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Sensitivity Analysis of Key Parameters on the Long-term Behavior of CO 2 Injected Into a Deep Saline Aquifer

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Geological storage of $CO_2$is one of the methods to mitigate the global warming. Several kinds of reservoir are suggested including depleted oil/gas fields, unminable coal seams, and deep saline aquifers, and test and demonstration projects for them are underway. In Japan, saline aquifers without structural trapping are known to keep water soluble methane gas and are considered to be the targets of geological storage of CO_2.
If the seal capacity and the continuity of the layer located immediately above the reservoir are sufficient, all injected $CO_2$is expected to be stored within the reservoir. On the other hand, if they are not sufficient alone, CO_2gradually migrates upward through the layers during shut-in period. In this case, CO_2will be trapped by multi-layers due to dissolution and residual gas mechanism.
In this study, we will present the study results of the sensitivity analysis on the long-term behavior of CO_2injected into a deep saline aquifer, including the case where the seal capacity of single layer is not sufficient.

We constructed a two-dimensional geological model with 40 km width and 2 km depth for the simulation. Terrestrial conditions of 15 oC and 0.1 MPa is assumed for the top boundary. The topmost 300-meter region is composed of the unconsolidated sediment, and the alternating layers of sandstone and shale underlie it. $CO_2$is injected at the depth of 1 km at the rate of 1 Mt/year/km. The injection interval is 50 years. The relative permeability of water and $CO_2$is represented by van Genuchten type and Corey type, respectively. Capillary pressure is represented by van Genuchten type.

Using this model, we simulated the long-term behavior of CO_2including the evolution of CO_2plume and the mass of CO_2trapped by the dissolution and residual gas mechanism. The calculation time includes the injection period followed by 1000 years of shut-in. Sensitivity analysis is conducted for key parameters known to be site-specific and relating engineering. Simulations are carried out using the "STAR"reservoir simulation code with the "SQSCO2" equation of state.
As a result, even if the seal capacity of single layer is not sufficient, $CO_2$is trapped by multi-layers before reaching shallow depth. The results also show that if CO_2migrates upward through the layers, the geothermal gradient, relative permeability, and thickness of each alternating layer have large impact on the CO_2behavior as well as the permeability and capillary pressure.

Keywords: Geological storage of CO2, saline aquifer, simulation