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Re-Os isotopic constraints on the role of lithospheric melting in the Eocene northern U.S. Cordillera large igneous province

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The northern interior of the North American Cordillera experienced prolific magmatism in early Eocene time to form the Challis-Kamloops volcanic belt. This igneous province consists of a ~1200 km NW-SE trending belt extending from central British Columbia to Idaho and another similarly large belt extending from eastward from Idaho to South Dakota and from the Cordilleran back-arc to foreland. The drivers of such a large magmatic belt extending so far from the plate boundary remain unclear with models ranging from purely lithospheric triggers (i.e., extensional collapse) to slab rollback and/or window formation. To clarify the role of ancient lithospheric mantle in generating this magmatism, we report the first ^{187}Re-^{187}Os data along with new Sr, Nd, and Pb isotope and major and trace element data for representative lavas from the portions of this belt in the U.S. Samples come from the Challis volcanic field (Idaho), Montana alkalic province (Montana), and Absaroka volcanic field (Wyoming-Montana).

Despite differing petrological affinities (i.e., calc-alkaline vs. alkaline) and widely dispersed locations, samples share an arc trace element signature (e.g., depletion of HFSE over LILE and LREE). A single Challis volcanic field sample had a subchondritic Os isotope composition, providing unambiguous evidence of an ancient lithospheric mantle component. Other Challis samples have Os isotope compositions that are mildly superchondritic, overlapping with lithospheric mantle xenoliths derived from the Montana alkalic province. The remaining lavas, including nearly all from the other volcanic fields, have higher $^{187}Os/^{188}Os_{(i)}$ compositions, ranging between 0.2 and 1.1. When considered together with an inverse correlation between Os isotope compositions and Os and MgO content and strongly subchondritic Nd isotope compositions, the simplest explanation for the higher Os isotope ratios is crustal contamination of mantle-derived lavas, although it is currently unclear if the mantle end member is lithosphere or asthenosphere.

Combined Sr-Nd-Os-Pb isotope data indicate that the Challis volcanic field can be explained by melting entirely within the lithospheric column, whereas a direct role for asthenospheric magma is more difficult to eliminate in the Absaroka volcanic field and Montana alkalic province.