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A review of stable Li and Mg isotope systematics in Carbonatites: Understanding the crust-mantle recycling processes and mantle metasomatism

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Carbonatites, with their unique compositions of enriched in carbonate minerals are intriguing igneous rock types that can help understand the mantle compositions. They are excellent candidates for deciphering mantle sources and SCLM characters as they have the highest Sr concentrations along with Nd, Pb, and REEs. Moreover, their low viscosity buffers the crustal contamination during ascent and preserves the original isotope ratios. Although Significant Sr, Nd, and Pb as well as C, O isotopes geochemical work have been carried out on carbonatites, controversies still prevail on the origin and source of carbonatitic magma and the mantle metasomatism associated with its generation. Recent advances in MC_ICP-MS technology, the nontraditional stable isotopes of alkali metals such as Li and Mg have become an essential source of information regarding understanding the alkaline melt genesis in mantle. Li, an incompatible element, it is more enriched in crust and hence shows a wide range of isotopic values. Whereas, the convecting mantle has relatively uniform lithium isotopic values. Therefore, any input of fluid from the subducting slab and the subducted can alter the isotopic composition of the mantle wedge. As a result, Li isotopic variations in mantle-derived igneous rocks such as carbonatites may indicate the involvement of crustal material subducted into the source regions, preserving the signature of different geochemical processes that caused the variation in Li isotopic. Similarly, the sedimentary carbonate rocks being characterized by low δ^{26}Mg values and the mantle having a homogeneous Mg isotope composition, the mantle derived carbonatites can act as a powerful proxy to identify recycled carbonates as well as deeply recycled C in the mantle. Additionally, the detectable amount of Mg isotope fractionation may occur during silicate–carbonatite liquid immiscibility and fractional crystallization of carbonatite melts. Mg isotopes can potentially be a valuable tracer of these processes relevant to carbonatite petrogenesis. Thus the combined study of the nontraditional Li and Mg isotopic data with the available traditional stable and radiogenic isotopic data may enrich our understanding of the crust-mantle recycling processes and the effects of mantle metasomatism on the genesis of carbonatitic magma with a special reference to Indian carbonatites.