Quantifying CO_2 Saturation from Time-Lapse Well Logging in an Onshore Saline Aquifer, Nagaoka, Japan

Xue, Ziqiu[1], Jiro Watanabe[2], Daiji Tanase[3] (1) Research Institute of Innovative technology for the Earth, Kyoto, Japan (2) Geophysical Surveying Co. Ltd (3) Engineering Advancement Association of Japan

Injection of carbon dioxide (CO_2) into saline aquifers has been proposed as a means to reduce greenhouse gas emissions. In geological carbon sequestration, monitoring is necessary to confirm the containment of CO_2, assess leakage paths, and gain understanding into interactions between CO_2, the rock-forming minerals and formation fluids. Monitoring is also necessary to quantify the net quantity of CO_2 that has been sequestrated within the reservoirs. The major challenge is how to correlate wave velocity or electrical conductivity with fluid (CO_2 or formation water) saturations in partially saturated porous rocks. A series of time-lapse geophysical loggings consisted of dual induction, neutron, sonic and gamma-ray has been performed frequently at the Nagaoka pilot-scale sequestration site.

The pilot-scale CO_2 injection site is located at Minami-Nagaoka oil and gas fields, and one injection well (IW-1) and three observation wells (OB-2,-3,-4) were drilled at the pilot site. The goal of this paper is to interpret and analyze time-lapse sonic log data quantitatively obtained from observation wells OB-2 and OB-4, to better understand fluid saturations around the two wells. The CO_2 breakthrough was clearly confirmed from the sonic velocity reduction up to 20%. This significant velocity reduction agreed fairly well with the laboratory experiment result on drilled cores. Based on the rock-properties model and Gassmann's equation, we successfully matched the sonic velocity change due to presence of injected CO_2 at observation wells. The CO_2 saturation around the observation wells ranged from 10 to 40%. From the history matching result we also found that there is no CO_2 leakage from the reservoir, even a huge earthquake hit the Nagaoka area. Our results strongly suggested the capability for quantifying CO_2 concentration from seismic wave data with Gassmann's equation.