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Seismic structure of western Mediterranean back-arc basins and rifted margins – constraints from the Algerian-Balearic and Tyrrhenian Basins

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The Western Mediterranean Sea is a natural laboratory to study the processes of continental extension, rifting and back-arc spreading in a convergent setting caused by rollback of fragmented subducting oceanic slabs during the latest phase of consumption of the Tethys ocean, leading to rapid extension in areas characterized by a constant convergence of the African and European Plates since Cretaceous time. Opening of the Algerian-Balearic Basin was governed by a southward and westward retreating slab 21 to 18 Myr and 18 to15 Myr ago, respectively. Opening of the Tyrrhenian Basin was controlled by the retreating Calabrian slab 6 to 2 Myr ago. Yet, little is known about the structure of the rifted margins, back-arc extension and spreading. Here we present results from three onshore/offshore seismic refraction and wide-angle lines and two offshore lines sampling passive continental margins of southeastern Spain and to the south of the Balearic promontory and the structure of the Tyrrhenian Basin to the north of Sicily. Seismic refraction and wide-angle data were acquired in the Algerian-Balearc Basin during a cruise of the German research vessel Meteor in September of 2006 and in the Tyrrhenian Sea aboard the Spanish research vessel Sarmiento de Gamboa in July of 2015. All profiles sampled both continental crust of the margins surrounding the basins and extend roughly 100 km into the Algerian-Balearic and the Tyrrhenian Basins, yielding constraints on the nature of the crust covering the seafloor in the basins and adjacent margins. Crust in the Algerian-Balearic basin is roughly 5-6 km thick and the seismic velocity structure mimics normal oceanic crust with the exception that lower crustal velocity is <6.8 km/s, clearly slower than lower crust sampled in the Pacific Basin. The seismic Moho in the Algerian-Balearic Basin occurs at ~11 km below sea level, reaching >24 km under SE Spain and the Balearic Islands, displaying typical features and structure of continental crust. Offshore Sicily, continental crust reaches 22 km. However, the Tyrrhenian Basin indicates a lithosphere with velocities increasing continuously from ~3 km/s to 7.5 km/s, mimicking features attributed to un-roofed and hence serpentinized mantle. Therefore, even though the opening of both basins was controlled by slab rollback, the resulting structures of the basins indicate striking differences. It is interesting to note that the continent/ocean transition zone of the margins did not show any evidence for high velocity lower crustal rocks, in contrast to what has been sampled in Western Pacific arc/back-arc systems.