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Abstract Template

Geochemical and Short-Period Rayleigh Wave Dispersion Measurements as evaluation tools to estimate Madeira Island magma chambers depths

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Abstract:

Madeira, is an intraplate volcanic island, located at the eastern North Atlantic Ocean, with an emerged area of 737 km^2 and maximum altitude of 1861 m, and shows evidences of recent volcanism (6 my). In a volcanic geothermal system the heat source comes from magma emplacement at relatively shallow levels, thus knowledge of magma chamber(s) depth(s) is one of the keys to geothermal reservoir assessment. The tentative definition of these depths in Madeira is being studied by the integration of petrological, geochemical and geophysical methods. Whole rock analysis and mineral chemistry are a helpful tool to constraint the crystallization temperatures and pressures/depths of magmas and to unveil the physical-chemical crystallization history of selected phenocrysts, hence the depth of magma chambers. Volcanic rocks (effusive and explosive) in Madeira are predominantly olivine- and clinopyroxene-phyric alkaline basalts. Petrographic and chemical criteria show that olivine and clinopyroxene phenocrysts had polybaric crystallization, suggesting that they paused in crustal magma chambers prior to eruption. Selected geothermobarometers, based on olivine-liquid and clinopyroxene-liquid equilibrium, indicate that core crystallization for the youngest volcanic complex clinopyroxene phenocrysts occurred between 2 to 4 kb which is a good indication of a 6 to 12 km depth magma chamber beneath the island.

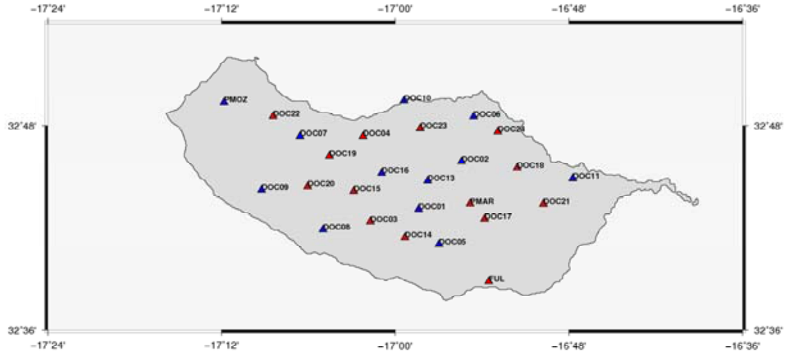

Figure 1 - Localization of the seismic stations at Madeira Island. Red triangles: short-period; blue triangles:broadband

From May 2011 to Septemper 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. Ambient noise tomography has proved to be an efficient tool to construct high resolution maps of shallower structures. Firstly, it allows measurements at periods shorter than 20 sec, which are hard to obtain from earthquake surface waves. Secondly, being independent of the epicentre-station geometry, it is suitable on regions of low seismicity. Cross-correlation of about 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 construct maps of Rayleigh-wave group-velocity lateral variations at different periods. Group velocity maps will be interpreted regarding a better constrain of velocity with depth.

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