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Stable zirconium isotope constraints on the petrogenesis of carbonatites

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Refractory as well as insoluble nature of zirconium (Zr) dictates that its behavior mostly is driven by magmatic fractionation [1] whereby Zr-rich accessory phases, such as zircon or baddeleyite, may control stable Zr isotope systematics of silicate system [2,3]. In carbonatites, HFSE often are carried by pyrochlore, garnet and/or pyroxene, and scavenging of these phases during magmatic evolution of carbonatite liquids results in common significant depletions, particularly apparent for Ti, Zr and Hf. Moreover, Zr depletion may exceed that of Hf in carbonatites. Therefore, fractional crystallization of HFSE-bearing phases may bear on the understanding of the role of carbonatites for HFSE distribution in the mantle.

In this study, we have analyzed Zr stable isotope composition ($\delta^{94/90}Zr_{IPGP\text{-}Zr}$) of several carbonatite bodies to further constrain their petrogenesis. The preliminary data shows ~0.4‰ variation wich is not easily related to major element chemistry of carbonatites. Most data plot above the mantle value ($\delta^{94/90}Zr$ = 0.04 ± 0.04‰; [3]), with $\delta^{94/90}Zr$ of up to ~0.35‰. However, distinctive trends are revealed between $\delta^{94/90}Zr$ vs. Zr/Hf and Nb/Ta. These cumulative observations suggest resolvable Zr stable isotope fractionation between silicate and carbonate melts in the mantle. Besides, they also indicate strong mineralogical control of HFSE-bearing phases on the stable Zr isotope systematics of carbonatites.

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