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Genetic implications, composition, and structure of trioctahedral micas in xenoliths related to Plinian eruptions from the Somma-Vesuvius volcano (Italy)

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Abstract

The present work is part of a systematic mineralogical and petrographic characterization of mica-bearing xenoliths from Somma-Vesuvius volcano (Roman Magmatic Province, southern Italy). Skarns, composite skarns-marbles and cumulates from Pompeii Plinian eruption (AD 79), and skarns and syenite from Avellino eruption (3945 ± 10 cal yr BP) were investigated to define the crystal chemistry of the Somma-Vesuvius trioctahedral micas and to draw inferences on petrogenetic processes to which they were subjected. Xenoliths were characterized by means of polarized optical microscopy, scanning electron microscopy (SEM-EDS), X-ray powder diffraction (XRPD), and bulk-rock geochemical analyses. Mica crystals were studied using electron microprobe analysis (EMPA) and single-crystal X-ray diffraction (SCXRD).

Micas from skarns are variably associated with Mg ± Ca silicates (clinopyroxene, vesuvianite, humite, clinohumite, chondrodite, forsterite, and garnet), other sporadic silicates (anorthite, sodalite, titanite, and britholite), apatite, calcite, various types of oxides, as well as rare sulfides and halides. In composite skarn-marble rocks, the mineral assemblages show some differences compared to skarns, as a lack of clinopyroxene and the presence of dolomite. Cumulate samples consist of mica and clinopyroxene, whereas syenite is mainly composed of mica, K-feldspar, feldspathoids, and clinopyroxene. Together with mica, apatite occurs in all the lithotypes.

Trace element arrays are scattered for skarn and composite skarn-marble samples. The REE patterns have a general enrichment in light (La, Ce, Pr, Nd) and medium (Sm, Eu, Gd, Tb, Dy) rare earth elements, in some cases with slight positive Gd anomaly. Cumulate samples generally have low amounts of Ba, Sr, Zr, and Th, while syenite exhibits low concentrations of trace elements, except for Rb, Cs, and Tl.

Mica crystals occurring in the studied xenoliths are phlogopite with different Al and Mg contents at the octahedral site, a negligible tetraferriphlogopite component and variable dehydrogenation degree. All samples belong to the 1*M* polytype (*C*2/*m* and *C*2 space group) and have a wide range of unit-cell parameters, especially of the *c* axis [$5.3055(1) \le a \le 5.3218(1)$ Å, $9.1893(1) \le b \le 9.2188(4)$ Å, $10.1803(2) \le c \le 10.2951(2)$ Å]. The shortest *c*-cell parameter pertains to de-hydrogenated phlogopite from Avellino skarn, whereas OH-rich phlogopite from Pompeii composite skarns-marbles has a *c*-cell parameter that approximates that of the end-member phlogopite. Overall, it is observed that the crystal chemistry of the micas studied here extends the known range of the other Vesuvian micas from the literature. The Ti-depletion and the wide degree of dehydrogenation of phlogopites from skarns and composite skarns-marbles suggest that the studied samples originated under variable pressure conditions. In addition, the presence of humite in the mineral assemblage seems to indicate the occurrence of devolatilization reactions. The scarce mica occurrence in cumulate and mainly in syenite, instead, may depend on pressure conditions in the magma storage system exceeding the mica stability.

Keywords: Phlogopite, crystal chemistry, ejecta, Vesuvius