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Surface-downhole geoelectrics for post-injection monitoring at the Ketzin pilot site

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The Ketzin pilot site in Germany represents Europe's longest operating on-shore CO_2 storage site. From June 2008 till August 2013, a total of ~67,000 tonnes of CO_2 were safely stored in a saline aquifer at depths of 630 m to 650 m. Within the national project "CO_2 post-injection monitoring and post-closure phase at the Ketzin pilot site" (COMPLETE), the storage site has now entered the abandonment phase. Continuation of the multi-disciplinary monitoring provides the unique chance to participate in the conclusion of the complete life cycle of a CO_2 storage site.

The geoelectrical surveillance concept at the Ketzin pilot site consists of permanent crosshole measurements and non-permanent large-scale surveys (Kiessling et al., 2010). During the CO_2 injection, a continuous series of weekly crosshole data were measured at near-wellbore scale. These data were complemented by six surface-downhole surveys at a scale of 1.5 km. In the derived time-lapse geoelectrical tomographies, a noticeable resistivity signature within the target storage zone was observed, which was attributed to the CO_2 plume (Schmidt-Hattenberger et al., 2011) and interpreted in terms of the relative CO_2 and brine saturations (Bergmann et al., 2012).

Analysis of the previous surface-downhole measurements have shown that these can extend the imaging volume for monitoring the CO_2 plume and brine interaction in the near-wellbore area. However, resolution was limited due to the sparse acquisition geometry of 16 surface dipoles deployed on two concentric circles. A key task within the COMPLETE project is therefore the further development and verification of optimized surface-downhole acquisition geometries offering efficient and flexible operational performance without compromising image quality.

Synthetic modeling studies of a sparse array of surface electrodes have been conducted with particular focus on (i) optimized surface-downhole acquisition geometries and efficient data processing, (ii) improved resolution within the target storage zone and (iii) quantitative constraints on the lateral extent and the detection limit of CO_2 within the target storage zone.

One important aspect of developing an optimized surface-downhole acquisition geometry is the deployment of a permanent set of surface electrodes at the injection site, which will allow for regular current injections without the demand of an extensive field survey. In particular, which geometries provide a compromise between the costs, operational performance, broad azimuthal coverage and resolution within the target storage zone? Another important aspect of the synthetic modeling is the application of the optimized surface-downhole acquisition geometries to other test sites, in particular if only a single well is available for downhole data acquisition.

In the future, it is planned to evaluate the results of the synthetic modeling using real data from additional surface-downhole measurements from the Ketzin site. This will allow for further improvement of the adapted processing, time-lapse interpretation and integrative evaluation of the deployed optimized surface-downhole acquisition geometries.

References

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