Crustal Thickness Estimatives and Vp/Vs Ratio Using Receiver Functions.

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Abstract

Receiver Functions calculated by frequency domain deconvolutions have been widely used to estimate crustal thickness and Vp/Vs ratio. The aim of this research is to obtain such estimatives using seismographic data recorded by seven stations belonging to Seismological Observatory: BRA7 (Brasília-DF), CAN3 (Cana Brava-GO), FOR1 (Fortaleza-CE), JAN7 (Itacarambi-MG), PDRB (Porto dos Gaúchos-MT), SFA1 (Serra do Facão-GO) e TUCA (Tucuruí-PA). In addition, all the results complement and corroborate the crustal thickness values already obtained for several tectonic provinces and it helps us to understand the processes involved in the tectonic formation of Brazilian territory.

Introduction

Receiver Function (RF) is a geophysical technique used mainly to study the Earth structure employing teleseismic events located at epicentral distances ranging from 30° to 90°. This technique is very important for determining the depth of Moho discontinuity beneath a seismographic station.

When the P-wave reaches a discontinuity, part of its energy is converted into S (Ps-wave) and also in multiple reflections (Ppps and Psps+Ppss). The incidence angle of the seismic waves in the mantle-crust interface are typically smaller than 40°, which would require a record of the P wave dominant in the vertical, and that converted to S (Ps) predominant in the radial component. The RFs are obtained by the deconvolution of the radial component from the vertical. The deconvolution process isolates the receptor response and then the result contains the signature of the converted phases and multiple reflections (Langston, 1979; Owens, 1984; Ammon, 1991).

Method

Teleseismic events located at epicentral distances ranging from 30° to 90° (Figure 1) and magnitudes equal or greater than 4.5 m_b were selected. All records were obtained by seismographic stations belonging to Seismological Observatory, Brasília University (SIS-UnB). The data were converted from GCF (Güralp Systems format) to SAC (Seismic Analysis Code; Goldstein & Snoke, 2005). The teleseismic waveforms were selected using the program *getevts* (An, 2004), which searches for information about earthquakes in the IRIS (Incorporated Research Institutions for Seismology) network.

After choosing the waveforms, it was made a visual inspection marking the P-wave time in the best events. For this analysis, it was used the SAC software (Goldstein & Snoke, 2005). The deconvolution in frequency domain was performed using the program *pwaveqn* (Ammon, 1991). All the RFs were plotted according to their azimuths and epicentral distances of the events. The stacking was performed by the program *HK-Stacking* (Zhu & Kanamori, 2000). This technique uses the relative moveout correction of secondary arrivals generated at a seismic discontinuity beneath the station to infer the depth and the Vp/Vs ratio above the discontinuity (França, 2003).

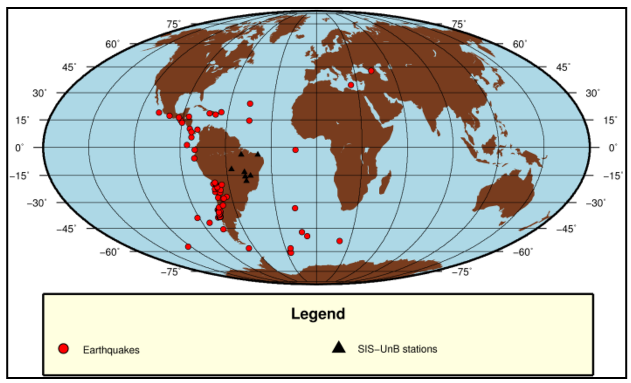


Figure 1 – *Teleseismic events and location of SIS-UnB stations.*

Results

The crustal thickness estimatives and Vp/Vs ratios are shown in the Table 1.

Table 1 – *Crustal thickness and Vp/Vs ratios.*

Station	Depth (Km)	Vp (Km/s)	Vp/Vs
BRA7	41.7 ± 0.7	6.3	1.69 ± 0.02
CAN3	40.0 ± 1.1	6.3	1.64 ± 0.02
FOR1	32.4 ± 0.7	6.3	1.75 ± 0.02
JAN7	40.3 ± 1.0	6.4	1.70 ± 0.02
PDRB	37.6 ± 1.5	6.4	1.68 ± 0.05
SFA1	37.1 ± 2.7	6.4	1.69 ± 0.07
TUCA	30.6 ± 4.5	6.4	1.79 ± 0.10

The figures 2 to 5 show the best Receiver Functions obtained using the stations BRA7, CAN3, FOR1 and JAN7. The direct P wave and the refracted P wave (Ps) are indicated by the red boxes.

