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Geophysical Monitoring at the CO2SINK Site: Combining Seismic and Geoelectric Data

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The CO2SINK project at the German town of Ketzin (near Berlin), is aimed at a pilot storage of CO2, and at developing and testing efficient integrated monitoring procedures (physical, chemical, and biological observations) for assessing the processes triggered within the reservoir by a long term injection operation.
In particular, geophysical methods as seismic and geoelectric measurements have delivered the structural framework, and they enable to observe the reaction of the reservoir and the caprock to CO2 propagation at locations which are not accessible for direct observations.
We report on the seismic monitoring program of the CO2SINK project which comprises baseline and repeat observations at different scales in time and space, combined with comprehensive geoelectrical monitoring performed in the Ketzin wells and on the surface.
The main objectives of the 3D seismic survey (carried out in spring 2005) were to provide the structural model around the location of the Ketzin wells, to verify earlier geologic interpretations of structure based on vintage 2D seismic and borehole data, as well as providing a baseline for future seismic surveys. The uppermost 1000 m are well imaged and show an anticlinal structure with an east-west striking central graben on its top.
The 3D baseline survey was extended by VSP (vertical seismic profiling), MSP (moving source profiling) on 7 profiles, and crosshole tomographic measurements. 2D "star" measurements were carried out on the 7 MSP profiles in order to tie-in the down-hole surveys with the 3D baseline survey. These measurements provide enhanced resolution in time (faster and more cost effective than a full 3D survey) and space (higher source and receiver frequencies). Three crosshole measurements were performed, one baseline survey in May 2008, and two repeats in July and August 2008, respectively. A third crosshole repeat is planned for a later stage in the project when a steady state situation has been reached in the reservoir between the two observation boreholes Ktzi 200 and Ktzi 202.
The interpretation of the time lapse crosshole seismic measurements is still work in progress. A time lapse effect can be recognized on cross correlations of baseline and repeat data indicating that considering the full wave form of the recordings does have the potential to locate subtle changes in the seismic properties of the reservoir due to CO2 injection.
In addition, we show the results of the site-specific geoelectrical monitoring concept VERA (Vertical Electrical Resistivity Array), which covers electrical resistivity measurements in all three Ketzin wells. The array consists of 45 permanent electrodes (15 in each well), placed on the electrically insulated casings of the wells in the 600 m to 750 m depth range with a spacing of 10 m. This layout has been designed according to numerical forward modeling assuming electrical properties of pre- and post-injection scenarios. In addition to the geoelectric downhole measurement setup, surface to surface, and surface to downhole measurements are added in order to enlarge the area of observation between the three Ketzin wells to a hemispherical area (with a radius of about 1.5 km) around the wells. First results of the Electrical Resistivity Tomography (ERT) fit the expected reservoir behaviour. Higher resistivity values (presently up to factor 3 compared to other horizons) represent the intervals of the sandstone reservoir as preferred pathways of the CO2 propagation.