Receiver Function Constraints on Slab Geometry and Upper Mantle Discontinuities Under Northern Chile

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Introduction

The Central Andes has been developed by the convergence of the Nazca plate and the South American plate. Images of the subduction slab and the continental Moho as well as the upper mantle discontinuities are important keys to understand the evolution of the orogenic processes. During the German Collaborative Research Programme 267 "Deformation Processes in the Central Andes" several seismological station networks have been in operation. A few distant earthquakes with epicentral distance between 30 and 95 deg have been recorded. Using these records we study the P-to-S converted phases to construct receiver function images of the lithosphere and upper mantle.

Data

(1) The PISCO '94 network was operated in spring 1994. About 30 stations with station spacing of about 30km were located from the Pre- to the Western Cordillera. Two teleseismic events and two Argentinian earthquakes have been recorded.

(2) The CINCA '95 network was operated in summer 1995 with more than 40 stations located in the Coastal Cordillera. 6 teleseismic events have been recorded.

(3) The ANCORP '96 network was operated in winter 96/97, just north of the PISCO area. More than 30 stations have recorded 3 teleseismic events.

(4) GFZ Potsdam had deployed 5 broadband stations in Northern Chile from September 1996 to November 1997. About 10 distant earthquakes have been recorded in the first half year.

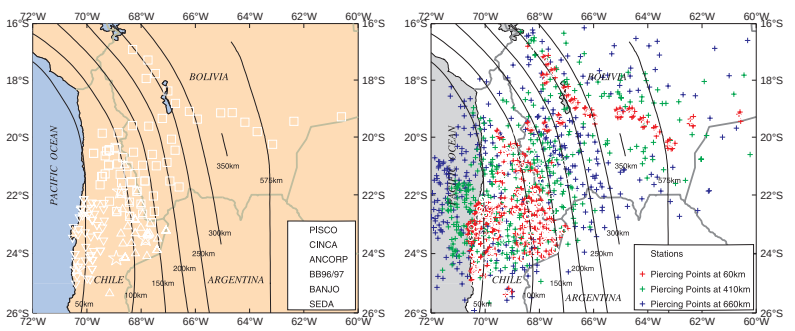
(5) We also used records of about 10 events from the American BANJO and SEDA projects with 20 stations deployed in Southern Bolivia.

Results

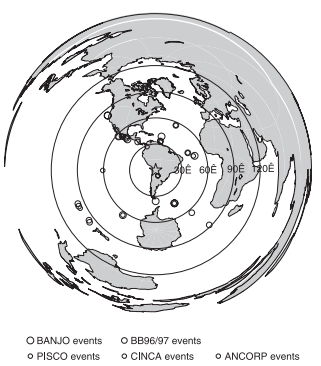
(1) Oceanic Moho is 40 km depth at the coast and can be traced till 130 km deep under the Preandean Depression.

(2) Continental Moho is very clear in the east of Southern Bolivia and the Altiplano and becomes weaker under the Western Cordillera, and could be seen farther west to the coast.

