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Experimental program and technical implementation of CO2 injection experiment in a deep geological formation at Heletz, Israel ‘

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Most of the predictions regarding the storage potential and the trapping mechanisms for geological storage of CO2, rely on model simulations. Before large-scale use, however, these models and modeling approaches still need careful validation, which in turn requires comprehensive, well-controlled CO2 injection experiments accompanied with refined MMV (Measurement, Monitoring and Validation) technologies.
This work presents the experimental plan and designs of a highly controlled CO2 injection experiment to be carried out at the Heletz site (Israel), the main experimental site of the EU FP7 project MUSTANG, and discussed the requirements of the experimental design in the light of the objectives of the experiment. The overall objective of the experimental program is to find optimal experimental ways to characterize CO2 relevant in-situ medium properties, including field scale values to residual and dissolution trapping, to explore ways of characterizing heterogeneity effects through joint analysis of different types of data, and to detect leakage. A secondary objective is to form consistent and comprehensive datasets for model validation.
The Heletz site is a depleted oil reservoir filled with brine at its edges. The geology of the site is relatively well characterised and consist of three sandstone layers and above them a sealing layer. The experiment will involve two wells, one injection and one monitoring well. The experiment has started in the re-entry of an existing well, to be used as the injection well and the drilling of a new well, to be used as the monitoring and withdrawal well. Prior to the actual CO2 injection experiments, preparatory experiments will be carried out. First, in the injection well, hydraulic, thermal and tracer tests will be carried out, including salinity logging for detection of the details of conductive layers, thermal logging for the temperature profile, hydraulic pumping tests for overall hydraulic properties as well as push-and-pull tracer tests for determining fluid-rock interface densities. After the drilling of the monitoring well, hydraulic as well as standard tracer tests will be carried out for the two-well system, to determine the water flow velocities, connectivity and effective porosity as well as a to get a preliminary understanding of the inter-well flow path heterogeneity and to aid in finalizing the design of the CO2 injection test. The actual CO2 injection experiment will consist of two experiments: 1) a single well injection-withdrawal experiment of water and CO2 and 2) two-well injection-withdrawal test with injection of CO2 and pumping of water from the monitoring well. Tracers will be introduced in both experiments and into both fluids (water and CO2) to further aid in detecting the development of the phase composition during the CO2 transport.
The experimental program requires sophisticated instrumentation in both wells, to enable e.g. a simultaneous pumping, sampling and monitoring in both wells and in multiple layers. The injection well will be instrumented to allow injection of water and or CO2, pumping of water, monitoring pressure and temperature, fluid sampling at depth, continuous temperature and pressure measurements by means of an optical fibre and seismic monitoring. The monitoring well will be instrumented so it shall allow pressure and temperature measurement and fluid sampling at five different vertical horizons (one above the seal, one inside the seal and three in the target layer). It will be possible to pump from the monitoring well during the injection operations, in order to create a directed flow field.