

Re-Os Isotopic Characterization of the Mantle Source Beneath the Walvis Ridge

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The Walvis Ridge is an iconic hotspot track in the southern Atlantic Ocean. Derived from the same plume that produced the Etendeka and Paraná flood basalts in Namibia and Brazil, respectively, Walvis Ridge lavas recovered during previous dredging and drilling expeditions are mostly evolved ($\text{MgO} < 7 \text{ wt\%}$), making it difficult to characterize the $^{187}\text{Os}/^{188}\text{Os}$ systematics of the mantle source(s) contributing to the hotspot track over time. New core recovered during IODP Expedition 391 contained more mafic flows, enabling the first characterization of the hotspot's $^{187}\text{Os}/^{188}\text{Os}$ signature away from direct influence of continental lithosphere. Site U1578 drilled 302m of basaltic lava ranging from thin pillow flows to ~15m thick massive flows. Fresh olivine was visible in some flows, and whole rock MgO ranges from ~4-12 wt%. Re-Os isotopes were measured on the freshest, most mafic samples from this site. Thirteen samples contained $> 8 \text{ wt\% MgO}$ and record $\text{Os} = 60\text{-}700 \text{ ppt}$, $^{187}\text{Os}/^{188}\text{Os}_i = 0.1295\text{-}0.1364$, and $\text{Re} = 0.2\text{-}0.7 \text{ ppt}$. There is a strong correlation ($R^2 = 0.999$) between $^{187}\text{Os}/^{188}\text{Os}$ and $^{187}\text{Re}/^{188}\text{Os}$ which generates an apparent age = 66 Ma; this is within error for preliminary $^{40}\text{Ar}/^{39}\text{Ar}$ ages for this site [1]. The strong correlation suggests the Re-Os systematics represent mantle signatures and are unaffected by seawater. The $^{187}\text{Os}/^{188}\text{Os}_i$ are mildly radiogenic compared to primitive mantle, consistent with a deep mantle plume source. In comparison, Etendeka and Paraná flood basalt $^{187}\text{Os}/^{188}\text{Os}_i$ values range from 0.1262-0.1331 [2] and 0.1066-0.1312 [3], respectively, demonstrating both shallow subcontinental lithospheric mantle

and deep plume contributions. Tristan da Cunha – the current location of the mantle plume – records more radiogenic $^{187}\text{Os}/^{188}\text{Os}_i$ values (0.1508-0.2401; [3]) than Walvis Ridge Site U1578, but the low Os abundances (3-10 ppt) in the Tristan da Cunha lavas made them highly susceptible to isotopic overprinting. The robust Os abundances, strong Re-Os isotopic correlation, and mildly radiogenic $^{187}\text{Os}/^{188}\text{Os}_i$ values suggest Walvis Ridge Site U1578 lavas were sourced from a mantle plume without a significant recycled component.

[1] Heaton et al. (2023) *AGU* PP41C-1666. [2] Day et al. (2024) *EPSL* 641, 118768. [3] Rocha-Júnior et al. (2012) *EPSL*, 337-338, 164-173.