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Crustal structure of the Walvis Ridge at the junction with the Namibian coast

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Continental breakup is commonly preceded or accompanied by massive volcanism and deposition of flood basalts. The large volumes of magma are thought to originate from hot upwelling mantle plumes arriving at the lithosphere. The following plume conduit often leaves a trail in form of volcanic islands or aseismic ridges on the newly created oceanic crust. Due to this correlation in space and time between plume-derived structures and continental breakup, plumes are considered to have a triggering effect or even cause continental breakups. The South Atlantic is a classical example for this model including the Parana (South America) and Etendeka (Africa) flood basalts as well as the aseismic ridges Rio Grande Rise and Walvis Ridge on both conjugate margins. The Walvis Ridge connects the Etendeka flood basalts with the active volcanic islands of Tristan da Cunha, the current hotspot position.

To investigate the modification of the continent ocean transition (COT) by the arriving plume head, a large geophysical on- and offshore experiment was conducted in 2011 at the intersection of Walvis Ridge with the African continent. We present two P-wave velocity models of the deep crustal structure derived from seismic refraction data. One profile crosses the ridge ~500km away from the coastline, while the other one extends along the ridge and continues onshore. 27 ocean bottom stations (OBS, spacing 13 km) were deployed for the perpendicular profile, 28 OBS, 50 land stations and 8 dynamite shots were used for the longitudinal profile.

Crustal velocities beneath Walvis Ridge range between 5.5 km/s and 7.0 km/s, which are typical velocities for oceanic crust. The thickness, however, is approximately three times than normal, 17 km in the western part and increasing to 22 km towards the continent. The COT is characterized by 30 km thick crust with a high velocity lower crustal body (HVLCB) with seismic velocities up to 7.5 km/s. The western boundary of the HVLCB is at a similar longitude as similar lower crustal bodies found more south. Towards the east the HVLCB terminates against the ~40 km thick crust of the Kaoko fold belt. Here, the variation of seismic velocities indicate that hot material intruded the continental crust during the initial rifting stage. However, beyond this relatively sharp boundary (40 km wide), the remaining continental crust seems not be affected by the hot material. The second line some 500 km west of the coast indicates that the Walvis Ridge might be broader than its topographic expression. The seismic velocities are similar to those closer to the coast, but the HVLCB is thinner.