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Trace element and Hf isotope constraints on "continental" sources of Southwest Indian Ridge lavas

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MORB from Indian Ocean (IO) ridges display geochemical signatures consistent with source contamination by continental materials [1,2,3]. However, it is unclear whether crust, crust-derived sediments or lithospheric mantle was involved [1,2,3]. We present new trace element and Hf isotopic data for a suite of 38 previously studied lavas from 12-47° E on the SWIR [2,3]. Using this and other recently published data [4] we have defined two distinct "continental" geochemical signatures. Samples from the anomalous "Dupal" segment at 39-41°E have trace element compositions that are consistent with mantle sources composed of N-MORB-source mantle mixed with up to 30% cratonic South African metasomatised perid-otite [e.g., 5]. The 39-41E lavas also have ε_{Nd}-ε_{Hf} values that lie slightly above the Nd-Hf mantle array line, similar to alkaline dikes from SW Madagascar and qualitatively similar to cratonic South African peridotites [6]. A second signature, termed "IO-type N-MORB", is dominant east of 26E. and is characterized by ε_{Hf} values typical of N. Atlantic/Pacific-type N-MORB (+13 to +21) and ε_{Nd} values that are, on average, significantly lower (+7 to +11). Lavas with this signature have strong depletions in most highly incompatible elements but commonly have enrichments in Ba. Modeling suggests that the trace element and isotope traits of the "IO-type" signature is consistent with the addition of Neoproterozoic (550-1000 Ma) fluid-modified mantle wedge material to Pacific/N.Atlantic-type MORB-source mantle [e.g., 7]. The presence of these signatures in the SWIR is likely related to disruption/delamination of lithospheric mantle during Gondwana breakup, which here occured mainly through Neoproterozoic orogenic belts (containing numerous arc-magmatic terranes) and to a much lesser extent through cratonic lithosphere.

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Isotopic systematics of the Southwest Indian Ridge, 30-69ºE

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We report high precision Pb-isotopes (double spike) and Sr-Nd isotope data for basaltic glasses dredged along the Southwest Indian Ridge (SWIR) between 30º and 69ºE. All samples from this ~4000 km section of the SWIR possess isotopic signatures typical of Indian Ocean MORB and encompass most of the range of isotopic compositions observed in the Indian Ocean. They are thus distinct from Pacific and North-Atlantic mantle sources. Pb-Sr-Nd isotopes are poorly correlated, with the exception of the 39-41ºE section which exhibits the most extreme DUPAL component on Earth. Considerable Pb isotopic variability is observed within the 61-69ºE SWIR section adjacent to the Rodrigues Triple Junction (RTJ), and these values are distinct from the RTJ.

New analyses from the 39-41ºE (DUPAL) section, extend the MORB isotope range to even lower $^{206}Pb/^{204}Pb$ values (16.583-18.426) and higher $^{87}Sr/^{86}Sr$ (0.7048-0.7029) than previously reported. Samples from another segment (57-61ºE) are characterised by some of the highest $^{143}Nd/^{144}Nd$ (0.51309-0.51322) ratios encoutered on the SWIR and also unradiogenic Pb-Sr isotopic compositions (e.g. $^{206}Pb/^{204}Pb$=17.363-17.535) for Indian MORB, and are thus distinct from the DUPAL segment.

Previous studies of the SWIR defined the low $^{206}Pb/^{204}Pb$ from the DUPAL section (39-41ºE) as a mixing end-member with other less radiogenic components in the Indian Ocean mantle. Our new data indicate that this end member is not in a mixing relationship with the SWIR, but defines a distinct component that may reflect a "local" contaminant with an origin from mid-Proterozoic "African" sub-continental mantle. Interestingly, this component may also be present in the RTJ and the Southeast Indian Ridge mantle source, but is NOT present in the rest of the SWIR suite. The latter does however define a highly depleted endmember (to the left of the geochron), found in the 57-61ºE segment. This component defines mixing arrays with radiogenic components such as oceanic recycled components. The Indian Ocean mantle appears to be defined by several depleted endmembers of distinct Pb-isotope composition which results in sub-parallel trends above the NHRL in MORB sources.