Journal of South American Earth Sciences 79 (2017) 431–442

Contents lists available at ScienceDirect

Journal of South American Earth Sciences

journal homepage: www.elsevier.com/locate/jsames

Crustal structure of the Amazonian Craton and adjacent provinces in Brazil

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ARTICLE INFO

Article history:
Received 13 March 2017
Received in revised form
1 August 2017
Accepted 21 August 2017
Available online 9 September 2017

Keywords:
Amazonian Craton
Receiver function
Crustal thickness
V_P/V_S ratio
Brazil

ABSTRACT

The study of the crust using receiver functions can provide valuable geological information, such as average crustal composition, its formation dynamics and the tectonic evolution of a region, as well as serve as an initial reference for the generation of seismic wave velocity models to improve earthquake location. To fill in gaps in information on the crust of the Amazonian Craton and adjacent provinces in Brazil, we used receiver functions and H-k stacking to estimate crustal thicknesses and the V_P/V_S ratios. The results indicate that the crust of the study region is predominantly felsic, with an average V_P/V_S around 1.73 and an average thickness of 38.2 km, with a range of 27.4–48.6 km. Minimum curvature interpolation of the crustal thickness values has made it possible to delimitate of the Amazonian Craton, which corresponds to the area with an average thickness equal to or greater than 39 km. In addition, it was possible to identify its potential cratonic blocks, as well as the Paranapanema Block of Paraná Basin. The geometry of the craton, defined by its crustal thickness, is corroborated by the distribution of natural seismicity that accompanies its edges. These are related to suture zones between the Amazonian, São Francisco/Congo and Paranapanema paleocontinents. The sedimentary basins that have undergone rifting processes have a thinner crust, usually less than 37 km thick. Due to the great variability of the results, it was not possible to determine a characteristic value of crustal thickness or V_P/V_S ratio for each structural province located in the study region.

1. Introduction

The first lithosphere and crustal studies in Brazil using receiver functions began in 1993 with the project “Seismic studies of continental lithosphere beneath SE Brazil”, a cooperation between the University of São Paulo (USP) and the Carnegie Institute of Washington (James et al., 1993). Since then, many additional projects have been carried out, but these have been concentrated in the Northeast, Southeast and part of the Midwest of Brazil, in regions that historically have had a higher density of seismographic stations.

This situation has been changing since 2003, when the number of stations increased substantially with the deployment of the Petrobras supported Brazilian Seismic Network (RSBR). Currently, the RSBR has more than 90 stations and approximately 22 are located in the North and Center-West regions (Fig. 1), which have real-time seismographic monitoring.

The motivation of this work emerged from the need to fill in gaps of crustal thickness and V_P/V_S ratio values of the Amazonian Craton and adjacent provinces. These parameters can provide important information on average crustal composition, formation dynamics, and tectonic evolution of a region and also serve as an initial reference for the generation of seismic wave propagation velocity models to improve earthquake location.

We have used the receiver function (RF) (Ligorría and Ammon, 1999) and H-k stacking (Zhu and Kanamori, 2000) to estimate the crustal thickness and V_P/V_S ratio of the Amazonian Craton and

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http://dx.doi.org/10.1016/j.jsames.2017.08.019
0895-9811/

