



Paleoproterozoic crust-formation and reworking events in the Tocantins Province, central Brazil: A contribution for Atlantica supercontinent reconstruction

Reinhardt A. Fuck^a, Elton Luiz Dantas^{a,*}, Márcio Martins Pimentel^a, Nilson Francisquini Botelho^a, Richard Armstrong^c, Jorge Henrique Laux^b, Sergio Luiz Junges^a, José Eduardo Soares^a, Igor Fernandes Praxedes^a

^a Universidade de Brasília, Instituto de Geociências, Campus Asa Norte, 70910-900 Brasília, DF, Brazil

^b CPRM – Serviço Geológico do Brasil, Brazil

^c ANU, Australia

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ABSTRACT

The Natividade–Cavalcanti crustal block is a Paleoproterozoic sialic terrain which forms the basement of sedimentary sequences belonging to the Neoproterozoic Brasília Belt in central Brazil. Two main domains were recognized in this crustal block, the limits of which are not well constrained due to the lack of geological maps at an appropriate scale. The northeastern domain is characterized by narrow supracrustal belts which wrap around gneiss domes. At least three rock-forming events are recorded in the calc-alkaline, metaluminous basement gneisses of this domain: (i) in the Almas–Dianópolis area, granitoids were dated at c. 2.2 Ga, (ii) early Paleoproterozoic magmatism was dated at c. 2.3–2.4 Ga in the Natividade–Conceição do Tocantins area, and (iii) younger additions were dated at 2144 ± 21 Ma. T_{DM} model ages range between 2.24 and 3.11 Ga, and $\epsilon_{Nd}(t)$ values range from +2 to close to zero, suggesting juvenile sources. Bordering this domain west- and southwards, extending from Cavalcante to Arraias, Paranaíba and Pindorama do Tocantins, mostly peraluminous granitoids of the Aurumina Suite are exposed. Geochronological data for Aurumina granitoid rocks of this sector point to magmatic events between 2.13 and 2.18 Ga, whereas T_{DM} model ages range between 2.21 and 2.92 Ga with generally negative $\epsilon_{Nd}(t)$ values. An exception is a largely undeformed tonalite sample from close to Arraias, dated at 2042 ± 12 Ma.

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1. Introduction

The growth of continental crust during Earth's history has been associated to successive events of juvenile crust formation, followed by periods of landmass stabilization and cratonization, leading to the formation of supercontinents. The accretion and subsequent stabilization events are followed by rifting, breakup and dispersion of the supercontinents, as the result of superplumes, leading to the development of Large Igneous Provinces (LIPs). The concept of Precambrian supercontinents cycles arises, in part, from global peaks of isotopic ages associated with the development of rock associations related to arc systems. Models of crustal growth during the Paleoproterozoic have considered the episodicity of crust formation events at c. 2.0, 1.9 and 1.8 Ga (Condie et al., 2000; Condie, 2002; Reddy and Evans, 2009; Condie and Aster, 2010; Evans and Mitchell, 2011). Several names have been

suggested for the resulting Paleoproterozoic continental assemblages (Columbia, Atlantica, Nuna; Unrug, 1996; Rogers and Santosh, 2002; Zhao et al., 2006; Evans and Mitchell, 2011). These supercontinents reconstructions are based on craton juxtaposition, using integrated paleomagnetic, geochronologic and geologic data. However, all supercontinents older than Pangaea are conjectural in both existence and paleogeography (Reddy and Evans, 2009). Thus, the identification of large segments of Paleoproterozoic continental crust represents significant contribution to the discussion on supercontinent models.

In this study we describe accretion and reworking events in central Brazil and their significance for the development of supercontinent evolution models. A number of good quality geochronologic data produced over the last years resulted in evidence to support new ideas about the Paleoproterozoic crustal growth in central Brazil. Some of the Rodinia reconstruction models suggest that the Amazonian, Rio de la Plata and São Francisco-Congo continents were still separated from West Africa and other African landmasses at around 1.0 Ga and that their amalgamation process occurred during the Brasiliano–Pan African orogeny

* Corresponding author. Tel.: +55 61 31070142.

E-mail addresses: elton@unb.br, angicos63@gmail.com (E.L. Dantas).

