Geophysical Research Abstracts
Vol. 14, EGU2012-12689, 2012
EGU General Assembly 2012

Surface expression of the Reunion Plumehead as witnessed by tectonics in the Indian Ocean

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The arrival of a mantle plumehead at the Earth's surface is inferred to have occurred underneath India around 67 Ma, with eruption of the Deccan traps and associated hotspot track to the present day position of the Reunion plume. It was recently shown that this event had a major effect on the global motions, particularly the Indo-Atlantic plates between 68 and 45 Ma (Cande and Stegman, Nature, 2011). The primary evidence for this is the observation that the motions of the Indian and African plates appear to have been coupled during this period: when the Indian plate speeds up between 68 and 66 Ma (from 80 to 180 mm/yr relative to Africa), the convergence of Africa with Eurasia slows down and perhaps stops, and when the Indian plate slows down between 52 and 45 Ma, Africa-Eurasia convergence speeds up. The superfast motion of India (roughly 180 mm/yr) relative to Africa is well documented by seafloor spreading anomalies between 66 and 63 Ma, corresponding to the formation of the Deccan traps.

Clearly, this event should have a large surface expression locally, and we have been reevaluating the tectonics of this region within this context, in particular the reorganization of mid-ocean ridge systems in response to the arrival of a mantle plumehead. A broad topographic swell associated with the mantle plumehead may have caused dynamic uplift across the region even as early as 70 Ma. Continental rifting between the Seychelles microcontinent and India occurred directly over the location of the Deccan plume. One idea is that a distinct, but short-lived, Seychelles microplate existed during this time period. India-Africa separation evolved from a two-plate system (with Seychelles part of the Indian plate) into a three-plate system (with formation of the Seychelles microplate), and finally back into a two-plate system (with the Seychelles part of the Somali plate).

The suggestion that a distinct Seychelles microplate existed is largely based upon the observation that during the short period between 65-62 Ma, seafloor spreading was occurring simultaneously within both the Mascarene basin as well as across the newly formed Carlsberg ridge. This indicates that the Seychelles microcontinent was isolated by divergent plate boundaries on both its southwest and northeast sides. Euler pole rotations based on magnetic anomalies across the Carlsberg ridge result in the inability to close the India-Antarctica-Africa plate circuit during the period between 65-50 Ma (Cande et al., 2010). This can be solved by introducing the Seychelles microplate into the plate circuit, however this does not help constrain the exact time of its formation nor how long it persisted. It is reasonable to expect uplift from the Deccan plumehead led to a plate boundary reorganization, shifting India-Seychelles seafloor spreading from the Gop Rift in the Arabian Sea to an incipient Carlsberg Ridge while simultaneously causing cessation of Seychelles-Madagascar spreading in the Mascarene Basin. If this scenario is correct, it provides further key observations that can be used as constraints for geodynamic models.