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Cannibalization of an amphibole-rich andesitic progenitor induced by caldera-collapse during the Matahina eruption: Evidence from amphibole compositions

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ABSTRACT

The diverse range of calcic-amphibole compositions in eruptive products from the ca. 330 ka Matahina eruption (ca. 160 km^3 rhyolitic magma) of the Okataina Volcanic Complex, Taupo Volcanic Zone, including crystal-rich basalt-dacite pumice from post-collapse deposits, reveals several pre- and syn-eruption magmatic processes. (1) Amphibole phenocrysts in the basaltic-andesite and andesite crystallized at the highest pressures and temperatures (P to 0.6 ± 0.06 GPa and T to 950 °C), equivalent to mid-crustal depths (13–22 km). Inter- and intra-crystalline compositions range from Ti-magnesiohastingsite → Ti-tschermakite → tschermakite → magnesiohornblende and some display gradual decreases in T from core to rim, both consistent with magma differentiation by cooling at depth. (2) The largest amphibole crystals from the basaltic-andesite to andesite display several core to rim increases in T (to 70 °C), indicating that new, hotter magma periodically fluxed the crystal mush. (3) The dominant population of rhyolite amphibole is small and bladed (magnesiohornblende) and crystallized at low P-T conditions (P = 0.3 GPa, T = 765 °C), equivalent to the eruptive P-T conditions. Dacitic and low-silica rhyolitic amphibole (tschermakite-magnesiohornblende) form two distinct populations, which nucleated at two different T (high: 820 °C and low: 750 °C). These compositional variations, governed primarily by differences in T conditions during crystal growth, record the mixing of two distinct amphibole populations that approached a thermal equilibrium at the eruptive temperature. Therefore, the diversity in amphibole compositions can be reconciled as an exchange of crystals + liquid between the basaltic-andesite to dacite from the mid-crust and rhyolite from the upper crust, which quenched against one another, modifying the dacite to low-silica rhyolite compositions as the eruption progressed.

Keywords: Amphibole, crystal growth, crystal mush, cummingtonite, geothermometry, geobarometry