Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.24094

Isotope geochemistry played a key role for the successful completion of the first pilot demonstration project of subsurface mineralization of CO_2 in Saudi Arabia

SERGUEY ARKADAKSKIY[1], ZEYAD AHMED[1], NOUSHAD KUNNUMMAL[1], JAKUB FEDORIK[1], MOUADH ADDASSI[2], ABDIRIZAK OMAR[2], NICCOLO MENEGONI[2], DAVIDE BERNO[2], ABDULKADER AFIFI[2], THOMAS FINKBEINER[2], HUSSEIN HOTEIT[2], GRIMUR BJORNSSON[3], SIGURDUR R GISLASON[4], ORFAN SHOUAKAR-STASH[5] AND **ERIC H. OELKERS**[4]

[1]Saudi Aramco
[2]KAUST
[3]Warm Arctic ehf
[4]University of Iceland
[5]Isotope Tracer Technologies Inc. - IAGC

Presenting Author: eric.oelkers@gmail.com

A novel method for *in-situ* mineralization of CO_2 in reactive rocks was developed and successfully tested in Saudi Arabia as part of Sauid Aramco's corporate decarbonization program. This method is based on the CarbFix concept deployed in Iceland, where CO_2 dissolved in water is injected into subsurface basalt, initiating a series of chemical reactions that fix the CO_2 into carbonate minerals. The CarbFix method requires large amounts of water, which presents challenges to its deployment in arid environments. However, the novel concept tested in Saudi Arabia overcomes these limitations by sourcing carrier water from the CO_2 injection reservoir itself using a tailored producer/injector well system. This water recycling approach eliminates the need for external water, minimizes reservoir over pressurization, limits potential compatibility issues, and optimizes CO_2 mineralization. The method was pilot-tested in the summer of 2023, when 131 tons of CO_2 were dissolved in water and injected into altered, 30-million-year-old basalt near Jazan, SW Saudi Arabia. Results indicate that more than half of the injected CO_2 was mineralized within six months, with over 90% projected to mineralize in less than three years. Isotope geochemistry played a critical role in the successful completion of this pilot test. Notably, the isotope compositions of rock, mineral, and groundwater samples collected from the region were instrumental in understanding the (paleo)hydrogeology of the basalt aquifer, ultimately leading to the selection of the pilot test site. Furthermore, the isotope compositions of the injected CO_2 gas and those of produced water samples collected before, during, and after the CO_2 injection not only provided important insights into the water-CO_2-rock reactions in the basalt reservoir but also played a key role in quantifying the CO_2 mineralization. Finally, the isotope compositions of carbonate precipitates retrieved from the production well provided direct evidence of ongoing mineral carbonation of CO_2 in the subsurface. This study underscores the critical importance of isotope geochemistry for the large-scale deployment of this carbon sequestration method in Saudi Arabia and beyond.