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Lithosphere and Asthenosphere Structure of the Western Mediterranean and Northwest Africa from Rayleigh Wave tomography and Ps Receiver Functions

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Since Cenozoic times the Western Mediterranean has been affected by complex subduction and slab rollback, during African-European convergence. The deformed region occupies a wide area from the Atlas mountains in northwest Africa to the southern Iberian Massif in Spain. Evolutionary models of the Western Mediterranean invoke extensive slab rollback and compression, as well as likely upper mantle delamination/convective drip scenarios during formation of the Alboran domain, the Betics, Rif, and Atlas Mountains. We report on a multidisciplinary, international investigation of the Alboran System and surrounding areas. In this study we have analyzed teleseismic data from the roughly 240 temporary and permanent broadband seismographs operated in this region by more than a dozen different cooperating research groups.

Here we present combined results from Rayleigh wave tomography and Ps receiver functions. Receiver functions were made in 3 frequency bands (2 Hz, 1 Hz, 0.5 Hz) using iterative time-domain and water-level frequency-domain methods. We measured Rayleigh phase velocities using the two-plane-wave method and finite-frequency kernels to remove complications due to multi-pathing and to improve lateral resolution, respectively. The resulting 3D shear velocity model was used to create 3D image volumes of the Ps receiver functions. The RF and tomography images are consistent with one another and withteleseismic body wave tomography (Bezada et al., submitted)

Our results show high velocities from $\sim$70 km to 230 km depth in an elliptical area just west of the Gibraltar straits which is interpreted as a near vertical slab beneath the Alboran Domain and the adjacent Spanish continental margin. The surface wave results map out the top of a 600+ km deep nearly vertical slab seen in the P body wave tomography. The RF images suggest that the top of this slab is still attached to the Alboran domain Moho beneath Gibraltar, a complex region where lower crustal velocities ($<$3.8 km/s) are observed to 50 km depth.. The lithosphere-asthenosphere boundary (LAB) is absent in the slab region. Elsewhere in this region the LAB depth is highly variable, ranging from $\sim$110 km beneath the Iberian Massif to $\sim$50 km depth beneath the eastern Alboran Sea, the Middle Atlas and the High Atlas. Shallow LAB depths are closely correlated with Tertiary volcanic centers in the Middle Atlas and Alboran Sea.