

## An attempt of evaluation of well integrity at Nagaoka site using ultrasonic logging and CBL data

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For the safety of CO<sub>2</sub> sequestration, injected CO<sub>2</sub> must be trapped in the underground and not be allowed to leak to the surface. Well integrity is one of the essential problems because potential leakage could occur along the well (Celia et al., 2004). Cement between the casing and the formation will be the first material exposed to CO<sub>2</sub> among the well components, so the state of cement in a CO<sub>2</sub> rich environment has been studied (e.g., Kutchko et al., 2007). It is important to measure and monitor the integrity of wells that are exposed to CO<sub>2</sub>. This paper reports well integrity examined by the ultrasonic and sonic logging at Nagaoka CO<sub>2</sub> injection site.

Ultrasonic tool is used to measure the internal condition of the casing, the thickness of the casing, and the acoustic impedance of the material outside the casing. Observed reflected wave was different at the part of iron and FRP casing. The amplitude of the first reflection at the part of FRP casing was smaller since the impedance contrast between casing and water is smaller. We evaluated the impedance of the cement from the analysis of the amplitudes of the multiple reflections.

CBL is used to measure the bond between the casing and the cement, and the bond between the cement and the formation. The bond between the cement and the casing can be evaluated from the amplitude of the first reflection. The time-lapse observation of the CBL showed that the amplitude became smaller after the cementing. This means that the bond became better. The waveform showed the reflection from the interface between the cement and the formation. By combining the results of ultrasonic tool and some numerical calculations we would extract more information about the formation.

We note other logging program at Nagaoka. About 40 times sonic logging at Nagaoka from the injection period to the post injection period showed temporal change with the correlation of CO<sub>2</sub> saturation. The sonic velocity decreased when CO<sub>2</sub> arrived at the observation well. Another logging program is the sampling of the formation water using cased-hole dynamics tester (CHDT). This logging provides the information on chemical reaction and permeability. These results would be used for the interpretation of the state of the materials near the well.

We investigated the well integrity of the observation well at Nagaoka by the combination of the above logging method. The analysis showed that there is no clear evidence of the CO<sub>2</sub> leakage at Nagaoka.

Keywords: CO<sub>2</sub> geological storage, well integrity, Nagaoka, sonic logging