

The active role of carbonate mineralisation in the peridotite aquifer of the Oman-UAE ophiolite

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In situ mineral carbonation is considered to be one of the safest options for permanent CO₂ Capture and Sequestration (CCS). The peridotite aquifer in Wadi Tayin, Sultanate of Oman, is an excellent natural laboratory to investigate in situ natural carbonation and has considerable CCS potential; adding just 1wt% of CO₂ as carbonate to the peridotite body of the Oman-UAE ophiolite would consume 25% of atmospheric CO₂ [1]. However, a better understanding of the fluid-rock reactions occurring in the peridotite aquifer is needed before any CCS-related mineral carbonation is attempted. To achieve this we have used the ⁸⁷Sr/⁸⁶Sr system to investigate the fluid-rock interactions that occur along the groundwater flowpath within the aquifer, and to determine the sources of the divalent cations (Mg²⁺, Ca²⁺ and Sr²⁺) required for carbonate precipitation.

Groundwater Sr-isotope data and Ca, Mg concentrations indicate that the aquifer rocks are the main source for the divalent cations and secondary carbonates are their main sink. This is supported by the decrease of ⁸⁷Sr/⁸⁶Sr from seawater-like values in rainwater (~0.7092) as pH increases. Groundwater values change from ⁸⁷Sr/⁸⁶Sr = 0.7087 (n=3) at pH 7 to 0.7075 (n=9) at pH 11. Peridotite serpentinisation reactions drive the pH to more alkaline conditions and provide a low ⁸⁷Sr/⁸⁶Sr source to the groundwater (av. ⁸⁷Sr/⁸⁶Sr = 0.7066 (n=12)). This fluid evolution occurs in several steps and individual fluids may follow different pathways. ⁸⁷Sr/⁸⁶Sr ratios change to as low as 0.7077 in pH 8 groundwaters (av. ⁸⁷Sr/⁸⁶Sr = 0.7082 (n=8)), whereas at pH 9 fluids ratios are ~0.7086 (n=6). At pH>11 fluid ⁸⁷Sr/⁸⁶Sr = 0.7075. The dissolution of pre-existing carbonates with ⁸⁷Sr/⁸⁶Sr ~0.7085 (n=8) could be the Sr source for the ⁸⁷Sr/⁸⁶Sr ratio rise at pH 9. Concurrently, at pH 9, groundwaters shift from Mg-rich to Ca-rich compositions. The replacement of existing carbonate minerals by dolomite may explain the groundwater evolution between pH 8 and 11.

[1] Kelemen, P.B. and Matter, J. (2008), *PNAS*, **105**, 17295-17300.