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Tracking of CO_2 injection to an aquifer for CCS in Iceland

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Mineral sequestration of CO_2 in basalt aquifers is a promising pathway for permanent carbon storage. Within the DemoUpStorage R&D project, CO_2 was dissolved in saline groundwater and co-injected with helium as an inert tracer into a deep basalt aquifer at a pilot injection site near Helguvik, Iceland. We tested a combination of two novel geochemical and geophysical tools to monitor the subsurface CO_2 dynamics. Real-time, on-site monitoring of dissolved gases was conducted over one year using a gas-equilibrium membrane-inlet mass spectrometer (GE-MIMS). Electrical resistivity tomography (ERT) was used to track changes in aquifer resistivity before and after injection. GE-MIMS measurements revealed a clear increase in He concentrations downstream of the injection point, confirming fluid transport. However, no corresponding CO_2 increase was observed, indicating substantial CO_2 retardation relative to the fluid transport. No anomalies in He or CO_2 were detected in the overlying freshwater aquifer, indicating minimal upward migration. ERT data showed localized resistivity decreases suggesting basalt dissolution near the injection borehole. Together, GE-MIMS and ERT provided complementary, cost-effective insights into CO_2 transport, reaction, and storage processes in the basalt aquifer. These tools enhance monitoring and assessment capabilities, supporting the development of safe and effective geological CO_2 storage.