



Crustal framework of the northwest Paraná Basin, Brazil: Insights from joint modeling of magnetic and gravity data

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ABSTRACT

The Transbrasiliano Lineament (TBL) is a major Proterozoic strike-slip shear zone crossing the Paraná Basin, Brazil, yet the relationship between the TBL and basin structures is poorly understood. Magnetic and gravity data are available from the whole northwestern region of the Paraná Basin and provide insights into crustal partitioning and basement geometry. Joint 2D modeling of these data was performed in three strategic sections of the study area. Two smaller sections were constrained by available borehole data and receiver function analysis. Modeling of these sections facilitated modeling of the third, larger NW–SE section, which crosses the basin in an area with significant lack of data. These three sections together form the basis for a preliminary tectonic model of the northern Paraná Basin. The TBL includes strong N30°E-trending gravity and magnetic gradients represented by the Serra Negra fault zone. This structure separates two crustal tectonic domains, the Paranapanema Block to the east, and the Amazon paleocontinent to the west. The tectonic domain northeast of the fault is represented by the Arenópolis Magmatic Arc. The N60°–70°E-trending General Carneiro fault, also reflected in gravity anomalies, forms another important magnetic contact. Our tectonic model shows a region of crustal thinning between the two fault zones, where structures associated with possible reactivation form small Cretaceous basins. The Baliza fault may accommodate significant vertical displacements of Devonian and Carboniferous sections of the Paraná Basin. The main structures revealed in the sections are associated with grabens and horsts, interpreted as reactivated structures that controlled Paraná Basin sedimentation. The northwestern portion of the basin exhibits basement asymmetry caused by dip- and strike-slip faulting along the TBL.

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1. Introduction

The Paraná Basin is among the five largest Phanerozoic basins of the South American Platform, and, like most large sedimentary basins of the world, our geological knowledge comes primarily from hydrocarbon exploration. Until 2012, about 97% of all wells in the Paraná Basin were drilled in the east-central portion of the basin, which reaches depths of 7 km. In contrast, stratigraphic data from the northwestern flank of the basin are relatively sparse, despite depths of only 2 to 3 km (Milani et al., 2007). A lack of seismic studies also contributes to our limited knowledge of the tectonic history of the basin and the structural framework of underlying basement.

The Transbrasiliano Lineament (TBL; Brito Neves et al., 1984; Curto et al., 2014; Schobbenhaus et al., 1975; Fig. 1) is a zone of N30°E trending Neoproterozoic strike-slip faults that crosses the South American Platform, of which at least 3000 km is within Brazilian territory (Bruto Neves et al., 1999; Cordani et al., 2013; Fairhead and Maus,

2003; Ramos et al., 2010; Tohver et al., 2010). This continental-scale structure is poorly understood, especially where it is concealed by Phanerozoic sedimentary cover. In an earlier paper (Curto et al., 2014), we showed that the early phase of Paraná Basin evolution was associated with TBL structures along the northern flank of the basin. In this paper, we focus on the same study area, aiming to better understand the tectonic setting through joint modeling of magnetic and gravity data from different surveys made available by various institutions (Fig. 4). We investigate geophysical anomalies from the entire crustal section to reveal structures and geologic units from deep to shallow crustal levels in order to establish the relationship between Precambrian basement and reactivated structures within the Paraná Basin.

2. Geological setting

2.1. Basement units

The study area is located in the Tocantins Province (Fig. 1; Almeida et al., 1981), which is composed of the Brasília, Paraguay and Araguaia mobile belts (Fig. 2). This branching system of mobile belts originated from a set of Neoproterozoic orogenic processes related to the Brasiliano orogenic collage (800–500 Ma; Brito Neves and Fuck, 2013; Brito Neves

