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Petrological mapping of Volcanic Plumbing Systems using amphiboles in mixed intermediate magmas

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Petrological mapping of volcanic plumbing systems (VPS) is essential to understand the magma evolution and to interpret geophysical signals of monitored volcanoes. The mapping includes the determination of the compositions of magmas feed the system and their storage depths. Intermediate magmas are usually formed by magma mixing a processes that mask the real compositional variation of magmas feed the VPS. However phenocrysts can preserve this information in their chemical stratigraphy. Amphibole can be a powerful tool in these studies because it can incorporate petrogenetically important trace elements primarily controlled by the coexisting melt composition, additionally the major element composition can be used to calculate pressure.

We studied the zoning, texture and major and trace element composition of amphiboles from the Ciomadul, a late pleistocen dacite volcano. The erupted dacites contain abundant amphibole phenocrysts. Amphibole coexist with all of the rock forming minerals (e.g. with quartz or with olivine) indicating their diverse origin. The amphiboles show large major element compositional variation (e.g. Al2O_3: 6-15 wt%) accompanied with large variation in trace element (e.g. Cr: 10-3000 ppm, Sr: 55-855 ppm, Eu/Eu*: 0.62-1.19) even in a single sample or single crystal and they represent antecryst (reworked) and phenocryst (in situ crystallized) populations. Such a large compositional variation of amphiboles is commonly observed at andesite-dacite arc volcanoes. Hornblendes (antecryst1) have low Al, Mg/Fe, and negative Eu-anomaly; they equilibrated with rhyolitic melt at near-solidus temperature. Antecryst2 is represented by Cr-, Mg-rich amphiboles; they can contain Cr-spinel inclusions suggesting near-liquidus crystallization from primitive mafic melts. Phenocrysts show large compositional variation sample by sample that is different from the antecrysts suggesting variable pre-eruptive conditions. The antecrysts are derived from a stratified (mafic-felsic) crystal mush column representing a main magma capture zone at upper-mid crustal depths (∼7-20km). Zoned amphiboles cored by antecrysts and rimmed by phenocrysts indicate that new intrusions can reactivate these mushes forming the eruptible magma.