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Carbonatite melt infiltration in mantle xenoliths from the Eurasian plate - North American modern plate collision zone (Ruditch, Yakutia)

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Within the seismic active Chersky belt, the modern border between North American and Eurasian plates (Indigirka River area, Sakha-Yakutia Republic), mantle xenoliths were found in eroded alkaline basalt dike remnants.The peridotite xenoliths are represented by mainly anhydrous spinel lherzolites that appear together with subordinate orthpyroxene, clinopyroxene and feldspar megacrysts.

Spinel lherzolites have protogranular textures and are well equilibrated, lacking any mineral zonation. The constituent minerals have minor compositional variations whithin and between different samples. Olivine compositions range from Fo 89-90.5, with CaO contents between 0.04 and 0.06 wt.%. Orthopyroxenes indicate a very narrow compositional variance (Wo1En63Fs36, Mg# 90-91 and Al2O3 from 4 to 4.7 wt.%), just like clinopyroxene phases that are represented by Wo38En40Fs22, with Mg#s from 90 to 91 and Al2O3 between 6.8 and 7.6 wt.%. Spinels also show a fertile composition with Cr#s ranging between 26 and 29 and Mg#s between 77 and 78 respectively. Equlibration temperature estimations gives approx. 1000 °C at 15 kbar pressure for all studied samples.

In one xenolith, a round melt pocket with 200 microns in diameter consisting of well crystallized dolomite (25 wt.% CaO, 31 wt.% MgO) in perfect contact with homogeneous glass (16 wt.% Na2O, 51 wt.% SiO2, 20 wt.% Al2O3), apparently an immiscibility of carbonatite and silicate melt, was found at the triple point of olivine, orthopyroxene and clinopyroxene.

Mineral chemistries show that the lithospheric mantle underneath the study area is a fertile lherzolith. Clinopyroxene LA-ICP-MS trace element analyses confirm the fertile nature of the xenoliths. The primitive mantle normalized REE patterns show a slight depletion of LREE with respect to HREE. The majority of the analyzed cpx have (La/Yb)N that vary between 0.1 and 0.5 and (Tb/Yb)N from 1.0 to 1.1 indicating the overal absense and metasomatic processes and low degree of melt extraction melting. Zr/Hf ratios vary from 30 to 40 and are similar to the theoretical ratios of primitive mantle clinopyroxenes. Melting models show that these clinopyroxenes represent the residue after 2-5% batch melting of a primitive mantle.

It seems likely that shortly before transportion to the surface, the carbonate-silicate melt was introduced into the host xenolith, with subsequent rapid separation of the immiscible liquids and without any reaction with constituent xenolith mineral phases. As erupted carbonatites and highly undersaturated silica melts frequently occur together in intra-plate settings, the survival of the immiscible dolomitic and Na-rich melt in these xenoliths provide additional evidence for a common origin for the carbonatites and highly undersaturated lavas from the same primary magma.