Carbonation freezing and mineralogy of the metasomatized cratonic mantle

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Cratonic mantle is known to be metasomatized, but its mineralogy is controversial. Often it is imagined as "carbonated peridotites" or the veined mantle with "metasomes". Peridotite xenoliths from the Chidliak kimberlite province (SE Baffin Island, Canada) suggest that the enriched cratonic mantle may rather comprise coarse peridotites with elevated modes of clinopyroxene, garnet and olivine with thin rims of calcic silicate minerals storing incompatible elements. In Chidliak, the calcic minerals are 3-20 micron coronas of clinopyroxene and monticellite on pyroxenes. The Chidliak peridotites were affected by "carbonation freezing", i.e. immobilization of carbonatitic metasomatic agent via decarbonation reactions, whereby ephemeral carbonatitic fluid gave away Ca to silicate minerals and exsolved CO_2. We determined closure-corrected metasomatic fluxes of major elements based on measured and reconstructed bulk compositions of xenoliths and the immobile element ratios. The metasomatism was associated with the significant removal of Na, Al, and Cr, minor removal of Si and Mg and the inflow of Ca, Ti, K and incompatible trace elements. Trace element patterns suggest <10% addition of a metasomatic agent that resembles carbonatitic or proto-kimberlitic fluids. The observed fluxes from the carbonatitic metasomatism match the documented temporal Ca addition to the cratonic mantle.