# Moho depth estimates and Vp/Vs ratio using Receiver Functions in Time Domain and PWSS.

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## Abstract

The objective of this paper is to calculate the Moho depth and Vp/Vs ratio using Receiver Functions with time domain deconvolution (Lígorria & Ammon, 1999). Such values were obtained using the program PWSS (Phase Weighted Slant Stacking method; Bianchi, 2008).
The teleseismic waveforms were obtained from four broadband seismographic stations belonging to the Seismological Observatory (SIS-UnB): BRA7 (Brasília-DF), CAN3 (Cana Brava-GO), FOR1 (Fortaleza-CE) and SFA1 (Serra do Facão-GO).
The figures of crustal thickness were considered satisfactory, varying from 34.6 Km to 41.1 Km and the Vp/Vs ratio varying from 1.65 to 1.86, being consistent with previous studies.

## Introduction

The Receiver Function (RF) method (Langston, 1979) is essential to estimate the crustal thickness and the Vp/Vs ratio. Therefore, this technique provides information about the geological structures beneath a seismographic station in addition to allow discussions about the tectonic evolution of the region.
This study presents some estimation of the crustal thickness and the Vp/Vs ratio for the broadband stations of the Seismological Observatory.
In this work we used the FR in the domain of time (Langston, 1979; Owens, 1984; Ammon, 1991) in order to obtain better accuracy and to seek the understanding of this technique and disseminate it.

## Method

The FR method is done by a temporal series calculated on the three components of a seismogram that uses teleseismisc events in distances ranging from 30° and 90º, with incidence angle close to the vertical. When the P-wave reaches a discontinuity, part of its energy is converted in S-wave (Ps). Therefore, in order to concentrate all the energy of the horizontal components of the Ps-wave it is necessary to rotate the seismogram using the Radial-tangential coordinate system. In the present study we are going to use the deconvolution in time domain, which is based on the theory of linear inversion.
It is important to highlight that although the deconvolution in time domain has some advantages, such as the possibility of defining the big amplitudes of the seismogram, with a posterior observation of the details, it necessarily will have to present similar results in comparison to those obtained by the deconvolution in frequency domain.

## Data processing

In order to create a data base of teleseismic waveforms ranging from 30º and 90º of distance and with magnitudes above 4.5 $m_b$, it was used the program *getevts* (An, 2004) were chosen with an epicenter between 30° to 100 °.
The stacking process was done by the program PWSS (Bianchi, 2008) and the visual inspection by SAC (Seismic Analysis Code; Goldstein & Snoke, 2005). And finally, the deconvolution was done with the program *iterdecon* (Ammon, 1997).

## Results

The values obtained for Moho depth and Vp/Vs ratios are indicated in the Table 1.

***Table 1 –*** *Moho depths and Vp/Vs ratios.*

| Station | Moho depth (Km) | Vp (Km/s) | Vp/Vs |
|---|---|---|---|
| BRA7 | 41.06 ± 1.20 | 6.30 | 1.67 ± 0.04 |
| FOR1 | 34.60 ± 3.10 | 6.30 | 1.76 ± 0.14 |
| CAN3 | 37.50 ± 2.20 | 6.20 | 1.65 ± 0.07 |
| SFA1 | 35.14 ± 0.48 | 6.30 | 1.86 ± 0.02 |

The direct P-wave and Ps-wave are clearly visible in the figures from 1 to 3 (stations BRA7, CAN3 and FOR1, respectively). However, the Ps-wave is not clearly visible in the Figure 4 (station SFA1).
The figures from 5 to 8 show the estimates of crustal thickness and Vp/Vs ratios obtained by PWSS method for the stations BRA7, CAN3, FOR1 and SFA1. The results are, respectively, 41.06 Km ± 1.20 Km, 37.50 ± 2.20 Km, 34.60 Km ± 3.10, 35.14 Km ± 0.48 Km.

