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Zinc isotopes in deep carbonated mantle melts do not hint at recycled carbon

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Zinc isotopes in primitive magmatic rocks have been used recently to interrogate the origins of mantle heterogeneity. Of special interest are the high d^{66}Zn values obtained for HIMU-type OIBs, and this signature hints possibly at recycled carbon-bearing oceanic crust in their mantle sources. In contrast, other studies argue that large zinc isotope fractionation results from the peridotite melting process, based on correlations between the degree of partial melting and d^{66}Zn of basaltic to komatiitic lavas. To further explore the utility of zinc isotopes in mantle geochemistry and the study of deep volatile cycles, we investigate the d^{66}Zn of kimberlites and lamproites (formerly Group-2 kimberlites) from the Kalahari craton in southern Africa. These rocks formed by H_2O-CO_2 fluxed partial melting of metasomatized peridotite at >180 km depths, and their contrasting Sr-Nd-Hf isotopic compositions indicate distinct sources near the lithosphere-asthenosphere boundary. Both rock types contain notable amounts of magmatic carbonates with mantle-like d^{13}C values.

In keeping with the discrete Sr-Nd-Hf isotope groupings, the kimberlites and lamproites have different d^{66}Zn compositions, with median values of 0.33 ±0.07‰ (n=22) and 0.25 ±0.06‰ (n=18), respectively. They have low zinc concentrations (64 ±35 and 51 ±29 ppm), similar to MORBs (64 ±25 ppm) but different from OIBs (120 ±40 ppm). Given that the degree of partial melting is equally low for kimberlites and lamproites (<1%), our study provides evidence for significant zinc isotope heterogeneity in the deep upper mantle. Modeling shows that the kimberlite and lamproite zinc systematics fit with near-solidus melting of asthenospheric and refractory cratonic peridotites, respectively. The minor alkali-metasomatic components required to explain the petrology of lamproites do not influence the zinc systematics of carbonated mantle melts, probably owed to the compatible nature of zinc in mineralogically exotic metasomes. Although the origins of kimberlites and OIBs are frequently compared because of their apparent link to LLSVPs in the lower mantle, our large dataset for African kimberlites lacks the anomalously high d^{66}Zn values reported for OIBs (up to 0.38‰). This suggests that recycled carbon plays no important role in the formation of carbonated melts within the asthenosphere, in agreement with their mantle-like d^{13}C compositions.