Demonstration of applicability of geoelectrical imaging as monitoring tool for the complete life-cycle of a CO2 storage reservoir

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For any CO_2 storage site, an appropriate monitoring program is a key requirement, which needs to address the following main objectives:

Support of safe and efficient storage operations (operational monitoring)Quantitative imaging of CO_2 plume development (migration monitoring)Control of brine displacement as a consequence of injection-related pressure increase (safety monitoring)The application of geoelectrical measurements for CO_2 storage monitoring was first introduced at the Nagaoka, Ketzin and Cranfield test sites. The usage of this method is motivated by the significant resistivity contrast of conductive brine and electrically insulating CO_2. At the Ketzin pilot site, geoelectrical monitoring contributed to all of the above mentioned monitoring aspects (operational/migration/safety) and comprises crosshole and large-scale surface-downhole measurements (Bergmann et al., 2016). The following phases of the CO_2 injection and post-injection operation were successfully monitored by geoelectrical surveys:

During the initial phase of CO_2 injection, which includes the arrivals of CO_2 at the monitoring wells, ERT measurements display the rapid evolution of a CO_2-related resistivity signature and its transient behavior. In addition to the increase in CO_2 saturation, this signature is driven by the increasing reservoir pressure.

Various injection regimes (i.e. variable injection rates, shut-in and re-start periods) led to a transition from a steady-state CO_2/brine contact towards a decreasing CO_2 plume thickness. This is further conditioned by the brine backflush, corresponding solubility trapping and halite precipitation (Baumann et al., 2014).

The post-injection phase shows the buoyancy-driven behavior of the plume and its spreading with significantly reduced vertical thickness.From controlled CO_2 release and brine injection experiments, the cone-shaped CO_2/brine front has been investigated in order to study the capability of such withdrawal/injection measures for potential CO_2 plume management. A very promising development is the recently studied, joint hydrogeophysical evaluation of reservoir and geoelectrical data (Wiese et al., submitted).

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