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Deep crustal framework of the Borborema Province, NE Brazil, derived from gravity and magnetic data

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ABSTRACT

The Borborema Province **BP** (NE Brazil) consists of a complex rock mosaic composed mainly by Proterozoic metasedimentary belts that amalgamate Archean-to-Paleoproterozoic gneiss-migmatite complexes. It is a key region to understand the West Gondwana amalgamation, during the Pan-African/Brasiliano orogeny because it is an important portion of the orogen located between the São Francisco-Congo and West African cratons. We present the deep-rooted crustal framework of the **BP** interpreting the lateral contrasts of density and magnetization using the first available regional coverage of gravity and aeromagnetic data. The external boundaries of the **BP** having deep-rooted crustal significance are the Transbrasiliano shear zone, to the west, and the limit with the São Francisco craton, to the south. The latter limit is marked by a gravity anomaly which is the typical gravity signature of collisional sutures. Inside the **BP** crustal block, the Pernambuco, Patos, and Jaguaribe shear zones are identified as the major structures, based on termination and/or truncation criteria of geophysical anomalies. The three shear zones correspond to geophysical lineaments which conform with the Transbrasiliano shear zone, forming a single splay that opens to the northeast/east direction. The external boundaries and major shear zones divide the **BP** crustal block into four internal major domains of contrasting geophysical characteristics, namely the Southern, Transversal Zone, Rio Grande do Norte, and Ceará geophysical domains in analogy with the division based on surface geology. However, compared with the delimitations based on surface geology, there are three differences: the Médio Coreau belt is not positioned over the **BP** crustal block, a portion of the Parnaíba basin baseament should be included in the **BP** crustal block, and the basement beneath the folded-and-thrusted metasedimentary rocks of the Casa Nova Group (which form the nappes of the Riacho do Pontal belt) is part of the São Francisco craton crustal block. A subdivision of each major domain is also presented. Of special relevance is a pattern of alternate-polarity, quasi-parallel aligned geophysical anomalies present in the Transversal Zone domain, suggesting a clear alternation of high-density/high-susceptibility with low-density/low-susceptibility deep-rooted crustal subdomains. This geophysical pattern is compatible with a tectonic model of terrane collage.

1. Introduction

The Borborema Province (**BP**) in Northeast Brazil (Fig. 1) consists of a complex rock mosaic composed mainly by metamorphic belts that amalgamate basement rocks. The **BP** is internally compartmentalized by an interconnected framework of shear zones and, in the Neoproterozoic, it suffered a widespread intrusion of granitoids (Fig. 1).

The **BP** has a long and complex geological history, with an evolution dating from the Archean to the Phanerozoic (Almeida et al., 1981; Brito Neves et al., 2000; Neves, 2003; Santos et al., 2010; Brito Neves et al., 2014; Ganade de Araujo et al., 2013). It is a key region to understand the formation of the Gondwana supercontinent because it is an important part of the orogen (Fig. 2) located between the São Francisco-Congo and West African cratons (Brito Neves and Cordani, 1991; Trompette, 1994, 1997; Brito Neves et al., 1999). Geologic correlations between South America and Africa in a late Paleozoic pre-drift reconstruction present evidence of continuity of major structures and geological domains. According to Arthaud et al. (2008), both continents present Late Paleoproterozoic (c. 1.8 Ga) rift-related magmatism and metasedimentary sequences overlying basement rocks. In addition, in the Late Neoproterozoic, the Igarra Sequence in SW Nigeria presents lithologic and stratigraphic similarities with the Seridó Group in **BP**

