Impact of large-scale geologic CO2 storage on regional groundwater systems -Numerical simulation using parallelized code-

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Recently, CO_2 geologic storage in deep saline aquifers has been recognized as an effective way to reduce greenhouse gas in the atmosphere. Geologic storage of CO_2 is through capturing carbon dioxide from large-scale emission sources such as power plant and storing it in deeply located virgin aquifers by means of borehole injections. In Japan, pilot injection test at Iwanohara has successfully demonstrated the feasibility of current technologies for small-scale CO2 storage in an aquifer. Storage capacities of CO2 in deep aquifers in Japan have been estimated to be more than $100GtCO_2$.

Practically, the amount of CO_2 injected into an aquifer would exceed several million tons per year. However, impact of such large-scale fluid injection on subsurface environment has not been quantitatively evaluated, in the aspects of fluid dynamics, geochemistry, and geomechanics. From the view point of fluid dynamics, the large-scale injection of CO_2 into a virgin aquifer will push equivalent volume of water out from the aquifer. Consequently, upward groundwater movement from deeper to shallower aquifers will occur. This movement possibly changes subsurface groundwater environment regarding to regional flow regime and/or water quality. Hence, evaluation of the impact of large-scale injection on groundwater flow systems would be important to ensure the safety of geologic CO_2 storage.

In this study, the impact of large-scale CO_2 underground injection on regional groundwater systems is evaluated through numerical simulations. Firstly, with simple model, we examine a wide variety of topographic and geological settings. Next, for a hypothetical storage site, we perform numerical simulations of large-scale CO_2 injection in a regional-scale flow model in which surface topography and multi-layer structures of geological strata are conceptualized. The model domain is discretized into some million grid blocks. This large model can be efficiently solved by using a parallelized multiphase flow simulator TOUGH2_MP (Zhang et.al, 2003) with ECO2N fluid properties module of sub/supercritical CO_2 (Pruess, 2005). In the conference, we will present our recent findings obtained from the simulations.