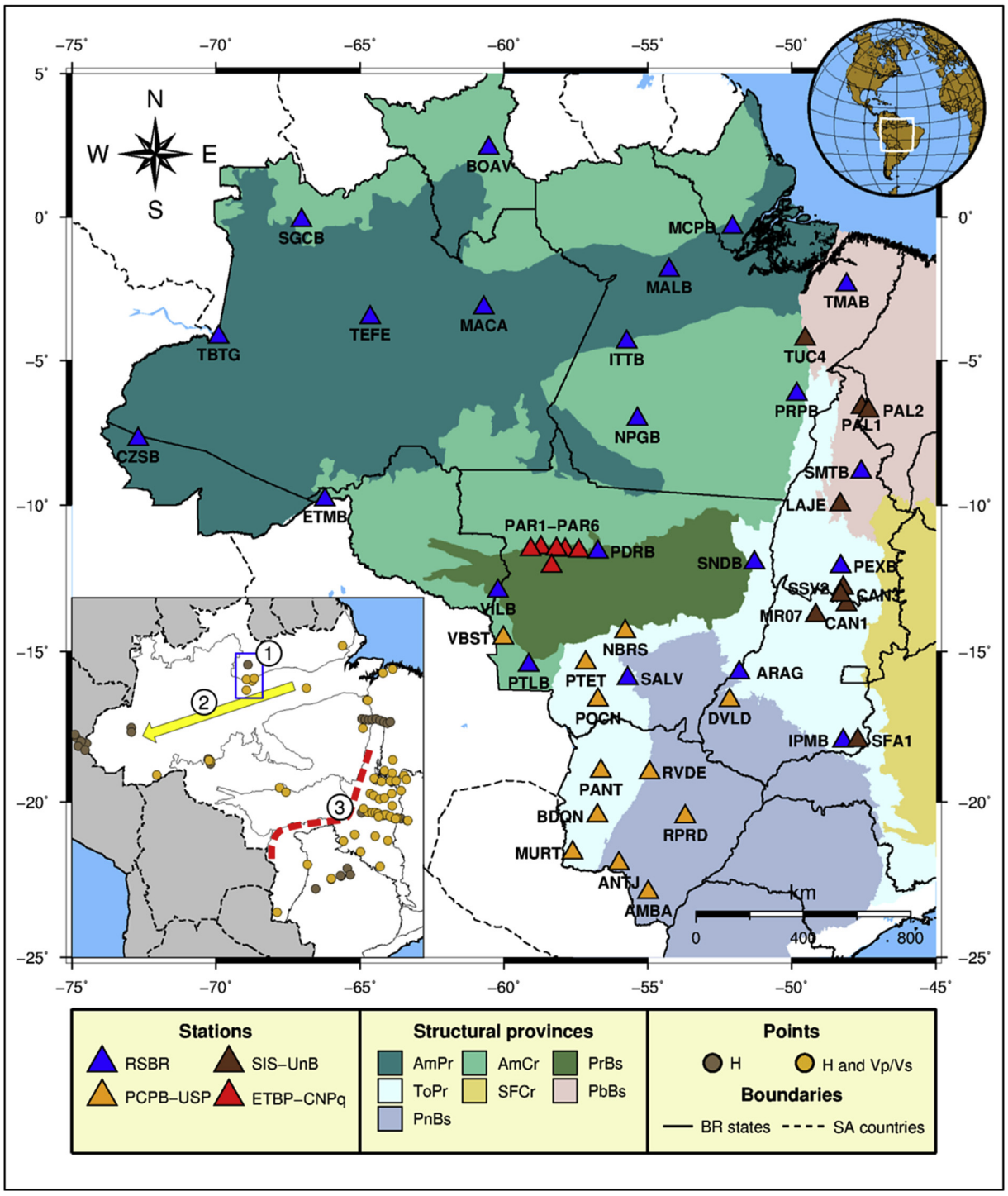

Fig. 1. Brazilian structural provinces (Almeida et al., 2000) and the location of seismographic stations used in this study. The inset map in the lower left corner highlights hypotheses found in prior literature for the region and shows the location of the data points. Caption acronyms: Amazonas Province (AmPr), Amazonian Craton (AmCr), Parecis Basin (PrBs), Tocantins Province (ToPr), São Francisco Craton (SFCr), Parnaíba Basin (PbBs) and Paraná Basin (PnBs). Networks: Brazilian Seismographic Network (RSBR); Seismological Observatory at the University of Brasília (SIS-UnB); Tectonic Studies of the Pantanal, Chaco and Paraná Basin (PCPB-USP); Tectonic Studies of Parecis Basin (ETBP-CNPq).

other geological provinces using data from 49 stations belonging to 4 networks (Fig. 1): 22 stations of the Brazilian Seismic Network (RSBR); 9 stations of the Seismological Observatory, University of Brasília (SIS-UnB); 6 stations of the Tectonic Studies of Parecis Basin (ETBP); 12 stations of the Structural Studies Network of the Pantanal, Chaco and Paraná Basin (PCPB-USP).

França (2003) presented the first crustal thickness (H) compilation map of the Southeast and part of the Center-West of Brazil. Building on this, Pavão et al. (2012) compiled H and V_P/V_S values obtained by RFs and built a contour map for Brazil. Assumpção et al. (2013) updated this work by including H estimates for all the South America from deep seismic refraction (Berrocal et al., 2004; Soares et al., 2006), RF (Niu et al., 2007; Bianchi, 2008; Lloyd et al., 2010; Albuquerque et al., 2011; Rosa et al.,