Carbonated sediment recycling and its contribution to lithospheric refertilization under the northern North China Craton

CHUNFEI CHEN[12], YONSHENG LIU[1], STEPHEN F. FOLEY[2], MIHAI N. DUCEA[3]

[1]School of Earth Sciences, China University of Geosciences, Wuhan 430074, China; [2] ARC Centre of Excellence for Core to Crust Fluid Systems, Dept. of Earth and Planetary Sciences, Macquarie University, New South Wales 2109, Australia, [3]Department of Geosciences, University of Arizona, Tucson, Arizona 85721, USA

Subduction of carbonated sediments is the principal mechanism for the replenishment of mantle carbon reservoirs, but the processes of transport of carbonated sediments into the mantle and their incorporation into mantle chemical and isotopic heterogeneities are poorly constrained. Here in-situ major and trace element and Sr isotopic compositions and mineral Sr-Nd isotopes of the peridotite xenoliths (lherzolites with minor harzburgites) in the latest Oligocene Fanshi basalts from the northern North China Craton (NCC) are used to decode two metasomatic events caused by subduction of carbonated sediments. Clinopyroxenes in the harzburgites are characterized by high $(La/Yb)_N$ (8.4-66), Ca/Al (4.7-6.4) and Zr/Hf (30-66) ratios but low Ti/Eu ratios (478-1268) coupled with strongly enriched in large ion lithophile elements and light rare earth elements but depleted high field-strength elements, suggesting that they have been metasomatized by carbonatitic melt. Highly evolved Sr-Nd isotopic compositions of these clinopyroxenes ($^{87}Sr/^{86}Sr$=0.70640-0.70716, $^{143}Nd/^{144}Nd$=0.512304) imply that metasomatic carbonatitic melt was derived from carbonated sediments. Compositional zonation of Cpx in a harzburgite shows decreasing $^{87}Sr/^{86}Sr$ ratio, increasing Sr content and decreasing Zr/Hf ratio from cores to the rims, documenting a later stage of metasomatism. In situ Sr isotopes in clinopyroxenes from both harzburgites and lherzolites converge in diagrams of $^{87}Sr/^{86}Sr$ vs Sr, Zr/Hf, Ti/Eu and $(La/Yb)_N$, indicating that these peridotites could have been extensively affected by the later metasomatic event. Clinopyroxenes in the lherzolites display lower $(La/Yb)_N$ (0.16-10.6) and Zr/Hf ratios (25-39), suggesting that the later metasomatic agent is probably a carbonate-rich silicate melt and not a carbonatite. Sr and Nd isotopes of these clinopyroxenes ($^{87}Sr/^{86}Sr$ = 0.702075-0.706148, $^{143}Nd/^{144}Nd$ = 0.512410-0.513286) exhibit negative correlation along a simple mixing line between a depleted and marine sediments. Low Ce/Pb ratio (<12) for the metasomatic agent suggests that carbonate-rich silicate melt also originated from carbonated sediments. The timing of two metasomatism events and the regional tectonic setting are consistent with derivation of the carbonated sediments from the Paleo-Asian Oceanic slab: low degree melting formed early carbonatite melts, whereas subsequent higher degree melting produced the later carbonate-rich silicate melt.