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Structure of the lithosphere-asthenosphere system in the vicinity of the Tristan da Cunha hot spot as seen by surface waves

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Tristan da Cunha is a volcanic island located above a hotspot in the South Atlantic. The deep mantle plume origin of the hotspot volcanism at the island is supported by anomalous geochemical data (Rohde et al., 2013 [1]) and global seismological evidences (French and Romanovicz, 2015 [2]). However, until recently, due to lack of local geophysical data in the South Atlantic and especially around Tristan da Cunha, the existence of a plume has not yet been confirmed. Therefore, an Ocean Bottom Seismometer experiment was carried out in 2012 and 2013 in the vicinity of the archipelago, with the aim of obtaining geophysical data that may help to get some more detailed insights into the structure of the upper mantle, possibly confirming the existence of a plume.

In this work we study the shear wave velocity structure of the lithosphere-asthenosphere system beneath the Island. Rayleigh surface wave phase velocity dispersion curves have been obtained using a recent powerful implementation of the inter-station cross-correlation method (Meier et al., 2004 [3]; Soomro et al., 2016 [4]). The measured dispersion curves are used to invert for the 1D shear wave velocity structure beneath the study area and to obtain phase velocity tomographic maps.

Our results show a pronounced low shear wave velocity anomaly between 70 and 120 km depth beneath the area; the lid shows high velocity, suggesting a cold, depleted and dehydrated shallow lithosphere, while the deeper lithosphere shows a velocity structure similar to young or rejuvenated Pacific oceanic lithosphere (Laske et al., 2011 [5]; Goes et al., 2012 [6]). Below the base of the lithosphere, shear wave velocities appear to be low, suggesting thermal effects and partial melting (as confirmed by petrological data). Decreasing velocities within the lithosphere south-westward reflect probably a thermal imprint of an underlying mantle plume.

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