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Short-Period Rayleigh Wave Dispersion Measurements as an evaluation tool to estimate Madeira heat source depths

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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 km2 and maximum altitude of 1861 m. The existence of recent volcanism (6 my) with well preserved volcanic cones and thermal evidences suggest the presence of a heat source at shallow levels. An attempt to define the depths of these heat sources depths in Madeira is being conducted by the integration of petrological, geochemical and geophysical methods, including seismic tomography.

Constrains like source-receiver geometry, irregular seismicity distribution or, for some methods, low seismicity occurrence did not allow to obtain high-resolution models of the Madeira shallow structure using traditional passive seismology. Seismic interferometry/ambient noise surface-waves tomography allows imaging regions with a resolution that mainly depends on the seismic network coverage.

From May 2011 to September 2012, a temporary pool of 23 seismometers (Fig.1) has been continuously recording at Madeira Island. This deployment, complemented with other local permanent stations, provided a dense coverage of the island. Cross-correlation of the ambient seismic noise recorded at the network allowed us to measure short-period Rayleigh waves on all interstation paths. These cross-correlograms enabled us to compute short-period surface-wave group-velocity measurements on interstation paths. We used these measurements to obtain lateral variations of the Rayleigh-wave group-velocities as function of the period. As a result we were able to address some of the unknowns regarding the crustal structure beneath Madeira. The dispersion curves, extracted from the Rayleigh-wave group-velocity maps, have been inverted to obtain a quasi-3-D model of the crustal shear wave velocities.