Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

HRE031-P01 Room:Convention Hall Time:May 24 16:15-18:45

Semi-permanent continuous monitoring of the CO2 sequestration zone using Seismic ACROSS and multi-geophones - Part I

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In order to continuously monitor the physical state of CO2 sequestration zone in the ground, we are developing a new technology to use seismic ACROSS(s) (Accurately Controlled and Routinely Operated Signal System) and multi-geophones by simulation method and field experiments. The seismic ACROSS source is a very stable semi-permanent seismic source developed by the Tono Geosciences Center and Nagoya University in Japan. Six units are now in nearly continuous operation in Japan and the seismic ACROSS source in Tono was continuously operated for 8 years. The newest seismic ACROSS source can generate 10-50 Hz with 40 ton-f at 50 Hz.

In this report, we explain the results obtained by 2D simulation using a single seismic source and multi-geophones. The result of 3D simulation using small model is reported in Part II in this session. We assumed 20% velocity changes associated with the change of reservoir characteristics or sequestration of CO2. We used rectangular shape reservoirs such as 1) 500 m width and 50 m thick, and 2) 50 m width and 10 m thick located at 1 km depth. We included the velocity change in shallow sedimentary layer. As assuming seismic ACROSS which generates single forces by use of clockwise- and anticlockwise-rotation waveforms, we synthesize forces in two perpendicular direction. By use of synthesized full-wave seismograms, the reverse-time (back propagation) method can generate P, S and P-S phases.

If velocity change of the sedimentary layer is $< 0.1\%$, we can clearly obtain the rectangular shape for the reservoirs using before and after change of characteristics. Even if velocity change of the surface layer is 1 %, we can reproduce rectangular shape. However, the extent of knowledge on velocity structure and large change of velocities at the surface strongly affect to the results. Use of a vertical geophone array can reduce the effect of surface velocity change. Considering the results of simulation, we are testing the imaging by single source and multi-receiver method for a small scale CCS test site in Awaji Island, Japan. The 3D field test will be done in Awaji Island in February and March, 2011.

Keywords: CCS, CO2 sequestration, time lapse, ACROSS, back-propagation, time-reversal

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An Experimental Equipment for Permeability Using Super-Critical CO2

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To estimate fluid flow in underground during CO2 geological sequestration, the properties of the two phase flow such as relative permeability are necessary. There are essentially three means by which relative-permeability data can be obtained. They are (1) direct measurement in a laboratory, (2) calculation by capillary pressure data and (3) calculation from field-performance data. In CO2 geological sequestration, however, residual water saturation which means the non displaced portion of water by CO2, is very important and this value can't be estimated from capillary pressure. Also field-performance data can't be acquired except demonstrations of CO2 geological sequestration or EOR gas storage in oil-fields. So we think that direct measurement of relative permeability in laboratory is necessary for site assessment.

There are two kinds of test methods to determine relative permeability directly by laboratory experiment. One is the steady-state method and the other is unsteady-state or displacement method .In the steady-state method, a specimen is initially saturated with water. Two fluids are introduced at predetermined fluid ratio and are flowed through the specimen until the produced ratio is equal to the injected ratio. At this time, the specimen is considered to be in steady-state flow condition and the existing saturation of the specimen is considered to be stable. The injected ratio is increased, removing more of water, until once again the specimen be in steady-state flow condition. This process has to be continually repeated until complete relative permeability curve is obtained. So this method is rather involved and time consuming.

On the other hand, the displacement method is rather simple and fast. A specimen is saturated with water, and only gas (CO2) is injected into the specimen. Differ from the steady-state method, only one fluid is entering the core, and two fluids are leaving.

Figure.1 shows the schematic view of relative permeability test apparatus. Using this apparatus, the test samples can be flooded with CO2 in super-critical condition. CO2 is pressurized in the injection pump, then flow into the sample inside the core holder which is set in the incubator at desired temperature. The maximum pressure capacity of the core holder is 50MPa, and the maximum pressure capacity of fluid tubing system is 25MPa. So this apparatus can reproduce the pressure condition of underground in the depth of 2000m.

In the process of relative permeability test, two kinds of fluids flow out from a core sample. In the displacement method, cumulative volume of each fluid must be measured individually for the calculation of relative permeability and saturation of the sample. Two fluids separate in a separator on account of the effect of their density difference and one fluid (usually displacing fluid) flows out, the other (displaced fluid) remains in the separator. The total outflow volume can be evaluated from the amount of the back-pressure pump during the experiment, so the cumulative volume of each fluid can be calculated using data of water level change in the separator. There are some ways to measure water level in a separator. One is the visual measurement through a window of separator. The other is indirect measurement using differential pressure transducer or electric capacitance. We adopted electric capacitance because installing a window to the separator is difficult in compliance with regulation.

In steady-state method, the main experimental problem is accurate measurement of saturation. In many case, the saturation is measured directly by measuring sample weight or estimated by in-situ measurement using resistivity, NMR, micro wave absorption or X-ray CT scanning. These are the technique that we must add with our apparatus if we conduct the steady-state relative permeability test.

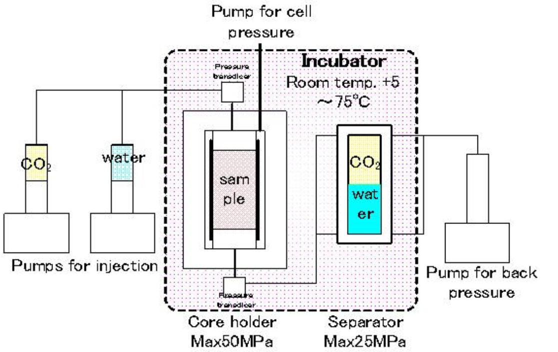

Figure.1 the schematic view of the relative permeability test apparatus

Keywords: CCS, Two Phase Flow, Relative permeability, laboratory experiment

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Matsushiro district, Nagano, as a natural analogue of leakage of stored CO2 - A preliminary report of follow-up study -

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Mechanical deformation, activation of fractures and leakage of stored CO2 as a consequence of these geomechanical responses caused by the increase in fluid pressure underground are important issues for CO2 geological storage. The issues are particularly important for the deployment of CO2 geological storage in Japan because of the tectonic setting of Japanese Islands as a young, active island arc. We are carrying out studies on CO2 flux and water geochemistry in the Matsushiro district, Nagano, as a natural analogue of CO2 leakage, following up the early study by Tosha et al. (2008). The presentation is a preliminary report we have conducted in the 2010 FY.

Keywords: CO2 geological storage, Leakage, Natural analogue, Matsushiro