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Relict refractory lithospheric mantle beneath the central North China Craton: Evidence from geochemistry of peridotite xenoliths from Xiyang-Pingding

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In-situ major and trace element and Sr isotope compositions of peridotite xenoliths from the Cenozoic Xiyang-Pingding basalts were investigated to constrain the nature of the lithospheric mantle beneath the central North China Craton (NCC). These peridotites can be divided into four groups, according to olivine forsterite (Fo), trace element distribution patterns and Sr isotopic signatures in clinopyroxene. The type 1 peridotites show the most refractory mineral compositions including high Fo (93.2–93.7) and Cr# in spinel (83.6–83.8) and low Al_2O_3 contents in orthopyroxene (0.70–0.76 wt%). The type 2 peridotites exhibit relatively lower Fo (91.5–92.1) and Cr# (~ 57.8). Clinopyroxenes in the type 1 and 2 peridotites display similar convex-upward rare earth element (REE) patterns and radiogenic Sr isotopes ($^{87}Sr/^{86}Sr$ = 0.7057–0.7059 vs. 0.7053–0.7062). These observations indicate that the type 1 and 2 peridotites could be relics of old cratonic root, which has experienced Paleoproterozoic enrichment. In contrast, clinopyroxenes in the type 3 peridotites (Fo = 92.2–92.7) show strong enrichment of light (L)REE and variable depletions of high-field-strength elements, and unradiogenic Sr isotopic compositions ($^{87}Sr/^{86}Sr$ = 0.7038–0.7044). These peridotites are interpreted as reaction products of the ancient lithospheric mantle with carbonatitic asthenospheric melts with contribution of recycled oceanic components. The type 4 peridotites have the most fertile mineral compositions including low Fo (< 91) and Cr# (< 20) and high Al_2O_3 contents in orthopyroxene (4.25–5.73 wt%). Clinopyroxenes in these peridotites have LREE depleted to slightly enriched patterns, and low $^{87}Sr/^{86}Sr$ ratios (0.7029–0.7033). The type 4 peridotites represent fragments of modified lithospheric mantle that was recently refertilized by small volume silicate melts formed by partial melting of the asthenospheric mantle. The complex architectures of the lithospheric mantle underneath the Xiyang-Pingding region reflect overprinting of multistage mantle metasomatism. Combined with previous studies, our findings suggest that the lithospheric mantle beneath the central NCC has been heterogeneously modified with the more comprehensive refertilization from the center (Xiyang-Pingding) to both the south (Hebi) and north sides (e.g., Hannuoba).