SEISMIC STUDIES IN SOUTHERN PERU FROM ARRAY DATA

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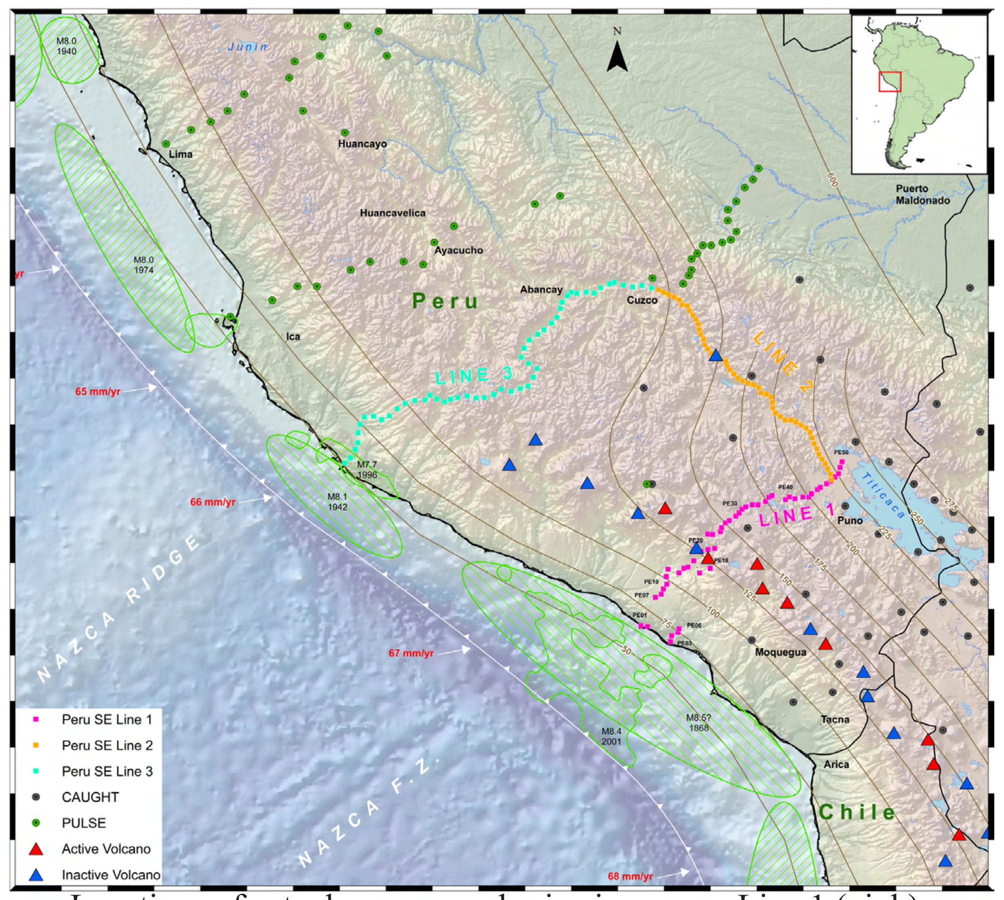
Abstract

