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Age, composition, and source of continental arc- and syn-collision granites of the Neoproterozoic Sergipano Belt, Southern Borborema Province, Brazil

Elson P. Oliveira [a, *], Juliana F. Bueno [a], Neal J. McNaughton [b], Adejardo F. Silva Filho [c], Rosemery S. Nascimento [d], José P. Donatti-Filho [a]

[a] Department of Geology and Natural Resources, Institute of Geosciences, P.O. Box 6152, State University of Campinas – UNICAMP, 13083-970 Campinas, SP, Brazil
[b] John de Laeter Centre of Mass Spectrometry, School of Applied Physics, Curtin University of Technology, Perth, WA 6845, Australia
[c] Department of Geology, Federal University of Pernambuco, 50740-530 Recife, PE, Brazil
[d] Faculty of Geology, Geosciences Institute, Federal University of Para, Belém 66075-110, Brazil

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ABSTRACT

The Sergipano belt is the outcome of collision between the Pernambuco-Alagoas Domain (Massif) and the São Francisco Craton during Neoproterozoic assembly of West Gondwana. Although the understanding of the Sergipano belt evolution has improved significantly, the timing of emplacement, geochemistry and tectonic setting of granitic bodies in the belt is poorly known. We recognized two granite age groups: 630–618 Ma granites in the Canindé, Poço Redondo and Macururé domains, and 590–570 Ma granites in the Macururé metasedimentary domain. U–Pb SHRIMP zircon ages for granites of first age group indicated ages of 631 ± 4 Ma for the Sítios Novos granite, 623 ± 7 Ma for the Poço Redondo granite, 619 ± 3.3 Ma for the Lajedinho monzodiorite, and 618 ± 3 Ma for the Queimada Grande granodiorite. These granitoids are dominantly high-K calc-alkaline, magnesian, metaluminous, mafic enclave-rich (Queimada Grande and Lajedinho), or with abundant inherited zircon grains (Poço Redondo and Sitios Novos). Geochemical and isotope data allow us to propose that Sítios Novos and Poço Redondo granites are product of partial melting of Poço Redondo migmatites. Sr-Nd isotopes of the Queimada Grande granodiorite and Lajedinho monzodiorite suggest that their parental magma may have originated by mixing between a juvenile mafic source and a crustal component that could be the Poço Redondo migmatites or the Macururé metasediments. Other 630–618 Ma granites in the belt are the mafic enclave-rich Coronel João Sá granodiorite and the Camará tonalite in the Macururé sedimentary domain. These granites have similar geochemical and isotopic characteristics as the Lajedinho and Queimada Grande granitoids. We infer for the Camará tonalite and Coronel João Sá granodiorite that their parental magmas have had contributions from mafic lower crust and felsic upper crust, most probably from underthrust São Francisco Craton, or Pernambuco-Alagoas Domain. The younger 590–570 Ma granite group is confined to the Macururé metasedimentary domain. Although these granites do not show typical features of S-type granites, their U–Pb age, field relationships, geochemical and Sr-Nd data suggest that their parental magmas have originated from high degree melting of the Macururé micas-chists. Field observations support a model in which the Macururé domain, limited by the Belo Monte-Jeremoabo and São Miguel do Aleixo shear zones, behaved as a ductile channel flow for magma migration and emplacement during the Neoproterozoic, very much like the channel flow model proposed for emplacement of leucogranites in the Himalayas.

1. Introduction

Granites are of prime importance in studies of crustal evolution because they are one of the main components of continental areas, are related in space and time with orogenic belts, and isolate

* Corresponding author.
E-mail address: elson@ige.unicamp.br (E.P. Oliveira).

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snapshots of the superimposed deformations as they freeze part of their structural evolution. During ascent through the lithosphere, granitic magmas crosscut an expressive crustal thickness and entrain xenoliths from both their sources and the country rocks. For this reason, granites are of particular geological interest for direct and indirect investigation of how the continental crust evolves.

Granites are a common component of the Sergipano belt but their ages and petrogenesis are only locally known (e.g. Silva Filho et al., 1997; Guimarães and Silva Filho, 1995; McReath et al., 1998; Long et al., 2005). More uncertain is their tectonic significance (e.g. Bueno et al., 2009), melt source(s) and evolution. The belt is one of the most important Precambrian orogenic belts of Northeastern Brazil, not only because it was considered as evidence for continental drift (e.g. Allard and Hurst, 1969), but also because it contains several structural and lithologic domains that allow it to be compared with Phanerozoic orogens (Oliveira et al., 2006, 2010). The Sergipano belt is located in the southernmost part of the Borborema Province (Fig. 1) and originated through collision between the Congo-São Francisco Craton and the Pernambuco-Alagoas Domain during the Neoproterozoic Brasiliano/Pan-African Orogeny (e.g. Brito Neves et al., 1977; Van Schmus et al., 1995; Brito Neves and Fuck, 2013). It is a key belt for reconstructing part of the history of West Gondwana assembly.

In this paper we present field relationships, new U–Pb zircon ages, whole-rock geochemichal and Sr-Nd isotope data for granites of the Sergipano Belt as a contribution to understanding their source(s) and evolution. Our results indicated that crust- and mantle-derived magmas conributed to granite genesis, and that both arc-like and syn-collision granites are present in domains of the Sergipano belt.

