MiReCOL: REMEDIATION OF SHALLOW LEAKAGE FROM A CO_2 STORAGE SITE

Mark Wilkinson[1], Katriona Edlmann[1], Ivana Demic[2] & Anna Korre[3]

[1]University of Edinburgh, UK
[2]NIS j.s.c. Novi Sad, Serbia
[3]Imperial College, London, UK

Abstract

While strenuous efforts will be made to minimise the risk of the leakage of CO_2 from engineered storage sites, there will always remain a residual risk that CO_2 could migrate from the storage site into the shallow subsurface. Within the EU-funded project MiReCOL (Remediation and Mitigation of CO_2 Leakage; project number 608608), a comprehensive review was undertaken of techniques available for the remediation of leakage of CO_2 to the near surface environment, here defined as the depth range of typical remediation techniques used by the pollution clean-up industry rather than by the hydrocarbon industry. The review drew from existing relevant fields of experience such as the remediation of groundwater pollution; the remediation of industrial waste; CO_2-EOR, natural gas storage sites; the geothermal energy industry; the construction of dams (as barriers to subsurface fluid flow); pilot scale CCS projects and natural analogues.

The applicability of each method to clean-up CO_2 contamination; the indicative cost; and the ease of implementation of the method were compiled to produce a summary table of the probable roles of the available remediation techniques, to assess the relative merits of near-surface CO_2 leakage remediation methods. The results indicate that a wide range of remediation techniques are potentially available for near surface CO_2 remediation, and that any remediation strategy will be site specific. Emphasis should be on achieving the earliest possible detection of CO_2 migration from the reservoir, to maximise the time available for suitable mitigation actions to be implemented before leakage.

Choice of technology would depend on the location of the leakage (onshore or offshore; residential or farmed area); geology (porous versus fractured host-rock; soil zone; unconfined or confined aquifer); and the pollutant to be remediated (CO_2; mobilised metals) but key technologies include:

- hydrodynamic isolation using control well(s) to regulate porefluid flow in a shallow aquifer and isolate a CO_2 plume from regional groundwater flow;
- water injection in which a plume is immobilised by increasing dissolution and residual saturation trapping;
- hydraulic barrier, involving increasing pressure in a shallow aquifer to reduce or prevent the vertical migration of CO_2 from a deeper source;
- cutoff walls and grout curtains to isolate one portion of an aquifer from another (in porous or fractured media respectively);
- treatment walls (or permeable reactive barriers) to concentrate fluid flow through a reactive material which absorbs or otherwise immobilises the CO_2 or dissolved metals;
- soil-vapour extraction, either actively by pumping or passively using buried pies and trenches of permeable media such as gravel.
- air sparging, with active pumping of air into the soil zone to flush the CO_2 out;
- bioremediation, microbes metabolise the CO_2, or otherwise cause it to be fixed as a mineral;
- engineering of house foundations to prevent CO_2 ingress;
- and faunal restoration.

CO_2 leakage from known naturally occurring CO_2 reservoirs reveals that natural leakage from known single reservoirs can cover large areas at the surface (> 10 km^2), and commonly follows the traces of faults. Gas release can be either steady state or episodic, sometimes with an obvious control by tectonic activity. Undetected CO_2 can exist in high concentrations at shallow depths, and be released by the drilling of boreholes, or by excavation though a low permeability caprock.

The Bečej field in Serbia, a naturally occurring CO_2 reservoir which suffered a well blowout in 1968, provides a fully costed example of remediation and monitoring techniques, and their effectiveness. At 2014 prices, €4.76M were spent on the remediation of the blowout of a single well.