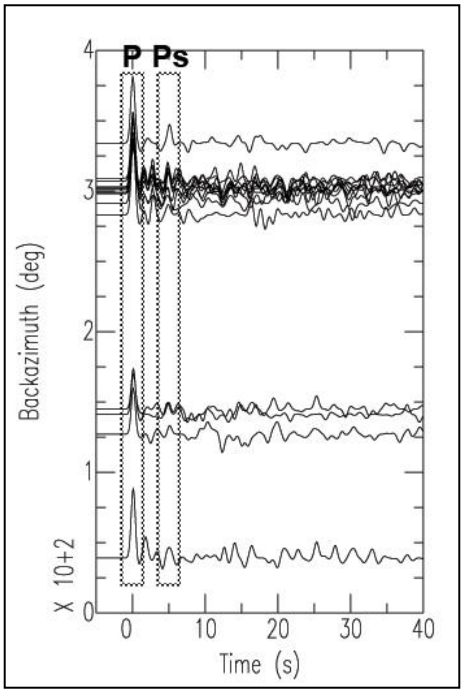


***Figure 1 –*** *Radial RF result for the station BRA7 plotted according the events azimuths. The direct P-wave and the Ps-wave are shown by the dotted boxes.*

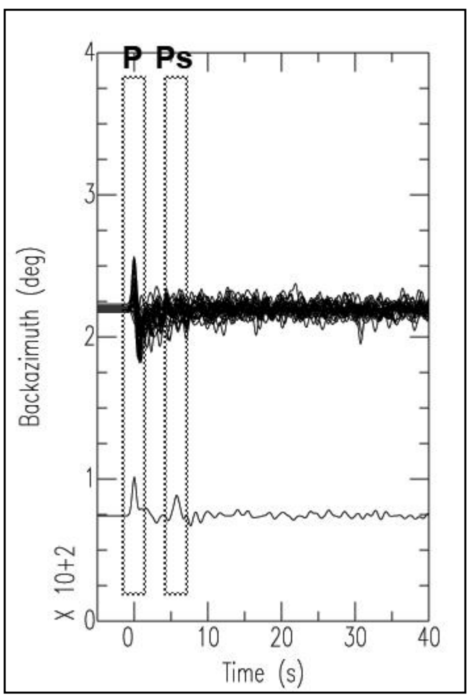


***Figure 2 –*** *Radial RF result for the station CAN3 plotted according the events azimuths. The direct P-wave and the Ps-wave are shown by the dotted boxes.*

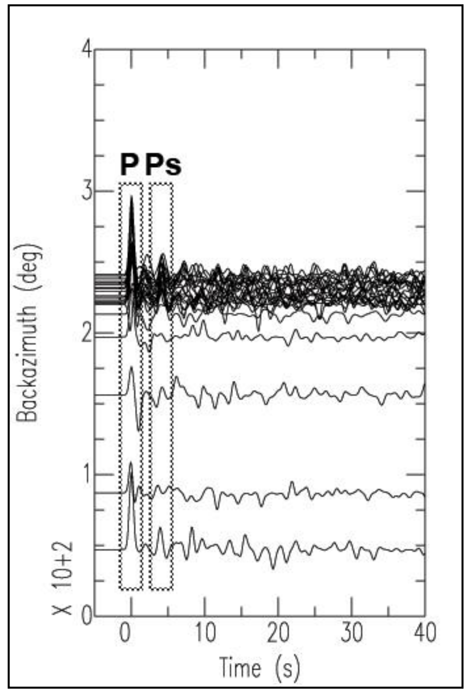


***Figure 3 –*** *Radial RF result for the station FOR1 plotted according the events azimuths. The direct P-wave and the Ps-wave are shown by the dotted boxes.*

