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Integrated geological map of the São Roque Domain, North of São Paulo City – Brazil

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The São Roque Domain has an extensive geological cartographic base that began in the nineteenth century with the works performed by the *Geographic and Geological Commission of São Paulo Province*. The first more detailed geological maps of geological substrate of the São Paulo city and neighboring areas were executed in the decades of 1940–1950, and culminated in the integrated maps by *José Moacyr Vianna Coutinho* published in the 1970s. As part of a systematic geological mapping campaign led by PRÓ-MINÉRIO, most of the São Roque Domain was mapped at 1:50,000 scales; these maps, and others at the same or more detailed scale published mostly in the 1980s, are only available in unpublished academic theses and reports. This article presents an integrated map of most of the São Roque Domain based on all the available maps and some new stratigraphic and geochronological data that appeared in recent local literature.

Keywords: são roque group; serra do itaberaba group; geological map

1. Introduction

Mineral exploration in Brazil began in the sixteenth century, particularly in the Pico do Jaraguá (Jaraguá Peak – north of São Paulo city) where the exploration of the first gold mines began. The fast demographic growth in São Paulo city during the nineteenth century resulted in the necessity of new cartographical and geological maps, which were surveyed by the *Geographic and Geological Commission of São Paulo Province*. However, more detailed geological maps of the São Paulo city region and neighboring areas started to be executed only in the twentieth century. After the hallmark studies by *José Moacyr Vianna Coutinho* (Coutinho, 1968, 1972, 1980), a program for systematic mapping of the Precambrian crystalline basement at 1:50,000 scale was developed by the Government of the State of São Paulo, under a Program named PRÓ-MINÉRIO, mostly in the 1980s. Unfortunately, these maps remain unpublished, as well as those later presented as appendices to academic theses, some at more detailed scales (e.g. 1:25,000).

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This work presents an integration of the previous maps in the western portion of the São Roque Domain (Main Map), using updated stratigraphic and geochronological data, and aided by some new field observations by the authors (Henrique-Pinto et al., 2012; Henrique-Pinto & Janasi, 2010).

2. Geological setting

The São Roque Domain (SRD) in Southeastern Brazil is a tectonic block located between the high-metamorphic grade Socorro-Guaxupé Nappe (interpreted as related to the evolution of the southern branch of the Brasília Fold Belt), in the north, and the Embu Domain (related to the Ribeira Fold Belt) in the south. In a tectonic model presented by Campos Neto (2000), the SRD is part of a larger block dominated by meta-volcanic sedimentary sequences metamorphosed to low to medium-grade (the Apiaí-São Roque Domain) which, together with the Socorro-Guaxupé Nappe, corresponds to a magmatic arc domain developed at the border of an older cratonic nucleus that is mostly covered beneath the Phanerozoic Paraná sedimentary basin (the Paranapanema Craton; Mantovani & Brito Neves, 2005 – Figure 1).

