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# Crustal thickness map of Brazil: Data compilation and main features

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ABSTRACT

We present a crustal thickness map of Brazil and adjacent areas based on a compilation of data published in the literature as well as new measurements. We used crustal thicknesses mainly derived from seismic datasets such as deep seismic refraction experiments, receiver function analyses, and surface-wave dispersion velocities. Crustal thicknesses derived from modelling gravity anomalies commonly depend on assumptions, such as constant density contrast across the Moho interface, which are not always easily verifiable and were considered only along the continental shelf to fill large gaps in the seismic data. Our compilation shows that the crust in the stable continental area onshore has an average thickness of $39 \pm 5$ km (1-σ deviation) and that no clear difference can be observed between low altitude, intracratonic sedimentary basins, NeoProterozoic foldbelts (except for the Borborema Province), and cratonic areas. The thinnest crust is found in the Borborema Province of NE Brazil (30–35 km) and along a narrow belt within Tocantins Province (~35 km), roughly parallel to the Eastern border of the Amazon craton, while the thickest crust is found in the Amazon and São Francisco cratons ($41 \pm 4$ km), and the Paraná Basin ($42 \pm 4$ km). Both the Ponta Grossa and the Rio Grande Arches are areas of thinned crust, and the western border of the Brazilian platform, near the sub-Andean region, seems to be characterized by a crustal thickness of less than 40 km. Although sparse in data coverage, we expect the resulting crustal thickness map to be useful for future studies of isostasy, dynamic topography, and crustal evolution of the country.


## 1. Introduction

Mapping variations of crustal thickness in the continents have many important applications. Besides giving information on its crustal evolution, isostatic compensation, and intraplate stresses (e.g. Lithgow-Bertelloni and Guynn, 2004; Sacek and Ussami, 2009), it is essential for modelling wave-propagation in global and regional seismic studies and for developing surface corrections to investigate the upper mantle (e.g. Mooney and Kaban, 2010). Moreover, the increasing use of shorter and shorter wavelengths in global seismic modelling requires correspondingly more accurate models of crustal thickness variation.

In spite of its importance, the crustal thickness of South America is one of the least known of all the continental areas. Large areas of the continent, such as the Amazon craton, have been sparsely sampled (e.g. van der Lee et al., 2001) and detailed information on crustal structure is lacking. Perhaps the best studied area is the Andean region, for which detailed models of crustal structure have been developed by combining seismic data and gravity modelling in Venezuela (Niu et al., 2007; Schmitz et al., 2005, 2008) and South and Central Andes (Tassara and Echaurren, 2012). In the stable part of the continent, mapping of crustal thickness has been done by Feng et al. (2007) and Lloyd et al. (2010), from the tomographic inversion of surface-wave data (using both average epicenter-station 1D models as well as group velocities) constrained by local crustal thicknesses derived from receiver functions (RF) and seismic refraction profiles. Some additional information based on isostatic assumptions was also included. These models fit the seismic point constraints with an *rms* deviation of about 3–4 km, which increases up to 10 km for areas without point constraints.

In this study, we build on previous works (Tassara and Echaurren, 2012; Feng et al., 2007; Lloyd et al., 2010) and update the crustal thickness map for Brazil and adjacent areas by augmenting the set of point constraints from ~240 (Feng et al., 2007; Lloyd et al., 2010) to ~930 (640 onshore and 190 offshore), mainly

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in the Andean region. Most of the new point constraints have been compiled from the published literature and include estimates from both active source profiling and receiver functions. We have also included 13 new estimates of crustal thickness in the stable part of the continent that were determined within the present study.

## 2. Compilation of crustal thickness data

We built on previous compilations for South America (229 point constraints from Feng et al. (2007), 244 from Lloyd et al. (2010), and 183 from Tassara and Echaurren (2012), and 200 from Pavão et al. (2012)) and increased the combined set of point constraints with additional data from published papers, congress proceedings, and theses, as well as unpublished monographs. We used basically two types of data: active source experiments (deep seismic refraction lines, or deep seismic reflection surveys) and receiver functions (see Fig. 1). In the offshore continental areas, we complemented the seismic constraints with published crustal thickness estimates based on Bouguer gravity anomalies constrained by seismic data (Mohriak et al., 2000; Zalán et al., 2011). Our final compilation includes uncertainties for each point constraint. If uncertainties were not provided in the original publication we added our best estimate based on our necessarily subjective judgement of the quality of the published data, as detailed below.

