CRUSTAL THICKNESS BENEATH THE CHACO-PARANA BASIN, NE ARGENTINA, USING SURFACE WAVES AND AMBIENT NOISE TOMOGRAPHY

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INTRODUCTION

The Chaco-Paraná basin is a Neopaleozoic intracratonic basin, formed by a complex history of different processes of subsidence. It would correspond to the southern extension of the Paraná basin that reaches its maximum development in Brazil. Despite sharing part of the Paleozoic and Mesozoic development with the Paraná basin, it differs widely in the Cambro-Ordovician and Cenozoic sequences (Ramos, 1999). It consists of several depocenters separated by structural elevations, each with a distinctive sedimentary tectonic record. This basin is limited to the west by the Andes Mountains and to the east and northeast by the Brazilian shield (Fig. 1).

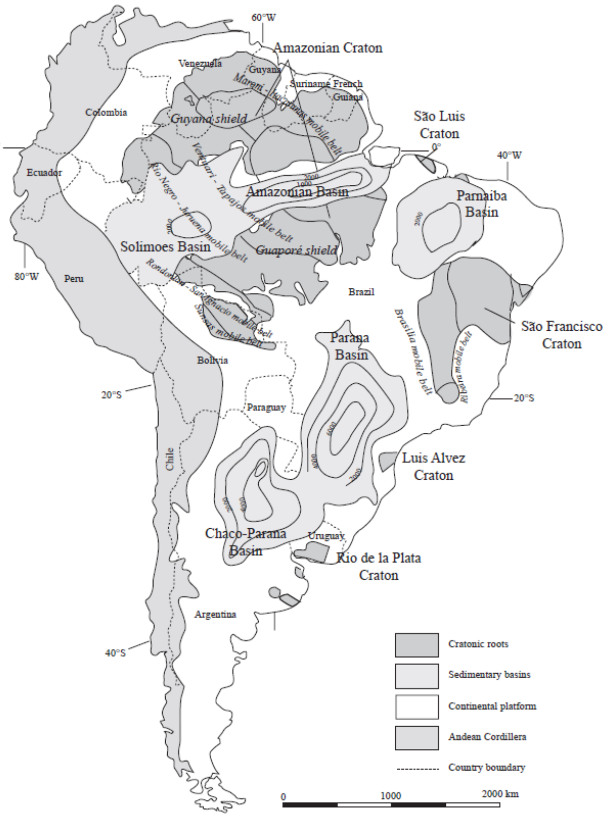

Figure 1: Geotectonic map of South America (from Heintz et al., 2005)

Feng et al, (2007) estimated Moho depth of 30 km in the central Chaco basin and a low-velocity anomaly in the lithospheric mantle. Snokes and James, (1997) found a Moho depth of 32 km and low upper-mantle S-wave velocities for Chaco basin. Crustal thickness and Vp/Vs ratio are available only for CPUP station in Paraguay (EARS). However the seismic structure of the crust and upper mantle remains little characterized across the region due to the rather poor resolution, especially for the south region. The aim of this work is to improve the resolution and fidelity of crustal images obtained from traditional earthquake-based measurements. Hence we present the results of a study of surface-wave dispersion data obtained by tomography inversion, using seismic data from regional events recorded at LPA (La Plata) station, permanent (GSN) stations, portable (BLSP and BRASIS) stations, as well as inter-station dispersion curves derived from ambient seismic noise correlation. The resulting path coverage is denser and displays a more uniform azimuthal distribution that allows us to produce better tomographic images.

METHOD

DISPERSION CURVES

We applied a multiple filter technique to measure fundamental mode group velocities. We used regional events recorded at LPA (UNLP) and TRQA (GSN) stations for the last five years, to improve resolution in NE Argentina (Fig. 2), and Andean earthquakes recorded at new stations (BRASIS) recently deployed by USP in southern Brazil.

