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PICASSO: Lithosphere Structure in the Western Mediterranean from Ps Receiver Functions and Rayleigh Wave Tomography

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The western Mediterranean is a diffuse plate boundary separating the African and Eurasian plates. Cenozoic deformation is centered on the Gibraltar arc and Alboran Sea, and occupies a wide area from the southern Iberian Massif in Spain to the Atlas Mountains in Morocco. We present a model of the lithospheric structure of this region derived from Rayleigh wave tomography and Ps receiver functions, using data from the PICASSO (Program to Investigate Convective Alboran Sea System Overturn) linear broadband array of ∼100 seismographs. This array is deployed from central Spain to the Morocco-Algerian border. We complement these data with some of that recorded by IberArray, an areal broadband array, operated by the Spanish seismological community, covering the same region with a uniform 50 km x 50 km grid of stations.

Rayleigh phase velocities have been measured from 20-167s period using the two-plane-wave method to remove complications due to multi-pathing, and finite-frequency kernels to improve lateral resolution. The phase velocities were inverted for 1D structure on a 0.25 by 0.25 degree grid. Ps receiver functions at 1Hz and 2Hz were calculated for the same area using water-level and time-domain iterative deconvolution, and were then CCP stacked. The Rayleigh wave shear velocity model, jointly interpreted with the discontinuity structure from the CCP stack, shows the first-order lithospheric structure, and the lithosphere-asthenosphere boundary (LAB). From north to south along the PICASSO profile: The lithosphere is ∼120 km thick beneath the Iberian Massif, where it has the highest shear velocity, 4.45 km/s. To the south the lithosphere thins dramatically beneath the Betic Mountains to ∼85 km, and then varies in thickness and decreases in velocity beneath the Alboran Sea and Gibraltar Arc. The thinnest lithosphere, ∼60 km, is observed beneath the Rif mountains and Middle Atlas, with a low velocity feature (4.2 km/s) at ∼60 km depth beneath a site of Late Cenozoic basaltic volcanism. Further south the lithosphere thickens again beneath the High Atlas and the Sahara Platform (∼100 km) where the upper mantle shear velocity increases (∼4.40 km/s). The CCP images show surprisingly complicated crustal and upper mantle structures under the Betics. The combined images show that lithospheric thickness in the plate boundary zone varies by more than a factor of 2 and that upper mantle shear wave velocities are reduced by ∼6% relative to the Iberian Massive and Sahara Platform.