The Crust and Uppermost Mantle Structure of Southern Peru From Ambient Noise and Earthquake Surface Wave Analysis

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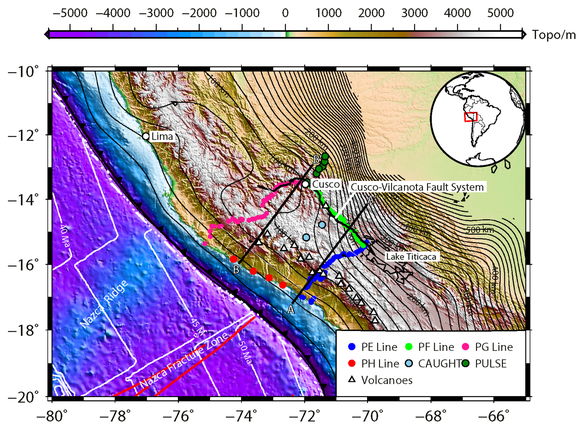
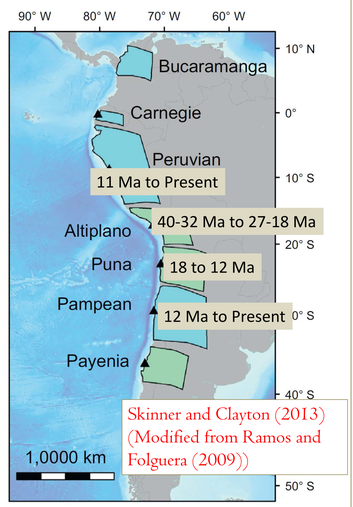
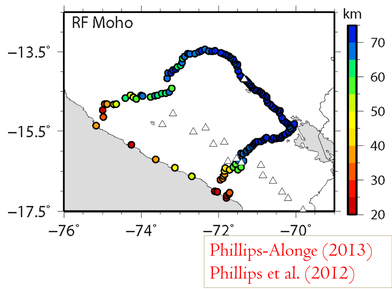
Introduction



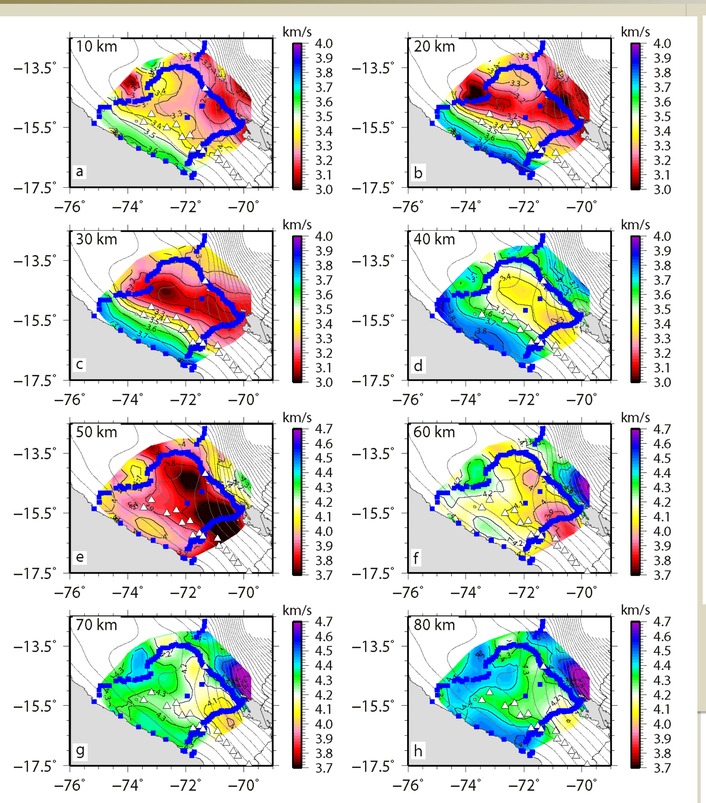
Location of the seismic stations (dots) used in this study. The Holocene volcanoes are denoted with white triangles. The Cusco-Vilcanota Fault System is digitized from Carlier et al. (2005). Slab contours are from Slab 1.0 model (Hayes et al., 2012) plotted in 20 km intervals. The seismic structure along A-A' and B-B' profiles (thick black lines) are shown in the following.