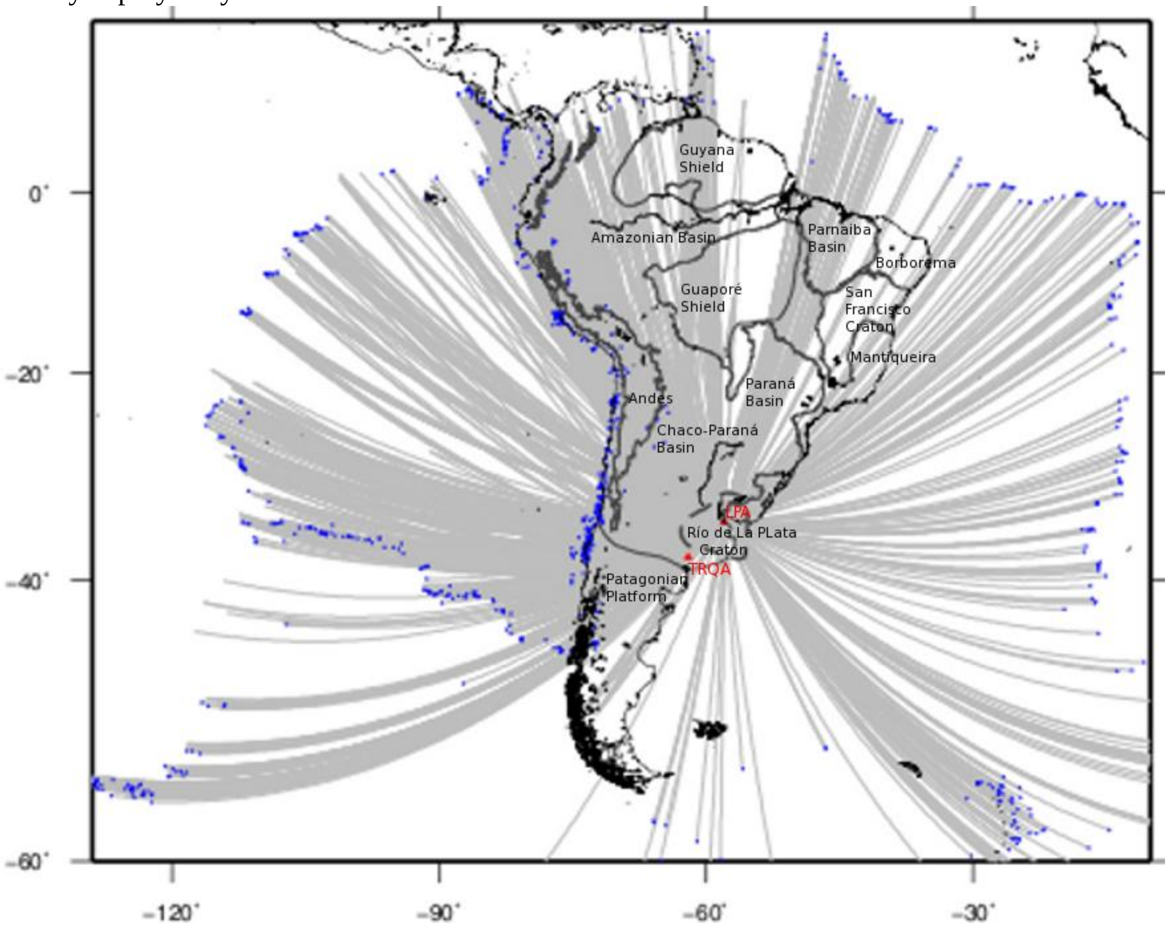

Figure 2: Schematic map of South America with the main geological provinces. Path of all group velocity measurements at LPA and TRQA stations (red triangles)

We also calculated group velocities between pairs of stations from cross-correlation of ambient seismic noise using a dataset of seismic noise recordings from INPRES stations, Brazilian network stations, CPUP, TRQA and LPA stations. Figure 3 shows group velocity dispersion curves.

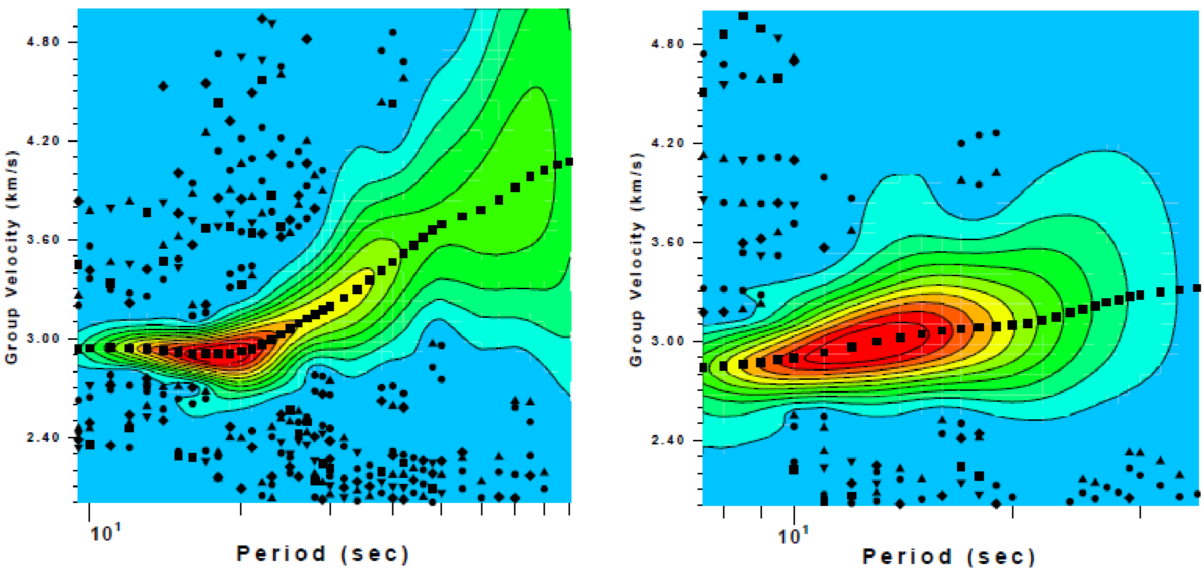

Figure 3: Dispersion curves. Left: corresponding to an Andean earthquake crossing the Chaco-Paraná basin recorded at LPA. Right: corresponding to an inter-station (LPA and TRQA) path from ambient seismic noise cross-correlation

