Journal of the Geological Survey of Brazil

The Zona Transversal Domain of the Borborema Province, northeastern Brazil: Synthesis of the Archean to Cambrian evolution, and new tectono-stratigraphic interpretation

Frank Gurgel Santos[1*], Camila Franco Basto[2], Felipe José da Cruz Lima[1], Roberta Galba Brasilino[1], Vladimir Cruz de Medeiros[3], Débora Melo Ferrer de Morais[1], Tercyo Rinaldo Gonçalves Pinéo[4], Jocilene dos Santos Santana[5].

[1]CPRM - Serviço Geológico do Brasil (GEREMI/SUREG-RE), Avenida Sul, 2291, Afogados, Recife, Pernambuco, Brazil, CEP: 50.770-011
[2]CPRM - Serviço Geológico do Brasil (GEREMI/SUREG-BE), Avenida Brasil, 1731, Funcionários, Belo Horizonte, Minas Gerais, MG, Brazil, CEP: 30.140-002
[3]CPRM - Serviço Geológico do Brasil (NANA/SUREG-RE), Rua Professor Antônio Henrique de Melo, 2010, Capim Macio, Natal, Rio Grande do Norte, Brazil, CEP: 59078-580
[4]CPRM - Serviço Geológico do Brasil (GEREMI/REFO), Avenida Antônio Sales, 1418, Joaquim Távora, Fortaleza, Ceará, Brazil, CEP: 60.135-101
[5]CPRM - Serviço Geológico do Brasil (GEREMI/SUREG-SA), Avenida Ulysses Guimarães, 2862, Sussuarana - Centro Administrativo da Bahia, Salvador, Bahia, Brazil, CEP: 41.213-000

Abstract

The Transversal Zone Domain (TZD) is the central segment of the Borborema Province, with its limits given by the Patos and Pernambuco shear zones, to the north and south respectively. This part of the province presents Archean nuclei surrounded by Paleoproterozoic units that together correspond to the basement of belts of Neoproterozoic metasupracrustal rocks. All this set was intruded by syn to post-tectonic granitoids related to the Brasiliano Orogeny (c. 640 – 500 Ma). The TZD records important shear zones of regional scale, dextral (Patos and Pernambuco), and sinistral (Serra do Caboclo, Afogados da Ingazeira and Congo), being the dextral used to delimit the TZD of adjacent domains and the sinistral ones for internal compartmentalization in four subdomains: Piancó-Alto Brígida, Alto Pajeú, Alto Moxotó and Rio Capibaribe. The lithostratigraphic units of this domain were described and organized in a way that would be regionally presentable. An unprecedented dating is presented for a metagranitoid of the Serra de Jabitaca Complex, with maximum crystallization age at 1790 ± 40 Ma and metamorphism at 615 ± 3 Ma. The tectonic evolution of the domain begins with an orogenic event and development of magmatic arches at the beginning of the Paleoproterozoic (involving Archean portions), in addition to an extensional event at the end of this period, already in the transition with the Mesoproterozoic. The Neoproterozoic begins with two extensional events (Cariris Velhos and pre-Brasiliano) until the formation of the magmatic arches related to Brasiliano Orogeny.

Article Information

Publication type: Review article
Received 15 August 2022
Accepted 25 November 2022
Online pub. 6 January 2023
Editor: Evandro Klein

Keywords:
Central Domain
Serra de Jabitacá Complex
Paleoproterozoic
Neoproterozoic

*Corresponding author
Frank Gurgel Santos
frank.santos@sgb.gov.br

1. Introduction

The Borborema Province (BP), located in the extreme northeast of Brazil, consists of a gneissic-migmatitic basement with ages from Archean to Paleoproterozoic superimposed and intruded by supracrustal sequences and Meso- to Neoproterozoic granitoids, respectively. The BP was formed around 600 Ma, when the collision among the Cratons São Luis-West African, Amazonian and São Francisco-Congo-Kasai resulted in the consolidation of the supercontinent Gondwana West, in the event known as Brasiliano-Pan African Orogeny (Almeida et al. 1981; Van Schmus et al. 2011; Neves et al. 1996; Jardim De Sá 1994; Vauchez et al. 1995).

With recognized importance within BP, the regional shear zones were used by several authors to separate distinct geological compartments within the province (Jardim de Sá 1994; Caby et al. 1991; Brito Neves 1983; Santos et al. 1984; Vauchez et al. 1995). The BP was divided by Delgado et al. (2003) in: (1) Northern, located north of the Patos shear zone; (2) Transversal Zone or Central Sector, limited to the north by the Patos shear zone and to the south by the Pernambuco shear zone; (3) External or Southern, located south of Pernambuco shear zone, until contact with São Francisco Craton. In this work, we use North Sector and South Sector to replace the terms Northern and External or Southern, respectively. In relation

ISSN: 2595-1939
https://doi.org/10.29396/jgsb.2023.v6.n1.4
Open access at jgsb.cprm.gov.br

to the Central Sector, classical works in BP (Ebert 1962; Brito Neves 1983; Jardim de Sá 1994; Gomes et al. 1981; Santos and Brito Neves 1984; Santos et al. 1984) already dealt with the area between the two large shear zones that splits the province in the east-west direction (Patos and Pernambuco) as "Transversal Zone", therefore, as it is a very widespread nomenclature in the geological literature of the province and has well established historical roots, we chose to remain with the use of Transversal Zone.

The TZD comprises part of the states of Paraíba, Pernambuco, Ceará and Piauí, in northeastern Brazil; it is limited to the west by the Parnaíba Basin and to the east is covered by the sediments of the Coastal Province (Figure 1).

The TZD limits, in relation to adjacent domains, are highlighted by contrast in the intensity of the magnetometric anomaly (reduction to pole). This anomaly is strongly positive within the domain and presents a signal from medium to low intensity in adjacent domains (Figure 2B). In the airborne gamma-ray spectrometry image of ternary composition, in addition to the external limits of TZD, it is also possible to highlight the internal partitioning of the domain (Figure 2A). From the observation of geological-geophysical data, we have also proposed an update of the internal subdivision of the Transversal Zone Domain.

Within the TZD units of the Archean to Cambrian are known, as well as important regional-scale, dextral shear zones (Patos and Pernambuco) that separate the TZD from neighboring domains, and sinistral shear zones (Congo, Afogados da Ingazeira and Serra do Caboclo) that form the TZD's internal compartmentalization. These shear zones were formed or reactivated during the Brasiliano event, affecting the main units of the domain.

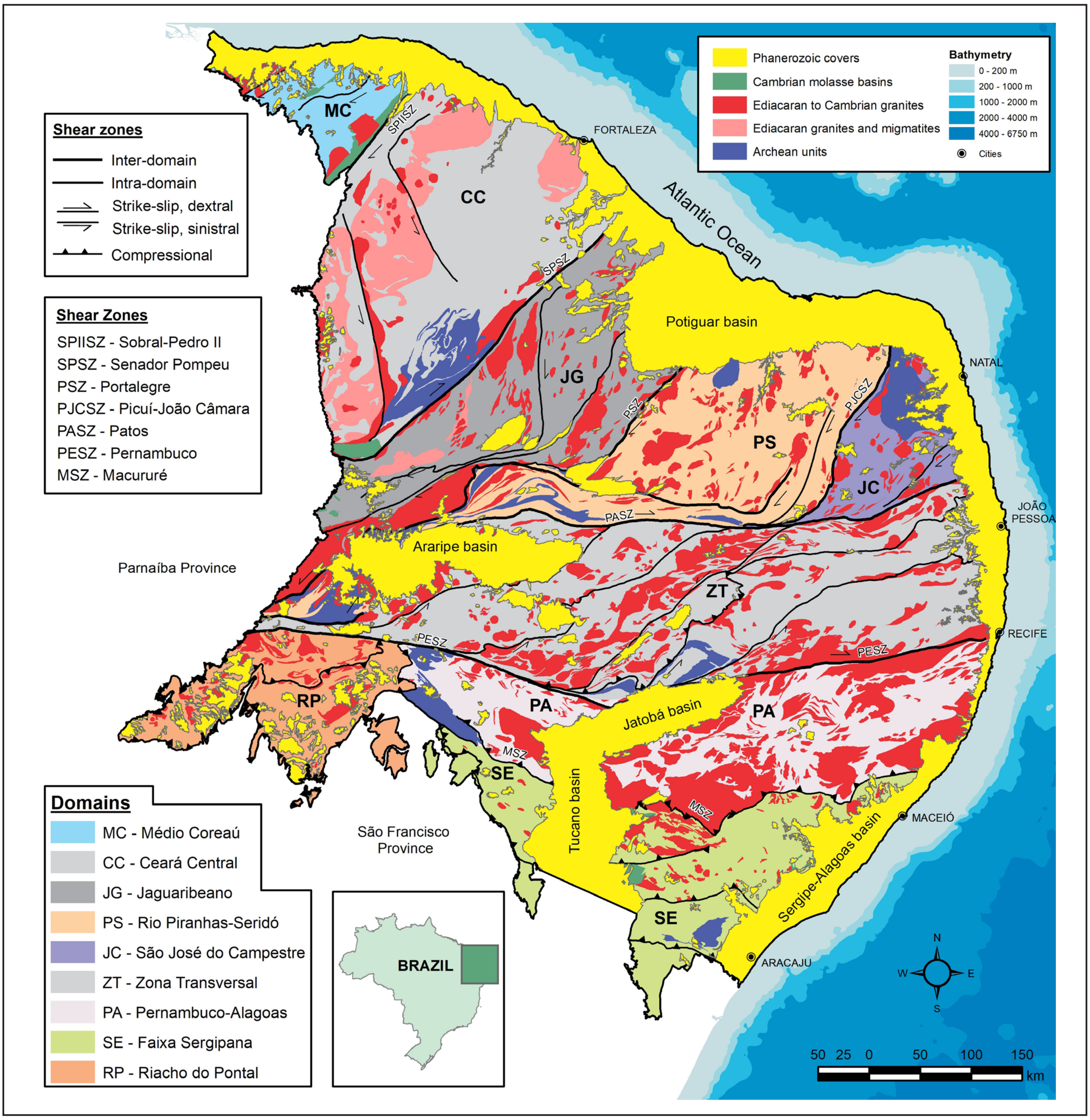

FIGURE 1. Location of the Transversal Zone Domain in the context of the Borborema Province. Modified from Medeiros et al. (2017).

This work aims to review the lithostratigraphic units, the geophysical and geochronological data available in the literature and discuss the TZD's evolutionary scenario. New geochronological data (U-Pb in zircon) are also presented for Serra de Jabitacá Complex, in the Alto Moxotó subdomain, and the conception of the Orobó Complex, in the Rio Capibaribe subdomain.

2. Material and Methods

2.1 Bibliographic, lithostratigraphic, geochronological and geotectonic review

The applied methodology involved bibliographical survey, interpretation of remote sensing products (satellite images,

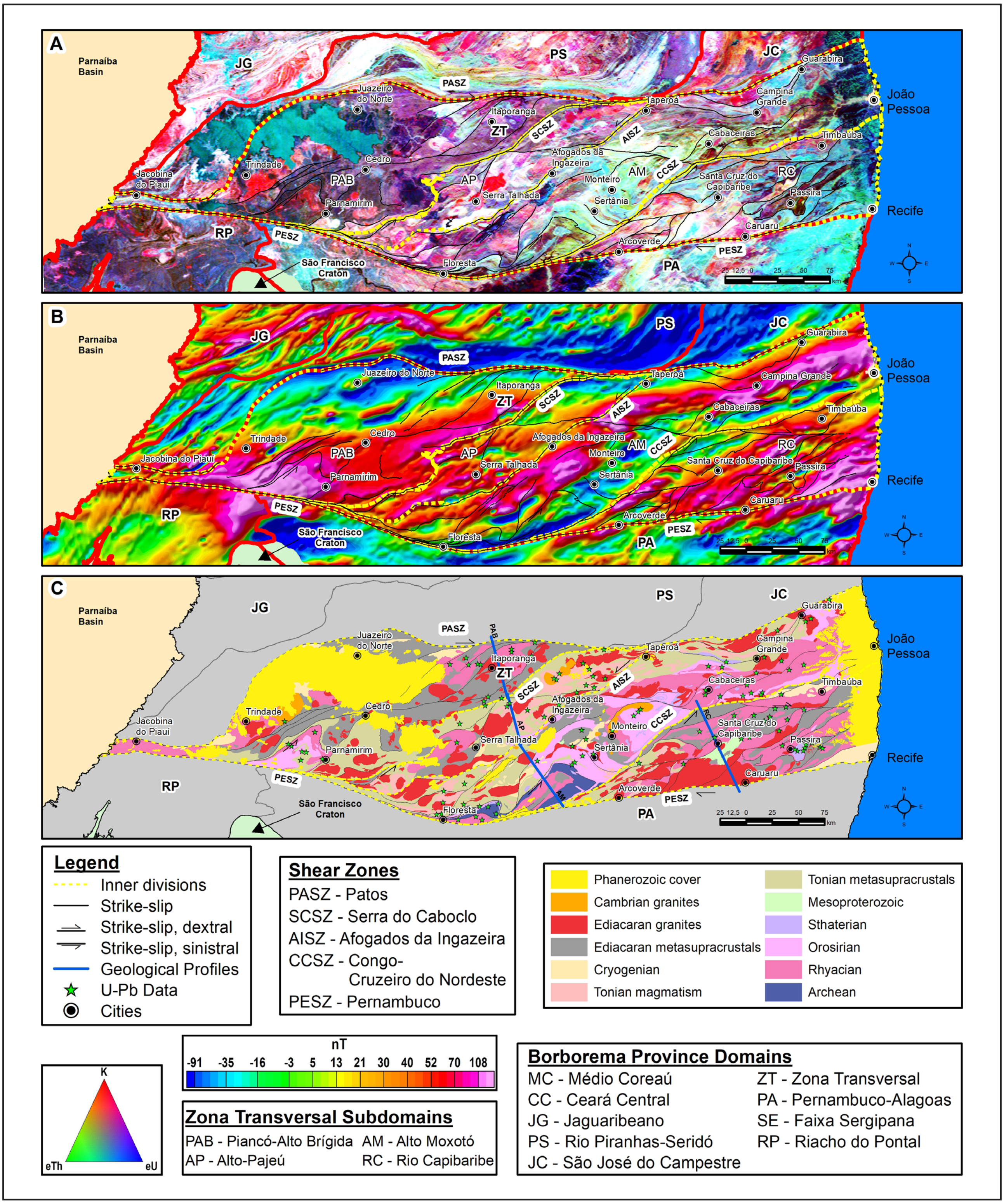

FIGURE 2. Airborne gamma-ray spectrometry images of ternary composition (A) and reduction to pole magnetometric anomaly (B) emphasizing the limits of the Transversal Zone Domain and the internal compartmentation through the main shear zones. (C) Main lithostratigraphic units and shear zones of the Transversal Zone Domain.

SRTM data and aerogeophysical maps), geological mapping and regional integration. The lithostratigraphic units were reviewed based on the geological maps published by the SGB-CPRM, as well as journals articles and thesis/dissertations. Thus, geological texts and maps were consulted of sheets on the 1:100,000 scale, state geological maps, geophysical-geological maps and regional geological maps, mainly the Geological Map of the Borborema Province (Santos et al. 2021).

For the geochronological review, in addition to data published by the SGB-CPRM in maps and explanatory notes, articles published in journals and compiled data from doctoral thesis, master dissertations and event summaries were consulted. A selection of data was performed, with preference to those acquired by the U-Pb method in zircon using the SHRIMP and LA-ICP-MS techniques. However, when this information is not available, we also used data obtained by the ID-TIMS technique, as well as by the Pb-Pb Zircon method. The geochronological data compiled in this work for TZD's orthoderived rocks and detrital zircons are available in Appendix 1 (electronic supplementary data).

2.2 U-Pb Geochronology

A sample of the orthogneiss of Serra de Jabitaca complex (FJ-085B) was prepared in the laboratory of the Recife Superintendence (SGB-CPRM) and submitted to U–Pb geochronology analysis at the University of São Paulo (USP). The sample was crushed and sprayed at approximately 500µm. The heavy minerals were concentrated by panning and the magnetic portion was separated by the Frantz isodynamic separator. The sample zircon grains were manually separated in binocular microscope, embedded in epoxy resin (cold), worn out for inside exposure of the grains and polished in 0.25 µm diamond paste. The mounts were characterized by Backscatter electron (BSE) images from a Scanning Electronic Microscope of Laboratory of Geochronological, Geodynamic and Environmental Studies of the University of Brasília (UnB, Brasília, Brazil).

The analyses were performed in the CPGeo laboratory of USP, where isotopic determinations were performed at LAM-MC-ICP-MS Neptune (Thermo-Finnigan) coupled to the ARF Excimer Laser (λ= 193nm) (Photon Machines). For the cleaning of the mounts, a solution of diluted nitric acid (3%) and then ultra clean water was used.

The ablation occurred in spots of 32 µm, with frequency of 6 Hz and intensity of 6mJ. The pulverized material was carried by a flow of He (0.6 l/min) and Ar (0.7 l/min) and in all analyzes, the international standard GJ-1 was used to correct the drift of the equipment, as well as the fractionation between the U and Pb isotopes. To verify the accuracy, analyzes were performed in the international standard MUD TANK.

The data were obtained in 60 cycles of 1 second, following the acquisition sequence of 2 blanks, 3 patterns, 12 spots in zircon, 2 blanks and 2 patterns and in each reading the intensities of the masses ^{202}Hg, ^{204}(Pb Hg) were determined, ^{206}Pb, ^{207}Pb, ^{208}Pb and ^{238}U.

The reduction of the raw data included the corrections to blank, derived from the equipment and common lead using the spreadsheet developed by CPGeo/USP. The ages were calculated with the chards built with the ISOPLOT 3.0 (Ludwig 2003) features and the raw data were reduced using an Excel spreadsheet.

3. Limits of the Transversal Zone Domain and the geological setting

Historically, the internal subdivision of TZD is treated with the definition of Tectonostratigraphic Terrains in several works (Santos et al. 1984, 1999; Santos and Medeiros 1999), but there is still a lot of discussion regarding the tectonic evolution of BP (Santos 1999; Brito Neves et al. 2000; Kozuch 2003; Santos et al. 2010; Van Schmus et al. 2008; Araujo 2014; Caxito et al. 2020; Araujo et al. 2021), where the term Terrain would not be compatible with all existing lines of thought for the province evolution (e.g. Neves et al. 2006, 2015; Neves 2015). The nomenclature of the internal units used in this work are the same adopted for almost 30 years by several authors, but we consider using the term subdomain in order to disconnect any reference to the BP evolution in the internal subdivision of TZD.

