KANSAS GEOLOGICAL SURVEY
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HYDRAULIC FRACTURING AND INDUCED SEISMICITY IN KANSAS

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For some time the public has asked questions about seismic activity related to hydraulic fracturing and other oil-field related activities. In particular, there is concern that the energy that goes into the subsurface during hydraulic fracturing is sufficient to cause felt earthquakes. The following is a response to those questions.

1) Seismic activity that is related to human activities is generally referred to as “induced seismicity” or “triggered seismicity.” Induced seismicity is defined as “seismic events attributable to human activities” (National Research Council, 2012). The term “triggered seismicity” is also used to describe situations in which human activities “could potentially ‘trigger’ large and potentially damaging earthquakes” (Shemeta et al., 2012). The following discussion uses only the term “induced seismicity” to refer to seismic activity in which human activity plays a role.

2) Because it uses energy to fracture rocks to release oil or natural gas, hydraulic fracturing does create microseismic events (of a magnitude less than 2.0). Felt earthquake activity (generally greater than a magnitude 3.0) resulting from hydraulic fracturing has been confirmed from only one location in the world (National Research Council, 2012). In the midcontinent, the U.S. Geological Survey (USGS) has stated that there is “no evidence to suggest that hydraulic fracturing itself is the cause of the increased rate of earthquakes” (Hayes, 2012). As noted by Stanford University geophysicist Mark Zoback, “the pressurization during hydraulic fracturing affects only limited volumes of rock (typically several hundred meters in extent) and pressurization typically lasts only a few hours” (Zoback, 2012).

3) It has long been known that earthquakes can be triggered by fluid injection. As Zoback noted, “The first well-studied cases were earthquakes triggered by waste disposal at the Rocky Mountain arsenal near Denver in the early 1960s and by water injection at the Rangely oilfield in western Colorado in the late 60s and early 70s” (Zoback, 2012). The USGS and other studies have found that “at some locations the increase in seismicity coincides with the injection of wastewater in deep disposal wells” (Hayes, 2012). As the USGS notes, “We know that the Earth’s crust is pervasively fractured at depth by faults. These faults can sustain high stresses without slipping because natural ‘tectonic’ stress and the weight of the overlying rock pushes the opposing sides of the fault together, increasing the frictional resistance to fault slip. The injected wastewater in deep wells can counteract the frictional forces on faults, causing an earthquake” (Hayes, 2012). In other words, fluids injected near a fault can, in effect, act as a friction-reducing agent, allowing a fault to move.

4) Significant amounts of saltwater are produced along with oil and natural gas in the United States, including Kansas. This saltwater is generally injected back into the deep surface. Nationally, the USGS estimates that there are 150,000 injection wells (called Class II wells by the U.S. Environmental Protection Agency), of which 40,000 are used to dispose of the waste fluids from oil and gas operations. Hydraulic fracturing also produces non-potable water that requires disposal under State permits. There are approximately 16,000 Class II wells in Kansas. They are regulated by the Kansas Corporation Commission (KCC). There are 47 Class I disposal wells in Kansas, used to dispose of hazardous or non-hazardous industrial waste. These are regulated by the Kansas Department of Health and Environment (KDHE). In general, waste fluids from oil and gas production in Kansas are injected back into deep subsurface formations that take those fluids "under gravity." That is, because of the ability of these formations to accept substantial amounts of fluid, fluids are not injected under additional pressure, but simply allowed to flow into these rock formations under the force of gravity. The KDHE has noted that gravity injection allows only the amount of fluid to be injected that the formation can naturally accept, thereby limiting pressure build-up in the disposal formation and reducing the potential of rock movement at a fault. Any pressure increases that do occur from injection are limited to the vicinity of the well, which also decreases the likelihood that injection fluids would travel far enough from the well to encounter a fault and cause earthquakes.

5) An example of induced seismicity, related to a Class II well, may have occurred in Kansas in 1989. A series of small earthquakes, strong enough to feel, occurred in the Marcotte oil field in Rooks County. Studies of that seismicity noted that "one disposal well lies directly above the western, most active part of the zone of seismicity" (Armbruster et al., 1989). That well may also have been in proximity to a deeply buried fault zone. "The coincidence of a disposal well, recent pore pressure history, extended swarmy nature of the seismicity, and low level of prior earthquake occurrence in this area allow for the possibility that this seismicity could have been induced." The authors also concluded that "comparing the size of this zone of seismicity with others in the Eastern U.S. suggests that it would not generate events of magnitude greater than (about) 5" (Armbruster et al., 1989).

The conclusion is that there is no evidence of felt earthquake activity related to hydraulic fracturing in Kansas. Some induced seismicity in the midcontinent may be related to waste fluid disposal. There has been one documented instance of a possible association between disposal wells and low-level seismic activity in Kansas.

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