

# Magnesium isotopic compositions of Bushveld Carbonatites and implications for recycling in the Paleoproterozoic

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Carbonatites are unique igneous rocks with > 50% modal carbonates. They have gained importance for numerous studies lately primarily for their ore grade concentration of certain elements (e.g., rare earth elements) and their highly abundant carbon rich mineralogy which could potentially be linked with the deep carbon cycle. Two contrasting hypotheses regarding the source of carbon in carbonatites have emerged lately: (i)  $d^7\text{Li}$  and  $d^{137}\text{Ba}$  compositions of carbonatites worldwide advocate for mantle origin of carbon<sup>1,2</sup>; while (ii)  $d^{11}\text{B}$  and  $d^{44}\text{Ca}$  compositions of global carbonatites suggest recycled origin of carbons for carbonatites younger than 300 Ma; while such origin is sporadic for carbonatites older than 300 Ma<sup>3,4</sup>. The apparent discrepancy across isotopic proxies could be due to the indistinguishable isotopic compositions between Earth's mantle and recycled carbonates. Of these, Mg isotope system ( $d^{26}\text{Mg}$ ) is important as Mg is one of the major constituents of any magmatic rocks and Earth's mantle has a different ( $d^{26}\text{Mg} = -0.26 \pm 0.04\text{‰}$ ) isotopic compositions than crustal carbonates ( $d^{26}\text{Mg} \leq -1\text{‰}$ )<sup>5</sup>. Therefore,  $d^{26}\text{Mg}$  of carbonatites could provide further insights into their source characteristics and evolutionary processes.

We report the  $d^{26}\text{Mg}$  of carbonatites and phonolites from the 2.06 Ga old Phalaborwa carbonatite complex, associated with the economically significant Bushveld Large Igneous Province. Carbonatites display much lighter  $d^{26}\text{Mg}$  values (-0.38 to -0.75‰) than Earth's mantle. By contrast, the  $d^{26}\text{Mg}$  values of phonolites (-0.23 to -0.42‰) show a constricted range and mostly overlap with mantle composition. The preliminary results, based on  $d^{26}\text{Mg}$  and major element concentrations, suggest that partial melting of carbonated mantle peridotite, fractional crystallization or liquid immiscibility are unlikely to cause such lighter  $d^{26}\text{Mg}$  values in carbonatites. Based on the combined  $d^{13}\text{C}$  (-3.4 to -3.9 ‰) and  $d^{26}\text{Mg}$  of these carbonatites, we predict the presence of recycled carbon in the source of these carbonatites. This result also highlights the role of recycling in the Paleoproterozoic era.

## References:

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