Electrical Resistivity Tomography Concept for CO₂ Injection Monitoring at the Svelvik CO₂ Field Lab

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Carbon Capture and Storage technology is considered to be able to contribute to a carbon neutral society and is again receiving increased attention in the efforts to reduce CO₂ emissions. To ensure safe operation of such CO₂ storage projects, reliable monitoring technologies are required. Due to the generally high electrical resistivity contrast between CO₂ and formation water, Electrical Resistivity Tomography (ERT) can be considered one of the most effective geophysical techniques in the monitoring of CO₂ migration in the subsurface.

Within the ERA-NET co-funded ACT project Pre-ACT (Pressure control and conformance management for safe and efficient CO₂ storage - Accelerating CCS Technologies) a CO₂ injection and monitoring experiment was planned at the Svelvik CO₂ Field Lab, located on the Svelvik ridge at the outlet of the Drammensfjord in Norway. The Svelvik field lab consists of four 100 m deep monitoring wells, drilled in July 2019, surrounding an existing well used for brine and CO₂ injection.

Each monitoring well is equipped with modern sensing systems including five types of fiber-optic cables, conventional and capillary pressure monitoring systems, as well as 16 ERT electrodes with a spacing of five meters.

With 64 installed electrodes, a large number of measurement configurations is possible. We combine the free and open-source geophysical modeling library pyGIMLI with ECLIPSE reservoir modeling to simulate the expected behavior of all cross-well electrode configurations during a CO₂ injection experiment. Simulated CO₂ saturations are converted to changes in apparent resistivity using Archie’s law. Different considerations have to be made to select a suitable set of electrode configurations, i.e. not too large geometric factors, maximum response to the predicted change, as well as sensitivity in the target area. We select sets of configurations based on different criteria, i.e. the ratio between the measured change in resistivity in relation to the geometric factor, the maximum change in apparent resistivity, and maximum sensitivity in the target area. The individually selected measurement schedules are tested by inverting them with different assumed data errors. The numerical results show adequate resolution of the CO₂ plume.

The CO₂ injection took place between 27th October 2019 and 5th November 2019. Approximately two metric tonnes of CO₂ were injected in 65 m depth. Preliminary field results indicate a considerably lower response than predicted by our model. These discrepancies can potentially be explained by oversimplified simulations as well as operational uncertainties. Results from baseline and repeat surveys can therefore support an integrated approach towards a revised static and
dynamic model for the test site.

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