

Sulfur cycling the gabbroic section of the Samail Ophiolite Oman

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We report sulfur geochemistry for the Samail ophiolite, Oman, using samples from the Oman Drilling Project (OmanDP; [1]). Hole GT3 drilled the upper crustal sheeted dike (basalt + diabase) upper gabbro transition. The lower crustal section holes GT2 (foliated-layered gabbro transition) and GT1 (layered gabbro) are mainly composed of olivine (bearing) gabbro. All sections record the effects of hydrothermal metamorphism under decreasing temperatures.

Acid Volatile Sulfides (AVS, e.g. pyrrhotite-*Po*), Cr-Reducible Sulfur (CRS, e.g. pyrite-*Py*, chalcopyrite-*Ccp*) and acid-soluble sulfate were analyzed for $\delta^{34}\text{S}$ at WWU-Muenster (Fig.1). The dike-gabbro transition has significantly higher and more variable $\delta^{34}\text{S}_{\text{CRS}}$ values (-12.8‰ to +13.3‰) compared to the lower crustal section (-3.2 to +2.3‰).

No magmatic sulfides are preserved in GT3. $\delta^{34}\text{S}_{\text{CRS}} < 0$ and low total sulfide sulfur contents ($\text{TS}_{\text{Sulfide}}$) relative to MORB suggest that open system sulfur leaching and bacterial sulfate reduction-BSR were dominant in the upper ~80m. Below, thermochemical seawater sulfate reduction via Fe-oxidation of silicates and magmatic sulfides was the pathway for sulfide formation. Following the maximum ^{34}S -enrichment at ~120m, values decrease downhole. $\text{TS}_{\text{Sulfide}}$ and ^{34}S -enrichments associated to sulfide mineralization may represent localized hydrothermal fluid upflow zones.

Low recovery of $\delta^{34}\text{S}_{\text{AVS}}$ (-0.2‰ to +1.9‰) in the lower crustal section reflects the ubiquitous occurrence of secondary sulfides from recrystallization of primary sulfides or silicates. $\delta^{34}\text{S}_{\text{CRS}} X = 1.2\text{‰}$ close to MORB implies formation of secondary sulfides did not involve significant S-seawater input but redistribution of magmatic sulfur. $\text{TS}_{\text{Sulfide}}$ enrichments in some sections may reflect crystal fractionation processes.

Mass balance for hydrothermal fluid composition in the upper crustal section (lithology integrated excluding BSR, $X\delta^{34}\text{S}_{\text{CRS}} = +6.3\text{‰}$) implies 37% (max=80%) contribution of seawater; sulfate yielding $\delta^{34}\text{S} = +4.9\text{‰}$ formed by abiotic oxidation of hydrothermal sulfides. Estimates for seawater contribution in the lower crustal section are low ($X=7\%$; max=12%) although the occurrence of $\delta^{34}\text{S}_{\text{sulfate}} \sim 17\text{‰}$ implies precipitation from Cretaceous seawater, conceivably introduced via deep oceanic faults. Preservation of sulfates in the deep crust could be favoured by limited fluid upflow, contrarily to the upper crustal

section where open-system circulation prevailed.

[1] Kelemen PB, Matter JM, Teagle DAH, Coggon JA, OmanDP Science Team (2020) Proceedings of the OmanDP: College Station, TX (IODP).

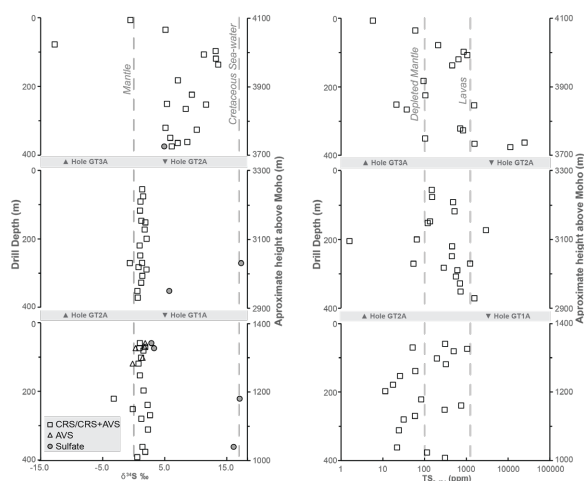


Fig 1. Isotopic variations (left) and Total Sulfur extracted from Sulfide- $\text{TS}_{\text{sulfide}}$ (right) for the upper (hole GT3) and lower crustal sections (holes GT2 and GT1) of the Samail Ophiolite.

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