Mapping Lithospheric Structure by Multichannel Processing of Depth Phase Precursors across the Andean Orogenic Belt

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Abstract:

New large scale, high density seismic arrays such as EarthScope's USArray provide a powerful means of detailing lithospheric features (including crustal and upper mantle) by exploiting rarely used seismic arrivals such as the precursors to the depth phases pP. From the EarthScope dataset we have extracted recordings of more than 120 of M>5.5, depth>100km earthquakes from the subduction zone beneath the Andes during 2003 and 2012. With proper signal enhancement, precursors to the pP phase from slab earthquakes beneath South America can be successfully (even for the smallest M=5.5 earthquake) identified as underside reflections from the crustal reflectors (pxP), possibly magma bodies (e.g. APMB), from the crust-mantle boundary - Moho (pmP), from the lithosphere-asthenosphere boundary (plP), and from the 410-km (p410P, s410P) discontinuity. The redundancy provided by the EarthScope's USArray allows us to increase signal-to-noise ratios by stacking within reflection point bins and by the application of multichannel coherency filters. Synthetic seismograms and traveltime calculations confirm that the observed arrivals are appropriate for reflections from the crustal structure, Moho, the 410-km discontinuity and possible interfaces between Moho and 410-km discontinuity, which we propose to be the base of the lithosphere in this region. Our results were also calibrated and compared with previous receiver functions, teleseismic precursor studies in the Andes and showed consistency to those studies and regional geology. The new results provide us with detailed images of crustal structures and constraints of crustal thickness through the whole Andean orogenic belt.

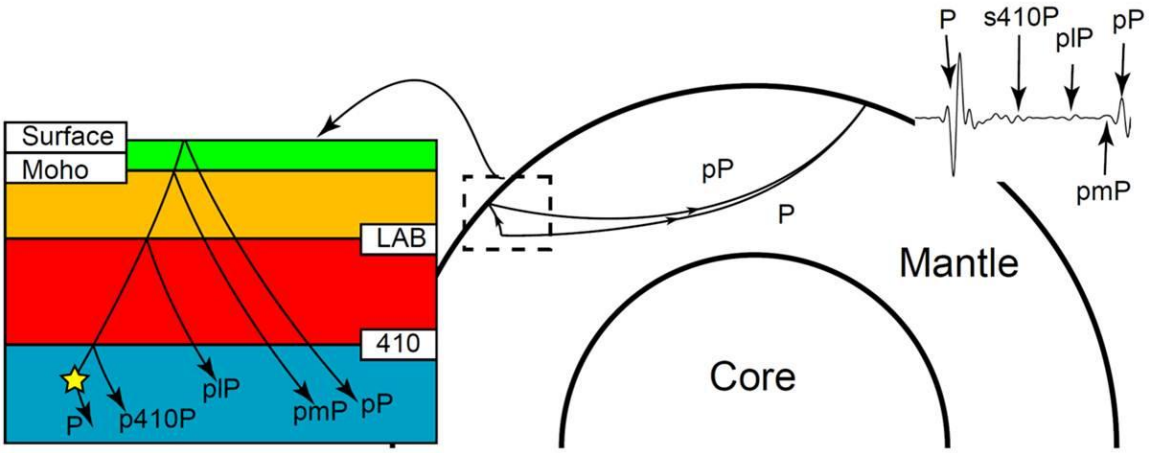

Figure 1 Illustration of raypaths for P, pP and precursor phases (pmP, plP etc.) expected for underside reflections from the Moho, the lithosphere-asthenosphere boundary (LAB), and the 410 discontinuity as recorded at teleseismic stations. Modified from McGlashan et al. **[2008a]**

