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In Salah CO_2 injection modelling: a preliminary approach to predict short term reservoir behaviour.

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The Carbon Capture and Storage (CCS) option relies on the exploitation of an appropriate underground structure to efficiently and safely store significant amounts of CO_2. Two types of reservoirs are targeted: deep saline aquifers or depleted oil and gas reservoirs, combining or not an EOR phase before CO_2 storage in this last case. In particular, oil & gas operators are testing to manage in situ gas field CO_2 production by re-injecting this gas into deep saline aquifers (such as in the Sleipner and Snøhvit projects) or directly into the aquifer of the producing reservoir (as it is done by BP, STATOIL and SONATRACH in the Krechba field as part of the In Salah Gas project).

In the CO2ReMoVe European project, involved partners work on developing tools and methods to model and monitor the CO_2 injection and the plume migration in both the short and long term. The aim is to be able to predict and verify how CO_2 migrates and interacts in the formation and to validate any remediation action (if needed) while considering the different geomechanical and physico-chemical phenomena. The challenge is to understand the reservoir and storage complex behaviours on the basis of, at least, a database associated with an important monitoring programme operated on a series of sites. Site characterization is the key step prior developing a reservoir model and at least a complete earth model of the storage complex. A progressive approach is generally applied considering: at first, injection feasibility into the reservoir and then, the impact of injecting and storing CO_2 on the site behaviour when this becomes observable (the final step being to predict and monitor site abandonment in the long term after injection has ceased).

The paper first describes the preliminary work performed by IFP to model the injection of CO_2 in the northern part of the Krechba field. This study on the short-term storage performance has mainly consisted of better characterizing the field and in understanding its behaviour taking into account the two important monitoring results. In practice, using reservoir gas production and CO_2 injection data, different approaches have been investigated to correctly map the pressure evolution and the observed CO_2 breakthrough at an old appraisal well located close to one of the injector wells. The main result is the history matching of the dual media model performed between August 2004 and December 2007. This result obtained with the COORES^{TM} v1.2 3D flow simulator is coherent with other approaches achieved by CO2ReMoVe partners. One history matching result concerns the fracture density showing that the fracture network is characterized by long fractures/faults spaced 1000-2000 m apart. The analysis of the flow simulation results predicts a vertical CO_2 migration through the fractures in the injection regions up to the C10.2 top first, then up to the C10.3 top and a lateral spreading in x and y directions at the tops. At the end of 24 years of production/injection, the CO_2 plumes appear as mainly located around the injectors, but a small part may reach the producers. Such results will be improved / updated when the results of the seismic monitoring of the plume extension will be available and by considering associated earth model updates.

The second part of the paper illustrates the on-going approach applied to be able at least to model the site behaviour at both short and long terms and at a larger scale. It presents the extension and the updating of the initial reservoir model to consider geomechanical effect and

particularly to consider observed surface deformation monitored by satellite imaging. A structural model from below the reservoir up to the surface with lateral extension has been developed. After updating the short term storage performance, the pressure distribution will be used to simulate effective stress evolution and surface deformation over time while constraining the modelling with observed data. This step is important before considering long term reactive transport as it helps to better predict the CO_2 migration within the reservoir.

Conclusions on this preliminary large scale modelling for the Krechba site and recommendations on further work considering the field monitoring programme will be presented.