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The Leucite Hills, Wyoming: Hf Isotope Constraints from the Legacy Plasma 54 in Lyon

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The Leucite Hills of SW Wyoming consist of 22 volcanic outcrops that occur over an area of about 2,500 km^2. The lavas consist of three types of lamproite, basic to ultramafic madupite, and more silicic wyomingite-orendite, characterized by phlogopite phenocrysts in a groundmass of leucite, diopside, apatite, ±sanidine, ±glass. Volcanism spanned 3.0-0.89 Ma. 84% of the <0.7 km^3 of magma was erupted between 0.94 and 0.89 Ma. The lamproites cross-cut the NE flank of the Late Cretaceous Rock Springs Uplift and are underlain by the Archean Wyoming craton, stabilized at 3.2-2.5 Ga, forming a refractory harzburgite residue. The Wyoming subcontinental lithospheric mantle was subsequently enriched metasomatically >1.0 Ga by ancient subduction of carbonate-bearing sediments.

Previous radiogenic isotope studies indicate that the madupite, relative to the wyomingite-orendite, have distinct Nd isotopic compositions, but overlap in Pb and Sr isotope space. Hafnium isotope ranges for the lamproite subpopulations are indistinguishable. The $_{Hf}$ ranges from -13.1 to -15.9 for maudupite and from -13.5 to -17.1 for wyomingite-orendite. In the $_{Nd}$-$_{Hf}$ diagram the madupite fall about the mantle array with Δ_{Hf} varying from -4.0 to +1.1. In contrast, wyomingite-orendite plots above the mantle array, at more negative $_{Nd}$, with Δ_{Hf} varying from -0.8 to +5.7. The isotopic character of the madupite and wyomingite-orendite require discrete mantle sources.

The positive Δ_{Hf} of the wyomingite-orendite relative to the madupite suggests that the mantle source of the former contained residual garnet. The wyomingite-orendite source may have been depleted in Hf a few million years prior to the formation of the lavas, perhaps during the eruption of the madupite lavas.