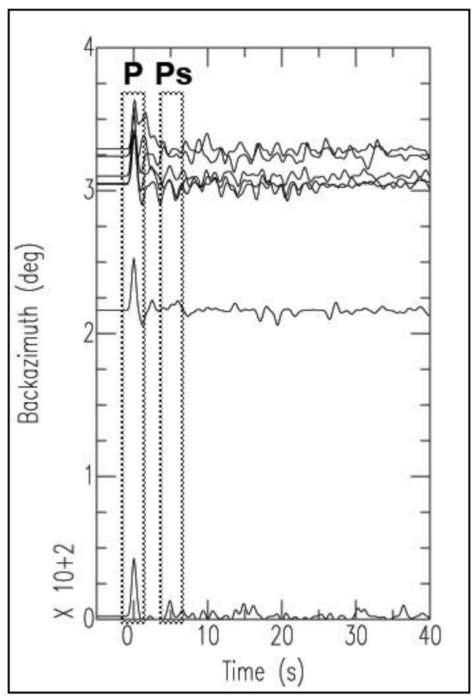


***Figure 4 –*** *Radial RF result for the station SFA1 plotted according the events azimuths. The direct P-wave and the Ps-wave are shown by the dotted boxes.*

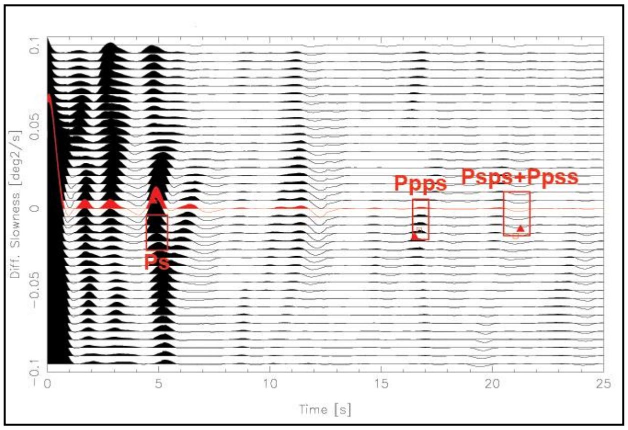


***Figure 5 –*** *PWSS result for the station BRA7. The red boxes are the indications of Ps-wave and multiple reflections (Ppps and Psps+Ppss).*

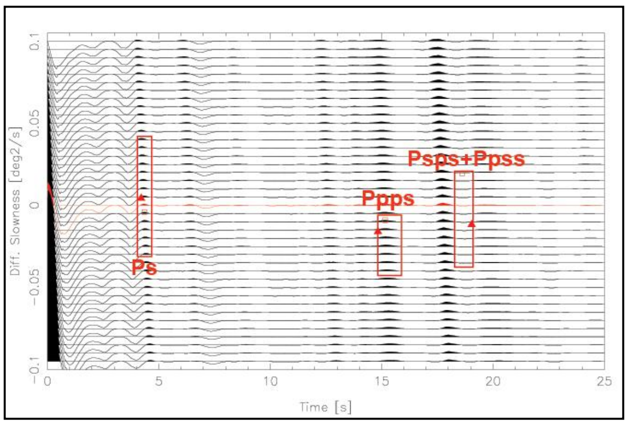


***Figure 6 –*** *PWSS result for the station CAN3. The red boxes are the indications of Ps-wave and multiple reflections (Ppps and Psps+Ppss).*

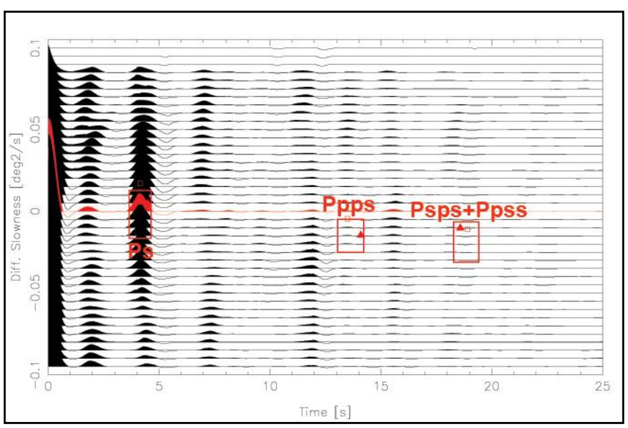


***Figure 7 –*** *PWSS result for the station FOR1. The red boxes are the indications of Ps-wave and multiple reflections (Ppps and Psps+Ppss).*

