Reaction path modelling of the *in-situ* mineralisation of CO_2 at the CarbFix site in SW-Iceland

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Results from injection of 175 tonnes of CO_2 into the basaltic subsurface rocks at the CarbFix site in SW-Iceland in 2012 show almost complete mineralisation of the injected carbon in less than two years [1,2]. Reaction path modelling was carried out to illuminate the rate and extent of CO_2-water-rock reactions during and after the injection. Modelling calculations were constrained by the fluid composition sampled prior to, during, and after the injection from the injection well and the first monitoring well at the site.

The mineralisation of the main breakthrough of the injected fluid, occurring about 400 days after the onset of the injection, appears to be dominated by basaltic glass dissolution. Basaltic glass glazes the tops and bases of the lava flows that host the main flow paths of fresh to moderately altered lava piles. However, considerable mineralisation appears to be driven by crystalline basalt dissolution during the first 60 days of the injection via fast fracture flow. The crystalline basalts of the interiors of the lava pile are transected by the fracture that hosts the flow path. The pH of the fluids ranged from 3.7 at the injection well to as high as 8.2 in the monitoring well. At low pH, Mg, and Fe are preferentially released from crystalline basalts due to the higher dissolution rates of olivine, and to lesser extent pyroxene, compared to plagioclase and glass [3]. This favours the formation of siderite and Fe-Mg carbonates over calcite during this early mineralisation. The model suggests the formation of carbonate mineral sequences; siderite at pH below 5, and Ca-Mg-Fe-carbonates and calcite at higher pH. Other minerals forming along with the carbonates are Al- and Fe-hydroxides, chalcedony, zeolites, and smectites. Dissolution of pre-existing calcite at the onset of the injection does not have a net effect on the carbonation, but does contribute to more rapid pH rise early on during the injection, and influences which carbonates form.

[1] Matter et al. (2016) *Science* **352**, 1312-1314.
[2] Snæbjörnsdóttir et al. (2017a) *IJGCC* **58**, 87-102.
[3] Gudbrandsson et al., 2011. GCA 75, 5496-5509