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SPIRAL Project: Overview and main results

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We report here on the main results obtained from the *SPIRAL («Sismique Profonde et Investigation Régionale du nord de l'ALgérie»*) Project (2009-2014), a joint research initiative co-funded by 6 institutions from Algeria and France in order to elucidate the deep structure, the tectono-sedimentary evolution, the Tertiary geodynamics and the potential for geo-resources of the northern Algerian margin.

The SPIRAL project has included a new marine cruise of deep seismic investigation along the whole margin with land recording (**Figure**), the training of 9 PhD students (8 Algerian and 1 French), the sharing and re-interpretation of previously acquired marine data sets, and new field studies in the Maghrebides belt in structural geology, petro-geochemistry and sedimentology on selected targets. The coordination of the SPIRAL project was made through a Head Committee convened every 6 months and an internal report every year. Until today, 7 "co-tutelle" and 1 French PhD theses have been defended, and one is in progress.

Section I-J (Annaba, **Figure**) depicts a 5.5-km-thick oceanic crust (OC) with a lower part composed mainly of gabbros, a wide rifted continental crust, a pre-Messinian sediment layer made of backthrusted flyschs, and Miocene magmatic intrusions, with an atypical geometry of oceanic spreading (Bouyahiaoui et al., 2015). Section G-H (Skikda, **Figure**) displays a thinner OC and narrower COB, with a steeper and asymmetric continental crust (Mihoubi et al., 2014). Off Greater Kabylia (section E-F, **Figure**), the OC is even thinner, the COB is narrow or even absent, and the thinned continental crust gets wider (Aidi et al., 2013). Section C-D (**Figure**) is similar, except a major tilted block identified upward, followed seaward by a sharp transition to a thin CO (Leprêtre et al., 2013). Finally, Section A-B (**Figure**) is a typical-transform-type margin interpreted as a STEP-fault (subduction-transform edge propagator), supporting the Late Miocene westward migration of the Alboran block (Medaouri et al., 2014; Badji et al., 2015).

Except A-B Line, all profiles clearly display southward-dipping Quaternary thrusts at the foot of the tectonically inverted Algerian margin together with downward flexure of the oceanic basement. Using gravity anomalies and models (**Figure**), Hamai et al. (2015) interpreted this behavior as opposite flexures of two plates separated by a plate boundary at the margin toe, with a maximum deflection (7 km) off Greater Kabylia. A major discovery is also the presence of a narrow basin bounded by vertical faults and Messinian salt diapirs from A-B to E-F lines, assumed to result from a strike-slip deformation on crustal faults (STEP fault signature).

As a whole, our new SPIRAL observations brought key elements favoring a contrasted kinematic evolution into 2 phases: (1) a major SE-rollback of a Tethyan slab, shaping rifted margins and opening Oligo-Miocene basins in the upper plate, and finally forming a thin magmatic OC until the collision of the Kabylian blocks with Africa before 17 Ma (Bouyahiaoui et al., 2015; Arab et al., 2016b); (2) a new oceanic basin at the western and central margins, resulting from a westward migration of the Alboran block, giving birth to a highly stretched crust at the transition with the Alboran sea (Medaouri et al., 2014) and a STEP-fault margin superimposed above the previous rifted margin segments (Badji et al., 2014). This scenario matches the hypothesis of a slab detachment that

triggered a calc-alcaline plutonic intrusion in Lesser Kabylia at ~17 Ma and evolved as slab tears propagating bilaterally along 450 km with a coast line magmatic activity until ~11 Ma (Abbassene et al., 2016; Chazot et al., 2017).

