Constraints on the petrogenesis of the Laurentian 1.4 Ga pluton belt: a Sm-Nd and Lu-Hf isotope study of peridotite xenoliths from the Colorado Plateau

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1.4 Ga plutons intrude across the southwestern US and Colorado Plateau (CP). Despite the large volumes of magma and the scale of the intrusion event, the origin of the 1.4 Ga plutonism is unclear. Geochemical investigations show that the 1.4 Ga plutons are partial melts of the crust [e.g., 1], but the cause of melting is still debated. Proposed models include: subduction, rifting, sub-supercontinent heat build-up, and anatexis caused by crustal thickening [e.g., 1]. Work on crustal xenoliths from the Navajo Volcanic Field (NVF, central CP) suggest that the 1.4 Ga event is recorded in the CP middle crust [2, 3].

Re-Os analyses of refractory xenoliths from the NVF yield unradiogenic $^{187}Os/^{188}Os$ values (0.1140 to 0.1170), which correspond to Re depletion ages of 2.1 to 1.6 Ga, consistent with the age of the overlying Yavapai and Mazatzal crust [4]. However, new Sm-Nd and Lu-Hf analyses on cpx in peridotite xenoliths from NVF diatremes show that LREE-depleted xenoliths fall on a ~1.45 Ga isochron. Clinopyroxene from unmetasomatised samples have highly radiogenic Nd and Hf isotope compositions (up to $\varepsilon_{Nd} = +405$ and $\varepsilon_{Hf} = +586$). These samples form a linear trend in isochron space, with a Sm-Nd isochron age of 1450 ±30 Ma and an intercept model age of 1510 ±140 Ma. Lu and Hf are hosted in opx as well as cpx in peridotites, which must be taken into account to calculate an accurate isochron age [5]. The calculated whole rock Lu-Hf isochron yields an age of ~1.40 Ga, consistent with the Sm-Nd isochron age but older than the age of initial lithosphere stabilization. We interpret the Sm-Nd and Lu-Hf isochrons to represent an episode of mantle isotopic resetting at ~1.45 Ga.

Mantle peridotites recording a ~1.45 Ga event suggest the lithospheric mantle was involved in the 1.4 Ga plutonism, which places constraints on the tectonic models feasible for pluton melt production. Our constraints support pluton formation models that include mantle melting rather than models that do not, such as anatexis due to crustal thickening.

[1] Goodge & Vervoot, 2006, EPSL 243, 711-731; [2] Wendtlandt et al, 1996, GSAB, 108, 757-767; [3] Crowley et al, 2006, CMP, 151, 313-330; [4] Bennett & DePaolo, 1987, GSAB 99: 674-685; [5] Byerly & Lassiter, 2015, Chem Geol 413: 146-158.