Magmatic processes and mantle melting under La Picada stratovolcano (CSVZ, Chile)

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The depth and detailed mechanisms of arc magma differentiation and generation are still debated and we are currently investigating these in part of the andean arc (Southern Volcanic Zone) where the continental crust is thin. Results are presented here for the La Picada stratovolcano where a basalt to dacitic differentiation trend shows a conspicuous compositional (Daly) gap between the most evolved basaltic andesites and the dacites. Detailed mineral composition and geochemical data indicate that differentiation occurred in the upper crust (0.2 GPa), probably at the intracrustal discontinuity separating the upper and lower crust, with no sign of fractionation in the lower crust. Textures displayed by the basaltic andesites and the dacites combined with modelling of crystal fractionation suggest that the Daly gap results from critical cristallinity that was reached in the basaltic andesites and precluded eruption of more evolved lavas. The interstitial dacitic melt was however extracted from the crystal mush and emplaced as dykes that were possibly connected to small dacitic domes now eroded away.

The basalts to basaltic andesites display variable MgO, Al_2O_3, Cr and Ni content at any given SiO_2. Crystal accumulation and high pressure fractionation fail to predict this geochemical variability. It is thus interpreted as a signature of the parent magmas (least evolved compositions). As these have mostly identical trace element contents, particularly for elements that track the slab component, this variability is thought to result from the mantle-wedge thermal structure. Geothermobarometry using recalculated primary magmas indicate last equilibration at about 1.3-1.5 GPa and at a temperature higher than the anhydrous peridotite solidus suggesting that decompression melting was possible. Rapid magma ascent from the upper mantle was likely facilitated by the occurrence of a major fault zone that increased crustal permeability. Insights from La Picada thus stress the importance of crustal structure on arc magma processes.