Thrust - wrench interference tectonics in the Gulf of Cadiz (Africa - Iberia plate boundary): insights from (sand-box) analogue modeling experiments.

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Introduction

The Gulf of Cadiz is a complex tectonic region situated in the North Atlantic Ocean, west of the Gibraltar Straights, offshore SW Iberia and NW Morocco (Fig. 1), corresponding to the transition zone between the Mediterranean Alpine Collision Belt and the Atlantic Azores – Gibraltar Fracture Zone, and encompassing a puzzling segment of the Africa-Eurasia plate boundary.

Morphotectonic mapping of the Gulf of Cadiz region revealed the existence of two main features: the Gulf of Cadiz Accretionary Wedge (GCAW) and the more recently proposed SWIM fault system (see Fig. 1; Gutscher et al., 2002; Zitellini et al., 2009; Duarte et al., in press). The accretionary wedge consists in a westwards thrust propagating wedge, which according to some authors is associated to Miocene to Present day eastwards active subduction beneath the Gibraltar Arc (Gutscher et al., 2002; 2004; 2009), although such interpretation is the focus of some debate (Platt et al., 1989; Seber et al., 1996; Zitellini et al., 2009; Marques, 2010). The SWIM fault system has been recently described as corresponding to a newly developing dextral transcurrent plate boundary between Africa (Nubia) and Iberia, which intersects the frontal accretionary wedge (Zitellini et al., 2009).

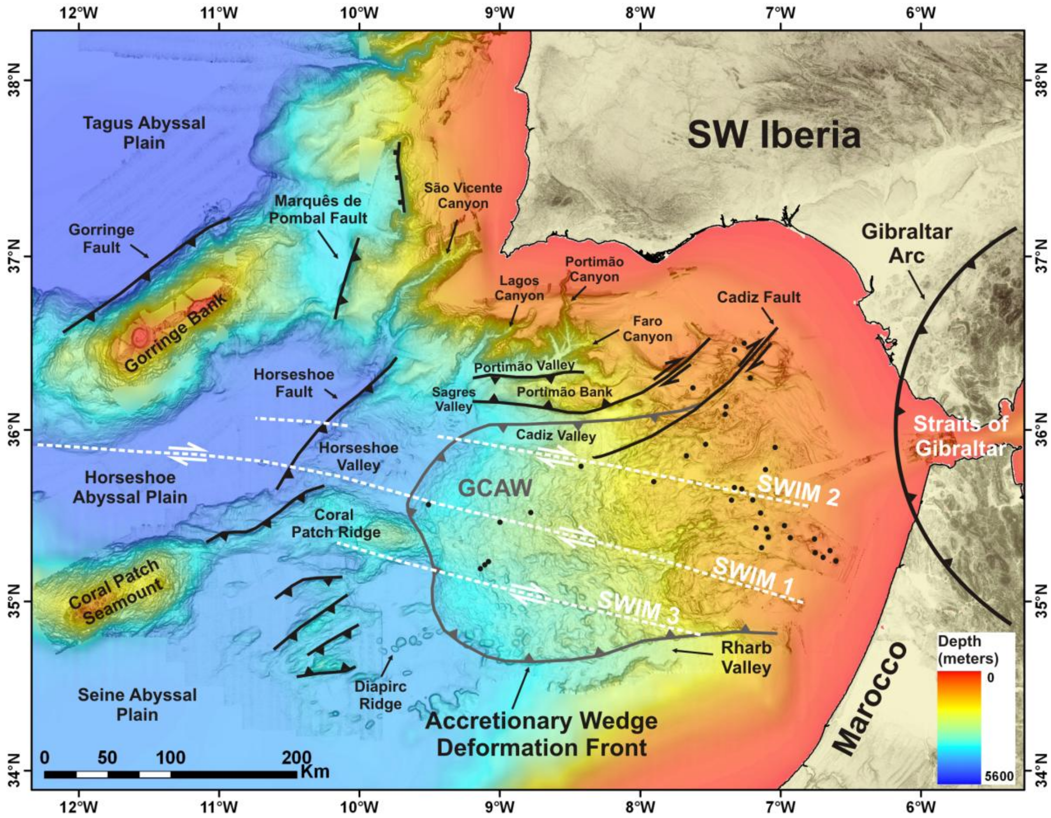

Figure 1. Simplified tectonic map of the Gulf of Cadiz area (adapted from Duarte et al., in press; bathymetry from the SWIM compilation; Zitellini et al., 2009). Gulf of Cadiz Accretionary Wedge - dark grey outline; SWIM dextral strike-slip faults - dashed white lines. Black dots correspond to the location of known mud volcanoes.

