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3D free-air gravity anomaly modeling for the Southeast Indian Ridge

Chiara Girolami (1), Ingo Heyde (2), Massimiliano Rinaldo Barchi (1), and Cristina Pauselli (1)

(1) Department of Physics and Geology, University of Perugia, Perugia, Italy (chiara.girolami@studenti.unipg.it), (2) Federal Institute for Geosciences and Natural Resources (BGR), Hannover, Germany (ingo.heyde@bgr.de)

In this study we analyzed the free-air gravity anomalies measured on the northwestern part of the Southeast Indian Ridge (hereafter SEIR) during the BGR cruise INDEX2012 with RV FUGRO GAUSS. The survey area covered the ridge from the Rodriguez Triple Junction along about 500 km towards the SSE direction. Gravity and magnetic data were measured along 65 profiles with a mean length of 60 km running approximately perpendicular to the ridge axis. The final gravity data were evaluated every 20 seconds along each profile. This results in a sampling interval of about 100 m. The mean spacing of the profiles is about 7 km.

Together with the geophysical data also the bathymetry was measured along all profiles with a Kongsberg Simrad EM122 multibeam echosounder system.

Previous studies reveal that the part of the ridge covered by the high resolution profiles is characterized by young geologic events (the oldest one dates back to 1 Ma) and that the SEIR is an intermediate spreading ridge.

We extended the length of each profile to the area outside the ridge, integrating INDEX2012 high resolution gravity and bathymetric data with low resolution data derived from satellite radar altimeter measurements.

The 3D forward gravity modeling made it possible to reconstruct a rough crustal density model for an extended area (about 250000 km2) of the SEIR.

We analyzed the gravity signal along those 2D sections which cross particular geological features (uplifted areas, accommodation zones, hydrothermal fields and areas with hints for extensional processes e.g. OCCs) in order to establish a correlation between the gravity anomaly signal and the surface geology.

We started with a simple "layer-cake" geologic model consisting of four density bodies which represent the sea, upper oceanic crust, lower oceanic crust and the upper mantle. Considering that in the study area the oceanic crust is young, we did not include the sediment layer.

We assumed the density values of these bodies considering the relation between the density and the seismic P-wave velocity VP. We choose the velocity data from the scientific literature. We found that the "layer-cake" model does not explain the measured anomalies satisfyingly and lateral density changes have to be considered for the area beneath the ridge axis. Accordingly we reduced the density values of the lower crust and the upper mantle beneath the axial ridge introducing in the model two additional bodies called partial melted crust and anomalous mantle.

Finally we present isobaths maps of the anomalous mantle which highlight the lateral heterogeneity of the oceanic crust beneath the ridge axis. In particular there are areas characterized by crustal thickening related to magmatic accretion and areas of crustal thinning related to depleted accretion of the mantle which can lead to the exposure of OCCs.