The “Achilles heel” of carbon capture and storage

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Given the unprecedented increase of atmospheric carbon dioxide (CO_2) concentration and its implication for global climate, ocean acidification and sea level rise, carbon capture and storage (CCS) is one of the most promising mitigation options. It is already being demonstrated at a growing number of facilities worldwide. However, the “Achilles heel” of CCS is its cost and safety. Much of the security risk associated with geologic carbon storage stems from its buoyancy, which can be eradicated by dissolving CO_2 into water prior to or during its injection into reactive rocks which eventually leads to mineral storage of the carbon dioxide [1]. We have demonstrated the dissolution of CO_2 into water during its injection in less than 5 minutes and mineral storage within basaltic rocks in two years at 20–50°C at the CarbFix field injection site in SW Iceland [2, 3].

This method requires substantial water, therefore the cost of storing and transporting a tonne of CO_2 via the CarbFix method is about twice that of geologic storage via “conventional supercritical” CO_2 injection. However, the cost of carbon capture and storage is still dominated worldwide by capture and gas separation [1]. This cost could be lowered by capturing and injecting gas mixtures into rocks as is now being tested at the CarbFix2–Sulfix2 site in SW–Iceland at the Hellisheidi geothermal power plant. Since June 2014 we have injected 8000 tonnes per year of a 60% CO_2 and 40% H_2S gas mixture, which is dissolved in condensation water from the turbines at 20°C and co–injected with efluent water (60–120°C) into the basaltic rock at 700m depth where the temperature is 250°C. This injection capacity was doubled mid year 2016. After about two and a half years of continuous operation, the transmissivity of the injection well is still stable and monitoring data suggests significant mineralisation of the injected gas mixture during this period of injection. This integrated method provides the safe and long-term storage of carbon dioxide and other acid gases at a cost that is significantly lower than the one for conventional CCS metonds [4].

[1] Gislason & Oelkers (2014), *Science* 344, 373–374.
[2] Sigfússon et al. (2015), *International Journal of Greenhouse Gas Control* 37, 213–219
[3] Matter et al., 2016, *Science 352, 1312-1314*
[4] Gunnarsson et al., 2017 (in review).