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Speciation of Fe and S in volcanic glasses from Troodos, Cyprus: tracking the redox evolution and cycling of sulfur in supra-subduction zone ophiolites

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The speciation of Fe and S was measured using micro X-ray absorption near edge structure spectroscopy (μ-XANES) in a suite of volcanic glasses from the Troodos ophiolite, Cyprus. The glasses are basaltic andesites that track the petrogenesis of primary basalts derived from melting of mantle proximal to a subduction zone [1]. Fe speciation ($Fe^{3+}/\Sigma Fe = Fe^{3+}/[Fe^{3+}+Fe^{2+}]$) in the glasses ranges from $Fe^{3+}/\Sigma Fe$ = 0.12 to 0.16, and sulfur speciation ($S^{6+}/\Sigma S = S^{6+}/[S^{6+}+S^{2-}]$) varies from all sulfide ($S^{6+}/\Sigma S$ = 0) to coequal sulfide and sulfate ($S^{6+}/\Sigma S$ = 0.53). Both $Fe^{3+}/\Sigma Fe$ and $S^{6+}/\Sigma S$ increase sympathetically in glasses with decreasing MgO contents between 10.5 wt% and 4.6 wt%, corresponding to an increase in $\log_{10} fO_2$ relative to the fayalite-magnetite-quartz(β) (ΔFMQ) buffer of approximately ΔFMQ+0.2 to ΔFMQ+0.8 [2]. This suggests a modest increase in melt fO_2 due to fractionation of olivine and chromite, and that during differentiation the fO_2 of Troodos volcanics was not externally buffered. This is broadly consistent with observations from Fe μ-XANES measurements of a wide range of spreading ridge volcanic glasses, including from the modern Mariana Trough and the Eocene-aged forearc basalts and boninites of the Izu-Bonin-Mariana ophiolite [3, 4].

Primary quenched sulfide melt inclusions were identified in magnesian olivine and chromite phenocrysts from picritic bodies at Marki in the Upper Pillow Lava sequence. The sulfides are Ni-rich and have Ni/Cu ratios which overlap with sulfide compositions from ocean floor basalts, and are distinctive from most modern arc and backarc sulfides [5]. When projected onto well-defined liquid lines of descent, the sulfides demonstrate that some primitive basalts at Troodos were relatively reduced and sulfide-saturated. These results will be discussed in conjunction with the constraints on fO_2 to explore implications for the nature of the mantle source region of Troodos basalts and its paleotectonic environment.

[1] Woelki et al. 2018, Earth and Planetary Science Letters, 498:203-214

[2] Borisov et al. 2018, Contributions to Mineralogy and Petrology, 173:98

[3] Brounce et al. 2014, Journal of Petrology, 55(12):2513-2536

[4] Brounce et al. 2021, G-cubed 22: e2021GC009823

[5] Keith et al. 2017, Chemical Geology, 451:67-77