



Mantle Sources Beneath the SW Indian Ridge - Remelting the African Superplume

H. J. B. Dick (1) and H. Zhou (2)

(1) Woods Hole Oceanographic Institution, Geology & Geophysics, Woods Hole, MA, United States (hdick@whoi.edu), (2) Tongji University, Shanghai China

The SW Indian Ridge runs some 7700 km from the Bouvet to the Rodriguez Triple Junction, crossing over or near two postulated mantle plumes. The latter are associated with large oceanic rises where the ridge axis shoals dramatically in the vicinity of the mantle hotspot.

The Marion Rise, extends 3100 km from the Andrew Bain FZ to near the Rodriguez TJ, with an along axis rise of 5600-m to its crest north of Marion Island. The rise has thin crust inferred on the basis of abundant exposures of mantle peridotites along its length. We suggest that this is the result of its sub-axial mantle source, which is a depleted residue originally emplaced by the African Superplume into the asthenosphere beneath southern Africa during the Karoo volcanic event ~ 185 Ma. Based on shallow mantle anisotropy, plate reconstructions, and hotspot traces, it now forms the mantle substrate for the SW Indian Ridge due to the breakup of Gondwanaland. The Marion Rise is associated with Marion Island, the present location of the Marion Hotspot, some 256 km south of the modern ridge. This plume is a vestigial remnant of the African Superplume now imbedded in and centered on asthenospheric mantle derived from the Karoo event. Based on the numerous large offset fracture zones, which would dam sub-axial asthenospheric flow along the ridge, the low postulated flux of the Marion plume, its off-axis position, and the thin crust along the ridge it is clear that the present day plume does not support the Marion Rise. Instead, this must be supported isostatically by the underlying mantle residue of the Karoo event.

The Bouvet Rise is much shorter than the Marion Rise, extending ~ 664 km from the Conrad FZ on the American-Antarctic Ridge to the Shaka FZ on the SW Indian Ridge. It has ~ 3000 -m of axial relief, peaking at Speiss Smt at Speiss Ridge: the last spreading segment of the SW Indian Ridge adjacent to the Bouvet TJ. Unlike the Marion plume, Bouvet is ridge-centered, and much of its rise is likely supported by sub-axial flow of hot mantle from the present-day plume. It is also clear from the isotopic composition of the Bouvet Plume that while it may also be a manifestation of the underlying seismic anomaly situated above D'' that gave rise to the Marion Plume, this source must be compositionally heterogeneous at a very large scale.

Secondary mantle heterogeneities are evident beyond those associated with the Marion and Bouvet Plumes. These likely explain the frequently extreme local isotopic variability of MORB along the SW Indian Ridge, and are likely due to entrainment of cratonic lithosphere from beneath Africa into the asthenosphere (e.g.: Meyzen et al., Nature, 2003). This is supported by major element anomalies in peridotites from adjacent to the 750-km offset Andrew Bain FZ, and by anomalously thick crust situated at Atlantis Bank, the site of an abrupt MORB isotopic anomaly, that suggest anomalously fertile mantle sources inconsistent with the regional basalt and peridotite major element compositional gradients attributed to the Superplume.