Shear Wave Anisotropy Beneath the Central Andes from the BANJO, SEDA and PISCO Experiments

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Key Words: Anisotropy, shear-wave splitting, Central Andes

We analyze broadband data from portable stations of the BANJO, SEDA and PISCO experiments to determine shear wave splitting parameters (fast polarization direction ϕ, delay time δt) beneath the arrays. The BANJO array constitutes an 800 km-long east-west transect at a latitude of 20^{o} south. It extends from the west coast of South America (near Iquique) to the Chaco Plain, east of the Andes. The SEDA array is located between 16^{o} and 21^{o} south in a line roughly parallel to and 500km east of the coast. The PISCO array is situated in a roughly equidimensional array between 21 and 26^{o} south. Results for the BANJO array, using teleseismic SKS, SKKS and PKS as well as ScS from deep-focus events, which take near-vertical paths through the upper mantle, reveal the following pattern. Delay times vary from 0.5 s to 1.3 s. All but one stations show ϕ almost EW. This direction is approximately orthogonal to the trench and the slab contours. However, the value of ϕ for one station follows the contour of the slab (-30^{o}). In addition, we have measured splitting in S waves from local deep-focus events from the north (related to the Bolivian earthquake of 1994) and the south (Argentina). These ray paths sample the above-slab region is nearly the same place, but sample the below slab region about 200km north and south of the BANJO line. The resulting values of ϕ for the western BANJO stations are more northerly than the teleseismic results for the same station and suggest rapid variations in anisotropic properties north and south of the BANJO line from below the slab. The SEDA stations reveal values of ϕ that are locally parallel to the contours of the Nazca slab, with ϕ rotating from 60^{o} in the north to 10^{o} in the south, and with δt around 1s. These are more or less consistent with the values of ϕ for the BANJO direct-S measurements that sample the subslab region in the same locale. The PISCO stations further to the south reveal a less clear-cut pattern. There is a mixture of NS and EW values of ϕ with a predominance of EW values. Taken together, these results reveal an intriguing pattern: a thin coherent east-west band of EW-fast values of ϕ, with predominantly trench-parallel values of both north and south of this zone. They furthermore suggest that this pattern originates from below the slab. There is no morphologic feature in the slab itself that could cause the observed pattern. Based on knowledge of how olivine deforms, the observed subslab pattern suggests a complex three-dimensional flow field beneath the Nazca slab, consisting of both trench-normal and trench parallel components. The trench-parallel component may be the result of the trenchward motion of the South American plate in a hot spot reference frame. It has been argued previously that this component provides the large-scale structural control of the Andes (Russo and Silver, 1994; 1996)

In order to isolate the mantle-wedge component above the slab, we have performed splitting analysis on local intermediate-focus events. While the values of ϕ are difficult to constrain, the delay times are found to be about 0.3-0.4s. This is larger than the values usually obtained for crustal splitting (global average is about 0.2s, even regions with a large crustal thickness, such as Tibet, see McNamara et al, 1994), suggesting that there is some mantle-wedge component, although it is small compared to the values usually obtained for stable continental regions (Silver, 1996). The remaining signal is due to the subslab region. For the eastern BANJO stations, the top of the slab is deeper than 300 km, so that the subslab zone is below the olivine stability field. Therefore, the subcontinental mantle probably provides the dominant contribution. In this region, the EW direction, subparallel to the relative plate motion of the Nazca plate, could be explained by slab-induced delamination of the subcontinental mantle. Alternatively it could be due to 'fossil' anisotropy associated with the Brazilian Craton. Spltting values obtained from the BLSP experiment further to the east in Brazil (James and Assumpcao, 1996), which show a close correspondence to cratonic geology, suggest the latter interpretation.

James, D. E. Assumpcao, M. 1995. Tectonic implications of S-wave anisotropy beneath SE Brazil. *Geophys. J. Int*, in press.

McNamara, D.E., Owens, T.J., Silver, P.G., Wu, F.T. 1994. Shear wave anisotropy beneath the Tibetan Plateau, *J. Geophys. Res.* 99, 13,655--65

Russo, R., Silver, P.G. 1994. Trench-Parallel flow beneath the Nazca Plate from seismic anisotropy. *Science*, 263, 1105-11

Russo, R., Silver, P. G. 1996. Cordillera formation, mantle dynamics and the Wilson Cycle. *Geology*, in press.

Silver, P. G, 1996. Seismic anisotropy beneath the continents: Probing the depths of geology. *Annu. Rev. Earth Planet. Sci.*, 24, 385-432.