

OVERALL TECTONIC PATTERN OF THE ALGERIAN MARGIN: EVIDENCES FOR ACTIVE FOLDING AND THRUSTING FROM THE 2003 AND 2005 MARADJA CRUISES

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Abstract

In this presentation, we give a first overview of the strain pattern of the north Algerian margin from a new set of high resolution swath bathymetry and seismic data acquired during the 2003 and 2005 MARADJA cruises led in the frame of a French-Algerian research Project. We produce the first tectonic sketch of the Algerian margin and show evidences for recent (mostly Quaternary) deformation on the slope and the deep Algerian Basin, resulting in the formation of perched basins on the slope and at the foot of the margin. Folds frequently develop in response to the play of thrust ramps and flats, triggering slides, turbidity currents and debris flows that are observed all along the margin. Several places display paleodislocations at the sea floor. We attempt to link these observations to historical earthquakes, typically covering the 6.5-7.5 magnitude range, as depicted by the 2003 Boumerdes earthquake.

Keywords : Algerian Basin, Bathymetry, Continental Margin, Geomorphology, Tectonics.

Although severely shaken by historical and recent earthquakes (e.g., [3]), North Africa did not receive much attention until now concerning natural threats from the sea. The recent Boumerdes earthquake has dramatically recalled that this area represents the outer limit of a wide deforming zone that encompasses the Tell and Atlas domains on land and that accommodates much of the 4-8 mm/yr of relative plate convergence between Africa and Europe, from west to east.

In this paper, we first report on the area off the 2003 Mw 6.9 Boumerdes earthquake, where we have identified about 5 main fault-propagation folds 20-35 km long, leaving prominent cumulative escarpments on the steep slope and in the deep basin [1]. Fault activity creates Plio-Quaternary growth strata within uplifted areas such as a rollover basin on the slope and piggy back basins in the deep ocean. Most thrusts turn to fault-propagation folds at the sub-surface and are organized as overlapping ramps and flats, although the fault dips are not easy to image. The two main slip patches of the 2003 Boumerdes earthquake are spatially correlated to two segmented cumulative scarps recognized on the slope and at the foot of the margin. The overall geometry indicates the predominance of back thrusts inverting the previously passive margin and implying underthrusting of the Neogene oceanic crust.

Then we have tried to map the offshore boundary between the external and the internal zones of the Maghrebides [2]. The internal zones are relics of the so-called Alkapeca block that is assumed to belong to the former European plate and is found onshore in the Kabylies for instance, and further west in the Moroccan Rif. We identify major changes in the morphology that could correspond to transitions in the lithology or to faulting.

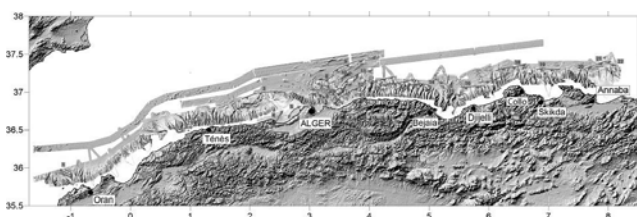


Fig. 1. Map of the 19 main fault segments identified off Algeria during the MARADJA 2003 and 2005 cruises, together with the onland main faults known, plotted on shaded bathymetry and topography.

We finally present a study of the breaks in the seafloor topography, correlate them to seismic lines (Chirp, high resolution, or 6- or 24-channel seismics) in order to determine their rooting and relative activity through time. We identify about 19 main faults (Figure), often associated to folds, and interpret them as parts of a large zone of transpression that shaped the Algerian margin during the Neogene. Most of them represent thrusts striking nearly perpendicularly to the present-day maximum stress direction. Especially, 3 large faults systems, striking ENE-WSW to E-W, rather similar to those found off Boumerdes, have been identified off Mont Chenoua, Annaba and the Great Kabylie. Other fault systems seem

deeper off Skikda and Djidjelli areas: although less expressed in the morphology, they clearly fold and tilt recent sediments at depth, including pre-Messinian layers, and trigger large-scale slumps of recent deposits, in connection with Messinian salt movements towards the deep basin. From the position and geometry of the recent and active structures reported, we explore their link to the instrumental and historical seismicity, discuss their possible space and time evolution, and try to correlate the strain evolution (apparently, from Pliocene to Upper Quaternary) to other tectonic events found in the Betics or in the Tell-Atlas mountain belts. It appears that the length of faults reported matches quite well the magnitude range (6.5-7.5) of historical earthquakes.

We conclude that a significant part of the Africa-Eurasia plate motion may indeed be absorbed in recent times by an active, complex thrust fault system located near the foot of the Algerian margin, which has to be considered for better assessing seismic hazards in the future.

References

- 1 - Deverchère J., Yelles K., Domzig A., Mercier De Lépinay B., Bouillinj-P., Gaullier V., Bracene R., Calais E., Savoye B., Kherroubi A., Leroy P., Pauc H. and Dan G., 2005. Active thrust faulting offshore Boumerdes, Algeria, and its relations to the 2003 Mw 6.9 earthquake, *Geophys. Res. Letters*, 32, L04311, doi:10.1029/2004GL021646.
- 2 - Domziga., Yelles K., Le Roy C., Deverchère J., Bouillinj J-P., Bracener., Mercier De Lépinay B., Le Roy P., Calais E., Kherroubi A., Gaullier V., Savoye B. and Pauc H., 2006. Searching for the Africa-Eurasia Miocene boundary offshore western Algeria (MARADJA'03 cruise), *C.R. Geoscience, Académie des Sciences*, Paris, 338, 80-91, doi:10.1016/j.crte.2005.11.009.
- 3 - Yelles K., Boudiaf A., Djellit H., and Bracene R., 2006. La tectonique active de la région Nord-Algérienne, *C.R. Geoscience, Académie des Sciences*, Paris, 338, 126-139, doi:10.1016/j.crte.2005.11.002.