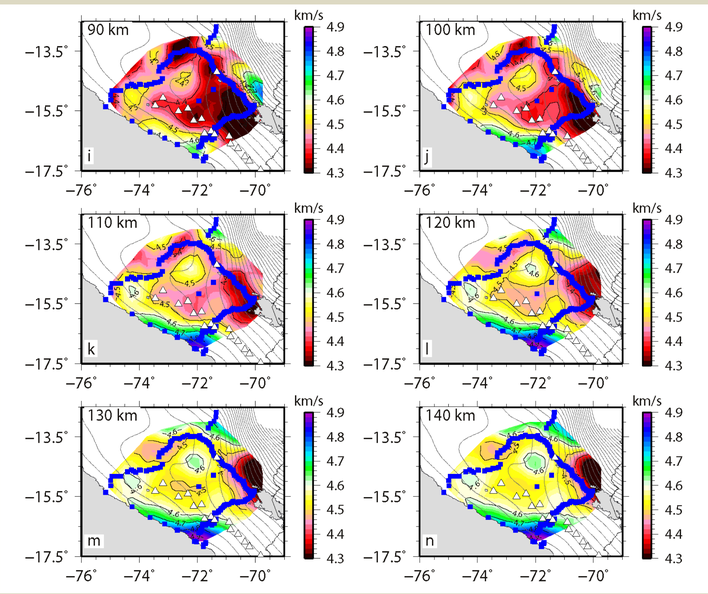




- The formation of the largest continental plateau (Altiplano-Puna plateau) after Tibet.
- The flattening of the subducted Nazca slab, and the cessation of the Holocene volcanism above it.
- The extensive crustal melting in the Central Andes.
- The underthrusting of the Brazilian shield.

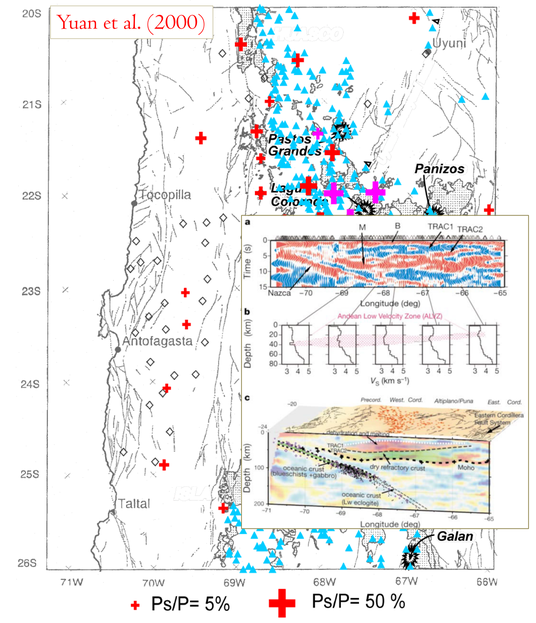
Results and Discussions



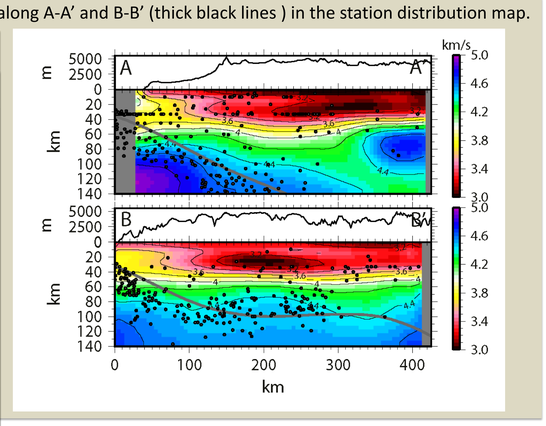


Depth slices from surface to 140 km depth. We invert for a smooth model without a Moho discontinuity for the reason that the surface wave method is well-known to be insensitive to the discontinuities since it sees an integral of structure, and also we do not have a good reference Moho inside of the box array.

