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Seismic structure beneath the Gibraltar Arc, Western Mediterranean region using broadband data from IberArray and permanent networks

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We present new tomographic models of seismic structure beneath the Gibraltar Arc-Alboran basin (western Mediterranean) using broadband data from stations of the permanent networks in the region, complemented by temporary broadband stations from the first (southern) and second (central) deployments of the IberArray transportable network. Using this combined dataset we have applied different tomographic methods, including local earthquake travel-time tomography, teleseismic travel-time tomography, surface-wave tomography from regional and distant earthquakes, and surface-wave tomography from correlations of seismic ambient noise. The combination of these methods, with their strengths and weaknesses, allows us to obtain a detailed and consistent picture of the crustal and mantle structure beneath the westernmost Mediterranean region. Using local earthquake and seismic ambient noise tomography we have imaged the shallow crustal structure, also in the areas of the study region with low seismicity. In particular we have obtained constraints on the lateral and vertical extent of the major sedimentary basins (Gulf of Cadiz, west Alboran basin, Valencia trough, and Ebro basin) and the areas of greater than average crustal thickness beneath the mountain ranges of the Rif, Betics, Iberian chain and Pyrenees. Using very precise travel-time measurements of teleseismic earthquakes determined using waveform similarity we have obtained a well resolved image of a high velocity anomaly beneath the Betics and Alboran Sea that extends down to the mantle transition zone and probably corresponds to a subducted slab. These results are similar to those obtained using cataloged data in the bulletins of the International Seismological Centre (ISC), and seem to indicate the existence of a tear in the slab that initiated in the southeastern Iberian Peninsula and propagated to the east. Mechanisms of deep focus earthquakes occurred inside the high velocity anomaly in 1954 and 2010 are consistent with this tearing process.