TOMOGRAPHY INVERSION

We performed Rayleigh wave group velocity tomography with the new dispersion curves combined with previous datasets from portable BLSP stations (Feng et al., 2007). The inversion was made with a grid of 1º x 1º.

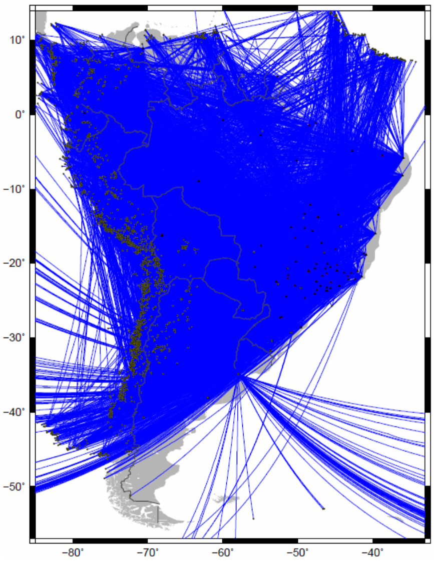

Figure 4: Group velocity paths for 20s used in the tomography inversion

Figure 4 shows the group velocity paths used for tomography inversion, for 20s. The improved path coverage allows us to determine high resolution group velocity images to produce more detailed maps of crustal structure in Northern Argentina and Southern Brazil. We constructed maps from 10 to 140 seconds by separate inversion in 10s intervals. At short periods (10s, 20s), surface waves are sensitive to shallow crustal structures, such as the sediment thickness. At longer periods (40s), surface waves become more sensitive to average crustal seismic velocity and crustal thickness. At 70s, we are starting to sample the uppermost mantle (Feng et al., 2004). Maps of 10, 20, 40 and 100s periods are shown in Figure 5.

RESULTS

Group velocities for 10s (Fig. 5a) are low in the sub-Andean basins and highest in the Atlantic shield. Rayleigh-waves for 20s (Fig. 5b) show relatively low group velocities associated with the major sedimentary basins such as Amazonian, Parnaíba, Paraná, Chaco- Paraná and the subandean foreland basins. For the Río de La Plata craton, the sedimentary thickness is shallower than for the Chaco basin in central Argentina.

