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Crystal chemistry of trioctahedral micas in the top sequences of the Colli Albani volcano, Roman Region, central Italy

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ABSTRACT

Trioctahedral mica crystals are frequently found in the volcanoclastic products emplaced during the final stages of the activity of the Colli Albani volcano (Roman Region, central Italy). In the youngest phreatomagmatic deposits, mica is found either as a minor mineral phase in holocrystalline ejecta, scoriae, and coherent pyroclastics, or as loose phenocryst in incoherent pyroclastics. Based on optical and electron microscope investigations, as well as crystal chemical and structural data, the micas selected for this study were divided into two groups, the first one encompassing brownish, Fe-rich crystals (type-*A* phlogopites, hereafter referred as *t-A*) with $0.68<Mg/(Mg+Fe_{total})<0.85$ and $0.062<Ti_{apfu}<0.199$, and the other one encompassing colorless, Mg-rich crystals (type-*B* phlogopites, hereafter referred as *t-B*) with $Mg/(Mg+Fe_{total})$ in excess of 0.85 and $0.007<Ti_{apfu}<0.052$. *t-A* phlogopites also show a tetrahedral ring cavity, overlapped tetrahedral hexagon area, and basal tetrahedron area greater than in the *t-B* phlogopites. From a petrological point of view, the textural and chemical variations of *t-A* phlogopites are compatible with fractional crystallization processes taking place within the magma chamber. *t-B* phlogopites show evidence of a Ti-oxy substitution mechanism, thus suggesting high fO_2 conditions. Textural and paragenetic features observed in *t-B* phlogopite-bearing rock samples, indicate a genesis by thermal metamorphism of a siliceous dolomitic limestone with the input of a variable amount of a potassic magma, possibly the same from which the *t-A* phlogopites formed, with the exception of one sample, for which a different parental magma is suggested. Indeed, there is an almost continuous spectrum of crystal-chemical and structural parameters starting from *t-B* and evolving towards *t-A* phlogopites. The *t-A* phlogopites displays complex, apparently meaningless relationships in their crystal-chemical parameters, thus indicating interplay of several substitution mechanisms. They possibly formed in polybaric conditions, since their cell volumes differ, but the total size of the cations hosted in the octahedral sheet is the same.

1. Introduction and volcanological background

Trioctahedral micas are common mafic phases in volcanic rocks, where they can show considerable chemical and structural variations. Crystal chemical studies have shown that these variations are influenced by the composition of the magma from which micas crystallize (Foley et al., 1987; Brigatti et al., 1996, 2000a,b; Benincasa et al., 2003; Downes et al., 2005; Rios et al., 2007), as well as by pressure (*P*) and temperature (*T*) of crystallization (Foley, 1989, 1990). Though potassium-rich rocks are not so abundant on Earth-scale, they are widespread in Italy. The compositional and isotopic fingerprint of potassic (K) and ultrapotassic (HK) rocks in Italy is attributed to variable magmatic settings, which imply, even if their geodynamic significance is still a matter of debate, wide chemical variations and very different mineralogical assemblages depending on *T*–*P* conditions and magma composition (Peccerillo, 2005).

Colli Albani (Fig. 1) is one of the main volcanic fields of the potassic and ultrapotassic magmatic provinces that developed along the Tyrrhenian margin of Italy during Middle and Late Pleistocene time (Giordano et al., 2006, and references therein). Magmatism was generated in a complex tectonic setting (Faccenna et al., 1996; Doglioni et al., 1999), as the result of the combined effects of source metasomatism, crystal fractionation, and crustal assimilation (Peccerillo, 2005; Freda et al., 2006); yet their main geochemical features suggest that the peculiarity of the Colli Albani magmas can be ascribed to the nature of the mantle source (Conticelli et al., 2002; Gaeta et al., 2006). De Rita et al. (1988) and Funiciello et al. (2003) suggested that the Colli Albani magma chamber is emplaced within a carbonatitic wall rock, thus accounting for the presence of carbonate and skarn-like xenoliths within its volcanic products. This is also confirmed by the experiments carried out by Freda et al. (2008).

