The Gulf of Cadiz Accretionary Prism: The Active Offshore Link Between the Rif and Betic Mountain Belts

Marc-Andre Gutscher[1], Stephane Dominguez[2], Graham Westbrook[3], Pascal Gente[4], Nathalie Babonneau[4], Thierry Mulder[5], Eliane Gonthier[5], Raphael Bartolome[6], Joaquim Luis[7], and Filipe Rosas[8]
[1] IUEM, Univ. Brest, UMR 6538, Plouzane, France
[2] Univ. Montpellier
[3] Univ. Birmingham
[4] IUEM, Univ. Brest, UMR 6538, Plouzane, France
[5] Univ. Bordeaux
[6] CMIMA, Barcelona
[7] Univ. Algarve
[8] Univ. Lisbon

The offshore continuation of the arcuate Rif and Betic mountain belts lies within the Gulf of Cadiz. Here, the plate boundary between Africa and Eurasia is diffuse, with deformation spread over a 200 km wide (N-S) zone. The complex plate kinematics suggest the presence of independent blocks with strong internal deformation. The study of the historical seismicity in this area (the Great Lisbon earthquake of 1755, M8.7) and assessment of the modern-day tsunami hazard, has stimulated an international effort to map the seafloor and active faults in this region. We report on the results of recent bathymetric swathmapping and multi-channel seismic surveys carried out here, primarily the Delila cruise (R/V Dom Carlos Oct. 2004) and DelSis cruise (R/V Suroit April 2005), but also the Cadisar 1 and 2 surveys (R/V Suroit Aug. 2001, Sept. 2004).

The seafloor is marked by contrasting morphological provinces, spanning the SW Iberian and NW Moroccan continental margins, abyssal plains and an elongate, horseshoe shaped, accretionary wedge. The accretionary wedge, with abundant curvi-linear ridges and troughs, presents evidence of recent deformation at its boundaries. It appears to be the active offshore link between the Rif and Betic mountain belts. The older Miocene external Betic allocthons as well as the external Rif nappes (“nappe pre-rifaine“) are both currently inactive and buried beneath several km of sediment. However, a new tectonic boundary has formed further south, and north, respectively (in a more “internal“ position) abandoning the older tectonic front.

Bathymetric data and high-resolution seismic profiles provide evidence for frontal and possibly basal thrusting, actively deforming the accretionary wedge. The frontal portion of the accretionary wedge is marked by an undulating morphology formed by anticlinal thrust ridges and suggesting deformation is distributed over a very wide region (at least 100 km from the deformation front). The very shallow mean surface and basal slopes of the accretionary wedge (1° each) indicate a very weak decollement layer, geometrically similar to the Mediterranean Ridge accretionary complex.

Further upslope, there are two-sub-arcs which appear to bound a gravitationally sliding upper portion of the wedge (roughly above 2000 m water depth). Locally steep slopes (10-15°) indicate strongly focused, active deformation and present potential gravitational instabilities. The unusual surface morphology of the upper accretionary wedge includes “raftingtectonics” type fissures and abundant sub-circular depressions. The possible contribution of dissolution and/or diapiric processes to the formation of this morphology is discussed. Mesozoic salt is present on both the Portugese/Spanish as well as the NW Moroccan continental margins. The role of salt and/or mud diapirism in the wedge and the relation to the tectonic style observed is discussed.