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Evidence for Neoproterozoic terrane accretion in the central Borborema Province, West Gondwana deduced by isotopic and geophysical data compilation

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ABSTRACT

The Borborema Province in NE Brazil is part of a large Neoproterozoic orogenic system related to the assembly of West Gondwana. Its evolution is contentious, due to the superposition of events that overprinted former records. We present a compilation of geological, isotopic (U-Pb detrital zircon and whole-rock Sm-Nd), and geophysical data that support a terrane accretion model for the Transversal subprovince (central Borborema Province). Bounded by thrust- and strike-slip shear zones of regional extent, the terranes vary in nature and age, and magmatic-arc related rocks, retro-eclogites, and dismembered ophiolites provide evidence of accretion. In addition, detrital zircon compilation suggests variable sources, including Palaeoproterozoic detritus related to the Rio Capibaribe and Alto Moxotó terranes and Neoproterozoic sources attributed to the Alto Pajeú and Piancó-Alto Brígida blocks. Accordingly, Archaean and Palaeoproterozoic Nd T_{DM} model ages are concentrated within the Alto Moxotó and Rio Capibaribe terranes, whereas early- to late Mesoproterozoic isotopic sources dominate in the Alto Pajeú and Piancó-Alto Brígida. A compilation of robust geophysical data shows contrasts in magnetic, gamma-spectrometric, and gravity signatures between the terranes, whereas modelled depths and density values are variable, coinciding with the proposed terrane boundaries. Our analysis suggests that now eroded oceanic lithospheric branches existed within the Transversal subprovince, later converted into dry suture zones. Terrane accretion is a plausible mechanism to rearrange the crustal pieces of West Gondwana, including those of the Borborema Province, and should be considered in other orogenic belts of South America.

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Accretion tectonics; terrane assembly; borborema province; west gondwana; neoproterozoic

Introduction

One of the prominent attributes of accretionary/cordilleran orogens is their complex puzzle of tectono-stratigraphic terranes that record major lithospheric growth and reworking episodes (Coney *et al*. 1980). The largest modern examples are those of the Circum-Pacific region (Cawood *et al*. 2009), but it is believed that accretionary orogenesis has been active throughout the geological history as testified, for instance, by the Neoproterozoic-Palaeozoic Terra Australis (Cawood 2005; Cawood *et al*. 2011) and Palaeoproterozoic Svecofennian orogens (Lahtinen *et al*. 2009).

Crustal assembly of West Gondwana, involving major periods of accretion and collision is referred to in South America and Africa as the Brasiliano-Pan African orogeny (*ca*. 0.65–0.5 Ga; Brito Neves, Fuck, Pimentel, 2014; Caby 2003; De Wit *et al*. 2008). The resultant orogenic belts include numerous arc-related volcanic-plutonic suites, high-grade metamorphic sequences, and sparse occurrences of ophiolite slivers (*e.g*. Brown *et al*. 2020; Heilbron *et al*. 2020; Massuda *et al*. 2020).

The Borborema Province (BP) occupies most of the northeast South American platform and represents a key orogenic area of central West Gondwana. Prior to the South Atlantic Ocean opening, its crustal architecture presented direct linkage to the major West African orogenic belts (*e.g*. Van Schmus *et al*. 2008). A number of models have been presented concerning its evolution during the Neoproterozoic, including: (i) accretion of exotic terranes (Brito Neves *et al*. 2000; Santos *et al*. 2010, 2017a, 2018; Neves *et al*. 2020), (ii) intracontinental orogenesis (Neves 2015; Neves *et al*. 2017, 2020), and (iii)

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different stages of the Wilson cycle (Oliveira *et al*. 2010; Caxito *et al*. 2014a). Intermediate proposals include the recognition of coeval collision-accretion and intracontinental reworking in distinct domains (Ganade de Araújo *et al*. 2021) and combined extrovert–introvert phases and ocean closing in certain areas (Caxito *et al*. 2020a). Although each of these models provides adequate evolutionary descriptions, they do not account for the complex crustal arrangement of several domains of the province (*e.g*. Santos and Medeiros 1999; Brito Neves *et al*. 2000; Santos and Caxito 2021).

In 1990´s, classical concepts of accretion tectonics (*e.g*. Coney *et al*. 1980; Howell 1989, 1995; Jones *et al*. 1977) were applied to the Transversal subprovince (central Borborema Province; Santos 1996; Santos and Medeiros 1999). This area is characterized by a variety of lithotectonic units that reflect systematic stages of crustal growth as well as variable regional-scale shear zones interpreted as possible crustal boundaries (Brito Neves *et al*. 2000, 2016).

In this contribution, we review arguments for the division and assembly of the Transversal subprovince, building on the seminal work of Santos (1996). We compile geological, geochronological, and geophysical data to provide an up-to-date overview of the subprovince terranes as well as possible correlations with the African orogenic belts and neighbouring cratons.

Geological overview

Early descriptions of the orogenic system referred to as Borborema Province date back to the works of Ebert (1962) and Brito Neves (1975). In Palaeogeographic reconstitutions, the province extends into the West African orogens in Togo, Benin, Nigeria, and Cameroon (Almeida *et al*. 1981; Santos *et al*. 2008; Van Schmus *et al*. 1995). This large orogenic region was built-up during the Brasiliano-Pan African Orogeny (0.6–0.5 Ga; Brito Neves *et al*. 2000) via convergent episodes between the Amazonian-West Africa-São Luís and São Francisco-Congo Palaeo-plates (Figure 1a; De Wit *et al*. 2008 and references therein).

In a simplified view, the Borborema Province is characterized by Palaeoproterozoic gneissic-migmatitic basement sequences (*ca*. 2.2–2.0 Ga; *e.g*. Brito Brito Neves *et al*. 2020; Santos and Caxito 2021), local Archaean nuclei (*ca*. 3.5–2.6 Ga; *e.g*. Pitarello *et al*. 2019; Ferreira *et al*. 2020), and Neoproterozoic supracrustal-dominated terranes (*ca*. 1.0–0.6 Ga; *e.g*. Brito Neves, Fuck, Pimentel, 2014; Santos *et al*. 2010, 2019; Lima *et al*. 2018). Several early- to late Neoproterozoic pre-, syn-, late- and post-orogenic granitic suites intruded the basement and supracrustal sequences, considered as markers of the Brasiliano-related crustal accretion (*ca*. 0.9–0.5 Ga; *e.g*. Santos *et al*. 2010; Sial and Ferreira 2015; Nascimento *et al*. 2015).

A distinguishing feature of the province is the dense network of up to several kilometres-wide shear zones (Vauchez *et al*. 1995), interpreted by some authors as lithospheric boundaries/collisional sutures (*e.g*. Cordani *et al*. 2013; Santos *et al*. 2015a, 2017a). Among them, the E–W Pernambuco and Patos lineaments divide the province in the northern, Transversal, and southern subprovinces (Figure 1b; Van Schmus *et al*. 1995).

Based on geological and geophysical data, the Transversal subprovince is divided in the Piancó-Alto Brigida, Alto Pajeú, Alto Moxotó, and Rio Capibaribe terranes (Figure 1c; Santos 1995, Santos 1996; Santos and Medeiros 1999; Van Schmus *et al*. 2008). Minor subterranes have also been locally proposed (*e.g*. Riacho Gravatá; Santos *et al*. 2010). In addition, the São Pedro Terrane occupies the extreme west of the Transversal subprovince and apart from recent punctual contributions (*e.g*. Caxito *et al*. 2021), its evolution is still poorly known.

Terranes of the transversal subprovince

Definition and character

The Transversal subprovince composes a sigmoidal-arranged crustal framework, in response to the deformation imposed by E–W and NE–SW regional shear zones, a typical configuration of dispersed terranes (Howell 1995). The main periods of crust generation through juvenile inputs and crust reworking/recycling are distinct for each terrane, indicating individual partial melting episodes of different sources and ages covering almost all Precambrian eras (Figure 2; *e.g*. Brito Neves 2020 and references therein).

Rio capibaribe terrane

This terrane is in tectonic contact with the southern subprovince along the E–W transcurrent Pernambuco Lineament (Figure 1c). This structure represents an almost 700 km-long transcontinental structure, that can be traced along the Adamawa Lineament in NW Africa (Davison *et al*. 1995; Castellan *et al*. 2020). Several calc-alkaline magmatic-plutons were emplaced along this structure, leading Santos (1995) and Brito Neves *et al*. (2000) to describe it as a tectonic boundary (*i.e*. plutonic suturing, *sensu* Howell 1995). This lineament is also the focus of recent and frequent earthquakes through crustal reactivation (Lima Neto *et al*. 2014).