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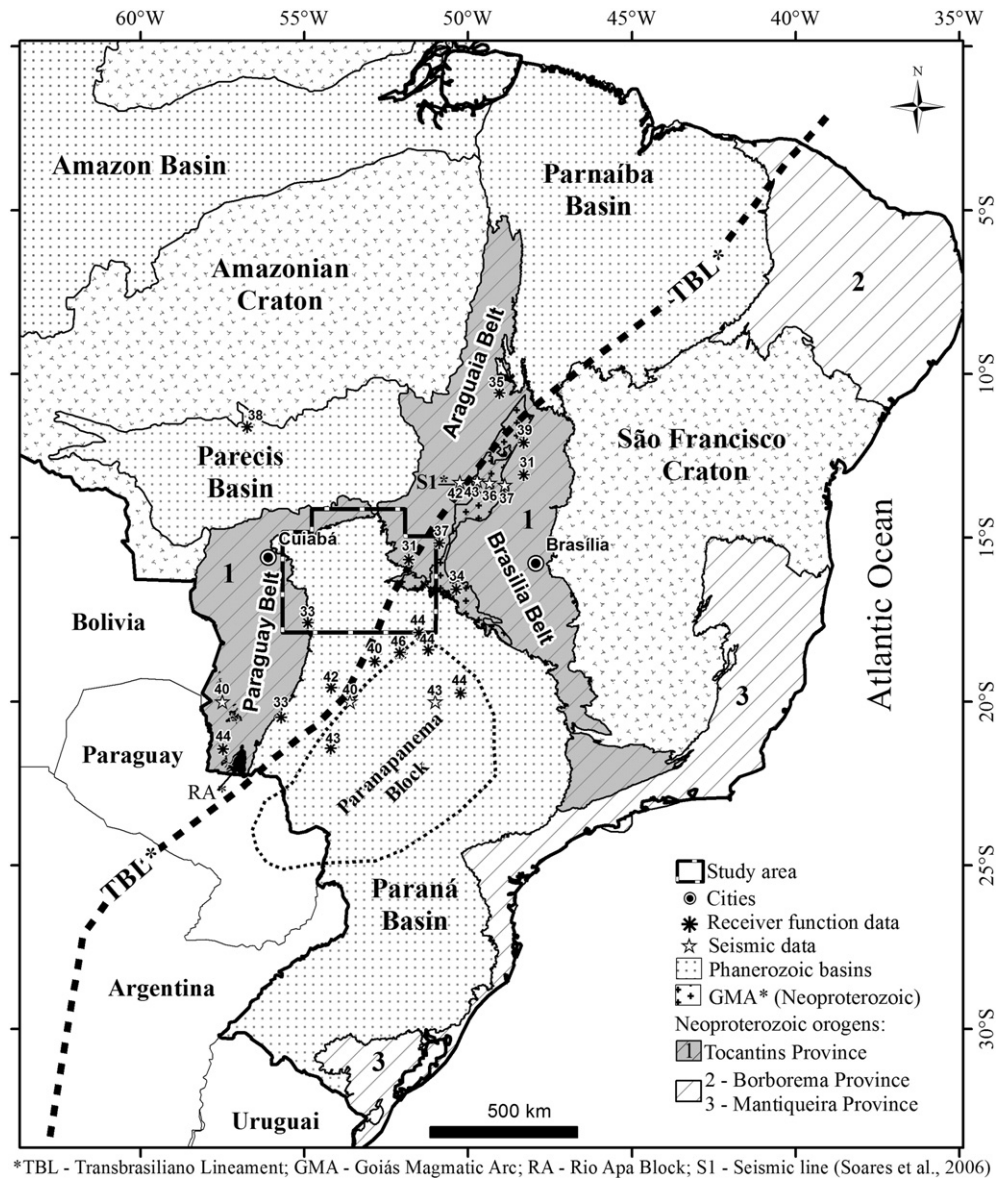


Fig. 1. Major tectonic units of the study area. The Transbrasiliano Lineament (LTB) is according to interpretation of magnetic data (Curto et al., 2014; Vidotti et al., 2011) and previous studies (e.g., Ramos et al., 2010). Crustal thickness data are derived from analysis of receiver function and seismic refraction compiled by Pavão et al. (2012).

et al., 2014). It resulted from convergence of three main geologic domains: the Amazonian craton to the west, the São Francisco craton to the east, and the Paranapanema block to the southeast (Fig. 1). Pre-Cryogenian basement within the mobile belts (>850 Ma, Brito Neves and Fuck, 2013) was intensely reworked during this convergence.

In the western part of the Brasília Belt, the Goiás Magmatic Arc (Figs. 1 and 2, label GMA), generated by subduction of pre-existing oceanic lithosphere, evolved from intra-oceanic arc magmatism (920–860 Ma, Laux et al., 2005; Pimentel and Fuck, 1992; Pimentel et al., 1997; Pimentel et al., 2000a, 2000b; Pimentel et al., 2011; Matteini et al., 2010) to younger continental arc magmatism (670–600 Ma; Fuck et al., 2008; Laux et al., 2005). The younger magmatic event corresponds to an important period of plate interaction and subduction (Brito Neves and Fuck, 2013), marked by collision and metamorphism of greenschist to amphibolite facies at ca. 630–600 Ma (Brito Neves et al., 2014; Cordani et al., 2013; Pimentel and Fuck, 1992). The GMA is divided into the northern Mara Rosa sector and southern Arenópolis sector (Fig. 3, label AA).

The Paraguay Belt surrounds the southwestern border of the Amazonian plate. It has been interpreted as a sedimentary basin formed on the continental margin of the Amazonian paleocontinent, subsequently

inverted to a foreland basin during Brasiliano convergence (Almeida, 1964; Alvarenga et al., 2009; Dantas et al., 2009). The northern sector of the Paraguay Belt is characterized by increased metamorphic polarity toward east, marked by E–W thrusts. The basal unit consists of metasedimentary rocks of the Cuiabá Group (~635 Ma; Alvarenga et al., 2004), which crops out along the northern boundary of the Paraná Basin, and is limited to the east by the Serra Negra fault (Fig. 3; Seer, 1985; Pimentel and Fuck, 1992).

Late to post-orogenic bimodal intrusions of gabbro and granite intruded the Arenópolis magmatic arc 600–500 Ma (Pimentel et al., 2011). Granitic rocks also intruded in deformed Cuiabá Group of the Paraguay Belt (550–500 Ma, Godoy et al., 2007, 2010). The transcurrent Transbrasiliano Lineament (TBL, Fig. 1) was formed during the final phase of the Brasiliano orogeny (<560 Ma; Brito Neves and Fuck, 2013; Cordani et al., 2013) and now extends northeast-southwest across the Borborema Province, Parnaíba Basin, Tocantins Province, Paraná Basin, Paraguay Belt, and terminates at the eastern edge of Sierras Pampeanas, Argentina (Fig. 1; Ramos et al., 2010). Phanerozoic basins formed in the Cambrian in response to reactivation of Precambrian basement structures, including the TBL (Brito Neves et al., 1984; Cordani et al., 2009a).

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