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Evidence for magmatic underplating under the Azores Islands from P-wave receiver functions

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The Azores plateau is located near the Mid-Atlantic Ridge and consists of nine islands. Various methods including seismic reflection, gravity, and passive seismology, have been used to investigate the crustal thickness beneath the islands. They have yielded depth estimates that range between roughly 10 km and 30 km, but until now, a model of the fine-scale crustal structure has been lacking. Geochemical studies carried out across the islands suggest the existence of volcanic interfaces within the shallow crust. Moreover, magma might have accumulated beneath the existing crust (magmatic underplating), causing a shift of the crust-mantle boundary to lower depths. In this study, we use data from ten seismic stations located on the Azores Islands to investigate the crustal structure with P-wave receiver functions (PRFs). A challenge of using ocean island data is oceanic noise that interferes with the useful conversion signals. Here, we employ a frequency-domain deconvolution with objective regularisation based on the pre-event noise spectrum to reduce the effect of the oceanic noise. Our fine-scale PRFs yield conversions at about 0.3 s, 1 s, and 2-3.5 s, which we attribute to a shallow volcanic interface, a mid-crustal interface, and the crust-mantle boundary, respectively. Following the interpretation of similar PRF studies beneath other volcanic ocean islands, the 1 s signal (mid-crustal interface) may correspond to a conversion at the top of the underplated magmatic material. Underplating is most pronounced in the southeastern portion of the Azores plateau. Considering lower seismic P- and S-wave velocities within the volcanic interfaces (vp=4.9 km/s, vs=2.6 km/s) and higher velocities within the underplated material (vp=7.3 km/s, vs=4.2 km/s) compared to the normal crust (vp=6.3 km/s, vs=3.6 km/s), the total crustal thickness amounts to approximately 12-15 km.