The Andean Low-Velocity Zone

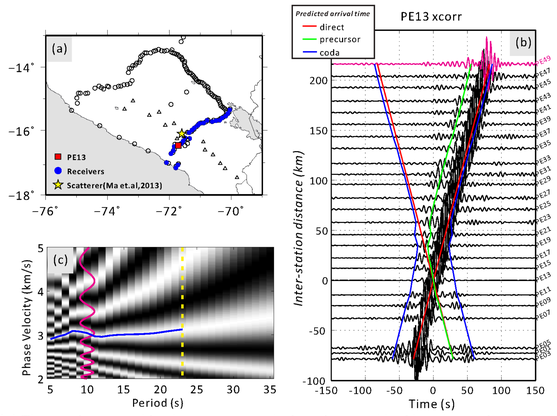


Cross-sections along A-A' and B-B' (thick black lines) in the station distribution map.

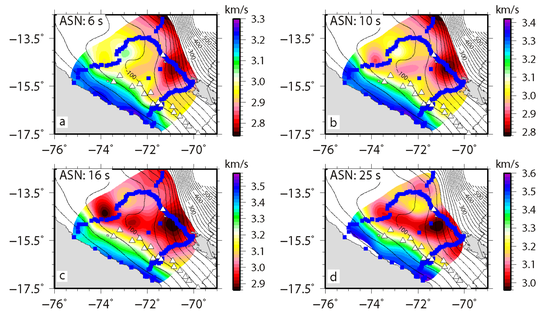


Data and Method

Ambient Noise Tomography

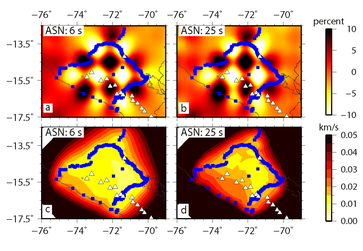


(a) The stations used in the cross-correlations in panel b. Also shown is the location of the strong wave scatterer. (b) The cross-correlations between PE13 and all the odd number stations on PE line. (c) An example of measuring the dispersion curve of the cross-correlation between PE13 and PE49 (pink trace in b), using the method of Yao et al. (2006).

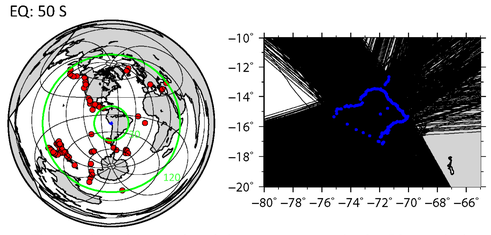


Top: Ambient noise phase velocity maps of 6, 10, 16 and 25 s period. The results are clipped with model error less than 10% of the average velocity in each period.

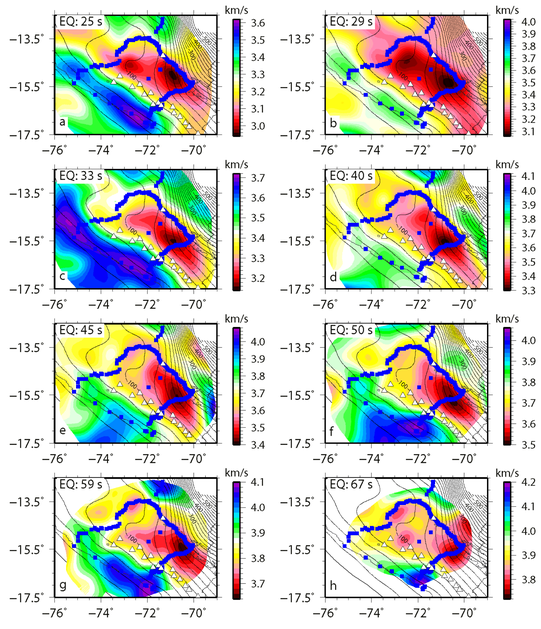
Right: Resolution test and model error estimated from the resolution matrix and model covariance matrix.



