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Imaging the arc source in Central America: The TUCAN broadband seismic experiment

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Central America exhibits some of the global extremes in the processing of material through the subduction factory: in the Nicaragua volcanic arc geochemical tracers of subducting sediment are among the highest globally, while many are weak to absent in adjacent Costa Rica. To understand this variation we deployed the MARGINS TUCAN seismic array (Tomography and other things Under Costa Rica And Nicaragua), of 48 broadband PASSCAL seismographs, from 2004 to 2006. Receiver functions show a strong Moho in the back-arc and complicated structure beneath and trenchward of the arc, weakly defining the top of the mantle wedge with $<$10 km alongstrike change in crustal thickness. The base of the mantle wedge shows much greater variability: intraslab seismicity (50-250 km depth) forms a narrow ($<$ 10 km thick) seismic zone that underlies the Nicaragua arc at 150-180 km depth but 80 km beneath the Costa Rica arc. Thus, the potential region of mantle melting is twice as large beneath Nicaragua as Costa Rica. Travel-time tomography shows a $>$15 km thick slow layer to depths of 150 km within the downgoing plate under Nicaragua. Such a layer is largely absent beneath Costa Rica. This variation is consistent with the downgoing plate being extensively serpentinized beneath Nicaragua but not Costa Rica, so more volatiles are available to the Nicaragua arc. Seismic attenuation reveals the wedge clearly as a broad hot region below and behind the arc. Vp/Vs ratios, by contrast, are elevated only in a narrow zone beneath the Nicaragua arc, perhaps revealing a melt column. Attenuation and Vp/Vs are greatest beneath Nicaragua, consistent with more extensive melting. Overall, the first-order differences in arc output are reflected well in the structure of the subduction factory at depth.