### 2.1. Active sources

Deep seismic refraction lines in the continent are very scarce in Brazil. Besides a single seismic transect across the Tocantins Province (Berrocal et al., 2004; Soares et al., 2006), only preliminary results from two other lines in the Borborema province are available (Soares et al., 2010, 2011; Lima, 2011). From 2D velocity models derived for these seismic refraction lines, point estimates for crustal thickness were taken every 50 km, on average. When seismic

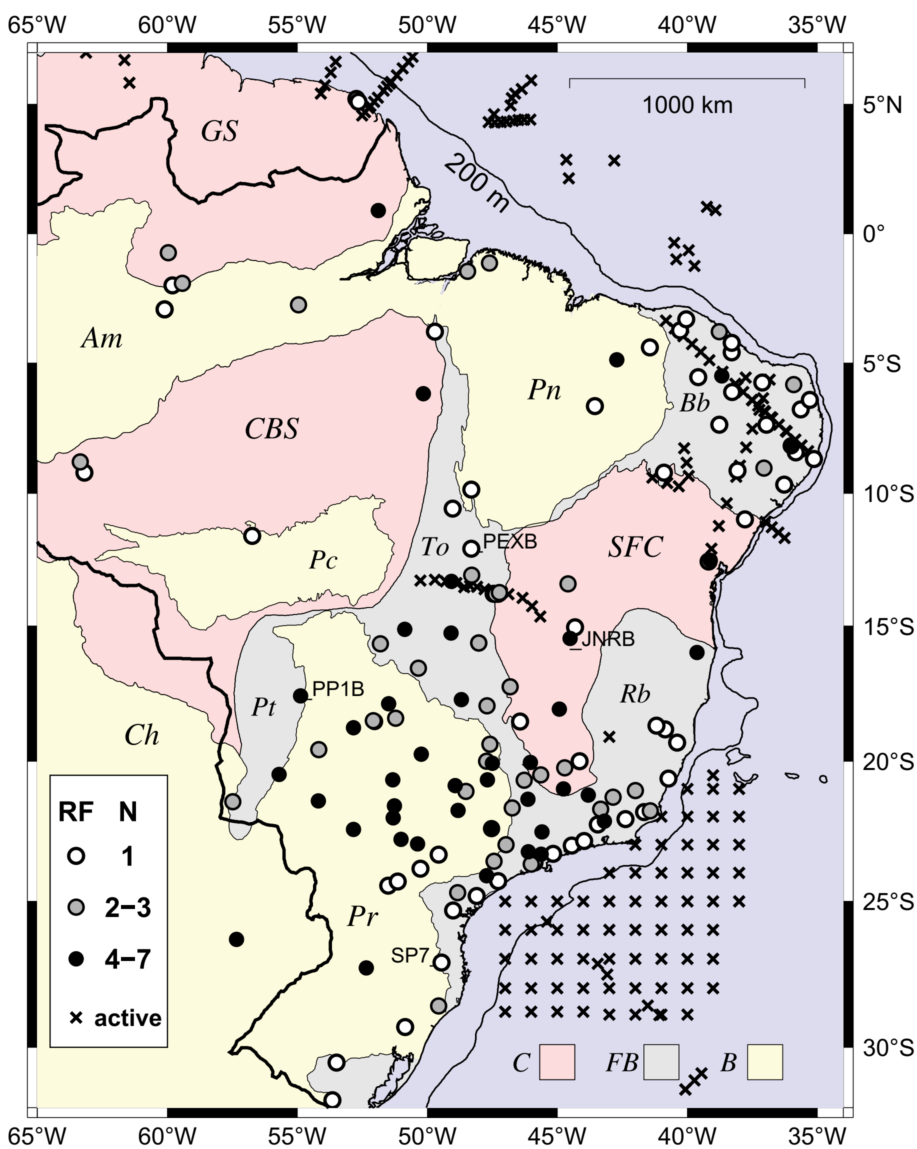


**Fig. 1.** Distribution of data points from seismic refraction/reflection profiles (crosses) and stations with receiver function (circles), colored according to the number, "N", of different measurements. Open circle: just one measurement of crustal thickness; gray: two or three measurements; solid: four to seven measurements. Major geological provinces are colored by cratons (pink, C), NeoProtrozoic foldbelts (gray, FB) and intracratonic basins (yellow, B). GS, CBS = Guyana and Central Brazil shields of the Amazon craton; SFC = São Francisco craton; Bb, To and Rb are the Borborema, Tocantins and Riberia foldbelts, respectively; Intracratonic basins: Am = Solimões and Amazon; Pn = Parnaíba, Pc = Parecis, Pt = Pantanal (overlying the Araguaia foldbelt), Pr = Paraná, Ch = Chaco.