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The SW Indian Ridge - Remelting the Gondwanan Mantle

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The breakup of Gondwana initiated a string of geodynamic events resulting in the creation the SW Indian and neighboring ridges as well as the impact of numerous mantle plumes in the southern oceans. Two of these plumes interact with the SWIR: Bouvet in the south Atlantic and Marion in the southern Indian Ocean. The origin of these plumes and the nature of the surrounding mantle has been a subject of great interest and debate, and how they relate to the extreme isotopic variability found along the SWIR. The culmination of the systematic study of the SWIR over the last 40 years is that there now exists a systematic sampling of both mantle peridotites and ridge basalts along nearly its entire length. This has revealed that the ocean crust is thinner than that at other slow spreading ridges like the Mid-Atlantic Ridge, and is even missing over large regions, including the Marion Rise, which accordingly cannot be supported by the Marion Plume. Thus another explanation for the Marion Rise is that it reflects the remelting of old previously depleted arc mantle wedge material, and that the mantle plume represents an imbedded megalith of subducted material in the upper mantle that initially melted to produce a LIP on the Madagascar Margin and adjoining plateau, with the residue of this melting anomaly entrained in the ambient depleted arc mantle wedge material of the East-African Orogenic Belt, produced itself during the closure of the Mozambique Ocean and the collision of East and West Gondwana. The western limit of the EAOB can be traced from the African margin, across the southern Indian Ocean along the Andrew Bain FZ, which separates mantle pulled from beneath the orogenic belt to feed SWIR magmatism, from mantle pulled from beneath the Archean cratons of southern Africa. It is not coincidentally also the major break in both major element and isotopic geochemistry of MORB along the SWIR, reflecting the different composition of the mantle source beneath the western SWIR. On close inspection the interaction of the Bouvet Plume and the SWIR closely resembles that of the Marion Plume, and thus it too likely has an origin as an imbedded megalith of subducted material from earlier in Earth History, possibly the formation and breakup of Rodinia. However, the ambient mantle there likely reflects interaction between the Karoo Plume and erosion of the base of the cratonic lithosphere beneath southern Arfrica rather than delamination of old Neoproterozoic lithosphere as to the east.