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Insights into the relative hydration of the Colorado Plateau lithospheric and asthenospheric mantle

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Dewatering of the Farallon slab under cool conditions is hypothesized to have hydrated the lithosphere in the southwestern USA during the Laramide Orogeny (~80-45 Ma). Combined with the effects of subsequent slab rollback, this could have led to uplift, magmatism, and deformation across the western USA. In contrast to its surroundings, the Colorado Plateau (CP) remained relatively untouched by these processes until the beginning of the Neogene. The CP has since been succumbing to encroaching volcanism and deformation around the margins. We combine water contents with isotopic characteristics and trace element patterns in basalts to evaluate how much water was present and contributing to melting of the lithospheric and asthenospheric mantle beneath the CP.

This study presents new estimates for water contents in near-primary ~25 Ma to Holocene-aged basalts that accompanied northward migration of the southern margin of the CP. Older basalts have $\varepsilon_{Nd} < 2$ and subduction signatures such as elevated LILE and LREE abundances relative to HFSEs, suggesting an enriched lithospheric source. Younger basalts have $\varepsilon_{Nd} > 2$ and trace element patterns characteristic of asthenospheric melts. Water contents determined via Ca-in-olivine hygrometry [1] in basalts that appear to have a lithospheric source (1.5-2 wt.%, with two outliers ~4 wt.%) overlap with basalts that appear to be dominated by an asthenospheric source (~1-2 wt.%). Initial estimates of mantle source water contents cluster around 100 ppm for the latter, but range to higher values for the former.

Both lithosphere- and asthenosphere-derived CP basalts have uniformly MORB/OIB-like H2O/Ce values (~100-300), which are much lower than typical of arc lavas (up to 20k). Oceanic basalt-like H2O/Ce values and high LREE:HFSE suggest that the lithospheric source for CP basalts was metasomatized by a silicate melt. The > 100 Ma Farallon slab was likely too cold and subducted too recently to be responsible for the chemical signatures of silicate melt metasomatism and negative ε_{Nd} in the CP lithosphere. Hydration of the lithosphere likely pre-dated Farallon subduction, which may have played a smaller role in CP mantle evolution than previously proposed.

[1] Gavrilenko, Herzberg, Vidito, Carr, Tenner & Ozerov (2016), *J. of Pet.*57, 1811-1832.