Zinc isotopic composition of the lower continental crust estimated from granulite xenoliths

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This study presents high precision Zn stable isotope analyses for lower crustal xenoliths from the north margin of the North China Craton (NCC) to understand the behavior of Zn isotopes during deep crustal processes and the Zn isotopic composition of the lower continental crust (LCC). These xenoliths include pyroxenites, two-pyroxene mafic granulites, garnet-bearing mafic granulites, plagioclase-rich mafic granulites, intermediate granulites, felsic granulites, and metasediments[1]. The $\delta^{66}Zn$ (the permil deviation of the $^{66}Zn/^{64}Zn$ ratio from the JMC-Lyon standard) values of lower crustal xenoliths range from 0.18‰ to 0.38‰ (28 out of 30 samples). The lack of correlations of $\delta^{66}Zn$ with geochemical indicators (e.g., Al_2O_3, Cr, LOI, Ba/La,$^{87}Sr/^{86}Sr$) indicate that assimilation of Precambrian lower crust, fluid metasomatism, and accumulation of pyroxene and plagioclase had a limited effect on Zn isotopic compositions of these lower crustal xenoliths. The $\delta^{66}Zn$ values (0.34‰ to 0.18‰) of garnet-bearing mafic granulites decrease with increasing $FeO_{(T)}$ and V content is likely a result of the accumulation of Fe-Ti oxides. Meanwhile, fractional crystallization of Fe-Ti oxides during magma differentiation in the lowermost crust could produce an evolved melt with high $\delta^{66}Zn$ value.

For comparison, nine granulites from Archean terrain in the NCC were also analyzed. Combining lithologies from different depths, a weighted average $\delta^{66}Zn$ of the lower crust of 0.29 ± 0.07‰ (2SD) is estimated by using lower crustal xenoliths. This $\delta^{66}Zn$ value is similar to the estimated value (0.29 ± 0.10‰, 2SD) if only granulites from Archean terrain are considered. The Zn isotopic composition of the lower crust is heavier than the upper mantle of NCC (0.18‰)[2], which may be the results of partial melting of mantle and delamination of garnet-bearing mafic granulites with Fe-Ti oxide accumulation.

1. Liu et al., GCA 65, 2589-2604 (2001).
2. Wang et al., GCA 198, 151-167 (2017).