Origins of the Leucite Hills lamproites constrained by magnesium isotopes

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Lamproites are commonly found in post-collisional or intracontinental environments and characterized by unique elemental and radiogenic isotopic signatures that signify derivation from the subcontinental lithospheric mantle. An improved understanding on their genesis is important regarding the dynamics of the Earth's mantle lithosphere, and requires knowledge in identifying source components and magmatic processes. In order to better constrain the mechanism producing the geochemical diversity of lamproites, we measure the elemental and Mg isotopic compositions of a suite of lamproites from the well-known locality Leucite Hills, Wyoming, U.S.A. The two types of lamproites therein, madupitic and phlogopite lamproites, display distinct characteristics in many element and Mg isotope diagrams. These variations cannot be ascribed to crustal contamination, fractional crystallization or source heterogeneity. Instead, the strong correlations between melting-sensitive elemental ratios (e.g., Sm/Yb and La/Yb) and indices of carbonatitic metasomatism (e.g., CaO/Al_2O_3, Hf/Hf*, and Ti/Ti*) with $\delta^{26}Mg$ indicate that variable degrees of partial melting of a common carbonated mantle source have generated the observed geochemical distinctions of the Leucite Hills lamproites. Our study reveals that geochemical variations in a given lamproite suite might have been controlled mainly by the degree of mantle melting.