Geophysical Research Abstracts
Vol. 13, EGU2011-372, 2011
EGU General Assembly 2011

Influence of Deeper Crustal Structures on Free-air Gravity Anomaly Maps Interpreted from Cross-Product and Angular Differences Method

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Summary
The main objective of this study was to determine regions where the observed gravity anomaly is generated by bathymetric or deeper crustal structures without applying Bouguer correction. We interpreted morphological correlations between bathymetric, free-air gravity and magnetic anomaly maps. We applied cross-product and angular differences method to determine the imprint of deeper crustal structures on free-air gravity anomaly maps. Results and maps are discussed.

Data and Method
Our method is based on the assumption that similar morphologies of two maps indicate correlation between the mapped properties. We used angular differences and cross-product as criteria to access morphological similarities. Map of angular differences can be used to find areas with direct and inverse relation between properties and contour common tendencies independently of structures magnitudes. Angles between gradients range from 0º to 180º. Areas dominated by small angles are morphologically correlated. Values close to 180º show inverse correlation. Averaged statistical distribution of angles indicates the rate of correlation between maps. For correlated maps statistical dominance of smaller angles is expected. While for not-correlated data it is expected that angles will tend to be equally distributed over the interval.
We applied cross-product method to interpret the strength of morphological correlation. Regions where magnitudes product is significantly minimized after multiplication by the sine of the angle are considered correlated.
We used satellite short-wave gravity and bathymetry data and longer-wave crustal magnetic anomaly maps.

Results and Discussion
We applied this method for maps of south-east Brazilian coast. Area is limited by 10ºS and 30ºS parallels and from Brazilian shore up to 25 ºW. This area includes westward slope of the mid-ocean ridge, Vitoria-Trindade Fracture zone, continental slope and seamounts and other structures.
Map of angles between magnetic and gravity anomaly show a general weak correlation between them. As expected the main source of the free-air gravity anomaly is the bathymetry. But for some smaller regions (ex. fracture zones) morphological correlation between gravity and magnetic anomalies is strong. Many of those structures are also presented in bathymetry but with smaller magnitudes suggesting that the main structure is underneath the surface. For some longer-wave structures the correlation between bathymetry and magnetic anomaly is stronger than with gravity.
Cross-product map also indicates a strong correlation between bathymetry and free-air gravity. Cross-product between gravity and magnetic anomaly presents general higher values than with bathymetry. But again for some regions we can see a strong reduction of product magnitudes suggesting strong morphological correlation.
According to our results we can conclude that the principal source of the regional free-air gravity anomaly is the bathymetry but in several smaller regions deeper crustal structures have a dominant role. This method allowed us to find regions with distinct geological conditions - where deeper structures play the dominant role in gravity anomaly formation.