The north (Patos shear zone), south (Pernambuco shear zone) and east (Phanerozoic covers) limits of TZD are already well consolidated in the geological literature, but the west limit still raises discussion. It was verified by geological cartography and airborne magnetometry image that this limit occurs with a part of the Rio Piranhas-Seridó Domain that advances south under the Araripe Basin. The presence of Paleoarchean and Neoarchean rocks of the Granjeiro Complex (Silva et al. 1997; Pitarello et al. 2019; Vale 2018) in the western end of the area allowed the adjustment in the limit of TZD, as proposed here. The geophysical signature analysis (magnetometric and gamma-spectrometric) shows that the Patos shear zone does not follow the east-west direction for its entire length. In fact, this structure borders the Araripe Basin to the vicinities of the municipality of Araripe/CE, when it then changes direction southwest for almost one hundred kilometers, crossing the entire length of the basin, underlying its sediments, until it returns to the east-west direction and is covered by the Parnaíba Basin approximately twenty kilometers from the municipality of Jacobina do Piauí-PI.

Internally, the TZD is divided from west to east in the subdomains: Piancó-Alto Brígida (PABS), Alto Pajeú (APS), Alto Moxotó (AMS) and Rio Capibaribe (RCS) (Figure 3). The limit between PABS and APS is given by Serra do Caboclo shear zone, which constitutes the contact between the metasediments of the Cachoeirinha Group, to the west, with the lithotypes of the Riacho Gravatá Complex, to the east. The southeastern boundary of APS with AMS is marked by the Afogados da Ingazeira shear zone, which delimits the contact between the Riacho Gravatá complexes to the west, and São Caetano, to the east. The southeastern boundary of the AMS with the RCS is represented by the Congo-Cruzeiro do Nordeste shear zone system.

Some of these limits are difficult to be recognized throughout their entire length. To try to minimize this effect, the APS/AMS limit was readjusted, following a stronger signal in depth (1000 and 3000 meters), corresponding to the Afogados do Ingazeira shear zone (Figure 3).

Magnetometric anomalies also suggest that the southwestern boundary of AMS (Afogados da Ingazeira shear zone) suffers an inflection to the west, bordering the Pajeú granite, south of Serra Talhada/PE, until parallelizing with the Pernambuco SZ (Figure 3). In this context, the São Caetano and Lagoa das Contendas complexes are inserted in the Subdomain Alto Moxotó, and the Riacho Gravatá and Riacho da Barreira complexes, in the Alto Pajeú subdomain.

The TZD is composed of Archean gneissic-migmatitic associations, a dominant basement of Rhyacian age, Rhyacian-Orosirian metasedimentary units, orthogneisses with ages from Orosirian to Calymmian, a Mesoproterozoic gneiss, Neoproterozoic metasupracrustal sequences and an intense Neoproterozoic-Cambrian magmatism. The Brasiliano Orogeny, occurred between c. 640 and 500 Ma, generated a series of plutons and deformed and metamorphosed the oldest units.

The Paleoproterozoic units (Sertânia, Floresta, Salgadinho complexes, among others), the Neoproterozoic supracrustal rocks (Cachoeirinha Group, São Caetano, Surubim-Caroalina, Riacho Gravatá and Salgueiro complexes), and the Ediacaran-Cambrian plutonic rocks are the most expressive in terms of the outcrop area in the TZD (Figure 2C).

Throughout the Borborema Province there is some difficulty to individualizing some lithostratigraphic units. In the Rio Capibaribe subdomain, this issue is portrayed between the Vertentes and Surubim-Caroalina Complexes. The Vertentes Complex was originally defined by Santos and Medeiros (1999), Ferreira and Santos (2000) and Gomes (2001) as a metavolcano-sedimentary sequence. The Surubim complex was originally defined by Mello and Siqueira (1971) to encompass schists, paragneisses, quartzites and marbles, and when Santos et al. (1984) described rocks with similar characteristics being designated as Caroalina type, Ferreira and Santos (2000) coined the term Surubim-Caroalina to group these units. Still within this extensive package of rocks, Sá et al. (2002), Neves et al. (2006) and Brasilino and Miranda (2017) identified interspersed orthoderived lithotypes that did not seem to belong to any of these units and redefined the Vertentes Complex as a Paleoproterozoic unit composed of orthogneisses. In order to organize the lithostratigraphic nomenclature in the RCS, we propose the adoption of a new stratigraphic arrangement where the Orthogneiss Vertentes unit comprises the metaplutonic lithotypes, the Surubim-Caroalina Complex the paraderived rocks and the Orobó complex is created to encompass the metavolcano-sedimentary sequence (see section 3.4).

3.1 Piancó-Alto Brígida Subdomain (PABS)

3.1.1 Paleoproterozoic units

The Paleoproterozoic in PABS is represented by the Piancó, Itaizinho, Bom Jesus, Parnamirim Complexes and by the Icaiçara Intrusive Suite. The Piancó complex consists of migmatized banded orthogneisses and gneisses, presenting granitic, granodioritic or tonalitic composition, with U-Pb ages in zircon between 2059 and 2250 Ma (Kozuch 2003; Brito Neves and Passarelli 2020) (Appendix 1).

The Itaizinho Complex (Bizzi et al. 2003) consists of tonalitic-granodioritic orthogneisses partially migmatized and milonitized (Figure 4A), with supracrustal remnants (layers of quartzite, marble, calc-silicate rock and amphibolites).

The Bom Jesus complex is a set of paraderived rocks metamorphosed in the amphibolite facies, with a predominance of metapelites, presence of marbles and amphibolites (Medeiros 2004). Dating of the paleosome fraction (metaquartzo-dioritic) of migmatized metasediment provided U-Pb age in zircon of 2157 ± 15 Ma (Brito Neves and Passarelli 2020).

The Parnamirim Complex is composed of para- and orthoderived rocks, including granitic to granodioritic, meta-arkose, biotite-muscovite gneisses with garnet (Figure 4B) and arkose schists. U-Pb zircon ages of the orthogneisses range from 2108 to 2161 Ma (Cruz 2015; Brito Neves and Passarelli 2020).

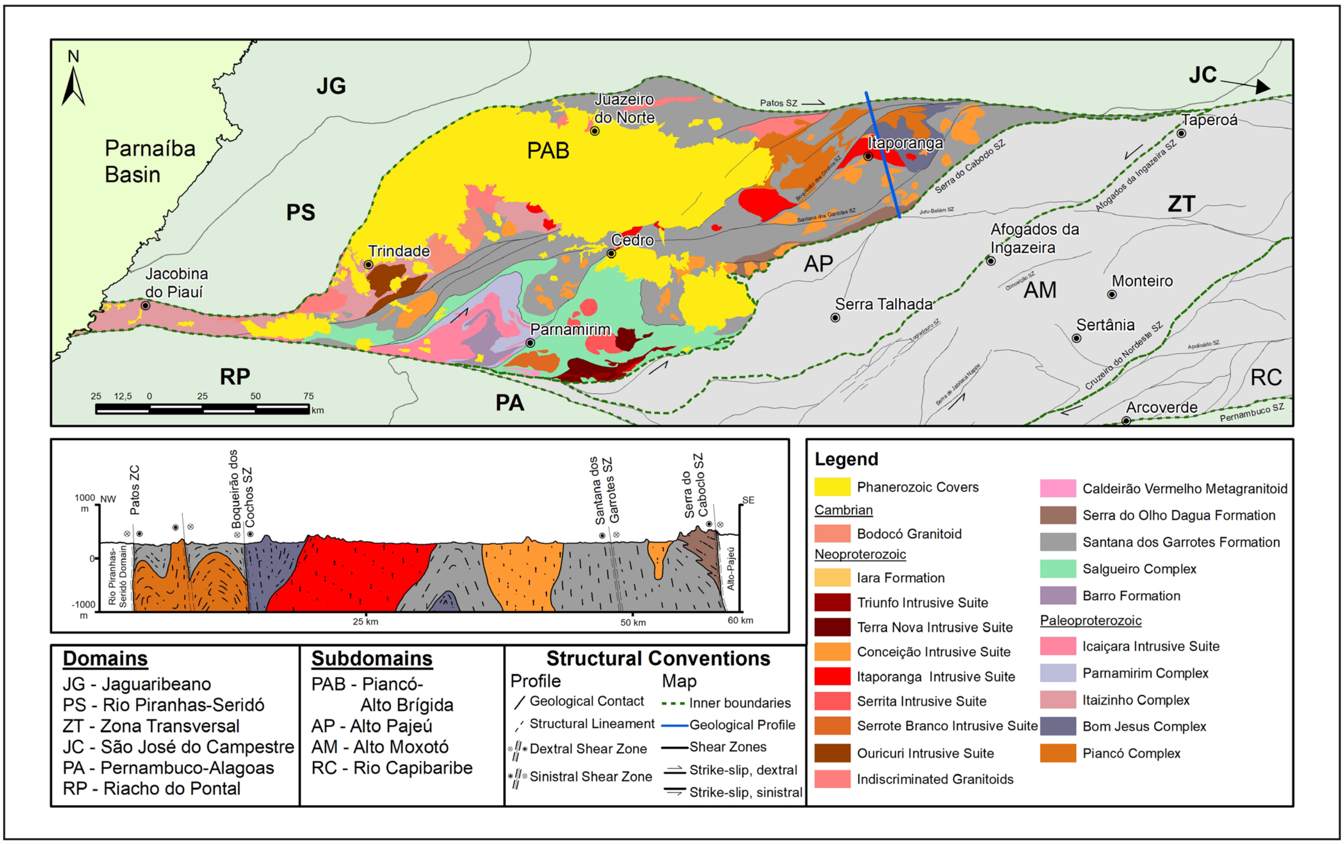

FIGURE 3. Lithostratigraphic units and geological profile for the Piancó-Alto Brígida Subdomain. Vertical exaggeration: 5x.

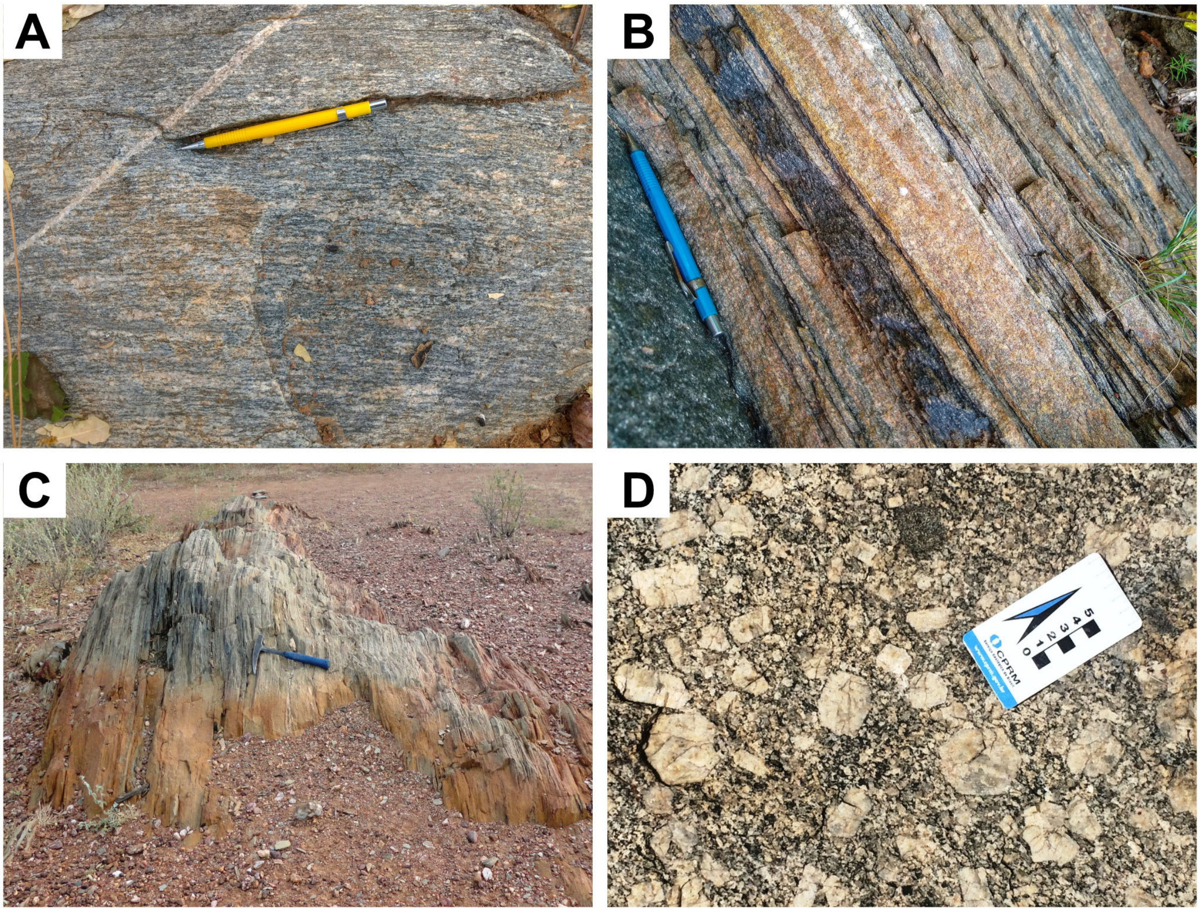

FIGURE 4. Field photos of the PABS units. (A) Granodioritic orthogneiss of the Itaizinho Complex; (B) Biotite-muscovite gneiss with garnet of the Parnamirim Complex; (C) Sericite-quartz phyllite with intercalations of metasediments of the Santana dos Garrotes Formation; (D) Porphyritic granite of the Itaporanga Intrusive Suite in the locality type.

The Icaiçara Intrusive Suite comprises augen-gneisses from granitic to granodioritic composition (Brito and Fernandes 2021) with U-Pb zircon age ranging from 2116 to 2193 Ma (Brito Neves and Passarelli 2020).

3.1.2 Neoproterozoic units

The Neoproterozoic in PABS is represented by the Barro, Salgueiro complexes and the Brasiliano granitogenesis. The Barro Complex is characterized as a metasedimentary unit composed of garnet-biotite schists with intercalations of paragneisses, marbles, calc-silicate rocks, iron formations, quartzite and amphibolites (Cruz 2015) with detrital zircon grains U-Pb ages between 950 and 995 Ma (Brito Neves and Passarelli 2020) (Appendix 1).

The Salgueiro Complex was defined as a clastic metasedimentary sequence consisting mainly of metarythmites and mica schists, with subordinated metapsammite and intercalations of quartzite, foliated iron formation, amphibolites and calc-silicate rocks (Silva Filho 1984; Brito and Marinho 2017). These lithotypes suggest matrix-rich protoliths (greywackes and pelite) and a felsic metavolcanic interspersed with metasediments provided age of 962 ± 12 Ma. (Brito and Fernandes 2021; Brito and Marinho 2017) (Appendix 1).

Cachoeirinha Group consists of two formations: Santana dos Garrotes and Serra do Olho Dágua (Medeiros and Jardim de Sá 2009). The Santana dos Garrotes Formation (Figure 4C) represents the basal portion of this group and is composed of metaturbidites (phyllites and sericite-micashists), metapelites (biotite-muscovite schists) and felsic metavolcanic (metarioliths and metadacites). Dating of metavolcanic rocks associated with metasediments provided U-Pb zircon ages between 603 and 685 Ma (Caxito et al. 2021; Medeiros 2004) (Appendix 1). The Serra do Olho d'Agua Formation represents the top of the Cachoeirinha Group and consists of metapelites, metarenites and metaconglomerates (Medeiros 2004).

3.2 Alto Pajeú Subdomain (APS)

3.2.1 Paleoproterozoic units

In APS the Paleoproterozoic units are represented by the Serra Talhada and Afogados da Ingazeira complexes (Figure 5). The Serra Talhada Complex (Figure 6A) consists of foliated orthogneisses of dioritic, tonalitic, granodioritic and monzogranitic composition, locally migmatized and/or mylonitized, as well as metamafic rocks and marble lenses (Bittar 1998; Medeiros 2004; Brasilino and Morais 2020). Granodioritic orthogneisses of this unit provided a U-Pb zircon age of 2136 ± 14 Ma (Kozuch 2003). In lithotypes correlated to this complex located adjacent to the city of Afogados da Ingazeira (State of Pernambuco), ages of 2.08 Ga (U-Pb in zircon, Van Schmus et al. 2011) and 1.97 Ga (single-zircon Pb-Pb, Silva et al. 1996) (Appendix 1).

3.2.2 Neoproterozoic units

The Neoproterozoic units are represented by the Riacho Gravatá and Riacho da Barreira complexes and the Cariris Velhos Intrusive Suite. The Riacho Gravatá Complex (Figure 6B) consists of metavolcanic and metavolcanoclastic rocks (metandesite, metadacite, metarhyolite and metatuff) and metasedimentary rocks (muscovite-biotite schists or paragneisses, metagreywackes, marble lenses), including also metamafic-metaultramafic rocks (talc-schists, amphibolites, pyroxenite, serpentinites. Mafic metavolcanic rocks have U-Pb zircon ages ranging from 964 to 996 Ma (Van Schmus et al. 2011; Santos et al. 2010; Guimarães et al. 2012) (Appendix 1).

The Cariris Velhos Intrusive Suite is represented mainly by granitic augen-gneisses, and here we include the Recanto and Riacho do Forno suites from Santos (1999) (Figure 6C). U-Pb dating of zircon from orthogneisses have ages between 995 and 926 Ma (Santos et al. 2010; Van Schmus et al. 2011; Guimarães et al. 2012) (Appendix 1).

The Riacho da Barreira Complex (Figure 6D) consists of a metamafic sequence not dated yet (mica schists with amphibolites, chlorite-talc schists, chloritites, pyroxenites and iron formation) and a sequence of metarhythmites, encompassing quartzitic gneisses, aluminous schists, quartzites lenses, marbles and calc-silicate rocks (Santos 1999; Brito and Marinho 2017).

3.3 Alto Moxotó Subdomain (AMS)

3.3.1 Archean units

The Archean units of the AMS consist of migmatites, metagranitoids and orthogneisses of quartz-dioritic, tonalitic, granodioritic and monzogranitic composition (Figure 7). Ages between 2625 ± 14 and 2643 ± 18 Ma were reported to the Riacho das Lajes Metamorphic Suite (Figure 8A); 2600 ± 13 Ma for the mafic orthogneisses of the Mulungu-Feliciano Complex and 2.911 ± 69 Ma for the migmatitic complexes in the farm Oiti, Itatuba-PB (Santos 1999; Santos et al. 2015, 2017; Brito Neves et al. 2020) (Appendix 1).

3.3.2 Paleoproterozoic units

The Paleoproterozoic units are represented by the Floresta, Serra de Jabitacá, Sertânia and Sumé complexes, by the Camalaú, Carnoió and Riacho do Navio intrusive suites, and by the Fazenda Salvador, São Joãozinho and Coloete orthogneisses units (Figure 7).

The Floresta Complex (Figure 8B) is composed of quartz-diorite, tonalite and granodiorite with biotite and/or amphibole, presenting levels of amphibolite rocks, and more rarely schists (Lima et al. 1985; Santos 1999). Geochronological analyzes provided U-Pb ages between 2103 Ma and 2016 Ma for granodioritic orthogneisses (Santos et al. 2017; Santos et al. 2004) (Appendix 1).

