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Geoelectrical methods and simulations for improved monitoring of induced changes in shallow aquifers

Susann Birnstengel (1), Ulrike Werban (1), Linwei Hu (2), Sebastian Bauer (2), Stefan Klingler (3), Thomas Günther (4), and Peter Dietrich (1)

(1) Helmholtz Centre for Environmental Research GmbH - UFZ, Monitoring and Exploration Technologies, Leipzig, Germany (susann.birnstengel@ufz.de), (2) Institute of Geosciences, Geohydromodelling, Christian-Albrechts-Universität zu Kiel, Kiel, Germany, (3) Departement of Geoscience, Eberhard Karls Universität Tübingen, Tübingen, Germany, (4) Leibniz-Inistitut for Applied Geophysics, Hannover, Germany

Geotechnical usage in connection with energy transition, such as synthetic gas- or heat storage in subsurface porous media, might have impacts on shallow aquifer-structures due to temperature variations and gas leakages. Realising such applications strongly depends on public acceptance and political appraisal. In consequence of the lack of field sites away from laboratory studies there is an urgent need to develop and validate monitoring methods as a basis for resilient impact analysis.
Geophysical methods provide technological possibilities to monitor the subsurface noninvasively or with the help of borehole installations under controlled constraints to assess potential groundwater hazards.
For the BMBF funded project "TestUM-Aquifer – A test site for investigation and monitoring of reactive multi-phase transport processes in shallow aquifers" two experimental field sites have been installed. At the depth of 17m controlled injections of reactive and non-reactive gasses as well as tests for thermal energy storage and extraction will be conducted during a limited time period.

A main part during these injections is the quantification of petrophysical coherencies and dependencies under field conditions in the upper 20m of the near-surface.
The saturation behaviour as well as the temperature distribution is therefor conducive by applying geophysical proxies: electrical conductivity and seismic velocities.
An underground model regarding porosity, permeability and pressure gradient was generated on the base of numerical simulations of the heat- and gas propagation behaviour. Ensuing, a geophysical parameter model was created to simulate conductivity changes in affected areas at the injection area.
Based on the numerical model and a conceptual model an electrical resistivity monitoring network consisting of surface and borehole geoelectrics down to 18m was installed at the test site to give qualitative evidence of the lateral and horizontal temperature- and gas variations at various points of time. The combination of a long offset surface profile and 19 borehole measurements, covering different electrode configurations within and between the boreholes, lead to a good coverage of different sensitivity areas.

In my presentation I will focus on the simulated results given by the parameter model. With the completion of the experiments a comparison of the simulated and the field data will help to evaluate the results.