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Development of an approach for quantification of the CO_2 saturation in the Ketzin storage reservoir, based on geoelectrical crosshole data

Joao Reis (1,2), Dennis Rippe (1), and Cornelia Schmidt-Hattenberger (1)

(1) Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences, Germany, (2) Earth Sciences Institute, Sciences and Technology School, University of Évora, Évora, Portugal

To control the atmospheric levels of CO_2 and prevent disastrous climate change consequences related to rising temperatures, all available mitigation methods need to be applied to reduce greenhouse gas emissions, as for example the technology of carbon capture and storage (CCS). The German CO_2 pilot site at Ketzin represents the first European on-shore site for demonstrating the geological storage of CO_2 in the underground. Here, a multi-disciplinary monitoring concept has been conducted to study the migration and long-term behavior of the injected CO_2.
One promising geophysical method to monitor CO_2 in the underground is electrical resistivity tomography (ERT). Geoelectrical measurements are sensitive to the detection of pore-fluid changes in the rock pores. The ERT helps to visualize the displacement of fluids in porous media, using an inversion algorithm, which converts raw data from field measurements of electrical resistance into a tomographic image (resistivity or conductivity) of a CO_2 plume. Furthermore, CO_2 quantification based on geoelectric results can provide complementary information to saturation estimates derived from 3D seismic results. Finally, the results can be compared against additional constraints from well logs and reservoir modelling studies.
First, this paper studies synthetic geoelectrical data of typical CO_2 signatures using a commercial geoelectric modelling and inversion software. The results represent typical saturation scenarios of the reservoir and have to be compared to inverted Ketzin ERT crosshole data which provide the corresponding true resistivity distributions of the injection history. A comparison with saturation results derived from field data inverted using an alternative open-source geoelectric code provide additional information about uncertainties due to data reduction and fitting data within error bounds . This study is the pre-requisite for a first ERT based mass-balance approach. The influence of petrophysical parameters onto the CO_2 mass calculation is investigated. Existing saturation values from pulsed neutron-gamma (PNG) logs have been taken into account as constraints for the near-wellbore region.