TRENCH-PARALLEL MANTLE FLOW BENEATH THE SUBDUCTED NAZCA PLATE

P. G. Silver and R. M. Russo

DTM, Carnegie Institution of Whashington
5241 Broad Branch Rd., N.W., Washington, DC 20015

We examine seismic anisotropy of the Andean subduction zone and NE South America, through shear-wave splitting measurements, in order to characterize mantle flow beneath the subducted Nazca Plate. The shear-wave splitting parameters (fast polarization direction ϕ and delay time δt between the two split shear waves) from two data sets are discussed: splitting from the SKS phases recorded at Andean stations, and S waves originating in the descending slab and recorded at other stations at teleseismic distances. This latter data set primarily samples the region directly below the slab. The SKS data, however, also sample layers above the slab: part of the descending slab itself, the mantle wedge and the subcontinental mantle below the station. It appears as though the dominant contribution, however, is coming from below the slab. The splitting delay times for upgoing S waves from events in the descending slab, which sample these same layers are much too small to account for the SKS splitting parameters.

ϕ and δt provide constraints on the direction of mantle flow and thickness of the flowing layer respectively. Based on reasonably well established relationships between splitting parameters and deformatin characteristics, and assuming that below the Nazca plate there is an asthenospheric shear flow parallel to the absolute plate motion direciton (APM) of the Nazca plate, then we would expect a roughly EW direction for ϕ for nearly al of the west coast of South America. Instead, we find that about half of the available data yield values of ϕ that are locally parallel to the trench. The other half are more nearly trench-normal, most of which are localized in two bands at 14°S and 24°S. The delay times δt vary from about 0.7s (for SKS) to more than 3.0s for the direct S phases. These large values for S are found between latitudes of 15°S and 25°S and constitute the largest S delay times recorded globally thus far.

We propose the following model for our data. We interpret the trench-parallel values of ø as a manifestation of significant trench-parallel flow beneath the Nazca plate with the flowing region having a thickness of order 100 km. We suggest the flow is a direct result of the retrograde motion of the Nazca slab due to compression-driven slab retreat, and represents the transfer of mantle material from the Pacific to the Atlantic basins. The two

zones of trench-normal values of ϕ are coincident with two changes in slab dip: from 'normal' subduction beneath the Altiplano to 'flat' subduction both north and south. We suggest that the trench-normal values of ϕ represent either a modulation in the trench parallel flow, or possibly flow associated with an actual breack in the slab. Finally, we consider the possibility that the existence of Caribbean and Scotia arcs, as well as the Altiplano are direct or indirect manifestations of the trench parallel flow.