Elemental mobility following CO_2-H_2S injection into basaltic rocks at the CarbFix2 site, Iceland

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Since 2014, CO_2 and H_2S emissions from the Hellisheidi geothermal power plant in Iceland has been injected using the CarbFix method into geothermally altered basalts at the CarbFix2 industrial injection site. The gas injection has remained stable throughout the 2014-2017 monitoring period, with carbon and sulfur mineralization rates accelerated by the high temperatures and increased after the doubling of gas mixture injection rates in July 2016 [1, 2].

Injection of the acidic gas-charged water in basaltic rocks accelerates their dissolution and release of divalent cations, such as Ca^{2+}, Mg^{2+}, and Fe^{2+}, into the formation waters. Trace elements are known to also be released from basaltic rocks, especially at the early stages of water-rock interaction while the pH is still low [3, 4].

Assessment of the trace element geochemistry from the CarbFix2 monitoring wells suggests the mobilization followed up by uptake of several trace elements, such as Ba, Sr, Mn, As, Sb, and Mo as well as transition metal elements. Furthermore, all the trace elements but As were generally below WHO, EU, and Iceland drinking water standards. However by 2017, levels of As have reduced over time to levels at or below drinking water standards as a direct result of the gas injection.

The relative mobility of the major and trace elements was also determined based on data from the monitoring wells fluids and drill cuttings from nearby geothermal wells. Results indicate that 17 elements measured were more mobile than the immobile Zr, excluding Mn, Fe, Mg, and Ti. Despite many, like Ni, Cr, Co, and La, being at or near the detection limit, these trace elements are up to 1 to 2 orders of magnitude more mobile that Zr. Results indicate minimum effects to elements of environmental concern during carbon capture and storge at the CarbFix2 site.

[1] Clark et al., Geochim. Cosmochim. Ac., 2020. [2] Gunnarsson et al., Int. J. of Greenh. Gas Con. 79, 117-126, 2018. [3] Flaathen et al., Appl. Geochem. 24, 463-474, 2009. [4] Galeczka et al., Energy Procedia 37, 5823-5833, 2013.