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THE DIVERSIFICATION OF CORDILLERAN ARC MELTS IN THE DEEP CRUST OF FIORDLAND, NEW ZEALAND

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There is an ongoing debate about the relative role of high-pressure minerals such as garnet in the diversification of melts in the deep crust of Cordilleran arcs. We investigate this problem in a well-exposed arc in Fiordland, New Zealand, which preserves a near continuous section of Mesozoic lower and middle crust from 65 to 20 km paleo depth where successive intrusions were stacked on top of each other. These Late Cretaceous arc rocks have high Sr/Y (>40) and Na_2O (>4 wt. %), which have been interpreted to reflect the production of a thick garnet-bearing mafic arc root.

Microbeam geochemical data were collected from igneous clinopyroxenes and amphiboles from the Inboard Median batholith including the lower crust (Misty and Malaspina Plutons) and the middle crust (Puteketeke Pluton). Clinopyroxenes and amphiboles in the lower crust crystallized at 1050-850ºC and ca. 1.1-0.8 GPa. Chemometry calculations indicate that amphiboles were in equilibrium with fractionated andesites and dacites (SiO_2 = 56-66 and MgO = 0.5-2.0 wt. %; Mg#s = 25-35). Calculated melt compositions derived from partition coefficients are bimodal and include a trace-element enriched group (Zr >35 ppm) and a trace-element depleted group (Zr <35 ppm). Both melt groups have flat heavy-rare-earth element patterns, low Sr/Y (<40) and low Dy_N/Yb_N (<2.0), which are inconsistent with garnet control but indicate fractionation of amphibole + plagioclase ± clinopyroxene.

In the middle crust, amphiboles crystallized at 825-800ºC and 0.7-0.6 GPa. Calculated melts were dacitic to rhyolitic (SiO_2 = 67-75 and MgO <0.5 wt. %; Mg#s <25) and similar to depleted melts in the lower crust (Zr <35 ppm). Most analyses display flat heavy-rare-earth element patterns and low Dy_N/Yb_N (<2.0), though some melts have Sr/Y values up to 400. The lack of correlation between Sr/Y and Dy_N/Yb_N precludes garnet control and suggests that melt diversification was controlled by amphibole fractionation. We conclude that bulk-rocks in the middle and lower crust of Fiordland reflect crystal accumulation of plagioclase and amphibole, and they are poor proxies for original melt compositions. Our data do not support the production of a voluminous garnet-bearing residue and suggest that the use of high-Sr/Y values as an indicator of garnet in the lower crust requires re-evaluation.

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Back to: T23. The How, When, Where, and Why of Open-System Magma Processes

<< Previous Abstract | Next Abstract >>