

Plume-ridge connection: seismic evidence for an asthenospheric flow between La Réunion and the Central Indian Ridge

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Forty years ago, Morgan (1978) proposed that mid-ocean ridges could be fed by mantle plumes, even at large distance. He suggested that La Réunion hotspot could have preserved a physical connection for more than 30 My with the Central Indian Ridge, presently located at 1000 km distance, through a sub-lithospheric, near-horizontal flow of upper mantle plume material. Imaging such hypothetical plume-ridge connection remained an open challenge due to the lack of seismic instrumentation in the oceans.

To assess the question of plume imaging and of plume-ridge interplay, we deployed 57 broadband seismometers on the seafloor in the Western Indian Ocean in the frame of the RHUM-RUM project (Réunion Hotspot and Upper Mantle - Réunions Unterer Mantel), around La Réunion and particularly over the area between La Réunion and the Central Indian Ridge. Based on the results of surface wave tomography and SKS wave splitting, we present seismological evidence of such interaction. Surface waves clearly image a large-scale, low velocity body located beneath the lithosphere of the Mascarene Basin and spreading toward the Central Indian Ridge, and a more local, elongated low-velocity asthenosphere, 100-150 km thick, throughout the area between La Réunion and the Central Indian Ridge. Seismic anisotropy revealed by both body and surface waves show that this hot mantle trapped beneath the Mascarene Basin is flowing towards the Central Indian Ridge, likely dragged by the effect of its own buoyancy and the eastward lithosphere thinning. These results show that hot asthenosphere can spread and migrate horizontally beneath a slow-moving tectonic plate (here, the African plate that appears to act as a physical barrier), over large distances (>1000 km) before feeding a neighbouring mid-ocean ridge (here, the CIR) and perhaps an active hotspot (here, La Réunion hotspot), through a broad (>400 km) and thick (~100 km) channel. In this picture, the Réunion – Rodrigues – CIR channelled flow could represent the southern edge of a larger scale asthenospheric flow allowing to evacuate heat from mantle upwelling to the Earth's surface.

Keywords: Réunion hotspot, Asthenosphere, Anisotropy, Indian Ocean, Seismic tomography