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Sulfur, Selenium, Tellurium, and Copper Systematics as a Function of Oxygen Fugacity in the Manus Back-Arc Basin

LAUREN GOROJOVSKY[1], OLIVIER ALARD[1], ANDREW BERRY[2] AND SIMON TURNER[1]

[1]Macquarie University

[2]Australian National University

Presenting Author: Lauren.gorojovsky@mq.edu.au

Sulfur is a redox-sensitive volatile element that largely dictates the behaviour/transport of chalcophile and siderophile elements in magmas. This is owing to sulfur's occurrence as sulfide and/or sulfate which is a response to changes in oxygen fugacity (fO_2). Sulfur's high oxidation potential is believed to significantly impact the redox budget in mantle regions (e.g. mantle wedge) and thus influence the chemical and physical properties of magmatic systems.

Due to sulfur's volatile nature, understanding its behaviour in parental magmas is challenging. Yet the strongly chalcophile behaviour of Se and Te, and Cu, make these elements ideal proxies for monitoring the behaviour of S in magmatic systems. S, and markedly Se and Te form a suite of elements that have been conventionally regarded as analytically challenging. This is owing to severe polyatomic interferences during typical ICP-MS analysis and their low concentrations in natural glasses that are close to or below typical detection limits for LA-ICP-MS.

Twenty-nine submarine glasses from the Manus Basin associated with the subduction of the Solomon oceanic plate have been analysed for $S^{6+}/\sigma S$ and $Fe^{3+}/\sigma Fe$ ratios using XANES, and S, Se, Cu and Te contents using enhanced LA-ICP-MS/MS techniques developed for this study. MORB, BABB, and Arc lavas have been identified as the main magma types in this study area and range between 3.4 – 8.7 wt% MgO. We find no obvious indication of S loss via degassing or seawater alteration. Sulfur contents range between 364 – 1196 μg g^{-1}, where lowest S contents are found in the most evolved samples. This is whilst maintaining PM-like (~ 3000) S/Se ratios across all magma types (~ 3300). HFSE depletion trends reveal a depleted MORB mantle source, where magmas evolve as sulfide-undersaturated melts. Further, Cu and Te contents positively correlate with LILE enrichments, indicating that their contents are systematically tied to the increased influence of slab-derived components into the Manus Basin magma source.

Despite being oxidised (>FMQ +1) and thus able to accommodate higher S contents as S^{6+} within the melt, Manus Basin magmas are not enriched in S and do not show significant deviation from the primitive mantle S/Se ratio.