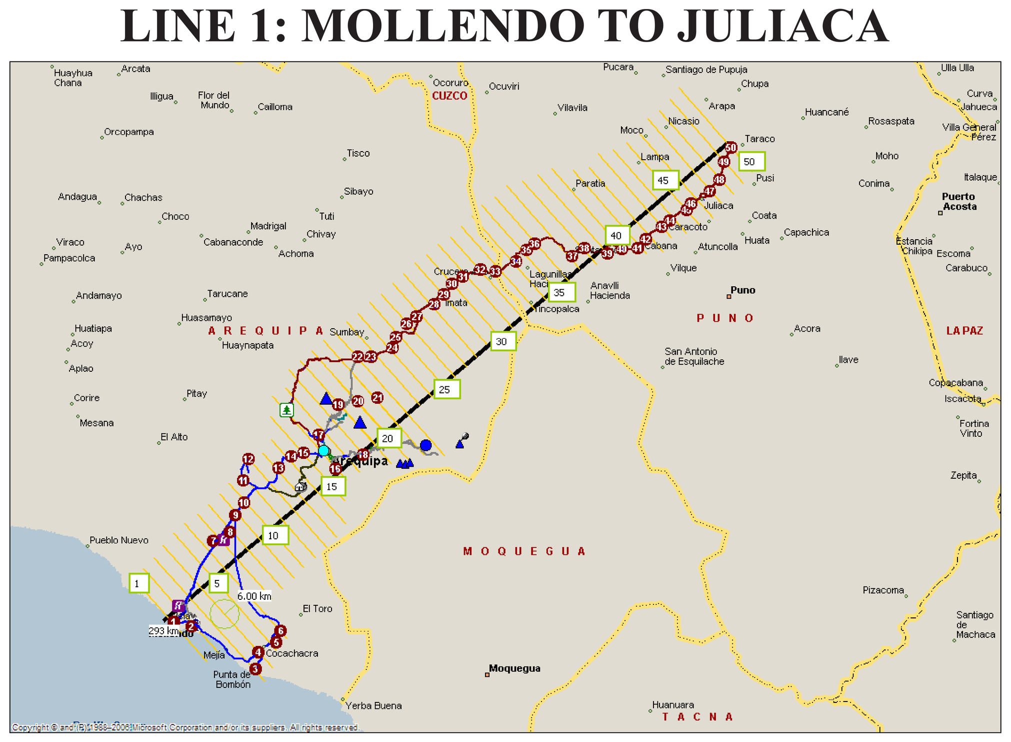
\Studies were performed using data collected from an array of 50 seismic stations in Southern Peru. The seismic array runs perpendicular to the trench between Mollendo and Juliaca and is part of a UCLA CENS (Center for Embedded Networked Systems) project. This area is of interest because Southern Peru represents a transition between subduction with a dip angle of around 30 degrees and shallow subduction to the north. The current line is located in a region with steeper subduction while a second line has been constructed between Cusco and Juliaca to study the transition between flat and steep subduction. A third line from Cusco to the coast is will study the region with shallow subduction. Based on teleseismic receiver functions (RFs), the crustal thickness gradually thickens to a depth of approximately 70km beneath the Altiplano. A mid-crustal structure has also been observed at a depth of close to 40km. This may represent a remnant of the original Moho before the rapid uplift of the Altiplano, or may indicate some type of underplating episode. Images also show the subducting slab, which is best imaged by RFs based on PKP phases. Additional information on the subducted slab and overlying crust is being sought from PP phases, S-wave RFs, and undersided reflections. The goal of this study is to compare the structure and properties of the "normally" subducting slab with the "flat" slab that will be imaged on the third line.

