Reaction of serpentinite and CO2 in natural crack

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1. Introduction

Serpentinite rock mass with highly alkaline groundwater has the potential of CO2 mineral fixation as carbonates. CO2 underground mineral fixation technology, which is one of the options of geological sequestration technologies, is expected to extent the region for CO2 storage.

This study aimed to develop the efficient CO2 fixation system in the serpentinite rock mass and was carried out from 2004 FY to 2006 FY.

We will report mainly the results of in-situ CO2 injection tests and laboratory experiments executed in 2006 FY.

2. In-situ tests

The in-situ CO2 injection tests were carried out at the Iwanaidake ultramafic mass in the Kamuikotan metamorphic belt, Hokkaido, Japan. The bored wells used at the test site were No.1 (110 m in depth), No.2 (102 m in depth and 25 m away from No.1), and No.3 (110 m in depth and 5 m away from No.1 to the direction of No.2).

In 2006 FY, flow through tests between No.1 and No.3 well were carried out to understand the precipitations of carbonates in a natural fracture by analyzing the change of water quality in case that the discharge rate of water and CO2 concentration were changed. Moreover, resistivity tomography between No.1 and No.2 wells and reaction test of rock fragment in wells were executed.

In the flow through tests, CO2 saturated water of 140 liters adjusted at the pressure of 0.1 and 0.8 MPa were injected at the No.3 well. Then water was discharged from No.1 well at the different rate (2, 4, and 6 liters/min.), and the water quality was monitored. As a result, comparing temporary change of electric conductivity of the discharged groundwater, the peak of the electric conductivity became clear at the condition of the high CO2 concentration. There was no remarkable difference at the time to peaking even if the discharge rate was changed. There was a case that white precipitation was observed in the pumped groundwater. This precipitation is inferred to be hydromagnesite with a small amount of low-crystallized serpentine and iron hydroxide from the result of analysis.

After CO2 injection, the electric conductivity of groundwater increased, in other words, the resistivity decreased. On the other hand, the resistivity of bedrock increased in the results of resistivity tomography. This inconsistent result would derive from the change of electric state on the surface of serpentinite. This result is important not only to develop the monitoring technology but also to understand the reaction of the serpentine rock with CO2.

Serpentinite fragments, which is bored core crushed into a size of about 3 cm, were set at the point of CO2 injection and lifting pump. After 10 days of duration of reaction tests, the rocks were collected and their surfaces were observed. A reddish brown serpentine adhered to the surface of the rocks collected from the CO2 injection point. The precipitations thought to be a hydromagnesite and low-crystallized serpentine (chrysotile) were observed on the surface of rock collected from lifting pump.

3. Laboratory experiments

In the laboratory experiments, CO2 saturated water adjusted at the pressure of 0.8 MPa was flow through the 3 bored cores with a crack, water analysis and surface observation were carried out. Flow rates were set at 0.1 or 0.01 ml/min. for each sample. Durations were 32 and 160 hours, respectively.

A white precipitate vein composed of serpentine and brucite changed to the reddish brown minerals on the crack surface. The transparent needle-like crystal that would be a carbonate was generated. Details of the crystal and the solution composition are being analyzed.

4. Summary

To examine the CO2 mineral fixation system using a chemical environment of the serpentinite rock mass, the in-situ tests at Iwanaidake and the laboratory experiments were executed. As a result, the findings concerning the environment of carbonate generation under various conditions in the natural crack were obtained.