2. The Sergipano Belt, NE-Brazil

The Sergipano Belt is a triangular shape orogenic belt with WNW-ESE direction (Fig. 1), located in the southern part of Borborema Province, NE-Brazil. It comprises five lithostructural domains: Canindé, Poço Redondo-Marancó, Macururé, Vaza Barris and Estância (Davison and Santos, 1989; D'el-Rey Silva, 1995; Oliveira et al., 2006, 2010) limited each from the other by the following major shear zones from north to south: Macururé, Belo Monte-Jeremoabo, São Miguel do Aleixo and Itaporanga (Fig. 1). The Macururé, Vaza Barris and Estância are dominated by metamorphic to non-metamorphic sedimentary rocks, whereas the other domains are more diverse and composed of igneous, metamorphic and sedimentary rocks. Granites are abundant in the Macururé, Canindé, and Poço Redondo-Marancó domains (Fig. 2).

Three main events of regional deformation are recognized in the sedimentary domains of the belt (D'el-Rey Silva, 1995; Oliveira et al., 2010; and references therein). The first event is characterized by south-verging D_1 nappes and thrust zones, which probably displaced the metasedimentary rocks of the Macururé and Vaza Barris domains for large distances over the edge of the São Francisco Craton in the south; a few granitic bodies were emplaced into the Macururé Domain during or shortly after D_1. The D_2 event is marked by reactivation of D_1 and has a transpressive character associated with significant vertical movements; most granite plutons were emplaced during this event. The D_3 event is the last ductile deformation event in the Sergipano Belt and it took place during uplift of the belt in response to compression in a brittle to ductile-brittle regime.

Part of the studied granites (Fig. 2) occurs in the Macururé domain, which is mostly composed of garnet micaschists with minor marble and quartzites. The Macururé domain was metamorphosed under amphibolite facies conditions and is separated from the Vaza Barris Domain in the south by the São Miguel do Aleixo shear zone, and from the Poço Redondo-Marancó Domain in the north by the Belo Monte-Jeremoabo shear zone. The original sedimentary basin and its depositional settings are no longer easy to reconstruct owing to deformation and erosion. However, in less metamorphic or deformed portions of the Macururé domain, Davison and Santos (1989) recognized centimetre-thick rhythmic layers of micaschists, with plane-parallel structures and abrupt contact indicative of deposition in deep water settings such as turbidites. Also, Oliveira et al. (2010) report on a sequence of chaotic blocks of mica-schist, phyllite, meta-rhythmite and rare granite embedded in a meta-sandstone matrix; the entire rock package was subsequently deformed by D_2. The authors interpret this sequence as an ancient alluvial fan and suggest a significant time gap between the D_1 and D_2 deformation events.

The granites occupy large portion of the Macururé domain (Fig. 2) and are of two types: (1) pre-collisional granites (pre-to early-D_2 granites) including tonalite-granodiorite of restrict

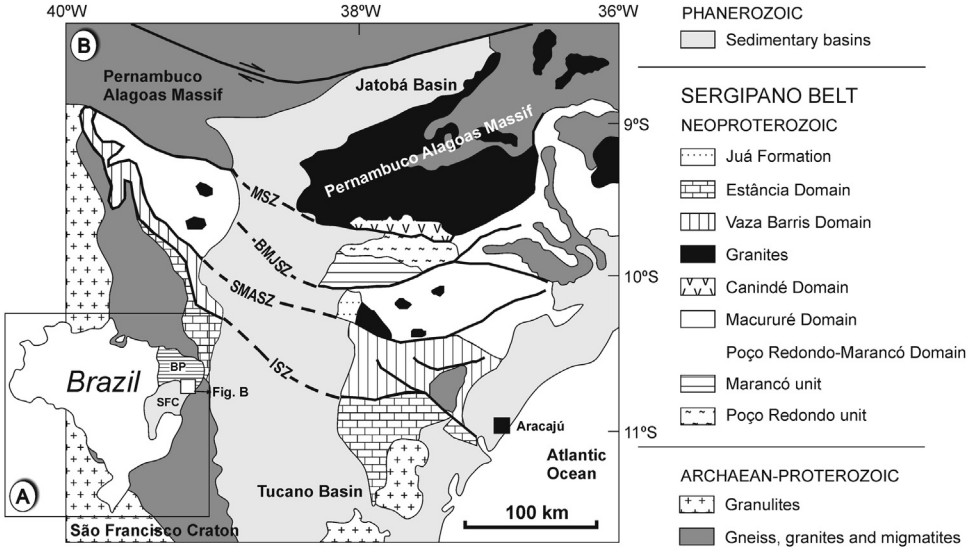

Fig. 1. Symplied geology of the Sergipano Belt. A. Location of the Sergipano Belt (square) in Brazil. SFC-São Francisco Craton, BP-Borborema Province. B. The Sergipano Belt and its domains (modified after Oliveira et al., 2010). MSZ, BMJSZ, SMASZ and ISZ stand, respectively for the Macururé, Belo Monte-Jeremoabo, São Miguel do Aleixo and Itaporanga shear zones.