Oxygen Fugacity Variations among Tonga Trench Forearc Peridotites

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The Tonga Trench 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, which have been collected at 4-9 km depth, appear in dredges along almost 1000 km of the trench's length. The samples are very refractory, consisting entirely of dunites and harzburgites, with no observed lherzolites. Low modal abundances of orthopyroxene and high spinel Cr# 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. Previous studies have suggested that subduction zone processes result in arc magmas with increased oxygen fugacity (fO_2) relative to ridge magmas [1], but few direct observations of mantle wedge fO_2 are available. Oxygen fugacity values for the Tonga peridotites were determined by spinel oxybarometry, following the procedures of Wood *et al*. [2] and Lopez *et al* [3]. Results from one dredge show average oxygen fugacity values of 0.5 log units below the QFM buffer, close to the ridge peridotite average of QFM -1. In contrast, five other dredges along approximately 600 km of trench show significantly more oxidized values of QFM +1. Interaction with oxidized fluids in the mantle wedge has been proposed as a mechanism for oxidizing forearc peridotites relative to ridge peridotites. This interaction may not be pervasive, however, leading to the observed heterogeneity in oxygen fugacity values.

[1] Kelley *et al* Science (2009) [2] Wood *et al* Science (1990) [3] Lopez *et al* EOS Trans., T51D-2632 (2012).