SEISMIC ARRAYS IN S PERU

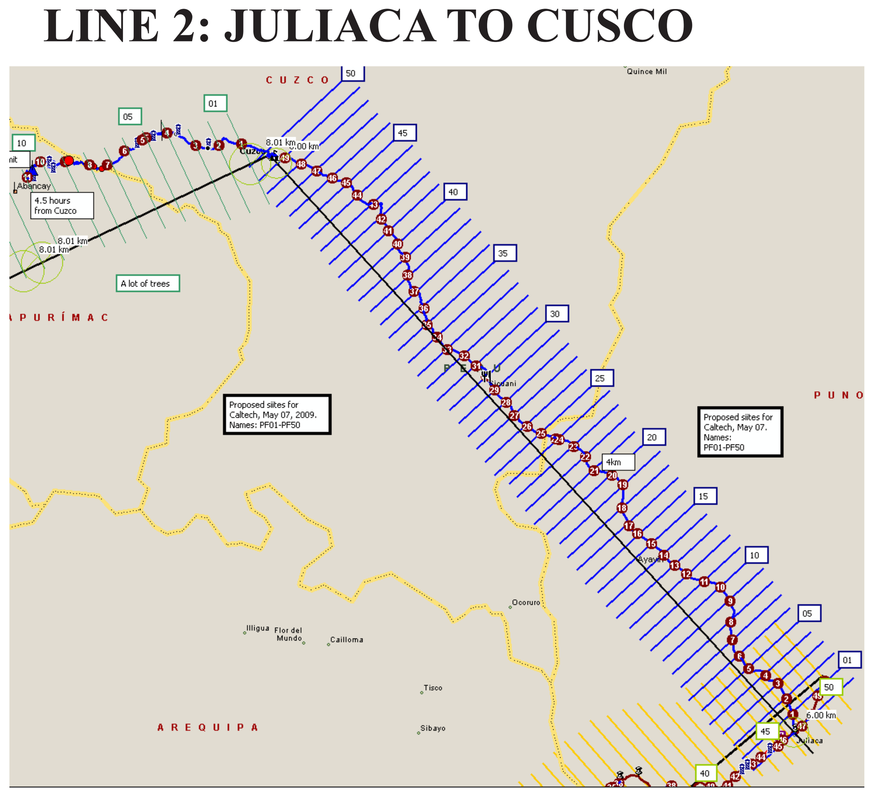


Above: Locations of actual or proposed seismic arrays. Line 1 (pink) currently operational; Line 2 (yellow) recently constructed; Line 3 (light blue) planned; other symbols represent other proposals

