TECTONIC IMPLICATIONS OF BOUGUER AND MAGNETIC ANOMALY MODELS IN THE EVOLUTION OF THE CENTRAL ALBORAN SEA

J. Galindo-Zaldivar [1], F. Gonzalez-Lodeiro [1], A. Jabaloy [1*], A. Maldonado [2] and A.A. Schreider [3]

[1] Departamento de Geodinamica, Universidad de Granada, 18071-Granada, Spain
[2] Instituto Andaluz de Ciencias de la Tierra (C.S.I.C - Universidad de Granada), 18071-Granada, Spain
[3] P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences, 23, Krasikova, 117218 Moscow, Russia

Abstract

Largest magnetic anomalies in central Alboran Sea are related to ENE-WSW elongated bodies of basic igneous rocks located along the Alboran Channel. Bouguer anomaly models show that minimum crustal thicknesses are reached in this area and along the arched western Alboran basin. These two axes of crustal thinning were probably active during the Oligocene - Early Miocene. The western Alboran basin axis is subparallel to the Gibraltar Arc and its origin may be related to the origin of the arc. The ENE-WSW trending Alboran Channel axis may represent the western end of the Algerian-Balearic basin rift.

Key-words : crust structure, Alboran Sea

Introduction

The Alboran Sea developed above the Internal Zones of Betics and Rif. The thickest depositional sequences of the sea are located at the western Alboran Basin (1), and begin in Late Aquitanian (1). Deep seismic refraction profiles (2, 3) indicate that Alboran Sea has a thinned continental crust that thickens towards the Betics and Rif. The low P and S spread velocities (3) and high regional heat flow (4), suggest that an anomalous mantle exists below the sea (4). Gravimetric studies confirm this deep structure for the Alboran Sea (5, 6, 7). Magnetometric studies, however, are scarce (8, 9, 10). The objective of this work is to determine the geometry of the bodies responsible for the largest gravimetric and magnetic anomalies. Gravimetric and magnetic data have been compiled, reinterpreted, and 2D profile models have been developed for these anomalies.

Magnetometry

The largest dipoles have N70°E elongation and are located in the central Alboran Sea (Fig. 1). Another N45°E elongated anomaly occurs in the NE Alboran Sea, where acid and intermediate volcanic rocks crop out onshore. The most important isometric anomalies coincide with peridotite outcrops, to the W of the sea.

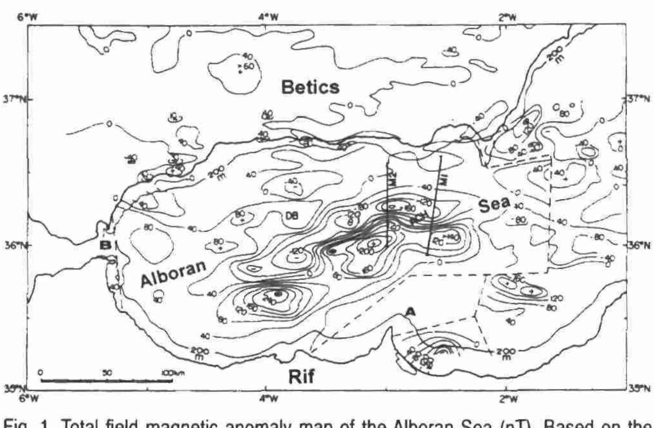

Fig. 1. Total field magnetic anomaly map of the Alboran Sea (nT). Based on the marine magnetometric data (9 and 10) and aeromagnetic data (8 and 15). A: area with complex local aeromagnetic anomalies; B: Gibraltar Strait area not included in this study. ACH, Alboran Channel. DB, Djibouti Bank.

The 2D magnetic models (Fig. 2) cut the anomaly bands in the central Alboran Sea and are located along seismic profiles (1, 10). Tops of magnetic bodies coincide with the top of acoustic basement. Normal polarity of dipoles suggests that remanent magnetism oblique to induced one may be of very low intensity. In the models, we consider equivalent magnetic susceptibilities that include the effects of induced and parallel remanent magnetism. The models indicate that the main body producing the intense magnetic anomalies in the central Alboran Sea (polygon 5, profile M1; polygons 5 and 7, profile M2) is more than 90 km long, trends N70°E- N80°E and is probably located below the Alboran Channel. Westward, another body, subparallel to the previous one, although displaced southward, is found.