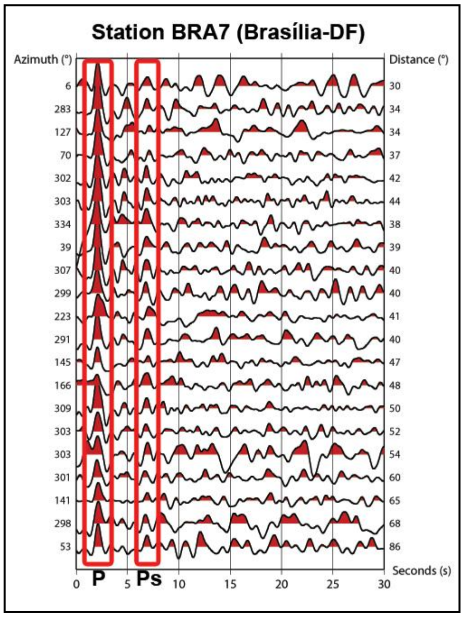


***Figure 2 –** Receiver Function result for BRA7 station plotted according the azimuths and epicentral distances of the events.*

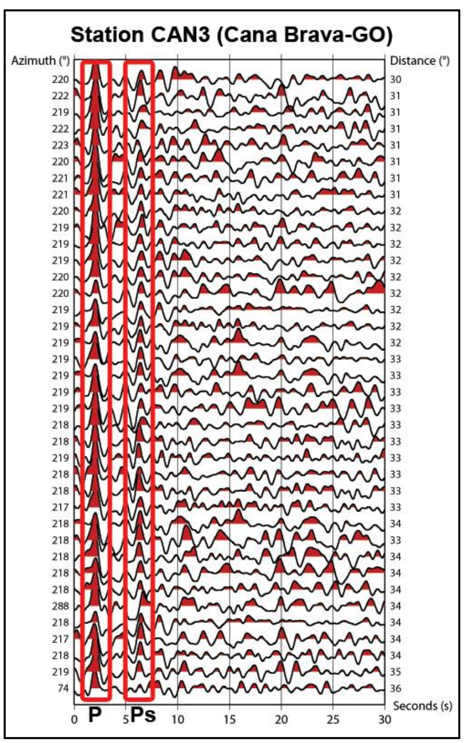


***Figure 3 -** Receiver Function result for CAN3 station plotted according the azimuths and epicentral distances of the events.*

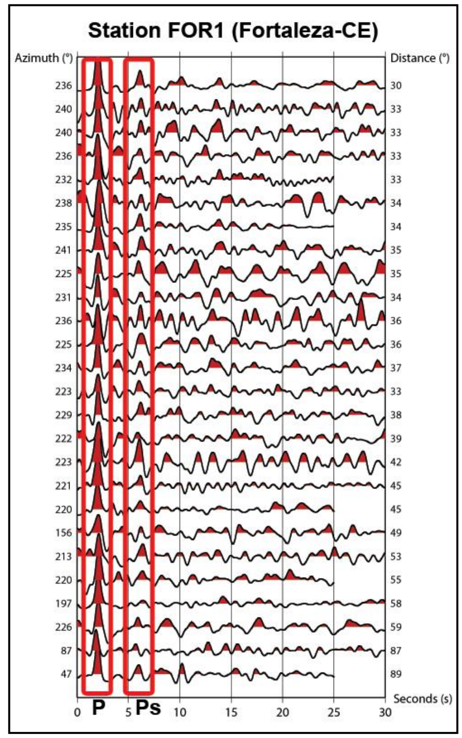


***Figure 4 -** Receiver Function result for FOR1 station plotted according the azimuths and epicentral distances of the events.*

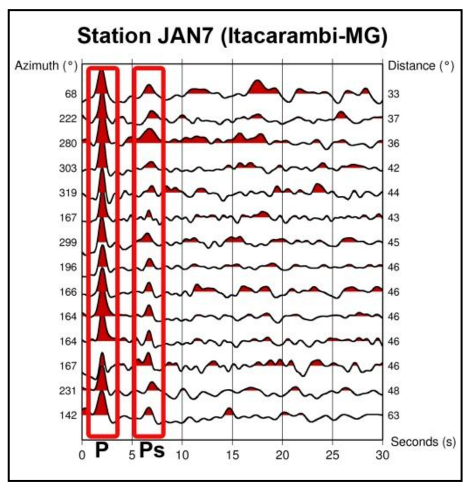


***Figure 5 -** Receiver Function result for JAN7 station plotted according the azimuths and epicentral distances of the events.*

The figures 6 to 9 show the HK-Stacking results obtained using the stations BRA7, CAN3, FOR1 and JAN7. The crustal thickness values are 41.7 ± 0.7, 40.0 ± 1.1, 32.4 ± 0.7, 40.3 ± 1.0, respectively.