Granitic orthogneisses are also reported in AMS, aged between 2137 ± 21 Ma (Rodrigues et al. 2015) and 2012 ± 17 Ma (Santos et al. 2004) for Fazenda Salvador orthogneiss and 2109 ± 15 Ma for São Joãozinho orthogneiss (Lages 2017) (Appendix 1).

The Serra de Jabitacá complex consists of folded or foliated biotite metagranitoids, usually migmatitic, of diffuse mesosome, presenting enclaves of garnet-bearing gneisses, amphibolites and letptynite. The composition varies between monzonitic and syenogranitic, and a U-Pb age of 1790 ± 40 Ma was obtained in this work (Section 4).

The Sertânia Complex consists of paragneisses and schists with intercalations of marbles, amphibolites, calc-silicate rocks, iron formations and a small volcanic contribution.

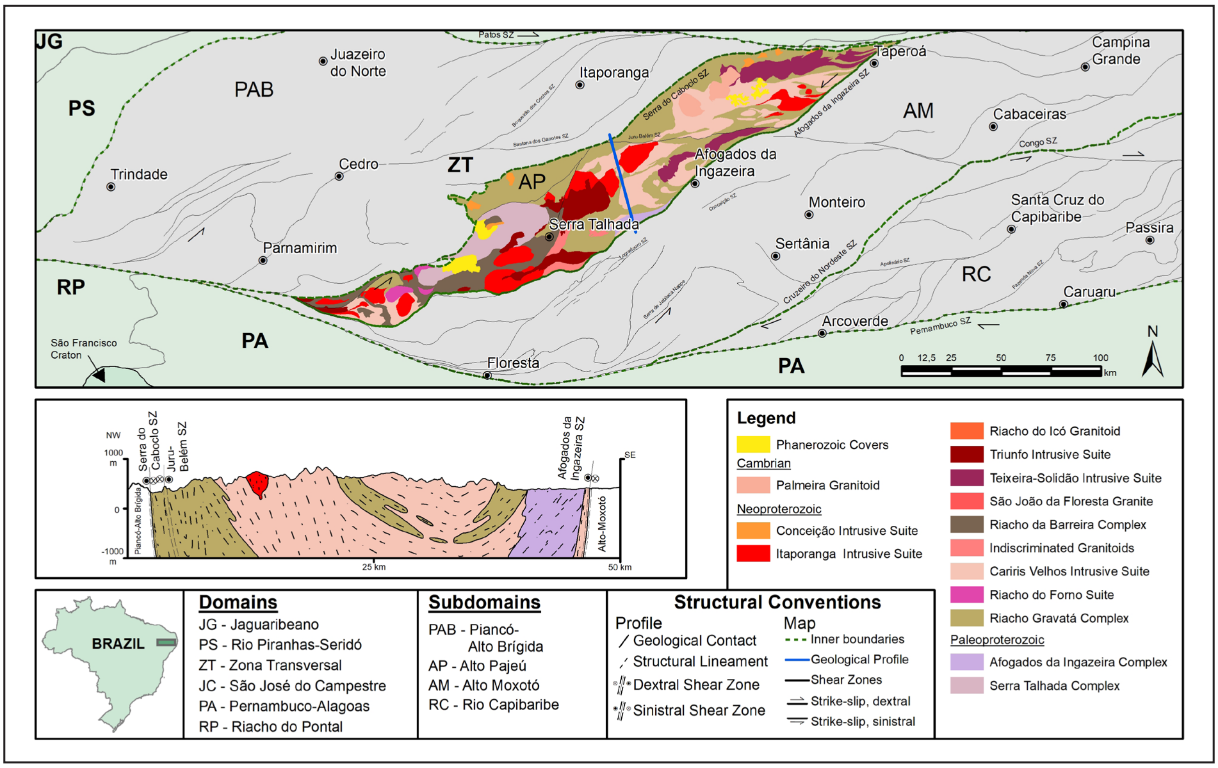

FIGURE 5. Main lithostratigraphic units and geological profile for the Alto Pajeú Subdomain. Vertical exaggeration: 5x.

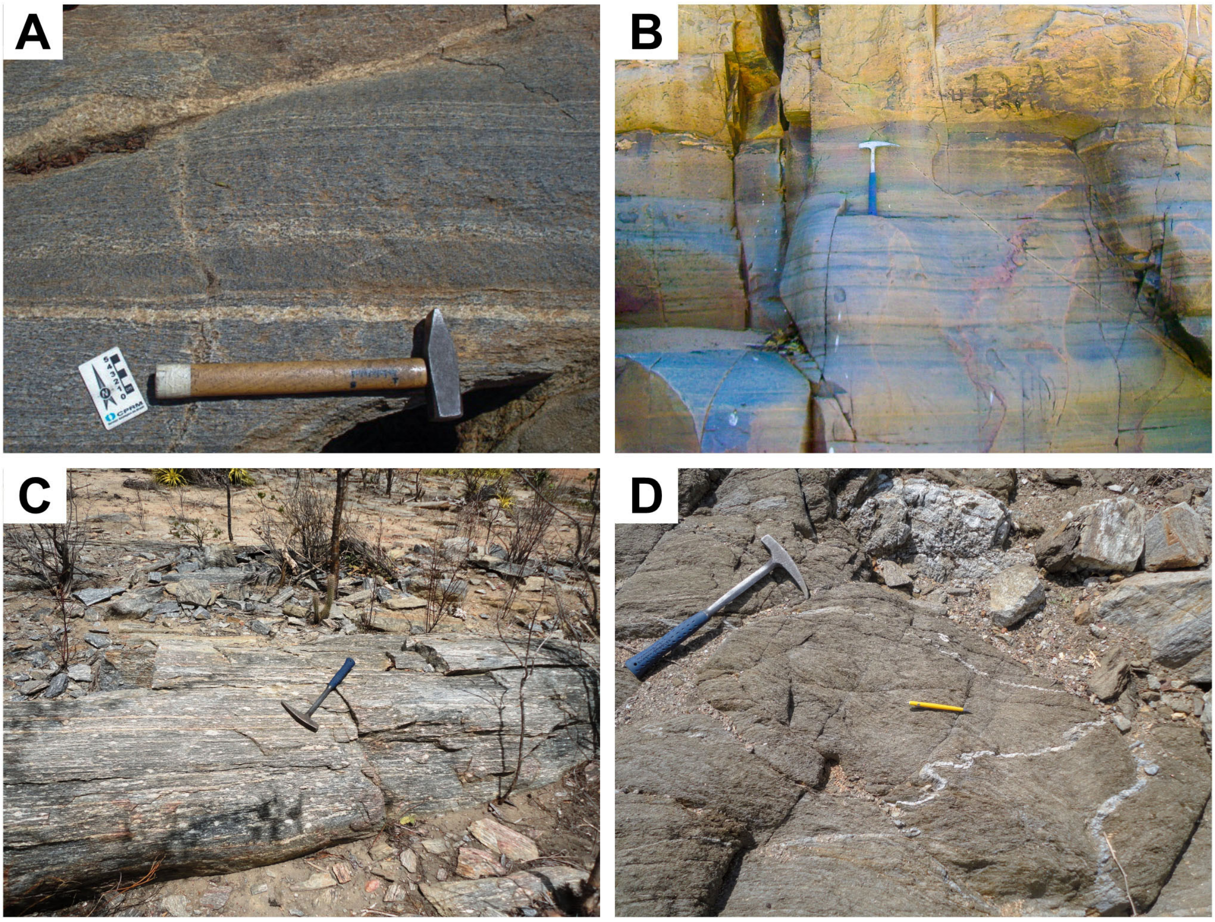

FIGURE 6. Field photos of the Alto Pajeú Subdomain units. (A) Foliated orthogneiss of Serra Talhada Complex; (B) Intermediate metavolcanic rock of the Riacho Gravatá Complex; (C) Biotite augen-gneiss of the Recanto-Riacho do Forno Intrusive Suite; (D) Mica schist with folded quartz veins of the Riacho da Barreira Complex.

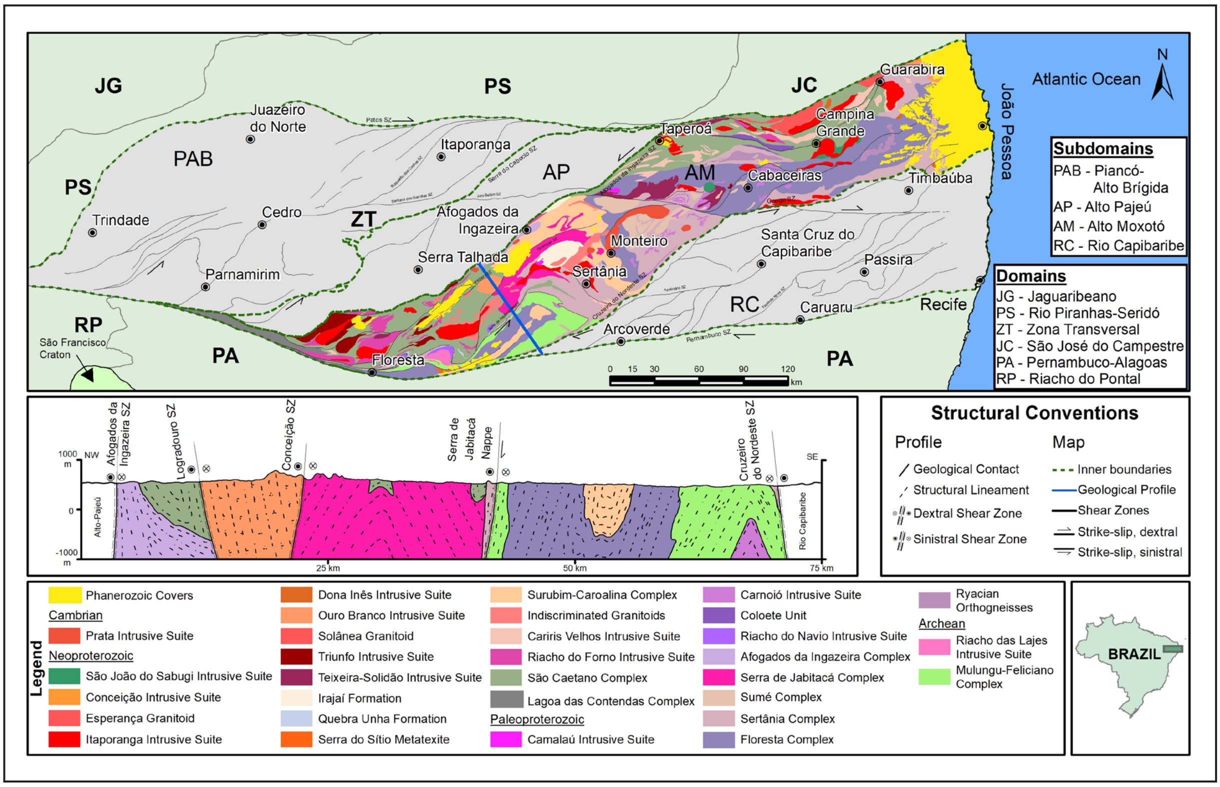

FIGURE 7. Lithostratigraphic units and geological profile for the Alto Moxotó Subdomain. Vertical exaggeration: 5x.

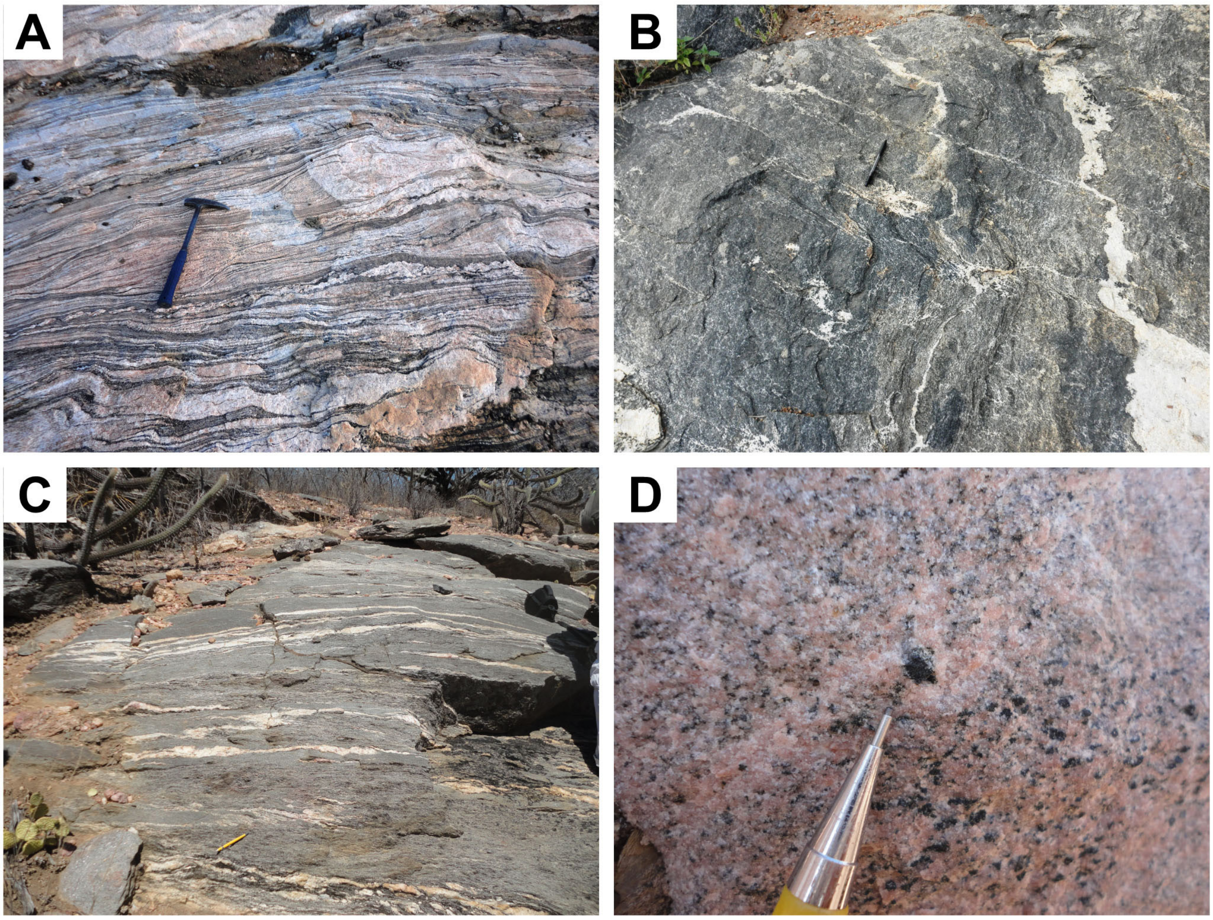

FIGURE 8. Field photos of the Alto Moxotó Subdomain units. (A) Stromatic migmatite of tonalitic composition of the Riacho das Lajes Intrusive Suite; (B) Orthogneiss of granodioritic composition of the Floresta Complex; (C) Biotite schist of the São Caetano Complex; (D) Syenite of the Triunfo Intrusive Suite with clots of amphibolite.

Dating in metavolcanic rocks have ages between 2126 and 2041 Ma (Santos et al. 2004; Brito Neves et al. 2020). The Sumé Complex was defined as an association of high-grade metamorphic gneiss including orthogneisses and paragneisses (Medeiros and Torres 1999; Santos et al. 2019), with age U-Pb in orthogneiss of 1976 Ma. The undated Camalaú Intrusive Suite consists of monzonitic, quartz monzonitic, monzogranitic to syenogranitic orthogneisses (Leite 1997).

At the end of the Paleoproterozoic, orthogneisses from granitic to syenogranitic composition present U-Pb ages of 1652 ± 19 Ma (Coloete Orthogneiss), 1638 ± 13 Ma (Carnoió Intrusive Suite) and 1611 ± 78 Ma (Riacho do Navio Intrusive Suite) (Lima et al. 1985; Lages 2017; Santos et al. 2017; Brasilino and Miranda 2017; Lages et al. 2019) (Appendix 1).

3.3.3 Neoproterozoic units

The Neoproterozoic units are represented by the São Caetano, Lagoa das Contendas and Irajai complexes (Figure 7). The São Caetano Complex (Figure 8C) consists of mica schists, paragneisses, two-mica gneisses and quartzites, which have as protoliths pelites/psammites, greywackes and metavolcanoclastic rocks. U-Pb zircon ages of the metavolcanic rocks of this unit range from 858 to 806 Ma (Guimarães et al. 2012; Santos et al. 2019).

The Lagoa das Contendas Complex is represented by calc-silicate gneisses, garnet-mica schists/paragneisses, quartz-feldspathic gneisses, metavolcanic rocks, marbles and quartzites (Brasilino and Morais 2020).

The Irajai Complex is a metavolcano-sedimentary sequence composed of two facies, one clastic, immature, with intercalations of chemical sediments and another consisting of metavolcanic rocks predominantly mafic with intrusions of gabbros and diorites (Wanderley 1990; Wanderley et al. 1992). U-Pb dating of metavolcanic rock showed age of 565 ± 7 Ma (Kozuch 2003) (Appendix 1).

3.4 Rio Capibaribe Subdomain (RCS)

3.4.1 Paleoproterozoic units

The Paleoproterozoic basement of RCS (Figure 9) is composed of foliated orthogneisses (including migmatites) associated with intrusive metaultramafic bodies (layers, dikes and boudins) (Santos 2012; Accioly 2015; Santos et al. 2020). The Pão de Açúcar Complex consists of orthogneisses and migmatites of dioritic/tonalitic composition and U-Pb zircon age of 2145 ± 28 Ma (Santos 2012; Accioly 2015) (Figure 10A). The Salgadinho Complex consists of orthogneisses and migmatites of granodioritic, monzogranitic and syenogranitic composition with U-Pb zircon age of 2065 ± 13 Ma (Brasilino and Miranda 2017; Neves et al. 2015). The Mata Virgem Orthogneiss presents a syenogranitic composition and U-Pb zircon age of 1981 ± 23 Ma (Santos et al. 2020; Neves et al. 2017a) (Appendix 1).

The Vertentes Orthogneiss unit comprises orthogneisses from monzogranitic to monzodioritic and granodioritic to dioritic compositions, usually with centimetric to decimetric regular layering, with metamafic lenses and granitic sheets, as described by Neves et al. (2006, 2017a), Neves and Alcantara (2010) and Brasilino and Miranda (2017). They are calcium-alkaline rocks, formed in volcanic arc with U-Pb zircon ages between 2127 ± 7 Ma and 2085 ± 15 Ma and may have originated during the subduction stage related to the Rhyacian event (Neves et al. 2006, 2017a; Neves and Alcantara 2010; Brito Neves et al. 2013; França et al. 2019) (Appendix 1).

