Geophysical Research Abstracts
Vol. 18, EGU2016-6647, 2016
EGU General Assembly 2016

Numerical modelling of production-induced seismicity in natural gas exploitation

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Observations at several sites show that the exploitation of natural gas can induce seismicity. Studies have indicated that the pressure drop in the gas reservoir caused by production may lead to compaction, affecting the stress field in the surrounding rock formations. This in turn can reactivate pre-existing faults, hence inducing earthquakes. Despite the moderate magnitude of these seismic events, they can often be felt at the surface due to their shallow hypocenters, posing the population at risk. A well-known example is Groningen in the Netherlands, where production-induced seismicity has caused damage to houses located near the gas field. Given the public significance, it is highly relevant to understand the geomechanical processes involved during natural gas production. This work investigates the geomechanical behaviour of pre-existing faults during gas production. We use a simple model with a permeable reservoir cut by a fault zone and surrounded by impermeable rock formations, preventing the gas from escaping toward shallow depths. The permeabilities are chosen to be stress-dependent allowing for hydro-mechanical coupling. Our aim is to study different parameters, such as production rate, fault permeability and other rock properties, and analyze their influence on the strength of the seismic event as well as the reactivation time of the fault measured from the onset of production.