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Structural framework of the Jaibaras Rift, Brazil, based on geophysical data

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The Cambro-Ordovician Jaibaras Rift is a NE–SW trending elongated feature, controlled by the Transbrasiliano lineament, locally known as Sobral-Pedro II shear zone (SPIISZ). An integrated study of geophysical data (gammaspectrometry, magnetometry and gravimetry) was undertaken in the Jaibaras Rift area, between Ceará Central (CCD) and Médio Coreaú domains (MCD), northwest Borborema Province. Geophysical data were interpreted qualitatively and quantitatively in order to understand the tectono-magmatic relations and rift formation based on the main geophysical lineaments, source geometry and depth, and separation of geophysical domains. In addition, a 2D gravity model was generated. The results show a structural partition characterized by NE–SW lineaments and E–W inflexions, where CCD presents a relatively mild magnetic field, whilst the MCD field is more disturbed. The Jaibaras Rift is characterized by positive magnetic and gravity anomalies. The SPIISZ, which corresponds to the SE fault edge of the Jaibaras Rift, is marked by strong magnetic dipoles and strong gravity gradients in the profile, showing the deep character of the Transbrasiliano lineament in the region. The Café-Ipueiras fault, at the NW edge of the rift, is well marked in gravity profiles, but displays low contrast of the magnetic field. Interpretation of the gravimetric anomaly map allowed to recognizing the main NE–SW axis, with alternation of maxima and minima in MCD. A regional gravity gradient reveals significant lateral density variation between the MCD and CCD perpendicular to the SPIISZ, emphasizing it as a main continental suture zone between crustal blocks.

1. Introduction

Over the past 50 years, geological studies in the northwestern portion of the Borborema Province (Fig. 1) have shown its complex geological evolution (Kegel et al., 1958; Cobra, 1963; Costa et al., 1979; Sá et al., 1979; Gomes et al., 1981; Nascimento et al., 1981; Gorayeb et al., 1993; Torquato, 1995; Torquato and Nogueira Neto, 1996; Almeida, 1998; Oliveira, 2001; Oliveira and Mohriak, 2003). Most of these studies are related to regional geological mapping, as well as geological and geotectonic characterization of the Borborema Province (Santos and Brito Neves, 1984; Santos et al., 1984, 2008; Silva Filho, 1995). The exposed rocks in the region are the end products of several episodes of sedimentation, magmatism, metamorphism and tectonics, occurred in the Proterozoic and Paleozoic, in addition to magmatic events and restricted sedimentation episodes in the Meso-Cenozoic. Shear zones cut and delimit the main lithostratigraphic units, configuring a complex system of rift basins (Fig. 1), whose geological evolution is still controversial.

The Sobral-Pedro II Shear Zone (Figs. 1 and 2), the northern part of the Transbrasiliano Lineament, is the most prominent structural feature in the study site. This lineament is considered the continuation of the Kandi lineament in Africa, interpreted in some studies as a Neoproterozoic suture that was active during formation of the Gondwana supercontinent (Caby, 1989; Castaing et al., 1993; Vauchez et al., 1995; Arthaud et al., 2008; Santos et al., 2008; Cordani et al., 2013a, b) (Fig. 1). The geophysical methods applied in this study, combined with the geological-structural control in the study area, provided new information about the nature of the boundary between Médio Coreaú (MCD) and Central Ceará (CCD) domains and a possible suture or continental discontinuity (Fig. 1).

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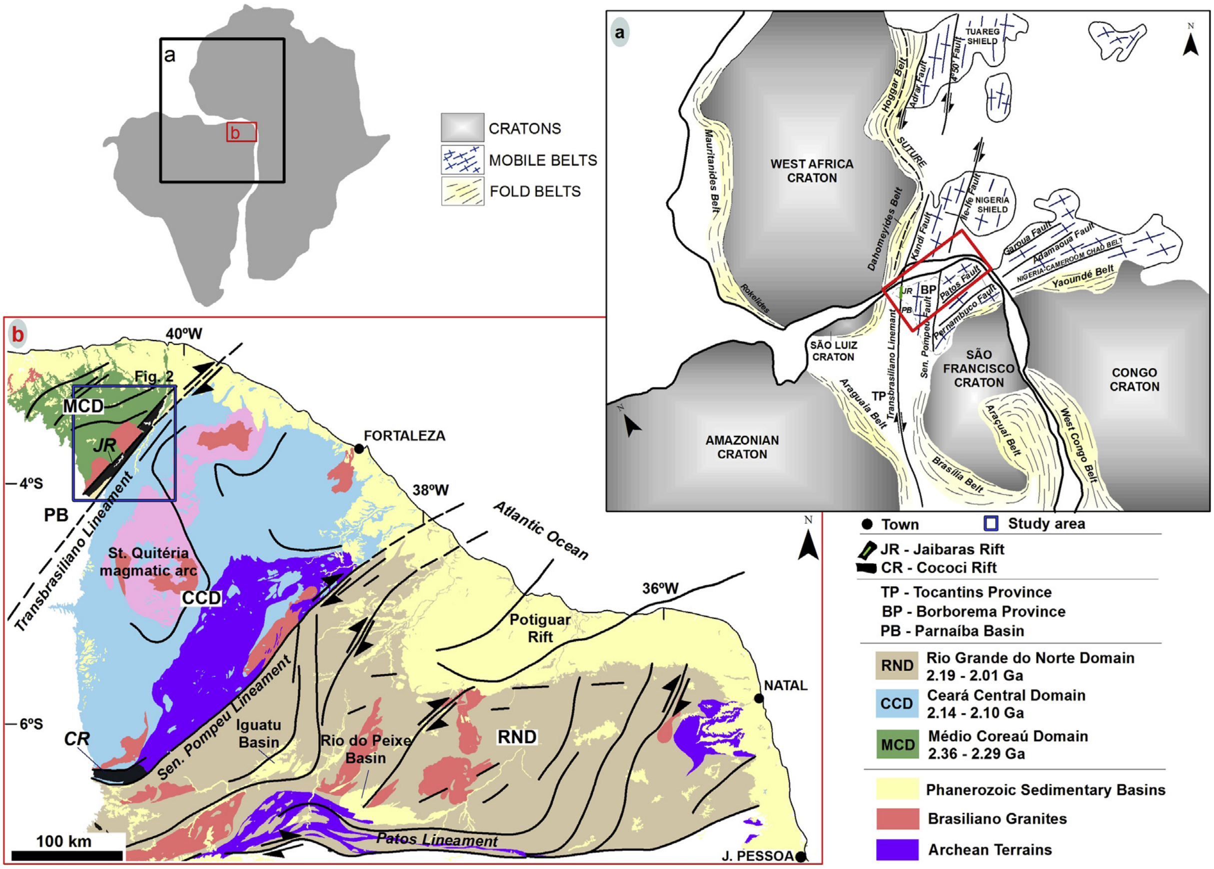