The Orobó Complex (Figure 10B) defines a metavolcano-sedimentary sequence consisting of biotite gneisses, garnet-biotite-quartz-feldspar schists with kyanite, intermediate metavolcanic rocks, felsic, mafic and ultramafic rocks all gneissified with fine granulation (Santos et al. 2020). Peculiar facies are formed by banded gneisses with alternation of mafic-intermediate volcanic material and pelitic, with a perfect regularity of layers, suggestive of a turbiditic sedimentation with a volcanic component (Santos 1999; Santos et al. 2020).

The Gabbro-Anorthositic Passira complex consists mainly of meta-anorthosites with U-Pb zircon age of 1718 ± 20 Ma and, secondarily, by metagabbros, metanorites, metagabbronorites and ultramafic rocks with Fe-Ti oxides (Accioly 2000; Santos et al. 2020). The Bengala Orthogneiss is represented by biotite-alkali-feldspar metagranites to metasyenogranites aged 1580 ± 90 Ma (Accioly 2000) (Appendix 1).

3.4.2 Mesoproterozoic unit

The Serra da Taquaritinga Intrusive Suite is the only Mesoproterozoic unit dated in the ZTD so far. It is composed of augen orthogneisses from syenogranitic to monzogranitic composition with U-Pb zircon age of 1521±7 Ma (Sá et al. 2002) (Appendix 1).

3.4.3 Neoproterozoic units

The Neoproterozoic units are represented by the Riacho do Tigre and Surubim-Caroalina complexes. The Riacho do Tigre Complex (Figure 10C) is characterized by a metavolcano-sedimentary sequence consisting of schists, schist gneisses (derived from greywackes), paragneisses and orthogneisses associated with mafic rocks (metabasalt, metandesites) and volcanoclastic rocks. Dating of metavolcanic rock showed age of 961 ± 11 Ma (Accioly 2015) (Appendix 1).

The Surubim-Caroalina Complex (Figure 10D) comprises paraderived lithotypes represented by sillimanite-garnet-biotite gneisses and/or schists, biotite schists, muscovite quartzites, quartz-feldspathic gneisses, calc-silicate rocks and marbles (Mello and Siqueira 1971; Santos et al. 1984; Brasilino and Miranda 2017; Neves et al. 2017a). Detrital U-Pb zircon ages vary from Archean to Neoproterozoic, with the youngest zircon indicating deposition after 665 Ma, with metamorphic peak around 625 Ma (Neves et al. 2006; Neves et al. 2009) (Appendix 1).

3.5 Ediacaran-Cambrian Magmatism

The TZD has numerous granitic plutons related to the Brasiliano tectonomagmatic event with very varied dimensions and compositions. They include syenites, biotite-amphibole monzogranites, syenogranites, tonalites, diorites and gabbros grouped in several suites, according to their textural, mineralogical and chemical characteristics. These suites are classified as calc-alkaline (Conceição type), high-potassium calc-alkaline (Itaporanga and Dona Inês types),

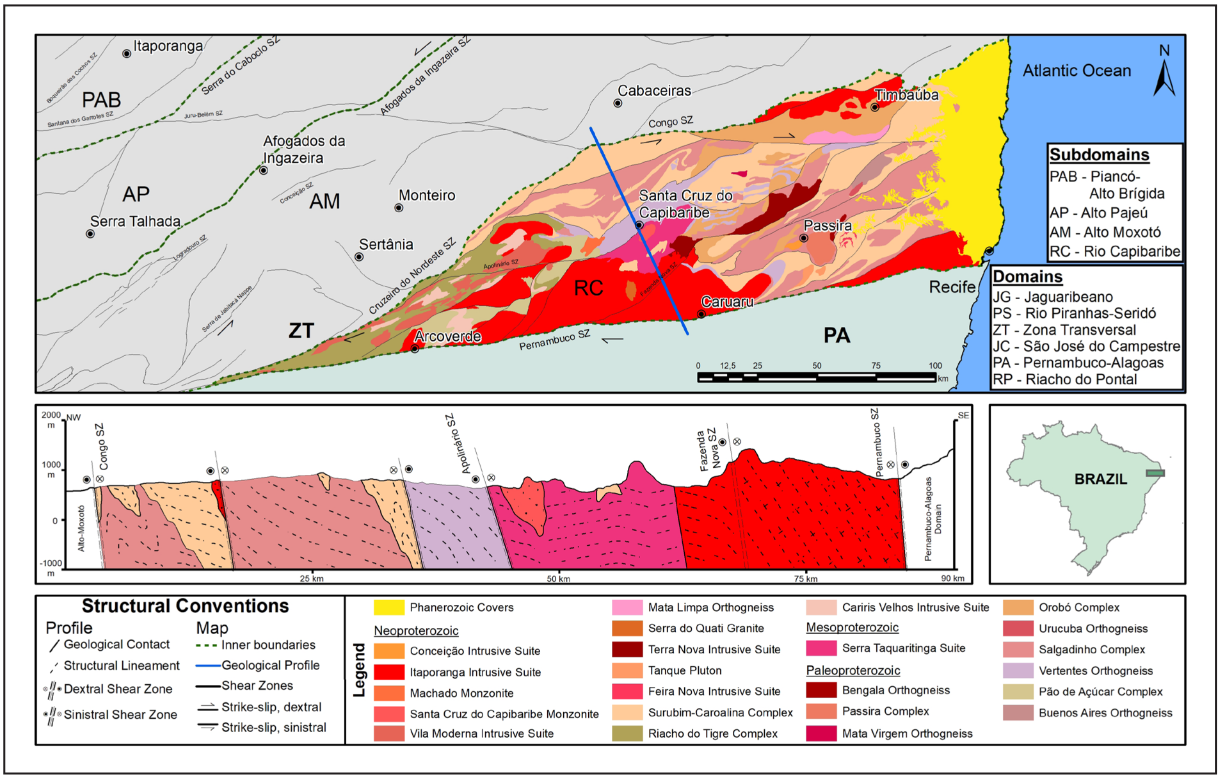

FIGURE 9. Lithostratigraphic units and geological profile for the Rio Capirabibe Subdomain. Vertical exaggeration: 5x.

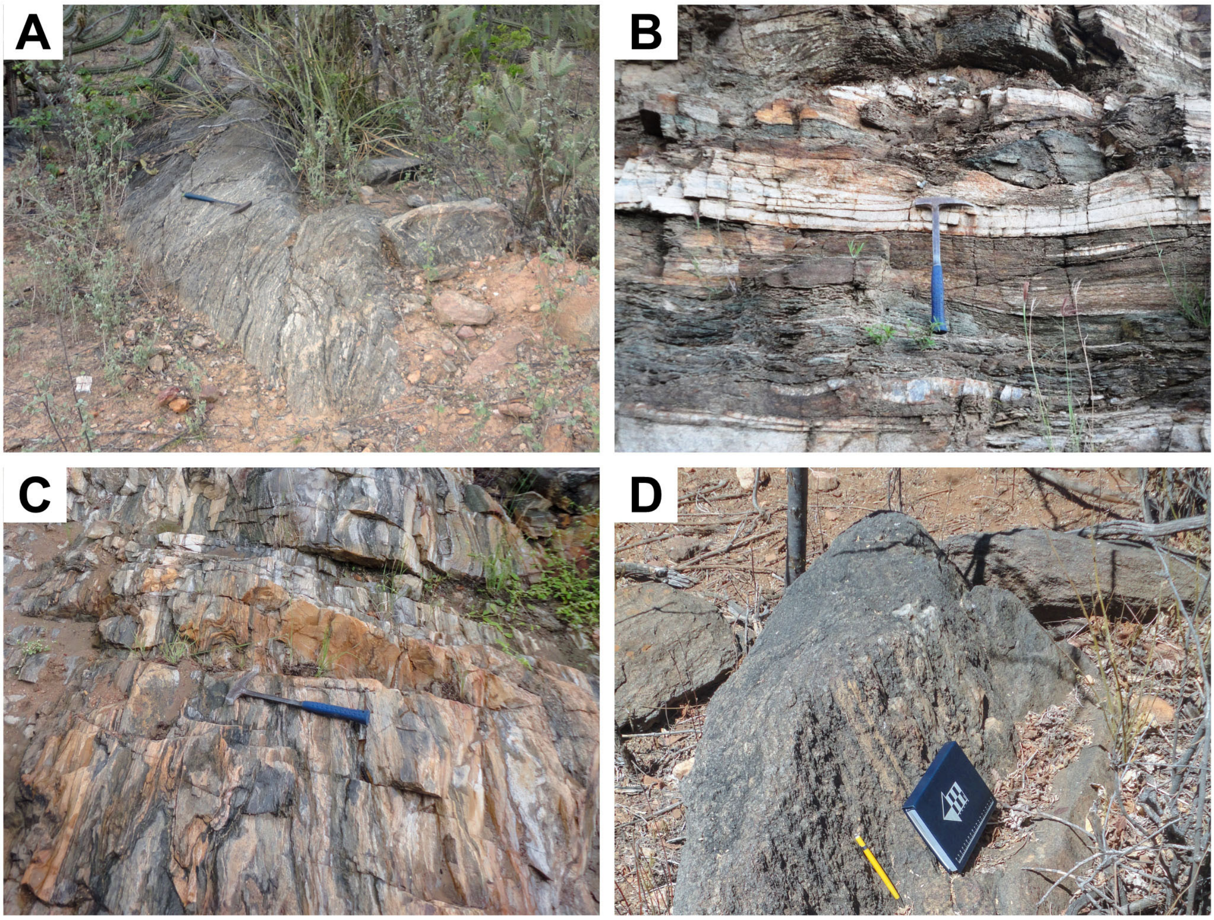

FIGURE 10. Field photos of the RCS units. (A) Foliated Orthogneiss of gabbro-diorite composition with felsic injections of the Pão de Açúcar Complex; (B) Metavolcano-sedimentary sequence of the Orobó Complex; (C) Intercalation of felsic and intermediate metavolcanic rocks of the Riacho do Tigre complex; (D) Mica schist of the Surubim-Caroalina Complex.

peralkaline (Catingueira type) and ultra-potassic (Triunfo type). U-Pb zircon ages for Conceição type granitoids were reported between 635 and 611 Ma in PABS (Brito Neves et al. 2003; Medeiros 2004; Sial and Ferreira 2016), 618 Ma in the AMS (Guimarães et al. 2014) and between 645 and 616 Ma in the RCS (Guimarães et al. 2004, 2011a; Neves et al. 2017a). For granitoids of the Itaporanga/Dona Inês type, there are U-Pb zircon ages of 605 Ma in APS (Medeiros 2004), between 592 and 570 in AMS (Guimaraes et al. 2009; Guimarães et al. 2017; Sial and Ferreira 2016; Lages 2017) and 618 Ma in the RCS (Guimarães et al. 2011a). Triunfo granitoids report U-Pb zircon ages between 612 and 591 Ma in APS (Archanjo et al. 2008) between 580 to 520 Ma in the AMS (Ferreira et al. 2004) and 592 in the RCS (Guimarães et al. 2004).

For post-Brasiliano magmatism, there is a record of U-Pb zircon ages of 533 Ma for the Prata Intrusive Suite in AMS and 506 Ma for the Palmeira Granitoid in APS (Hollanda et al. 2010; Kozuch 2003) (Appendix 1).

4. U-Pb geochronology

The geochronological analysis by the U-Pb method in zircon performed in this work aimed to understand the stratigraphic positioning and age of the Serra de Jabitacá Complex, given that there is no published absolute dating for this unit so far.

The FJ-085B sample was extracted from a deactivated quarry on the banks of BR-232 road, near the city of Custódia (State of Pernambuco). It is a fine to medium-grained gneissic monzogranite (Figure 11A), foliated (compositional layering), medium gray color, and composed of plagioclase (~45%), quartz (~33%), potassium feldspar (~10%) and biotite. Bands rich in biotite, local migmatization and leucocratic granite veins are observed (Figure 11B). A homogeneous monzogranite portion of the outcrop was selected for dating.

Twenty-nine spot analyses in zircon grains were performed, of which six show discordance above 10% (Table 1). With the exception of these grains, the zircons analyzed present considerable scattering along the concordia when plotted in the diagram, with ages ranging from Neoproterozoic (606-621 Ma) to Paleoproterozoic (1790-2431 Ma), and a single Archean zircon (2681 Ma). A Neoproterozoic crystal cluster provided a concordant age of 615 ± 3 Ma, interpreted as the age of metamorphism associated with the Brasiliano Orogeny (Figure 11C). This metamorphism would have been responsible for the gneissification of the protolith of these rocks, as well as for local migmatization, and generated remarkable overgrowth in the zircons, with prismatic terminations, sometimes bipyramidal, and concentric oscillatory zoning (Figure 11D). The overgrowths involve xenocrystic nuclei of different ages.

The data also provide a discordia aligning the concordant and discordant Neoproterozoic zircons and the main Paleoproterozoic zircons population of this sample, which provides superior and inferior interceptor ages at 2008 ± 11 Ma and 608 ± 4 Ma, respectively (Figure 11E). The lower intercept age coincides, within the error, with the concordia age attributed to the Brasiliano metamorphism, and the age of upper intercept could represent the age of the rock crystallization, or an important component inherited/assimilated from pre-existing Orosirian rocks. In fact, the inheritance/assimilation of zircons seems to constitute an important feature in this rock, which contains Rhyacian, Siderian and Archean zircons. The presence of three concordant zircons younger than 2008 Ma suggests a more recent crystallization for this rock, with maximum crystallization age at 1790 ± 40 Ma (younger zircon) (Figure 11F). Additional geochronological data is necessary to clarify this question, as well as to understand if this age would be representative of the entire Serra de Jabitacá Complex.

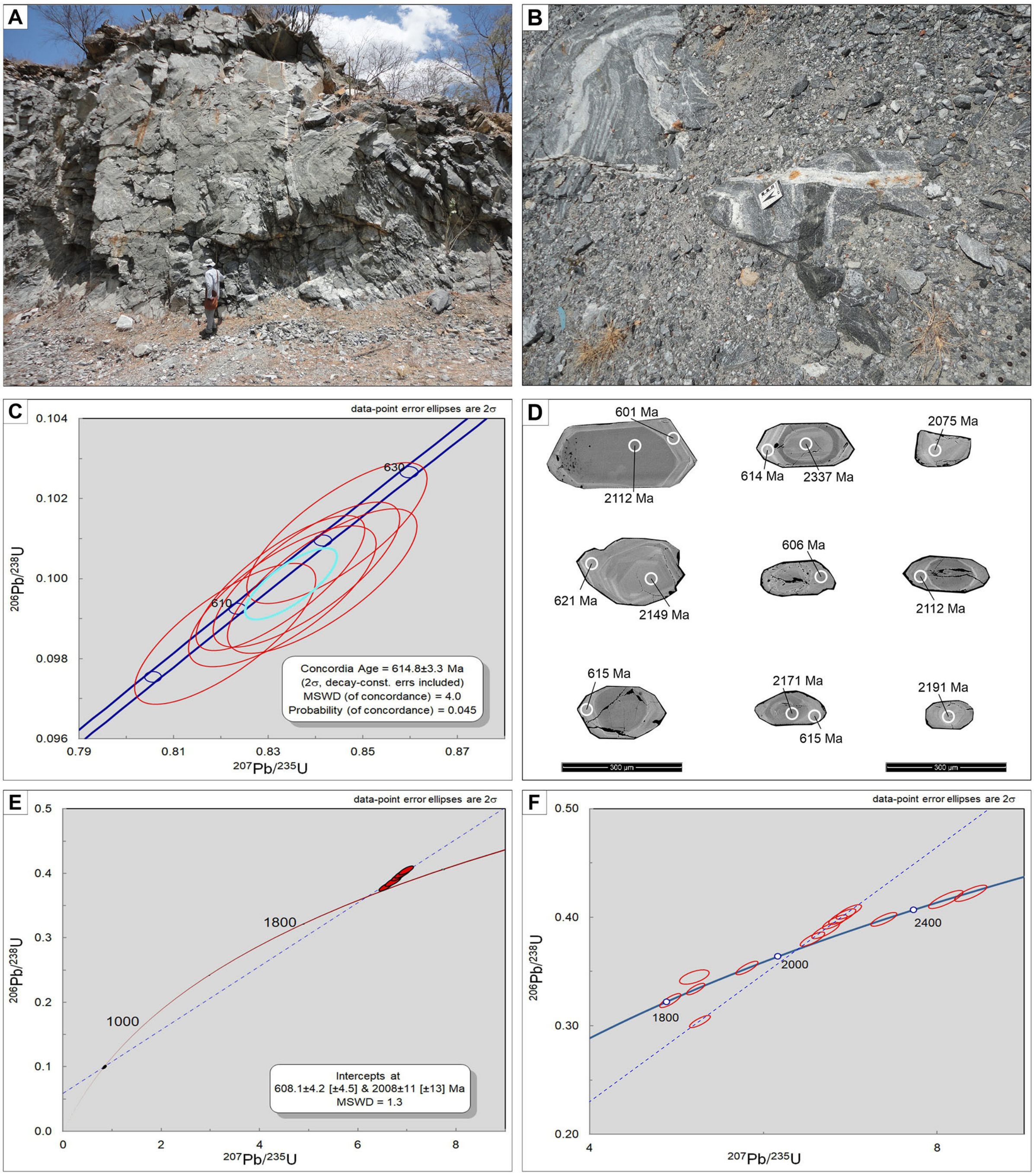

FIGURE 11. F(A) Gneissic metagranitoid outcrop with compositional layering of the Serra de Jabitacá Complex (FJ-085B); (B) Metagranitoid of monzogranitic composition, medium gray color, medium to fine granulation, biotite rich bands and mobilized/ dikes of granite leucocratic of Serra de Jabitacá Complex; (C) Sample discordia showing lower and upper intercepts; (D) Detail for concordant grains near the lower intercept in the sample discordia; (E) Zircon grains showing oscillatory zoning and the spots used in age calculation; (F) Detail for concordant grains near the upper intercept in the sample discordia.

