

A relationship between V_p/V_s and lithology in the reservoir at the Nagaoka site

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Seismic methods have been widely used for explorations of CCS sites and monitoring of CO₂ behavior. In this method P-wave data are primarily used. S-wave velocity has independent properties from P-wave velocity, such as S-wave is insensitive to the existence of fluid in the pore of rock. The ratio of these velocities has been utilized to evaluate lithology of formations and gas saturation in the rocks (e.g. Brie et al. 1995). This paper reports a relationship between V_p/V_s data and rock properties at the reservoir of Nagaoka site in Japan.

Nagaoka is the first Japanese pilot-scale CO₂ injection site. A thin permeable zone at the depth of 1100m was selected for the reservoir. For the sonic logging, a low frequency dipole sonic tool has been used at Nagaoka to observe P- and S-wave velocities. Data for the uncased hole logging were used to analyze V_p/V_s , since the V_s data of the cased hole logging had difficulty to separate true S-wave from flexural waves through the casing. Therefore V_p/V_s data in this paper showed results before the CO₂ injection.

Cross plot between porosity and V_p/V_s in the reservoir showed that the scattered data can be categorized into two parts; V_p/V_s were almost constant but porosity changed, and V_p/V_s were dispersive but porosity remained constant. This tendency cannot be seen in the cross plot between porosity and V_p , therefore V_p/V_s might have better response for the lithological evaluations. These differences in the V_p/V_s distributions are consistent with the Fullbore Formation MicroImager logging results, and the distribution in V_p/V_s had dependency on shale volume. The relationship between V_p/V_s and rock properties will be interpreted. Note that the difference in V_p/V_s distribution can be seen in the reservoir with the thickness of 10m. These V_p/V_s distribution might be a feature in Japanese formations, where rock properties change within complex alternate layers.

Keywords: CO₂ geological storage, Nagaoka, V_p/V_s , Well logging