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CO_2-rich basanitic magmas generation in continental intraplate regions: insight from olivine-hosted melt inclusions in the Bas-Vivarais volcanic province (Ardèche, France)

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The contribution of a carbonate component has been increasingly mentioned to explain the origin of intraplate volcanism and particularly of silica-undersaturated alkaline lavas. The Bas-Vivarais (French Massif Central, Ardèche) is one of the two most recent volcanic provinces in France. Very homogeneous basanitic lavas containing abundant crustal and mantle xenoliths have been produced, but the magma genesis conditions remain unclear. Here, we bring textural, compositional and volatile clues to constrain the origin of the parental magmas of this volcanic province through the study of melt inclusions hosted in olivine phenocrysts. We characterised the glass phase of the melt inclusions by electron probe microanalysis (major elements, Cl, F and S), LA-ICP-MS (trace elements) and Raman spectrometry (H_2O and CO_2), and obtained basanitic compositions with high volatile contents (ranging from 0.8 to 2.5 wt% H_2O and up to 1.9 wt% CO_2 dissolved in glasses). However, one peculiar feature of these inclusions is that, in addition to the silicate glass, CO_2-rich bubbles whose walls are covered by microcrystals (mainly carbonates) are systematically present. Hence, the CO_2 contents characterizing primary magmas are underestimated if considering only glass phase. In order to assess the total CO_2 content at the time of melt inclusion entrapment, we developed a new technique of homogenization at high pressure and temperature in a piston-cylinder on olivine-hosted melt inclusions. After homogenization, total CO_2 contents in melt inclusions were increased to as high as 4.8 wt% (3.4 wt% in average). These high CO_2 contents, the highest ever measured in melt inclusions, are consistent with the fractional melting of a phlogopite-bearing carbonated pyroxenite, as suggested by the major element compositions of the melt inclusions. Trace element ratios, such as (Rb, Ba, Nb, Ta)/Th, imply that the mantle source of these CO_2-rich magmas was metasomatized by carbonatites, possibly derived from melting of recycled lithosphere.