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Caprock integrity and induced seismicity from laboratory and numerical experiments

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CO_2 leakage, either across the caprock or through faults, is a major concern for geologic carbon storage. To assess the caprock sealing capacity and the strength of faults, we investigate clay-rich geomaterials in the laboratory. We focus on the thermo-hydro-mechanical coupled processes that shale may undergo during CO_2 storage. Specimens of Opalinus clay – a Swiss shale – are brought to the conditions of suitable storage formations (1 km depth) and are fully saturated with in-situ brine. Poro-thermo-mechanical parameters are measured in drained, undrained, and unjacketed compression experiments. We use the measured parameters at the laboratory as input data to a numerical model that simulates CO_2 injection in a deep saline aquifer bounded by a low-permeable fault. We find that the caprock sealing capacity is maintained and that even the fault may undergo a series of microseismic events, leakage is unlikely to occur through the ductile clay-rich fault.