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TITLE: Variations in Oxygen Fugacity among Forearc Peridotites from the Tonga Trench

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ABSTRACT BODY: The Tonga subduction zone is an extension-dominated, non-accreting convergent plate margin in the South Pacific, characterized by rapid slab rollback [1]. It is unusual among subduction zones in that forearc peridotites, thought to be pieces of lithospheric mantle originating from the overriding plate, have been dredged from the trench. These spinel peridotites appear in dredges along almost 1000 km of the trench's length, from near the Samoa hotspot in the north to the Louisville seamounts in the south, and have been dredged from 4-9 km depth. The samples are very depleted, consisting entirely of dunites and harzburgites, with no observed lherzolites. Low modal abundances of orthopyroxene and high spinel Cr# (Cr/(Cr+Al)) also indicate large degrees of melt extraction. While some samples have been variably altered by hydrothermal processes, a large fraction of them are remarkably unaltered, making them ideal targets for geochemical investigation.

Oxygen fugacity is an important geochemical control on phase stability, the composition of volatiles, and the position of the mantle solidus, thus rendering it critical to the understanding of mantle processes. Previous studies have suggested that subduction zone processes result in arc magmas with increased oxygen fugacity (fO_2) relative to ridge magmas [2], but few direct observations of mantle wedge fO_2 are available. In order to investigate the oxygen fugacity of the Tonga peridotites, mineral major element compositions were determined via electron microprobe. $Fe^{3+}/\Sigma Fe$ ratios were calculated for the spinel phase, calibrated with spinel standards of known $Fe^{3+}/\Sigma Fe$ ratio provided by B.J. Wood to the Smithsonian following the procedure of Lopez et al [3]. Oxygen fugacity was calculated according to the olivine-orthopyroxene-spinel oxybarometer method of Wood et al. [4]. Results from five dredges along approximately 600 km of trench showed oxygen fugacity values of 1 log unit above the QFM buffer, compared to the global ridge peridotite average of QFM -1. A sixth dredge from the middle of the sample area showed significantly more reduced values of QFM -2. Interactions with oxidized fluids in the mantle wedge have been proposed as a mechanism for oxidizing forearc peridotites relative to ridge peridotites. The additional observation of small length-scale variations in fO2 suggests that the interaction of fluids with the mantle is not a pervasive process, leading to the observed heterogeneity in oxygen fugacity values.

[1] Wright et al., Marine Geophys Res (2000); [2] Kelley et al., Science (2009); [3] Lopez et al., EOS Transactions, T51D-2632 (2012); [4] Wood et al., Science (1990).

KEYWORDS: 8413 VOLCANOLOGY Subduction zone processes, 1038 GEOCHEMISTRY Mantle processes, 1011 GEOCHEMISTRY Thermodynamics, 1025 GEOCHEMISTRY Composition of the mantle.

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