Generation and crystallization conditions of the Colle Fabbri melilitite melt, Italy: melt inclusion data

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The Colle Fabbri volcano consists of 4 m thick freetomagmatic breccia and volcanic neck of fine-medium grained leucite - wollastonite melilitite. The wollastonite – anortite – pyroxene igneous rocks are located at the contact of the melilitolite body and the pelite country-rock. (Stoppa and Sharygin, 2009; Stoppa and Rosatelli, 2009).

The Colle Fabbri melilitolites are rocks of the kamafugite series (Stoppa et al., 2002). However, they differ with the presence of wollastonite, which is not characteristic of common kamafugites.

Leucite – wollastonite melilitolite contains almost equal amounts of (35 – 40 vol%) melilitite and wollastonite, as well as small amount of leucite, plagioclase, Ti-garnet, apatite, magnetite and Fe-Ni-sulphides. The chemical composition of leucite – wollastonite melilitolites is Si-undersaturated (about 42 mass% SiO$_2$) with a low content of Al$_2$O$_3$ (10.7 – 11.2 mass%) and extremely high content of CaO (37.3 – 38.5 mass%). Despite the presence of leucite in the rock, the total amount of Na$_2$O+K$_2$O is low (about 1.4 – 1.9 mass%). The contents of MgO (1.6 – 2.4 mass%) and FeO (3.3 – 3.7 mass%) are also low.

The chemical composition of unheated glasses varies considerably in the contents of (mass%) 36.76 – 58.69 SiO$_2$, 19.89 – 29.65 Al$_2$O$_3$, 2.17 – 11.42 CaO, 0.23 – 1.68 FeO, 0.03 – 0.58 MgO and 7.79 – 26.42 K$_2$O. The amounts of TiO$_2$ (up to 0.67 mass%), Na$_2$O (up to 0.59 mass%), BaO (up to 0.98 mass%), P$_2$O$_5$ (up to 2.91 mass%) and SO$_3$ (up to 1.84 mass%) are also appreciable.

The chemical composition of heated glasses varies as well and are compared to unheated ones characterized by lower values (mass%) of SiO$_2$ (38.04 – 39.57), Al$_2$O$_3$ (mostly 14.4 – 17.6), K$_2$O (mostly 0.21 – 5.7) and higher CaO (21.63 – 30.59), FeO (5.59 – 6.65), MgO (0.44 – 2.83), Na$_2$O (0.37 – 0.75) and SO$_3$ (up to 1.29).

Wollastonite also contains single, partly crystallized melt inclusions (< 40 µm). Their phase composition is glass, garnet, ore phases and gas bubble (Fig. 2). $T_h$ is higher than 1230 °C.

The glasses of unheated inclusions contain (mass%): 43.37 – 47.49 SiO$_2$, 10.78 – 16.71 Al$_2$O$_3$, 0.78 – 0.97 FeO, 0.06 – 0.09 MgO, 20.79 – 29.92 CaO, 3.94 – 5.75 K$_2$O, 1.18 – 2.24 Na$_2$O and minor TiO$_2$ (up to 0.17), P$_2$O$_5$ (up to 0.10) and SO$_3$ (up to 0.09).

The glasses of heated glass compared to unheated ones are characterized (mass%) by high FeO (4.27 – 14.39), MgO (0.14 – 0.45), TiO$_2$ (up to 4.75), P$_2$O$_5$ (up to 1.17) and SO$_3$.

Fig. 1. Inclusion in melilite (transmission light).

Fig. 2. Inclusion in wollastonite (transmission light).
(up to 0.78), equal $\text{Al}_2\text{O}_3$ $(11.62 – 25.03)$, $\text{CaO}$ $(25.18 – 36.64)$ and low $\text{SiO}_2$ $(28.61 – 36.7)$, $\text{K}_2\text{O}$ $(0.31 – 1.63)$ and $\text{Na}_2\text{O}$ $(0.80 – 1.83)$.

It is noteworthy that the chemical composition of heated glass in wollastonite compared to ones in melilite has less amounts of $\text{Si}$, $\text{Al}$, $\text{K}$ and more values of $\text{Fe}$, $\text{Mg}$ and $\text{Ti}$ at similar $\text{Ca}$ and $\text{Na}$ contents.

According to the geochemical data melilite (gehlenite – akermanite) contains about an order of magnitude more LILE and much less HFSE compared to the primitive mantle (PM). The pattern for melilite (Fig. 3) normalized to primitive mantle has a negative slope with positive anomalies of $\text{K}$ and $\text{Sr}$ and negative anomalies of $\text{Nb}$, $\text{Zr}$ and $\text{Ti}$.

Thus, thermometric data suggest that the crystallization of melilite in the studied rocks started at $1320 \pm 15 \degree\text{C}$ and crystallization of wollastonite occurred above $1230 \degree\text{C}$.

The initial magma for leucite – wollastonite melilitolite was a $\text{Ca}$-enriched melilitite melt.

Geochemical data indicates that the studied rocks are enriched in trace elements and the crustal material was involved in the magmatic process during their formation.

REFERENCES