Contributions of Modern Seismic Imaging to Understanding the Andean Convergent Margin

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Improved seismic images of the South American convergent margin are providing new insights to longstanding tectonic problems including: (1) variations in forearc structure and segmentation in the seismogenic zone, (2) the influence of flat slab subduction on the over-riding plate, (3) large-scale mantle and crustal melting leading to volcanism and (4) the role of slab morphology on mountain building. We have combined data from seismic deployments and national seismic networks and used multiple techniques to generate seismic images spanning ~5000 km of the South American convergent margin.

The South American subduction zone has two regions of flat slab subduction in Peru, and central Argentina separated by a segment of "normal" subduction and an active magmatic arc. Both flat slab segments show indications of strong coupling to the over-riding plate and associated slab tears. In the depth range of 70-120 km, the Argentina flat slab has high rates of seismicity while the Peru flat slab has much less seismicity suggesting a possible difference in hydration between the two regions. The thick crust (up to ~75 km) of the central Andes has strong positive radial anisotropy in the mid-crust that we interpret as the result of mineral alignment due to ductile crustal deformation and flow. The active arc and backarc of the Puna Plateau in southern Bolivia and northern Argentina show evidence of MASH zones at the crust-mantle transition and large mid-crustal low-velocity bodies. These large low-velocity bodies represent a partially molten mid-crust where magma can further evolve to higher silica concentrations before erupting. Associated with the largest of these low-velocity bodies, we observe very strong positive radial anisotropy interpreted as a horizontally layered magmatic storage system. These results place new constraints on the plumbing system of the arc and back arc magma system. The subducting Nazca slab penetrates into the lower mantle along the central Andes with a steep dip beneath the north central Andes and a shallower dip in the south central Andes. We image a well defined slab beneath the south central Andes where many global models lack a slab anomaly. We observe a major slab tear at ~200-350 km depth down-dip of the Argentina flat slab and evidence of asthenospheric flow through the tear from shear-wave splitting results. The increase in seismic data has dramatically improved our ability to image the Andes and associated subduction zone.