Hydrous mantle melting at ridges and back-arc basins

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The net effect of water on mantle melting relates to the pattern of mantle flow and the geometry of the melting regime. At ocean ridges, more water leads to a wider and deeper melting regime. Mixing in of low degree melts ("low F melts") from depth leads to lower mean extents of melting and greater crustal thickness[1,2]. In contrast, at back-arc basins more water leads to greater extents of melting[3]. This contrast can be understood as a simple consequence of the arc environment where there is no room for a ridge melting regime with broad and deep low F tails. While back-arc melting has been modeled as an isobaric, isothermal process, [3,4] it needs to be considered in the polybaric context of mantle flow and melt segregation. An important constraint is that hydrous back-arc melts show no garnet influence and are exceptionally low in Fe, even when corrected properly for hydrous fractionation. We successfully model these results only by low pressure (<12kb) equilibrium melting. Back-arc volcanics are then mixtures between low pressure, hydrous melts from the "arc-side" of the melting regime and fractional melts from the "back-side" of the melting regime that are similar to normal MORB. Quantitative modeling shows that the effect of water on melting ($dF/dH2O_o$) is largely independent of temperature above the anhydrous solidus, in contrast to results from MELTS modeling[5] and from other recent interpretations[4]. This result has important implications for sorting out the effects of water and source composition for melts from the entire range of mantle temperatures.

References

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