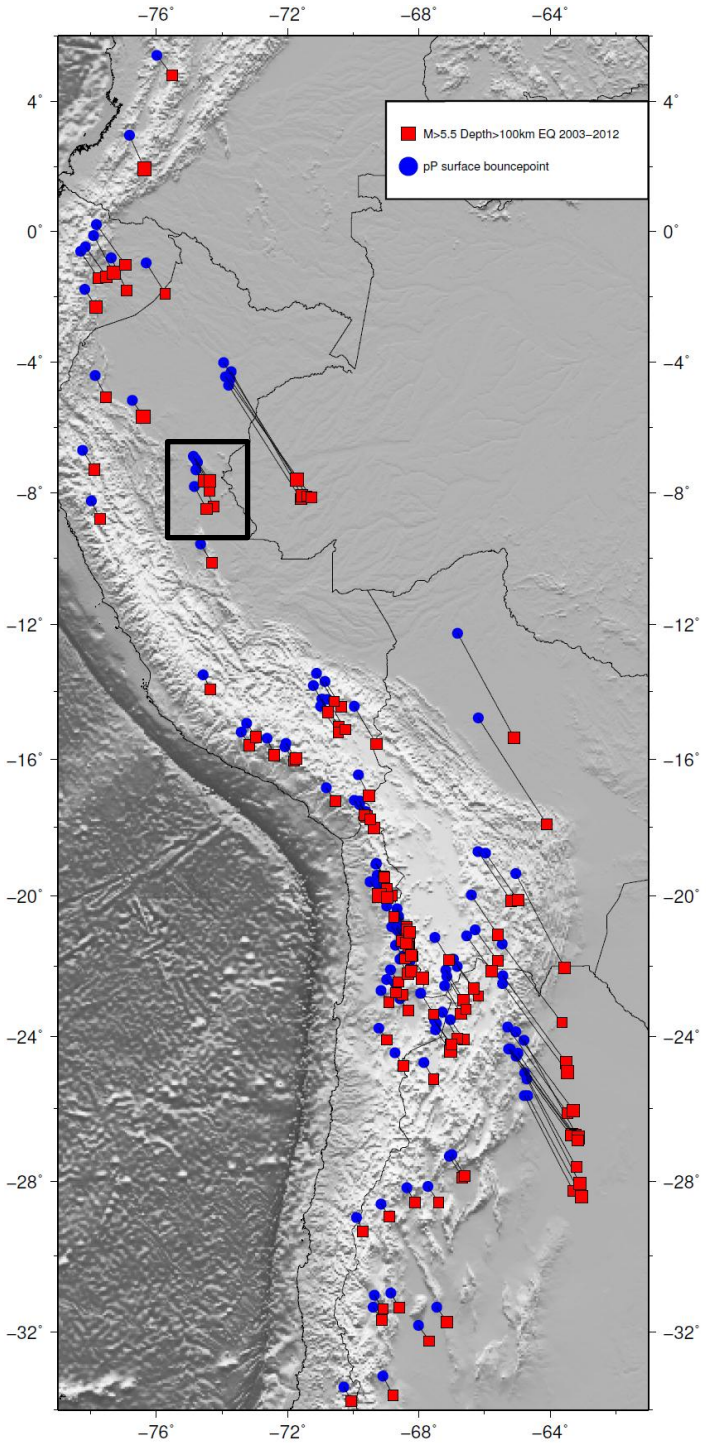

Figure 2 All M>5.5, depth>100km earthquakes from 2003-2012 (red square, size proportional to magnitude) and their surface bounce point of pP phase (blue circle). Black box indicates the earthquake location from figure 3.

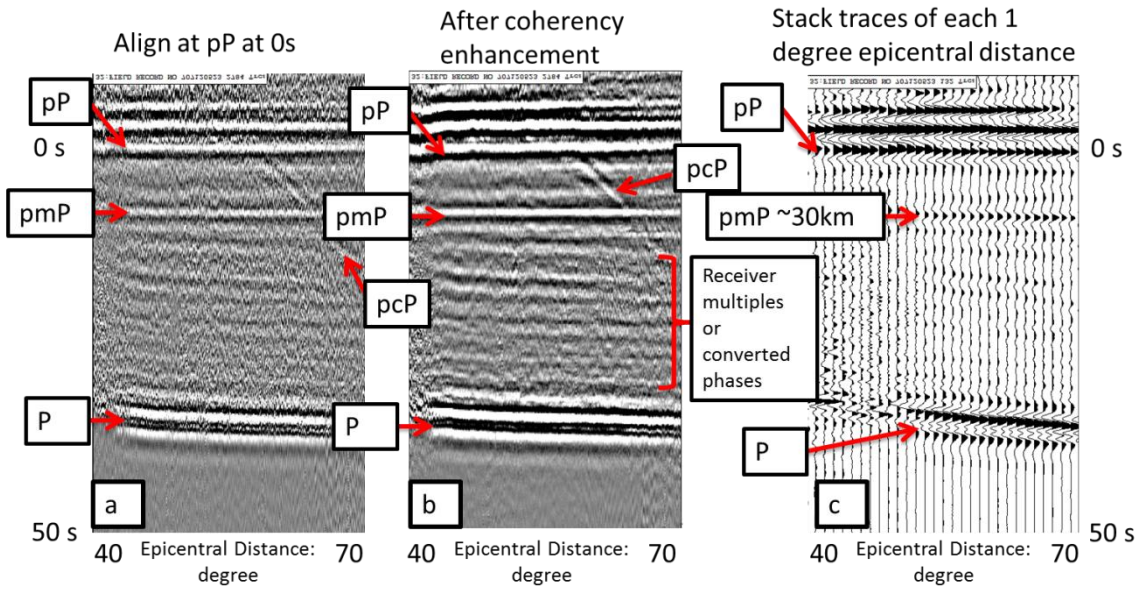

Figure 3 An example of the earthquake 2007/07/12, M=6.1, Depth=152 km (location see figure 2). Main phases and receiver side multiples and converted phases are marked. Data are bandpass filtered with window of 0.1-0.2-0.4-0.8 Hz. (a) shows data aligned at pP phase at 0s. (b) shows data after a series of coherency enhancement. (c) shows data after stacking of 1 degree of epicentral distance (in wiggle display).