TABLE 1.Geochronological data of the Serra de Jabitacá Complex metagranitoid (sample FJ-085B; Lat/Long: -8,088503/-37,727175)

Sample-Spot	Th/U	Measured Isotopic Ratios						Corrected ages (Ma)						Conc (%)
		$^{207}Pb/^{206}Pb$	% err	$^{206}Pb/^{238}U$	% err	$^{208}Pb/^{232}Th$	% err	$^{207}Pb/^{206}Pb$	2σ err	$^{206}Pb/^{238}U$	2σ err	$^{208}Pb/^{232}Th$	2σ err	
66	0.58	0.0631	1.8	0.1013	1.9	0.0290	4.8	711.9	38	621.8	11	840.8	42	87.3
67**	0.10	0.0604	1.2	0.0986	1.5	0.0359	5.2	616.9	26	606.3	8	2435.7	47	98.3
68*	0.06	0.0611	1.3	0.0999	1.5	0.0436	6.5	641.4	27	614.1	9	2456.4	96	95.7
69**	0.06	0.0607	1.3	0.0996	1.4	0.0426	8.7	627.9	28	611.8	8	2246.1	46	97.4
70	0.17	0.2035	1.0	0.4845	1.4	0.1834	1.8	2854.2	17	2546.9	29	877.6	45	89.2
71*	0.67	0.1251	1.1	0.4049	1.4	0.1140	1.5	2029.9	19	2191.4	25	2583.9	86	108.0
72*	0.89	0.1253	1.0	0.3798	1.4	0.1110	1.6	2033.6	18	2075.4	25	2313.2	67	102.1
73	0.28	0.1134	1.0	0.3339	1.3	0.0902	1.8	1854.4	18	1857.0	21	1671.4	105	100.1
74	0.28	0.1346	1.0	0.3981	1.3	0.1281	2.0	2158.4	18	2160.1	24	712.3	36	100.1
75	0.28	0.1094	2.2	0.3449	1.6	0.0919	3.7	1789.9	40	1910.3	26	845.3	44	106.7
82**	0.07	0.0606	1.2	0.1011	1.4	0.0381	5.8	623.6	25	621.1	8	3404.1	57	99.6
83*	1.42	0.1251	1.0	0.3956	1.3	0.1077	1.5	2029.5	18	2148.9	25	8424.9	107	105.9
85	0.78	0.1441	1.1	0.4220	1.5	0.1175	2.2	2277.2	19	2269.7	28	842.7	72	99.7
86	0.28	0.1411	1.1	0.4164	1.6	0.1292	4.1	2240.6	20	2243.9	31	996.6	49	100.1
87	0.20	0.1577	1.1	0.4369	1.4	0.1364	3.5	2430.6	18	2336.6	28	862.1	55	96.1
88**	0.03	0.0605	1.1	0.0999	1.4	0.0505	5.0	619.7	23	613.8	8	2969.1	253	99.0
89*	0.46	0.1256	1.1	0.3877	1.6	0.1301	3.3	2037.7	20	2112.3	28	1745.1	29	103.7
90	0.14	0.0650	1.3	0.0977	1.6	0.0425	5.1	775.0	28	601.0	9	1513.9	100	77.5
91**	0.06	0.0607	1.2	0.1001	1.5	0.0480	5.9	629.4	26	615.0	9	1777.7	62	97.7
96*	0.08	0.0615	1.2	0.0994	1.4	0.0427	5.3	656.8	26	610.6	8	2164.0	71	93.0
97	0.11	0.0636	1.3	0.0977	1.5	0.0444	5.2	726.7	27	601.0	8	947.1	54	82.7
98	0.47	0.1569	1.1	0.4564	1.6	0.1213	3.1	2422.5	18	2423.7	33	755.4	43	100.0
99	0.15	0.1831	1.0	0.5166	1.3	0.5171	1.6	2680.9	17	2684.9	28	576.9	27	100.1
100*	1.47	0.1251	1.1	0.4005	1.5	0.1118	1.8	2029.9	20	2171.3	27	2142.8	38	107.0
101*	0.05	0.0622	1.4	0.1000	1.6	0.0778	6.8	682.0	29	614.6	9	2182.5	31	90.1
102	0.08	0.1106	1.2	0.3232	1.6	0.1582	9.2	1808.8	22	1805.4	26	1862.7	43	99.8
103	0.09	0.1193	1.1	0.3533	1.4	0.1130	3.5	1945.5	19	1950.1	24	2127.5	33	100.2
104	0.05	0.0630	1.3	0.0984	1.6	0.0862	6.5	709.2	28	604.8	9	2471.6	77	85.3
105	0.54	0.1257	1.1	0.3039	1.5	0.0965	2.4	2039.1	20	1710.7	23	2067.6	29	83.9

**Concordant grain
*Discordant grain

5. Summary of the geochronological data

5.1 Transversal Zone Domain magmatic barcode

A magmatic barcode was constructed in order to gather the main data compiled from the literature (Appendix 1) and allow an easy visualization and correlation of the magmatic events that occurred in the various subdomains of the TZD, as well as its correlation with regional geotectonic events (Figure 12). This information will suit to support the discussions of sedimentary provenance and geodynamic evolution, presented in the following topics.

The Archean record in the TZD is in the Alto Moxotó subdomain, represented by the Mulungu-Feliciano Complex and the Riacho das Lajes Intrusive Suite (Santos et al. 2017), in addition to Mesoarchean ages (< 2.91 Ga) reported recently, but still lack geological positioning (Brito Neves et al. 2020).

In the Paleoproterozoic, the orogenic event was recorded in igneous rocks distributed throughout all the subdomains, with an expressive generation of continental crust.

In the Mesoproterozoic, little thing was marked in the TZD, being the Rio Capibaribe subdomain the only one that presents ages in this interval (Serra Taquaritinga Suite: 1.52 Ga). So far, a regional extensional event was not characterized during this period in Borborema Province, however, records of rift basins are found in São Francisco Craton at very close ages (Pedrosa-Soares and Alkmim 2011; Neves 2021).

The early Neoproterozoic Cariris Velhos event is recorded in three of the four subdomains of the TZD, being the highest representativeness in the Alto Pajeú subdomain. Although the chemistry of these metagranitoids points to a collisional origin (continent-continent type) (Santos et al. 2010), it was not still possible to identify lithological/structural characteristics that corroborate with the installation of a collisional environment in the Tonian (Neves 2003; Medeiros 2004; Rodrigues 2008). The most likely is that an extensional event generated an intraplate magmatism (Cariris Velho Intrusive Suite) associated with sedimentation (Riacho Gravatá Complex), ceased for 50 million years and reactivated for the opening of a new basin (São Caetano Complex) (Guimarães et al. 2012; Neves 2021). Other alternatives are discussed in Medeiros (2004).

In the Neoproterozoic, the magmatic activity is intensified during the Brasiliano Orogeny, responsible for the intense magmatism and the implantation of the regional scale shear zones.

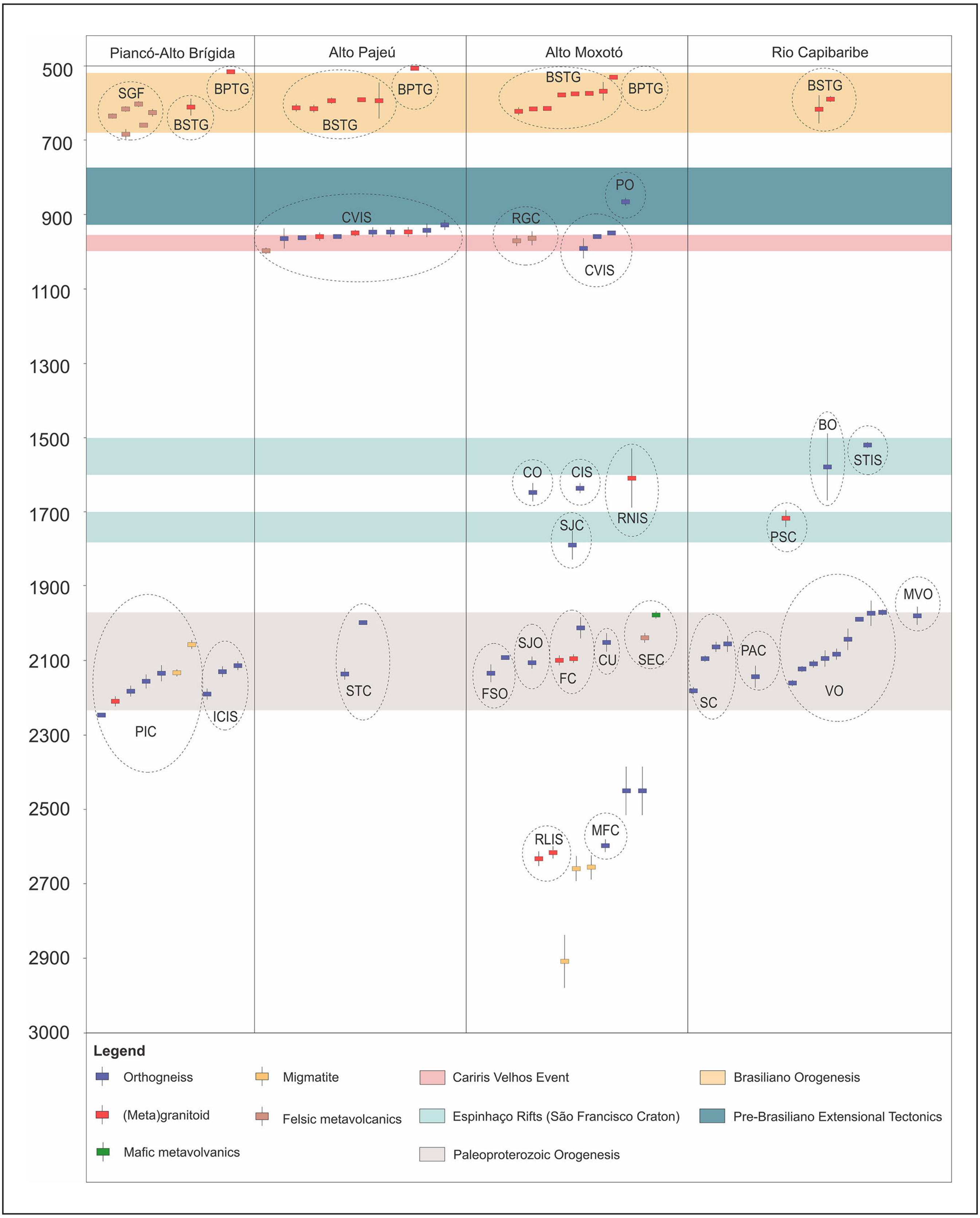

FIGURE 12. "Barcode" chart of the ages of the orthoderived rocks of the TZD compiled from the literature. BSTG: Brasiliano sin-tectonic granitoids; BPTG: Brasiliano post-tectonic granitoids; SGF: Santana dos Garrotes Formation; CVIS: Cariris Velhos Intrusive Suite; PO: Pinhões Orthogneiss; CO: Coloete Orthogneiss; CIS: Carnoió Intrusive Suite; RNIS: Riacho do Navio Intrusive Suite; PSC: Passira Complex; BO: Bengala Orthogneiss; STIS: Serra Taquaritinga Intrusive Suite; PIC: Piancó Complex; ICIS: Icaiçara Intrusive Suite; STC: Serra Talhada Complex; FSO: Fazenda Salvador Orthogneiss; SJO: São Joãozinho Orthogneiss; FC: Floresta Complex; CU: Cabaceiras Unit; SJC: Serra de Jabitacá Complex; SEC: Sertânia Complex; SC: Salgadinho Complex; PAC: Pão de Açúcar Complex; VO: Vertentes Orthogneiss; MVO: Mata Virgem Orthogneiss; RLIS: Riacho das Lajes Intrusive Suite; MFC: Mulungu-Feliciano Complex.

5.2 Sedimentary record and provenance of debris

5.2.1 Piancó-Alto Brígida Subdomain

The Barro and Salgueiro complexes are located in the central-south portion of Piancó-Alto Brígida subdomain, being composed of schists/paragneisses and schists, respectively. We have compiled data from 76 detrital zircon grains, which point ages from Neoarchean to Neoproterozoic (Van Schmus et al. 2011; Brito Neves and Passarelli 2020). Both units present as main detrital sources Neoproterozoic rocks, with main peaks close to their maximum sedimentation age and little contribution from older sources.

The Barro Complex (Figure 13B) showed a well-marked peak between 900 and 1000 Ma (Tonian), suggesting an important provenance of rocks belonging to the Cariris Velho Intrusive Suite. The zircon grains that presented Paleoproterozoic ages probably have as source the units that make up the PABS basement, since the Piancó, Itaizinho, Parnamirim complexes and the Icaiçara Suite have Rhyacian and Orosirian ages. Since there is no record of Archean units in PABS so far, the zircon grains with Neoarchean ages registered in PABS are likely to be external, and may be from the Riacho das Lajes Suite/Mulungu-Feliciano Complex in the Alto Moxotó subdomain, from the Granjeiro Complex in the Rio Piranhas-Seridó Domain, from the Entremontes Complex in the Pernambuco-Alagoas Domain or even from the São Francisco Craton (Santos et al. 2017; Brito Neves et al. 2020; Freimann 2014; Gomes et al. 2021; Ancelmi 2016; Silva et al. 1997; Cruz 2014). The maximum sedimentation age of 637 ± 12 Ma can be attributed to the Barro complex (younger population weighted average).

The Salgueiro Complex (Figure 13A) recorded a higher concentration of ages between 700 and 900 Ma, a period in which significant magmatic events were not characterized in TZD, in a way that this basin may have received a significant amount of debris from other BP domains, like Lagoa Caiçara Unit and Tamboril-Santa Quitéria Complex, in the northern sector of the province (Castro 2004; Teixeira 2005; Costa 2017; Araujo 2014; Pitombeira et al. 2021). U-Pb dating performed in a metarhyolite associated with the Salgueiro complex suggest crystallization in 962 ± 12 Ma (Brito and Marinho 2017) that would correspond to the minimum sedimentation age of this basin. However, data of detrital zircons for this same unit suggest maximum sedimentation age at 736 ± 13 Ma (younger population weighted average), or even more recent, with sedimentation extending up to 666 Ma (younger zircon).

5.2.2 Alto Pajeú Subdomain

The Riacho Gravatá complex is the most representative unit of APS. Data of 72 detrital zircon grains (Figure 13E) were compiled from Guimarães et al. (2012) and Van Schmus et al. (2011), which showed ages from the Paleoarchean to Neoproterozoic. The greatest amount of age data is concentarted in the transition between the Neoproterozoic and Mesoproterozoic (900 and 1100 Ma), with a peak around 1000 Ma, suggesting the main provenance from the Cariris Velhos Intrusive Suite. A large amount of grains also shows Mesoproterozoic ages between 1100 and 1600 Ma, and as the only Mesoproterozoic unit in the TZD is in the RCS (Serra da Taquaritinga Intrusive Suite: 1521 ± 7 Ma: Sá et al. 2002), it is more likely that the provenance of these grains is external to the domain. In the Paleoproterozoic, the detrital grains revealed ages between 2.2 and 1.7 Ga, which may be associated with the Afogados da Ingazeira and/or Serra Talhada complexes, or sources external to APS, in the case of the Orosirian and Statherian zircons. The single Paleoarchean age grain was found in the Riacho Gravatá Complex, with similar age to those found in the São José de Campestre domains (Presidente Juscelino and Brejinho complexes: Dantas et al. 2013) and Rio Piranhas-Seridó; (Granjeiro Complex: Freimann 2014), which suggests an external provenance to the TZD, whose oldest nuclei found so far are Meso- to Neoarchean in age (Riacho das Lajes Suite/Mulungu-Feliciano Complex; Santos et al. 2017; Brito Neves et al. 2020). Alternatively, this zircon could have been inherited by younger magmatic rocks that acted as a source of debris for the basin. The maximum age of sedimentation compatible with the Riacho Gravatá Complex would be ca. 806 Ma, given by the youngest zircon nucleus of the GN-P93 sample (Guimarães et al. 2012). A higher volume of data could contribute to the refinement of the interpretations presented here.

5.2.3 Alto Moxotó Subdomain

For the Sertânia Complex (Figure 13D), 221 detrital zircon grains were compiled from Neves (2009, 2017a, 2017b). Practically all the grains are Paleoproterozoic age, with a well-marked peak between 1.9 and 2.2 Ga, and the provenance of these sediments is compatible with the AMS basement. A small Archean contribution was recorded, with possible internal provenance to AMS (Riacho das Lajes Suite/Mulungu-Feliciano Complex: Santos et al. 2017; Brito Neves et al. 2020) and external contribution of the Granjeiro Complex/Campo Grande Block in the Rio Piranhas-Seridó domain and the units of the Archean nucleus of the São José do Campestre Domain (Freimann 2014; Gomes et al. 2021; Ancelmi, 2016; Silva et al. 1997; Ferreira et al. 2020; Dantas et al. 2013). The histogram presented a significant amount of Neoproterozoic zircon grains, which is not expected for this unit, which is historically mapped as Paleoproterozoic (Santos et al. 2004).

For the São Caetano Complex, Guimarães et al. (2012) and Santos et al. (2019) published information on 89 detrital zircon grains, which showed distributed ages from Neoarchean to Neoproterozoic (Figure 13C). The concentration of the ages remained throughout the Neoproterozoic extension and at the end of Mesoproterozoic, presenting a peak of greater intensity between 900 and 1000 Ma (Tonian), which suggests an important detrital contribution of sources associated with the Cariris Velhos Event. Another possibility would be part of these zircons having come from the reworking and recycling of sediments belonging to the basin of the oldest Riacho Gravatá complex. Mesoproterozoic ages, between 1100 and 1500 Ma, were also found in the lithotypes of the São Caetano complex. These debris are probably of external origin, since there is no record of rocks in this age range in the Borborema Province. The Paleoproterozoic record is very sparse, with most of the data concentrated in a single interval (2.1 to 1.9 GA), compatible with the AMS basement. A single Neoarchean zircon is present in the São Caetano complex, and could indicate internal sedimentary contribution (Riacho das Lajes Suite/Mulungu-Feliciano Complex), or also the Entremontes Complex, in the Pernambuco-Alagoas Domain, in the Southern portion of the Borborema Province (Santos et al. 2017; Brito Neves et al. 2020; Cruz 2014). Alternatively, this single zircon represents a grain inherited by younger magmatic rocks that acted as areas-source for the basin. Thus, the maximum sedimentation age of 612 Ma of the SCBMGV sample (Guimarães et al. 2012), could represent the São Caetano complex as a whole or a younger basin, Ediacaran, with a strong detrital contribution of cryogenic source areas.

5.2.4 Rio Capibaribe Subdomain

For the Surubim-Caroalina Complex, data of 156 detrital zircons were compiled, dated by Neves et al. (2006) and Brito Neves et al. (2013). This unit had as main contribution detrital zircon grains of Neoproterozoic age (Figure 13F). Tonian detrital zircon grains point out the lithotypes of the Cariris Velho Intrusive Suite as the most likely source. For the Mesoproterozoic detrital zircon grains (Stennian), lithotypes are not known with this age range in the TZD so far, being most likely from an external origin. A smaller cluster is observed in the Rhyacian-Orosirian, with provenance possibly related to the Paleoproterozoic basement of the RCS (Santos 2012; Accioly 2015; Neves et al. 2006; Brasilino and Miranda 2017; Neves et al. 2017a; Santos et al. 2020). A single Paleoarchean zircon was reported, and its age is compatible with the units of the Archean nucleus of the São José do Campestre Domain, in the Northern portion of the Borborema Province (Dantas et al. 2013). According to Neves et al. (2006) and Brito Neves et al. (2013), the maximum deposition age of this unit is 665 Ma and 640 Ma, respectively. Brito Neves et al. (2013) reported younger detrital zircon grains on the outskirts of Siriji (Pernambuco state), however, given the strong metamorphic overgrowth reported for this sample, these data should be used with caution and sedimentation for this unit is maintained as pre-orogenic.