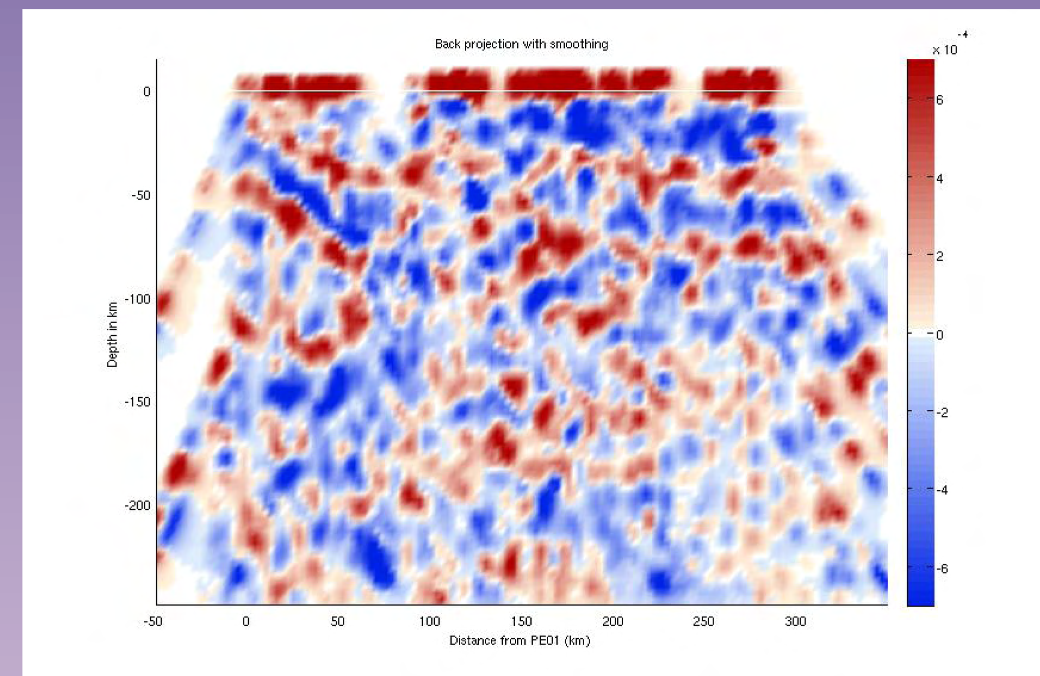
LINE 1: MOLLENDO TO JULIACA



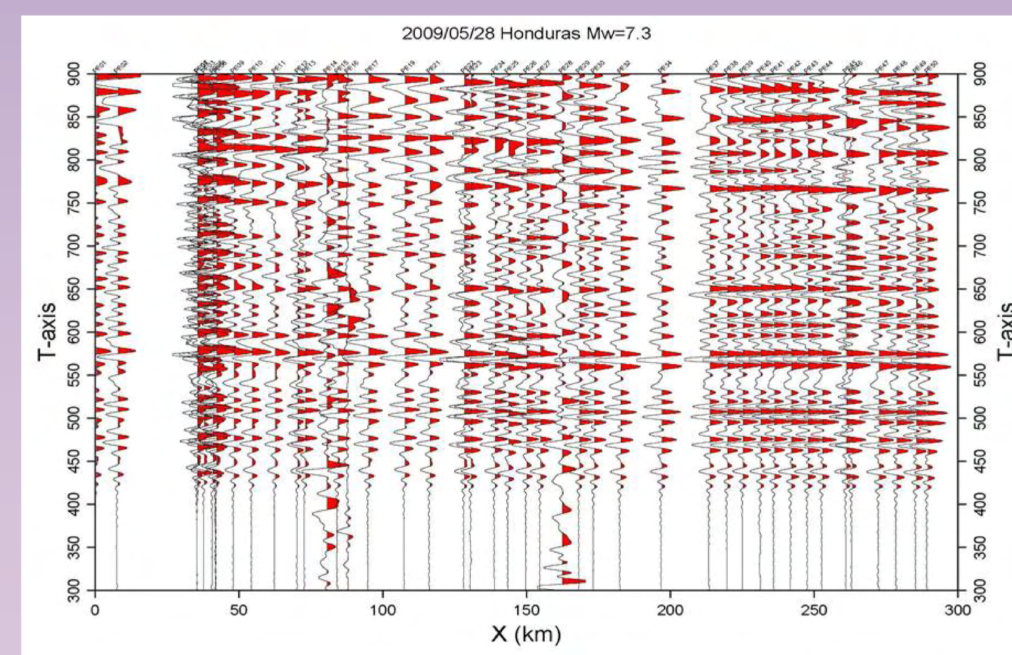
LINE 2: JULIACA TO CUSCO



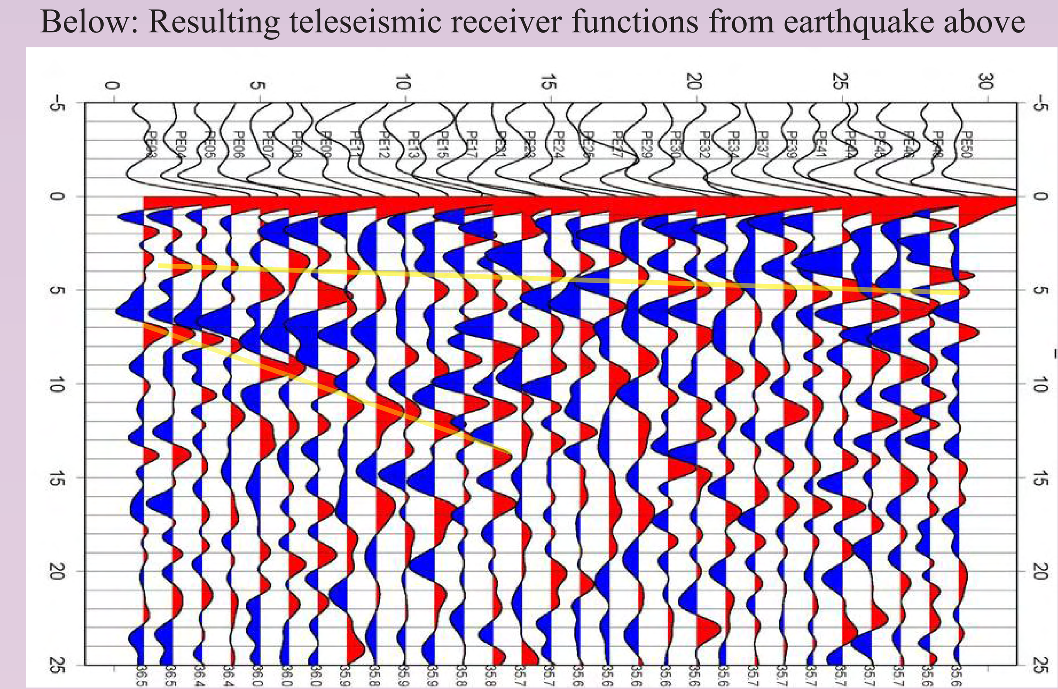
RECEIVER FUNCTION RESULTS



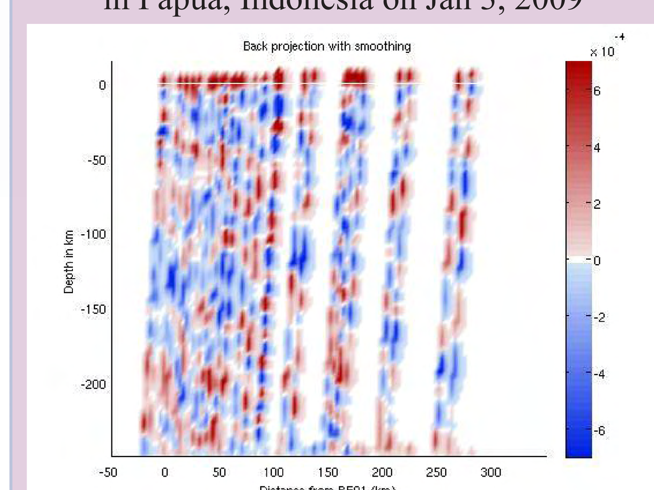
Backprojection image of teleseismic receiver function data

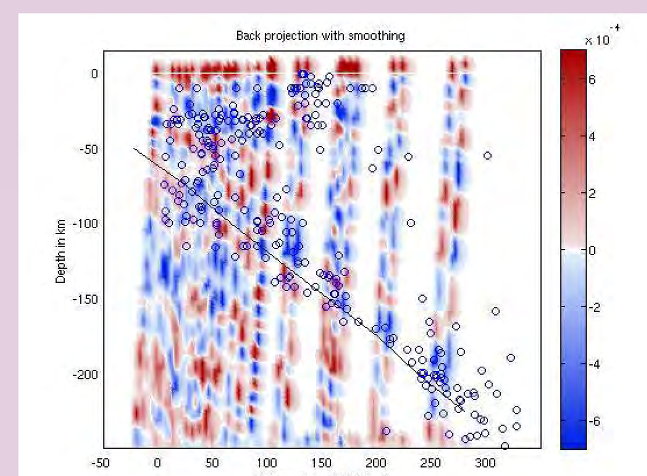


Above:Data from May 28, 2009 earthquake in Honduras with magnitude 7.3
Below: Resulting teleseismic receiver functions from earthquake above

