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A new, comprehensive model for the geometry of the Nazca slab down to 1,200 km depth derived from teleseismic P-wave tomography and earthquake data

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The tectonics and geodynamics of the Andes are closely tied to subduction of the Nazca plate along the western margin of South America and understanding variability in the structure and behavior of the subducting Nazca slab is critical to understanding the Andes. To investigate Nazca slab structure, we compile teleseismic traveltime residuals from >1,000 broadband and short period seismic stations distributed across South America in a single finite-frequency teleseismic P-wave tomographic inversion, producing the highest resolution images of the mantle beneath South America to date. With this model, we see the structure of the Nazca slab geometry in unprecedented detail.

Using this tomography model, we extract the location of the Nazca slab between 10°N and 46°S from ~200-1,200 km depth. We then combine our new constraints on slab geometry with existing bathymetry, active source, earthquake, and receiver function data using the Slab2 methodology to produce a comprehensive model of the Nazca slab from the surface to 1,200 km depth. With this model, we reveal a number of robust features of Nazca slab behavior, including slab dip variations along strike, slab penetration into the lower mantle, slab stagnation at ~1,100 km depth, and a large gap in the slab beneath the eastern Sierras Pampeanas of Argentina. We find that to first order, these observable slab characteristics do not correlate with upper plate deformation patterns, indicating that models of lower mantle slab penetration and slab dip angle as a control on upper plate shortening are inconsistent with modern slab structure. Instead, alternative variables such as slab strength, slab age, slab kinematics, and mantle dynamics should be explored as potential controlling parameters on upper plate deformation.