Modelling surface displacements associated with CO_2 re-injection at Krechba (In Salah project - Algeria)

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CO_2 storage in geological formations such as deep saline aquifers or depleted oil and gas reservoirs constitutes the Carbon Capture and Storage (CCS) option to fight against global warming. In this context, BP, STATOIL and SONATRACH started the In Salah Joint Venture to manage on a series of fields the CO_2 produced -and captured to fit with the exportation concentration threshold- by re-injecting it in the northern part of the aquifer of the Krechba gas field. The injection started in August 2004 and to date up to 3 million tonnes of produced CO_2 have been re-injected -17 million tonnes being scheduled at least.

In the frame of the CO2ReMoVe European project, IFP Energies nouvelles and his partners work at developing tools and methodologies to simulate the CO_2 migration within the reservoir and the resulting site behaviour by working on a series of pilot sites (including Krechba). The final objective of this project is to be able to model the short term behaviour of the site and to predict its long term at the scale of the storage complex in order to assess the storage integrity and its long term performance.

This paper presents the results of a joint 3D fluid flow and geomechanical modelling, focussing on the geomechanical aspect. An extended structural geomodel has been developed to simulate the site geomechanical behaviour up to the surface. The pressure field is computed using a dual-media reservoir model and is extracted at different time to load the geomechanical model. 3D fluid flow modelling is constrained by history matching (on both natural gas production data and CO_2 injection ones) while also considering an unexpected CO_2 breakthrough at an old appraisal well (occurring between August 2006 and June 2007). A poro-elastic approach is used to quantify effective stress redistribution and ground deformation associated with reservoir pressure evolution (Figure 1). Results of the comparison of observed surface displacement data (~20 mm using InSAR satellite imaging at end of January 2009) with the simulated ones (~15mm at same date) are analyzed versus time in order to improve the constitutive law. The success of this approached is demonstrated by a good fit of the modelling results together with the observed displacement magnitude and surface extension (uplift and subsidence zones respectively green and blue at ground surface in Figure 1).

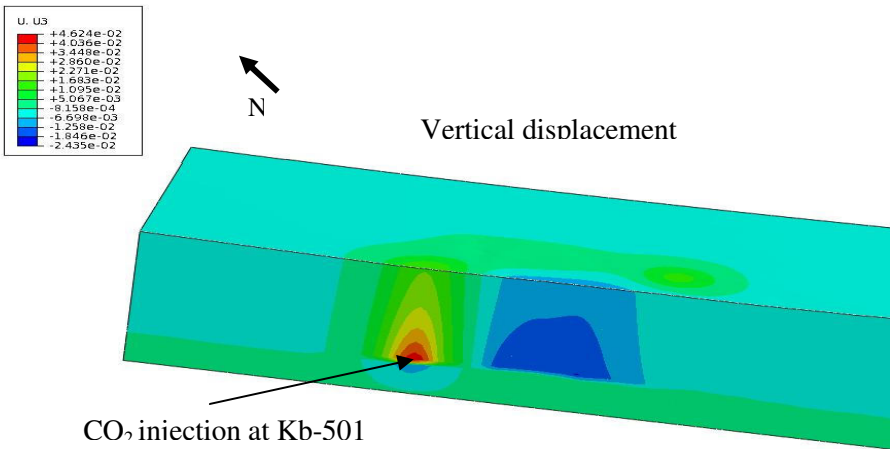

Figure 1: Section cut of vertical displacements resulting from reservoir pressure evolution at Krechba after ~5.5 years of injection (January 2009).