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Deep carbon cycling process within NE Asian big mantle wedge: Mg-Zn isotopic evidence from mantle xenoliths in northeastern China

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The subduction zone, as a main location of exchange between crust-mantle material, controls global deep carbon cycling. However, compared with small mantle wedge, studies on the process of deep carbon cycling within a big mantle wedge are poorly constrained. Here, we report whole-rock major and trace elements, and Mg-Zn isotopes of a suite of peridotite and pyroxenite xenoliths occurred in the Cenozoic alkaline basalts from Yitong and Shulan, NE China, with the aim of understanding deep carbon cycling processes within a big mantle wedge.

Mantle xenoliths in Shulan comprise (spinel) harzburgite, lherzolite, and wehrlite. Harzburgite and lherzolite exhibit granoblastic texture, and are geochemically similar to mantle peridotites. In contrast, it is observed that wehrlite replaced lherzolite, and the wehrlite has similar $Mg^{\#}$ (90~91), $\delta^{26}Mg$ (-0.21‰), and $\delta^{66}Zn$ (0.17‰) to peridotites. Moreover, *in-situ* $\delta^{26}Mg$ of olivine and clinopyroxenes from wehrlite are -0.18‰ and -0.66~-0.42‰, respectively. The former is similar to that of mantle, but the latter is much lower than that of mantle. These data indicate that lherzolites experienced modification of carbonated silicate melt to form wehrlites.

Mantle xenoliths in Yitong comprise lherzolite, wehrlite, orthopyroxenite, websterite, and clinopyroxenite. Lherzolite has similar geochemical compositions to peridotites in Shulan. However, wehrlite and pyroxenites exhibit cumulate texture, low $Mg^{\#}$ (77~83), and relatively LREE-enriched REE patterns of whole-rocks and clinopyroxenes, indicating that they were crystalized from mantle-derived magma. They also have lower $\delta^{26}Mg$ (-0.82~-0.49‰) and higher $\delta^{66}Zn$ (0.34~0.40‰) than mantle peridotites, implying that these xenoliths represent carbonated silicate melts modifying mantle. Combined with decrease of crystallization temperatures from orthopyroxnite to websterite as well as clinopyroxenite, we propose that the melt modifying mantle experienced transformation from silica-rich melt to carbonated silicate melt.

Taken together, we conclude that pyroxenite xenoliths in Yitong represent transformation from silica-rich melt to carbonated silicate melt, whereas wehrlite xenoliths in Shulan reflect modification of lithospheric mantle by carbonated silicate melts within the NE Asian big mantle wedge related to subduction of the Pacific Plate.

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