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Active tectonics of the Gulf of Cadiz accretionary wedge: multibeam bathymetry and analog modeling

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The Gulf of Cadiz straddles the Africa - Eurasia plate boundary offshore southwest Iberia. Geophysical data (seismic profiling, tomography, hypocenters and other seismological data) reveal a narrow subduction zone here, dipping steeply to the east beneath Gibraltar. Its continued activity and possible link to the Great Lisbon earthquake and tsunami of 1755 is a source of ongoing debate and bears strongly on the overall hazard assessment for the area. These topics are being further investigated by the EU FP6 funded project NEAREST. We report here on the results of recent bathymetric swathmapping surveys carried out here within the framework of the SWIM (EuroMargins) Project (in particular the following surveys: Cadisar1&2, R/V Suroit, 2001& 2004; TV-GIB, R/V Suroit, 2003; GAP R/V Sonne 2003; MatesPro, R/V Dom Carlos, 2004; Delila, R/V Dom Carlos, 2004; DelSis R/V Suroit 2005).

Numerous basement ridges and associated faults, with primarily N60˚E and N120˚E orientations, are imaged over nearly the entire survey area. The most prominent feature, however, is a horseshoe shaped region with a rugous, undulating morphology, the accretionary wedge. It is marked by curvi-linear ridges and troughs and presents evidence of recent compressional deformation at its boundaries. It is also marked by an asymmetric embayment where a 2 km high basement ridge (Coral Patch Ridge) displaces the deformation front. The uppermost portion of the accretionary wedge (<2000m water depth) shows abundant sub-circular and elongate depressions, as well as “rafting-tectonics” type fissures, suggesting the occurrence of gravitational processes here, possibly related to salt and/or other (mud?) diapiric processes. The Miocene deformation fronts of the external Rif and Betic allocthons show no sign of activity and have been abandoned. However, high-resolution seismic data and the sea-floor morphology indicate that active tectonic boundaries have formed in a more “internal“ position, near the Guadalquivir River (SW Spain) and Lalla Zara hills (NW Moroccan platform).

Analog modeling of thrust-wedge formation using granular materials, can explain the horseshoe-shaped deformation front, as the result of accretion of sediments located within a narrow (N-S) oceanic domain, against a curved, rigid backstop (representing the Rif and Betic orogenic belts). The indentation of an oblique ridge successfully reproduces the shape of the asymmetric embayment. The modeled wedge, however is shorter and has a steeper surface slope than the submarine accretionary wedge. The extremely shallow surface slope (1˚) of the Cadiz accretionary wedge, suggests that the frictional strength at its base is very low, possibly related to high fluid pressures or the presence of evaporites.