Where and how magma differentiated at La Picada stratovolcano (CSVZ, Chile)

Jacqueline VANDER AUWERA[1], Olivier NAMUR[1-3], Adeline DUTRIEUX[1 4], Camilla M. WILKINSON[5], Morgan GANERØD[5], Valentin COUMONT[1], Olivier BOLLE[1]

[1] *Université de Liège, Département de géologie (Belgium)*
[2] *Leibniz Universität Hannover, Institute of Mineralogy (Germany)*
[3] *KU Leuven, Department of Earth and Environmental Sciences (Belgium)*
[4] *University of Southampton, Ocean and Earth Science (UK)*
[5] *Geological Survey of Norway (Norway)*

La Picada stratovolcano (41°S) belongs to the Andean Central Southern Volcanic Zone (CSVZ) (38°S-41.5°S, Chile) that results from the subduction of the Nazca plate beneath the western margin of the South American continent. Forty-seven representative samples collected in different units of the volcano define a differentiation trend from basalt to basaltic andesite and dacite (50.9 to 65.6 wt. % SiO_2). This trend straddles the tholeiitic and calc-alkaline fields and displays a conspicuous compositional (Daly) gap between 57.0 (most evolved basaltic andesite) and 62.7 wt. % SiO_2 (dacite). Interstitial, mostly dacitic glass pockets extend the trend to 76.0 wt. % SiO_2. Basalts and basaltic andesites (50.9 to 57.0 wt. % SiO_2) are lavas with macrocrysts of plagioclase (An_{93-28}), olivine (Fo_{86-51}), clinopyroxene (Mg# = 82.8-55.2) and orthopyroxene (Mg# = 74.1-56.1), plagioclase being the dominant phase. On the contrary, the dacites were only observed in dykes and are poor in macrocrysts of plagioclase (An_{68-46}), clinopyroxene (Mg# = 72.2-60.3) and orthopyroxene (Mg# = 63).

A collection of geothermobarometers and hygrometers based on crystal and lava compositions were used to quantify the conditions of differentiation. They indicate that the parent magma(s) had low to moderate H_2O content (1.1-2.5 wt. %) and an oxygen fugacity close to NNO. This latter agrees with experimental data on basalts that straddle the tholeiitic/calc-alkaline boundary. Moreover, clinopyroxene-melt equilibria show that differentiation took place at shallow depth (~ 0.2 GPa). This low pressure is supported by the bulk rock geochemistry and corresponds to an intracrustal discontinuity separating the lower and upper crust.

As mineral and bulk rock compositions don't show the trace of an intermediate fractionation stage in the lower crust, the observed Daly gap likely results from upper crustal magmatic processes. Samples from both sides of the Daly gap show contrasting textures: basalts and basaltic andesites are rich in macrocrysts (18-54 vol %), whereas dacites, only observed in crosscutting dikes, are very poor in macrocrysts (<10 vol %). Moreover, modelling of the fractional crystallization process indicates a total fractionation of 43% to reach the most evolved basaltic andesites. This proportion of crystals in the main storage region is close to the value at which crystals start to form a connecting network (critical cristallinity). The Daly gap is thus interpreted as resulting from critical cristallinity that was reached in the basaltic andesites, thus precluding eruption of more evolved lavas. Some interstitial dacitic melt was extracted from the crystal mush and emplaced as dikes possibly connected to small dacitic domes, now eroded away. However, because of the occurrence of immiscible globules in the matrix, silicate-liquid immiscibility is an alternative hypothesis that needs to be further tested.