The northern boundary with the Alto Moxotó Terrane is the Congo-Cruzeiro do Nordeste Shear System (Figure

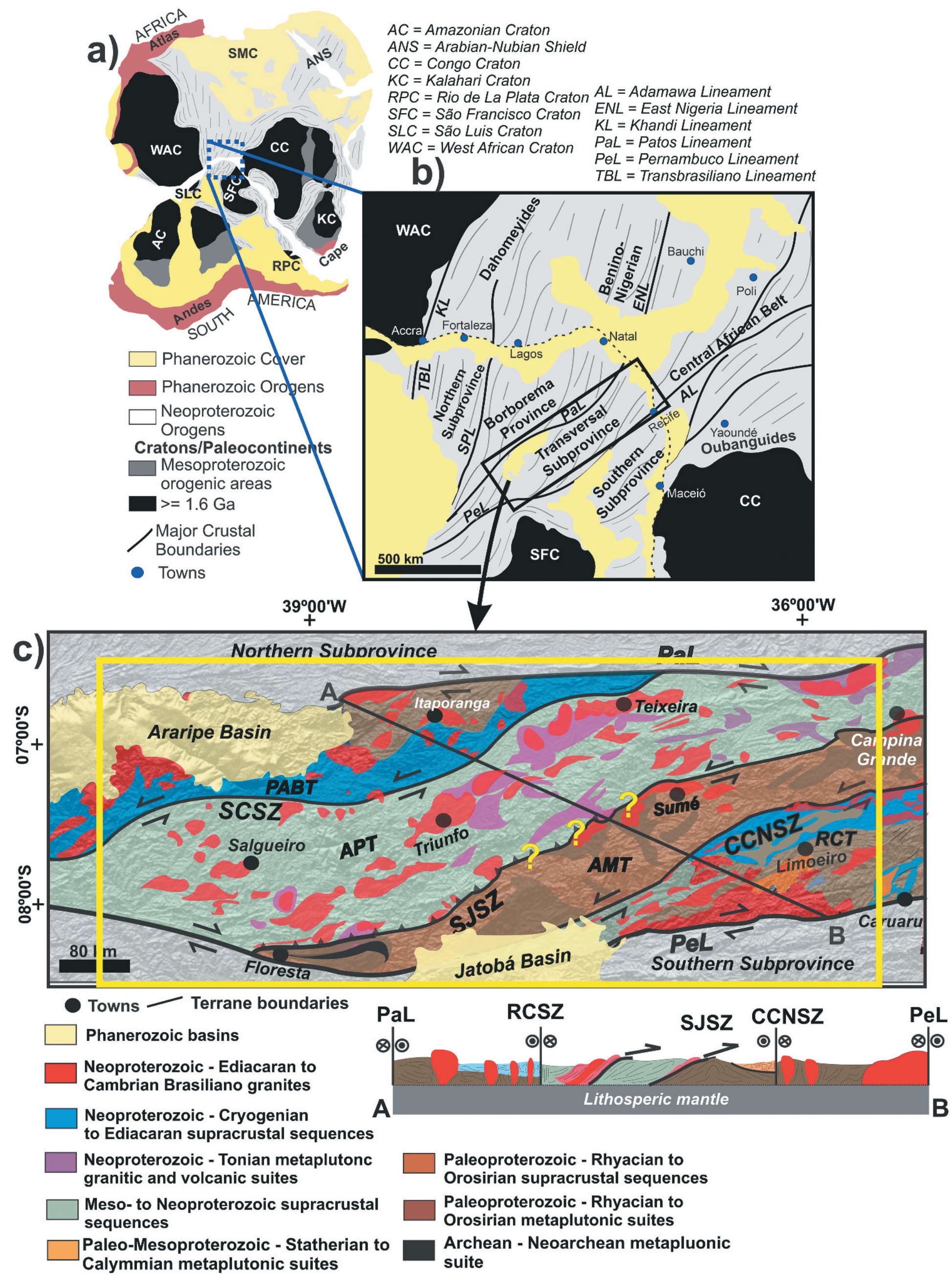

Figure 1. (A) Geodynamic context of the Borborema Province in a simplified pre-drift reconstruction of West Africa and northeastern South America modified from De Wit *et al*. (2008); (B) Tectonic framework of the Borborema Province and its general internal domains (Van Schmus *et al*. 1995; Santos *et al*. 2018); (C) Terranes of the Transversal subprovince over an SRTM satellite image base as well as a NW-SE structural cross-section showing the disposition of the regional structures (modified from Santos and Medeiros 1999). Geological unit colours in c are related to the **dominan**t **ages** of each terrane and the yellow open rectangle marks the area used for the geophysical modelling. Cratons: AC = Amazonian, RPC = Rio de la Plata, SFC = São Francisco, CC = Congo, WAC = West Africa, KC = Kalahari, SMC = Saharan Metacraton. Transversal subprovince terranes: PABT = Piancó-Alto Brígida, APT = Alto Pajeú, AMT = Alto Moxotó, RCT = Rio Capibaribe. Transversal subprovince lineaments and shear zones: PaL = Patos, SCSZ = Serra do Caboclo, SJSZ = Serra de Jabitacá, CCNSZ = Congo-Cruzeiro do Nordeste, PeL = Pernambuco.

1c), covering a series of parallel to subparallel strike-slip structures where plutonic suites crop out, dated at *ca.* 0.59 Ga (Santos 2012; Brito Neves *et al*. 2013). This shear system is highly heterogeneous and divided into two major branches displaying shallow and deep-seated deformation conditions (*e.g.* Miranda *et al*. 2020).

The Rio Capibaribe terrane (Figure 1c; Figure 2) is characterized by a Palaeoproterozoic (*ca.* 2.1–2.0 Ga;

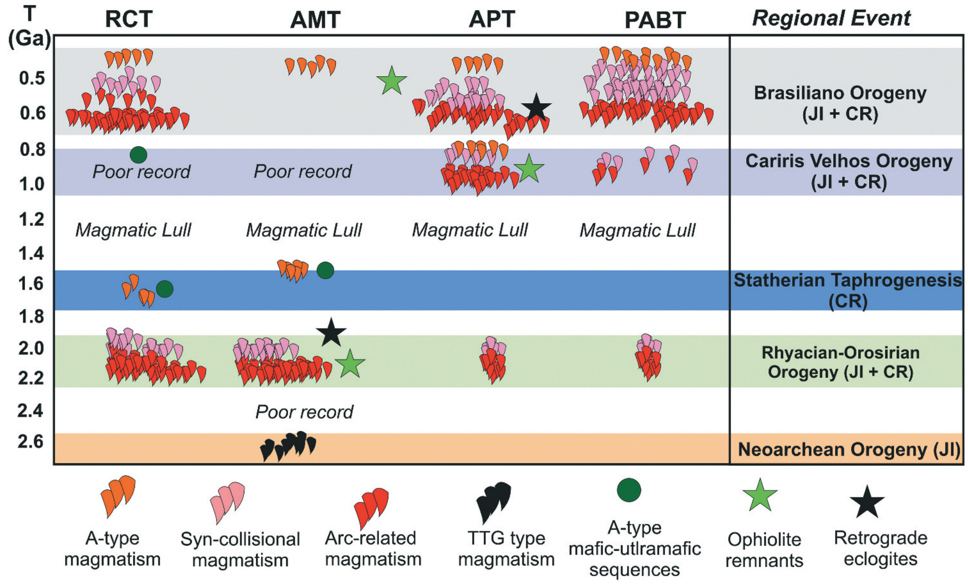

Figure 2. Diagram showing synthesis of the **dominant periods** of orogenic and magmatic events in the Transversal Subprovince, including periods of juvenile inputs (JI) and crustal reworking (CR). Terranes: RCT = Rio Capibaribe, AMT = Alto Moxotó, APzT = Alto Pajeú, PABT = Piancó-Alto Brígida.

Neves *et al*. 2015) gneissic-migmatitic basement with occurrences of late Palaeoproterozoic anorogenic plutons (*ca*. 1.5–1.7 Ga; Accioly 2000; Sá *et al*. 2002). This set is covered by early and late Neoproterozoic (*ca*. 0.96–0.65 Ga) medium grade (amphibolite facies) supracrustal sequences (Neves *et al*. 2006a, 2009; Brito Neves *et al*. 2013). This succession is intruded by large late Ediacaran calc-alkaline I-type plutonic batholiths (*ca*. 0.6 Ga), that mark conspicuous magmatic activity of the Brasiliano Orogeny (Guimarães *et al*. 2004). Within the terrane, transcurrent structures, including the Pernambuco Lineament, also host several granites that were emplaced between 590 and 570 Ma (*e.g.* Neves *et al*. 2006b), interpreted as possible collisional to post-collisional crustal markers (*e.g.* Brito Neves *et al*. 2013; Ganade de Araujo *et al*. 2014b; Mariano *et al*. 2001).

Alto moxotó terrane

The Alto Moxotó Terrane (Figure 1c; Figure 2) contains the oldest sequences within the Transversal Subprovince, comprising large exposures of Palaeoproterozoic high-grade gneissic and migmatitic domains (*ca*. 2.2–2.1 Ga). Supracrustal rocks, including metavolcanic and metavolcanoclastic members, are slightly younger (*ca*. 2.1–2.0 Ga) and strongly migmatized (Santos *et al*. 2004). However, evidence for Neoproterozoic detrital material has been documented by Neves *et al*. (2017). The dominant framework includes juvenile metamafic-ultramafic rocks interpreted as remnants of island-arc to MORB-like magmas and arc – related to syn collisional metagranites and orthogneisses (Santos *et al*. 2012, p. 2015b). Part of it was later metamorphosed under eclogitic-granulitic conditions probably at *ca*. 1.97 Ga (Almeida *et al*. 2009; Santos *et al*. 2013a; Neves *et al*. 2015).