6. Discussion

6.1 Tectonic Evolution of the Transversal Zone

The tectonic evolution of BP has been widely debated in the last 20 years, and three lines of thought stand out and divide the publications in this topic. One of the proposed models suggests a sequence of collage of tectono-stratigraphic terrains during the Brasiliano Orogeny (Brito Neves et al. 2000; Kozuch 2003; Santos et al. 2010; Caxito et al. 2020). The second model argues that the collage of crustal fragments occurred only during the Paleoproterozoic, being the rest of the configuration in a dominantly intracontinental environment, with episodes of crustal reworking until the province consolidation in the Ediacaran-Cambrian transition (Neves et al. 2006, 2015; Neves 2015). Finally, a third model defends the rupture of a Paleoproterozoic continent, with opening of basins and formation of oceanic crust, and subsequent closure during the Brasiliano Orogeny, with associated arc magmatism in some parts of the province (Van Schmus et al. 2008; Araujo 2014; Caxito et al. 2020; Araujo et al. 2021).

6.2.1 Piancó-Alto Brígida Subdomain (PABS)

A magmatic arc environment is proposed for the Paleoproterozoic in PABS, with a remarkable generation of continental crust represented by the Piancó (2250 to 2059 Ma) and Itaizinho complexes, along with the intrusion of the Icaiçara Suite (2193 to 2116 Ma). Concomitantly, we would have the deposition of metapelites and marbles with the presence of mafic types of the Parnamirim (2161 to 2108 Ma) and Bom Jesus (2157 Ma) complexes, in fore-arc (Kozuch 2003; Medeiros 2004; Cruz 2015; Brito Neves and Passarelli 2020) (Figure 14A).

Mesoproterozoic is not represented in this part of the TZD, the next record being already in the Tonian. A deep-water environment with deposition on continental crust between 950 and 995 Ma is suggested for the paraderived lithotypes of the Barro and Salgueiro complexes, with subsequent inversion of these basins and possible arc environment formation in the Cryogenian, represented by the Santana dos Garrotes (603 to 685 Ma age of crystallization in metarhyolites) and Serra do Olho d'Agua formations (Figure 14B) (Brito and Fernandes 2021; Brito and Marinho 2017; Brito Neves and Passarelli 2020; Medeiros 2004; Caxito et al. 2021).

The textural immaturity of the Barro and Salgueiro complexes, as well as their zircons spectrum, with little contribution from older sources, suggests that the recycling of pre-existing sedimentary rocks would not be a dominant process in the formation of these basins. Data from the geochronological compilation suggest that sedimentation in the basin currently represented by the Salgueiro complex would have extended by 200 Ma or more, which seems unlikely, since the distribution of the ages in the histogram is typical of active continental margin basins (Cawood et al. 2012). Thus, there are two main explanations for the coexistence of these data: i) what is now mapped as Salgueiro Complex would actually represent two distinct sedimentary basins, one of them Tonian and the other Cryogenian; or (ii) the upper intercept age available for the metarhyolites associated with the Salgueiro Complex would actually represent a population of inherited zircons, not the crystallization age of this rock. Brito and Marinho (2017) describe the zircons analyzed in this metarhyolites as crystals of porous and rounded edges, suggesting the acting of processes after their crystallization, and strengthening the hypothesis that these zircons represent xenocrysts inherited by the magma in question. More geochronological data are necessary to better understand the evolution of the basin today represented by the Salgueiro Complex, as well as its stratigraphic positioning. Until more robust geochronological data are presented, we chose to adopt the conception of Brito and Marinho (2017) of a Tonian deposition for the Salgueiro Complex, and we suggest the existence of a younger, Cryogenian basin, spatially associated with this unit and time-related to the Cachoeirinha Group. It is worth noting that the data available for the Barro and Salgueiro complexes are scarce, and a greater number of analyzes would increase the reliability of this study.

The Ediacaran-Cambrian magmatism is very expressive throughout BP. In PABS, ages between 630 and 620 Ma in the granodiorites of the Conceição Intrusive Suite would represent the pre- to syn-collisional stage of the Brasiliano Orogeny (Sial and Ferreira 2016).

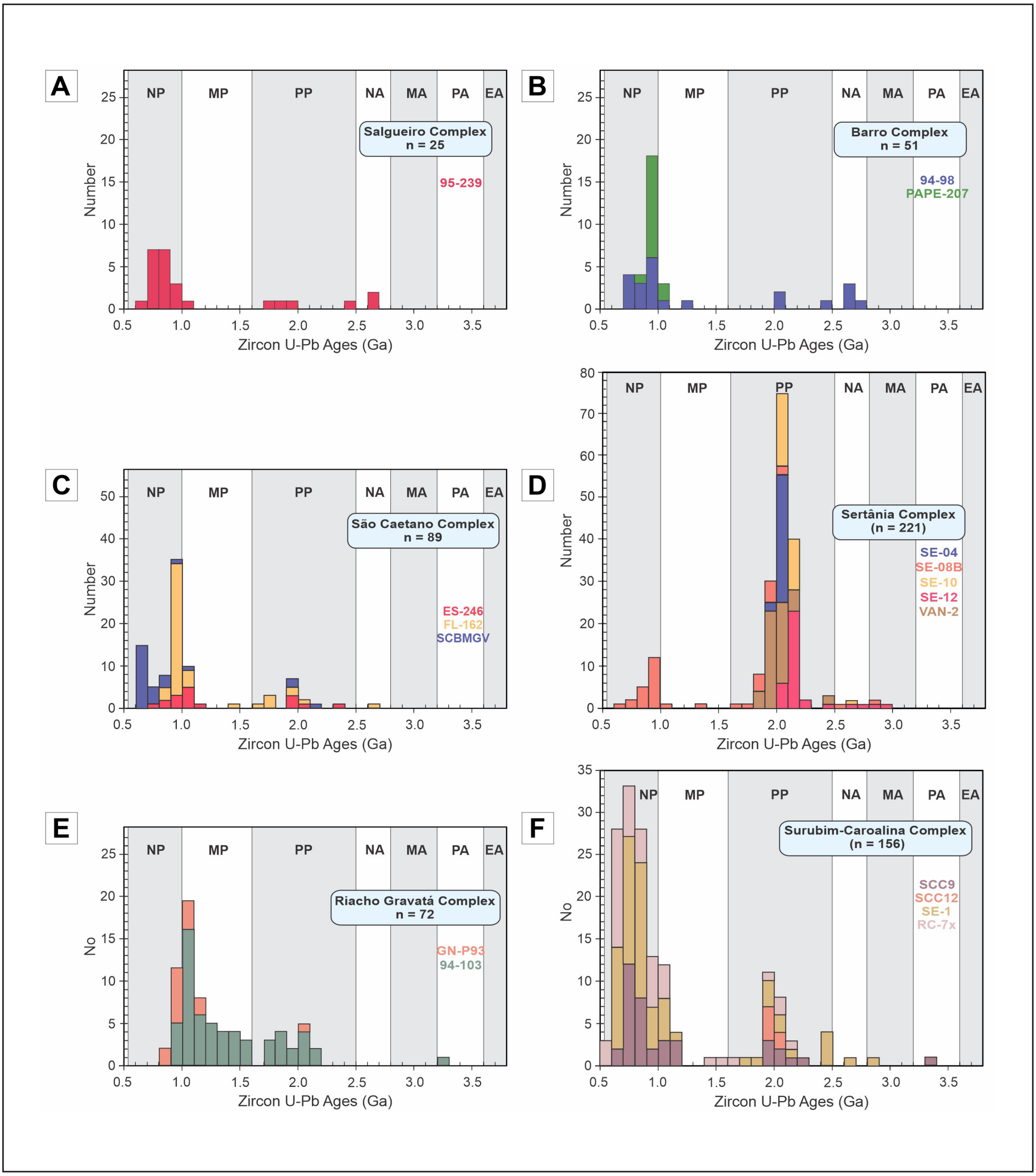

FIGURE 13. (A) Histograms of detrital zircon grains U-Pb ages of Salgueiro Complex in the Piancó-Alto Brígida Subdomain. Data compiled from Van Schmus et al. (2011) in red (95-239); (B) Histograms of detrital zircon grains U-Pb ages of Barro Complex in the Piancó-Alto Brígida Subdomain. Data compiled from Van Schmus et al. (2011) in blue (94-98) and Brito Neves and Passarelli (2020) in green (PAPE-207); (C) Histograms of detrital zircon grains U-Pb ages of the São Caetano Complex in the Alto Moxotó Subdomain. Data compiled from Guimarães et al. (2011a) in red (ES-246) and blue (SCBMGV) and Santos et al. (2019) in yellow (FL-162); (D) Histograms of detrital zircon grains U-Pb ages of Sertânia Complex in the Alto Moxotó Subdomain. Data compiled from Neves et al. (2009) in brown (VAN-2), Neves et al. (2017a) in pink (SE-12) and Neves et al. (2017b) in yellow (SE-10), orange (SE-08B) and blue (SE-04); (E) Histograms of detrital zircon grains U-Pb ages of the Riacho Gravatá Complex in the Alto Pajeú Subdomain. Data compiled from Van Schmus et al. (2011) in green (94-103); Guimarães et al. (2011a) in orange (GN-P93); (F) Histograms of detrital zircon grains U-Pb ages of Surubim-Caroalina Complex in the Rio Capibaribe Subdomain. Data compiled from Neves et al. (2006) in purple (SCC9) and orange (SCC12), Neves et al. (2009) in brown (SE-1) and Brito Neves et al. (2013) in rose (RC-7x). NP: Neoproterozoic; MP: Mesoproterozoic; PP: Paleoproterozoic; NA: Neoarchean; MA: Mesoarchean; PA: Paleoarchean; EA: Eoarchean.

6.2.2 Alto Pajeú Subdomain (APS)

An arc environment is also suggested for the APS basement formation (2.1 Ga) through the emplacement of the Serra Talhada and Afogados da Ingazeira complexes (Brasilino and Morais 2020; Kozuch 2003) (Figure 14A). The Mesoproterozoic does not present occurrence in APS and only in the Tonian there is the record of metavolcanic rocks of the Lagoa das Contendas (995 ± 8 Ma) and the Riacho Gravatá complexes (996 to 964 Ma) and the augen gneisses of the Cariris Velhos Intrusive Suite (995 to 926 Ma), correlated to the Cariris Velhos event (Figure 14B) (Brasilino and Morais 2020; Kozuch 2003; Medeiros 2004; Santos et al. 2010; Guimarães et al. 2012). Following in Neoproterozoic, there is a well-marked record of the Ediacaran-Cambrian magmatism related to the Brasiliano Orogeny. This event is represented by a series of magmatic suites with ages between 616 Ma (Conceição Intrusive Suite) and 591 Ma (Itaporanga Intrusive Suite), placed in pre- and post-collisional environments, respectively (Guimarães et al. 2011b; Archanjo et al. 2008; Medeiros 2004). Probably still in the Neoproterozoic, the metavolcano-sedimentary sequence of the Riacho da Barreira Complex presents intercalation of metamafic and metarythmite, and possibly deposited in a back-arc environment (?) associated with the Brasiliano magmatic arc (Santos 1999; Brito and Marinho 2017).

6.2.3 Alto Moxotó Subdomain (AMS)

The AMS presents the oldest TZD crustal record, with the Meso-Neoarchean rocks derived from a magmatism of TTG type (Brito Neves et al. 2020; Santos et al. 2017) (Figure 14A). In the Rhyacian-Orosirian, this subdomain underwent an orogenic event with arc magmatism and associated basins generation, with Floresta Complex formation, which is superimposed by the metavolcano-sedimentary sequence of Sertânia Complex (Neves et al. 2015; Santos et al. 2013; Lima et al. 1985; Santos 1999; Melo 1998; Medeiros 2000; Gomes 2001; Neves et al. 2017b). In the Paleo-Mesoproterozoic transition (Statherian-Calymmian), an extensional environment is installed, with the emplacement of the anorogenic granitoids of the Carnoió (1.63 Ga), Coloete (1.61 Ga) and Riacho do Navio (1.61 Ga) units, interpreted as intraplate granites (Lages 2017; Brasilino and Miranda 2017; Lages et al. 2019). Geochronological data obtained in the present work suggest that the Serra de Jabitacá Complex may be associated with this same context, with maximum crystallization age at 1790 ± 40 Ma.

At the beginning of the Neoproterozoic there is the deposition/volcanism associated with the São Caetano Complex between 1012 and 858 Ma (Van Schmus et al. 2011; Kozuch 2003; Santos et al. 2010; Guimarães et al. 2012; Santos et al. 2019), and in the Ediacaran the deposition of the Irajaí Complex/Quebra Unha Formation (Fonseca et al. 1996; Kozuch 2003; Lima et al. 2018), as well as the granitogenesis associated with the Brasiliano Orogeny (Figure 14B).

More detailed geological and geochronological studies still need to be conducted to truly understand the stratigraphic positioning and the depositional context of the São Caetano Complex, as well as to evaluate the possibility of a still not individualized Ediacaran basin juxtaposed to it. Detrital zircon grains of ca. 858 to 883 Ma suggest a possible post-Cariris Velhos deposition for the São Caetano complex.

Just as it occurs with the São Caetano Complex, it is expected a younger basin not known yet in the area currently assigned to the Sertânia Complex. If this is the case, the SE-8B sample would not belong to this unit, which would actually have a maximum sedimentation age of 1851 ± 12 Ma (younger zircon, VAN-2 sample). The other possibility, raised in the literature, is that at least part of the Sertânia complex is of Neoproterozoic age (Neves and Alcantara 2010; Neves et al. 2009, 2017b), however, additional geochronological studies are necessary to prove this hypothesis. If this hypothesis is confirmed, the SE-8B sample would in fact be representative of the Sertânia Complex, whose maximum sedimentation age could be estimated at 700 Ma (Neves et al. 2017b; younger peak).

6.2.4 Rio Capibaribe Subdomain (RCS)

The first tectonic event of the RCS corresponds to the crust generation in an arc environment through the implantation of a Rhyacian basement, represented by the rocks of the Vertentes Orthogneiss and Pão de Açúcar and Salgadinho complexes (2.14 to 2.06 GA). In the Orosirian, there is the protoliths intrusion of Buenos Aires, Mata Virgem (1.98 Ga) and Urucuba orthogneisses (Neves et al. 2017a) in a post-collisional phase. From the Paleo- to Mesoproterozoic, there was the emplacement of Passira's Gabbro-Anorthositic Complex (1.72 Ga), Bengala Orthogneiss (1.58 GA) and Serra de Taquaritinga Intrusive Suite (1.52 Ga) (Neves et al. 2017a; Accioly 2000; Sá et al. 2002) in intraplate environment (Figure 14A).

At the beginning of the Neoproterozoic, an island arch environment is suggested for the rocks of the Riacho do Tigre Complex (961 Ma) (Accioly 2015). Prior to the Brasiliano orogeny in this subdomain, there is the deposition of the Surubim-Caroalina Complex with a maximum age between 666 and 640 Ma (Neves et al. 2006; Brito Neves et al. 2013). The Conceição, Itaporanga, Terra Nova intrusive suites and the Santa Cruz do Capibaribe pluton (616 to 592 Ma) represent the syncollisional stage, while the Vila Moderna and Mata Limpa suites could be representing the post-collisional intraplate stage (Figure 14B) (Neves et al. 1996, 2006, 2017a; Guimarães et al. 2004, 2011a; Santos et al. 2020; Accioly 2015).

7. Final remarks

This work brings a review of the lithostratigraphic units that make up the Transversal Zone Domain, which were updated and compatible according to the latest geological-geophysical-structural mapping work of the Geological Service of Brazil (SGB-CPRM) and literature data, allowing to characterize units from Archean to Cambrian.

In order to solidify the geological information, a collection of geochronological data was made in the internal documents of the SGB, in publications of journals and thesis/dissertations made available by the universities.

A orthogneiss dating (U-Pb in zircon) of the Serra de Jabitacá Complex indicate a maximum crystallization age at 1790 ± 40 Ma and metamorphism at 615 ± 3 Ma.

From the geological profiles and schematic drawings representing the tectonic evolution of each subdomain of the Transversal Zone, magmatic arc environments for PABS, magmatic arc and extensional magmatism (intraplate) for APS, AMS and RCS are proposed. Such environments indicate a polyphase evolution for the TZD between the

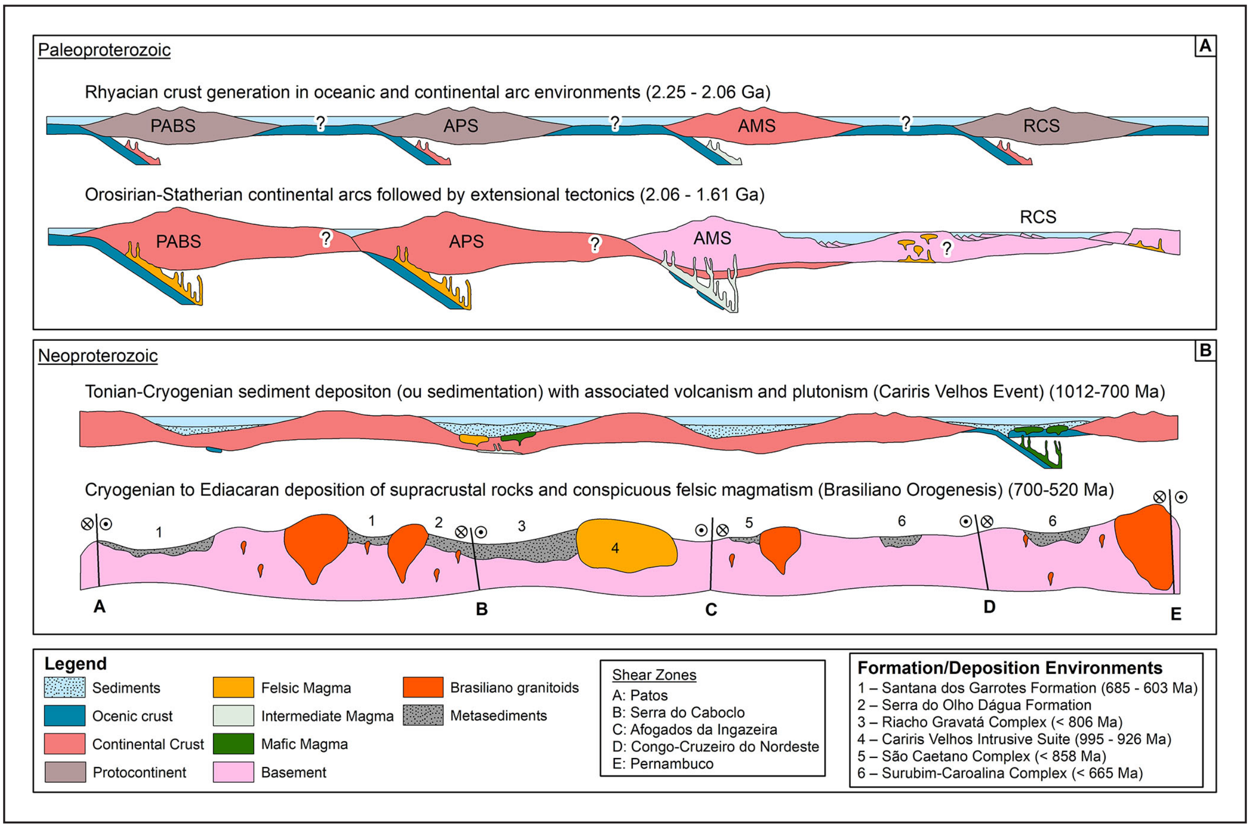

FIGURE 14. Formation/deposition environments in the subdomains of the Transversal Zone Domain in the (A) Paleoproterozoic and (B) Neoproterozoic. PABS: Piancó-Alto Brígida Subdomain; APS: Alto Pajeú Subdomain; AMS: Alto Moxotó Subdomain; RCS: Rio Capibaribe Subdomain.