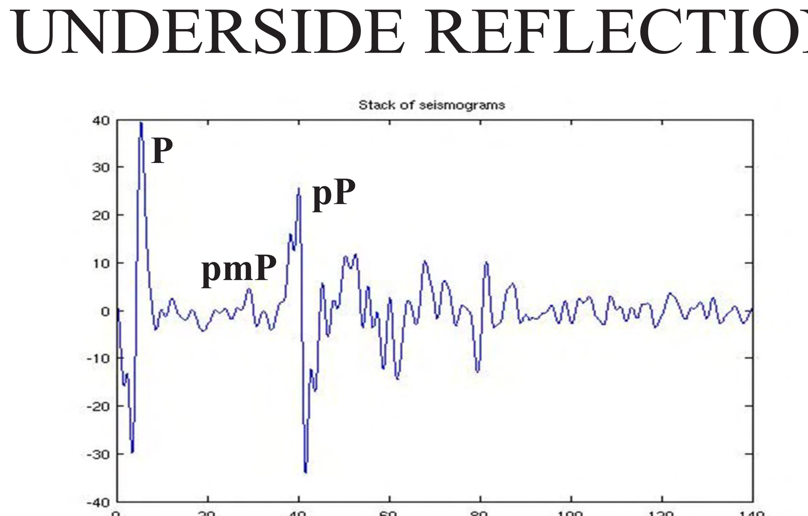


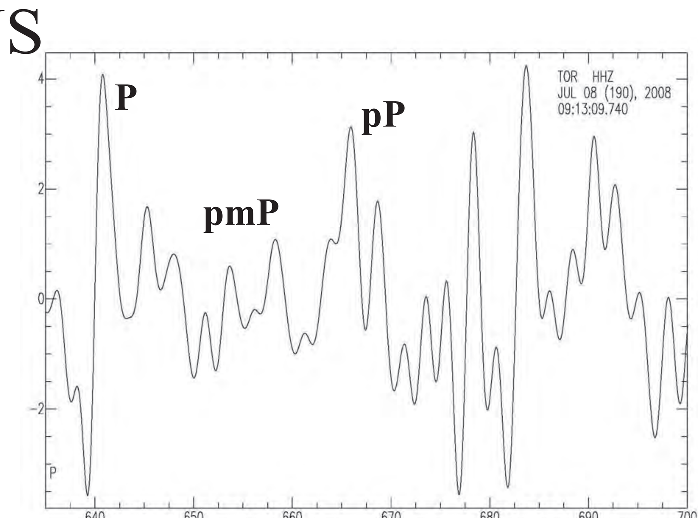
Below: PKP receiver functions backprojected from array from M 7.6 earthquake in Papua, Indonesia on Jan 3, 2009