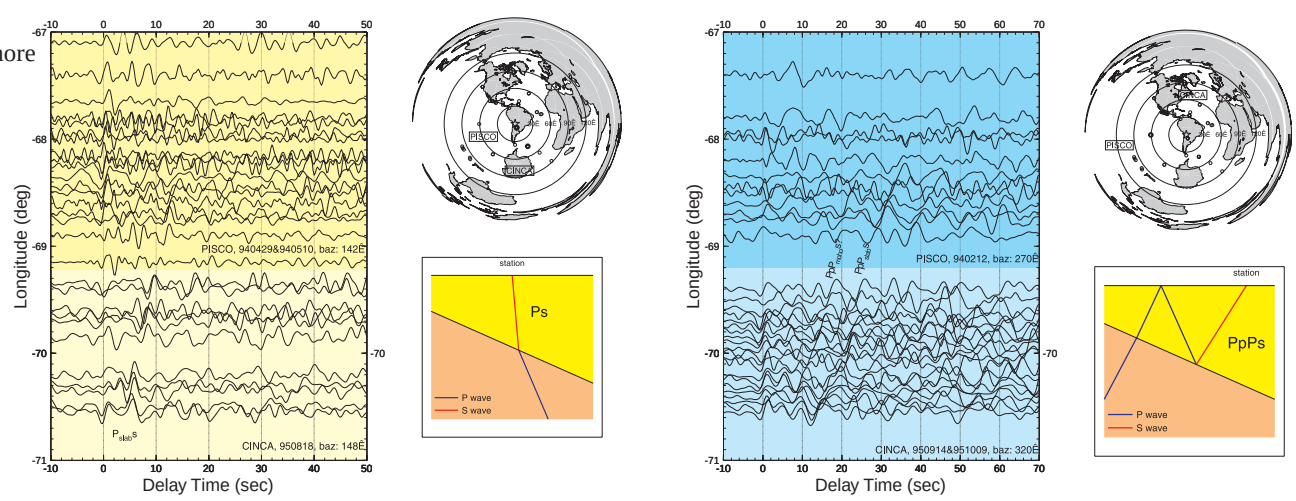
(3) The upper mantle discontinuities can be seen throughout the region. The thickness of the mantle transition zone is in agreement with the global model IASP91, but the "410" seems to be depressed under the magmatic arc.



Map of station locations (left) and piercing points of P-to-S conversions at different depths (right). Slab contours are from Cahill and Isacks.



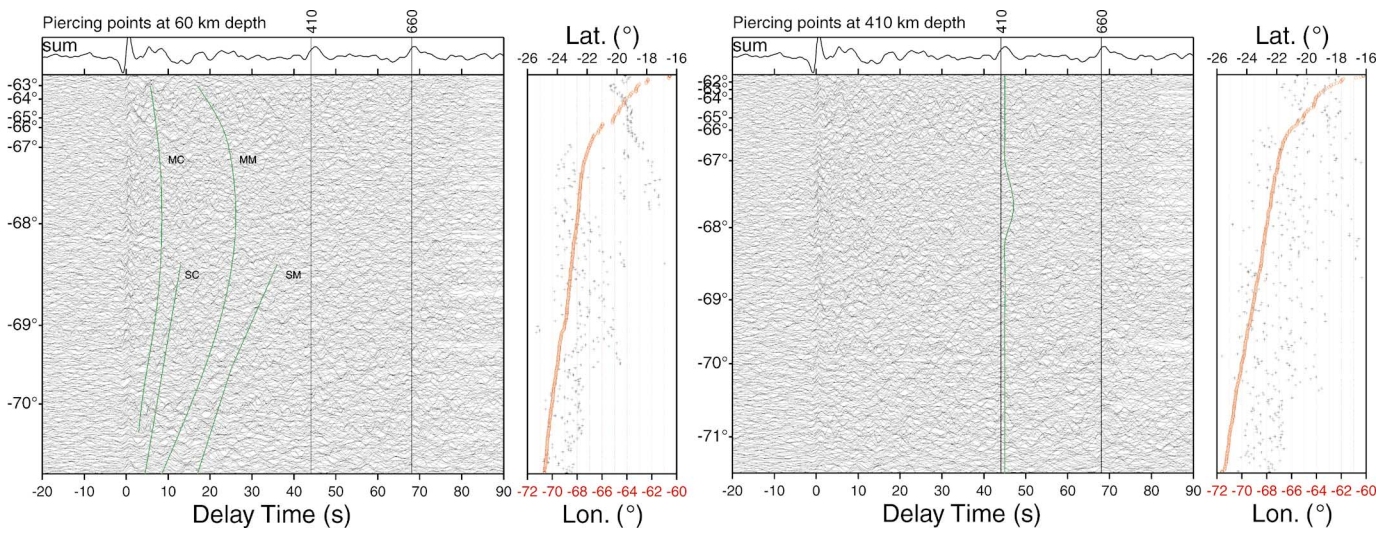
Earthquakes used in this study.