Earthquake Two-Plane-Wave Tomography

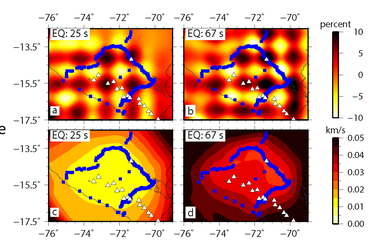


The earthquakes used and the ray coverage in the 50 s period.



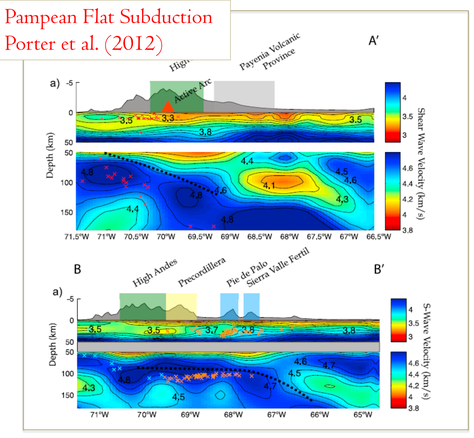
Top: Two plane wave phase velocity maps from 25 to 67 s period. The results are clipped with model error less than 10% of the average velocity in each period.

Right: Resolution test and model error

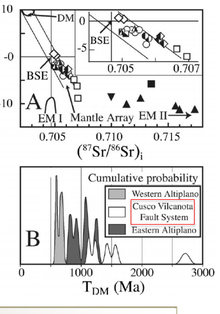


Normal Vs. Flat Slab

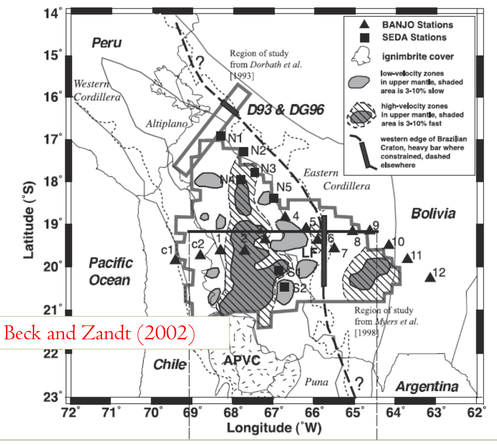
Pampean Flat Subduction
Porter et al. (2012)



K-UK rocks in S Peru
Carlier et al. (2005)



Underthrusting Brazilian Shield



Beck and Zandt (2002)

Conclusions

We imaged the shear wave velocity (V_{SV}) structure of Southern Peru using the surface wave signals from ambient noise cross-correlations and earthquake data. A low-velocity mid-crust structure is imaged, as part of the Andean low-velocity zone. The recently subducted slab below the forearc shows a decrease in velocity from normal to flat subduction regime, possibly related with the serpentinization during the formation of the Nazca ridge. A comparatively high velocity mantle wedge is observed above the flat slab, which indicates the lack of mantle melting and therefore the cessation of volcanism above it. A velocity contrast across the Cusco-Vilcanota Fault System is imaged, which delineates two lithospheric blocks. It indicates the underthrusting of the Brazilian shield beneath the Eastern Altipano-Eastern Cordillera in Southern Peru.

Acknowledgements

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