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An experimental study of Ca-rich carbonatite melt-peridotite interaction with applications to metasomatism type in lithospheric mantle beneath North China Craton

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Melt-peridotite interaction is the main process causing chemical and mineralogical changes in the cratonic lithospheric mantle. It has been suggested that carbonatitic and silicate melt metasomatisms may both contribute to the modification of the lithospheric mantle beneath the North China Craton (NCC). While the mineral compositional variations and the kinetics of carbonatite melt-peridotite reaction are poorly constrained in comparison with silicate melt-peridotite reaction. Here we performed a series of Ca-rich carbonatite melt-harzburgite interaction experiments at 3GPa and 1100°C ~ 1300°C with various durations. The starting harzburgite was first pre-synthesized to minimize porosity. Experimental results show that Ca-rich carbonatite melt can percolate very quickly along grain boundaries in harzburgite matrix, and reaction between Ca-rich carbonatite melt and refractory harzburgite results in a reactive boundary layer consisting of clinopyroxenite layer with high porosity and a cpx-rich harzburgite layer. Based on results of the present study and previous carbonatite melt-peridotite reaction experiments a clinopyroxene compositional variation trend characterized by increasing CaO content, Ca/Al and decreasing Al_2O_3 and TiO_2 contents with increasing Mg# can be established. This variation trend is distinct with that of silicate melt-peridotite reaction experiments which varies in the opposite direction. Comparison of clinopyroxene compositional variations in melt-peridotite reaction experiments with those observed in mantle peridotites from the NCC helps to assess the spatial and temporal distributions of individual melt metasomatism type in the lithospheric mantle beneath the NCC. We found that carbonatite melt metasomatism was prevailing across the ancient lithospheric mantle prior to destruction. Multiple-stage subductions of surrounding plates might have contributed to these metasomatic processes. While the metasomatism type was dominated by silicate melt metasomatism after its decratonization since late Mesozoic. However, a few carbonatite metasomatism spatially occurred along the northern and eastern subduction margins of the NCC. Thus, the infiltration of carbonatite melts could be a significant factor for the destruction of the lithospheric mantle.