



Evaluation of CO₂ geochemical reactions at an onshore saline aquifer, Nagaoka, Japan

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Carbon dioxide (CO₂) capture and storage has been proposed as one of the most practical options for reducing CO₂ emissions to the atmosphere. The retention time and effectiveness of the CO₂ storage in a saline aquifer partly depend on the geochemical reactions between the injected CO₂, the formation water and the aquifer rocks. Dissolution of cation containing minerals due to acidification of the formation water by CO₂ will help converting free CO₂ into aqueous CO₂ and enhance geochemical trapping of CO₂ (e.g., HCO₃⁻ and CaCO₃). Forming carbonate, or mineral trapping of CO₂, is considered the most secure mechanism of CO₂ storage. To evaluate geochemical reactions at a reservoir, we compared chemical compositions of formation water before and after CO₂ injection at the pilot-scale CO₂ injection site, Nagaoka, Japan. A total of 10,400 tons of CO₂ were injected at 1,100 m depth into a 12-m-thick sandstone section of the Haizume Formation from 7 July 2003 to 11 January 2005. At one of the observation wells, OB-2, CO₂ breakthrough was detected by reduction of P-wave velocity on 12 February 2004, and fluid samples were collected from three depths by CHDT (Cased Hole Dynamic Tester) on 3 December 2005. One fluid sample collected from at the depth of 1114 m was almost CO₂ gas. The other two fluid samples from the depth of 1109 m and 1118 m were mainly formation water. At the depth of 1118m, we observed the increase in the concentration of HCO₃⁻ due to dissolution of injected CO₂. The concentrations of Ca, Mg, Fe and Mn were also increased. These elements potentially provided by dissolution of calcite, gypsum, plagioclase, pyroxenes, chlorite and biotite. The batch experimental results using rock and water samples obtained from the Nagaoka test site also supported the above inferred geochemical reactions. Such results enable us to estimate the mineral trapping capability of the storage system.