Seismicity-Permeability Coupling in Gas Shales, CO_2 Storage and Deep Geothermal Energy

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Abstract

Contemporary methods of energy conversions that reduce carbon intensity include sequestering CO_2, fuel switching to lower-carbon sources, such as from gas shales, and recovering deep geothermal energy *via* engineered geothermal systems (EGS). In all of these endeavors, either maintaining the low permeability and integrity of caprocks or in controlling the growth of permeability in initially very-low-permeability shales and geothermal reservoirs represent key desires. At short-timescales of relevance, permeability is driven principally by deformations – in turn resulting from changes in total stresses, fluid pressure or thermal and chemical effects. These deformations may be intrinsically stable or unstable, result in aseismic or seismic deformation, with resulting changes in permeability conditioned by the deformational mode. We report experiments and models to represent the respective roles of mineralogy, texture, scale and overpressures on the evolution of friction, stability and permeability in fractured rocks. The physics of these observed behaviors are explored *via* parametric studies and surface measurement of fractures, showing that both permeability and frictional strength are correlated to the fracture asperity evolution that is controlled in-turn by the sliding velocity and fracture material.