This set has been interpreted as the result of progressive oceanic lithosphere consumption during a major Rhyacian-Orosirian orogeny (*ca*. 2.1–1.9 Ga; *e.g.* Santos *et al*. 2013b), widely described in the major cratons of South America. Most of these were possibly intrusive into recently described juvenile Neoarchean (*ca*. 2.6 Ga) TTG suites (Santos *et al*. 2017b) as well as local older nuclei composed mostly of 2.7–2.9 Ga grey gneisses (Brito Brito Neves *et al*. 2020). These Meso- to Neoarchean complexes represent the unique occurrence of Archaean crust within the Transversal subprovince.

Mesoproterozoic (*ca*. 1.6 Ga) units include anorogenic bimodal suites (Santos *et al*. 2015b; Lages *et al*. 2019), whereas Neoproterozoic granitic suites are scarce as compared with most domains of the Borborema Province, but small Cambrian (*ca*. 0.54–0.52 Ga) plutons are described (*e.g.* Guimarães *et al*. 2004) (see Figure 1c).

The boundary between the Alto Moxotó and Alto Pajeú terranes is unclear, being referred to as a set of strongly folded core-nappe structures grouped as the Serra de Jabitacá Thrust System (Santos *et al*. 2017a, 2018). Alternatively, the boundary is taken as the deep-seated strike-slip Afogados da Ingazeira Shear Zone, due to its parallel combination of strong magnetic and gravity gradients (*e.g.* Oliveira and Medeiros 2018).

Alto pajeú terrane

This terrane (Figure 1c; Figure 2) is characterized by early Neoproterozoic supracrustal and metaplutonic sequences, including volcanic, volcanoclastic, and metasedimentary rocks, but lacks a major Palaeoproterozoic basement. The Neoproterozoic units are part of the Cariris Velhos Event (*ca*. 1.0–0.92 Ga), interpreted either as an early Neoproterozoic orogenic episode (Kozuch 2003; Santos *et al*. 2010; Caxito *et al*. 2020b) or as a pre-Brasiliano extensional phase (Guimarães *et al*. 2016; Neves *et al*. 2020). Mafic-ultramafic rocks of the Alto Pajeú Terrane are interpreted as arc cumulates, and evidence of MOR-like (mid-ocean-ridge) associations are dated at *ca*. 1.0 Ga, later submitted to high-grade metamorphic conditions during the Brasiliano Orogeny at *ca*. 0.62 Ga (Lages and Dantas 2016).

The abundance of early Neoproterozoic metaplutonic, metasedimentary, and metavolcanic sequences marks the Cariris Velhos Belt (1.1–0.92 Ga), suggesting that this terrane constitutes a possible exotic descendent of Rodinia (Fuck *et al*. 2008; Santos *et al*. 2019). The Alto Pajeú Terrane also contains a vast number of late Neoproterozoic calc-alkaline granites (Guimarães *et al*. 2011), as well as the unique occurrence of an Ediacaran adakite-like granite (*i.e.* Riacho do Icó Stock), interpreted as the evidence of slab-melting during the Brasiliano subduction (Santos *et al*. 2020).

Piancó-alto brígida terrane

The Piancó-Alto Brígida Terrane (Figure 1c; Figure 2) occurs in the westernmost portion of the Transversal subprovince. Late Neoproterozoic (*ca*. 0.63–0.58 Ga) units dominate, characterizing the major testimony of the Brasiliano magmatic manifestation within the Transversal subprovince (Brito Neves, Fuck, Pimentel, 2014, Sial and Ferreira 2015; Brito Neves *et al*. 2016). The terrane is bounded by the sinistral strike-slip Serra do Caboclo Shear Zone to the south and the continental-scale dextral Patos Lineament to the north (Medeiros *et al*. 2011 and references therein).

Up to now, there are no clear evidence that the Patos Shear Zone represents a transcontinental suture in its entire extent. Nevertheless, it has been associated with high-grade metamorphism (granulite facies; Viegas *et al*. 2014) and due to its association with several subduction-related rocks (*e.g*. Sial and Ferreira 2015), it has been described as an oceanic 'boundary transform' (Brito Neves *et al*. 2016, 2018). The African correlative of the Patos Lineament is the East Nigeria Shear Zone, which also contains rocks with evidence of high-temperature anatexis (>800°C – granulite facies) related late Neoproterozoic oceanic closure/continental collision (*e.g*. Ferré *et al*. 2002).

The remarkable characteristic of the Piancó-Alto Brígida Terrane is the vast number of *ca*. 0.63–0.59 Ga granitic domains comprising a broad geochemical spectrum (*e.g*. Sial *et al*. 2008). They cover normal calc-alkaline, high-K calc-alkaline and alkaline magmatic series, presenting geochemical signatures akin to classical arc-related granites (Pitcher 1983; Pearce 1984; Murphy 2007). Integration of field, geochemical and geochronological data led Brito Neves *et al*. (2016) to group these granites as roots of a 750-km long ENE-WSE continental magmatic arc. In addition, recently described coeval rhyolitic metavolcanic and metavolcanoclastic rocks (Caxito *et al*. 2021) were interpreted as part of a widespread back-arc system. It is worth mentioning that the isotopic composition (δO^{18} values) of part of these rocks is not typical of I-type arc-related magmatism as shown by Neves (2018), and the complete understanding of this orogenic realm still need further investigations.

Associated supracrustal sequences encompass low-grade metamorphosed quartzite-pelite-carbonate (QPC) rocks that are interleaved with some strongly folded Palaeoproterozoic basement inliers, interpreted as subterranes (Brito Neves *et al*. 2018). These rocks preserve sedimentary structures such as ripple marks and cross stratifications (Brito Neves *et al*. 2016), strongly contrasting with the high-grade metamorphic conditions along the Patos Shear Zone and the adjacent Alto Pajeú Terrane (*e.g*. Kozuch 2003; Santos *et al*. 2010; Lages and Dantas 2016).

Isotope record

Detrial zircon ages

We have compiled published $^{206}Pb/^{238}U$ and $^{207}Pb/^{206}Pb$ data from detrital zircon crystals (Figure 3, n = 817; Brito Neves *et al*. 2013; Brito Neves *et al*. 2018; Caxito *et al*. 2021; Guimarães *et al*. 2012; Neves *et al*. 2006a, Neves *et al*. 2009; Neves 2015; Santos *et al*. 2004, Santos *et al*. 2019; Van Schmus *et al*. 2011; Table 1). The age distribution is evaluated on probability density plots, compared with the ranges for the main orogenic events, *i.e.* Rhyacian-Orosirian (2.2–1.9 Ga), Cariris Velhos (1.0–0.9 Ga), and Brasiliano (0.6–0.5 Ga). A crucial point relies on the late Neoproterozoic ages. Most of them reflect the Brasiliano high-grade metamorphic episodes, such as those from the Alto Moxotó Terrane (Neves *et al*. 2017; Santos *et al*. 2004), a persisting geochronological problem that needs to be untangled in the future.