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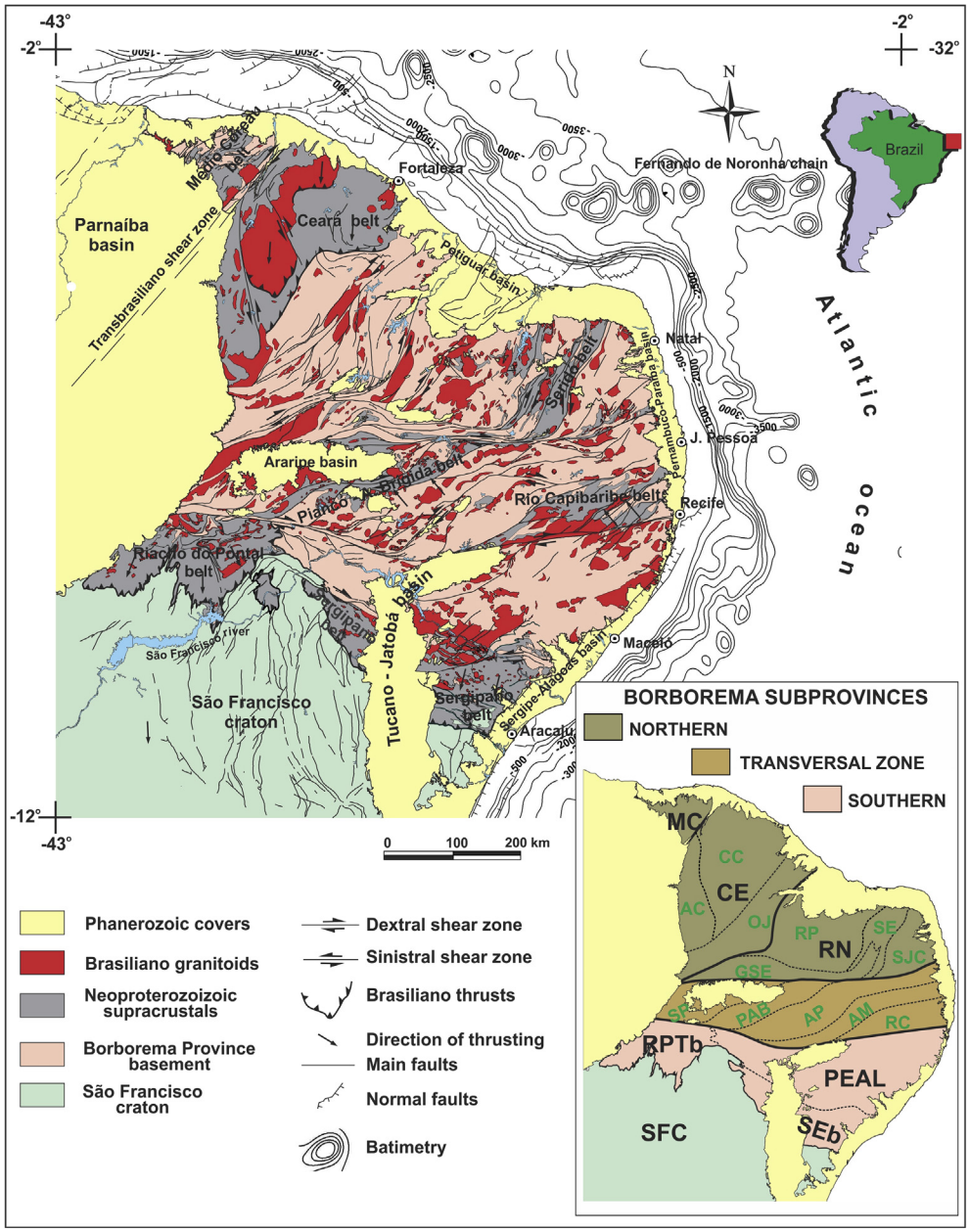

Fig. 1. Simplified geological and tectonic framework of the Borborema Province (**BP**), Northeastern Brazil. In the offshore region the bathymetry is shown (contours in meters). The inset in the lower right corner shows the **BP** division, according to Santos and Medeiros (1999) and Santos et al. (2000), into the Northern, Transversal Zone (or Central), and Southern subprovinces, besides major and secondary domains. Major domains: MC-Médio Coreau, CE-Ceará, RN-Rio Grande do Norte, PEAL-Pernambuco-Alagoas, RPTb-Riacho do Pontal belt, and SEb-Sergipano belt. Secondary domains (or terranes): CC-Ceará Central, AC-Acaraú, OJ-Orós-Jaguaribe, GSE-Granjeiro-Seridó, SE-Seridó, RP-Rio Piranhas, SJC-São José de Campestre, PAB-Piancó-Alto Brígida, AP-Alto Pajeú, AM-Alto Moxotó, RC-Rio Capibaribe, and SP-São Pedro.

(0.65 Ga). Also according to Arthaud et al. (2008), the Transbrasiliano shear zone in NE Brazil can be interpreted as the prolongation of the Kandi-4°50 lineament in Hoggar, thus representing a cryptic suture. This continuity for the two lineaments was also interpreted by Cordani et al. (2013a) and Ganade de Araujo et al. (2014). Corroborating this pre-drift reconstruction, Oliveira et al. (2006) and Van Schmus et al. (2008) correlate the Sergipano domain, located at the north of the São Francisco craton in Brazil, with the Yaoundé domain, located at the north of the Congo craton in Africa. However, according to Van Schmus et al. (2008), no continuation has been identified into Africa of the Cariris Velhos event in Brazil. On the other hand, the basements of the Rio Grande do Norte and Ceará Central domains in **BP** continue into western Nigeria and western Sahara (Van Schmus et al., 2008; Cordani et al., 2013a). Despite these geologic correlations, the role of the **BP** in the formation of the Gondwana supercontinent is a theme still under debate (Neves, 2003; Van Schmus et al., 2008; Cordani et al., 2013a; Ganade de Araujo et al., 2013; Brito Neves and Fuck, 2013; Brito Neves et al., 2014; Santos et al., 2015; Ganade de Araujo et al., 2016; Neves et al., 2017). Nonetheless, ages around 600 Ma are associated with the peak of deformation, magmatism and methamorphism caused by the Pan-African/Brasiliano orogeny (e.g. Brito Neves et al., 2014).

An important step to better understand the **BP** is to elucidate its crustal tectonic framework. Over the past decades, a large volume of surface geologic data was produced, which added important information for understanding the **BP** evolution (Brito Neves and Fuck, 2013; Brito Neves et al., 2014). However, advances in understanding its deep-rooted crustal framework have been hampered by the lack of geophysical data for correlation with surface geological information. Only in the last decade a complete regional coverage of gravimetric data of the **BP** was carried out (Oliveira, 2008; Oliveira and Medeiros, 2012). In addition, a good aeromagnetic coverage was available just around the last decade as a result of several surveys contracted by the CPRM-Geological Survey of Brazil. Using preliminary datasets, Oliveira (2008) presented the first integrated interpretation of gravity, magnetic, and geologic data for the whole **BP**. Also in the last decade some geophysical transects were done using both magnetoteluric (Padilha et al., 2013; Santos et al., 2014; Padilha et al., 2016, 2017) and refraction seismic data (Lima et al., 2015), which added important contributions