APR16-2016-000700

Abstract for an Invited Paper
for the APR16 Meeting of
the American Physical Society

Fracking, wastewater disposal, and earthquakes

ARTHUR MCGARR, US Geological Survey, Menlo Park, CA

In the modern oil and gas industry, fracking of low-permeability reservoirs has resulted in a considerable increase in the production of oil and natural gas, but these fluid-injection activities also can induce earthquakes. Earthquakes induced by fracking are an inevitable consequence of the injection of fluid at high pressure, where the intent is to enhance permeability by creating a system of cracks and fissures that allow hydrocarbons to flow to the borehole. The micro-earthquakes induced during these highly-controlled procedures are generally much too small to be felt at the surface; indeed, the creation or reactivation of a large fault would be contrary to the goal of enhancing permeability evenly throughout the formation. Accordingly, the few case histories for which fracking has resulted in felt earthquakes have been due to unintended fault reactivation. Of greater consequence for inducing earthquakes, modern techniques for producing hydrocarbons, including fracking, have resulted in considerable quantities of coproduced wastewater, primarily formation brines. This wastewater is commonly disposed by injection into deep aquifers having high permeability and porosity. As reported in many case histories, pore pressure increases due to wastewater injection were channeled from the target aquifers into fault zones that were, in effect, lubricated, resulting in earthquake slip. These fault zones are often located in the brittle crystalline rocks in the basement. Magnitudes of earthquakes induced by wastewater disposal often exceed 4, the threshold for structural damage. Even though only a small fraction of disposal wells induce earthquakes large enough to be of concern to the public, there are so many of these wells that this source of seismicity contributes significantly to the seismic hazard in the United States, especially east of the Rocky Mountains where standards of building construction are generally not designed to resist shaking from large earthquakes.