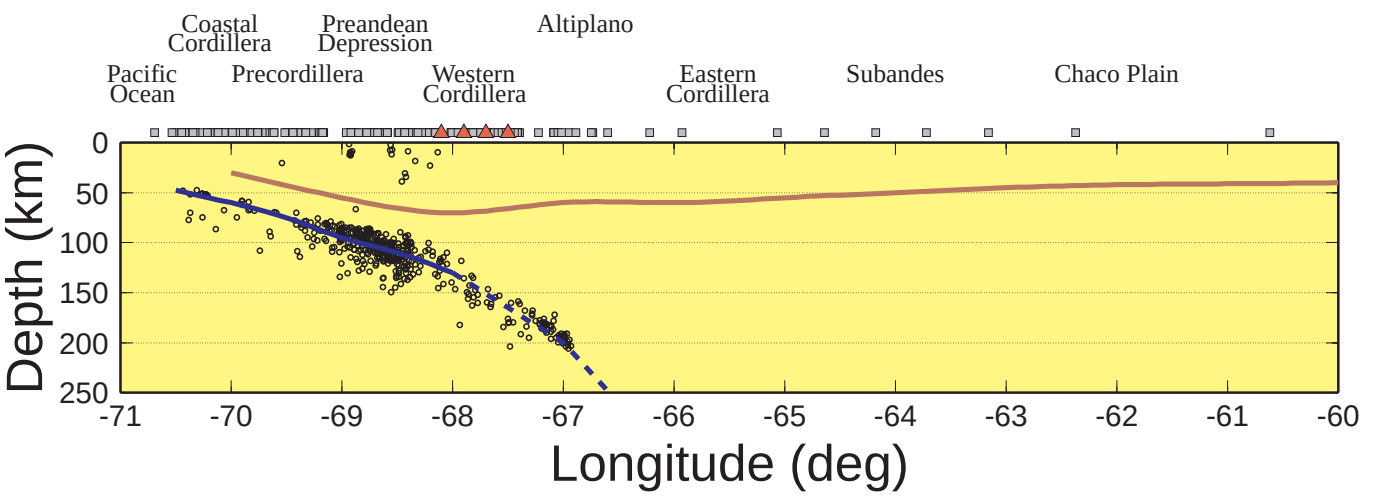
For a dipping structure receiver functions have strong azimuthal dependence. For rays incident on a down-dipping interface the Ps conversion is weak or may disappear. But the multiple phases may be observed instead. Here we show:

left: selected receiver functions of 3 earthquakes from southeastern azimuth: the earthquake of South Sandwich Islands with back-azimuth 148 deg recorded at CINCA (lower part), and two deep Argentinian earthquakes (baz:142 deg) recorded at PISCO (upper part). Seismograms are stacked in bin of 0.05 deg of station longitude. The coherent Ps phases of the Nazca plate are shown from the coast to -68 deg (Preanden Depression).

right: selected reveiver functions of 3 earthquakes from western azimuth: two Mexico earthquakes recorded at CINCA with baz of 320 deg (lower part), and the earthquake of Sorth Pacific Ocean with baz of 270 deg (upper part). The dominating phases are PpPs multiples of Nazca plate and of Moho.



All 380 receiver functions are plotted equally spaced. They are ordered accoring to longitudes of piercing points running from east to west. The traces are moveout corrected for P-to-S converted waves. The time scale is valid for 67 deg epicentral distance. In the right panel of each plot are shown the longitudes and latitudes of piercing points for each trace. We clearly see the Ps phase of the slab (SC) and the multiples PpPs (SM). The Ps phase of continental Moho (MC) is clear in the east part of the profile. We could correlate the continental Moho to the west above the slab with strong PpPs multiples (MM).



Raw interpretation of the phases. Red line is the continental Moho, blue line is the oceanic Moho. Earthquakes are relocated by Frank Graeber.