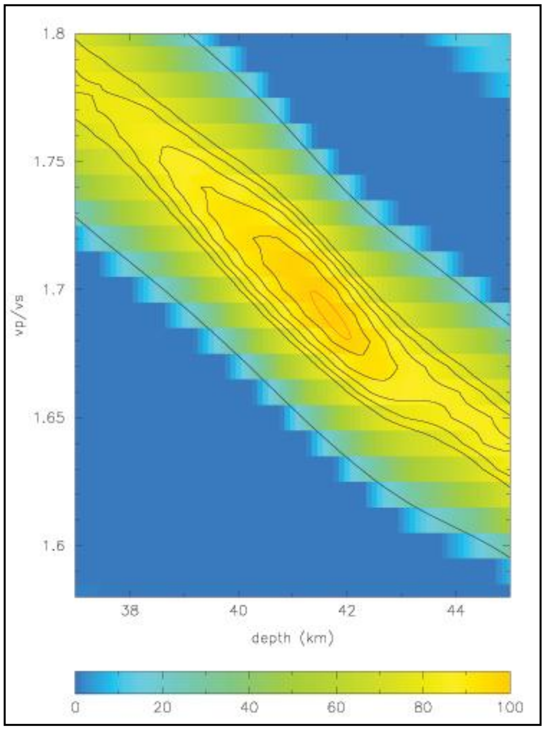


Figure 6 – *HK-Stacking result for BRA7. The red ellipse indicates the variation in the value of crustal thickness and Vp/Vs ratio.*

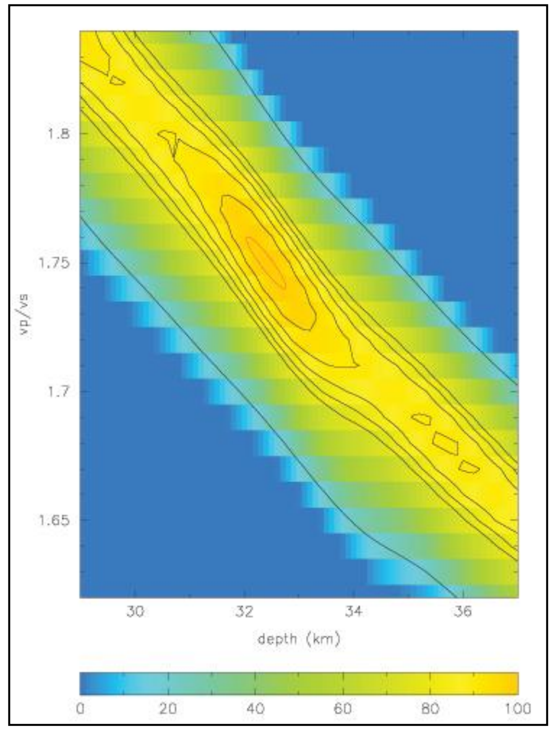


Figure 8 – *HK-Stacking result for FOR1. The red ellipse indicates the variation in the value of crustal thickness and Vp/Vs ratio.*

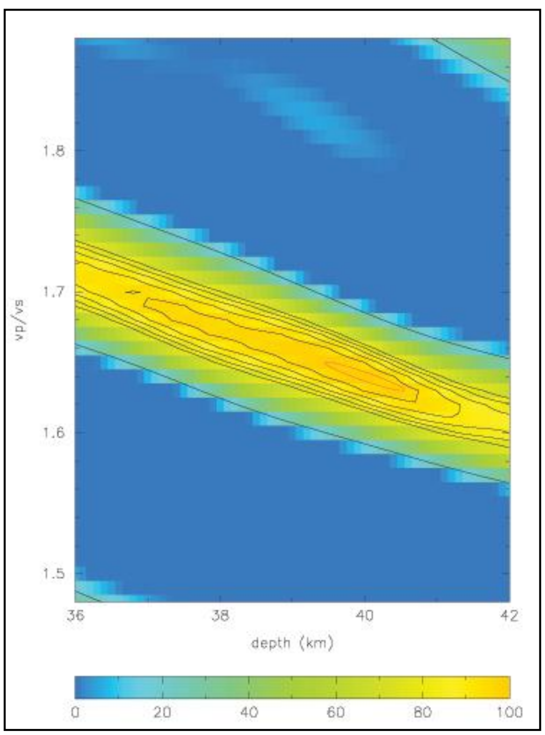


Figure 7 – *HK-Stacking result for CAN3. The red ellipse indicates the variation in the value of crustal thickness and Vp/Vs ratio.*

