

He Isotope Evidence of a Primitive Mantle Source Beneath the Tristan-Gough-Walvis Hotspot Track

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Previous geochemical work on basalts from the Tristan-Gough-Walvis (TGW) hotspot track documented bilateral Sr-Nd-Pb-Hf isotopic zonation along the track after ~70 Ma. At this time, the plume-spreading ridge system separated, allowing plume-fed seamounts to form separate from Mid-Atlantic Ridge extensional dynamics [1,2]. Previous analysis of olivine, pyroxene, and amphibole phenocrysts from Tristan da Cunha and Gough Islands exhibit average compositions of $5.30 \pm 0.52 R_A$ and $6.05 \pm 0.75 R_A$ respectively, which were attributed to radiogenic ^4He production in Th-U-enriched plume sources [3,4]. In contrast, Etendeka flood basalts and dikes range in $^3\text{He}/^4\text{He}$ from 0.3 to $21.15 R_A$, where low values $<3 R_A$ He isotope compositions have been attributed to crustal contamination of plume-derived melts [5] (Fig. 1). To this point, plume-like He isotope signatures demonstrated an isotopically primitive component only in the source of the flood basalt stage of the TGW hotspot track.

Analysis of olivine and pyroxene phenocrysts from basalts recovered during International Ocean Discovery Program (IODP) Expeditions 391 and 397T in this work further illuminate He isotope variability along the TGW track. Olivine and pyroxene phenocrysts from Site U1575 (~84-80 Ma) exhibit an average composition of $5.82 \pm 0.54 R_A$, resembling Tristan and Gough islands signatures. Olivine phenocrysts from U1585 (~70-66 Ma) exhibit an average composition of $9.49 \pm 2.35 R_A$, overlapping the range of Mid Ocean Ridge Basalt (MORB). Olivine phenocrysts from U1578 (~64-61 Ma) exhibit a primitive, plume-like average composition of $17.48 \pm 1.45 R_A$ (Fig. 1) in multiple flow units separated by layers of interbedded

sediment over >230 m of drill core. Thus, the primitive signature persisted at this location for an extended period. The MORB and "low $^3\text{He}/^4\text{He}$ mantle plume" isotopic signatures observed at sites U1575, U1585, Tristan da Cunha, and Gough Island, and the primitive plume signature at Site U1578 are linked to changing sources tapped during episodes of hotspot volcanism along the TGW hotspot track.

[1] Rohde et al., 2013, *Geology* **41**, 335-338; [2] Hoernle et al., 2015, *Nature Communications* **6**, 7799; [3] Kurz et al., 1982, *Nature* **297**, 43-47; [4] Class et al., 2005, *Earth and Planetary Science Letters* **233**, 391-409; [5] Stronik et al., 2017, *Geology* **45**, 827-830.

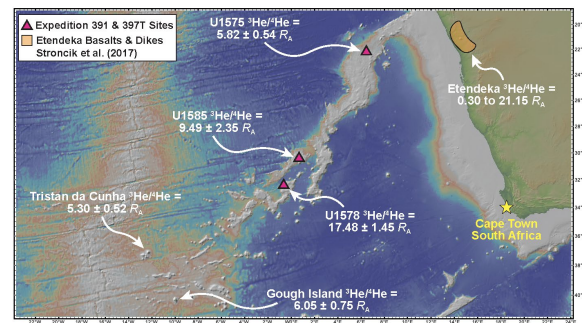


Figure 1. Map showing the location of samples analyzed during this study relative to Tristan da Cunha, Gough Island, and the Etendeka flood basalts and associated dikes. The average He isotope compositions of each drill site and island are presented with the labels.