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Modelling of crustal anomalies of Lanzarote (Canary Islands) in light of gravity data

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SUMMARY

The application of a gravity inversion method enables us to obtain a 3-D density contrast model of the upper crustal anomalies of the volcanic island of Lanzarote (Canary Islands). For this, we use a network of 296 gravity stations distributed over the whole island, and a digital terrain model of about 45 000 terrestrial and oceanic data to determine the corresponding terrain correction. A density value of 2480 kg m^{-3} is chosen for this correction by means of a new approach. The resulting Bouguer anomaly is analysed by means of a least-squares prediction which gives us a mean level of uncorrelated observational noise of about 1.2 mgal. This anomaly is considered in order to obtain independent information about the inner anomalous mass density distribution by means of a 3-D gravity inversion based on a systematic exploration on a prismatic partition of the subsoil volume, and adopting *a priori* values of the density contrast (positive and negative) to determine the geometry of the anomalous bodies. The problem of non-uniqueness of the solution is avoided by using a minimization mix condition on the weighted residuals and the weighted whole anomalous mass. The structural solution is finally presented by means of horizontal sections and vertical profiles.

A main intrusive body is located under the central-eastern area and could correspond to a dilated volcanic activity of shield formation. It shows a prismatic form of more than 15 km depth, subducted with only the ridges remaining as horst blocks. Moreover, the SW and NE extreme areas of the island show smaller and shallower positive bodies, interpreted as less-developed magmatic intrusions. Conversely, several density lows offer interesting shallow alignments, 45°N (ENE–WSW) and 125°N (WNW–ESE), which could be associated with a fracture system corresponding to structural stress, and also correlate with historic eruptions, such as, for instance, the Timanfaya eruption. The monitoring of several geophysical parameters at two underground geodynamic stations, in the NE zone of the island and Timanfaya, shows characteristic differences between the two zones which confirm crustal anomalies in the second station.

Key words: gravity anomalies, inverse problem, Lanzarote island, volcanic structure.

INTRODUCTION

The Canary Islands (Fig. 1) are an old volcanic feature sited on top of Jurassic oceanic crust, located at the edge of the West African Continental Margin. Their origin is still under debate, and authors have proposed different types of genetic models (e.g. Wilson 1973; Schmincke 1982; Holik *et al.* 1991; Anguita & Hernan 1975; Marinoni & Pasquarè 1994) for the archipelago, where some age determinations (Abdel-Monem *et al.* 1971) indicate a general E–W age progression. The diverse models apply, for instance, hotspot theory (Wilson 1973), a connection to the Alpine orogeny, which reached its maximum activity in this zone during the Miocene (Anguita & Hernán 1975), and the coexistence of a hotspot and a constraining complex regional structural framework (Schminke 1982). Several geophysical research projects have been conducted in the archipelago (e.g. Bosshard & MacFarlane 1970; Banda *et al.* 1981; Canales & Dañobeitia 1998; Dañobeitia *et al.* 1994; Ranero *et al.* 1997), pointing out clear structural differences among the islands. Among these differences, from recent seismic studies it seems reasonable that the oceanic crust west of El Hierro islands is very shallow, Ranero *et al.* (1997) deduced a crustal thickness