MONITORING OF A CO2 INJECTION AT THE SVELVIK TEST-SITE IN NORWAY USING CROSS-HOLE SEISMIC METHODS

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Carbon capture and storage (CCS) is one component of the strategy for reducing greenhouse gases in the atmosphere within the next decades. Any CCS project needs to include a measurement, monitoring and verification (MMV) program enabling a project and storage risk assessment and addressing corrective measures to the identified risks. Thus, adequate technologies need to be implemented to ensure safety and security. Within the framework of the ACT-DIGIMON research project a CO2 injection experiment was planned at the SINTEF CO2 field site in Svelvik (Norway) and conducted in September 2021. An injection well and four observation wells down to a depth of approximately 100 meters are installed at the site. The wells are additionally equipped with linear and helically-wound (HWC) DAS cables. A seismic cross-hole survey using high-resolution P-wave tomography with hydrophone strings and the DAS system was carried out to monitor the CO2 (gas) propagation during a six day injection period. Additionally, S-wave tomography using SH- and SV-sources was performed using a multi-station borehole acquisition system consisting of eight tri-axial geophones at two meter separation and the DAS system. A baseline survey was carried out before the experiment started and P-wave measurements were repeated on a daily basis whereas the more time-consuming S-wave surveys were carried out only at injection level depth and within the upper aquifer at later injection stages. Results from conventional P-wave tomography indicate a horizontally layered sedimentation with alternating high and low velocity zones, i.e., lower or higher permeable sediments. Two P-wave tomographic images between the baseline data and data acquired on day 4 show the migration of CO2 along higher permeable zones within the aquifer. These findings were also confirmed by images obtained on a second tomography plane. By exploiting the information of shear waves using the Geotomographie SH and SV sources, changes induced by the CO2 injection could be recognized.