EVOLUTION OF THE GULF OF CADIZ MARGIN INFLUENCED BY THE MEDITERRANEAN ALPINE BELTS

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Abstract

The initial Mesozoic and Early Cenozoic evolution of the Gulf of Cadiz margin was characterized by passive style, which controlled development of extensional structures and carbonate platforms. Subsequent ocean-spreading in the North Atlantic induced extensional tectonics, which deformed synsedimentary Cretaceous deposits. The African-Eurasian plate boundary experienced transpression during Tertiary and the Mesozoic basins floored by oceanic crust underwent subduction. An olistostrome was emplaced during Tortonian as results of the westward motion of the Alboran Domain. The closing of the Betic and Rif seaways in Messinian and the subsequent opening of the Strait of Gibraltar controlled the recent evolution.

Key-words : tectonics, Western Mediterranean, seismic, stratigraphy, continental margin

Introduction

This study of the Gulf of Cadiz summarizes the evolution of the Iberian continental margin from its Mesozoic inception until the present day. The main objective is to provide an integrated view of the growth patterns and factors that controlled the evolution of the margin through time. The Cadiz margin developed near the boundary between the two major Eurasian and African plates under the control of a complex tectonic evolution (Fig. 1). It is located also in an area largely influenced by the closing and opening of straits, which acted as major gateways between the Atlantic Ocean and the marginal, semi-enclosed Mediterranean Sea (1, 2).

Evolution of the Cadiz margin

The Gulf of Cadiz straddles the boundary between the African and Iberian plates and it is intersected in the eastern area by the orogenic Gibraltar Arc (Fig. 1). It occupies a key location for understanding the development of the central North Atlantic and the Alpine belts of the Mediterranean The evolution of this area was influenced by the successive phases in the opening of the North Atlantic, the closure of the Tethys ocean and the opening of the western Mediterranean basins (1, 3).

Triassic to Early Cretaceous rifting and Mesozoic passive margins

The breakup of Pangea in Triassic time and the subsequent rifting formed the southern margins of Iberia and northern Africa. The initial stages in the evolution of these margins are characterized by a passive style linked to the development of the Tethys and Central-North Atlantic domains. Later during the Early Mesozoic, the Azores-Gibraltar Fracture Zone constituted a major transcurrent boundary where the Central Atlantic ridge ended and which caused extension into the Tethys area along deep oceanic basins (3). The Late Jurassic and Early Cretaceous progressive rifting of the Central Atlantic resulted in a major sinistral translation between Africa and Laurasia plus spreading in the Tethys. Very active rifting in the Gulf of Cadiz occurred during the Kimmeridgian-Tithonian times (143-155 Ma), and the Valangian-Barremian times (118-143 Ma), while the northern passive margin of Iberia was occupied by extensive carbonate platforms (1, 4).

A wide spread unconformity recorded in the Gulf of Cadiz before Early Aptian time (anomaly M0, 118 Ma) indicates a compressional event. The southern margin of Iberia was probably affected during this time by a transpressional regime. Active sea-floor spreading in the North Atlantic since anomaly M0 favored further spreading and transcurrent motions between Iberia and Africa. During this Late Jurassic and Early Cretaceous evolution, half graben structures were developed in the Gulf of Cadiz, which were subsequently filled with carbonate slope facies and submarine fans. (Fig. 1)

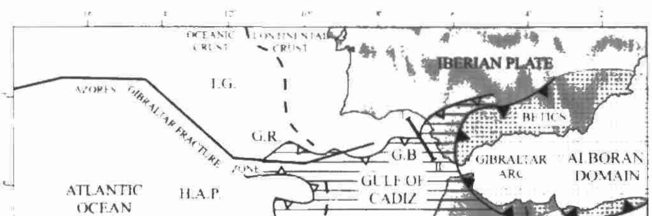

Fig. 1.- Geographic chart showing the regional tectonic setting of the study area and distribution of the present major lithospheric structures. Legend: G.B., Guadalquivir Bank G.R., Gorringe Bank; H.A.P., Horseshoe Abyssal Plain; T.G., Tagus Abyssal Plain; Open triangle, olistostrome front: Bold triangle; Alboran domain thrust front. Explanation in the text. (Modified from 1). Profile I-II in Fig. 2.

Late Cretaceous to Early Tertiary intraplate evolution

From about the time of Late Albian (110 Ma) to the Late Eocene (41 Ma) Iberia moved as part of the African plate (3). This intraplate evolution was characterized by the development of generally thin depositional sequences, which draped the structural highs and grabens of the basement (1). These deposits are characterized, however, by significant facies and thickness variations and many parts of the margin underwent extensive erosion.

Late Eocene to Early Miocene active margin

During Late Eocene to Early Miocene (41-24 Ma) Iberia became again an independent plate (3). The relative motion between the Iberian and African plates in the Gulf of Cadiz was small between anomalies 18-13, but since then a significant amount of shortening occurred in the area. The tectonic evolution was characterized by an increase of the subsidence rate and graben development (1). The Lower Oligocene deposits are very reduced or absent, which reflected the compresional regime along the AGFZ. Extensive areas of erosion show uplifted blocks developed during the generalized compressional regime. Middle-Late Oligocene carbonate platforms onlaped the Cretaceous and Early Tertiary highs, while a high-energy, carbonate platform linked the Central Atlantic and Mediterranean basins through the north African Rif and south Iberia Betic seaway corridors. Thick turbidite deposits of the "Campo de Gibraltar" flysch, were also developed during this time interval in deep troughs between the Iberian and African margins and the forearc of the westward thrusting Alboran Domain (1).

Miocene foredeep basins of the Gulf of Cadiz

The northward drift of Africa caused the progressive closure of the Tethys basins and the rapid westward migration of the Gibraltar Arc front towards the Gulf of Cadiz area (5, 6). The existence of closely juxtaposed regions of compression and extension between Iberia and Africa is attributed to the westwards progression of the Gibraltar Arc mountain front over a subducting thinned Tethys crust (Maldonado et al., this issue). The Gulf of Cadiz was part of the extensive area of deformation located along the transcurrent fault system between Africa and Iberia, while wrench zones within conjugate fault systems induced the development of subsiding, roughly oriented WSW-ENE basins (1).

An autochtonus calcareous margin developed along southern Iberia, while an allochtonous terrigenous margin was located around the morphological highs of the Betic Cordillera (Figs. 1, 2). Between these two margins, deep basins and straits connected the Atlantic and Mediterranean basins forming the Betic corridor (6). In addition, the westward migration of the Gibraltar thrust front into the flysch trough during the Burdigalian led to the formation of an accretionary forearc which collided with the passive margins of southern Iberia and northern Africa (1, 5). The progression of the mountain front continued into the Middle Miocene when the olistostrome of the Gulf of Cadiz is emplaced. Rapid increase of basement subsidence rates in the Gulf of Cadiz during Early Tortonian may have favored the foredeep basin formation and the emplacement of the olistostrome (1).

Late Miocene closing and opening of straits

The generalized compressional regime during the Late Tortonian and Messinian time in the southern Iberian margin induced relative sea level lowering and together with a global low eustatic sea level resulted in the closure of the Betic and Rif straits (5). This stress field facilitated, however, transcurrent movements and extension in an east-west to ESE-WNW direction. At the end of the Messinian and during the Early Pliocene, the stress field changed to a more roughly north-south oriented direction and pull-apart basins were developed under a transtensional regime, which induced the reopening of the connection between the Atlantic and the Mediterranean through the Strait of Gibraltar. The Gulf of Cadiz was affected by significant foredeep subsidence with the development of deep depositional basins trending NE-SW (1).