Geophysical Research Abstracts
Vol. 15, EGU2013-10183, 2013
EGU General Assembly 2013

Inter-well field test to determine in-situ CO_2 trapping in a deep saline aquifer: Modelling study of the effects of test design and geological parameters

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Trapping of CO_2 by capillary effects and dissolution to groundwater is important for the security of geologically stored CO_2 at many potential storage sites. Field tests are critical to measure the amount of CO_2 which is effectively trapped in-situ and evaluate parameters that influence the trapping over larger scales and under influence of geological heterogeneity. Such well-monitored, small-scale field tests are being designed within the EU-FP7 MUSTANG project at the Heletz site, Israel. In an inter-well test, supercritical CO_2 is injected in one well while fluids are produced from a second well. Several measurement techniques, including hydraulic, tracer, thermal and geophysical tests, are used to measure the trapping that occurs as the CO_2 migrates through the formation between the two wells. The general outcome and success of the test depend on design options such as the distance between the wells and the injection/withdrawal rates and volumes, and also on site-specific geological parameters such as permeability, trapping parameters and heterogeneity. The objective of this study was to use numerical modelling to investigate how these design options and geological parameters affect the flow and transport processes in the formation and outcome of the test. The feasibility of the test depends e.g. on the amount of dissolution and residual trapping that occur, the pressure build-up in the formation and the time required to achieve complete trapping and perform the tests. Furthermore, the accuracy of the test depends on the ability of the different measurement techniques to quantify the trapping under different conditions. The results illustrate the sensitivity of the test outcome criteria to both the design options and the geological conditions. An efficient test design should take into account site-specific conditions so that design criteria are met and measurement accuracy and robustness are maximized.