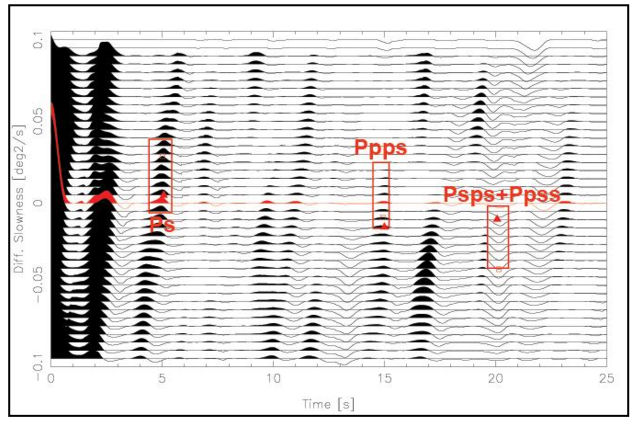


***Figure 8 –*** *PWSS result for the station SFA1. The red boxes are the indications of Ps-wave and multiple reflections (Ppps and Psps+Ppss).*

**Discussion and conclusions**

The study presents results of the crustal thickness and Vp/Vs ratio, which are consistent with other studies done with the same station (Albuquerque et al., 2010) or in the same geological province (Bianchi, 2008). Therefore, we can infer that the data quality recorded by the stations BRA7, CAN3, FOR1 and SFA1 (Figure 9) are satisfactory.

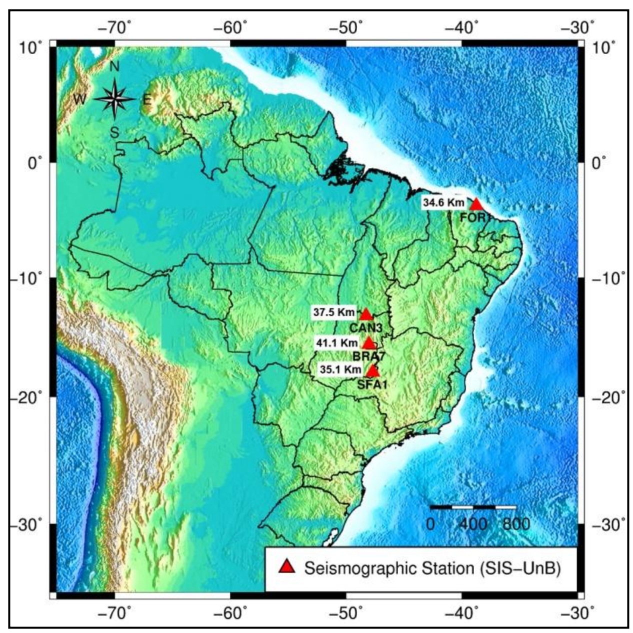


***Figure 9 -*** *Localization of SIS-UnB stations (BRA7, CAN3, FOR1 and SFA1).*

It is worth highlighting that the results are directly connected to some factors that can affect the interpretation of data, these being the low signal-noise ratio, frequent and long periods without data (gaps), poor presence of teleseismic events in the register, bad

calibration of the seismometer or a flaw and concentration of seism in the same azimuth.
Even though the present work doesn't bring detailed studies about the geology and tectonic evolution of the regions considered (it will be treated in future works), it is possible to conclude that the RF method in the time domain has proved itself to be very reliable, having good precision comparing to the RF executed in the frequency domain.

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