Characterization and working programme of Hontomín CO_2 injection site (Spain). Monitoring, Hydrogeochemical Characterization and Injection Tests

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INTRODUCTION: THE HONTOMIN TDP

Hontomín (Northern Spain) is the site for the CO_2 storage Technology Demonstration Plant (TDP) of the Compostilla OXYCFB300 project. This research facility is operated by the Energy City Foundation (CIUDEN) of the Spanish Government. The geological setting of Hontomín consists of a dome-like structure located in the central zone of Burgos province, about 30 km to the north of the capital. The CO_2 will be injected in a dolomitized level located at, approximately 1450 m depth. A large number of multidisciplinary experiments are planned, including: site characterization studies and, development of new technologies and injection schemes. The research facility for the geological storage of CO_2 will consist of three wells: an injection well (Hontomín-5), a geophysical monitoring well (Hontomín-6) and a hydrogeochemical sampling well (Hontomín 7).

INSTRUMENTATION AND MONITORING TECHNIQUES

Cross borehole electrical resistance tomography (ERT) and cross-well electromagnetic (EM) technology are two of the various monitoring techniques that will be implemented at the Hontomín TDP. An EM baseline survey will be completed in wells Hontomín-5 and Hontomín-6, prior to characterization and CO_2 injection tests. The ERT measurements and monitoring will contribute to define the dynamics of CO_2 migration. ERT data will be interpreted together with the information obtained from the hydraulic and tracer tests in order to monitor the movement of the front of the CO_2 plume.

As one of the key monitoring technologies, seismic data will also be used to show the migration behavior of CO_2 through the reservoir and cap-rock formations. Full wave-field seismic data will be used to establish a baseline model of physical properties and to follow their variation (4D evolution of the physical properties) during the injection. This should provide a physical model to be able to forecast the changes in the state of the reservoir and the spatial distribution of the CO_2-rich phase. Hontomín-6 will be instrumented with a downhole multi-level seismic tool that will be flexible enough to move up and down through the well around the target

formation (reservoir and seal). This design is imperative for surface seismic studies such as Vertical Seismic Profile (VSP), offset VSP, walk away and full 3D VSP, as well as for cross-hole experiments. The downhole seismic tool will be recording continuously during the injection to assess the possible micro-seismicity. The seismic studies to be developed in the research site include: evolution of physical properties; parameter determination (inversion, tomography) for fluid flow modeling with special interest in full-waveform inversion; crack distribution; focal mechanisms of micro-seismicity.

In order to carry out hydraulic and geochemical tests and to monitor the movement of CO_2, the sampling well (Hontomín-7) is intended as a Multi-Level System (MLS), i.e., a system that will enable to sample fluids (brine and/or CO_2) and measure a range of parameters in-situ at different intervals of the cap-rock and reservoir formations. The idea is to be able to sample phases that are lighter (supercritical CO_2) and denser (brine with dissolved CO_2) than the resident brine. The three geological formations that will be investigated are the cap-rock, the waste zone (a transition zone of low porosity) and the storage reservoir, which is roughly divided into three production zones. Through these geological units we want to sample and measure within 5 intervals.

Distributed Temperature Systems (DTS) will be implemented in the three wells to monitor disturbances in thermal equilibrium over time and detect changes in the temperature profile around the wells. In well Hontomín-5, DTS will allow to know the distribution of different phases through the injection tubing and the occurrence of phase changes as well. We expect that the arrival of CO_2 will affect the temperature distribution and thermal conductivity near the monitoring and sampling wells. Moreover, a heating cable will be installed in these wells to measure the thermal diffusivity, which will allow us to obtain a more accurate detection of CO_2.

Pressure transducers will be distributed through the target formations in the injection and observation wells to monitor the hydraulic response of the system. To this end, we are evaluating the option of installing simple pressure gauges or a more sophisticated solution such as the hybrid opto-electrical devices, which enable to run simultaneously pressure quartz gauges and DTS fibers in one single cable. Mechanical deformation will be monitored by means of extensometers: optical fiber at Hontomín-5 and -6 and mechanical displacement at Hontomín-7.

HYDROGEOCHEMICAL CHARACTERIZATION TESTS

Planned hydrogeochemical characterization experiments include not only conventional hydraulic tests but also CO_2 storage specific tests. Among these, a mid-term (several days) high pressure, high flow rate, water injection test will be performed to identify potential brine leakage paths and to assess mechanical stability issues. To this end, the site will be heavily instrumented to measure micro-seismicity and mechanical deformation. Push-pull tests using brine and both reactive and inert tracers will be performed to assess the porosity structure and in situ reactivity of the rock. Supercritical CO_2 (with gaseous tracers) push pull tests will also be performed to assess retention mechanisms. Tracers will allow identifying chromatographic effects so as to characterize CO_2 dissolution rates.

CO_2 INJECTION ESTRATEGIES

Regarding the CO_2 injection phase, several injection techniques will be tested to promote CO_2 stabilization. These include continuous and fluctuating injection rates, temperature controlled injection, dissolved CO_2 and prior injection of gases. The interpretation of these tests should allow us to validate the injection concepts implicit in the long term geological storage of CO_2.