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Arc Interrupted: The birth, life, and death of the Peruvian flat slab

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The Peruvian flat slab is a unique natural laboratory for investigating the temporal evolution of flat slab subduction and its associated thermal, tectonic, and seismic implications. This is because the flat slab has been hypothesized to have first formed further north (at approximately the latitude of Lima, Peru), but broadened to the south over the past 11 Ma. This means that areas further to the north represent an older, more evolved flat slab setting, whereas the southernmost edge of the modern flat slab reflects conditions experienced by a newly formed flat slab. Here we present findings from a suite of recent temporary broadband seismic deployments that spanned this entire region. Results from intermediate depth earthquake locations, surface wave tomography (ballistic and ambient Rayleigh wave), and Rayleigh wave anisotropy all indicate that the flat slab did indeed first form further to the north and broadened to the south, along with the southward migration of the Nazca ridge. Subsequently, a trench-parallel tear developed in the older portions of the flat slab north of the ridge, resulting in a resumption of normal subduction geometry where once a flat slab had existed. This tear allows for an interchange of mantle material from beneath the slab to the south to above the slab to the north. This mantle flow has significant thermal implications, both beneath the flat slab and in the lower continental crust located above the relatively newly formed tear. Our results provide unique constraints on the thermal and tectonic evolution of this unusual subduction geometry that may help us to understand better subduction zone processes everywhere.