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Oxygen isotope geochemistry of mafic magmas at Mt. Vesuvius

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Pumice and scoria from different eruptive layers of Mt. Vesuvius volcanic products contain mafic minerals consisting of High-Fo olivine and Diopsidic Pyroxene. These phases were crystallized in unerupted trachibasaltic to tephritic magmas, and were brought to surface by large phonolitic/tephri-phonolitic (e.g. Avellino and Pompei) and/or of tephritic and phono-tephritic (Pollena) eruptions. A large set of these mm-sized crystals was accurately separated from selected juvenile material and measured for their chemical compositions (EPMA, Laser Ablation ICP-MS) and ^{18}O/^{16}O ratios (conventional laser fluorination) to constrain the nature and evolution of the primary magmas at Mt. Vesuvius. Uncontaminated mantle δ^{18}O values are hardly recovered in Italian Quaternary magmas, mostly due to the widespread occurrence of crustal contamination of the primary melts during their ascent to the surface (e.g. Alban Hills, Ernici Mts., and Aeolian Islands). At Mt. Vesuvius, measured olivine and clinopyroxene share quite homogeneous chemical compositions (Olivine Fo 85-90 ; Diopside En 45-48, respectively), and represent phases crystallized in near primary mafic magmas. Trace element composition constrains the near primary nature of the phases. Published data on volatile content of melt inclusions hosted in these crystals reveal the coexistence of dissolved water and carbon dioxide, and a minimum trapping pressure around 200-300 MPa, suggesting that crystal growth occurred in a reservoir at about 8-10 km depth. Recently, experimental data have suggested massive carbonate assimilation (up to about 20%) to derive potassic alkali magmas from trachybasaltic melts. Accordingly, the δ^{18}O variability and the trace element content of the studied minerals suggest possible contamination of primary melts by an O-isotope enriched, REE-poor contaminant like the limestone of Vesuvius basement.

Low, nearly primitive δ^{18}O values are observed for olivine from Pompeii eruption, although still above the range of typical mantle minerals. The $\delta^{18}O_{olivine}$ and $\delta^{18}O_{cpx}$of the minerals from all the studied eruptions define variable degrees of carbonate interaction and magma crystallization for the different eruptions, and possibly within the same eruption, and show evidence of oxygen isotope equilibrium at high temperature. However, energy-constrained AFC model suggest that carbonate assimilation was limited. On the basis of our data, we suggest that interaction between magma and a fluxing, decarbonation-derived CO_2 fluid may be partly accounted for the measured O-isotope compositions.