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A message from the depth: the origin of the amphibole crystal clots with pyroxene cores in the Late Pleistocene Ciomadul dacites, Romania

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Identification of trans-crustal magma reservoir processes beneath volcanoes is a crucial task to better understand the behaviour and possible future activities of volcanic systems. Detailed petrological investigations have a fundamental role in such studies. Dacitic magmas are usually formed in an upper crustal magma reservoir by complex open-system processes including crystal fractionation and magma mixing following recharge events. Conditions of such processes are usually constrained by crystal-scale studies, whereas there is much less information about the petrogenetic processes occurring in the lower crustal hot zone. Here we provide insight into such processes by new results on amphibole crystal clots found in dacitic pumices from an explosive volcanic suite of the Ciomadul volcano, the youngest one in eastern-central Europe.

Amphibole is a common mineral phase of the Ciomadul dacites, occuring as phenocrysts and antecrysts, but occasionally they also form crystal clots with an inner core of either pyroxene or olivine with high Mg-numbers. Olivine is observed mostly in the 160-130 ka lava dome rocks, whereas the younger explosive eruption products are characterised by orthopyroxene and clinopyroxene. Such mafic crystal clots are most common in the pumices of the earliest explosive eruptions, which occurred after long quiescence at 56-45 ka. The most common appearance has high-Mg pyroxene core (mg#: 0.76-0.92) rimmed by amphibole. Two types of amphibole are found in such clots: irregular zone of actinolite to magnesio-hornblende directly around orthopyroxene and high Mg-Al pargasitic amphibole as the outer zone. Several crystal clots contain smaller amphibole crystals with diffuse transition to clinopyroxene at the inner part and complexly zoned amphibole with biotite inclusions in the outer part. These amphibole and pyroxene have lower Mg-number (< 0.80), and higher MnO content (up to 0.52 wt%) than the most common type. In both cases, amphibole could be a peritectic product of earlier-formed pyroxenes, which reacted with water-rich melt at higher and lower temperatures, respectively. Actinolite to magnesio-hornblende at the contact represents a transitional phase between pyroxene and the newly formed amphibole. In a few cases, crystal clots contain amphibole inclusions in pyroxene macrocrysts. These amphiboles have a particular composition not yet reproduced by experiments: they have high mg# (>0.86), but low tetrahedral Al (0.9-1.0 apfu) and usually high Cr content (Cr_2O_3 is up to 0.9 wt%), similar to the orthopyroxene and clinopyroxene hosts (0.26-0.71 and 0.78-0.89 wt%, respectively). We interpret these amphiboles as an early formed liquidus phase crystallized along

with pyroxene from an ultra-hydrous mafic magma. Occasionally, crystal clots are complexly zoned amphibole macrocrysts with dispersed clinopyroxene inclusions. The amphibole has a wide compositional range, usually with high Mg-Al pargasitic core. These amphiboles could have formed by peritectic reaction between clinopyroxene and a water-rich melt.

The observed mafic crystal clots in the dacites indicate the presence of strongly hydrous mafic magmas accumulated probably at the crust-mantle boundary. During mafic recharge, volatile transfer may contribute to the crystal mush rejuvenation at shallow depth and triggering explosive eruptions.

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