Tracing fluid-rock interaction in carbonated serpentinites and listvenites from Hole BT1B (Samail ophiolite, Oman): First SIMS $\delta^{18}O$ results

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Listvenites are carbonate-quartz rocks (with >30 wt.% CO_2) formed when serpentinites undergo extensive metasomatic alteration by CO_2-bearing fluids. They play a crucial role into deep carbon cycling and carbon sequestration, offering insights into Earth's long-term habitability and climate mitigation via mineral carbonation (Menzel et al. 2024). The Oman Drilling Project Hole BT1B intersected carbonated serpentinites and listvenites formed along the basal thrust of the Samail ophiolite (Oman). Previous studies suggest formation temperatures lower than 200 °C and interaction with fluids derived from devolatilization of metasediments during subduction (e.g., Kelemen et al. 2022). Recent advancements with Secondary Ion Mass Spectrometry (SIMS) allow measuring $\delta^{18}O$ in serpentinites at scales less than 20 µm, and to constrain fluid sources and alteration temperatures recorded at the microscale (e.g., Scicchitano et al. 2021). Here we present the first in-situ $\delta^{18}O$ measurements in four carbonated serpentinites and two listvenites from Hole BT1B. We targeted different generations of serpentine, magnesite, dolomite, talc and quartz from the rock matrix and from multiple crosscutting veins. Oxygen isotope ratios ($\delta^{18}O_{VSMOW}$) vary significantly across different generations of the targeted minerals: 4.2 to 13.2‰ in serpentine, 15.9 to 29.7‰ in magnesite, 16.1 to 17.3‰ in talc, 16.3 to 29.4‰ in quartz, and 14.2 to 24.8‰ in dolomite. Such isotopic heterogeneities may be attributed to variations in temperature, fluid-rock ratio and/or fluid composition during ongoing hydration and carbonation reactions. By integrating petrographic observations with in-situ geochemical and isotopic data, we will assess the degree of isotopic equilibration at the microscale and estimate changes in temperatures and/or fluid compositions to reconstruct a more detailed thermal-fluid evolution during listvenite formation.

References

Kelemen et al. (2022), https://doi.org/10.1029/2021JB022352

Menzel et al. (2024), https://doi.org/10.1016/j.earscirev.2024.104828