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Evolution of a Miocene sag basin in the Alboran Sea

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The Alboran domain represents the westernmost termination of the peri-Mediterranean Alpine orogen. Its arcuate shape, delimited to the North by the Betic range and to the South by the Rif range, is the result of subduction, collision and slab migration processes. During the Neogene, several sedimentary basins formed on the Betics metamorphic basement, mainly due to the extensional collapse of the previously thickened crust of the Betic-Rif belt. The major sedimentary depocentre, the Western Alboran Basin (WAB), is surrounded by the Gibraltar arc, the volcanic Djibouti mounts and the Alboran ridge, and is partly affected by shale tectonics and associated mud volcanism. High-quality 2-D seismic profiles acquired along the Moroccan margin during the last decade reveal a complete history of the basin. Our study deals with the analysis of seismic profiles oriented parallel and orthogonal to the Mediterranean Moroccan margin. The stratigraphy was calibrated using well data from offshore Spain and Morocco. Our study focuses particularly on the tectono-stratigraphic reconstruction of the basin.

The formation of the WAB began in the Early Miocene (Aquitanian - Burdigalian). A massive unit of Early Miocene to Lower Langhian shales and olistostromes forms a thick mobile décollement layer that controls and accommodates deformation of the basin fill. From the Upper Langhian to the Upper Tortonian, the basin is filled by a thick sequence of siliciclastic deposits. Stratigraphic geometries identified on seismic data clearly indicate that deformation of the basin fill started during deposition of Upper Langhian to the Upper Tortonian clastics. Shale tectonic deformation was re-activated recently, during the Messinian desiccation of the Mediterranean Sea (and the following catastrophic Pliocene reflooding) or during the Quaternary contourite deposition

The sedimentary layers gently dip towards the basin centre and "onlaps" onto the basin margin, especially onto the basement high that bounds the basin toward the East. The contacts observed between the sediment and the basement reflectors are purely stratigraphic. These observations confirm that the geometry is essentially that of a sag basin. We discuss all these stratigraphic observations in the scope of the geodynamic evolution of the eastern and western Alboran basin and the extension recorded onshore during the basin development time interval.