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Shear wave velocity structure of the Ecuadorian forearc and the relationship to the mega-thrust zone

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Following the Mw 7.8 megathrust Pedernales earthquake in Ecuador on April 16, 2016, an international collaboration arranged by the IG-EPN mobilized a rapid deployment of ~60 broadband and short-period seismometers in order to capture the aftershock sequence. This data also provides an opportunity to examine how the crustal structure in the forearc region of Ecuador relates to seismic hazards in the region. We combine this new dataset with a sub-set of data from the permanent stations of the Ecuadorian national network (RENSIG). Here, we present receiver function (RF) common conversion point stacks and a shear-wave velocity model created from the joint inversion of RFs and Rayleigh-wave dispersion data obtained through ambient noise cross-correlations. The geology of the Ecuadorian forearc comprises Miocene basins thought to be underlain by oceanic terrains accreted in the Late Paleocene. These structures lead to complicated RF arrivals in an area where a traditional continental Moho is unlikely to be present. Our results show a strong shallow conversion in the Ecuadorian forearc that indicates an increase in velocity at a depth of ~15 km depth which corresponds to significant north-south variations in shear-wave velocity. This north-south change from slow to fast velocities may indicate an increased amount of hydration in the northern section, or may represent the transition to a more serpentinized oceanic terrane. This change also correlates geographically with the southern rupture limit of multiple high-magnitude megathrust earthquakes, including the 1942 and 2016 earthquakes and possibly the 1906 Mw 8.8 earthquake. Beneath the forearc crust, a slow, eastward dipping, velocity anomaly is observed coinciding with the subducting oceanic crust that shallows near the center of the subducted Carnegie Ridge. The earthquake history along the Ecuadorian trench shows that no Mw >7.5 event has ruptured south of ~0.5° S in southern Ecuador and northern Peru. This history, along with our observations, suggest that variations in the forearc crustal structure and subducting oceanic crust may control the occurrence and spatial distribution of high magnitude seismicity in the region.