

Hafnium-osmium isotope systematics of mantle peridotites from the Cameroon Volcanic Line: Implications for dating post-Archean lithospheric mantle

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The Re-Os isotope system is well suited to constraining the timing of melt depletion of Archean mantle peridotites. In contrast, the variability inherent in post-Archean mantle Os isotope evolution leads to increasing uncertainty in Re-Os model ages. The Lu-Hf isotopic system has shown some potential for dating peridotite formation ages, providing valuable ages that are complementary to the Re-Os system. For post-Archean mantle peridotites, the key target in the Lu-Hf isotopic work is clinopyroxene (Cpx), because of its high Lu and Hf concentrations and the typical absence of garnet in these rocks. However, orthopyroxene (Opx) can contain 20% or more of the Hf budget of spinel peridotites and sometimes over 40% of the Lu budget, with Lu/Hf ratios 3-4 times those of Cpx. Thus, Opx Lu-Hf isotopic compositions cannot be ignored or simply calculated, as the equilibrium temperatures of mantle peridotites prior to eruption could be lower or higher than the Hf closure temperature ($T_c(\text{Hf}) \sim 900^\circ\text{C}$). Here we explore Lu-Hf partitioning in spinel peridotite xenoliths from the Cameroon Volcanic Line in addition to WR Re-Os analyses. The Hf isotopic composition of Opx in these rocks is equal to or higher than that of Cpx, consistent with some samples having equilibrium temperatures close to $T_c(\text{Hf})$. Combining Cpx and Opx, the constructed WR Lu-Hf isochron yields an age of 2.01 ± 0.36 Ga (2σ ; MSWD = 11.4; $\epsilon_{\text{Hf}} = -0.8 \pm 19.2$), which is in accordance with the oldest of the variable Re-Os model ages. The continental sector of the Cameroon Line runs close to the edge of the Congo craton. The Hf-Os data indicate that the lithosphere underpinning this region formed in the Paleoproterozoic (~ 2 Ga) most likely during the Paleoproterozoic assembly between the Congo and West African Cratons. We emphasize that Opx and Cpx should be combined together to construct the WR isochron in order to obtain the precise age and initial Hf isotope compositions of post-Archean spinel peridotites.