

Chemistry and mineralisation of CO₂-H₂S fluids injected into basaltic rocks at the CarbFix2 site, Iceland

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Following the success of the original CarbFix carbon storage pilot project in Iceland, this approach was upscaled at the Hellisheiði geothermal power plant to inject and mineralize the plant's CO₂ and H₂S emissions in June 2014. The Carbfix method of dissolving the gas into water before its injection, whereupon the CO₂ and H₂S reacts with basaltic rocks that are rich in divalent cations, Ca^{II}, Mg^{II}, and Fe^{II}, to form stable carbonate and sulfide minerals. By the end of 2017, 23,100 tons of CO₂ and 11,900 tons of H₂S had been injected 750 m deep into a fractured, hydrothermally altered basalt reservoir at 240 – 250 °C [1,2].

Geochemical modelling results suggests that the injection fluids are undersaturated with respect to most common primary and secondary minerals, signifying minimal risk to clog injection wells and the pore space nearby. Mass balance calculations, based on a conservative tracer and observed dissolved carbon and sulfur concentrations in the monitoring wells, suggest that over 50% of the CO₂ and 76% of the H₂S precipitated within four to nine months of injection. This result is supported by carbonate and sulfide mineral saturation states with respect to the monitoring well fluids.

Mass balance calculations as well as saturation indices and predominance diagrams of relevant secondary minerals at the injection and monitoring wells indicate that sulfide precipitation is not limited by the availability of Fe^{II} or secondary mineral competition, however Ca^{II} is a significant limiting factor for calcite precipitation in this system due to its high temperature. At these temperatures, actinolite, prehnite, and epidote compete with calcite for the available aqueous calcium. The fluid compositions also indicate that although the geothermal wells are cased off to the chlorite-epidote alteration zone, mineral storage reaction likely occurs at greater depths in the reservoir within the epidote-actinolite zone.

[1] Gunnarsson *et al.* (2018) *International Journal of Greenhouse Gas Control* **79**, 117 – 126.

[2] Clark *et al.* (2018) *Energy Procedia* **146**, 121 – 128.