The two-stage melt metasomatism revealed by lithium isotopes distribution in peridotite xenoliths from Allegre (French Massif Central)

XIAOYAN GU[1], ETIENNE DELOULE[2], LYDERIC FRANCE[3] AND JANNICK INGRIN[4]

[1]CRPG, CNRS UMR 7358, U. Lorraine, BP20, 54501 Vandoeuvre les Nancy, France (gxy@crpg.cnrs-nancy.fr)
[2]CRPG, CNRS UMR 7358, U. Lorraine, BP20, 54501 Vandoeuvre les Nancy, France (deloule@crpg.cnrs-nancy.fr)
[3]CRPG, CNRS UMR 7358, U. Lorraine, BP20, 54501 Vandoeuvre les Nancy, France (lyde@crpg.cnrs-nancy.fr)
[4]UMET, CNRS UMR 8207, U. Lille 1, 59655 Villeneuve d'Ascq, France (Jannick. Ingrin@univ-lille1.fr)

A set of peridotite xenoliths from Allegre (French Massif Central) have been selected to analyze the major element compositions and lithium (Li) concentration and isotopic compositions to explore the Li exchanges during the melt-rock interactions and then to further highlight the role of melts/fluids in the evolution of the sub-continental lithospheric mantle. Their host magma erupted 3 Ma ago and formed a lava lake at the surface. Some petrographic features are suggestive of host magma percolation into these xenoliths.

The Li elemental and isotopic results of robust in-situ analysis by SIMS indicates at least two-stage metasomatism have induced the complicate intra- and inter-mineral Li distribution and isotopic fractionation. The extremely high Li concentration in Cpx (up to 50ppm) and the steep increase of Li contents in marginal areas of some olivine grains can be ascribed as recent diffusive uptake from infiltrated host magma. Whereas the interior zones of olivine, surviving the infiltration of host magma, have preserved the pristine Li contents and δ^7Li signatures prior to entrainment by host magma. Unexpectedly, the cores of olivine contains similar or slightly larger amount of Li (from 1.3ppm to 4.4ppm) than the normal mantle, but their Li isotopic compositions are very light with δ^7Li as low as -25‰. Moreover, the Li isotopic fractionation between Cpx and Ol ($\Delta^7Li_{Ol\text{-}Cpx}$) ranges from -8.1‰ to -1.4‰, values totally different from literature data for peridotites. Thus, prior to their entrainment by host magma, the peridotites from Allegre have suffered mantle metasoamtism by a melt of extremely low δ^7Li, which probably derived from partial melting of subducted materials in Variscan orogeny.

Due to the different diffusive rates of Li in Ol and Cpx, these two mineral phases show the Li elemental and isotopic imprints of two different metasomatic events. Meantime, we can use the distinct profile patterns in Ol and Cpx to quantitively restrict the duration of the cooling process of the lava lake.