Fig. 1. a) West Gondwana, circa 500 Ma. Main geological provinces and the correlation between northeastern Brazil and West Africa (Caby, 1989; Santos et al., 2008; Van Schmus et al., 2008); b) Simplified geological map of the northern portion of the Borborema Province showing the main tectonic domains and major Brasiliano shear zones.

Crustal heterogeneities influence the structural control, as well as the tectonic-sedimentary and magmatic evolution of rift basins, with the reactivation of a previously deformed continental lithosphere (Nicolas et al., 1994; Oliveira and Mohriak, 2003; Castro et al., 2007, 2012, 2014). Fundamental understanding of the relationships between extensional deformation, basement structures and their reactivation, and the resulting rift architecture can be achieved by integrated interpretation of gamma-ray spectrometric, magnetic and gravity data, especially in onshore basins, where the physical properties involved display significant contrast.

Continental rifting evolution and characteristics were explained by analogue models and by comparing the results with the East African rift system (Corti, 2009, 2012). Sykes (1978) and Boyce and Morris (2002) drew attention to the intraplate tectonics and revealed weakness zones in the continental crust, in rift basin regions with deep faults, as is also the case of the Jaibaras Basin that could be reactivated by stress generated at some distance from plate boundaries. Indeed, the geophysical data interpretation based on lineaments, geophysical fields, and modeling allowed identifying potential areas for the occurrence of earthquakes in the region (Oliveira et al., 2010; Moura, 2012; Moura et al., 2014).

The main objective of this study is to characterize the structural framework of the Jaibaras Rift based on gammaspectometric, magnetic and gravimetric signatures. Geological data and geophysical lineaments are integrated to investigate the tectonic evolution of the region and to determine the structural relationships between the geotectonic processes that generated the basin and the pre-rift structural inheritance.

2. Structural framework of the basement and the Jaibaras Rift

The study area is located in the northwestern part of the Borborema Province (BP), northeast of the South American Platform (Almeida et al., 1981). The BP (Fig. 1) is an extensive Precambrian geological segment whose current geometry results from the collision of the Amazonian, São Luiz-West Africa and São Francisco-Congo cratons, during the Brasiliano/Pan-African Orogeny in late Neoproterozoic and early Phanerozoic (0.7–0.55 Ga; Brito Neves and Cordani, 1991; Brito Neves et al., 2000; Arthaud et al., 2008; Van Schmus et al., 2008). Throughout its evolution, the BP or parts of it were involved in other major tectonothermal events in the Archaean (3.4–3.2 Ga, 2.7 Ga), in the Paleoproterozoic (2.4–2.3 Ga, 2.1–1.8 Ga) and in the Early Neoproterozoic (Cariris Velhos Orogeny, 1.0–0.95 Ga, Brito Neves et al., 1995; Brito Neves and Campos Neto, 2002; Van Schmus et al., 2008; Santos et al., 2008, 2010). Although the influence of each of these events is still controversial, there is consensus that the Brasiliano/Pan-African Orogeny that led to Gondwana amalgamation was responsible for most of the structures currently observed in the province (Fig. 1). Phanerozoic processes played a role in the formation of the Parnaíba Basin, whose sedimentation extended over the rocks of BP and Jaibaras Rift (Paleozoic) and the extension resulting from the Pangaea breakup, and subsequent opening of the Atlantic Ocean in the Cretaceous (Asmus, 1984; Matos, 1992).

The Jaibaras Rift (Figs. 1 and 2) represents the end of the Brasiliano/Pan African event, when contractional processes were replaced by the collapse of orogenic chains and rupture of the continental crust, associated with the breakup process that