Analogue Modeling and Experimental Results

Two sets of analogue modeling experiments were carried out to model the interference between the GCAW and the SWIM faults and to investigate the possible deformation patterns that are expected to develop as a result of synchronous or time succeeding of a thrust propagating wedge and dextral strike-slip faulting (Fig. 2). Results show that: a) a non-active basement fault (acting as a linear anisotropy) can markedly perturb the morphology of an overlying thrust wedge, affecting its surface; b) even in the absence of movement ascribed to such a basement fault, a kinematically misleading offset of the overlying thrust wedge front can occur; c) when the basement fault is active, and overprinting a previously formed non-active thrust wedge, an unmistakably offset of the frontal thrust wedge must occur, but if both tectonic structures are active the interference pattern can be more complex (see results in Fig. 2), either leading to an apparent offset of the frontal thrust wedge, opposite to the kinematics ascribed to the basement fault, or to no offset at all.

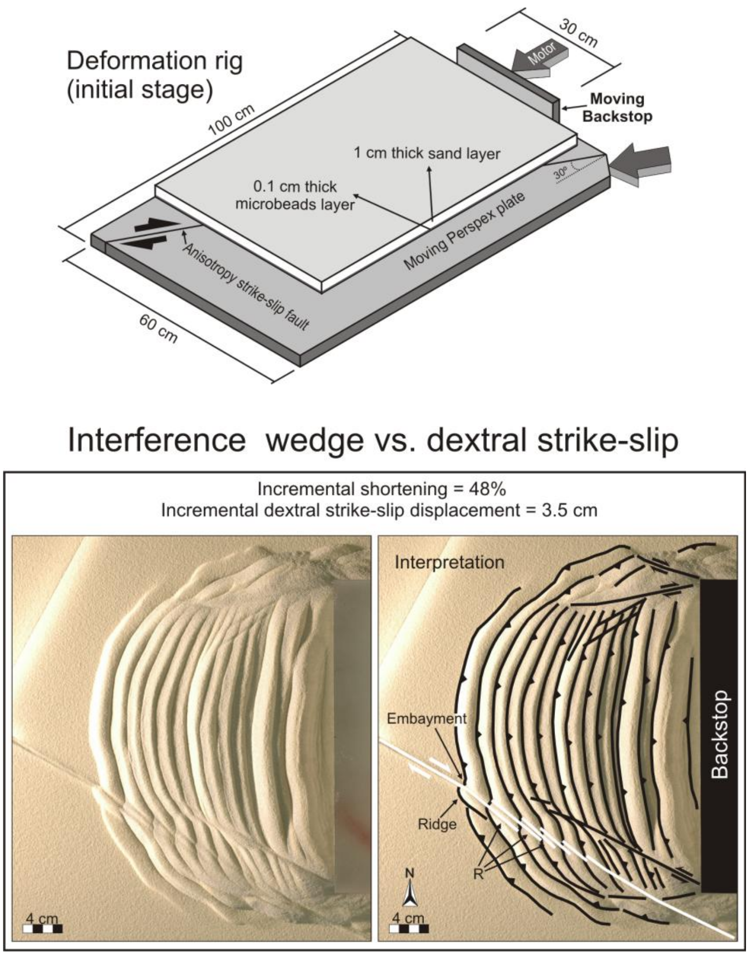

Figure 2. Experimental apparatus (top) and experimental results of alternating basal strike-slip and shortening.

Conclusions

Comparison of these experimental results with the natural examples of the Gulf of Cadiz suggests a combined activity of the Gulf of Cadiz Accretionary Wedge and the SWIM faults since at least Pliocene times, and unraveled the importance that sin-extensional, early Mesozoic, relic tectonic fabrics exerted in the Present day tectonic architecture of this segment of the Eurasia (Iberia) – Africa (Nubia) plate boundary.

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