Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37437

The mobility of trace metals upon CCS. An experimental study of CO2 injection at ambient temperature using freshwater and seawater

DANIEL CARRILLO, IWONA GALECZKA AND ANDRI STEFÁNSSON

University of Iceland/Institute of Earth Sciences

Carbon capture and storage (CCS) is an important technology for reducing anthropogenic CO_2 emissions and mitigating climate change. Among the available storage strategies, in situ mineralization in basaltic formations offers a secure and permanent solution by transforming dissolved CO_2 into stable carbonate minerals. The Carbfix approach dissolve CO_2 in water and pump it into basaltic subsurface where CO_2 precipitates as carbonate minerals. Because this technology requires a lot of water to dissolve the CO_2, seawater as an alternative CO_2 solvent has been tested in the laboratory and in the field. This study aims to investigate the trace metal behaviour during the dissolution of basaltic rocks (glassy basalt and fine-grain basalt) and sediment in freshwater and seawater under controlled temperature (23°C) and pH 3 conditions mimicking the freshwater and seawater-rock interaction upon CO_2 injection into the basaltic bedrock. Different parameters like relative mobility and leaching rates allow to identify the behaviour of trace elements during the fluid-rock interaction. This understanding is important for the environmental assessment of CO_2 injection into the subsurface.

Results indicate that most trace metals concentrations (Mn, Ni, Cu, Zn, Cr, Ba) decreased with time. Similar relative mobility and leaching rates are observed for glassy and fine-grained basalt in both freshwater and seawater systems, whereas sediment exhibits comparatively higher relative mobility, particularly for rare earth elements and lower leaching rates than the basaltic samples. Overall, trace metal release patterns are comparable between freshwater and seawater experiments, except for elements with elevated initial concentrations in seawater. Although most measured concentrations remained within environmental limits, Al exceeded WHO[1] drinking-water guidelines in freshwater experiments, and only Cu, Ni, and Cr surpassed Icelandic surface water thresholds under specific conditions. These findings suggest that trace metal mobilization during CO_2 injection into basalt is generally limited and that seawater represents a viable alternative to freshwater for CCS mineralization.

[1] World Health Organization. (2011). Guidelines for drinking-water quality (4th ed.).