

Carbonates in mantle xenoliths from French Massif Central: inference for carbonatite-related metasomatism.

Christiane Wagner (1) and Etienne Deloule (2)

(1) Sorbonne Universités, UPMC, Univ Paris 06, CNRS, IStEP, 4, Place Jussieu, F-75005 (christiane.wagner_raffin@upmc.fr),
(2) CRPG, UMR CNRS 5873 – Univ de Lorraine, BP20, 54501 Vandoeuvre les Nancy, France (deloule@crpg.cnrs-nancy.fr)

Mantle xenoliths from the sub-continental lithospheric mantle (SCLM) frequently display evidence of metasomatism by melts or fluids of variable composition, e.g. alkali-basaltic, alkali-carbonate or carbonate melts. Carbonate-bearing mantle xenoliths are particularly interesting as highly mobile carbonate melts are likely prominent metasomatic agents of the mantle. This study presents detailed petrographic descriptions and major and trace element compositions of minerals in protogranular spinel lherzolites from the Mont Coupet occurrence (Devès province, French Massif Central), with focus on the carbonate phases to discuss their possible link to carbonatite melt.

Two representative samples are described here. MC9 shows no evidence for infiltration of the host basanitic magma. Carbonates occur (1) as large (100 μm – 200 μm) anhedral crystals in interstitial pockets at triple point of primary olivine grains, (2) in a few cross-cutting veins (up to 200 μm width), (3) along grain boundaries and (4) in composite carbonate-silicate pockets from well-developed reaction zones, in which carbonates fill globular vesicles. The reaction zone contains secondary subhedral to euhedral phases: Al- and Ti-rich clinopyroxene, Ca-rich olivine, Cr-rich spinel and quenched plagioclase and relict sieved-textured primary spinel. MC2 shows carbonate-bearing thin (< 50 μm width) interconnected veinlets and only a few poorly-developed reaction zones around primary spinel. Large carbonate crystals (1), as in sample MC9, occur associated with (2) fibrous carbonate with a well-formed meniscus at the boundary between the two carbonate types. In some reaction zones the carbonate patches (3) show well-developed concentric carbonate structures, similar to those observed in the globular vesicles from the host basanite.

In sample MC9, the carbonate is an alkali-free Mg-poor calcite ($X_{\text{Ca}} = 0.95 - 0.98$; with 0.5 – 1.8 wt. % MgO) whatever the occurrence. In sample MC2, carbonates are Mg-richer, particularly the type 2 and 3 carbonates ($X_{\text{Ca}} = 0.88 - 0.91$; 3 - 5 wt. % MgO), a composition similar to that of the carbonates from the vesicles in the basanite ($X_{\text{Ca}} = 0.86 - 0.88$; 4 - 5 wt. % MgO). In both xenoliths, the carbonates have low REE abundances (mostly below the detection limit except La and Ce), similar to those reported for carbonates from mantle xenoliths. Moreover, the carbonate globules in the basanite have the same REE composition.

Although the presence of rounded vesicles of calcite was originally interpreted as an evidence for silicate-carbonate liquid immiscibility, experimental studies have shown that alkali-free immiscible carbonates cannot be almost pure calcite. Textural features and composition (high X_{Ca} , low alkali contents and low REE abundances) of carbonates rule out their origin as quenched carbonatitic melts or immiscible carbonate liquids and favor, thus, an origin as crystal cumulates from mantle-derived carbonate-rich melts (e.g. alkali-carbonate melts). A possible scenario is the injection of small amounts of a carbonate-rich melt at mantle level shortly before the eruption to preserve the calcite crystals. Carbonate-rich melt or emanated fluids may have permeated the xenoliths (MC2) during the ascent and precipitated calcite crystals in the xenolith as well as in the entraining basanitic magma.