Tracing the migration and fate of CO_2 in natural and CO_2-EOR fields using noble gases

STUART GILFILLAN[1*], DOMOKOS GYÖRE[2*], FINLAY STUART[2] AND STUART HASZELDINE[1]

[1]School of GeoSciences, University of Edinburgh, Edinburgh, EH9 3JW, UK (* correspondence: stuart.gilfillan@ed.ac.uk)

[2]Isotope Geoscience Unit, Scottish Universities Environmental Research Centre, East Kilbride, G75 0QF, UK

CO_2 capture and subsequent geological storage of CO_2 is an industrially proven means of abating anthropogenic CO_2 emissions from point sources. For the technology to be universally deployed it is essential that a robust, reliable and inexpensive means to trace the migration and fate of the CO_2 injected into the subsurface exists [1]. Monitoring during injection will increase confidence that the site characteristics were correctly determined and met.

The noble gases (He, Ne, Ar, Kr and Xe) are present in trace quantities in natural and engineered CO_2 streams. There are three distinct sources of noble gases in subsurface fluids (namely crust, mantle and atmosphere) which are isotopically distinct. Further, they are inert and are not affected by chemical reactions in the reservoir. Consequently the noble gases are extremely powerful tracers of both the CO_2 source, and when combined with carbon stable isotopes, the subsurface processes that control the fate of CO_2.

We will present a summary of noble gases and stable carbon isotope tracing techniques in CO_2 storage. This will include a comparison of recently obtained noble gas and C isotope data from the Cranfield CO_2-EOR reservoir (MS, USA) with previous work undertaken on global natural CO_2 reservoirs [2] [3]. Our results illustrate that good progress has been made in using noble gases to determine both the short-term and long-term fate of CO_2 in the subsurface and in the determination of the extent of interaction with the formation water that the injected CO_2 has undergone.

Given the breadth of the applications of noble gases in CO_2 storage and monitoring it is imperative that the progress made in this field is continued. Hence, future pilot and early industrial scale CO_2 injection studies should continue to investigate the behaviour of noble gases in the subsurface to further develop noble gas monitoring for future deployment.

[1] Scott et al. (2013), *Nature Climate Change*, **3**, p105-111 **DOI:10.1038/nclimate1695** [2] Gilfillan et al., (2008) *GCA* **72**, p.1174-1198. **DOI:10.1016/j.gca.2007.10.009** [3] Gilfillan et al., (2009) *Nature*, **458**, p.614-618. **DOI:10.1038/nature07852**