Investigating Seismic Anisotropy of the Madeira and Canaries Hotspots Using Teleseismic and Local Shear-Wave Splitting with the SIGHT project

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Madeira and the Canary Islands, located in the eastern North Atlantic, are two of many examples of hotspot surface expressions. Their tracks have been reconstructed to past locations close to the south-western part of the Iberian Peninsula and north-western Africa, respectively. Furthermore, due to their close proximity, an interconnected origin of these two hotspots has been proposed but details remain unclear. A better understanding of the crust and upper mantle structure beneath these islands is needed to investigate this potential connection.

The subsurface structure has an influence on the stress field, which can be investigated studying seismic anisotropy patterns of the region. Seismic anisotropy leads to variations in the speed of seismic waves as a function of the direction of wave propagation. In the crust an orientation in the direction of maximum stress is observed, commonly being parallel to the alignment of fractures or cracks. In the upper mantle the orientation is influenced by mantle flow. A widely used method to identify anisotropy is the observation of shear-wave splitting of data from teleseismic events. In case of multiple anisotropic layers, including measurements from local events it is possible to distinguish crustal from upper mantle influences.

As part of the SIGHT project (Seismic and Geochemical constraints on the Madeira HoTspot), we carried out the first detailed study of seismic anisotropy beneath both archipelagos, using teleseismic SKS and local shear-wave splitting measurements of data collected from land stations of seismic networks located on Madeira and the Canary Islands.

Significant changes, both in orientation and delay time, can be observed on short length-scales on the order of tens of kilometres, matching major geological features such as, for example, the major rift zone on Madeira island. In a further step, we compare these results to previous studies of crustal and upper mantle anisotropy focusing on north-western Africa and the Iberian Peninsula to investigate the nature of the lithospheric corridor between the present day hotspot positions and the Atlas-Gibraltar region.

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