



Characterisation of metasomatic agent using in-situ trace-element and stable isotope compositions in mantle xenoliths from Deves, Massif Central (France)

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The geological history of the French Massif Central is characterised by the pre-hercynian subduction, the Hercynian orogeny and a mantle upwelling (Cenozoic) that began the Tertiary-Quaternary volcanism.

Spinel lherzolites, harzburgites and pyroxenite from Marais de Limagne in Deves display a large range of microstructures from coarse grained, to porphyroclastic or granuloblastic. In some xenoliths, the petrographic observations have shown that clinopyroxene (cpx) is partly or totally reacted to amphibole (amp). These amphiboles can be either disseminated in the matrix or located around spinel. These minerals represent a silicate and OH⁻ rich metasomatism and have various modal contents: from 0.9 to 20.8 %.

Major-element compositions of primary orthopyroxene give similar equilibrium temperatures (910 and 950 Celsius degrees), corresponding to a depth of about 35 km by reference to an average basaltic province geotherm. The mg# of the primary assemblages (olivine-opx-cpx) ranges between 0.89 and 0.91.

Trace elements have been analysed by LA-ICP-MS in both cpx and amp in order to characterise the metasomatic agent(s). Co-existing minerals display similar trace element patterns (normalised to the chondrite or Primitive Mantle) suggesting the same metasomatic agent for both minerals. Cpx and amp can be either Light Rare Earth Element (LREE) depleted ($[La/Yb]_N = 0.1$) or LREE enriched. Both mineral species display negative anomalies in Nb and Ta and furthermore amphiboles display Zr, Hf

and Ti negative anomalies.

Comparison of oxygen isotopes values between mineral pairs of such as olivine-opx-cpx and amp, show that primary assemblages are in disequilibrium. Nevertheless, for some xenoliths cpx - amp pairs (more sensitive to metasomatism), the isotopic equilibrium between these two phases seems to be reached with an increasing $[La/Yb]_N$. Consequently, the metasomatic agent responsible for this re-equilibration is OHrich and has homogeneous $\delta^{18}O$ values. Moreover, the oxygen isotope values are heavier than those of the host peridotite, possibly indicating percolation of an asthenospheric silicate-OHrich melt.

Considering trace-element and isotopic signatures of cpx and amp, the metasomatic agent could correspond to melts related to a subduction (Hercynian ?) zone that have been recycled in the ' plume ' as also shown by radiogenic isotopes (Sr, Nd, Hf).