Rapid mineralisation of CO_2 and CO_2-H_2S-H_2-gas mixture at the CarbFix site in SW-Iceland

S. Ó. SNÆBJÖRNSDÓTTIR[1*], K. MESFIN[1], I. GUNNARSSON[2], E. S. ARADÓTTIR[2], M. STUTE[3], J. M. MATTER[3], E. H. OELKERS[4], K. DIDERIKSEN[5], S. STIPP[5] AND S. R. GISLASON[1]

[1]Institute of Earth Sciences, University of Iceland, Sturlugata 7, 101 Reykjavík, Iceland (*sos22@hi.is)
[2]Reykjavík Energy, Baejarháls 1, 110 Reykjavík, Iceland
[3]Lamont-Doherty Earth Observatory of Columbia University, 61 Route 9W, New York 10964, USA
[4]GET, CNRS/UMR 5563-Université Paul Sabatier, 14 rue Edouard Belin, 31400 Toulouse, France
[5]Nano-Science Center, Department of Chemistry, University of Copenhagen, 2100 København Ø, Denmark

Extensive groundwater monitoring was carried out prior to, during and after the injection of 175 tonnes of pure CO_2 in January-March 2012 and 73 tonnes of 75% CO_2-24%H_2S-1%H_2-gas mixture during June-August 2012 into basaltic rocks at the CarbFix site at Hellisheiði, SW-Iceland. The CarbFix project assesses the feasibility of mineral storage of carbon in basalts. The gases were dissolved in water during injection into a permeable basalt formation located at 500-800 m depth with temperatures from 30 to 60°C. Once dissolved in water, the gas is no longer buoyant and the acidic gas-charged water accelerates metal release from the basalts and formation of C-S-minerals. A drop in pH and increase in dissolved inorganic carbon (DIC) was observed in the first monitoring well, HN-04, located ~70 m downstream from the injection well, about two weeks after the injections began. A significant peak never appeared in H_2S concentrations. Chemical analysis show a rapid increase in Ca, Mg and Fe during the injections with a gradual decline in the following months. PHREEQC calculations indicate saturation of siderite about four weeks after the injections began and calcite saturation about three months after each injection. Pyrite is supersaturated prior to and during the mixed gas injection and in the following months, but mackinawite is at saturation during and after injection. In July 2013 the pump in well HN-04 broke down due to calcite precipitation. Preliminary mass balance calculations based on tracers co-injected with the pure CO_2 suggest that more than 90% of the CO_2 was mineralised within a year [1] and H_2S was mineralised even faster. This result suggests that the CarbFix method can change the time scale of mineral trapping considerably, and can readily co-mineralise injected C and S.

[1] Stute et al. AGU Fall meeting 2014. 12/2014