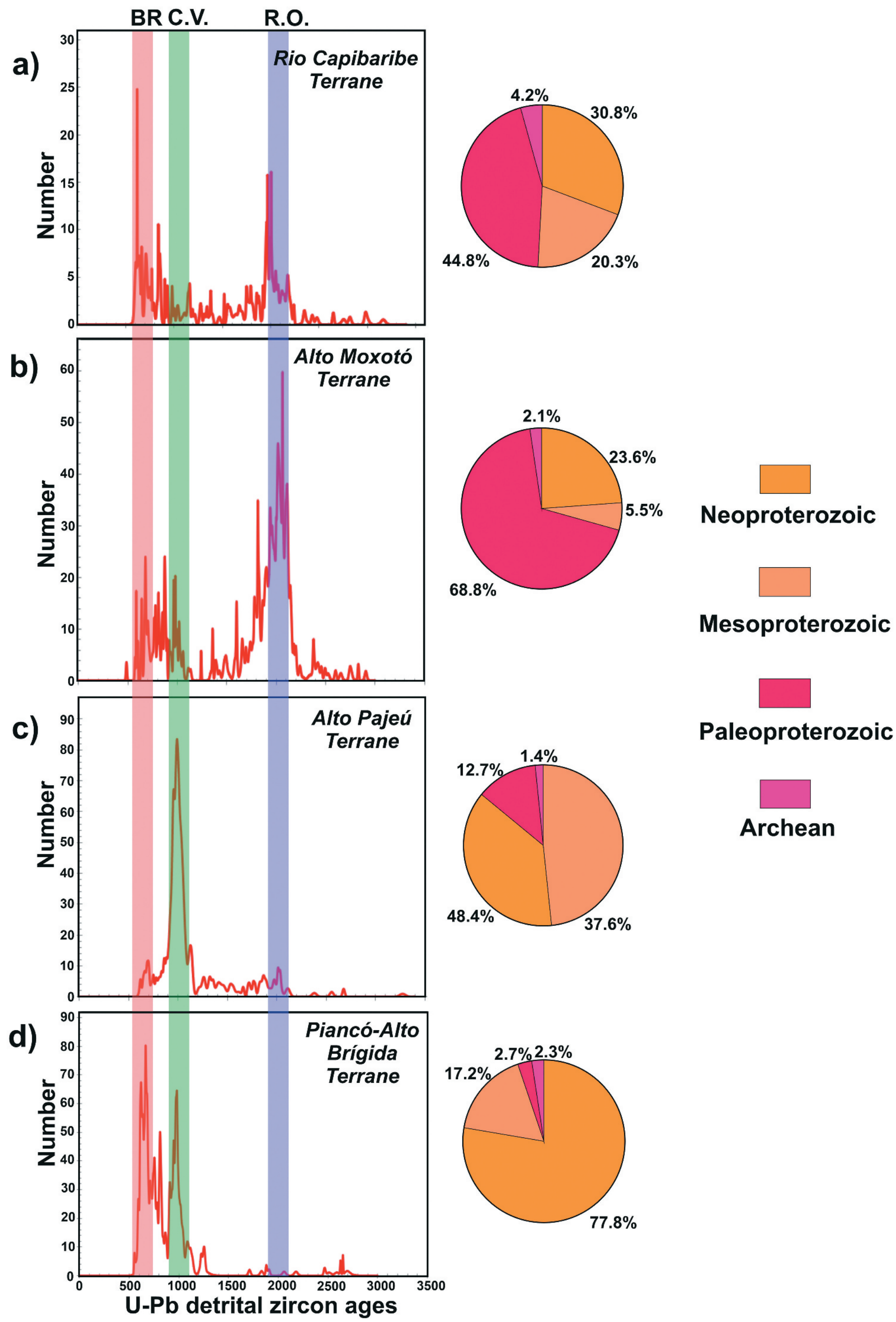

Figure 3. Composite U-Pb ages of detrital zircon grains of the Transversal subprovince supracrustal sequences, central Borborema Province. Pie charts with age percentage distribution were included. R.O. = Rhyacian Orogeny; C.V. = Cariris Velhos Orogeny, BR = Brasiliano Orogeny.

The Rio Capibaribe Terrane data distribution is concentrated on Mesoproterozoic-Neoproterozoic (51.3%) and Palaeoproterozoic detrital material (44.8%). Archaean ages are minor (4.2%). The obtained probability density plot is trimodal, characterized by a major peak at around 0.6 Ga, a secondary peak related to grains with ages close to 2.0 Ga and a less prominent peak around 0.7–0.8 Ga (Figure 3a). The dominance of late Neoproterozoic and Cambrian detritus in the Rio Capibaribe Terrane is compatible with the erosion of major granitic bodies. However, the presence of older detrital components, particularly those of Palaeoproterozoic age, suggests inputs from a Rhyacian-Orosirian lithosphere that correspond to the

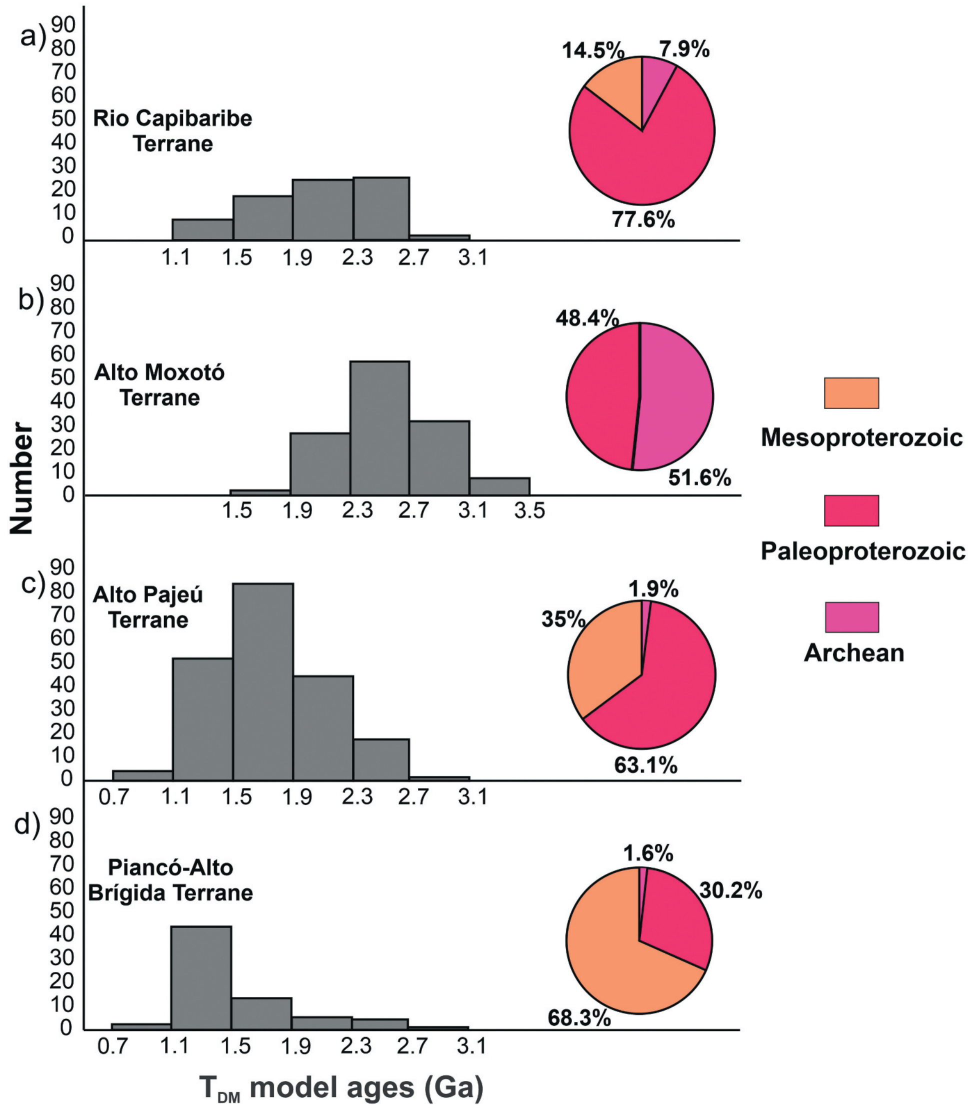

Figure 4. Histograms of neodymium depleted mantle model ages (T_{DM}) for different sequences of the Transversal subprovince terranes.

Table 1. Summary of the published detrital zircon data of the Transversal Subprovince terranes. RC = Rio Capibaribe, AM = Alto Moxotó, AP = Alto Pajeú, RC = Rio Capibaribe. SHRIMP stands for Sensitive high-resolution ion microprobe and LA-ICP-MS stands for Laser Ablation Inductively Coupled Plasma Mass Spectrometry.

Terrane	Dated rocks	Technique	Maximum deposition age	Dominant age interval	Reference
RC	Paragneisses	LA-ICP-MS	*ca.* 0.6 Ga	1.9–2.1 Ga	Neves *et al.* (2006a)
RC	Paraderived ultramylonites	LA-ICP-MS	*ca.* 0.6 Ga	0.6 Ga and 2.0 Ga	Neves *et al.* (2009)
RC	Metatuff	LA-ICP-MS	*ca.* 0.6 Ga	0.6–0.7 Ga	Brito Neves *et al.* (2013)
AM	Volcanoclastic rocks	SHRIMP	*ca.* 2.0 Ga	2.0–2.2 Ga	Santos *et al.* (2004)
AM	Muscovite-garnet quartzites	LA-ICP-MS	*ca.* 0.6 Ga	1.9–2.0 Ga	Neves *et al.* (2009)
AM	Garnet paragneisses	LA-ICP-MS	*ca.* 0.6 Ga	1.9–2.0 Ga	Neves *et al.* (2017)
AP	Metagraywackes and schists	LA-ICP-MS	*ca.* 0.9 Ga	1.1–0.9 Ga	Van Schmus *et al.* (2011)
AP	Metagraywackes	SHRIMP	*ca.* 0.8 Ga	0.8–0.9 Ga	Guimarães *et al.* (2012)
AP	Muscovite-biotite schists	LA-ICP-MS	*ca.* 0.9 Ga	0.9–1.0 Ga	Santos *et al.* (2019)
PAB	Metatuffs and mevacolcanoclastic rocks	LA-ICP-MS	*ca.* 0.6 Ga	0.6–1.0 Ga	Van Schmus *et al.* (2011)
PAB	Volcanoclastic rocks	SHRIMP	*ca.* 0.6 Ga	0.6–0.9 Ga	Caxito *et al.* (2021)

basement orthogneisses and migmatites described within the terrane (*e.g.* Brito Neves *et al.* 2013; Neves *et al.* 2006a).

The Alto Moxotó Terrane zircon distribution is characterized by a major peak between 2.0 and 1.8 Ga, followed by secondary peaks aged between 0.8 and 0.5 Ga. Palaeoproterozoic sources correspond to almost 70% of the available geochronological data, followed by Neoproterozoic (23%) and Mesoproterozoic detritus (5.5%). Unlike the Rio Capibaribe Terrane, the dominant ancient sources in the Alto Moxotó are compatible with erosion of Rhyacian-Orosirian magmatic arcs, with minor contributions from more recent sources. Such data distribution is partially in accordance with the described crustal basement units of the terrane, that consists almost entirely of Palaeoproterozoic rocks (*e.g.* Brito Brito Neves *et al.* 2020a; Santos *et al.* 2012, 2013; Santos and Santos 2019). The lack of Archaean detritus might reflect minor-exposed sources of this aeon at the time of sediment accumulation (Brito Brito Neves *et al.* 2020a) or biased data distribution due to the small number of geochronological data.

