2017 Geodynamics Seminar

The Southwest Indian Ridge, Remelting the Gondwanan Mantle

Henry Dick

Senior Scientist
Woods Hole Oceanographic Institution

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Talk Summary

The SW Indian ridge Marion Rise and the Icelandic Rise are the two largest oceanic rises. Whereas Iceland is supported in large part by thickened crust, sampling shows SWIR crust is generally thin and discontinuous, even over the rise. Thus, in the absence of thickened crust, the Marion Swell at the top of the rise should be supported by previously melted buoyant depleted mantle. Though basalts and peridotites are more refractory up the rise, the degree of melting inferred from peridotite Cr spinel and basalt Na_8 is only moderate. The peridotites, however, have substantially lower bulk alumina than those sampled to the east and west. Thus, the Marion platform mantle source must be garnet-poor and highly buoyant. This requires removal of high silica melts during the earlier melting, causing excess pyroxene depletion, consistent with a hydrous back-arc or arc environment.

Plate reconstructions shows the Marion Swell corresponds to mantle pulled from beneath the Pan-African Orogenic Belt, during breakup of Gondwana, while SWIR mantle to the east and west originated beneath Archean cratonic lithosphere. The Pan-African Orogenic belt is a 650 to 500 Ma ~1000-km wide terrain consisting of accreted micro-continental fragments and juvenile island arcs formed by subduction and closure of the Mozambique Ocean. Notably missing from the belt is any evidence of the old Mozambique Ocean Crust itself. The major suture zones bounding the belt are strike-slip zones due to southward-directed escape tectonics. These were re-occupied during Gondwana rifting, one of which now bounds the Marion Swell as the Andrew Bain Fracture Zones. Thus, the Marion Rise is likely the product of delamination of old arc-related lithosphere along with the Marion, Crozet, and Reunion Hotspots swept up in the radial mantle flow triggered by the emplacement of the Karoo Plume. The Karoo Plume itself is likely the product of the subduction of Mozambique Ocean crust, due to its greater density than old arc lithosphere, beneath the transition zone, up to ~560 Ma. This then eventually triggered the plume, initiating the breakup of Gondwana.