Were Karoo flood basalts derived from a LLSVP-related plume source?

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Examination of the least-contaminated rocks of the Jurassic Karoo flood basalt province indicates considerable compositional variability in the mantle source. New and previously published Sr, Nd, and Pb isotopic data are suggestive of two main categories of mantle reservoirs: one coincides with the field of depleted mantle (DM) -affinity oceanic crust and the other has low initial eNd (+3.3 to 0.3) and high \(^{87}\text{Sr}/^{86}\text{Sr}\) (0.7039 to 0.7057) and Δ\(^{8/4}\) (92 to 138) typical of enriched mantle 1 (EM1) -affinity oceanic crust. Previous studies have proposed the DM type reservoir included domains affected by subduction-related fluids and recycled oceanic components (e.g. Heinonen et al., 2014). The EM1 type reservoir probably also contained subducted crustal components, but the geochemical data are suggestive of an additional primitive mantle (PM) type component (Turunen et al., 2019).

Importantly, the two reservoirs can be geochemically linked to a recently identified bilateral compositional asymmetry in the voluminous Karoo flood basalts (Luttinen, 2018): The DM type reservoir is the most likely source of Nb-depleted flood basalts in the southeastern Karoo subprovince (Lebombo rifted margin and Antarctica), whereas the EM1-PM type reservoir has been identified as the principal source of the Nb-undepleted flood basalts in the northwestern subprovince (Karoo-Kalahari-Zambezi basins). The boundary between the flood basalt subprovinces and the occurrences of the DM-affinity and EM1-PM-affinity rocks overlie the Jurassic location of the margin of the Jurassic sub-African LLSVP. Magmas derived from the EM1-PM type reservoir were largely emplaced above the deep mantle anomaly, whereas those derived from the DM type reservoir were emplaced outside the footprint of the LLSVP.

Based on isotopic similarity, the EM1-PM type reservoir of the Karoo province may record the same overall LLSVP material as the Gough component in the zoned Tristan da Cunha plume (e.g. Hoernle et al., 2015). Furthermore, it is possible that the DM type reservoir of the Karoo province, which has been interpreted to represent depleted upper mantle heated by mantle plume, could also represent a plume component and that the bilateral Karoo flood basalt province as a whole could thus register melting of a large zoned plume source associated with the margin of the sub-African LLSVP.

References