The Alto Pajeú Terrane data distribution comprises mostly Neoproterozoic (48.4%) and Mesoproterozoic (37.6%) ages, followed by Palaeoproterozoic (12.6%) sources. However, based on the peak distribution, this terrane is characterized by an almost unimodal distribution with a prominent peak in the 1.0–0.9 Ga age interval. This terrane is the type area for the Cariris Velhos Orogeny (Brito Neves *et al.* 2000; Santos 1995; Santos *et al.* 2010, 2019, 2020; Lages and Dantas 2016) and exhumation of the continental magmatic arc associated with this orogen is the likely source. The rare Palaeoproterozoic contribution suggests minor erosion from a Rhyacian-Orosirian basement.

The Piancó-Alto Brigida Terrane age spectrum is dominated by Neoproterozoic zircon crystals (77.8%), whereas Mesoproterozoic sources correspond to 17.2% of the distribution. The major peaks are in between 0.5 and 0.6 Ga, with derivation inferred to be from magmatic arcs related to the Brasiliano Orogeny. Indeed, this terrane comprises numerous well-studied granitic batholiths related to I- and S-type magmas that crystallized between 0.63 and 0.56 Ga (Sial and Ferreira 2015 and references therein). Palaeoproterozoic peaks are absent and reflect limited exposure at the time of sediment deposition, whereas early Neoproterozoic crystals are widely distributed at *ca.* 0.8–0.96 Ga, suggesting some contribution from the Cariris Velhos orogen.

Nd T_{DM} model age distribution

Depleted mantle (T_{DM}) model ages of the parent–daughter Sm-Nd system were used to compare the general source characteristics and composition (*e.g.* DePaolo and Wasserburg 1976; Bennett and Depaolo 1986; Schoene *et al.* 2009). Used data were compiled from 464 analyses (Figure 4) of Palaeoproterozoic orthogneisses, metamafic and metasedimentary rocks and early- to late Neoproterozoic and Cambrian metavolcanic, metasedimentary, and granitic rocks (Guimarães *et al.* 2004; Rodrigues and Brito Neves 2008; Van Schmus *et al.* 2011; Brito Neves *et al.* 2013; Sial and Ferreira 2015; Santos *et al.* 2018; Caxito *et al.* 2021; Table 2).

The Rio Capibaribe Terrane T_{DM} model ages histogram reflects major concentrations of Palaeoproterozoic sources (77.6%), whereas Mesoproterozoic (14.5%) and Archaean (7.9%) data are minor. Most of the model ages occur in the 2.7–1.9 Ga interval, which is typical of the basement orthogneisses, whereas the younger model ages derived from supracrustal and granitic rocks. On the other hand, the model ages distribution of the **Alto Moxotó Terrane** is mostly Archaean (51.6%) and Palaeoproterozoic (48.4%) with almost complete absence of younger values. Most model ages are concentrated between 2.7 and 2.3 Ga and can be related to juvenile Neoarchean and early Palaeoproterozoic sources (*e.g.* Santos *et al.* 2017b), followed by those concentrated at the 3.1–2.7 Ga interval. A minor component of Palaeoarchean and Mesoarchean model ages (>2.7 Ga) represents the oldest sources within the Transversal subprovince.

The Alto Pajeú T_{DM} model ages are mostly Palaeoproterozoic (63.1%), followed by Mesoproterozoic (35%) data. They are concentrated between the 1.9 and 1.5 Ga interval, followed by a large number between 1.5 and 1.1 Ga. A minor concentration is represented by the 2.3–1.9 Ga range. The dominance of Palaeo-Mesoproterozoic data (1.9–1.4 Ga) is the typical Nd age interval of the Cariris Velhos rocks throughout the Borborema Province (*e.g.* Van Schmus *et al.* 1995; Santos *et al.* 2010). Such data indicate late Palaeoproterozoic to early Mesoproterozoic reservoirs and lack ancient sources. However, mixing of Palaeoproterozoic and younger sources is an alternative interpretation.

Unlike the other terranes, the **Piancó-Alto Brígida Terrane** is characterized by dominant younger model ages, that are mostly Mesoproterozoic (68.3%). Palaeoproterozoic and Archaean model ages are 32% of the compiled data, mostly restricted to the Rhyacian-Orosirian interval (2.2–1.9 Ga). The dominant Mesoproterozoic source is typical for the Brasiliano-related Ediacaran–Cambrian granitic batholiths and host supracrustal sequences, which are the dominant rock types of this terrane. Source mixing cannot be discarded.

Geophysical character of terranes and boundaries

Deep seismic refraction lines (Lima *et al.* 2015) and Curie Surface signatures (Correa *et al.* 2016) have shown that crustal thickness within the Transversal subprovince differs considerably from the adjoining terranes. Together, these data suggest that the Pernambuco and Patos lineaments could represent crustal boundaries (Lima *et al.* 2015). Magnetotelluric investigations coupled with

Table 2. Summary of the published Sm-Nd T_{DM} model ages of the transversal subprovince terranes. RC = Rio Capibaribe, AM = Alto Moxotó, AP = Alto Pajeú, RC = Rio Capibaribe.

Terrane	Rocks	T_{DM} model ages range	Reference
RC	*ca.* 0.6 Ga Brasiliano-related granites	1.4–2.0 Ga	Guimarães *et al.* (2004)
RC	*ca.* 2.1 basement orthogneisses and *ca.* 0.6 Ga paraderived rocks	1.2–2.4 Ga	Van Schmus *et al.* (2011)
RC	*ca.* 2.1 Ga basement orthogneisses, *ca.* 0.9 Ga paraderived rocks and *ca.* 0.6 Ga Brasiliano-related granitic rocks	1.6–3.0 Ga	Brito Neves *et al.* (2013)
RC	*ca.* 2.1 Ga basement orthogneisses	2.2–2.6 Ga	Neves *et al.* (2015)
AM	*ca.* 0.5 Ga A-type granites	2.1–2.2 Ga	Guimarães *et al.* (2004)
AM	*ca.* 2.1–2.0 Ga basement orthogneisses, migmatites and paraderived rocks	1.5–2.9 Ga	Rodrigues and Brito Neves (2008)
AM	*ca.* 2.1 Ga basement orthogneisses and migmatites	2.1–2.5 Ga	Van Schmus *et al.* (2011)
AM	*ca.* 2.1 Ga basement orthogneisses	2.2–3.2 Ga	Neves *et al.* (2015)
AM	*ca.* 2.1–1.6 Ga basement orthogneisses and migmatites, mafic-ultramafic rocks and metagranites	1.9–3.3 Ga	Santos *et al.* (2015)
AM	*ca.* 2.6–2.1 Ga basement orthogneisses and migmatites, mafic-ultramafic rocks and garnet-paragneisses	1.9–3.3 Ga	Santos *et al.* (2018)
AP	*ca.* 1.0–0.9 Ga Cariris Velhos-related orthogneisses and paraderived rocks	1.3–2.2 Ga	Rodrigues and Brito Neves (2008)
AP	*ca.* 0.9 Ga Cariris Velhos-related orthogneisses and paraderived rocks	1.0–2.4 Ga	Van Schmus *et al.* (2011)
AP	*ca.* 0.6–0.5 Ga Brasiliano-related granites	1.3–2.5 Ga	Sial and Ferreira (2015)
AP	*ca.* 0.9 Ga Cariris Velhos-related metagranites, metamafic and paraderived rocks	1.4–1.9 Ga	Santos *et al.* (2018)
PAB	*ca.* 0.6–0.5 Ga Brasiliano-related granites, paraderived- and volcanic rocks	1.0–2.8 Ga	Van Schmus *et al.* (2011)
PAB	*ca.* 0.6–0.5 Ga Brasiliano-related granites	1.2–2.3 Ga	Sial and Ferreira (2015)
PAB	*ca.* 0.6 Ga Brasiliano-related volcanic and volcanoclastic rocks	1.0–2.0 Ga	Caxito *et al.* (2021)

seismic refraction data indicate that the Alto Moxotó Terrane displays dominantly homogeneous and electrically resistive crust and upper mantle, in contrast with the adjacent domains (Santos *et al.* 2014). In addition, it is also suggested that accretion episodes might have started during the Cariris Velhos Event (*i.e.* a fossil subduction; Padilha *et al.* 2017) and the Brasiliano Orogeny might have acted as a crust reworking episode, which needs to be better investigated in the future. Considering a wider context, Oliveira and Medeiros (2018) combined magnetic and gravity data to unveil the geophysical structure of the Borborema Province. The deep-seated magnetic anomalies, associated with crustal blocks with contrasting high- and low gravity gradients, is suggestive of strong crustal heterogeneities.

