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Analysis of gravity anomalies in Maio Island, Cape Verde.

Joao Catalao (1), Patricia Represas (1), Fuensanta Montesinos (2), Carlos Antunes (1), José Madeira (1), and João Mata (3)

(1) IDL, Univ. Lisboa, DEGGE, Lisbon, Portugal (jcfernandes@fc.ul.pt), (2) Instituto de Astronomia y Geodesia, Universidad Complutense de Madrid, Spain, (3) CGUL, Univ. Lisboa, Dep. Geologia, Lisboa, Portugal

The Cape Verde archipelago is located in the Atlantic Ocean about 500 km west of Senegal. It stands on the south-western part of the Cape Verde Rise, the largest oceanic intraplate bathymetric anomaly, which also coincides with important geoid and heat flow anomalies. The oceanic crust in the region is about 120 to 140 Ma old and the lithosphere circa 80 km thick. Cape Verde has been considered a hotspot resulting from a mantle plume for which the depth of rooting is still debatable.

New gravimetric data were obtained on Maio (269 km2), which is one of the oldest islands of the Cape Verde archipelago. It presents a flattened morphology, mostly the result of quaternary marine abrasion, with a few residual hills in the centre. Geologically it is formed by a basement comprising uplifted sea-floor (N-MORB pillow lavas underlying a Jurassic-Cretaceous sedimentary suite) densely intruded by plutonic bodies of essexite/pyroxenite (and minor syenite) of probable Early Miocene age ($\sim$ 18-20 Ma) and dyke swarms. Unconformably resting on those units is a Mid to Late-Miocene ($\sim$15 – 7 Ma) sequence of hyaloclastites and pillow lavas, subaerial lavas and correlative volcaniclastic sediments. A set of Quaternary beach deposits (up to 70 m asl) and Holocene sediments (alluvial fans, aeolian sands) partially cover all sequences.

The gravity survey was obtained over a total of 144 stations with a mean spacing of 1 km, measured with a Lacost & Romberg gravimeter. Stations position and height were determined by GPS and the orthometric heights were determined using a global geopotential model. Regional gravity and topographic/bathymetric data were compiled from EGM08 geopotential model and Smith and Sandwell global model, respectively. Grids with a resolution of 1 arcmin were computed for the gravity data and for the outer topographic/bathymetric data. A denser topographic grid, with 20 m resolution, was derived from cartographic charts of the island of Maio. The analysis of the dataset was performed by a stabilized non-linear inversion methodology.

A local average terrain density of 2200 kgm-3 was determined by applying a fractal analysis to the free-air anomaly. Topographic gravity effects were computed and the Bouguer anomaly for Maio Island was revealed. The global model was used to estimate the regional field. The resulting residual field shows a single positive anomaly, with a maximum value of 63 mGal. It has an elliptic shape, slightly off-centred with the island, and presenting a long axis trending N20W. A 3-D density contrast model was estimated from the Bouguer anomalies by means of a stabilized non-linear inversion methodology. This gravimetric inversion technique aims to determine the geometry of the sources of the observed gravity field, upon the adjustment of a three dimensional model of prismatic cells which adopt a priori values of density contrast (positive and negative). The density contrast assigned for each cell is determined using a combination of a process of accretion with a search of model changes to achieve a minimum residual between gravity data and model response.

Results from the gravity inversion presents a good correlation with the geology of the island of Maio. The structural model obtained depicts a main high density body coinciding with the positive gravity anomaly which dominates the island. This body corresponds to the Basament Complex which is exposed in this area, where the plutonic bodies of essexite/pyroxenite crop out and thus reflect the highest density of those rocks relatively to mafic lava flows and accompanying sediments. The deepest sections of the model show the relation between this body and the earlier growth stage of the island.