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First-Row Transition Element Ratios as Indicators of Mantle Source and Metasomatic Processes in Continental Intraplate Magmatism

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To explain the geochemical heterogeneity of intraplate basalts, intraplate volcanism is often attributed to the presence of a mantle plume. However, there is growing recognition that the lithospheric mantle could also exert control over the intraplate basalt compositions. First-row transition elements (FRTE) in olivine can provide insights into the nature of the mantle source and the contributions of the various mantle components, as they are sensitive to source mineralogy and redox state

Samples from the eastern Snake River Plain (SRP) are known to be associated with the Yellowstone hotspot, while samples from the Lunar Crater volcanic field (LCVF) have been interpreted as generated at depths of approximately 60–130 km, corresponding to the uppermost asthenosphere, from a relatively depleted source. However, the role of interactions between asthenospheric melts and the lithosphere during the generation of LCVF magmas has not yet been investigated. By comparing olivine compositions from basalts collected at both locations with those from other volcanic fields in the central Basin and Range province, we aim to test whether FRTEs can be used to isolate the geochemical signature of a metasomatized lithosphere from the deep asthenosphere and a mantle plume.

Nickel contents from the LCVF olivine points toward a peridotitic source. In comparison, at a given forsterite content, SRP olivine tends to have higher Ni contents, that might be consistent with a mantle source containing a higher proportion of recycled component. Meanwhile, olivines from other volcanic fields exhibit substantially greater scatter in Ni, including values comparable to those observed in the SRP. Although the low Li contents observed in all samples suggest a limited role of fluid-related metasomatism, interactions between asthenospheric melts and the lithospheric mantle may nevertheless lead to the formation of hydrous minerals (amphibole or phlogopite), that have recently been recognized as reservoirs for FRTEs. To further constrain the role of metasomatic veins in shaping FRTE signatures, we will conduct bulk-rock Fe–Zn isotope analyses. As have been demonstrated to sensitively record mantle source characteristics and metasomatic overprinting, they will provide a complementary and independent proxy to constrain the role of the lithospheric mantle.