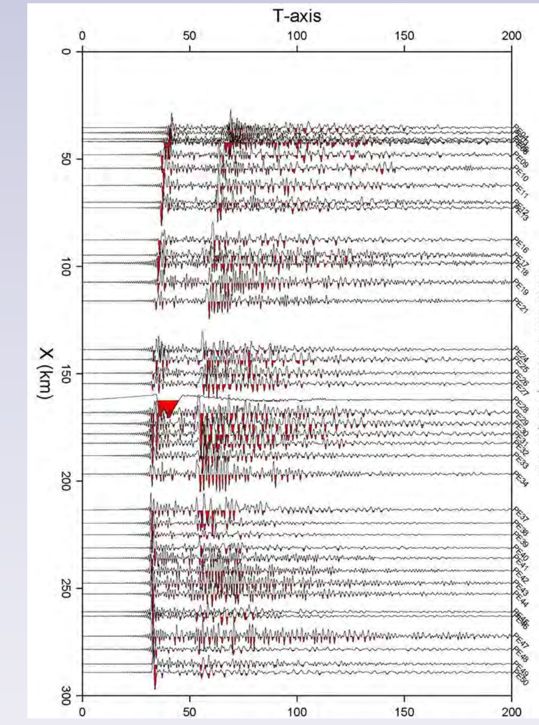
UNDERSIDE REFLECTIONS

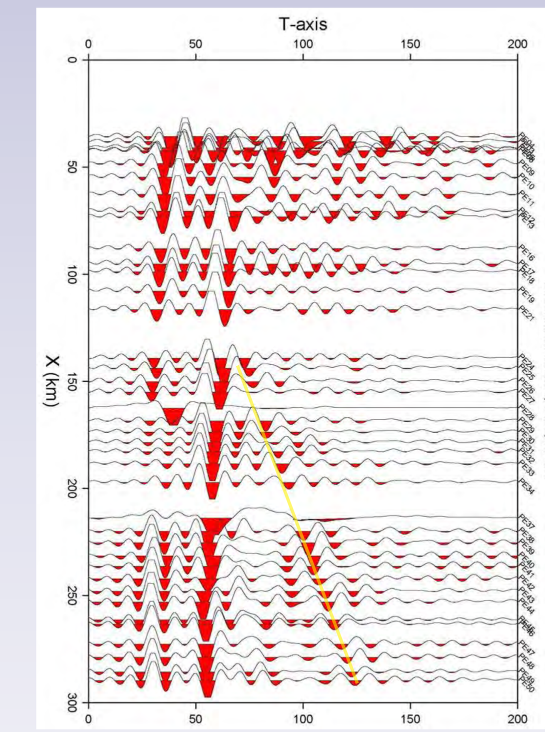




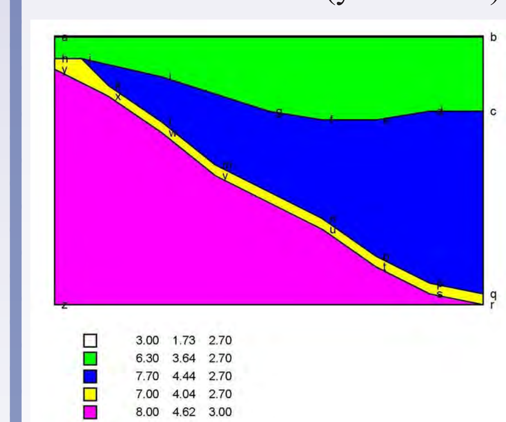
Local Peruvian earthquakes were analyzed using teleseismic data (the Southern California seismic network). The event on the left is a M6.3 N Peru event from Aug 26, 2008 and the event on the right is a M6.2 Arequipa event from July 8, 2008. The seismograms were aligned on the P arrival and stacked. A precursor to the pP arrival can then be looked for (pmP) which represents a underside reflection off of the Moho. The distance between pmP and pP provides an estimate of crustal thickness which can be compared to receiver function results. The best events for this method are larger than magnitude 6 and deeper than about 100 km.

LOCAL EVENTS AND FINITE DIFFERENCE MODELING

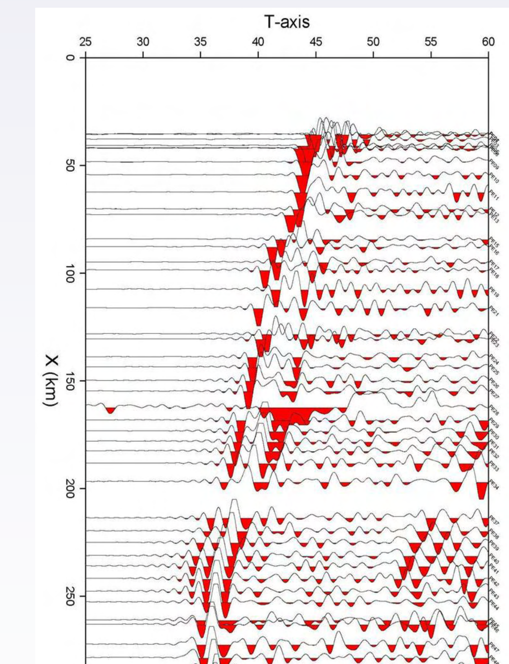


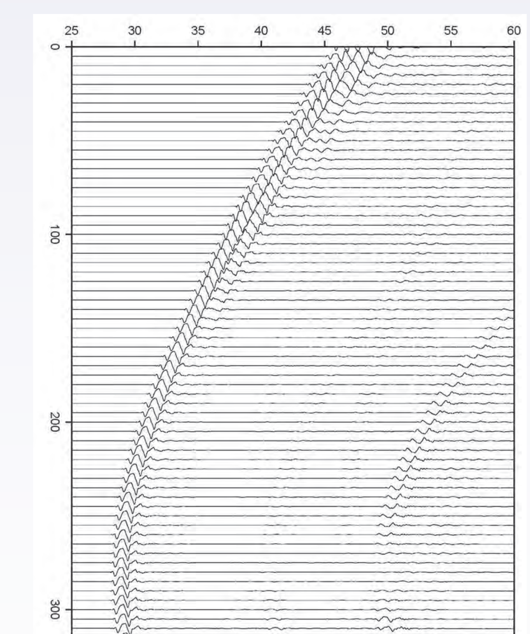


Juliaca earthquake, M 5.8 on Sept 5, 2009. Left is data bandpassed to 1s, right at 10s. Signal observable in 10s data which may be a surface wave reflection (yellow line) off of corner where slab meets the Moho or topography



