Gravity and Magnetic Investigations Along the Peruvian Continental Margin

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Abstract

This work presents the first three-dimensional gravity and magnetic investigation along the convergent Peruvian margin. Three-dimensional magnetic modelling is still a relatively untried and challenging technique. The gravity and magnetic models image nearly the whole margin which has been only partly resolved with geophysical methods up to now. The gravity and magnetic models are constructed for three areas between 7.25°S and 16.75°S and are based on the available wide-angle seismic velocity models (Hampel et al., 2002a; Broser et al., 2002). The continental margin is characterised by positive free-air anomalies of varying amplitudes, indicating that the margin has been shaped by the subduction of different features on the Nazca Plate. A comparison of the shipboard gravity measurements with the satellite data ensures that the data compiled from different marine surveys are compatible. In the Yaquina Area (7.25°S to 11°S) gravity anomalies caused by the Trujillo Trough and the Mendaña Fracture Zone are successfully modelled with remarkable undulations in the layer geometry of the oceanic crust. Along the continental margin, especially in the Lima Area (10.50°S to 14.40°S), strong undulations of the lower continental crust influence the upper sedimentary layers and support the development of basins along the Peruvian margin.

The theory stating that the Peruvian margin is uplifted by the subducting Nazca Ridge (Kulm et al., 1988; Hagen & Moberly, 1994) is supported by gravity modelling. Consequently the buoyant Nazca Ridge is, at least partly, responsible for the extended region of flat subduction. The thickened and slightly asymmetrical crust of the Nazca Ridge is envisaged in gravity modelling. In the Nazca Ridge Area (14.25°S to 16.75°S) no accretionary prism is modelled. I conclude that the ridge is eroding the continental margin; furthermore the subduction of eroded sediments is probable. Gravity modelling suggests that the Nazca Ridge has fractured the continental margin. North of the ridge, in the Lima Area, a rather uniform accretionary complex is observed. This indicates that, after the margin was eroded by the southwards moving Nazca Ridge, the prism rapidly reached its stable size. In the Yaquina Area an accretionary prism is modelled in the whole research area but local variations of its location and structure indicate the former erosive influence on the continental margin of subducting features on the Nazca Plate. The layers of the oceanic crust show increasing densities implying they possess an originally high degree of porosity before actually subducting.

The lineations 13 to 18 are traced from the southern part of the studied region as far north as the Mendaña Fracture Zone. Their orientation indicates that the Nazca Plate has not significantly changed its convergence direction between 12°S and 17.5°S in the past 33 Ma. In the Nazca Ridge Area a different anomaly pattern compared to the surrounding areas is observed. I conclude that the ridge is younger than the respective Nazca Plate and that it was formed on the already existing Nazca Plate and obliterated the original magnetic anomalies. In all models the basaltic layer sheeted dykes is considerably weaker magnetised than the upper pillow lavas and the lower gabbros. Generally the rocks of the continental margin possess a weak magnetisation.

The Königsberg ratio is small for all layers of the oceanic crust, i.e. the induced magnetisation is partly higher than the remanent magnetisation. When it has subducted to a minimum depth of 25 km the magnetised oceanic crust exerts almost no influence on the observed total intensity field.