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Upper-lower crust thickness of the Borborema Province, NE Brazil, using Receiver Function

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ABSTRACT

The thickness estimates of the upper-crust and the V_p/V_s ratios are essential in order to detail the structures and geologic features. They also corroborate the regional tectonic evolution models. The crust study using the Receiver Function is performed with teleseismic P-waves that reaches the interface, under the station, with an almost vertical angle. The Receiver Function is obtained through the deconvolution of the horizontal component from the vertical one. The synthetic seismogram of the Receiver Function has a higher peak of direct P-waves, followed by minor peaks of Psc waves, where P converted into S in the upper-lower crust limit and multiple reflections. It was used the phase weighted slant-stacked method for the estimate of upper-crustal thickness and m_b ratio. The best estimates are correctly stacked. The Normal Moveout correction for the Psc phase was used for the upper-crust thickness, simulating a vertical incidence. A total of 8 stations on the Borborema Province in the Brazilian Northeast was analyzed. The results show that there is an upper-lower crust limit in all the analyzed signs. The thickness estimates showed two thickness regions. The first one in Coast Region, that indicates of the thin upper-crust and the second, continental regions characterized by uniform thicker upper-crust. East station data suggests underplating of mafic bodies.

1. Introduction

Mapping crustal discontinuities is crucial to the understanding of the dynamics and the regional tectonic evolution beneath a study region. In NE Brazil, previous studies have been conducted until recently to estimate the crustal thickness in this important seismic active region (e.g., Christensen and Mooney, 1995; Mooney et al., 1998; Laske et al., 2000; Ferreira et al., 1998, 2008; Novo Barbosa et al., 2012; Pavão et al., 2012). Oliveira and Medeiros (2009) have pointed a crustal thickness of 28–33 km beneath the Borborema Province, using the conventional elastic flexural model to isostasy. Soares et al. (2009), also estimated the crustal thickness to be 30–36 km in this region using a 900 km deep seismic refraction line. More recently, a crustal thickness of 28–34 km was estimated by Lloyd et al. (2010), and also confirmed by Novo Barbosa (2008); Novo Barbosa et al. (2012); Pavão (2010); Pavão et al. (2012).

In the Northeast Brazil studies using the Receiver Function (RF) began with the setting up of two broadband stations in localities Caruaru and Castanhão (França et al., 2006). In 2012, Novo Barbosa et al. (2012) have done a more complete study of the crust using RF where seven triaxial temporary broadband stations were set up on the edges of these provinces, close to the main tectonics lineaments (Fig. 1). In this study, we used all stations already studied by França et al. (2006); Novo Barbosa et al. (2012); Pavão et al. (2012), plus the station FOR1 which belongs to the Observatrio Sismológico (SIS) seismograph network.

The RF analysis, besides providing information on the Moho depth, can also infer the existence of intracrustal discontinuities (and structure) when using closer events with higher frequency content and high quality registered waveforms (Assumpção et al., 2002). This information is also of great value in a complex tectonic context like the Borborema Province.

Trying to fulfill those requirements for a more detailed information of the Moho in the Borborema Province, this study have