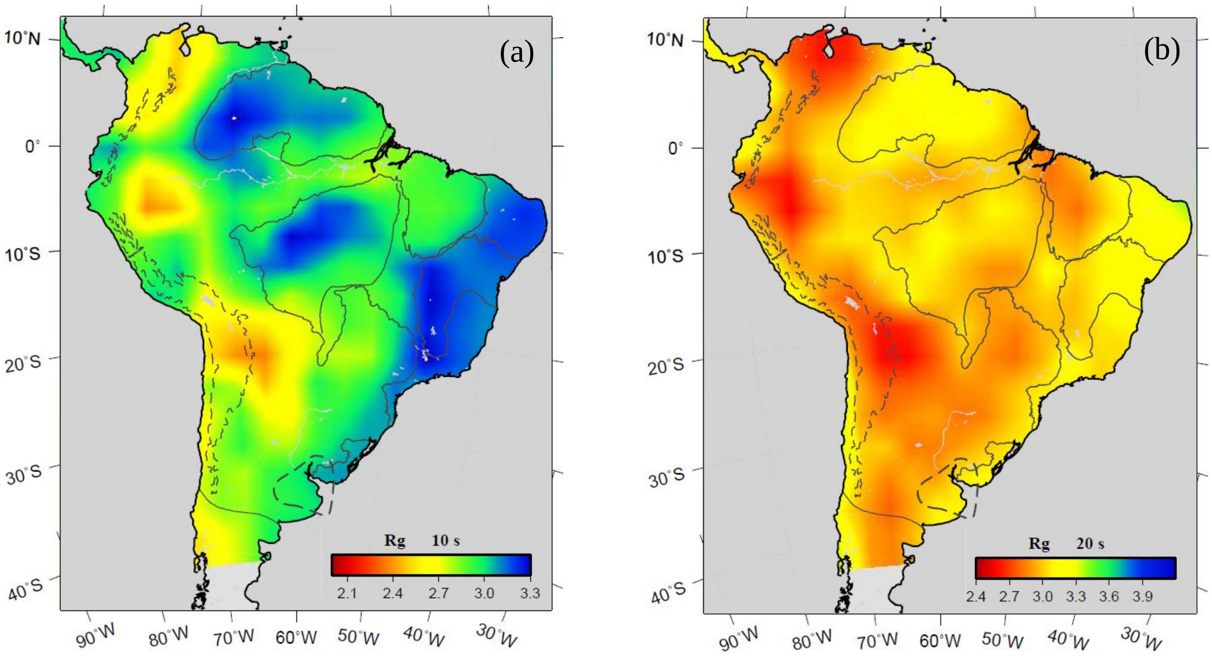

Figure 5: Group velocity tomographic maps a) at 10 seconds, b) at 20 seconds. Dashed line in the Andes is the 3000m elevation; dashed line around La Plata is the approximate limit of the Río de La Plata craton

In Fig. 5c, Rayleigh waves for T=40 are sensitive to crustal thickness. The Paraná basin has deeper crust compared with the Chaco basin in Paraguay and the eastern part of Argentina. The Río de La Plata craton has intermediate thickness.
At longer periods (Fig. 5d), higher group velocities are found in the Amazonian craton and around the San Francisco craton. These high velocity anomalies seem to concentrate in a smaller area in the northeastern Guaporé shield and the southeastern San Francisco craton and they could indicate a thicker lithosphere compared to other areas of the Precambrian craton.

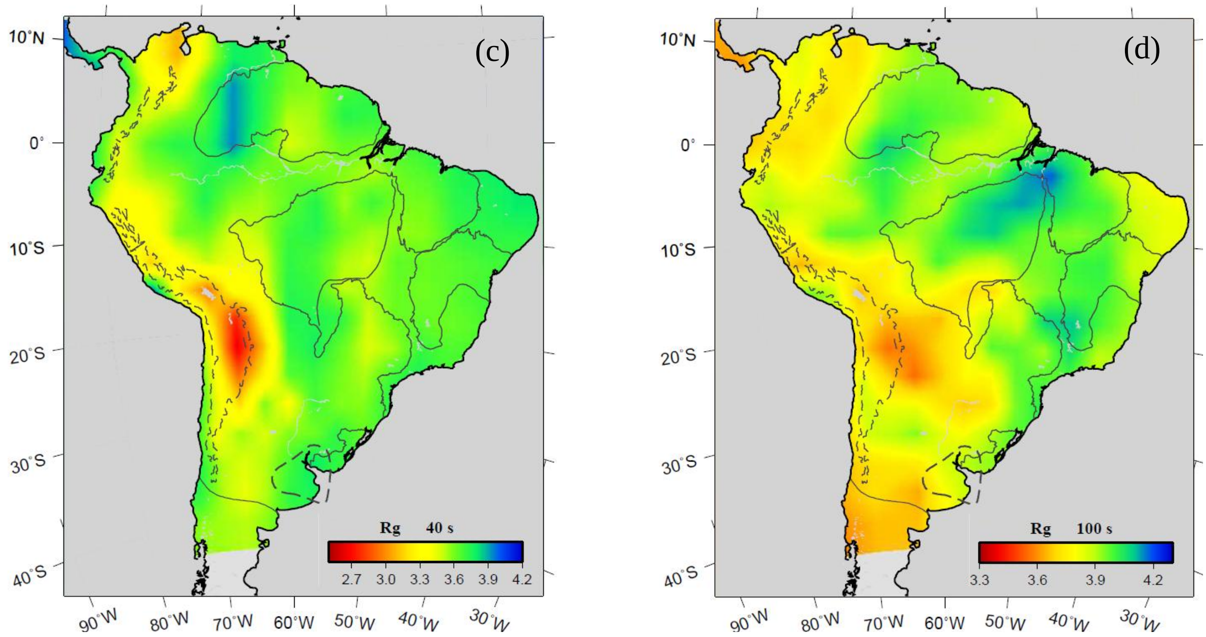

Figure 5: Group velocity tomographic maps c) at 40 seconds. d) at 100 seconds

The relatively high velocities in the Río de La Plata craton probably indicate thicker lithosphere than in the south region (Patagonian platform) and the north region (Chaco-Paraná basin). The high velocities to the NW of the Río de La Plata craton are due to the flat-slab subduction. The deep low velocity anomaly beneath the Chaco basin confirms the features shown in previous dispersion results (Feng et al., 2004).
The group velocity maps for different periods, derived from our inversion, correspond very well to tectonic structure throughout the studied area and the resolution was improved in the central and southern part by the better seismic ray coverage. The new group velocity maps will be used to estimate crustal structure in the Chaco-Parana basin.

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