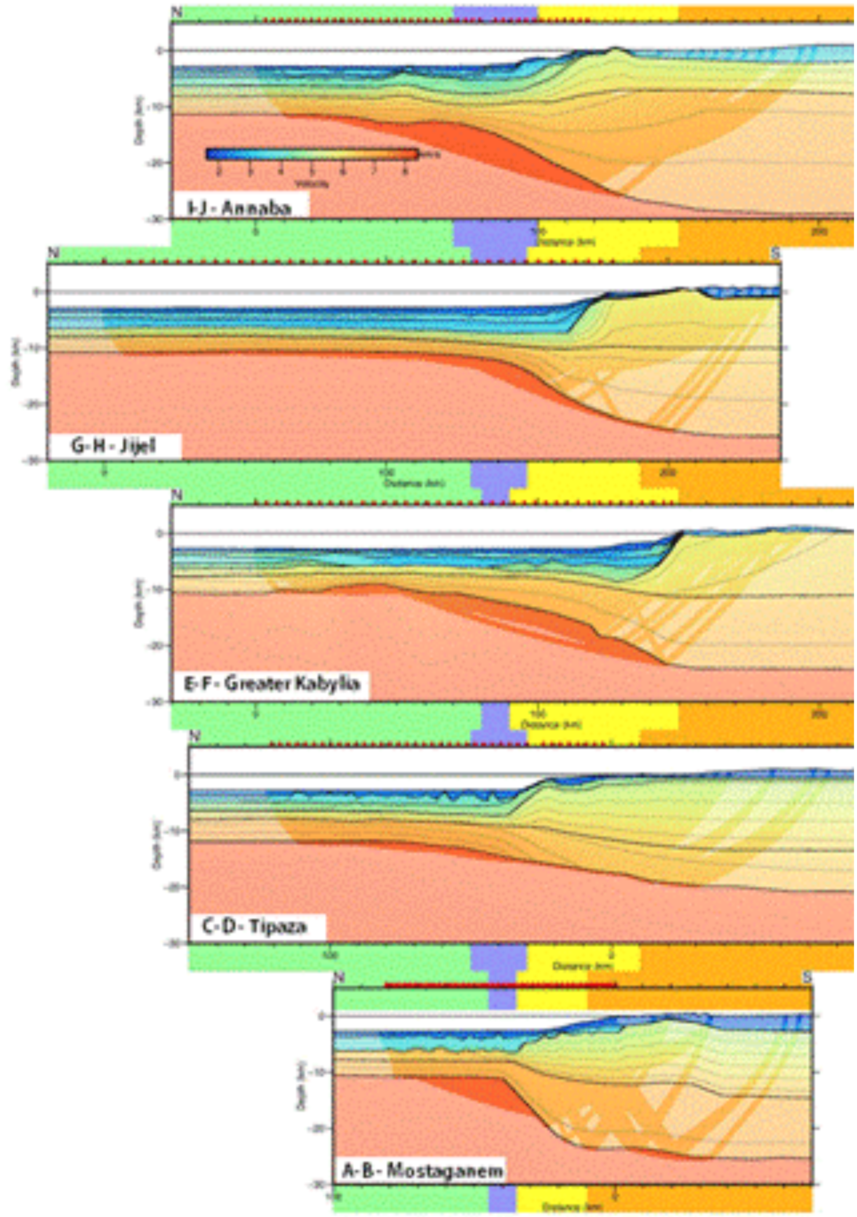
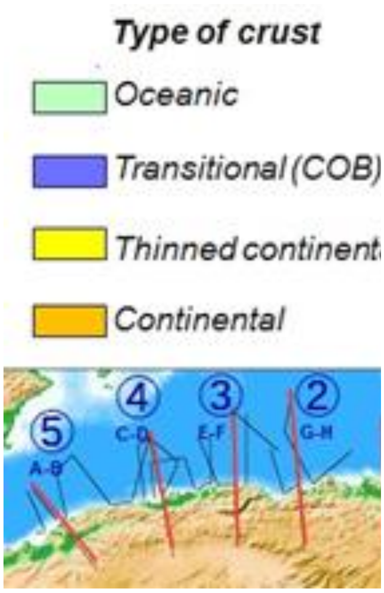


Figure. *A synthesis of the results of deep seismic investigations through 5 sections shot across the Algerian margin, from East (top) to West (bottom), located on the map below. Colors on cross sections refer to P-velocities (forward models) and colors on frames refer to types of crusts assumed (see captions below). Section A-B is a transform-type margin, while other sections depict rifted-type margins, except C-D which is interpreted as composite (multiphase evolution). COB = Continent-Ocean Boundary.*



The SPIRAL Project has also allowed to: (1) build a new chrono-stratigraphic chart West (Medaouri et al., 2014) and East (Arab et al., 2016b) of the Algerian basin, with strong on-land correlations; (2) evidence Paleogene metasomatism of Kabylian subcontinental lithospheric mantle and delamination of African mantle (Abbassene et al., 2016; Chazot et al., 2017); and (3) define and model for the first time the potential for several petroleum plays in the western (Medaouri et al., 2012) and eastern (Arab et al., 2016a) Algerian basins.

Some of our key results are presented by doctors involved in the SPIRAL project in this Conference. The SPIRAL project now opens new perspectives in Earth Science that should include land/sea projects or more focused objectives to be discussed between both parties.

Key words: Margins – Collision - Algerian basin geodynamics – Petroleum plays – Slab tear

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