Geophysical exploration in the geological sequestration of carbon dioxide

Toshiyuki Tosha[1]

[1] AIST

1. Introduction

The Kyoto Protocol came into effect on February 16 last year. A drastic solution is needed to attain 6% of curtailment target to the reference year during the first commitment period from 2008 to 2013. The geological sequestration of CO2 is one of the most feasible options. The geological sequestration has several approaches to the storage. One is the CO2 storage in depleted oil and gas layers, which is based on the analogy of oil and natural gases. Another type of the storage is to absorb CO2 into a saline aquifer, which has an analogy of the soluble methane gas in the aquifer. The other is the method using the ability of CO2 into coal. Small scale storage tests were carried out at Nagaoka and Yubari.

2. Geophysical measurements at the Nagaoka site

RITE conducted the small scale CO2 storage test from July 2003. A total of 10,000 tons CO2 were injected. They drilled one injection well and three observation wells at the site. Thermometers and pressure gauges were installed at the injection well and at one of the observation wells. Neutron, Sonic, resisitivity, and other loggings were conducted at the observation wells. Breakout of CO2 was observed at each observation well by the sonic and resisitivity loggings and Seismic tomography also revealed the movement of CO2. Seismic monitoring using a hydrophone, time lapse reflection survey, self-potential survey, and tilt-meters measurements were conducted.

3. Geophysical measurements at the Yubari site

CO2 was injected into the coal layer at Yubari. Two wells were drilled at the site. One is to inject CO2 and the other is to monitor. The breakout of CO2 was expected to measure directly at the observation well but no breakout was detected in 2005. There is only one well available for the monitoring during the injection test. It is, therefore, difficult to carry out the tomography.

Tilt-meters were installed and gravity, GPS, and self-potential surveys were conducted during the injection.

4. Geophysical measurements at other sites

Geological sequestrations are commercially carried out at Sleipner, the North Sea, and at Weyburn, Canada. At both fields seismic reflection measurements were carried out. The time lapse seismic reflection has very good resolution of the target layer but is difficult to monitor continuously and needs high costs. The geophysical exploration using a passive source can be measured continuously and cheaply but sometimes less accurately. Since well loggings with electric source succeeded to detect the breakout of CO2 at Nagaoka, the electro-magnetic surveys are necessary to be taken into account in the monitoring of CO2 geological storage. AIST carried out geo-electric measurements during the CO2 and air injection into a shallow aquifer to find out the self-potential observation and resisitivity survey are feasible.

5. Further studies

The depth of the target layer is shallower than that of the oil and geothermal exploration and deeper then the civil engineering. We need the technical development for the monitoring CO2 because the target layer is narrow and deep. The storage should be performed at the offshore close to the coastal line (littoral region). A new technique for shallow water depth is also necessary to carry out the sequestration in the saline aquifer.

Basic data for interpretation of the survey data are also requested to covert the geophysical change to the CO2 movement such as the change of the saturation factor of the super-critical CO2. More data are necessary. There are less data available for the velocity and resisitivity change in a coal sample.

6. Conclusive remarks

Geophysical measurement is very important not only in the construction of the geological and geophysical model of the sequestration layers but in the monitoring during and after the injection. Much technical investment is necessary for the geophysical measurements in the geological sequestration.