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Surface-downhole and crosshole geoelectrics for monitoring of brine injection at the Ketzin CO_2 storage site

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The Ketzin pilot site in Germany is the longest operating on-shore CO_2 storage site in Europe. 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. The storage site has now entered the abandonment phase, and continuation of the multi-disciplinary monitoring as part of the national project "**CO_2** post-injection **m**onitoring and **p**ost-c**l**osure phase at the **Ke**tzin pilot si**te**" (COMPLETE) provides the unique chance to participate in the conclusion of the complete life cycle of a CO_2 storage site.

As part of the continuous evaluation of the functionality and integrity of the CO_2 storage in Ketzin, from October 12, 2015 till January 6, 2015 a total of ~2,900 tonnes of brine were successfully injected into the CO_2 reservoir, hereby simulating in time-lapse the natural backflow of brine and the associated displacement of CO_2. The main objectives of this brine injection experiment include investigation of how much of the CO_2 in the pore space can be displaced by brine and if this displacement of CO_2 during the brine injection differs from the displacement of formation fluid during the initial CO_2 injection.

Geophysical monitoring of the brine injection included continuous geoelectric measurements accompanied by monitoring of pressure and temperature conditions in the injection well and two adjacent observation wells. During the previous CO_2 injection, the geoelectrical monitoring concept at the Ketzin pilot site consisted of permanent crosshole measurements and non-permanent large-scale surveys (Kiessling et al., 2010). Time-lapse geoelectrical tomographies derived from the weekly crosshole data at near-wellbore scale complemented by six surface-downhole surveys at a scale of 1.5 km showed a noticeable resistivity signature within the target storage zone, which was attributed to the CO_2 plume (Schmidt-Hattenberger et al., 2011) and interpreted in terms of relative CO_2 and brine saturations (Bergmann et al., 2012).

During the brine injection, usage of a new data acquisition unit allowed the daily collection of an extended crosshole data set. This data set was complemented by an alternative surface-downhole acquisition geometry, which for the first time allowed for regular current injections from three permanent surface electrodes into the existing electrical resistivity downhole array without the demand of an extensive field survey. This alternative surface-downhole acquisition geometry is expected to be characterized by good data quality and well confined sensitivity to the target storage zone.

Time-lapse geoelectrical tomographies have been derived from both surface-downhole and crosshole data and show a conductive signature around the injection well associated with the displacement of CO_2 by the injected brine. In addition to the above mentioned objectives of this brine injection experiment, comparative analysis of the surface-downhole and crosshole data provides the opportunity to evaluate the alternative surface-downhole acquisition geometry with respect to its resolution within the target storage zone and its ability to quantitatively constrain the displacement of CO_2 during the brine injection. These results will allow for further improvement of the deployed alternative surface-downhole acquisition geometries.

References

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