Geophysical Research Abstracts
Vol. 20, EGU2018-8389, 2018
EGU General Assembly 2018

Quantifying geological CO_2 storage security to deliver on climate mitigation

Stephanie Flude (1), Juan Alcade (2), Mark Wilkinson (1), Gareth Johnson (1), Katriona Edlmann (1), Clare Bond (2), Vivian Scott (1), Stuart Gilfillan (1), Xènia Ogaya (3), and R. Stuart Haszeldine (1)

(1) School of GeoSciences, University of Edinburgh, Edinburgh, Scotland, (2) Geology and Petroleum Geology, University of Aberdeen, Aberdeen, Scotland, (3) Institut GEOMODELS, Departament de Dinàmica de la Terra i de l'Oceà, Universitat de Barcelona, Barcelona, Spain

Carbon Capture and Storage (CCS) can help nations meet their Paris CO_2 reduction commitments cost-effectively. However, lack of confidence in geologic CO_2 storage security remains a barrier to CCS implementation. Leak rates of 0.01% yr-1, equivalent to 99% retention of the stored CO_2 after 100 years, are referred to by many stakeholders as adequate to ensure the effectiveness of CO_2 storage.

Here, we present a numerical program that calculates CO_2 storage security and leakage to the atmosphere over 10kyr. This links processes of geologically measured CO_2 subsurface retention (residual and dissolution trapping), and CO_2 leakage estimates (based on measured surface fluxes from appropriate analogues). We model 12 $GtCO_2$ of cumulative storage based on the EU's 2050 target, commencing injection in 2020, and calculate CO_2 retention for well-regulated onshore and offshore scenarios, and for a hypothetical onshore, poorly regulated scenario.

Simulations using base-case, expert chosen values for model input parameters give total leakage after 10,000 years of between 2 and 23% of the stored CO_2, equating to simplified time-averaged linear leak rates of between 0.0002% yr-1 and 0.002% yr-1, respectively. Uncertainty on the results, introduced through uncertainties in the input parameters, is quantified using Monte Carlo analysis. These Monte Carlo results show that CO_2 storage in regions with moderate abandoned well densities and that are regulated using current best practice will retain 96% of the injected CO_2 over 10,000 years in more than half of the cases, and will lose 9.6% of the injected CO_2 in fewer than 5% of cases.

Sensitivity analysis indicates that well density is a key control on storage security. Sensitivity tests also highlight that the most significant uncertainty in the model is how the leakage rate evolves over time; the leakage rate is expected to decrease over time once injection ceases, as the mass of mobile CO_2 in the reservoir decreases via residual and chemical trapping, and leakage.

Our new multi-parameter program can, for the first time, successfully simulate the storage of Gt of CO_2 regionally across multiple sites. As expected, we find that poorly regulated storage is less secure. This leakage is primarily through undetected and poorly abandoned legacy wells, and could be reduced through identification and remediation of leakage if a comprehensive site screening and monitoring program is deployed. Importantly, natural subsurface trapping mechanisms mean that this leakage will not continue indefinitely. Consequently, even with mitigation actions restricted solely to repair of abandoned wells that blow out, regions with a legacy of poorly regulated subsurface operations can reliably and robustly store and retain 73% of injected CO_2.

Our calculated leakage values are well below 0.01% yr-1. We therefore show geological storage of CO_2 to be a secure, resilient and feasible option for climate mitigation even in poorly regulated storage scenarios. Hence, deployment of carbon capture and storage can be recommended to all governments as part of their actions to comply with the Paris 2015 target of keeping the global mean temperature well below 2°C.