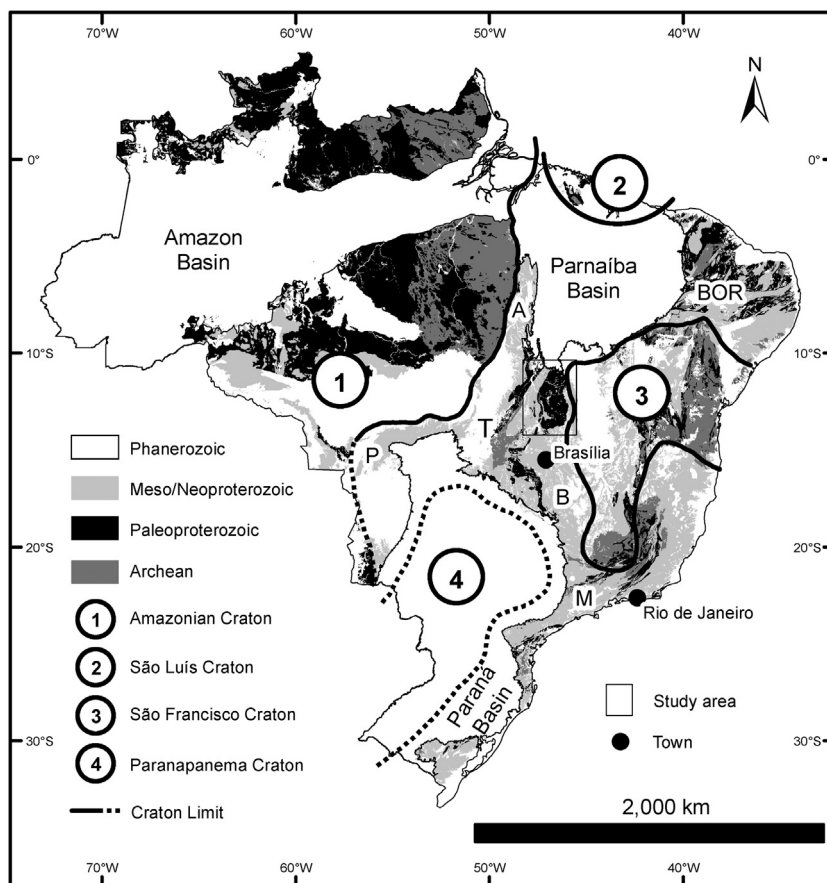


Fig. 1. Distribution of Paleoproterozoic rocks in the Brazilian shield. T Tocantins Province, BOR Borborema Province, M Mantiqueira Province, A Araguaia belt, P Paraguay belt, B Brasília belt.

Based on [Bizzi et al. \(2003\)](#).

([Cordani et al., 2003a,b](#); [Zhao et al., 2006](#); [Fuck et al., 2008](#)). However, little is known about the constitution and geometry of the large landmasses that existed between c. 2.0 and 1.8 Ga until the formation of Gondwana ([Rogers and Santosh, 2002](#)). Another important point addressed is the presence of juvenile rocks formed at approximately 2.3 Ga, which are quite rare in the geological record ([Condie, 1994, 2002](#)).

In central Brazil, the basement underlying the external domain of the Neoproterozoic Brasília Belt is c. 30,000-km²-crust fragment, informally called Cavalcante-Natividade block. It is considered as exposure of the western part of the São Francisco plate ([Cordani and Sato, 1999](#); [Cordani et al., 2000](#); [Fuck et al., 2008](#); [Brito Neves, 2011](#)), which was reworked during the Neoproterozoic Brasiliano Orogeny. Several questions remain unresolved concerning the tectonic evolution of this Paleoproterozoic terrain and will be addressed in this study. Some of these questions are: (i) Does it represent collisional or accretionary orogens? (ii) Are arc systems preserved in this area? (iii) What was the duration of the Paleoproterozoic magmatic events? (iv) What is the relevance of this large terrain for the reconstruction of Paleoproterozoic supercontinents?

In general, only Paleoproterozoic terrains within larger cratons such as the São Francisco and Amazonian cratons are taken into consideration in Paleoproterozoic-Mesoproterozoic supercontinent reconstructions, while smaller crustal segments such as the one investigated here have been neglected (e.g. [Unrug, 1996](#); [Condie et al., 2000](#); [Zhao et al., 2006](#); [Reddy and Evans, 2009](#); [Evans and Mitchell, 2011](#)). One of the basic questions to be addressed refers to the relationship between the Cavalcante-Natividade crustal block and the sialic basement exposed in the

São Francisco Craton, to the east. The Cavalcante-Natividade block may represent just the continuity of the craton sialic basement rock units or, alternatively, it may constitute an exotic fragment accreted to the western border of the São Francisco Craton during Paleoproterozoic orogenies, or even during late stages of evolution of the Neoproterozoic Brasília Belt.

The main objectives of this work are to investigate: (i) the history of crustal growth of the granite-gneiss complex in order to better understand the pre-Brasiliano crustal evolution of the northeastern sector of the Tocantins Province, (ii) the nature of the western limit of the Paleoproterozoic terrains and their relationships with the juvenile Neoproterozoic rock units of the Goiás Magmatic Arc, to the west.

New conventional U–Pb data of both single and multigrain zircon fractions are presented, along with Sm–Nd whole-rock data from orthogneisses exposed in southeast Tocantins and northeast Goiás, central Brazil. Additionally, data of zircon grains from three samples analyzed by ICPMS and from two samples analyzed by SHRIMP are also presented.

2. Geologic setting

The Tocantins Province ([Almeida et al., 1981](#); [Marini et al., 1984a,b](#)) in central Brazil is a large Neoproterozoic (Brasiliano-Pan African) orogen resulting from the convergence and collision of three major continental blocks: the Amazonian continent in the west, the São Francisco-Congo continent in the east, and the Paranapanema block in the south, presently covered by Phanerozoic rocks of the Paraná Basin ([Fig. 1](#)). Minor continental fragments,

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