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Inferences from gravity data interpretation of the volcanic complexes of the Terceira Island (Azores)

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Terceira Island, together with Graciosa, São Jorge, Pico and Faial islands form the Central Group of the Azores Archipelago. Located in the Terceira Rift, this island shows an active volcanism (with a wide variety of rocks compositions and structures) and an important seismic activity.

From east to west, Terceira Island includes four central polygenetic volcanoes with caldera (Serra do Cume, Guilherme Moniz, Pico Alto and Santa Bárbara) and a Basaltic Fissural Zone, mainly in the central and SE parts of the island. The volcanic activity from these central volcanoes took place mostly in Quaternary times. After the settlement of the island (in the fifteenth century) three basaltic volcanic eruptions took place: in 1761 (on-land) and in 1867 and 1998-2000, the latter two off-shore the NW coast of the island.

Regarding seismicity, Terceira Island has been affected by several damaging earthquakes, like the Praia da Vitória earthquakes in 1614 and in 1841, and the January 1st, 1980 earthquake, the strongest in Azores in the last century, with M=7.2. For most of these earthquakes and others (like the 1997 and 1998 seismic crisis) there was an anomalous Mercalli Modified Intensity distribution throughout the island, with higher intensity at the eastern zone.

We present a study of the structural setting of the volcanic island of Terceira by the analysis and interpretation of high-resolution gravity, geological and volcanological data recently acquired over the island (the last gravity survey on July 2008). We have carried out a structural study of the subsurface by means of gravity inverse problem, looking for information about lateral changes in mass distribution for crustal-upper mantle models and their correlation with the geologic, tectonic and volcanic edifices of the island and also with local seismic amplification phenomena registered in the island.

We employ an inverse methodology based in a genetic algorithm, which has been applied with success on other volcanic environments. The intrinsic non-uniqueness in the solution of this problem is reduced using a priori information (geological or geophysical) and including mathematical stabilizing constraints that are obtained from geological setting. Thus, our inversion technique aims to determine the geometry of the sources of the observed gravity field, upon a prismatic partition of the subsoil volume, and considering two constraints about the source compactness and the density contrast values fixed for these sources (positive and negative values are simultaneously accepted). It is thus expected that these constraints produce geologically meaningful results, compatible with the information available for the area.

The analysis of gravity data allows us to locate the main anomaly sources and lineaments of the island and the inversion technique was used to build a crustal model of the island structures. This model together with volcanological and geological information allowed us to draw inferences on the structural pattern of the central polygenetic volcanoes of Terceira and their calderas, the Basaltic Fissural Zone and also on the Praia da Vitória-Lajes graben located on the NE part of the island.