Rapid siderite mineralisation of carbon during CO_2-water-basaltic glass experiments at 50°C

DEIRDRE E CLARK[1*] IWONA M GALECZKA[2] DOMENIK WOLFF-BOENISCH[3] AND SIGURDUR R GISLASON[1]

[1]Institute of Earth Sciences, University of Iceland, Sturlugata 7, 101 Reykjavík, Iceland (*dec2@hi.is, sigrg@hi.is)
[2]ISOR, Grensásvegur 9, 108 Reykjavík, Iceland
[3]Department of Applied Geology, Curtin University, GPO Box U1987, Perth, 6845, Australia

Carbon dioxide was mineralised within two years of field injection into reactive basaltic rocks at 20-50°C at the CarbFix site in SW-Iceland [1, 2]. This rapid mineralization is attributed to enhanced dissolution of the basaltic minerals and glass at low pH and mixing of the injected fluid with high pH groundwater. The final mineral product at pH>8 is calcite. Reaction path modelling of the fluid from the first monitoring well suggests that the initial carbon mineralisation at the lowest pH (~5) starts with siderite ($FeCO_3$), and as pH increases, (Fe,Mg,Ca)-carbonates take over and finally at the highest pH calcite is the dominant alteration product [3]. This carbonate sequence is in agreement with (a) natural analogue studies, (b) the observed well fluid chemical composition, and (c) the ^{14}C isotopic fractionation of the calcite precipitates within the first monitoring well [1, 2, 4].

Here we investigate the possible sequence of carbonate minerals precipitation using a 2.3 m long titanium high-pressure column flow reactor [5]. The flow rates of water- and CO_2 syringe- pumps were set to deliver a pH ~4 injection solution of 20 mM dissolved inorganic carbon concentration. The column was first filled with Stapafell basaltic glass grains and DI water at 50°C. The starting *in situ* pH, before CO_2 injection, was 10.6 at the column outlet. Within 12 hours (one pore volume, PV) of CO_2-fluid-rock interaction the pH decreased to 6 and stayed constant for the next 400 hours. While the fluid was at first saturated with respect to calcite , it became undersaturated after 50 hours of experimental duration (4 PV). The fluid was initially undersaturated with respect to siderite but after 100 hours (>8 PV) it became saturated. The preliminary results suggest that after 100 hours of experimental duration (8 PV), about ¼ of the injected dissolved CO_2 mineralised within 12 hours (1 PV) of fluid-rock interaction.

[1] Matter et al. (2016) *Science* **352**, 1312-1314. [2] Snæbjörnsdóttir et al. (2017a) *IJGCC* **58**, 87-102. [3] Snæbjörnsdóttir et al. (2017b) Goldschmidt Abstract. [4] Rogers et al. (2006) *Lithos* **92**, 55-82. [5] Galeczka et al. (2014). *GCA* **126**, 123-145.