Magnesium isotope fractionation during carbonatite petrogenesis at Oldoinyo Lengai, Tanzania

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Magnesium isotopic compositions of natrocarbonatites and peralkaline silicate rocks from Oldoinyo Lengai, Tanzania, were measured in order to understand the behavior of Mg isotopes during carbonatite petrogenesis. The silicate rocks, comprising olivine melilitites, phonolites of unit *Lengai I*, combeite–wollastonite nephelinites (CWNs) of unit *Lengai II A* and carbonated combeite–wollastonite–melilite nephelinites (carbCWMNs), have relatively homogeneous and mantle-like Mg isotopic compositions (δ^{26}Mg of -0.30 to -0.10‰). This is consistent with limited Mg isotope fractionation during silicate magma differentiation. By contrast, the CWNs of unit *Lengai II B*, which represent the silicate melts that presumably experienced silicate–carbonatite liquid immiscibility, have heavier Mg isotopes (δ^{26}Mg of -0.06 to +0.09‰). This suggests that Mg isotope fractionation may occur during liquid immiscibility. Theoretical calculations predict that heavy Mg isotopes prefer silicates to carbonates and by inference silicate melts to carbonatite melts, so that an isotopically light value for the original carbonatite melt of δ^{26}Mg < -0.25‰ can be inferred. The variable and positive δ^{26}Mg values of natrocarbonatites (from +0.13 to +0.36‰) hence require a modification of their Mg isotopic compositions subsequent to the liquid immiscibility process. Since δ^{26}Mg correlates negatively with SrO, CaO and Na_2O+K_2O contents in natrocarbonatites, we suggest that significant Mg isotope fractionation occurs during carbonatite magma differentiation. Collectively, Mg isotope fractionation during both silicate–carbonatite liquid immiscibility and carbonatite magma differentiation will produce carbonatite melts with highly variable Mg isotopic compositions. Such melts may potentially lead to Mg isotopic heterogeneity in some parts of the mantle through carbonatite metasomatism.