In the following, we outline gamma-ray spectrometric, magnetic, and gravity data obtained via regional geophysical surveys carried out and made available by the Geological Survey of Brazil – CPRM. Gravity data survey and processing details are given in Oliveira and Medeiros (2012). For gamma-ray spectrometry and magnetic data survey and processing details, refer to the technical report of the Serviço Geológico do Brasil – CPRM (2010). The general geophysical internal structure of the Transversal subprovince is well constrained by the magnetic and gravity maps (Figure 5a, c). Gamma-ray spectrometric data have limitations for this approach due to its limited depth reach; however, they reflect heterogeneous geological units, being particularly useful for strongly eroded regions such as this portion of the Borborema Province (Figure 5b).

The Rio Capibaribe Terrane has a low magnetized crust, contrasting with the magnetic signature with deep expression of the Alto Moxotó Terrane (Figure 5a). The most significant magnetic signatures of the former are associated with isolated blocks of Palaeoproterozoic crust. In the gamma-ray spectrometric data, the K, eTh, and eU contents (Figure 5b) are above crustal averages (*e.g.* Dickson and Scott 1997), and are associated with Brasiliano-related granitic stocks and batholiths. Recently described Tonian metagranitoids and metavolcanic rocks and Palaeoproterozoic orthogneisses present K levels close to the average and eTh and eU below the average of the bulk crust. High levels of K, eTh, and eU are observed in the Brasiliano granites and Palaeoproterozoic orthogneisses. Neoproterozoic metasedimentary rocks have average levels of radioisotopes. The gravity data show dominance of negative anomalies (Figure 5c), indicating the existence of an upper crust composed of metasedimentary rocks and a large volume of granites, such as the Caruaru-Arcoverde batholith.

The Alto Moxotó Terrane is characterized by a magnetic relief with high gradients and alignments with dominant NE–SW directions (Figure 5a). This main direction presents modifications in the central region, where a strong rotation of the alignments towards the southeast is observed around a core of Archaean to Palaeoproterozoic migmatites and orthogneisses. In the northern region of the terrane, a semicircular signature is correlated with Rhyacian to Orosirian orthogneisses and paragneisses with intercalations of metamafic rocks.

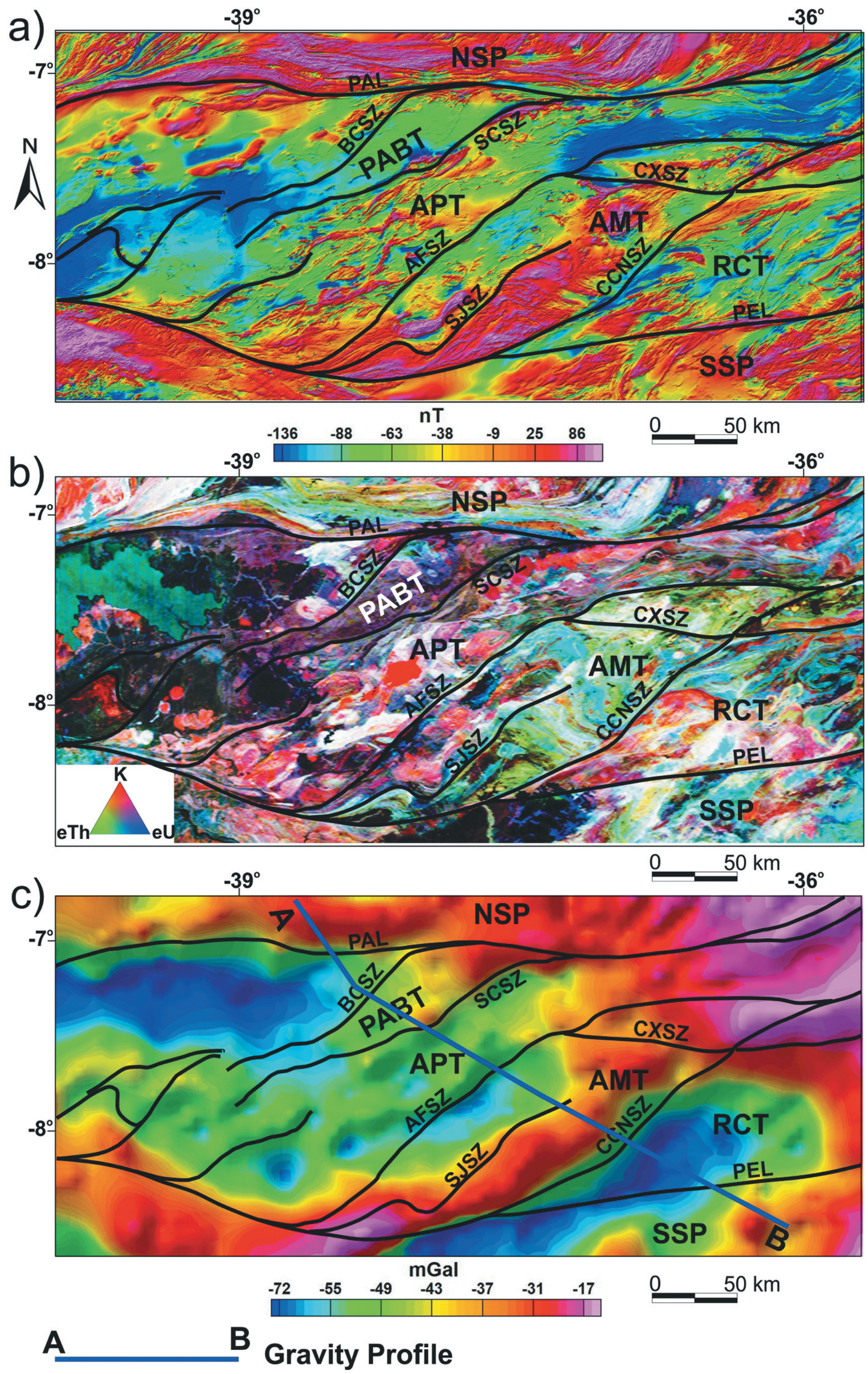

Figure 5. Maps of geophysical anomalies of part of the Transversal subprovince. (A) Magnetic anomaly map; (B) Gamma-ray ternary RGB map; (C) Bouguer gravity anomaly map. Subprovinces: NSP – northern, SSP = southern. Terranes: PABT = Piancó-Alto Brigídia, APT = Alto Pajeú, AMT = Alto Moxotó, RCT = Rio Capibaribe. Proposed terrane boundaries: PAL = Patos, BCSZ = Boqueirão dos Cochos, SCZ = Serra do Caboclo, AFSZ = Afogados da Ingazeira, SJSZ = Serra de Jabitacá, CCNSZ = Congo-Cruzeiro do Nordeste, PEL = Pernambuco.

The regional magnetic pattern of this terrane suggests the existence of a deep crustal block with well-defined magnetic contrasts in relation to the adjacent terranes as described above. In the gamma-ray spectrometric data, the Alto Moxotó Terrane is dominated by units with the highest values of eTh and very low K

(%) (Figure 5b). Such a pattern is typical of ancient crustal blocks that lack granitic intrusions, which characterize the adjoining terranes, whereas the relative enrichment of eTh could indicate a long-time radioactive decay for other radioelements in direct correspondence with reworked Archaean materials (*e.g.* Brito Brito Neves *et al*. 2020). Due to the lack of Brasiliano-related granitic bodies, the Alto Moxotó Terrane is characterized by positive gravity anomalies at the NE–SW direction with wavelength varying between 35 and 50 km and amplitude of up to 30 mGal (Figure 5c). The main correlative of these positive anomalies are the Palaeoproterozoic orthogneisses, most of them migmatized and with intercalations of ultramafic rocks metamorphosed under granulite to eclogite facies conditions (*e.g.* Santos *et al*. 2015b).

The proposed boundary between the Alto Moxotó and Rio Capibaribe terranes, the Congo-Cruzeiro do Nordeste Shear System, is correlated with gravity gradients that imply the juxtaposition of crustal blocks with different densities. Considering the Alto Moxotó and Rio Capibaribe terranes together, the gravity signature is defined by a positive-negative pair with an amplitude close to 40 mGal and a wavelength around 100 km. These parameters suggest the existence of an important crustal discontinuity between these two blocks.

The Alto Pajeú Terrane is characterized by longitudinal NE-SW domains of alternating negative and positive gravity anomalies of small amplitude (less than 10 mGal) and short wavelength (less than 40 km) (Figure 5c). This gravity pattern correlates with the magnetic data, that is, the negative gravity anomalies (less dense rocks) correspond to a low magnetized crust, whereas the positive gravity anomalies (denser rocks) (Figure 5a, c). The rocks with negative gravity signal and low magnetization are the Tonian metagranites and orthogneisses as well as the Brasiliano-related granites, whereas those with positive gravity signal are dominantly Tonian metavolcanosedimentary complexes related to the Cariris Velhos Event. In the gamma-ray spectrometric data (Figure 5b), rocks with K content much above the average (6–8%) are represented by Brasiliano-related granitoids.

The crustal boundary between the Alto Pajeú and Alto Moxotó terranes is the Serra de Jabitacá Shear Zone and its continuity along a NE–SW belt of Brasiliano-related granites located in the middle region of the gravity gradient (Figure 5c). Additionally, associated retrogressed eclogites are described (Beurlen *et al*. 1992; Lages and Dantas 2016). However, the results of the gravity modelling, outlined below, indicate that the deeper rocks of the Alto Moxotó Terrane extend to the northwest, beyond the outcrops of the Serra de Jabitacá Shear Zone, possibly coinciding with the Afogados da Ingazeira Shear Zone (Oliveira and Medeiros 2018).

