CO_2 Injection in a Faulted Multi-Layer System: Simulation of Hydrological and Geomechanical Processes

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A numerical study of hydrological and geomechanical processes during and after injection of supercritical CO_2 into a deep brine formation is conducted. The simulations are performed using the coupled computer code TOUGH2-FLAC3D, which considers multi-phase flow (in this case supercritical CO2 and water with dissolved NaCl) together with rock deformation. A hypothetical geologic setting is assumed, with the injection formation situated below a sequence of aquitard and aquifer layers, creating a multi-barrier system. Various scenarios are analyzed; in particular, those cases where the aquitard sequence is intersected by subvertical conductive high-permeability (fault) zones. These zones may be pre-existing, or may be created or enhanced by rock failure in response to the pressure increase during injection. The hydrological, mechanical, as well as coupled hydromechanical responses caused by the injection are investigated to study the behavior of the system with and without mechanical coupling. The study aims at (1) understanding the upward migration of CO_2 in a multi-layer aquifer-aquitard system as a function of formation characteristics and fault properties, and (2) evaluating the possibility of mechanical damage in the injection aquifer as well as in the overlying geologic units.