

While recent studies have demonstrated a correlation between seismic events and some areas of high-volume water injection, there are conflicting opinions regarding cause and solutions. ConocoPhillips and the industry have been actively sharing subsurface data with scientists and state geologists to advance public understanding of induced seismicity, as well as helping researchers arrive at science-based conclusions that can inform solutions.

ConocoPhillips is committed to the ongoing study of the causes of seismicity in areas of oil and gas production. The company funds independent university research and supports assessments by government agencies.

## About Seismic Activity

The Earth's crust is dynamic. Constantly shifting tectonic plates interact, building and storing energy. When the stress or pressure becomes great enough, the crust shifts along pre-existing faults, releasing energy. The natural release of stored energy are earthquakes.

The amount of energy released from an earthquake is measured on the Richter scale.

Most earthquakes are naturally occurring and according to the United States Geological Survey, millions occur annually worldwide. Approximately 100,000 of these are magnitude 3 or greater on the Richter scale, which can be felt at the Earth's surface. Of this number, a few hundred (generally magnitude 5 or greater) are powerful enough to result in structural damage.

While most earthquakes are caused by natural forces, some human activities can trigger seismic events. These include fluid withdrawal, water impoundment behind large dams, geothermal energy production, mining activity, water injection and hydraulic fracturing. Felt seismicity associated with the oil and natural gas industry has been attributed to both water injection and, to a much lesser degree, hydraulic fracturing.

## Water Injection Wells: Felt Seismicity

Injection wells have been safely and reliably used in the U.S. to dispose of produced water from oil and natural gas operations since the 1930s. The water is separated from the oil and natural gas at the Earth's surface and then re-injected deep underground to protect the environment, and in some cases, enhance oil recovery. Injection wells are regulated in accordance with the Federal Safe Drinking Water Act Underground Injection Control program.

Of the more than 172,000<sup>1</sup> oil and natural gas-related injection wells in operation in the U.S., only a small percentage have been associated with felt seismicity. In the cases where injection-related seismicity has been felt at the surface, reducing fluid injection rates or shutting in injection wells has mitigated seismicity. The risk of such events happening can be reduced through robust disposal well site selection and injection design, both regulated activities.

The oil and natural gas industry is not the only industry to use injection wells. The chemical, manufacturing, agriculture and

steel industries also rely on injection wells as a safe method to dispose of waste products.

## Hydraulic Fracturing: Felt Seismicity Is Rare

By design, hydraulic fracturing, or fracking, releases energy deep in the subsurface to fracture the rock within the targeted hydrocarbon formation.

More than two million wells have been hydraulically fractured worldwide during the past 65 years. Over this period, it has been rare for hydraulic fracturing to trigger a seismic event that can be felt at the Earth's surface, much less cause damage. Measurements made with highly sensitive listening devices indicate the reason seismicity is seldom felt is because the energy released is usually 1,000,000 times smaller than the felt seismicity threshold.

As with water injection wells, prudent site selection can reduce the risks of seismicity.

<sup>1</sup> Classes of Wells (n.d.). Retrieved May 4, 2015, from <http://water.epa.gov/type/groundwater/uic/wells.cfm>

## SEISMIC EVENT IMPACT



\*Each whole number increase on the Richter scale represents 32 times more energy release and 10 times more ground motion.