The Piancó-Alto Brígida Terrane magnetic framework is associated with a NE–SW low magnetization axis that corresponds to a negative gravity array (Figure 5a, c) It is related to exposures of Neoproterozoic-Cryogenian metasedimentary rocks and Neoproterozoic-Ediacaran granites, the typical units of the terrane. Nonetheless, granites of this belt are enriched in K, eTh, and eU, whereas the majority of supracrustal rocks are depleted in the three radioisotopes (Figure 5b), contrasting with the complex signature attributed to the adjoining terranes.

Gravity modelling

A NW–SE orientated gravity profile across the Transversal Subprovince was selected for two-dimensional modelling (location in Figure 5). The profile is 350 km long and was sampled on the Bouguer anomaly grid. The use of the Bouguer anomaly without removing shallow or deep components ensured that in the modelling process all sources were considered. For the modelling operations, the known geological data were considered. The density values of the surface rocks were considered according to data published in reference works (*e.g.* Telford *et al*. 1990).

The densities of the rocks at depth were modified according to the internal software data control, except for the lower crust and mantle, which had their densities fixed. Based on previous estimations pointed by seismological studies, we assumed an average of 33 km for the MOHO depth (Assumpção *et al*. 2013; Lima *et al*. 2015). The 2.5 D direct modelling procedure was performed using the GravSys module integrated in the Oasis Montaj software, adopting the following procedures: (i) adding high- or low-density blocks in relation to a background and according to the type of anomaly, positive or negative, respectively; (ii) calculation of effects; and iii) comparison of the calculated effects with the observed data.

Figure 6 presents the result of the gravity modelling. The model assumes the lithospheric mantle with density of 3200 kg/m^3, the lower crust with density of 2900 kg/m^3 and the upper crust with density of 2750 kg/m^3. It also assumes that the shortest wavelengths of the gravity anomaly are associated with sources in the upper crust. As we can see in the results, the largest variation in density occurs in the upper crust, especially the negative variations associated with granitic intrusions and metasedimentary sequences. It is also observed that all shear zones delimit geological domains with contrasting densities, especially the Patos and Pernambuco lineaments and the Congo-Cruzeiro do Nordeste and Serra de Jabitacá structures. An important aspect in the distribution of density in the upper crust is the existence of crustal blocks with high average density, as in the case of the deepest region of the Alto Moxotó Terrane. In this specific case, the model suggests that the deep rocks of this terrane continue to the northwest, constituting, at least in this region of the profile, part of the basement of the supracrustal rocks of the Alto Pajeú Terrane. Another important aspect is the strong contrast of density associated with the Congo-Cruzeiro do Nordeste Shear System, which defines the boundary between the Alto Moxotó and Rio Capibaribe terranes. The amplitude and wavelength of the gravity anomaly associated with this boundary have parameters that indicate the juxtaposition of two petrophysically contrasting blocks. We should also highlight the contrast of densities in the upper crust that occur at the limits of the Transversal subprovince with the northern and southern subprovinces.

Implications and geodynamic hypothesis

In recent years, a consensus has emerged regarding the role of Archaean and Paleoproterozoic accretionary episodes within ancient, but reworked domains of the Borborema Province (Neves *et al.* 2015; Caxito *et al.* 2015; Santos *et al.* 2017a; Lima *et al.* 2019). However, for the Neoproterozoic, some authors argue in favour of an accretionary/collisional evolutionary history (*e.g.* Brito Neves, Fuck, Pimentel, 2014, 2016; Caxito *et al.* 2014a, 2020a, b; Lima *et al.* 2018; Santos *et al.* 2017b, 2018), whereas others present evidence against crustal accretion (*e.g.* Neves 2015; Neves *et al.* 2020).

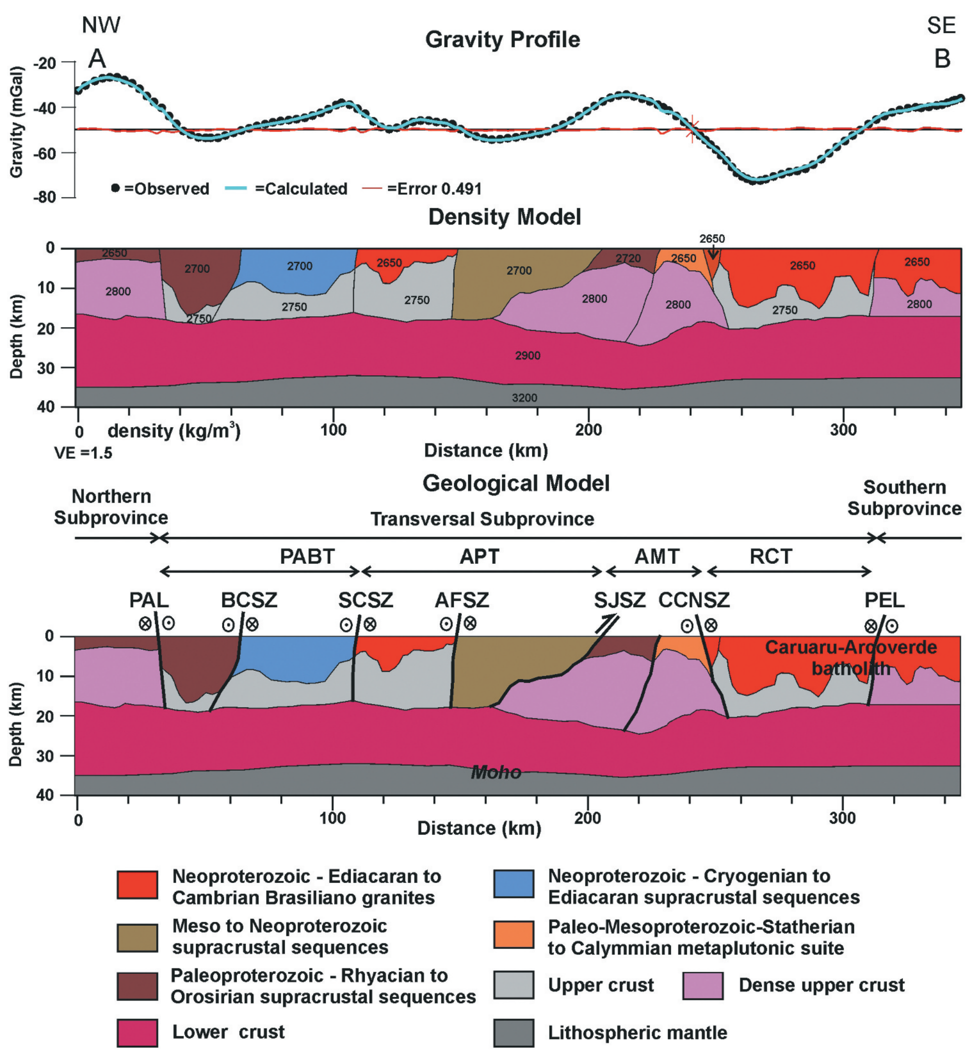

Figure 6. 2.5D modelling of the gravity profile A–B (location in Figure 3) that crosses the Transversal subprovince. The method and parameters employed are discussed in the text. A geological interpretation of the density model is shown at the bottom of the figure.

Intermediate proposal has emerged, taking into consideration the two contrasting orogenic styles (*i.e.* accretionary vs. intracontinental). For instance, Ganade de Araújo *et al.* (2021) have suggested that the São Francisco Craton was pulled away during 1.0 to 0.65 Ga extensional episodes than inverted by transpressive tectonics at the late Neoproterozoic giving birth to the Borborema Province structural framework.

In this contribution, we have presented key elements in support of Neoproterozoic accretionary orogenesis within the Transversal subprovince of the Borborema Orogen. For instance, we suggest that the available isotopic and U-Pb data are consistent with major temporal gaps between major crust-forming episodes of the terranes (*i.e.* Palaeoproterozoic vs. Neoproterozoic). Dispersed remnants of ophiolitic sequences and retrograde eclogites possibly associated with regional-scale shear zones are suggestive of early oceanic consumption during the Cariris Velhos and Brasiliano events. Contrasting detrital zircon U-Pb ages and Sm-Nd T_{DM} model ages also reflect differences in sediment sources and isotopic reservoirs for each of the terranes, despite strong crustal reworking due to the Brasiliano Orogeny. In addition, geophysical contrasts between the terranes including major variations in depth and density values, obtained via the presented geophysical modelling also reinforce the accretionary hypothesis, as suggested by previous geophysical surveys (*e.g.* Lima *et al.* 2015; Padilha *et al.* 2017; Oliveira and Medeiros 2018). The overall presented interpretations are in favour of the existence of ancient lithospheric sutures or terrane boundaries along the regional-scale shear zones, which is in discordance with the single intracontinental/intracratonic model proposed for the Transversal subprovince (*e.g.* Neves *et al.* 2006a, 2009, 2020).

