CO2 Storage in Saline Aquifers in Kuwait: A Geomechanical Assessment of Containment and Subsurface Integrity

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ABSTRACT

Geomechanics plays a key role in evaluating the subsurface integrity in CCS projects. Stress changes induced by increased pore pressure and thermal effects of CO2 injection pose a potential threat to the integrity and the containment of CO2 storage sites. Injection can cause fracturing and faulting of the reservoir-seal pairs creating the potential leakage pathways for unwanted CO2 migration out of the storage complex. A geomechanical assessment of containment-related risks is explained in the context of industrial-scale CO2 storage in an onshore aquifer storage site in Kuwait, investigated in a feasibility study. The study considered an ambition scenario of storing 11 Mt/y of CO2, which corresponds to annual emission of the Doha East and the Doha West power plants, over the period of 40 years. A multilayer aquifer in the Kra Al-Maru Trend was identified as a suitable storage site. Flow and geomechanical numerical simulations were conducted to assess geomechanical responses induced by large-scale CO2 injection in a 900m-thick storage complex at Kra Al-Maru. Sandstone formations within the reservoirs are characterized by high porosity (~30%) and excellent permeability (1-2 D). Flow simulations indicated a limited radial extent of CO2 plume from the injectors of 5 km, with a maximum pressure build-up in the reservoir of 3 MPa at the end of injection, assuming injection in an open system. Lateral extent of pressure build-up in the brine was however much larger, more than 50 km. Geomechanical responses associated with the low pressure build-up in the reservoir were weak but laterally extensive. Magnitudes of induced stresses in the caprock were small, in the order of a few tenths of a megapascal. The near-well region was mostly affected as pressure build-up and temperature changes there were much larger than in the far-field region. Simulations indicated that injection could induce a maximum surface uplift of 11 cm above the injection zone. Overall, geomechanical assessment indicates a low risk for the integrity of containment at Kra Al-Maru and supports the use of this site for geological CO2 storage. In the next project phase a dedicated well should be drilled for core material and detailed characterization of the selected storage site.