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Crustal evaluation of the northern Red Sea rift and Gulf of Suez, Egypt from geophysical data: 3-dimensional modeling

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Abstract

Combined 3-D interpretations of gravity and aeromagnetic data have been used in addition to continental and marine seismic profiles, well logs and geological cross-sections. The combination of gravity and magnetic data has improved the geometry and the density distribution in the 3-D calculated profiles. Results of the current work reveal possible crustal thickness and density distribution between the sedimentary cover and the upper mantle including the Moho discontinuity. The Moho depth map of the region, as obtained from the 3-D modeling exhibits various crustal thickness distributions. The type of crust changes gradually from continental to oceanic, from north to south. The zone of crustal thinning coincides mostly with zones of low-density, heated anomalous upper mantle beneath the rift floor (7 km). The eastern plateaus (the Red Sea hills) show by far the largest crustal thickness in the region (32 km).

The Moho relief, as indicated from magnetic interpretation, shows a poor flattening especially in the eastern region. This is contrary to what is given by other authors. However, the present results are in good agreement with the geothermal gradient values in the Red Sea.

The interpretation of magnetic data of the Red Sea Rift shows that the spreading rate of the part south of latitude 26.5° N agrees well with the theoretical model, in the order of 0.7 cm/yr. Less agreement has been obtained in the part north of latitude 27.5° N.

The magnetic anomalies along the axial portion of the rift floor, as deduced from the results of the regional and residual separation and the 3-D magnetic modeling, are mainly caused by the oceanic crustal structures beneath the graben.

Keywords: 3-Dimensional modeling; Bouguer and magnetic anomalies; Red Sea rift; Gulf of Suez; Egyptian off-shore

1. Introduction

The Red Sea is considered to be a typical example of a newly formed ocean; therefore, a great number of studies discuss its evolution as a key for understanding continental rifting and the initiation of sea floor spreading (Drake and Girdler, 1964; Tramontini and Davies, 1969; Makris et al., 1983; Gaulier et al., 1988; Martinez and Cochran, 1988; Cochran and Martinez, 1988; Meshref, 1990).

Drake and Girdler (1964), Tramontini and Davies (1969) indicated that the recorded seismic velocities are 5.8–5.9 km/s for the upper crust in the northern Red Sea, and the crust appears to be somewhat inhomogeneous in this area. Also, it was stated that the northern part of the Red Sea appears to be characterized by oceanic type crust, lying at a mean depth of 7–8 km, whereas the Moho is at a mean depth of 10–13 km, and at 32 km closest to the coastline (Gaulier et al., 1988; Makris et al., 1991; Rihm et al., 1991).

Data presented in Cochran and Martinez (1988) and in Martinez and Cochran (1988) imply that extension in the northern Red Sea has recently become concentrated in a

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