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Magma ascent, ponding and mixing in a Middle Triassic plumbing system: clues from clinopyroxene chemical-textural features in the Cima Pape volcano-plutonic complex (Southern Alps, Italy)

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Zoned crystals play a fundamental role in modern volcanology as a key to unravel the geometry and the dynamics of plumbing systems. Ancient volcano-plutonic complexes, nowadays exposed at the surface, can sometimes preserve textural-chemical record of such dynamics inside their constituting mineral phases. This is the case of the Cima Pape Middle Triassic complex (Dolomites, Southern Alps), which is composed by a 50 to 300 metres thick gabbroic to monzodioritic sill overlaid by basaltic to trachyandesitic volcanites with high Porphyricity Index (P.I. 43-48 %).

Volcanites contain a large number of concentric-zoned clinopyroxenes, while intrusive rocks are mostly made up of homogeneous and unzoned crystals. In volcanites, the typical clinopyroxene zoning pattern consists of one or more high-Mg# and high Cr_2O_3 bands (Mg# 84-91; Cr_2O_3 up to 1.2 wt%) with variable thickness, formed between cores and rims with relatively lower Mg# and Cr contents (Mg# 70-77; Cr_2O_3 <0.1 wt%). Chondrite-normalized incompatible element patterns of low-Mg# portions show Nb, Ta, Sr, Zr and Ti negative anomalies and Th-U positive peaks, while high-Mg# bands have a generally more depleted patterns maintaining similar profile. REE patterns in both high-Mg# and low-Mg# domains have a convex-upward shape and La/Yb_N from 1.3 to 2.1. Thermobarometric calculations reveal that the high-Mg# bands were in equilibrium with a more primitive, hotter and more H_2O depleted melt (Mg# = 65-70; T = 1130-1150°C; H_2O = 2.1-2.6 wt%) than cores and rims, which likely formed in a colder, H_2O-rich evolved melt (Mg# = 43-45; T = 1035-1075°C; H_2O = 2.6-3.8 wt%). According to our model, a first crystallization stage in a high crystallinity (P.I. almost 50%) “mush-type” system led to the formation of low-Mg# clinopyroxenes (Mg# 70-77) at P of 2-4 kbar. The ascent of one or multiple pulses of primitive, hot, and H_2O-poor basaltic magmas (Casetta et al., 2020) in the shallower portions of the plumbing system led to the formation of the high-Mg# bands. Later on, re-equilibration of clinopyroxene with the post-mixing melt system resulted in the formation of the low-Mg# rims. Cima Pape products have many textural-chemical similarities with those reported at the active Stromboli volcano, suggesting that they were formed through similar dynamics at comparable T-P conditions (Petrone et al., 2018; Di Stefano et al., 2020). The peculiarity of clinopyroxene texture in Cima Pape rocks allowed us to study the processes occurred in the plumbing system beneath an ancient volcano and offered the opportunity to test the approaches/models currently adopted for active systems.

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