Paleoproterozoic and Neoproterozoic, with periods in which collisional/accretionary processes predominate, alternating to extensional cycles.

Acknowledgements

The authors thank the Geological Service of Brazil – SGB/CPRM for carrying out the Geology and Mineral Potential of the Borborema Province Project and for the authorization of the data disclosure acquired in this project and presented in this study. We thank the Center of Geochronological Research of the University of São Paulo (CPGeo - IGC - USP) for helping to recover raw data for the geochronological compilation. We also thank the Editor-in-Chief of the Journal of the Geological Survey of Brazil, Evandro Klein and the reviewers, who contributed to the publication of this work.

Authorship credits

Author	A	B	C	D	E	F
FGS	■	■	■	■	■	■
CFB			■	■	■	
FJCL		■				
RGB		■				
VCM					■	
DMFM					■	
TRGP					■	
JSS		■				

A - Study design/Conceptualization **B** - Investigation/Data acquisition
C - Data Interpretation/Validation **D** - Writing
E - Review/Editing **F** - Supervision/Project administration

References

Accioly A.C.A. 2000. Geologia, geoquímica e significado tectônico do complexo Metanortosítico de Passira, província Borborema, nordeste do Brasil. PhD Thesis, Instituto de Geociências, Universidade de São Paulo, São Paulo, 168 p. https://doi.org/10.11606/T.44.2001.tde-27102015-130049 .

Accioly A.C.A. 2015. Geologia e recursos minerais da folha Pesqueira, folha SC.24-X-B-II: estados de Pernambuco e Paraíba. Escala 1:100.000. Recife, CPRM. Available online at: https://rigeo.cprm.gov.br/handle/doc/22143/ (accessed on 24 January 2023).

Almeida C.N., Guimarães I.P., Silva Filho A.F. 2002. A-Type Post-Collisional Granites in the Borborema Province – NE Brazil: The Queimadas Pluton. Gondwana Research, 5(3), 667-681. https://doi.org/10.1016/S1342-937X(05)70637-7 .

Almeida F.F.M., Hasui Y., Brito Neves B.B., Fuck R.A. 1981. Brazilian Structural Provinces: An Introduction. Earth-Science Reviews, 17(1-2), 1-29. https://doi.org/10.1016/0012-8252(81)90003-9 .

Ancelmi M.F. 2016. Geocronologia e geoquímica das rochas arqueanas do Complexo Granjeiro, Província Borborema. PhD Thesis, Instituto de Geociências, Universidade Estadual de Campinas, Campinas, 159 p. https://doi.org/10.47749/T/UNICAMP.2016.979098 .

Angelim L.A.A., Nesi J.R., Torres H.H.F., Medeiros V.C., Santos C.A., Veiga Junior J.P., Mendes V.A. 2006. Geologia e recursos minerais do estado do Rio Grande do Norte. Texto explicativo dos mapas geológico e de recursos minerais do estado do Rio Grande do Norte: Escala 1:500.000. Programa de Geologia do Brasil, Recife, CPRM, 119 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/10234 / (accessed on 24 January 2023).

Araujo C.E.G. 2014. Evolução tectônica da margem ativa Neoproterozóica do Orógeno Gondwana Oeste na Província Borborema (NE-Brasil). PhD Thesis, Instituto de Geociências, Universidade de São Paulo, São Paulo, 243 p. https://doi.org/10.11606/T.44.2014.tde-25092014-144415 .

Araujo C.E.G., Weinberg R.F., Caxito F.A., Lopes L.B.L., Tesser L.R., Costa I.S. 2021. Decratonization by rifting enables orogenic reworking and transcurrent dispersal of old terranes in NE Brazil. Scientific Reports, 11, 5719. https://doi.org/10.1038/s41598-021-84703-x .

Archanjo C.J., Hollada M.H.B.M., Rodrigues S.W.O., Brito Neves B.B., Armstrong R. 2008. Fabrics of pre- and syntectonic granite plutons and chronology of shear zones in the Eastern Borborema Province, NE Brazil. Journal of Structural Geology, United Kingdom, 30(3), 310-326. https://doi.org/10.1016/j.jsg.2007.11.011 .

Bittar S.M.B. 1998. Faixa Piancó-Alto Brígida: Terreno tectonoestrutural sob regimes metamórficos e deformacionais contrastantes. PhD Thesis, Instituto de Geociências, Universidade de São Paulo, São Paulo, 126 p. https://doi.org/10.11606/T.44.1999.tde-18112015-101917

Bittar S.M.B., Guimarães I.P., Barreto S.B. 2014. Folha Serra Talhada - SB-24-Z-C-V, Escala 1:100.000. Programa Levantamentos Geológicos Básicos do Brasil, Recife, CPRM. Available online at: https://rigeo.cprm.gov.br/handle/doc/18378 / (accessed on 24 January 2023).

Bizzi L.A., Schobbenhaus C., Vidotti R.M., Gonçalves J.H. 2003. Geologia, tectônica e recursos minerais do Brasil: texto, mapas e SIG. Brasília, CPRM, 674 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/5006 / (accessed on 25 January 2023).

Brasilino R.G., Miranda A.W.A. 2017. Geologia e Recursos Minerais da Folha Santa Cruz do Capibaribe SB-24-Z-D-VI: estado de Pernambuco. Programa Geologia do Brasil, Recife, CPRM, 140 p. Available online at: https://rigeo.cprm.gov.br/xmlui/handle/doc/17663 / (accessed on 6 February 2023).

Brasilino R.G., Morais D.F.M. 2020. Geologia e recursos minerais da folha Mirandiba SC.24-X-A-I: estado de Pernambuco. Programa Geologia do Brasil, Recife, CPRM, 169 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/21294 / (accessed on 25 January 2023).

Brito Neves B.B. 1983. O mapa geológico do Nordeste oriental do Brasil, escala 1:1.000.000. Habilitation Thesis, Instituto de Geociências, Universidade de São Paulo, São Paulo, Brasil. 177 p. https://doi.org/10.11606/T.44.2013.tde-30102013-131731 .

Brito Neves B.B., Passarelli C.R. 2020. Terrenos tectonoestratigráficos dispersos do embasamento pré Brasiliano (São José do Caiana, Açude Coremas e Icaiçara) na porção centro-oeste da Zona Transversal (Paraíba, Ceará e Pernambuco). Geologia USP, Série Científica, 20(3), 81–105. https://doi.org/10.11606/issn.2316-9095.v20-159425 .

Brito Neves B.B., Passarelli C.R., Basei M.A.S., Santos E.J. 2003. Idades U-Pb em zircão de alguns granitos clássicos da Província Broborema. Geologia USP, Série Científica, São Paulo, 3, 25-38. https://doi.org/10.5327/S1519-874X2003000100003 .

Brito Neves B.B., Santos E.J., Van Schmus W.R. 2000. Tectonic history of the Borborema Province, Northeastern Brazil. In: Cordani U., Milani E.J., Thomaz Filho A., Campos D.A. (eds.). Tectonic evolution of South America. Rio de Janeiro, 31st International Geological Congress, p. 151–182. Available online at: https://rigeo.cprm.gov.br/handle/doc/19419 / (accessed on 25 January 2023).

Brito Neves B.B., Sproesser W.M., Petronilho L.A., Souza S.L. 2013. Contribuição a geologia e geocronologia do Terreno Rio Capibaribe (TRC, Província Borborema). Geologia USP, Série Científica 13(2), 97-122. https://doi.org/10.5327/Z1519-874X2013000200006 .

Brito Neves B.B., Van Shmus W.R., Santos L.C.M. 2020. Alto Moxotó Terrane, a fragment of Columbia supercontinent in the Transversal Zone interior: Borborema Province, Northeast Brazil. Brazilian Journal of Geology, 50(2). https://doi.org/10.1590/2317-4889202020190077 .

Brito M.F.L., Fernandes P.R. 2021. Geologia e recursos minerais da folha Cruz de Malta SC.24-V-B-I: estado de Pernambuco. Programa Geologia do Brasil, Recife, CPRM, 137 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/18462/ (accessed on 25 January 2023).

Brito M.F.L., Marinho M.S. 2017. Geologia e recursos minerais da folha Salgueiro SC.24-V-B-III: escala 1:100.000, estado de Pernambuco. Programa Geologia do Brasil, Recife, CPRM, 207 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/17660 / (accessed on 25 January 2023).

Caby R., Sial A.N., Arthaud M.H., Vauchez A. 1991. Crustal evolution and the Brasiliano Orogeny in Northeast Brazil. In: Dallmeyer R.D., Lecorche J.P. (eds.). The West African orogens and circum-Atlantic correlatives. Berlin, Springer-Verlag. p. 373-397. Available online at: https://link.springer.com/chapter/10.1007/978-3-642-84153-8_16 / (accessed on 25 January 2023).

Castro N.A. 2004. Evolução geológica proterozoica da região entre Madalena e Taperuaba, domínio tectônico Ceará Central (Província Borborema). PhD Thesis, Instituto de Geociências, Universidade de São Paulo, São Paulo, 221 p. https://doi.org/10.11606/T.44.2005.tde-31032015-112038 .

Cawood P.A., Hawkesworth C.J., Dhuime B. 2012. Detrital zircon record and tectonic setting. Geology 40(10), 875-878. https://doi.org/10.1130/G32945.1 .

Caxito F.A., Basto C.F., Santos L.C.M.L., Dantas E.L., Medeiros V.C., Dias T.G., Barrote V., Hagemann S., Alkmim A.R., Lana C. 2021. Neoproterozoic magmatic arc volcanism in the Borborema Province, NE Brazil: possible flare-ups and lulls and implications for western Gondwana assembly. Gondwana Research 92, 1-25. https://doi.org/10.1016/j.gr.2020.11.015 .

Caxito F.A., Santos L.C.M.L., Araujo C.E.A., Bendaoud A., Fettous E., Bouyo M.H. 2020. Toward an integrated model of geological evolution for NE Brazil–NW Africa: The Borborema Province and its connections to the Trans-Saharan (Benino-Nigerian and Tuareg shields) and Central African orogens. Brazilian Journal of Geology, 50(2), 1-38. https://doi.org/10.1590/2317-4889202020190122 .

Costa F.G. 2017. Geologia e recursos minerais da folha Crateús – SB-24-V-C-III, estados do Ceará e Piauí: Escala 1:100.000. Fortaleza, CPRM, 119 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/19025 / (accessed on 25 January 2023).

Cruz R.F. 2015. Geologia e recursos minerais da folha Parnamirim SC.24-V-B-II: estado de Pernambuco. Programa Geologia do Brasil, Recife, CPRM, 146 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/15951 / (accessed on 26 January 2023).

Cruz R.F. 2014. Estudo isotópico aplicado a caracterização geotectônica do Domínio Pernambuco-Alagoas Oeste, Província Borborema, região nordeste do Brasil. MSc Dissertation, Universidade Federal do Rio Grande do Sul, Porto Alegre, 159 p. Available online at: http://hdl.handle.net/10183/171570 / (accessed on 26 January 2023).

Dantas E.L., Souza Z.S., Wernick E., Hackspacher P.C., Martin H., Xiaodong D., LI J.W. 2013. Crustal growth in the 3.4–2.7 Ga São José de Campestre Massif, Borborema Province, NE Brazil. Precambrian Research, 227, 120-156. https://doi.org/10.1016/j.precamres.2012.08.006 .

Delgado I.M., Souza J.D., Silva L.C., Silveira Filho N.C., Santos R.A., Pedreira A.J., Guimarães J.T., Angelim L.A.A., Vasconcelos A.M., Gomes I.P., Lacerda Filho J.V., Valente C.R., Perrotta M.M., Heineck C.A. 2003. Geotectônica do Escudo atlântico. In: Bizzi L.A., Schobbenhaus C., Vidotti R.M., Gonçalves J.H. Geologia, tectônica e recursos minerais do Brasil: texto, mapas e SIG. Brasília, CPRM, p. 227-334. Available online at: https://rigeo.cprm.gov.br/handle/doc/5006 / (accessed on 26 January 2023).

Ebert H. 1962. Bastil und regional metamorphose in Prakambrischen grundgebirge brasiliens. Tschermarks Min. U. Petr. Mitt., 8, 49-81.

Ferreira A.C.D., Dantas E.L., Fuck R.A., Nedel I.M. 2020. Arc accretion and crustal reworking from late Archean to Neoproterozoic in Northeast Brazil. Scientific Reports, 10, 7855. https://doi.org/10.1038/s41598-020-64688-9 .

Ferreira C.A., Santos E.J. 2000. Jaguaribe SE, folha SC.24-Z: estados do Ceará, Rio Grande do Norte, Paraíba e Pernambuco. Programa levantamentos geológicos básicos do Brasil, Rio de Janeiro, CPRM. 1 CD-ROM. Available online at: https://rigeo.cprm.gov.br/handle/doc/5359 / (accessed on 26 January 2023).

Ferreira V.P., Sial A.N., Pimentel M.M., Moura C.A.V. 2004. Intermediate to acidic magmatism and crustal evolution in the Transversal Zone, Northeastern Brazil. In: Mantesso-Neto V., Bartorelli A., Carneiro C.D.R., Brito Neves B.B. (eds.). Geologia do Continente Sul-Americano - Evolução da Obra de Fernando Flávio Marques de Almeida. Beca, São Paulo, p. 189-201.

Fonseca A.S.S., Guimarães I.P., Beurlen H., Almeida C.N. 1996. Caracterização geoquímica das rochas metavulcânicas do complexo Irajaí a NW de Sertania-PE. In: Congresso Brasileiro de Geologia, 39, 6-8. Available online at: http://www.sbgeo.org.br/home/pages/44 / (accessed on 26 January 2023).

França R.H.M., Neves S.P., Bezerra J.P.S., Bruguier O. 2019. Geochemistry and Geochronology of Orthogneisses across a Major Transcurrent Shear Zone (East Pernambuco Shear Zone, Borborema Province, Northeast Brazil): Tectonic Implications. Journal of South American Earth Sciences 91, 285–301. https://doi.org/10.1016/j.jsames.2019.02.015 .

Freimann M.A. 2014. Geocronologia e petrotrama de quartzo milonitos do duplex transcorrente de Lavras da Mangabeira. MSc Dissertation, Instituto de Geociências, Universidade de São Paulo, São Paulo, 83 p. https://doi.org/10.11606/D.44.2014.tde-26112014-144455 .

Gomes H.A. 2001. Geologia e recursos minerais do Estado de Pernambuco. Projeto de Mapeamento Geológico/Metalogenético Sistemático, Recife, CPRM, AD/DIPER, DNPM, 198 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/2422 / (accessed on 27 January 2023).

Gomes I.P., Palheta E.S.M., Braga I.F., Costa F.G., Souza F.R.F.R.O., Rocha J.M.A., Freire D.P.C., Holanda J.L.R. 2021. Projeto mapeamento geológico e integração geológica-geofísica-geoquímica na região de Granjeiro – Cococi, Ceará: escalas 1:250.000, 1:100.000, 1:50.000 – estado do Ceará. Fortaleza, CPRM, 175 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/18691 / (accessed on 27 January 2023).

Gomes J.R.C., Gatto C.M.P.P., Souza G.M.C., Luz D.S., Pires J.L., Teixeira W. 1981. Geologia, mapeamento regional. Folhas SB. 24/25 Jaguaibe/Natal: Texto e mapa. Projeto RADAMBRASIL, Ministério de Minas e Energia, 23, 27-176.

Guimarães I.P., Bittar S.M.B., Farias D.J.S., Silva L.H.N., Yadav R., Nery N. 2014. Folha Guarabira - SC-25-Y-A-V, Escala 1:100.000. Programa Levantamentos Geológicos Básicos do Brasil, Recife, CPRM. Available online at: https://rigeo.cprm.gov.br/handle/doc/18299 / (accessed on 30 January 2023).

Guimarães I.P., Bittar S.M.B., Farias D.J.S., Yadav R., Almeida C.N. 2017. Geologia e recursos minerais da folha Sapé SB.25-Y-C-II: estados da Paraíba e Pernambuco. Programa Levantamentos Geológicos Básicos do Brasil, Recife, CPRM, 75 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/17720 / (accessed on 30 January 2023).

Guimarães I.P., Silva Filho A.F., Almeida C.N., Macambira M.J.B., Armstrong R. 2011a. U-Pb SHRIMP data constraints on calc-alkaline granitoids with 1.3-1.6 Ga Nd TDM model ages from the central domain of the Borborema province, NE Brazil. Journal of South American Earth Sciences, 31(4), 383-396. https://doi.org/10.1016/j.jsames.2011.03.001 .

Guimarães I.P., Silva Filho A.F., Almeida C.N., Van Schmus W.R., Araújo J.M.M., Melo S.C., Melo E.B. 2004. Brasiliano (Pan-African) granitic magmatism in the Pajeú-Paraíba belt, Northeast Brazil: an isotopic and geochronological approach. Precambrian Research 135(1-2), 23-53. http://dx.doi.org/10.1016%2Fj.precamres.2004.07.004 .

Guimarães I.P., Silva Filho A.F., Silva F.M.J.V., Armstromg R. 2011b. U-Pb SHRIMP data and geochemical characterization of granitoids intruded along the Coxixola shear zone, Provincia Borborema, NE Brazil. In: Congresso Brasileiro de Geoquímica, 13, 2, 729-732. Available online at: https://www.sbgq.org.br/anais-dos-congressos / (accessed on 30 January 2023).

Guimarães I.P., Van Schmus W.R., Brito Neves B.B., Bittar S.M.B., Silva Filho A.F., Armstrong R. 2012. U–Pb zircon ages of orthogneisses and supracrustal rocks of the Cariris Velhos belt. Precambrian Research, 192–195, 52–77. https://doi.org/10.1016/j.precamres.2011.10.008 .

