Modeling of single-well CO$_2$ push-pull experiments at Heletz, Israel, for quantifying in-situ residual trapping

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CO$_2$ residual trapping is one of the key trapping mechanisms for CO$_2$ geological storage. A key challenge is, however, to obtain in-situ estimates of its magnitude and the estimates are normally based on experiments on core samples.

To address the issue, at Heletz, Israel, pilot CO$_2$ injection site, two dedicated push-pull experiments have been carried out for quantifying the residual trapping in-situ and for comparing the results to those from the core samples. The Heletz site is situated on saline edges of a depleted oil field and the reservoir layer where CO$_2$ is injected consists of two sandstone layers with a total thickness of about 11 m, at a depth of 1.6 km. The site is well-characterized and instrumented for CO$_2$ injection and sophisticated sampling and monitoring [1]. Both residual trapping experiments are based on the principle of a combination of hydraulic, thermal and/or tracer tests before and after creating the residually trapped zone of CO$_2$ and using the difference in the responses of these tests to estimate the in-situ residual trapping. The first experiment, carried out in autumn 2016, is based on hydraulic withdrawal tests before and after the creation of the residually trapped zone. In this experiment, the residually trapped zone was created by fluid withdrawal, by first injecting about 100 tons of CO$_2$, then withdrawing fluids until CO$_2$ was at residual saturation. In the second test, carried out in summer-autumn 2017, the main characterization method is injection/withdrawal of water and partitioning tracers Krypton and Xenon, whose recovery with and without residually trapped CO$_2$ in the formation is compared. In this second experiment the residually trapped zone is created by first injecting CO$_2$ and then injecting water saturated with CO$_2$ to push away the mobile CO$_2$ and leaving the residually trapped zone behind. The experimental field results have been modelled first with simplified analytical models for guidance, followed by full-physics modeling with the TOUGH2 [2] simulators, including simulations with T2WELL [3] that allows taking into account the processes in the injection well in detail as well. The resulting estimates for CO$_2$ residual trapping will be presented and the results from the two distinctly different experiments compared to each other and to results from laboratory measurements.

**References**