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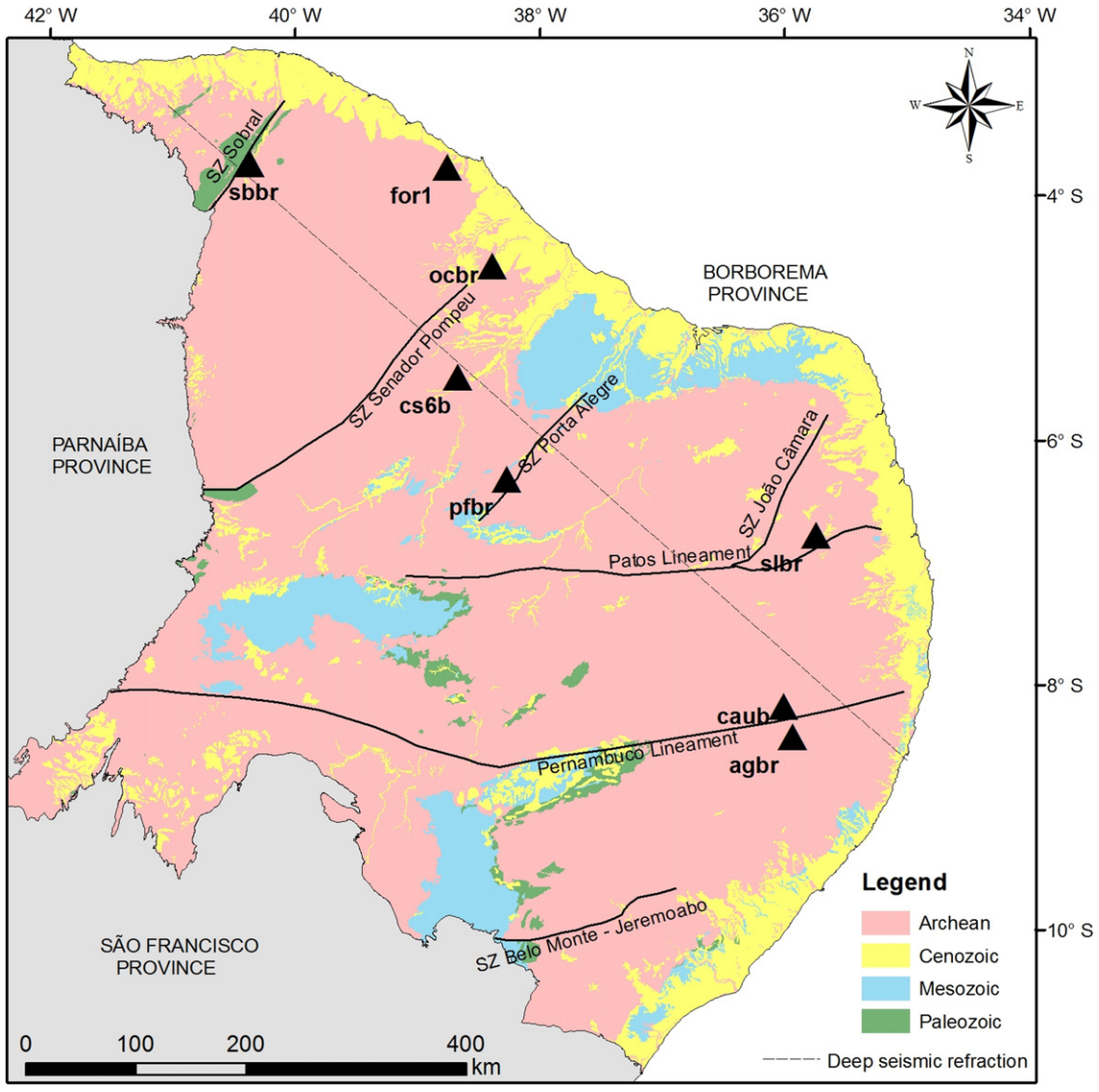

Fig. 1. Seismographic broadband localization and Chronostratigraphy in the Borborema Province. Triangles are seismic station. In the inset, SZ, shear zone. The gray lines show the lineaments and shear zones. The asterisks represent the line of seismic refraction.

used records acquired by 8 broadband seismic stations distributed along the province as shown in Fig. 1. By analyzing the RFs traces, we were able to identify intracrustal discontinuities when using closer events and more frequency content. We believe that this extra information for all the different compartments of the Borborema Province will contribute for a better regional model of the crustal velocity and thickness in this area.

2. Study area

The Borborema Structural Province (Fig. 1) is a large Precambrian domain resulting from the convergence between the Africa-São Luiz, Amazônico and São Francisco-Congo cratons. The geodynamical evolution of this province suggests accretion and amalgamation of different tectonostratigraphic terranes at the end of the Brasiliano-Pan-African orogenies (≈600 Ma), involving crustal blocks, microcontinents, minor old magmatic arches and supra-crustal sequences (Almeida et al., 1977, 1981; Trompette, 1994; Jardim de Sá, 1994; Caby et al., 1995; Van Schumus et al., 1995; Vauchez et al., 1995; Brito Neves et al., 2001; Dantas et al., 2004).

This province presents stratigraphic and geochronologic complexity with tectonic compartments of different geological and geophysical aspects and can be understood as a mosaic of archean-paleoproterozoic migmatitic granite-gneiss domains and proterozoic folded belts associated to granitoids and high neoproterozoic deformations (Brito Neves, 1975; Jardim de Sá, 1994). Also, lithostratigraphic correlation, the structural continuity of great tectonic lineaments, geochronologic and geophysical information suggest similarities between the Borborema Province with the existing terranes in West and Central Africa (Trompette, 1994; Caby et al., 1995; Van Schumus et al., 1995; Vauchez et al., 1995; Dantas et al., 1998, 2004).

Tectonic structural framework models were proposed by many authors (e.g., Brito Neves, 1975, 1983; Santos and Brito Neves, 1984; Jardim de Sá, 1994). In the last fifteen years, studies based on different geochronological methods (mainly U–Pb and Sm–Nd) have been used to characterize and refine the tectonic compartments that compose the Borborema Province (Van Schumus et al.,