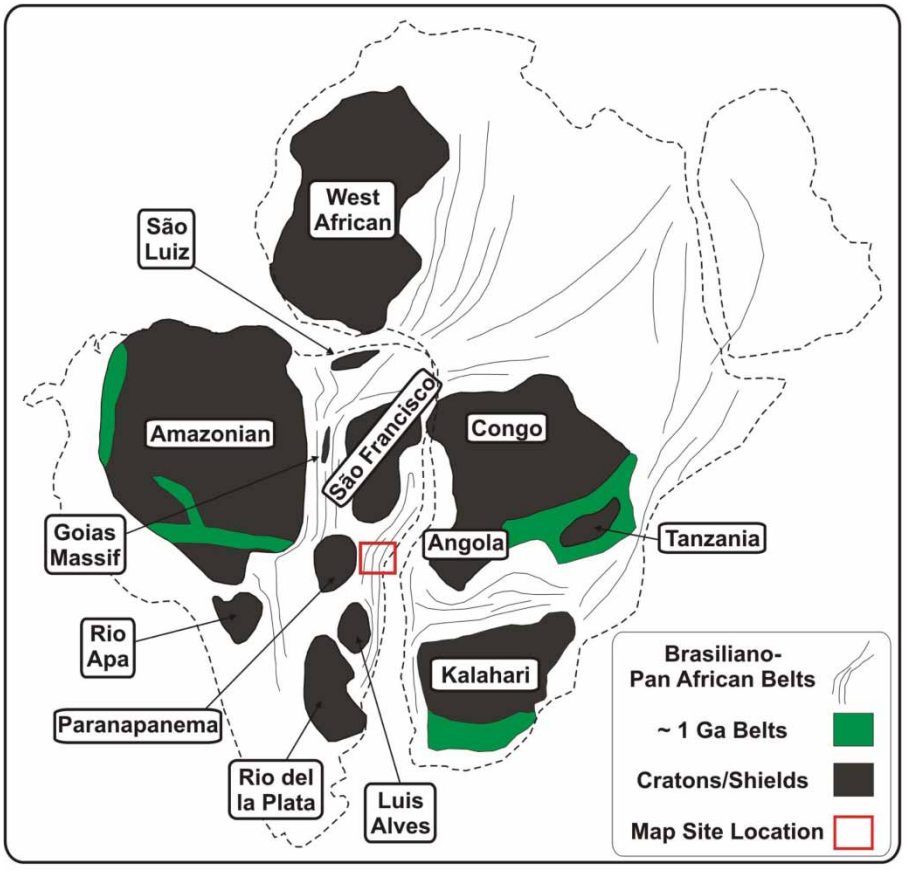

Figure 1. Modern view of western Gondwana during the middle Palaeozoic with fragments of cratonic shields representing pre-existing continental blocks, between orogenic belts assemblages generated during the Pan-African/Brazilian cycle (modified by De Wit et al., 2008).

Since the work of Derby (1878), the similarities between metasedimentary units present in the Paraná and São Paulo states have been recognized. These considerations were followed by many authors, such as Almeida (1944), Coutinho (1968), and others. However, after the early 1970s they were considered as distinct sequences separated by the Taxaquara Fault System (Hennies et al., 1967): the São Roque (north) and Cotia (south) domains.

Recent studies (e.g. Campos Neto, 2000) have shown that the Caucaia Fault divides the Cotia Domain into two portions and corresponds to a tectonic limit of higher order, separating the southern Ribeira Fold Belt *strictu sensu* (locally represented by the Embu Domain) and the reworked margin of Paranapanema craton in the north (locally represented by the Apiaí-São Roque Domain, intruded by the Agudos Grandes Granitic Batholith).

The Jundiuvira transcurrent fault zone (Hasui et al., 1978; Wernick et al., 1976) is interpreted to correspond to an important discontinuity in the reworked border of the Paranapanema Craton, separating blocks with different metamorphic grades, with predominance of migmatites in the Socorro-Guaxupé Nappe to the north. On the other hand, the Serra do Japi quartzites situated in the northern domain are considered by some authors as correlative to the Serra do Voturuna and Jaraguá quartzites of the SRD (Campos Neto, 2000; Moraes, 1944).

Hasui et al. (1976) suggested a two-fold stratigraphic division for the São Roque Group (SRG). The basal Boturuna Formation is characterized by the predominance of meta-feldspathic wackes interfingered with polymictic metaconglomerates with pebbles and cobbles encased by meta-arkose framework (e.g. at the Morro Doce locality) and local meta-quartzarenites which sustain some topographically higher regions (e.g. the Jaraguá Peak, near São Paulo). Small bodies of metavolcanic rocks occur in the sequence (Carneiro, 1983) as small lenses of basaltic trachyandesite intercalated with meta-feldspathic wackes and porphyritic meta-trachydacite, locally associated with metaconglomerates (e.g. in the Morro do Polvilho region). The volcanism in the Boturuna Formation is bimodal and has an intraplate geochemical signature (meta-trachydacites with low mg#, high Zr, Y, Nb, and low Sr; Henrique-Pinto & Janasi, 2010). A ~1.75–1.80 Ga depositional age seems well established from U-Pb zircon dating of meta-trachydacites (1790 ± 14 Ma; Van Schmus et al., 1986) and metabasic rocks (metamicrogabbro with clinopyroxene relics and preserving an intergranular texture) in the Cajamar region (1750 ± 40 Ma; Oliveira et al., 2008).

The upper Piragibu Formation is composed of a rhythmic sequence with predominance of meta-mudstones interbedded with metawackes, which possibly corresponds to turbidity current deposits in a marine environment (Carneiro, 1983; Dantas, 1990).

