Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35398

Seawater-based subsurface CO_2 mineral storage: Geochemical characterization of fluids at the Helguvík pilot site

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The Carbfix method is a safe, cost-effective alternative to conventional geological CO_2 storage. It involves injecting CO_2-charged water into the subsurface for immediate solubility trapping and rapid reaction with reservoir rocks to form stable carbonate minerals, permanently storing the CO_2. Its success has led to multiple scaled-up mineralization projects.

To expand the applicability of the method, the use of seawater for CO_2 dissolution and injection is being evaluated. If successful, it would enable storage in coastal and offshore basalt formations, including young oceanic crust with significant storage capacity. Laboratory experiments indicate that CO_2 mineralization rates in seawater–basalt systems are comparable to those in freshwater [1].

Here, we present new data on the geochemical characterization of groundwater at the Helguvík pilot injection site. The world's first field injections of seawater-dissolved CO_2 have been taking place at this location from 2023 to 2024 as part of the Seastone/DemoUpStorage [2] projects. Subsequently, injections have been restarted in 2025 after modifications to injection and monitoring system as part of a new project.

The site is located onshore the Reykjanes Peninsula in SW Iceland, and the seawater-dissolved CO_2 is injected ca. 250 to 400 m deep into a basaltic reservoir with temperatures below 100 °C. The salinities of both the injection water and reservoir water at this coastal site are close to that of seawater. However, there are significant compositional differences between shallow and deeper saline waters, indicating various degrees of low temperature seawater-rock interaction.

The chemical and reservoir data gathered in this first-of-its-kind project will provide crucial insights into the injection and mineralization of seawater-dissolved CO_2 in mafic reservoirs. This will further broaden our understanding of ongoing and future CO_2 injections in chemically diverse environments using the Carbfix method.

[1] Voigt, Marieni, Baldermann, Galeczka, Wolff-Boenisch, Oelkers & Gislason (2021) *Geochimica et Cosmochimica Acta* 308, 21–41.

[2] Junker, Obermann, Voigt, Maurer, Eruteya, Moscariello, Wiemer & Zappone (2025) *International Journal of Greenhouse Gas Control* 141, 104320.