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A detailed seismic investigation of the transition from oceanic to continental subduction in the Western Hellenic Subduction Zone

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The Hellenic subduction zone exhibits large variations in convergence rate along its western edge, an observation that has been attributed to differences in the type of lithosphere being subducted between the northern and southern regions of the system. Here, we test this model against new results from a passive seismic study aimed at constraining the structure of the Western Hellenic Subduction Zone in the 0-200 km depth range. We use data from two dense arrays of broadband seismometers deployed across southern and northern Greece as part of the MEDUSA experiment. These data are employed in three complementary analyses: 2-D teleseismic migration, receiver functions and shear-wave splitting. The subducted crust is imaged by teleseismic migration as an eastward dipping low-velocity layer. This low-velocity layer has a thickness of ∼8 km beneath southern Greece and ∼20 km beneath northern Greece, consistent with a transition from oceanic to continental lithosphere from south to north. The relative position of the two subducted crusts implies ∼70-85 km of additional slab retreat in the south relative to the north. Though a tear cannot be ruled out, receiver function signals suggest that this offset can be accommodated by a smooth continuous ramp, at least in the top 100 km of the system. This is consistent with shear-wave splitting results that show the same anisotropic pattern (i.e. one in which mantle flow is not disrupted by a large tear) for both northern and southern Greece: (1) trench-normal fast polarizations nearest the trench, (2) trench-parallel fast polarizations beneath the forearc, and (3) trench-normal fast polarizations within the back-arc. The fast directions in (1)-(3) can be explained by trench-normal flow of asthenospheric mantle being dragged by the downgoing plate, whereas those in (2) are attributed to hydration/alteration of the mantle wedge.