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From the Surface Topography to the Upper Mantle, Seismic constraints on the Crustal structure Across Morocco

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The most characteristic topographic features of Morocco are the Atlas Mountains and the Rif Coordillera. These two orogenic belts are the response of different geodynamic processes acting at lithospheric scale caused by a unique driver, the collision between two tectonic plates. Both are located within the diffuse plate boundary zone separating Africa and Europe. The boundary zone is characterized by a relatively broad zone of deformation that includes Mountain chains in southern Iberia, the Betics and the Rif cordillera in Morocco. The zone delineates the arcuate arc system of Gribraltar. Within the last decade a large international effort have been devoted to the area mostly leaded by Spanish groups with the collaboration of international research teams (including scientist form Europe and USA). Key multi-seismic projects have been developed that aim to constrain the structure, composition and tectonic scenario from south of the Atlas to the Betics, across the Rif cordillera and the Alboran basin. The multidisciplinary research program includes: natural source (earthquakes) recording with temporal deployments of broad band (BB) instrumentation and, controlled source seismic acquisition experiments where, spatially dense recording of wide-angle seismic reflection shot gathers were acquired. The passive experiments consisted on: a transect from Merzouga across the Gibraltar arc and into the Iberian peninsula (untill south of Toledo); a nearly regular grid of BB which was achieve by multiple deployments of a number of BB. The controlled source datasets were able to constrain the crustal structure and provide seismic P-wave propagation velocity models from the coast across the Rif and the Atlas. Travel-time inversion of the controlled source seismic data across the Atlas constraints a crustal root to the south of the High Atlas, and reveals mantle wedge. A limited crustal imbrication also appears in the Middle Atlas. The crustal thickness, does not exceeded 40 km in the root zone and is less than 35 km elsewhere. Approaching the Rif, the controlled source data reveals a prominent crustal root over 50 km depth which is located where the topography does not exceed 1400 m. These features indicate that complex structure and processes beneath the crust play a key role in supporting the particular geometry of the surface topography of this part of the western Mediterranean. On one hand the Atlas is being supported by the mantle, on the other the abrupt change in crustal thickness at the Nekkor fault and the deep Rif crustal root can be attributed to interaction of the subducting Alboran slab with the North African Neo-Tethys passive margin.