Gravimetry

The most intense negative Bouguer anomaly approximately coincides with the western Alboran basin and is concave (Fig. 3). A N70°E elongated positive anomaly follows the Alboran Channel (Fig. 3).

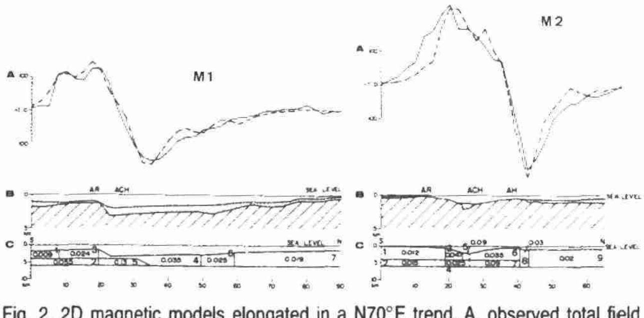

Fig. 2. 2D magnetic models elongated in a N70°E trend. A, observed total field magnetic profile (continuous line) and model profile (dashed line); B, simplified geological cross-section. Dotted area: sediments; dashed area: basement. Vertical exaggeration 1:2; C: magnetic models; large numbers: anomalous bodies; small numbers: equivalent magnetic susceptibilities (IS). Total field intensity: 43000 nT; inclination: 51°N; declination: 5°W.

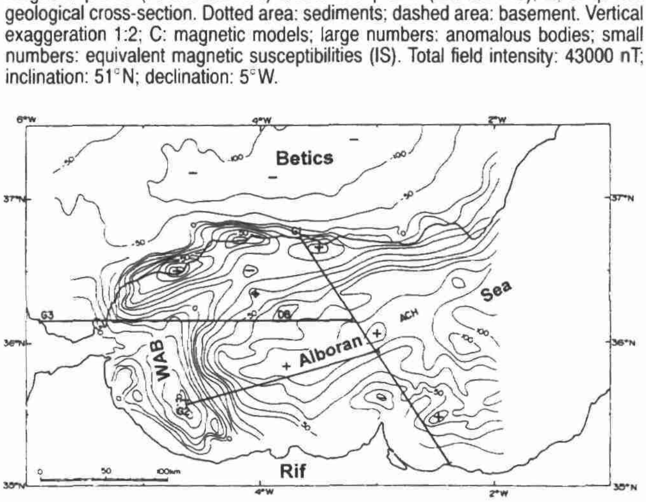

Fig. 3. Bouguer Anomaly map of the Alboran Sea (mGal). Based on Casas and Carbo (5). WAB, western Alboran basin.

Furthermore, there exist other isometric local maxima, as the located in the Djibouti Bank. The 2D gravimetric models along three profiles (Figs. 3, 4) are based on the results of the deep seismic refraction profiles (2, 3, 11), seismic reflection and borehole data (12).

Discussion and conclusions

The positive Bouguer anomaly along the Alboran Channel (profile G1, Fig.4) may have originated by the crustal thinning mainly in the deep and intermediate zones of the crust. The N70°E trend of the anomaly indicates that the thinning is oblique to the present-day boundaries of this sea, and extends toward the Algerian-Balearic basin, floored by oceanic crust (8). The crustal thickness variation is more gradual towards Africa than towards Spain, where the Moho may dip more than 60°N (6). The most intense magnetic anomalies of the Alboran Sea also are located along this gravimetric maximum (Figs. 1 and 3), and are probably related to bodies of basic igneous rocks. These data suggest that in the Alboran Channel there exists an asymmetrical axis of crustal thinning, where basic igneous rocks are intruded. Radiometric ages of basic volcanic rocks of Alboran Island are comprised between 25 and 18 m.y. (13).