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Geoelectric Monitoring of geological CO2 storage at Ketzin, Germany (CO2SINK project): Downhole and Surface-Downhole measurements

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Numerical models of the CO2 storage experiment CO2SINK (CO2 Storage by Injection into a Natural Saline Aquifer at Ketzin), where CO2 is injected into a deep saline aquifer at roughly 650 m depth, yield a CO2 saturation of approximately 50% for large parts of the plume. Archie's equation predicts an increase of the resistivity by a factor of approximately 3 to 4 for the reservoir sandstone, and laboratory tests on Ketzin reservoir samples support this prediction. Modeling results show that tracking the CO2 plume may be doable with crosshole resistivity surveys under these conditions.

One injection well and two observation wells were drilled in 2007 to a depth of about 800 m and were completed with "smart" casings, arranged L-shaped with distances of 50 m and 100 m. 45 permanent ring-shaped steel electrodes were attached to the electrically insulated casings of the three Ketzin wells at 590 m to 735 m depth with a spacing of about 10 m. It is to our knowledge the deepest permanent vertical electrical resistivity array (VERA) worldwide. The electrodes are connected to the current power supply and data registration units at the surface through custom-made cables. This deep electrode array allows for the registration of electrical resistivity tomography (ERT) data sets at basically any desired repetition rate and at very low cost, without interrupting the injection operations. The installation of all 45 electrodes succeeded. The electrodes are connected to the electrical cable, and the insulated casing stood undamaged. Even after 2-odd years under underground conditions only 6 electrodes are in a critical state now, caused by corrosion effects.

In the framework of the COSMOS project (CO2-Storage, Monitoring and Safety Technology), supported by the German "Geotechnologien" program, the geoelectric monitoring has been performed. The 3D cross-hole time-laps measurements are taken using dipole-dipole configurations. The data was inverted using AGI EarthImager 3D to obtain 3D images of the true resistivity distribution in the reservoir, which reflects the extent of the CO2 plume. The resistivity data provide information about the saturation state of the reservoir independently of seismic methods. Base data sets have been measured prior to the CO2 injection; monitoring data sets are registered while CO2 is being injected. Using combined 3D surface-downhole measurements (realized in cooperation with University of Leipzig) we got in addition an indication for effects of anisotropy in CO2 migration.

We present an overview of the electrode installation, first examples for baseline and monitoring datasets and the corresponding tomograms that show indications of the CO2 migration.