Stratigraphic studies by Coutinho et al. (1982) recognized a distinctive volcano-sedimentary sequence which was later recognized as a separate unit named the Serra do Itaberaba Group (SIG) by Juliani et al., (1986) on the basis of its higher metamorphic grade (amphibolite-facies) and the proposed existence of an erosive contact marked by the presence of clasts and volcanic fragments derived from it in metaconglomerates from the basal portions of the SRG (Juliani, 1993). The SIG is composed of amphibolites, metatuffs, banded iron formation, calc-silicate rocks and tremolite marble (Morro da Pedra Preta Formation), detrital metapelites with predominance of staurolite schists (Nhanguçu Formation) and metapsammites (Pirucaia Formation). A meta-andesite interpreted as a small intrusion linked to the beginning of sedimentation of the Serra do Itaberaba basin, located stratigraphically above the MORB-like metamafic unit (amphibolites and metatuffs), yielded a U-Pb zircon age of 1395 ± 10 Ma, interpreted as the maximum age of deposition (Juliani et al., 2000). In light of the above constraints for the SRG, this age suggests that, in spite of the higher metamorphic grade, the SIG was deposited after the SRG Boturuna Formation, and therefore the clasts found in the latter are not related to the SIG.

Another distinctive meta-volcanic sedimentary sequence was recognized in the Pirapora region (Bergmann, 1988), and it is dominated by tholeiitic metabasalts chemically similar to

MORB (Tassinari et al., 2001) with local pillow-lava structures (Figueiredo et al., 1982) that are associated with pyroclastic rocks and meta-limestones showing well-preserved stromatolitic structures (Bergmann & Fairchild, 1985). This sequence was named Pirapora do Bom Jesus Formation by Bergmann (1988), who interpreted it as corresponding to a passive margin with volcanic centers surrounded by stromatolites. U-Pb zircon (608 ± 7 Ma) and monazite (628 ± 9 Ma) ages (Hackspacher et al., 1999; Hackspacher et al., 2000, respectively) were used to infer a Neoproterozoic age for this sequence. This age range (~625–605 Ma) is coeval with the emplacement of large volumes of granite related to the 'syn-orogenic' period of Neoproterozoic evolution (e.g. Agudos Grandes Batholith), and this led some authors (Hackspacher et al., 2000; Juliani et al., 2000) to interpret the sequence as a back-arc basin. However, the Neoproterozoic age of this sequence still needs confirmation. Tassinari et al. (2001) interpreted the Pirapora do Bom Jesus Formation as part of an ophiolite slice, in view of the expressive volume of basic rocks with MORB signature and pillow-lavas structures, associated with magnetite/chromite mineralization in talc schists.

3. Methods

The geological cartographic bases for the central part of the São Roque Domain and neighboring southernmost Socorro-Guaxupé Domain were compiled from 1:50,000 scale geological maps published by the Instituto de Pesquisas Tecnológicas (IPT, 1983) (Santana do Parnaíba Sheet), Dantas (1990) (Guarulhos Sheet) and Andrade (1993) (São Roque and Cabreúva Sheets). A compilation of neighboring geological maps previously made by Neves (2005) integrating the 1:50,000 Atibaia, Jundiaí, Indaiatuba and parts of Cabreúva, Itu and Salto Sheets was used for the rest of the area. Maps in a more detailed scale (1:25,000) were compiled from Bergmann (1988) (Santana do Parnaíba region) and Juliani (1993) (Serra do Itaberaba region).

All these maps were digitalized and then integrated. When maps of different scale were available, those in a more detailed scale were preferred (e.g. Bergmann, 1988; Juliani, 1993). Inconsistencies were in some cases checked and solved by visits in the field; when these persisted, we defined the continuity of the units using the regional geological units defined in the scale 1:750,000 by the Geological Survey of Brazil (Serviço Geológico do Brasil – CPRM, 2006) as reference and/or the geomorphological structures from SRTM images.

4. Conclusions

A new map of the western São Roque Domain, SE Brazil (Main Map), is presented, integrating several unpublished maps from mapping reports and academic theses, and making use of recent stratigraphic and geochronological data. Although some uncertainties still remain on the stratigraphic division of the metasupracrustal sequences, this integration is expected to be useful for researchers interested in the Precambrian geology of this portion of SE Brazil.

Software

The field work points and geological structures were compiled in *Microsoft Excel*, the geological cartography database have been managed in ESRI *ArcGIS 9.3* and the final layout was made in *CorelDraw 12*.

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