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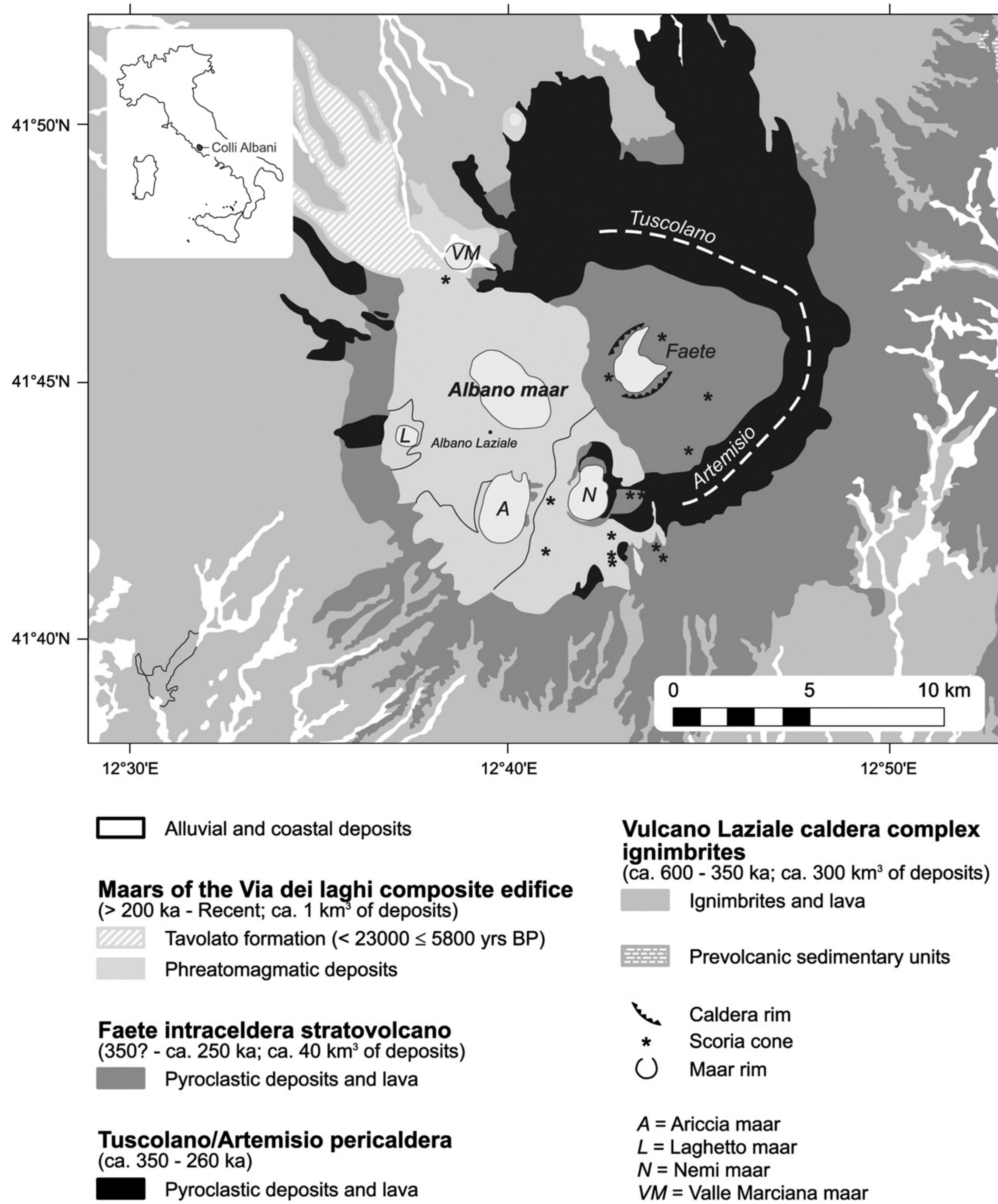

Fig. 1. Geologic map of the Colli Albani area (modified after De Benedetti et al., 2008).

The "Albano multiple Maar" represents the most recent eruptive event of the Colli Albani Volcanic field (De Rita et al., 1988; Marra et al., 2003; Funiciello et al., 2003; Giordano et al., 2006; Freda et al., 2006; De Benedetti et al., 2008). It was considered as either a new phase of volcanic activity (Karner et al., 2001; Marra et al., 2003) or the final hydromagmatic stage of the Colli Albani evolution (De Rita et al., 1995; Giordano et al., 2006; Freda et al., 2006; De Benedetti et al., 2008). In the Albano multiple maar, De Rita et al. (1988) recognized seven stratigraphic units (four hydromagmatic deposits, one pyroclastic flow deposit, and two wet pyroclastic flow deposits). Later, De Rita et al. (1995) described the Albano Maar as "a multiple tuff ring, consisting of five main explosive cycles each producing a new crater". The fifth eruption cycle was emplaced as a wet pyroclastic flow, known as "Peperino Albano" (Giordano et al., 2002). Afterwards, other sequences, believed to be very recent, post-Wurmian and even, possibly, pre-historic in the very last cases (23–5.8 ka; Funiciello et al., 2002, 2003; De Benedetti et al., 2008), were identified above the "Peperino Albano". These youngest sequences consist of variable phreatomagmatic deposits emplaced by surge and lahar flows, intercalated with palaeosols.