Mass transport in CO_2 fixation system using serpentinite rock mass

Ikuo Okamoto[1]; Atusi Ninomiya[2]; Yukihiro Mizuochi[3]; Takayuki Katoh[4]; Tatsuya Yajima[5]; Takashi Ohsumi[6]

[1] RITE; [2] SUMICON; [3] Sumitomo Metal Mining Co.,Ltd.; [4] Earth Sci. Co.; [5] Research Institute of Innovative Technology for the Earth; [6] CRIEPI

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Serpentinite rock mass with highly alkaline groundwater has a potential of CO2 mineral fixation as carbonates. The groundwater acidified by injected CO2 dissolves brucite (Mg(OH)2) and serpentine (Mg3Si2O5(OH)4) in the host serpentinite to increase its Mg content. The Mg-rich groundwater diffuses in the serpentinite-groundwater system with further dissolution of brucite and serpentine to recover its alkalinity. It is possible that Mg carbonates precipitate from the highly alkaline groundwater by a reaction between CO2 and excess Mg component.

The purpose of this study is to develop the efficient CO2 fixation system in the ultramafic regime with an in-situ CO2 injection test following the 2004 FY.

The in-situ CO2 injection test was carried out at the Iwanaidake ultramafic mass in the Kamuikotan metamorphic belt, Hokkaido, northern Japan. Two bored holes are drilled, and the depth is 101 and 102 m, respectively. The distance between two holes is about 25 m. The pH value of the groundwater is about 10.1-10.2, and the electrical conductivity is 25-30 mS/m. The groundwater level is about -34 m. Iwanaidake ultramafic mass mainly consists of harzburgite and serpentinite of harzburgite-origin. On the other hand, most of the core bored in 2004 FY is dunite-originated serpentinite.

In the in-situ test, the changes of electrical resistivity distribution of the rock mass were measured in order to estimate dimensions of CO2-serpentinite reaction field. Firstly, distribution of electrical resistivity of rock mass was measured before injection of CO2 into serpentinite rock mass. The CO2 gas was injected into one bored hole (injection well) at the pressure of 0.7 MPa and at the depth of 80 m, and resistivity distribution was measured again. Finally, reacted groundwater was pumped up from the other bored hole (pumping well), and the groundwater was analyzed. The above process was repeated in several times.

Low-resistivity region was observed between the depth of 40 m of the injection well and the depth of 50-60 m of the pumping well. It was clarified that reacted groundwater flows through this region. The region, which resistivity was changed by CO2 injection, was observed, and had a dimension of about 15 m. Resistivity distribution recovered to the condition before CO2 injection in a month. The groundwater, which pH value was slightly decreased by CO2, was observed by the water analysis. Afterwards, electrical conductivity increased to 40 mS/m with the recovery of pH value. Considering the change of the concentration of magnesium ion in reacted groundwater, low-crystallized serpentine and carbonate would precipitated.

According to some results, it is assumed that there are mineral dissolution region, low-crystallized serpentine precipitation region and carbonate precipitation region around CO2 injection point in serpentinite rock mass. The mass transport model considering permeability change in these regions will be also reported.