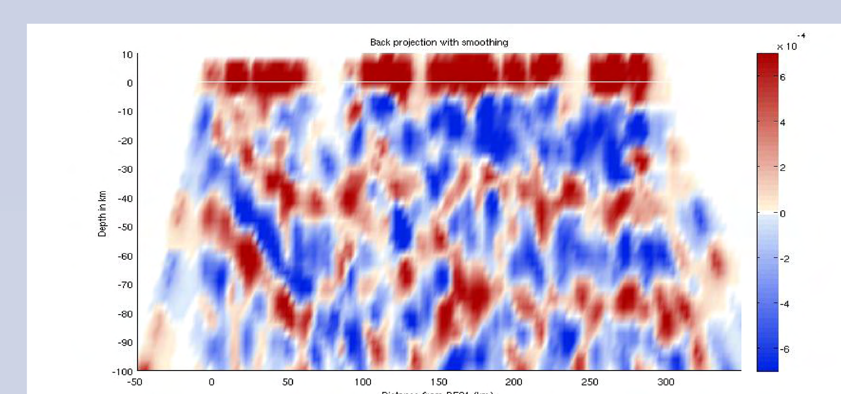
Above: P-wave speed model used in Finite Difference code. Crustal thickness based on receiver function results, slab dip of about 30 degrees basid on teleseismic and PKP

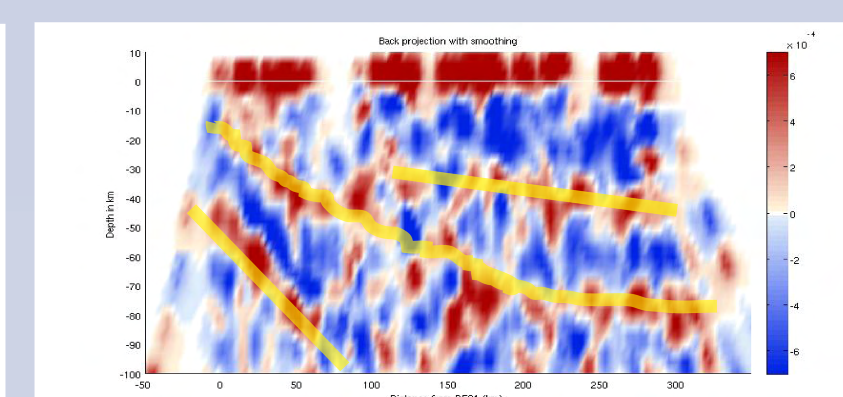




Left: Data from Sept 30, 2009 event near Puno, Peru/La Paz, Bolivia.
Right: FD synthetics based on the event to the left.

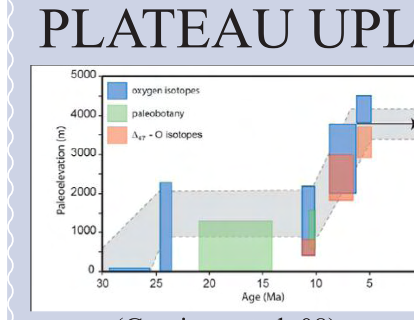
MOHO STRUCTURE AND PLATEAU UPLIFT



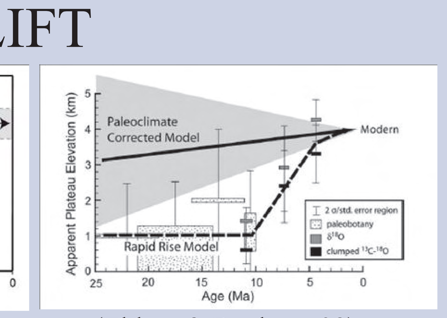


Above: Receiver function image of the lithosphere in Southern Peru. On the right is a possible interpretation of the results in which the middle line (thickening to about 70 km beneath the Altiplano) is the current Moho depth, the line at about 40 km is a mid-crustal structure, and the third line is the subducting slab

PLATEAU UPLIFT



(Garzione et al, 08)



(Ehlers & Poulsen, 09)

Model 1: Rapid Rise
- Paleoaltimetry data support estimate of ~2.5 km uplift between 6 Ma and 10 Ma
- Mechanism interpreted to be delamination

Model 2: Gradual Uplift
- Crustal thickening (compensated Altiplano thickness)
- RF results may support McQuarrie 02 model of underthrusting
- Effect of climate change on paleoaltimetry estimates and rapid rise model (Ehlers & Poulsen, 09)

Right: Elevation, data from gravity survey, and free air gravity anomaly
Below: Airy isostasy estimate (green) based on 2.7gcc crustal density, 3.3gcc mantle density, reference PE09 of 51km. Compared with RF stacking results (red)