

## Time lapse well logging for monitoring injected CO<sub>2</sub> in a saline aquifer, Nagaoka

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The first pilot scale CO<sub>2</sub> sequestration experiment in an onshore has been conducted in Nagaoka. One injection well (CO<sub>2</sub>-1) and three observation wells (CO<sub>2</sub>-2, CO<sub>2</sub>-3, CO<sub>2</sub>-4) were drilled in the test site. The supercritical CO<sub>2</sub> injection started on 7 Jul. 2003 and ended on 11 Jan. 2005. Total amount of 10,400ton of CO<sub>2</sub> has been injected a saline aquifer at a depth of 1100m from injection well CO<sub>2</sub>-1. Time lapse well loggings were conducted 37 times in order to detect CO<sub>2</sub> breakthrough and comprehend CO<sub>2</sub> behavior at the 3 observation wells during measurement period from Jun. 2003 to Dec. 2007. Induction log (Resistivity), Neutron log (Porosity) and Acoustic log (Primary wave velocity) were used as technique to measure the change of physical property that happened because CO<sub>2</sub> got mixed in with formation water. The first breakthrough was identified at observation well CO<sub>2</sub>-2 which is located 40m apart from the injection well almost 8 months after CO<sub>2</sub> injection started. The next breakthrough was observed at the observation well CO<sub>2</sub>-4. The decrease in V<sub>p</sub> (Primary wave velocity) and Phi<sub>n</sub> (Formation porosity), the increase in R (Formation resistivity) showed CO<sub>2</sub> breakthrough at CO<sub>2</sub> bearing zone. One of the goals of time lapse well loggings is to estimate CO<sub>2</sub> saturation in aquifer. Replacing formation water by CO<sub>2</sub> leads to changes in V<sub>p</sub>, Phi<sub>n</sub>, and R values. That is to say, CO<sub>2</sub> saturation in formation is able to be calculated by these variations of physical properties. On Dec. 2005, the formation fluid at CO<sub>2</sub>-2 was obtained from the middle of CO<sub>2</sub> bearing zone, top and bottom of this zone to know the condition of formation fluid. As the result of sampling fluid analysis, the components in sampling fluid are consistent with result of time-lapse well loggings. Time lapse well logging is proved to be effective in monitoring CO<sub>2</sub> and understanding of CO<sub>2</sub> behaviors in the reservoir.