The Alboran Sea : a case of extensional basin developed on a collisional orogen

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The Alboran Sea and the surrounding mountain chains form the westernmost segment of the Alpine Mediterranean orogenic belts. Like other Mediterranean basins, the Neogene Alboran Sea basin developed behind an arc-shaped mountain belt (the Betic and Rifean chains and the Gibraltar Arc) and is settled on the site of an orogen generated by collisional stacking from the Late Cretaceous. The region straddles the boundary between two major plates - Europe and Africa - which converged during the Neogene.

The Gibraltar Arc resulted from a continent-continent collision that involved different crustal domains. During the collision, the Alboran Crustal Domain, hanging wall of the collisional suture and itself composed of nappe metamorphic complexes, thrusted westwards over the Iberian and African thinned continental crust producing shortening and crustal thickening in the Gibraltar Arc (BALANYA and GARCIA-DUENAS, 1988). During the Miocene, the migration of the arcuate mountain front was nearly coeval with the extension in the inner part of the arc that resulted in crustal attenuation and basinal spreading in the Alboran Domain. The Alboran Basin thus formed since the early Miocene whereas outside the arc thrusting processes continued.

The fact that the present continental crust beneath the Alboran Sea is about 14 km thick indicates that considerable thinning of the previous thickened crust, formed by the collisional stacking, must have happened. The Miocene crustal thinning of the Alboran Domain is related to large-scale extensional detachment faults recognized in the emergent Alboran basement at the Betic chain (GARCIA-DUENAS *et al.*, 1992).

MCS profiles in the Alboran Sea show thick sedimentary sequences (in places up to 7 km thick) filling grabens or half-grabens between basement highs. Seismic studies and commercial well data reveal four major seismostratigraphic units, early Miocene to Recent in age, overlying the metamorphic basement (JURADO and COMAS, 1992). The Miocene sedimentary fill beneath the sea can be correlated with large outcrops of coeval marine sediments on land (Betics and Rif). This indicate that the "Miocene Alboran Basin" occupied an area that extended beyond the present limits of the present Alboran Sea.

The structure of the Alboran Basin (Fig. 1) results from superimposed tectonic stages in basin evolution. Earlier structures correspond to extensional grabens from several rifting episodes (from latest Aquitanian to early Tortonian). Magmatic events and mud diapirism occurred outing rifting. Later structures testify to a post-rift N-S contraction, involving folding and strike-slip faulting, which conditioned present day sea-floor morphology. The last faulting episode took place in the Early Pliocene and was related to basin subsidence or collapse during the Pliocene-Quaternary. This episode shaped the present coastal line. The direction of extension during the rift processes was not congruent with the coeval relative motion of Europe and Africa plates (COMAS *et al.*, 1992).

Conflicting hypothesis for the origin of the Alboran Basin have been proposed, considering such processes as extension induced by mantle diapirism or convective removal of a collisional lithosphere root. Other models consider this basin as an equivalent to Pacific-type subduction zones. Nevertheless, these different explanations are poorly constrained by data regarding the extensional mechanism and kinematics which caused crustal thinning of the orogen and originated the Alboran Basin.

The attributes summarized above allow to consider the Alboran Basin as a suitable location to investigate extensional processes in an overall convergent tectonic setting.

This is the reason why an international workshop during the C.I.E.S.M. XXXI Congress and Plenary Assembly (Athens, 1988) to develop ODP drilling initiatives in the Mediterranean identified the Alboran Sea as one of the potential area to address "investigations of deformation processes at convergent plate boundaries". After years of intensive survey on this subject, an international consortium of scientists submitted to JOIDES Office a proposal (reference n° 323-Rev, COMAS *et al.*, 1991) including geodynamic and tectonic objectives in the Alboran Sea. The drilling target in the Alboran Basin satisfies one of the priority objectives of the TECP: to investigate the dynamics of the extension collapse of collisional ridges resulting in the formation of arc-shaped orogenic belts. Also, this target complies with a prerequisite underlined by the TECP: the accessibility to the basement. Actually, in the case of the Alboran basin the compression and extension deformation of its basement is well known from onland geology as it crops out extensively throughout Betic and Rifean chains.

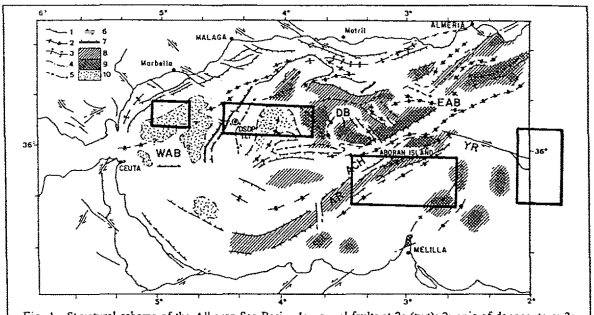

Fig. 1.- Structural scheme of the Alboran Sea Basin. 1: normal faults at 2s (twt); 2: axis of depocenters; 3: anticlines; 4: diapiric boundaries; 5: structural highs; 6: strik-slip components; 7: normal faults at 4s (twt); 8: acoustic basement presumed volcanic; 9: volcanic residual banks; 10: mud diapirs. ACH: Alboran Channel. AR: Alboran Ridge. DB: Djibouti Bank. EAB: Eastern Alboran Basin. WAB: Western Alboran Basin. YR: Yusuf Ridge. Squares: suitable drillsite-areas.

For tectonic purposes, deep drilling results in the Alboran Basin can provide accurate information on timing of extension-and-compression deformation and synchronous basin formation, rate and amount of subsidence, nature of the basin floor, role of volcanism, and interference between rifting and contractionneotectonic processes in the evolution of a young basin. Drilling here can clanfy the lithosphere defonnation mode, vital to the development of geodynamic models not only for this region but also for equivalent settings in nascent back-arc basins.

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