Numerical Simulation of Microgravity Change based upon CO_2 Geological Storage and Leakage

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Microgravity change due to density decrease caused by the replacement of the formation water by the injected/leaked CO_2 (Eq.1) will be an effective information for the monitoring of Carbon Capture and Storage (CCS).

density change = $porosity^{*}[density_{brine}\ (1\text{-}S_{CO2}) + density_{CO2}S_{CO2}\ \text{-}\ density_{brine,0}]$ (1)

Its continuous observation can work as a warning system for the decision of whether to conduct a close investigation such as the seismic reflection survey which is relatively costly. In this presentation, we will report the results of numerical simulation of microgravity change based upon a hypothetical CO_2 geological storage and potential leakage. Numerical simulation was conducted on long-term behavior of CO_2 injected into a saline aquifer under the seabed and resulting microgravity change to investigate what extent of the change would be observed at each location on the ground surface. A 3D model was built representing an offshore site below seabed of 20-m water depth. A high-permeable sandstone layer located at about 1 km below the seabed is considered to be the reservoir. A low-permeable seal layer is overlaid by a secondary aquifer and seal, and a top Quaternary sediment. CO_2 is injected into the reservoir at a rate of 0.4 Mt/year for 50 years. Numerical simulations of the injection period and following shut-in period were carried out for a no leakage case and a few cases in which a leakage occurred. Hypothetical faults were supposed to be the leakage path and they were assumed to open at the end of the injection. Fluid flow simulations were carried out using the "STAR" reservoir simulation code (Pritchett, 1995; Pritchett, 2002) with the "SQSCO2" equations of state package (Pritchett, 2008), and then microgravity change was calculated using STAR's "Gravity Postprocessor" (Ishido et al., 1995). The results indicate that continuous observation of microgravity change can be an effective method for the monitoring of CCS if carefully designed.

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References

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