding fracking, while still benefiting from its lower carbon emissions relative to coal, we have to back up and address the other activities that occur onsite.

To decrease fracking-induced earthquakes, maybe we need to figure out another way to handle the wastewater.