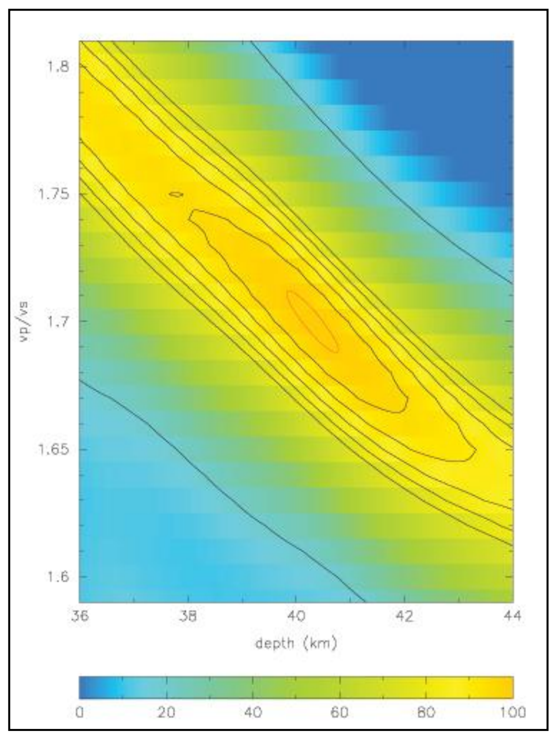


Figure 9 – *HK-Stacking result for JAN7. The red ellipse indicates the variation in the value of crustal thickness and Vp/Vs ratio.*

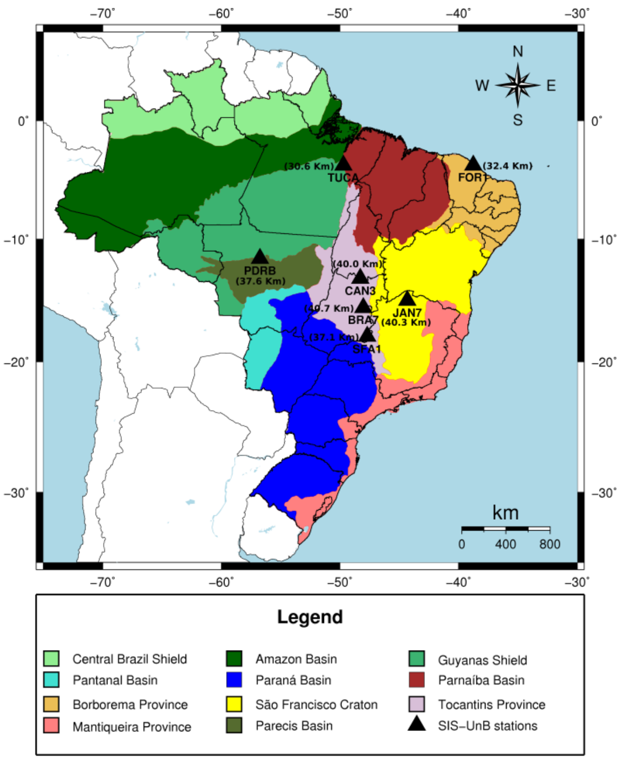
Discussion and conclusions

The crustal thickness and Vp/Vs results for the stations BRA7, CAN3, FOR1 and JAN7 are consistent with expected values in comparison to other previous studies which had been done using stations near or on the same tectonic province (Bianchi, 2008). The best results were obtained for stations placed in cratonic provinces (e.g. JAN7 and FOR1).

For the stations PDRB, SFA1 and TUCA the values are not in accordance with previous studies. Some possible causes are:

- Poor quality of recorded data (high background noise);
- Small amount of teleseismic waveforms;
- Gaps in the data period.

The Figure 10 shows the tectonic provinces, the crustal thickness and Vp/Vs ratio results and the stations belonging to SIS-UnB.



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