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Using controlled source electromagnetics in observation wells for monitoring CO_2 dissemination and saltwater migration: the BRINE case study

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A reliable and accurate monitoring of the reservoir state (pressure, fluid saturation, etc.) and possible saltwater migration triggered by the CO_2 dissemination is crucial for the success of geological CO_2 storage projects. The BRINE project, funded by the German Ministry of Education and Research (BMBF) has the double objective of investigating the possible endangerment of freshwater reservoirs by upward migration of brine from saline aquifers as a result of the pressure increase subsequent to a CO_2 injection into a target storage formation and the synergetic utilization of geothermal heat production and CO_2 storage by implementation of pressure discharge wells. Within BRINE, the geophysical work is aimed at developing an integrated electromagnetic monitoring system with multiple components focusing on different scales in the study area located in the North Eastern German Basin.

Based on the geological model of the study area and using conductivity values obtained from a magnetotellurics field experiment conducted in 2011 a baseline conductivity model was created. Integrating the baseline model with the evolution of salinity values caused by CO_2 dissemination and saltwater migration into upper horizons, which were obtained from mechanical modelling, several critical zones were identified and an integrated multi-component (magnetotellurics – MT, controlled source electromagnetics – CSEM, electrical resistivity tomography – ERT) monitoring system was designed. The preliminary models establish the importance of observation wells in order to monitor saltwater migration along potential pathways (regional faults, formation defects in the upper aquitards and leakages around the wellbore) which can threaten freshwater aquifers.

Observation boreholes equipped with electrodes can be used for multiple monitoring components such as CSEM and ERT. For the CSEM component, the observation wells are used as current sources for borehole-surface measurements which offer an increased sensitivity to local variations of electrical resistivity values.