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First high resolution P wave velocity structure beneath Tenerife Island, (Canary Islands, Spain)

Araceli Garcia-Yeguas (1), Koulakov Ivan (2), Ibañez Jesus M. (1), and Sallarès Valenti (3)

(1) University of Granada, Instituto Andaluz de Geofísica, Física Teórica y del Cosmos, Spain (araceli@ugr.es), (2) Laboratory for Forward and Inverse Seismic Modelling. Institute of Petroleum Geology and Geophysics, SB RAS. Novosibirsk, Russia, (3) Centro Mediterraneo de Investigaciones Marinas y Ambientales (CMIMA) (CSIC), Barcelona, Spain

3D velocity structure distribution has been imaged for first time using high resolution traveltime seismic tomography of the active volcano of Tenerife Island (Canary Islands, Spain). It is located in the Atlantic Ocean. In this island is situated the Teide stratovolcano (3718 m high) that is part of the Cañadas-Teide-Pico Viejo volcanic complex. Las Cañadas is a caldera system more than 20 kilometers wide where at least four distinct caldera processes have been identified. Evidence for many explosive eruptions in the volcanic complex has been found; the last noticeable explosive eruption (sub-plinean) occurred at Montaña Blanca around 2000 years ago. During the last 300 years, six effusive eruptions have been reported, the last of which took place at Chinyero Volcano on 18 November 1909. In January 2007, a seismic active experiment was carried out as part of the TOM-TEIDEVS project. About 6850 air gun shots were fired on the sea and recorded on a dense local seismic land network consisting of 150 independent (three component) seismic stations. The good quality of the recorded data allowed identifying P-wave arrivals up to offsets of 30-40 km obtaining more than 63000 traveltimes used in the tomographic inversion.
The images have been obtained using ATOM-3D code (Koulakov, 2009). This code uses ray bending algorithms in the ray tracing for the forward modelling and in the inversion step it uses gradient methods.
The velocity models show a very heterogeneous upper crust that is usual in similar volcanic environment. The tomographic images points out the no-existence of a magmatic chamber near to the surface and below Pico Teide. The ancient Las Cañadas caldera borders are clearly imaged featuring relatively high seismic velocity. Moreover, we have found a big low velocity anomaly in the northwest dorsal of the island. The last eruption took place in 1909 in this area. Furthermore, in the southeast another low velocity anomaly has been imaged. Several resolution and accuracy tests were carried out to quantify the reliability of the final velocity models. Checkerboard tests show that the well-resolved are located up to 6-8 km depth. Also we carried out synthetic tests in which we successfully reproduce single anomalies observed in the velocity models. Especially we have study carefully the low velocity anomalies found in the NW and SE, which have been recovered successfully. The jack-knife technique have been used and our results are stable if we remove the 50% of the data for different stations, but if we reject all the data for some stations, the velocity models can change. These tests assure the uniqueness of the first 3D velocity model that characterizes the internal structure of the Tenerife Island. As main conclusions of our work we can remark: a) This is the first 3-D velocity image of the area; b) we have observed low velocity anomalies near to surface that could be associated to the presence of magma, water reservoirs and volcanic landslides; c) high velocity anomalies could be related to ancient volcanic episodes or basement structures; d) our results could help to resolve many questions relate to the evolution of the volcanic system, as the presence or not of big landslides, calderic explosions or others; e) this image is a very important tool to improve the knowledge of the volcanic hazard, and therefore volcanic risk. We would like to highlight the importance of take into account the risk of eruption in other areas besides Pico Teide-Las Cañadas system.