Hollanda M.H.B.M., Archanjo C.J., Souza L.C., Armstrong R., Vasconcelos P.M. 2010. Cambrian mafic to felsic magmatism and its connections with the transcurrent shear zones of the Borborema province (NE Brazil): implications for the late assembly of the West Gondwana. Precambrian Research, 178(1-4), 1-14. https://doi.org/10.1016/j.precamres.2009.12.004 .

Jardim de Sá E.F. 1994. A faixa Seridó (província Borborema, NE do Brasil) e seu significado geodinâmico na cadeia brasiliana/pan-africana. PhD Thesis, Instituto de Geociências, Universidade de Brasília, Brasília, 804 p.

Kozuch M. 2003. Isotopic and trace element geochemistry of early neoproterozoic gneissic and metavolcanic rocks in the Cariris Velhos orogen of the Borborema Province, Brazil, and their bearing on tectonic setting. PhD Thesis, Department of Geology, University of Kansas, Kansas, 199 p.

Lages G.A. 2017. Geologia e recursos minerais da folha Boqueirão SB.24-Z-D-III: estado da Paraíba - Escala 1:100.000. Programa Levantamentos Geológicos Básicos do Brasil, Recife, CPRM, 167 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/17654 / (accessed on 30 January 2023).

Lages G.A., Santos L.C.M.L., Dantas E.L., Brasilino R.G., Rodrigues J.B. 2019. Statherian-Calymmian (ca. 1.6-Ga) magmatism in the Alto Moxotó Terrane, Borborema Province, northeast Brazil: Implications for within-plate and coeval collisional tectonics in West Gondwana. Journal of South American Earth Sciences, 91, 116-130. https://doi.org/10.1016/j.jsames.2019.02.003 .

Leite P.R.B. 1997. Petrologia, geoquímica de supracrustais e granitóides do Terreno Alto Pajeú na folha Monteiro - Província Borborema, Nordeste Brasileiro. PhD Thesis, Centro de Tecnologia e Geociências, Universidade Federal de Pernambuco, Recife, 109 p.

Lima F.J.C., Brasilino R.G., Horn B.L.D., Morais D.M.F., Lages G.A. 2018. Projeto Alto Moxotó, estados de Pernambuco, Paraíba, Alagoas e Bahia: Mapa Geológico-Geofísico. Escala 1:250.000. Levantamento Geológico e de Potencial Mineral de Novas Fronteiras, Recife, CPRM. Available online at: https://rigeo.cprm.gov.br/handle/doc/18557 / (accessed on 30 January 2023).

Lima M.I.C., Gava A., Fernandes P.E.C.A., Pires J.L., Siga Júnior O. 1985. Projeto ferro titanado de Floresta, PE. Projeto RADAMBRASIL, Salvador, Minérios de Pernambuco, 1.

Ludwig K.R. 2003. Isoplot 3.00: A geochronological toolkit for Microsoft Excel. Berkeley Geochronology Center, Berkeley, 70.

Medeiros V.C. (org.). 2000. Aracaju NE folha SC.24-X. Estados da Paraíba, Pernambuco, Alagoas, Sergipe e Bahia. Programa Levantamentos Geológicos Básicos do Brasil, Brasília, CPRM, 95 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/2757 / (accessed on 30 January 2023).

Medeiros V.C. 2004. Evolução geodinâmica e condicionamento estrutural dos terrenos Piancó-Alto Brígida e Alto Pajeú, Domínio da Zona Transversal, NE do Brasil. PhD Thesis, Pós-graduação em Geodinâmica e Geofísica, Universidade Federal do Rio Grande do Norte, Natal, 200 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/105 / (accessed on 30 January 2023).

Medeiros V.C., Cavalcanti R., Cunha A.L.C., Dantas A.R., Costa A.P., Brito A.A., Rodrigues J.B., Silva M.A. 2017. O furo estratigráfico de Riacho Fechado (Currais Novos/Rn), Domínio Rio Piranhas-Seridó (Província Borborema, NE Brasil): Procedimentos e resultados. Estudos Geológicos, 27(3). Available online at: https://periodicos.ufpe.br/revistas/estudosgeologicos/article/view/235881 / (accessed on 30 January 2023).

Medeiros V.C., Jardim de Sá E.F. 2009. O Grupo Cachoeirinha (Zona Transversal, NE do Brasil) Redefinição e Proposta de Formalização. Revista de Geologia, 22(2), 124-136.

Medeiros V.C., Torres H.H.F. 2000. Sumé, folha SB.24-Z-D-V: estados da Paraíba e Pernambuco: geologia e hidrogeologia. Programa Levantamentos Geológicos Básicos do Brasil, Brasília, CPRM, 88 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/3066 / (accessed on 30 January 2023).

Mello A.A., Siqueira L.P. 1971. Novas considerações sobre a geologia do pré-cambriano de Pernambuco Oriental. Revista da Associação dos Geólogos de Pernambuco, Recife, 1(2), 32-41.

Melo O.O. 1998. Petrologia e geoquímica das rochas gabro-anortosíticas e mineralizações de Fe-Ti associadas de Barro Vermelho - Custódia-PE, NE do Brasil. PhD Thesis, Pós-graduação em Geociências, UFPE, Recife, 216 p.

Neves S.P. 2003. Proterozoic history of the Borborema Province (NE Brazil): correlations with neighboring cratons and Pan-African belts, and implications for the evolution of western Gondwana. Tectonics, 22, 1031. https://doi.org/10.1029/2001TC001352.

Neves S.P. 2015. Constraints from zircon geochronology on the tectonic evolution of the Borborema Province (NE Brazil): Widespread intracontinental Neoproterozoic reworking of a Paleoproterozoic accretionary orogen. Journal of South American Earth Sciences, 58, 150-164. https://doi.org/10.1016/j.jsames.2014.08.004 .

Neves S.P. 2021. Comparative geological evolution of the Borborema Province and São Francisco Craton (eastern Brazil): Decratonization and crustal reworking during West Gondwana assembly and implications for paleogeographic reconstructions. Precambrian Research 355, 106119. https://doi.org/10.1016/j.precamres.2021.106119 .

Neves S.P., Alcantara V.C. 2010. Geochemistry of orthogneisses and metasedimentary rocks across a proposed terrane boundary in the Central Domain of Borborema Province, NE Brazil: Geodynamic implications. Journal of South American Earth Sciences, 29(2), 498-511. https://doi.org/10.1016/j.jsames.2009.08.002 .

Neves S.P., Bruguier O., Silva J.M.R., Bosch D., Alcantara V.C., Lima C.M. 2009. The age distributions of detrital zircons in metasedimentary sequences in eastern Borborema Province (NE Brazil): Evidence for intracontinental sedimentation and orogenesis? Precambrian Research 175(1-4), 187-205. https://doi.org/10.1016/j.precamres.2009.09.009 .

Neves S.P., Bruguier O., Vauchez A., Bosch D., Silva J.M.R., Mariano G. 2006. Timing of crust formation, deposition of supracrustal sequences, and Transamazonian and Brasiliano metamorphism in the East Pernambuco belt (Borborema Province, NE Brazil): implications for western Gondwana assembly. Precambrian Research, 149(3-4), 197–216. https://doi.org/10.1016/j.precamres.2006.06.005 .

Neves S.P., Lages G.A., Brasilino R.G., Miranda A.W.A. 2015. Paleoproterozoic accretionary and collisional processes and the build-up of the Borborema Province (NE Brazil): geochronological and geochemical evidence from the Central Domain. Journal of South American Earth Sciences, 58, 165-187. https://doi.org/10.1016/j.jsames.2014.06.009 .

Neves S.P., Mariano G., Silva J.M.R. 2017a. Geologia e recursos minerais da folha Surubim SB.25-Y-C-IV: estados de Pernambuco e da Paraíba. Recife, CPRM, 96 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/17775 / (accessed on 31 January 2023).

Neves S.P., Silva J.M.R., Bruguier O. 2017b. Geometry, kinematics and geochronology of the Sertânia Complex (central Borborema Province, NE Brazil): Assessing the role of accretionary versus intraplate processes during West Gondwana assembly. Precambrian Research, 298, 552–571. https://doi.org/10.1016/j.precamres.2017.07.006 .

Neves S.P., Vauchez A., Archanjo C.J. 1996. Shear Zone Controlled Magma Emplacement or Magma-Assisted Nucleation of Shear Zones? Insights from Northeast Brazil. Tectonophysics, 262(1-4), 349-364. https://doi.org/10.1016/0040-1951(96)00007-8 .

Pedrosa-Soares A.C., Alkmim F.F. 2011. How Many Rifting Events Preceded The Development Of The Araçuaí-West Congo Orogen? Geonomos, 19(2), 244-251. https://doi.org/10.18285/geonomos.v19i2.56 .

Pitarello M.Z., Santos T.J.S., Ancelmi M.F. 2019. Syn-to Post-Depositional Processes Related to High Grade Metamorphic BIFs: Geochemical and Geochronological Evidences from a Paleo to Neoarchean (3.5–2.6 Ga) Terrane in NE Brazil. Journal of South American Earth Sciences, 96, 102312. https://doi.org/10.1016/j.jsames.2019.102312 .

Ptombeira J.P.A., Amaral W.S., Santos T.J.S., Dantas E.L., Fuck R.A. 2021. A new record of continental arc magmatism in the Ceará Central Domain, Borborema Province (NE Brazil): evidence from the Pacatuba-Maranguape Complex. Precambrian Research 359, 106192. https://doi.org/10.1016/j.precamres.2021.106192 .

Rodrigues S.W.O. 2008. Evolução estrutural brasiliana da Província Borborema na região de Campina Grande (PB). PhD Thesis, Universidade de São Paulo, São Paulo, 178 p. https://doi.org/10.11606/T.44.2008.tde-18082008-144145 .

Rodrigues S.W.O., Medeiros V.C., Marinho M.S., Oliveira R.G. 2015. Geologia e recursos minerais da folha Campina Grande SB.25-Y-C-I: estados da Paraíba e Pernambuco. Programa Geologia do Brasil, Recife, CPRM, 80 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/18453 / (accessed on 31 January 2023).

Sá J.M., Bertrand J.M., Leterrier J., Macedo M.H.F. 2002. Geochemistry and geochronology of pre-Brasiliano rocks from the Transversal zone, Borborema province, northeast Brazil. Journal of South American Earth Sciences, 14(8), 851-866. https://doi.org/10.1016/S0895-9811(01)00081-5 .

Santos C.A. 2012. Cinturão de Cisalhamento Congo – Cruzeiro do Nordeste, uma descontinuidade crustal no domínio da Zona Transversal, Província Borborema. PhD Thesis, Universidade Federal de Pernambuco, Recife, 152 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/442 / (accessed on 31 January 2023).

Santos C.A., Brito M.F.L., Pereira C.S., Fernandes P.R. 2020. Levantamento geológico e de potencial mineral de novas fronteiras: Projeto Rio Capibaribe, Escala 1:250.000. Recife, CPRM. Available online at: https://rigeo.cprm.gov.br/handle/doc/18542 / (accessed on 31 January 2023).

Santos E.J. (org.). 1999. Belém do São Francisco, folha SC.24-X-A: estados de Pernambuco, Alagoas e Bahia. Escala 1:250.000. Programa Levantamentos Geológicos Básicos do Brasil, Rio de Janeiro, CPRM, 68 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/8471 / (accessed on 31 January 2023).

Santos E.J., Brito Neves B.B. 1984. Província Borborema. In: Almeida F.F.M., Hasui Y. (eds.). O Pré-cambriano do Brasil. São Paulo, Ed. Edgard Blucher, p. 123-186.

Santos E.J., Coutinho M.G.N., Costa M.P.A., Ramalho R. 1984. A região de Dobramentos Nordeste e a Bacia do Parnaíba, incluindo o Craton de São Luís e as bacias marginais. In: Schobbenhaus C., Campos D.A., Derze G.R., Asmus H.E. (eds.). Geologia do Brasil. Texto explicativo do mapa geológico do Brasil e da área oceânica adjacente, incluindo depósitos minerais. Brasília, Departamento Nacional de Produção Mineral, p. 131-189.

Santos E.J., Medeiros V.C. 1999. Constraints from granitic plutonism on proterozoic crustal growth of the Transverse Zone, Borborema Province, NE-Brazil. Revista Brasileira de Geociências 29(1), 73-84. http://dx.doi.org/10.25249/0375-7536.1999297384 .

Santos E.J., Nutman A.P., Brito Neves B.B. 2004. Idades SHRIMP U-Pb do Complexo Sertânia: Implicações sobre a evolução tectônica da Zona Transversal, Província Borborema. Geologia USP, Série Científica, São Paulo, 4(1), 1-12. http://dx.doi.org/10.5327/s1519-874x2004000100001 .

Santos E.J., Souza Neto J.A., Carmona L.C.M., Armstrong R., Santos L.C.M.L., Mendes L.U.S. 2013. The metacarbonate rocks of Itatuba (Paraíba): a record of sedimentary recycling in a Paleoproterozoic collision zone of the Borborema province, NE Brazil. Precambrian Research, 224, 454-471. https://doi.org/10.1016/j.precamres.2012.09.021 .

Santos E.J., Van Schmus W.R., Kozuch M., Brito Neves B.B. 2010. The Cariris Velhos tectonic event in Northeast Brazil. Journal of South American Eath Sciences, 29(1), 61-76. https://doi.org/10.1016/j.jsames.2009.07.003 .

Santos F.G., Pinéo T.R.G., Medeiros V.C., Santana J.S., Moraes D.M.F., Vale J.A.R., Wanderley A.A. 2021. Mapa geológico da Porvíncia Borborema, Escala 1:1.000.000. Projeto Geologia e Potencial Mineral da Província Borborema, Recife, CPRM. Available online at: https://rigeo.cprm.gov.br/handle/doc/22508 / (accessed on 30 January 2023).

Santos L.C.M.L., Dantas E.L., Cawood P.A., Lages G.A., Lima H.M., Santos E.J., Caxito F.A. 2019. Early to late Neoproterozoic subduction-accretion episodes in the Cariris Velhos Belt of the Borborema Province, Brazil: Insights from isotope and whole-rock geochemical data of supracrustal and granitic rocks. Journal of South American Earth Sciences, 96, 102384. https://doi.org/10.1016/j.jsames.2019.102384 .

Santos L.C.M.L., Dantas E.L., Cawood P.A., Santos E.J., Fuck R.A. 2017. Neoarchean crustal growth and Paleoproterozoic reworking in the Borborema Province, NE Brazil: Insights from geochemical and isotopic data of TTG and metagranitic rocks of the Alto Moxotó Terrane. Journal of South American Earth Sciences, 79, 342-363. https://doi.org/10.1016/j.jsames.2017.08.013 .

Santos L.C.M.L., Dantas E.L., Santos E.J., Santos R.V., Lima H.M. 2015. Early to late Paleoproterozoic magmatism in NE Brazil: the Alto Moxotó Terrane and its tectonic implications for the pre-West Gondwana assembly. Journal of South American Earth Sciences, 58, 188-209. https://doi.org/10.1016/j.jsames.2014.07.006 .

Sial A.N., Ferreira V.P. 2016. Magma associations in Ediacaran granitoids of the Cachoeirinha–Salgueiro and Alto Pajeú terranes, northeastern Brazil: Forty years of studies. Journal of South American Earth Sciences, 68, 113-133. https://doi.org/10.1016/j.jsames.2015.10.005 .

Silva Filho M.A. 1984. A Faixa de Dobramentos Piancó: Síntese do conhecimento e novas considerações. In: Congresso Brasileiro de Geologia, 33, 1, 3337-3347. Available online at: http://www.sbgeo.org.br/home/pages/44 / (accessed on 31 January 2023).

Silva E.G. 2013. Petrologia e geoquímica do magmatismo da suíte Fazenda Salvador, área Mogeiro – Gurinhém - Cajá, Paraíba. MSc Dissertation, Universidade Federal de Pernambuco, Recife, 101 p. Available online at: https://repositorio.ufpe.br/handle/123456789/10406 / (accessed on 31 January 2023).

Silva J.M.R., Lima E.S., Sales A.O., Moura C.A.V., Scheller T. 1996. Datação pelo método de evaporação de Pb de granitos cinza foliados da infra-estrutura da Faixa Pajeú-Paraíba. In: Congresso Brasileiro de Geologia, 39, 519-521. Available online at: http://www.sbgeo.org.br/home/pages/44 / (accessed on 31 January 2023).

Silva L.C., Mcnaughton N.J., Vasconcelos A.M., Gomes J.R.C., Fletcher I.R. 1997. U-Pb SHRIMP ages in Southern State of Ceará, Borborema Province, NE Brazil: TTG accretion and Proterozoic crustal reworking. In: International Symposium on Granites and Associated Mineralizations, 2., 280-281.

Teixeira M.L.A. 2005. Integração de dados aerogeofísicos, geológicos e isotópicos do limite norte do Complexo Tamboril - Santa Quitéria – CE (Província Borborema). MSc Dissertation, Instituto de Geociências, Universidade de Brasília, Brasília, 91 p.

Vale J.A.R. 2018. Caracterização geoquímica e geocronológica do Complexo Granjeiro, Província Borborema, NE Brasil: implicações para a evolução crustal paleoarqueana do distrito ferrífero de Curral Novo do Piauí. MSc Dissertation, Instituto de Geociências, Universidade de São Paulo, São Paulo, 126 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/20818 / (accessed on 31 January 2023).

Van Schmus W.R., Kozuch M., Brito Neves B.B. 2011. Precambrian history of the Zona Transversal of the Borborema Province, NE Brazil: Insights from Sm-Nd and U-Pb geochronology. Journal of South American Earth Sciences, 31(2-3), 227-252. https://doi.org/10.1016/j.jsames.2011.02.010 .

Van Schmus W.R., Oliveira E.P., Silva Filho A.F., Toteu S.F., Penaye J., Guimarães I.P. 2008. Proterozoic links between the Borborema Province, NE Brasil and the Central African Fold Belt. Geological Society, London, Special Publications, 294, 69-99. https://doi.org/10.1144/SP294.5 .

Vauchez A., Neves S., Caby R., Corsini M., Egydio-Silva M., Arthaud M., Amaro V.E. 1995. The Borborema shear zone system, NE Brazil. Journal of South American Earth Sciences, 8(3-4), 247-266. https://doi.org/10.1016/0895-9811(95)00012-5 .

Wanderley A.A. (org.). 1990. Monteiro, folha SB.24-Z-D-IV: estados de Pernambuco e Paraíba. Programa Levantamentos Geológicos Básicos do Brasil, Brasília, CPRM, 100 p. Available online at: https://rigeo.cprm.gov.br/handle/doc/8362 / (accessed on 31 January 2023).

Wanderley A.A., Veiga Júnior J.P., Santos E.J. 1992. O Complexo Irajaí no contexto evolutivo da Província Borborema. In: Congresso Brasileiro de Geologia, 37, 302-304. Available online at: http://www.sbgeo.org.br/home/pages/44 / (accessed on 31 January 2023).