Natural analogue study on carbon dioxide disposal: water-rock interaction and geochemical behaviour of carbon dioxide

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Experiments on the dissolution of carbon dioxide into groundwater, and reactions between gases, dissolved carbon species and surrounding rocks, and simulation on the natural analogue study on the geochemical behaviour of carbon dioxide in deep underground are useful and important to evaluate the suitability of the host rocks as the underground disposal site. For the elucidation of the long-term geochemical and geological behavior of migrating groundwater and carbon dioxide, particularly, natural analogue study is considered to be the most useful method. However, very few natural analogue studies have been carried out in comparison with experimental, theoretical and simulation studies.

Geochemical behavior of carbon dioxide in deep underground where groundwater interacts with surrounding rocks and migrates depends on the kind of rocks. It is generally expected that the sedimentary rocks (sandstone, shale, limestone) are beter than crystalline rocks(granitic rocks, volcanic rocks, metamorphic rocks) as the carbon dioxide disposal site from the following reasons. 1) Sedimentary rocks contains larger amounts of carbonates whose dissolution rate is very fast than crystalline rocks which are composed of silicates whose dissolution rate is very slow. 2)Groundwater flow rate in sedimentary rock area is generally slower than that in crystalline rocks area due to the difference in the density of cracks; Many cracks are found in crystalline rocks but not in sedimentary rocks and crystalline rocks, focusing on the geological and geochemical behavior ofcarbon dioxide, has been done. Therefore, in this study, it is intended to do natural analogue study on the geochemical and geological behavior of carbon dioxide dissolved into groundwater into groundwater in the sedimentary and granitic rock areas.

The important results from this study in the Hakusyu area, Yamanashi Prefecture are; 1)Departure from chemical ewuilibrium between calcite and groundwater in the granitic rock area is generally larger than the sedimentary rock area. This implies that the reaction rate of sedimentary rocks containing carbonates is higher than that of granitic rocks. This difference suggests that the sedimentary rocks are more useful as the potential host rocks for underground carbon dioxide disposal than granitic rocks.

2)The groundwater chemistry of granitic rock area could be explained in terms of the mixing of meteoric water-derived groundwater and fossil seawater trapped in the sedimentary rocks, although the proportion of seawater is very small, while it is thought that a significant amount of fossil seawater contributed to the chemistry of groundwater in sedimentary rock area.

3)The sedimentary rocks studied are of marine origin and the ages of sedimentary rocks are Paleozoic and middle Miocene. These ages and a significant contribution of fossil seawater indicate that the flow rate of groundwater in the sedimentary rock area is very slow. Very small proportion of seawater in the groundwater in granitic rocks area suggests that the groundwater migrates rapidly in the granitic rock area.

4) Above mentioned differences in the reactivity of the rocks and groundwater flow in the sedimentary rocks and granitic rocks areas suggest that the sedimentary rocks containing carbonates are more suitable for the underground carbon dioxide disposal than the granitic rocks.