Mixing following assimilation-fractional crystallization at Cerro Uturuncu, Andean Central Volcanic Zone, SW Bolivia as revealed from in situ laser ablation isotopic analysis of plagioclase

Gary S. Michelfelder, Todd C. Feeley, Alicia D. Wilder, Jacob Thacker

Department of Earth Sciences, Montana State University, United States

E-mail: gary.michelfelder@msu.montana.edu

Cerro Uturuncu is an andesitic to dacitic composite volcano located in the APVC of the Andean Central Volcanic Zone, SW Bolivia. We present new major and trace element data combined with whole rock $\delta^{18}O$ (7.2-10.4‰), Sr ($^{87}Sr/^{86}Sr$= 0.71009-0.71653), Nd ($^{143}Nd/^{144}Nd$= 0.512135-0.512247) and Pb ($^{208}Pb/^{204}Pb$= 18.82-18.9, $^{207}Pb/^{204}Pb$= 15.56-15.66, $^{206}Pb/^{204}Pb$= 38.9-39.0) isotope data and Sr isotopic ratio profiles of plagioclase phenocrysts from Uturuncu lavas and domes.

We have identified four plagioclase phenocrysts populations resulting from assimilation of granitic and noritic crust (suggested by granitic and noritic xenoliths), mixing with a chemically and isotopically similar magma (suggested by whole rock data) then repeating these processes in the chamber. These populations are: (1) normally zoned, (2) reverse zoned, (3) oscillatory zoned, and (4) unzoned. Reverse and oscillatory zoned phenocrysts commonly display complex zoning patterns in An content (An_{40-95}) and $^{87}Sr/^{86}Sr$ ratios (0.7092-0.7276), the latter of which are in disequilibrium with whole rock ratios. Consistent core to rim decreases of $^{87}Sr/^{86}Sr$ ratios and coincident increases in Sr concentration in plagioclase with maximum $^{87}Sr/^{86}Sr$ ratios of 0.7139-0.7276 (significantly higher on average than those measured in in the whole rock) are found in the cores, and minimum ratios of 0.7105-0.7138 are found in near the outer rims. These data demonstrate that Uturuncu magmas, regardless of the nature of the mantle or crustal sources, were modified by open system processes operating at crustal depths. One-dimensional diffusion modeling suggests that observed isotopic crystal heterogeneities cannot have existed for more than a few thousand years (700-8000 years) at inferred magmatic temperatures (850-1050℃). The chemical and isotopic variability observed in Uturuncu phenocrysts within a single lava flow or dome suggest that although shallow crustal assimilation and magma mixing appear to have had limited effect on whole rock chemistry, a complex late-stage petrogenetic history is recorded within the magmatic cargo of crystals and magmatic inclusions.

The isotopic, textural and compositional characters of these phenocrysts suggest that these crystals were inherited from isotopically more evolved crust then periodically recharged by a higher- temperature, more mafic magma. Though no Sr isotopic ratios exist for plagioclase from basement rocks or local ignimbrites, An compositions of plagioclase core in Uturuncu lavas, domes and magmatic inclusions can be related to a combination of dissagregation of the magmatic inclusions and during mixing and crystallization in the hybrid melts.