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UPPER CRUSTAL STRUCTURE OF MADEIRA ISLAND REVEALED FROM CROSS CORRELATION OF AMBIENT SEISMIC NOISE

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Madeira is an intraplate volcanic island, located at the eastern North Atlantic Ocean, in front of the Moroccan cost, with an emerged area of 737 km^2 and maximum altitude of 1861 m. Madeira shows an E-W-oriented elongation, which probably reflects the orientation of a rift zone. Imaging Madeira island internal structure as a function of depth it's fundamental to constrain the main shallow volcano-tectonic features and thereby contribute to better understand its geological evolution. Over the last decade, ambient noise tomography has been increasing in popularity among seismic imaging techniques, as it overcomes some limitations ascribed to traditional methods (eg. source-receiver geometry, sparse and irregular seismicity distribution) and allows to image regions with a resolution that mainly depends on the seismic network coverage. Recently, a dense temporary seismic network belonging to DOCTAR (Deep Ocean Test Array) project has been continuously recording in the study area. This deployment was complemented with other local permanent stations, operated by Portuguese National Seismic Network (see Figure 1). Cross-correlation of 16 months of ambient seismic noise data allowed us to retrieve short-period Rayleigh waves on all interstation paths (see Figure 2). Following Rayleigh wave Green's function extraction, traditional surface wave tomography techniques are then used to derive a quasi-3D shear wave velocity model of the upper crust. The high ray path coverage allows us to perform group velocity tomography on a 2 km x 2 km sized grid, for periods between 1 and 4 s. Then, each cell of the tomographic maps has been depth inverted for a shear wave velocity model, from 0 to 2.5 km, bellow sea level. Our results clearly show a strong high velocity anomaly well correlated with the rift zone, along which the island possibly has grown. This anomaly seems to be perturbed by the presence of a low velocity anomaly coherent with a large number of smaller volcanic cones mapped out in surface geological studies.

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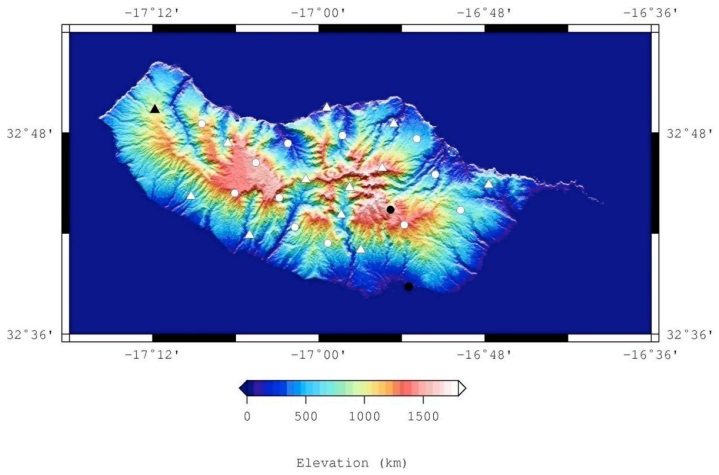

Figure 1. Topographic map of Madeira Island showing the distribution of the seismographic stations deployed in Madeira Island. Short period sensors are represented with circles and broad-band sensors with triangles. IPMA and DOCTAR stations are represented with solid and open triangles and circles, respectively.

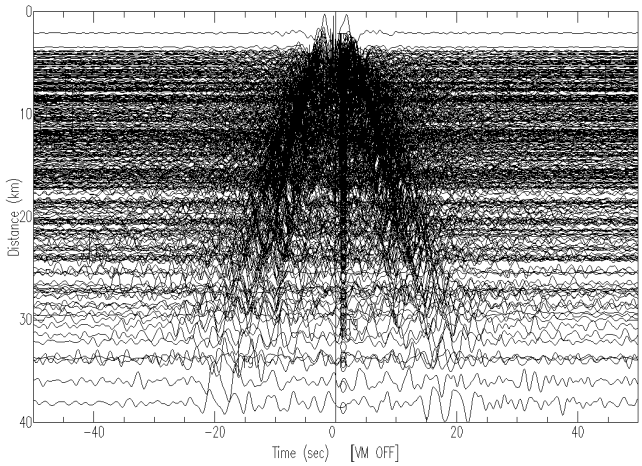

Figure 2. Short period record section (1 – 5 s) of the obtained cross-correlations computed between 325 station pairs, for a sixteen months stack.