Although petrological markers of such crustal discontinuities are yet poorly described, non-hydrated (dry) structural boundaries might be a possible explanation for the poor preservation of high-grade metamorphic rocks and oceanic lithosphere as well as high exhumation rates (see Santos and Caxito 2021 for discussion). A factual case includes the Neoproterozoic retrogressed eclogitic rocks associated to the Alto Moxotó and Alto Pajeú terrane boundary (Lages and Dantas 2016; Santos *et al.* 2018). They represent the effects of Brasiliano peak metamorphism (*ca.* 0.62 Ga) that have partially overprinted original crystallization textures of previously formed picritic melts/arc cumulates related to oceanic stages of the Cariris Velhos Orogeny (Santos 1995; Santos *et al.* 2010). In addition, Lages *et al.* (2017) described a series of metamafites and ultramafites with MORB-like signature that also occur close to the boundary between the Alto Moxotó and Alto Pajeú terranes, with geochemical and isotopic signatures akin to dismembered upper sections of the oceanic crust (*i.e.* Gurjão ophiolite).

Recent concise models have considered the role of accretionary, collisional, and intracontinental orogenesis for the development of distinct regions of the Borborema Province, following examples of several known Phanerozoic orogenic belts like the Himalayan-Tibetan system (*e.g.* Yin and Harrison 2000). For instance, Caxito *et al.* (2020a) invoked a combined extroversion-introversion model to explain accretionary events in the province borders and rift-drift-collision episodes in the central Borborema Province. In such a model, the region that comprises the Transversal subprovince was part of a single continental block, named as APAMCAPAY (acronym for Alto Pajeú, Alto Moxotó, Rio Capibaribe, and Yaoundé), that collided with the NOBO-BENIN (acronym for Northern Borborema/Benino–Nigerian) block between 0.63 and 0.50 Ga.

This model, although providing an important framework, does not account for the contrasting internal structure (terranes) of the subprovince, including their outlined geophysical characteristics presented herein. In addition, the assumption that the northern Borborema Province and the Benino-Nigerian Shield were part of a single block is contentious, once that recently described high-grade metamorphic might represent ancient suture zones (*i.e.* Ferreira *et al.* 2020)

To account for contrasting crustal terranes of the subprovince and their boundaries, we suggest the closure of a series of ocean basins including the Piancó-Alto Brígida and Transnordestino branches that might have existed and extended along the suture zones that separated the blocks. This concept is best displayed by the Archaean-Palaeoproterozoic Alto Moxotó Terrane, here taken as the best example of an exotic fragment within this accretionary system. Geophysical and isotopic evidence presented over the last years have shown that this terrane remained a rigid block until its docking along the other terrane margins (*e.g.* Santos *et al.* 2017a; Oliveira and Medeiros 2018; Brito Brito Neves *et al.* 2020).

A possible, but still very speculative origin of this allochthonous crust could be the decratonized margin of the São Francisco Craton to the south (Neves 2021), which was dislocated by dispersion along strike-slip shear zones within the province (Ganade de Araújo *et al.* 2021), once that it presents similar geological evolution to some crustal pieces within this craton such as the Gavião Block (Barbosa and Barbosa 2017 and references therein).

On the other hand, the dominant crust of the Alto Pajeú Terrane is mostly early Neoproterozoic (1.0–0.92 Ga), contrasting with other domains within the province or within the São Francisco Craton, despite similar ages has been found in the Southern Borborema Province (*e.g*. Caxito *et al*. 2014b; Cruz *et al*. 2014). The age interval itself allow us to speculate that this terrane might represent a missing piece of the Rodinia supercontinent (Fuck *et al*. 2008). In contrast, Neves (2021) has interpreted these age interval as failed attempts of breaking-up a previous formed continuous lithosphere.

Evidence of Neoproterozoic accretionary episodes is widely described in the Pan-African orogens, mostly recorded between 0.65 and 0.50 Ga, fitting with accretionary periods of the Brasiliano Orogeny in the Borborema Province, including correlative crustal segments of the Transversal subprovince. For instance, a number of arc-related volcanic and plutonic rocks with a wide compositional record have been described in the West Cameroon Domain (Itiga *et al*. 2019), which are similar to those described by Brito Neves *et al*. (2016), representing a broad spectrum of continental arc-related roots.

Dismembered but preserved oceanic crust slivers were recently described within the Yaoundé belt (*e.g*. Gentry *et al*. 2021), also attesting for accretionary models in the African counterpart of the Borborema Province. Based on these correlations, we propose modifications on the previous extroversion–introversion model of Caxito *et al*. (2020a), pointing out the importance of the development and consumption of oceanic branches separating inner pieces of the proposed APAMCAPAY block as tectonostratigraphic terranes that collided and were lately submitted to extrusion tectonics for strain accommodation between 0.7 and 0.56 Ga (Figure 7).

Accretionary orogenesis is the major mechanism of subduction at well-known peripheral margins of Gondwana, including the Cadomian (0.59–0.53 Ga), Terra Australis (0.30–0.23 Ga), and North Indo-Australis orogens (Cawood *et al*. 2021). In the inner portions of West Gondwana, early accretionary markers are hidden or obliterated by late collisional orogenesis related to the Kuunga-Pinjarra and Brasiliano-Damara systems developed between *ca*. 0.65 and 0.5 Ga (Collins and Pisarevsky 2005; Cawood and Buchan 2007). We suggest that the overall presented model illustrates that accretion and collision tectonics played a major and simultaneous/contemporaneous role in the assembly of the inner blocks of West Gondwana, whereas strike-slip shear zones might have acted as pathways for terrane dispersion in the later stages of the orogenic build-up.

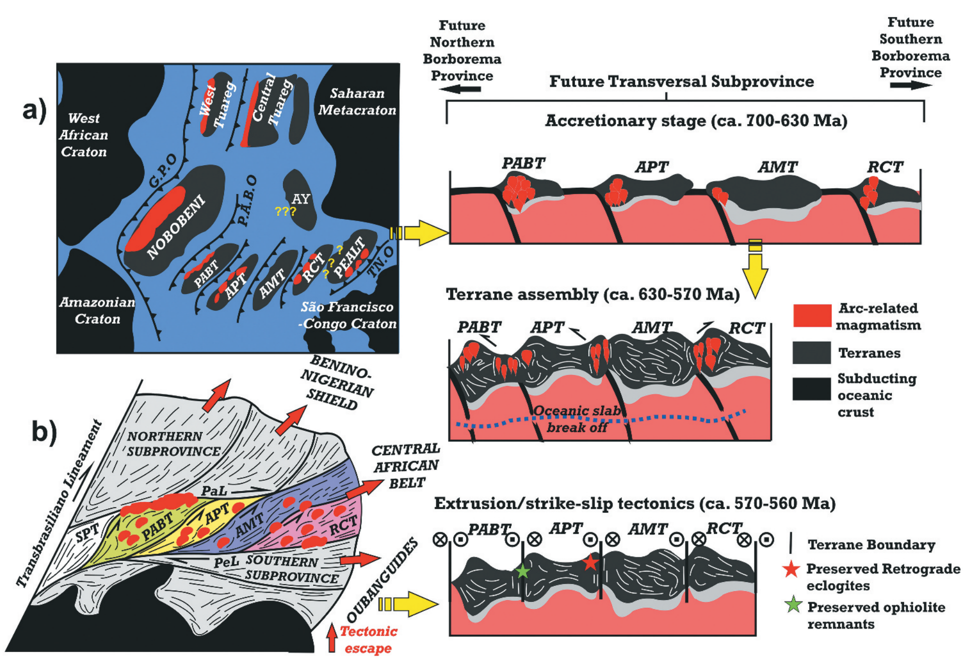

Figure 7. Envisaged geodynamic model for the assembly of Transversal Subprovince terranes. a) early stages of subduction followed by terrane assembly (continental collision); b) final arrangement of the terranes of the Transversal Subprovince as the result of extrusion tectonics. Crustal fragments/terranes: NOBOBENI = Northern Borborema Province-Benino Nigerian, PABT = Piancó-Alto Brigida, APT = Alto Pajeú AMT = Alto Moxotó, RCT = Rio Capibaribe, PEALT = Pernambuco-Alagoas, AY = Adamawa-Yadé. Oceanic basins: G.P.O. = Goiás-Pharusian, P.A.B.O. = Piancó-Alto Brígida, TNO. = Transnordestino. Major terrane boundaries: PaL = Patos, PeL = Pernambuco.

Concluding remarks

Distinct models have been proposed for the evolution of the orogenic belts of West Gondwana. The central Borborema Province preserves key evidence for division into and assembly of distinct lithotectonic crustal segments (terranes). Major shear zones separate blocks with contrasting age profiles, provenance records, and magma sources. The similarities between some of the crustal pieces with known large landmasses suggest that it preserves suspect blocks that might have been derived from the Nuna/Columbia and Rodinia supercontinents.

Terrane assembly might have occurred since the early Palaeoproterozoic, but in the central Borborema Province, preserved early to late Neoproterozoic arc-related granites and volcanoclastic rocks as well as remnants of retrograde eclogites and dismembered ophiolites are the main accretionary markers, and we suggest that branches of oceanic crust extended into the inner regions between the terranes. In addition to contrasting magnetometric and radiometric signatures between them as well as the distinct depths and density values obtained by the gravity modelling are in accordance the original proposed boundaries. Our compilation study is in favour that accretion tectonics played a major role on the crystal arrangement of the central Borborema Province.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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