Geochemistry of South Atlantic Hotspots: Intimate Association of EMI & HIMU End Members

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Seismic tomographic data and good age progressions along the St. Helena, Tristan-Gough, Discovery and Shona hotspot tracks point to a mantle plume origin. Whereas silica-undersaturated volcanism at St. Helena has end member HIMU type compositions, tholeiitic to alkalic volcanic rocks from the other three hotspot tracks have end member EMI type compositions. The Tristan-Gough hotspot track shows spatial geochemical zonation over the last ~70 Ma with a Gough type EMI composition in the south (DSDP Site 525A to Gough Is.) and a Tristan type EMI flavor in the north (DSDP Sites 527-528 to Tristan da Cunha Is.). Gough type EMI also dominates in the older Walvis Ridge, the Etendeka/Parana flood basalt provinces, northern half of the spatially zoned Discovery hotspot track and the entire Shona hotspot track, whereas the southern Discovery track has a more enriched EMI type composition with more radiogenic Sr and less radiogenic Nd and Hf isotope ratios. We believe all three EMI type flavors are derived from the margins of the African Large Low-Shear-Velocity Province (LLSVP).

Detailed sampling of the Walvis Ridge and Richardson Seamount of the Shona hotspot track have also unexpectedly turned up volcanic rocks with major and trace element and isotopic compositions overlapping end member St. Helena HIMU. In both cases, morphology and Ar/Ar age dating show that the HIMU volcanism is younger than the underlying EMI type basement. The HIMU-type volcanism on the Walvis Ridge displays a roughly sub-parallel age progression to the EMI basement volcanism, but is ~30 Ma younger at a given location and ceased ~55 Ma ago. The age data suggest the presence of a second weaker and shorter-lived HIMU hotspot, shifted in the direction of plate motion from the EMI Tristan-Gough hotspot. Younger (~50-80 Ma) carbonatites to melilitites in southwestern Africa also have end member HIMU compositions, suggesting upwelling of a swarm of weak HIMU plumes/blobs over the SW portion of the African LLSVP. In light of seismic tomographic data and high $^{3}He/^{4}He$ isotopic ratios, we suggest that HIMU and EMI reflect sampling of different layers or different portions (margins vs. interior) of the African LLSVP.