# The origin and fate of trace metals during $CO_2$-charged water injection into basaltic geothermal reserovir, Nesjavellir SW Iceland

Iwona Galeczka[ab], Barbara I. Kleine[bc], Jóhann Gunnarsson-Robin[b], Bergur Sigfússon[a], and Andri Stefánsson[b]

[a]Carbfix, Reykjavik, Iceland, iwona.monika.galeczka@carbfix.com, bergur.sigfusson@carbfix.com; [b]Institute of Earth Sciences, University of Iceland, Reykjavik, Iceland, joirobin@hi.is; as@hi.is; [c]GeoZentrum Nordbayern Friedrich-Alexander-Universität, Erlangen, Germany, barbara.kleine-marshall@fau.de

The Nesjavellir geothermal power plant is located within Hengill volcanic system (SW Iceland) where bedrock consists of successions of hyaloclastites and lava sequences formed during glacial and interglacial periods, respectively. The common alteration minerals include smectites, zeolites, quartz, calcite, prehnite, sulfides, feldspars, epidote, chlorite, wairakite and wollastonite (e.g., Franzson, 1998). The hydrothermal fluids in the geothermal system are meteoric in origin and dilute with chloride concentrations <250 ppm. Among the major solutes are $CO_2$ and $H_2S$ which are emitted during geothermal utilization in quantities of 15 and 8 kt/yr, respectively. Based on carbon and sulfur isotope systematics, the main sources of $CO_2$ and $H_2S$ in these hydrothermal fluids are magmatic gas input and host rock leaching (Stefánsson et al., 2017). To limit the power plant emissions, a pilot project using Carbfix technology has been conducted in Nesjavellir, where $CO_2$ and $H_2S$ are separated from the power plant exhaust stream, dissolved in condensed steam, and injected together with separated geothermal water into the injection reservoir (Gunnarsson et al., 2018). Here this mixture reacts with basaltic host rock resulting in mineralization of these gases and therefore providing their safe and permanent underground storage. One of the main concerns related to a subsurface injection of acidic $CO_2$-$H_2S$ fluids is enhanced mobilization of trace metals which constitute the reservoir rocks. This increased metal mobility has been observed during laboratory experiments mimicking water-$CO_2$-basalt interaction (e.g., Galeczka et al., 2013). To assess the possibility of toxic metals plume forming during the injection of $CO_2$-$H_2S$ charged water, we investigate sources and sinks of trace metals in the storage reservoir. We take into account the chemical composition of Nesjavellir boreholes' drill cuttings and the geothermal fluid at depth and on the surface after depressurization. We demonstrate that quantification of metal fluxes in such conditions is crucial for predicting long-term environmental impact of such gas injections especially when considering scaling up of the operations.

## References

Franzson, H., Zierenberg, R., Schiffman, P., 2008. Chemical transport in geothermal systems in Iceland. *Journal of Volcanology and Geothermal Research 173*, 217-229.

Galeczka, I., Wolff-Boenisch, D., Oelkers, E.H., Gislason, S.R., 2014. An experimental study of basaltic glass–$H_2O$–$CO_2$ interaction at 22 and 50°C: Implications for subsurface storage of $CO_2$. *Geochimica et Cosmochimica Acta 126*, 123-145.

Gunnarsson, I., Aradóttir, E.S., Oelkers, E.H., Clark, D.E., Arnarson, M.Þ., Sigfússon, B., Snæbjörnsdóttir, S.Ó., Matter, J.M., Stute, M., Júlíusson, B.M., Gislason, S.R., 2018. The rapid and cost-effective capture and subsurface mineral storage of carbon and sulfur at the CarbFix2 site. *Int. J. Greenhouse Gas Control 79*, 117–126.

Stefánsson, A., Hilton, D.R., Sveinbjörnsdóttir, Á.E., Torssander, P., Heinemeier, J., Barnes, J.D., Ono, S., Halldórsson, S.A., Fiebig, J., Arnórsson, S., 2017. Isotope systematics of Icelandic thermal fluids. *Journal of Volcanology and Geothermal Research 337*, 146-164.