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Crustal structure of the eastern Algerian continental margin and adjacent deep basin: implications for late Cenozoic geodynamic evolution of the western Mediterranean

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We determine the deep structure of the eastern Algerian basin and its southern margin in the Annaba region (easternmost Algeria), to better constrain the plate kinematic reconstruction in this region. This study is based on new geophysical data collected during the SPIRAL cruise in 2009, which included a wide-angle, 240-km-long, onshore-offshore seismic profile, multichannel seismic reflection lines, and gravity and magnetic data, complemented by the available geophysical data for the study area. The analysis and modeling of the wide-angle seismic data including refracted and reflected arrival travel times, and integrated with the multichannel seismic reflection lines, reveal the detailed structure of an ocean-to-continent transition. In the deep basin, there is a ~5.5-km-thick oceanic crust that is composed of two layers. The upper layer of the crust is defined by a high velocity gradient and P-wave velocities between 4.8 km/s and 6.0 km/s, from the top to the bottom. The lower crust is defined by a lower velocity gradient and P-wave velocity between 6.0 km/s and 7.1 km/s. The Poisson ratio in the lower crust deduced from S-wave modeling is 0.28, which indicates that the lower crust is composed mainly of gabbros. Below the continental edge, a typical continental crust with P-wave velocities between 5.2 km/s and 7.0 km/s, from the top to the bottom, shows a gradual seaward thinning of ~15 km over a ~35-km distance. This thinning is regularly distributed between the upper and lower crusts, and it characterizes a rifted margin, which has resulted from back-arc extension at the rear of the Kabylian block, here represented by the Edough Massif at the shoreline. Above the continental basement, a ~2-km-thick, pre-Messinian sediment layer with a complex internal structure is interpreted as allochthonous nappes of flysch back-thrusted on the margin during the collision of Kabylia with the African margin. The crustal structure, moreover, provides evidence for Miocene emplacement of magmatic intrusions in both the deep basin and the continental margin. Based on the crustal structure, we propose that the eastern Algerian basin opened during the south-eastward migration of the European forearc before the collision, along a NW-SE elongated spreading center that ran perpendicular to the subduction trend. Such an atypical geometry is explained by the diverging directions of the subduction rollback during the back-arc opening: eastward for the Corsica–Sardinia block, and southward for the Kabylian blocks. This geometry of the forearc can be interpreted as the surface expression of a slab tear at depth, which is responsible for atypical magmatism in the overlying back-arc oceanic basin.

Key words: western Mediterranean, back-arc opening, wide-angle seismic data, multichannel seismic data, Algerian margin, continental margin