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The successful carbon storage through subsurface mineral carbonation in the volcanic rocks near Jazan, Southwest Saudi Arabia

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As part of Saudi Aramco's Corporate Decarbonization Strategy, a system for geological storage of CO_2through mineralization was developed and successfully tested in the volcanic rocks of the Jizan Group in Southwest Saudi Arabia. The Jizan Group is a sequence of predominantly altered bimodal volcanic and volcanoclastic rocks of Oligocene age deposited in a continental rift valley during the early opening of the Red Sea. The subsurface carbon injection strategy, which was tested at Jazan, is based on that developed originally by CarbFix (Matter et al., 2016). In this process, CO_2 is released in water as it flows downward into the subsurface and is completely dissolved before it enters the basaltic reservoir. The interaction between the CO_2 charged water and the basalt promotes CO_2 mineralization, as basalt dissolution neutralizes the acidic CO_2-rich fluid and releases divalent cations to the aqueous phase. An important modification to the original Carbfix approach is the continuous recirculation of the CO_2 carrier water, which was sourced from the injection zone inside the basalt reservoir, thereby preventing the need to consume local water resources. Recirculation also kept the pH of the reservoir water low, limiting the precipitation of pore filling silicate minerals.

In total 131 tons of water dissolved CO_2 was injected into the subsurface using an injection/production well pair during June and July 2023. Samples collected from the production well demonstrate that the concentrations of dissolved inorganic carbon injected into the basalt reservoir decreased from 32 to less than 10 mmol/kg between its peak on July 29 until the end of December, 2023. The concentrations of the non-recreative tracers, SF_6 and Na Fluorescein, and the $d^{13}C$ of DIC all indicate that more than half of the injected CO_2 was mineralized within 6 months. Water chemistries and solids collected from the production well equipment indicate that CO_2 was mineralized as a combination of calcite, ankerite and siderite. These results thereby, demonstrate the feasibility of permanent carbon storage in regions of our planet where water resources may be limited and fresh basalts may not be present.

References

Matter, J.M., et al. (2016) *Science* 352, 1312-1314.