



## **Stable isotope composition of carbonated cumulates from the Alban Hills, Italy**

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The Alban Hills is one of the main Quaternary volcanic districts of the ultrapotassic Roman Province along the Tyrrhenian margin of Italy. It is characterized by the occurrence of K-foiditic ultrapotassic rocks and differentiated products with low silica, high CaO, and high K<sub>2</sub>O contents. Mass balance calculations and geochemical and experimental data indicate that the Alban Hills magmas underwent pervasive interaction with host carbonate rocks.

The Si-Mg-rich clinopyroxene are representative of early stages of magmatic differentiation and show  $\delta^{18}\text{O}$  values slightly higher than typical mantle values (+5.9 to +6.4 per mil), coupled with low  $\Sigma\text{REE}$  contents. The Al-Fe<sup>3+</sup>-rich clinopyroxene showing  $\delta^{18}\text{O}$  values as high as +8.2 per mil, and enriched  $\Sigma\text{REE}_N$  contents are characteristic of the late stages of magmatic differentiation (Dallai et al., 2004).

Carbonate assimilation occurred mainly by direct ingestion of carbonate wall-rocks into the magmas, as testified by relicts of sedimentary carbonates in the volcanic products, either at macro- or micro-scale. The petrological study on the magmatic cumulates (glass-bearing olivine-bearing clinopyroxenite) and pyro-metamorphic xenoliths (spinel-bearing olivine-clinopyroxenites) from the main breccia of the Albano Maar constrains the process of carbonate assimilation.

The cumulate rocks show tiny olivine crystals enclosed in large clinopyroxene poikiloblasts, and round calcite crystals within unaltered volcanic glass. Their trace-element

patterns are ambiguous, intermediate between the REE-depleted ones, typical and those of the enclosing glasses.

However, the stable isotope of the latter globules ( $\delta^{18}\text{O}_{Cc} > +20$  per mil and  $\delta^{13}\text{C}_{Cc} < -10$  per mil) argue for a sedimentary origin for these carbonates.

The mineral assemblage of pyro-metamorphic xenoliths is characterized by Al-rich spinel, Ca-rich forsterite, Al-diopside and phlogopite, and rare “hyper-calcic”, low silica glass (CaO=21 wt%, SiO<sub>2</sub>=38 wt.%). These phases likely formed upon solid-solid and solid-liquid reactions between carbonates and magmas. These reactions resulted into mineral phases with distinct oxygen isotope compositions: high  $\delta^{18}\text{O}$  values ( $> +10$  per mil) of glass-free pyrometamorphic rocks are consistent with a skarn crystallisation environment. Significantly lower O-isotope compositions of olivine, clinopyroxene and spinel ( $\delta^{18}\text{O} < +7$  per mil) from glass-bearing xenoliths argue for crystallization in contact with a silicate mafic melt.

Dallai, L., Freda, C., Gaeta, M., (2004): Oxygen isotope geochemistry of pyroclastic clinopyroxene monitors carbonate contributions to Roman-type ultrapotassic magmas. *Contributions to Mineralogy and Petrology*, 148, 247–263.