Reactive transport modeling of impacts of dissolved CO_2 on groundwater geochemistry

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Leakage of CO_2 to a shallow groundwater system results in changes of groundwater quality parameters, such as pH, electrical conductivity (EC), alkalinity, and cation concentrations. These are known as important monitoring parameters for detection of CO_2 leakage in a CO_2 capture and sequestration (CCS) site. This study evaluated geochemical changes of groundwater resulting from leakage of CO_2 through reactive transport modeling based on column experiments. The sediment and groundwater for the column experiments were collected from the environmental impact test (EIT) facility in Eumseong-gun, Chungchengbuk-do, Korea [1]. MIN3P [2, 3], a multi-component reactive transport model, was used in this study. For the reaction network for the model, dissolution of primary allumino-silicate minerals, including quartz, microcline, anorthite, abite, and biotite, and precipitation of seconary minerals, such as gibbsite, calcite, and domite, were considered to simulate the geochemical changes resulting from contact of the CO_2-saturated groundwater with native aquifer materials. The modeling reproduced the major geochemical changes observed in the column experiments, showing increased in pH, alkalinity, and concentrations of dissolved cations along the distacne of the column. With an exception of quartz, which showed dissolution and re-precipitation, primary minerals were dissolved upon contact with the CO_2-saturated groundwater. While calcite and dolomite were not formed, precipitation of gibbsite occurred, indicating a role for controlling dissolved Al concentration. Based on the results for the column experiements, predictive simulations were further performed to provide design variables of the moniotoring system for the CO_2 injection test in the EIT site. The reactive transport model can be a useful tool for indentifying impacts of CO_2 leakage and interpreting effects on geochemistry in the shallow groundwater system.

[1] Lee *et al.* (2016) *Geosci. J.* **20**, 569-583. [2] Mayer *et al.* (2002) *Water Resour. Res.* **38**, 1174. [3] Jeong & Jeen (2016) *Environ. Earth Sci.* **75**, 1-14.