Effects of melt percolation on Ca isotopic variation in peridotites from Yangyuan, North China Craton

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We investigated Ca isotopic compositions of minerals (orthopyroxene, clinopyroxene and phlogopite) separeated from two suites of mantle peridotite xenoliths (Mg-lherzolites and Fe-rich lherzolites) from Yangyuan, North China Craton to constrain the Ca isotopic composition of the upper mantle.

Those minerals were digested in HF+HNO_3 first, then spiked with a ^{42}Ca-^{43}Ca double-spike before purification using cation exchange chromatography. Calcium isotopic ratios were determined on a thermal ionization mass-spectrometry (Thermo Triton) in the State Key Laboratory of Isotope Geochemistry in China.

The Mg-lherzolites, which are residual peridotites with no or only moderate metasomatism, display a small variation in Ca isotopic composition ($\delta^{44}Ca$ = 0.86-0.92) with an average of 0.89 ± 0.05 (2SD, n = 3), and they show no significant inter-mineral Ca isotope fractionation between orthopyroxene and clinopyroxene. By contrast, the Fe-rich lherzolites, which are strongly metasomatized and enriched in iron, exhibit larger Ca isotopic variations, with $\delta^{44}Ca$ ranging from –0.08 to +0.70. The $\delta^{44}Ca$ values of minerals in these xenoliths also vary widely from –0.24 to 0.70 in orthopyroxenes, from–0.09 to +0.69 in clinopyroxenes and from 0.43 to 0.68 in phlogopites. Large Ca isotope fractionation occurs between coexisting pyroxenes and phlogopites in the majority of Fe-rich lherzolites ($\Delta^{44}Ca_{Opx–Cpx}$ = –0.50 to 0.31‰ and $\Delta^{57}Fe_{Phl–Cpx}$ = –0.15 to 0.21‰). Overall, the large isotope fractionations in Fe-rich lherzolites likely results from the kinetic nature of the isotopic exchange between the wall-rock mantle and the percolating melt.

These results confirm that distigusihable variations in Ca isotope compositons exist between mantle minerlas, and that Ca isotopic composition of the lithospheric mantle is heterogeneous at the scale of xenolith samples.