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Juvenile contribution of the Neoproterozoic Rio Negro Magmatic Arc (Ribeira Belt, Brazil): Implications for Western Gondwana amalgamation

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ABSTRACT

The ca. 790–600 Ma Rio Negro Complex (RNC) of the Ribeira belt (Brazil) consists of a plutonic portion of a magmatic arc built by the E-vergent subduction of the ESE border of the São Francisco paleoplate during the amalgamation of Western Gondwana.

The plutonic series comprises low- to medium-K granitoids (ca. 790–620 Ma) and high-K granitoids and shoshonite rocks (ca. 610–605). The age span of 185 m.y. is suggestive of a long history of arc-related magmatism, continuously or not in time. The Nd isotopic signatures of the RNC consist of εNd(t) ratios from −3 to +5 for the medium-K series shoshonite series and from −14 to −3 for the younger high-K group. This time-dependent trend of Nd isotopes is indicative of progressive maturity of the arc over time. The same evolution is indicated by Sr data, as the medium-K rocks have $^{87}Sr/^{86}Sr$ initial ratios < 0.705 while the high-K rocks yield values between 0.705 and 0.710. The predominance of intermediate rocks over mafic ones suggests an initial intra-oceanic to transitional stage, possibly developed in a distal portion of a passive margin, such as the Japanese arc, evolving to a more developed, differentiated felsic rock associations.

The role of transform fault zones, such as the Luanda shear zone, is emphasized in order to explain the consumption of a wide oceanic plate in the inner portion of Western Gondwana.

1. Introduction

At the onset of Western Gondwana amalgamation, east-verging subduction was in course along the eastern and southern margins of the São Francisco–Congo proto-continent (Ribeira and Araçuaí belts) and along the western margin (Coastal terrane) of the Angola-Kasai paleo-plate, presently in the Kaoko Belt (Heilbron et al. 2008; Babinski et al., 2011; Tohver et al., 2011). The active margin and the arc-related rocks of this episode are well preserved both in the Ribeira belt and in the Coastal terrane of Africa.

The Ribeira belt (Fig. 1) extends for almost 1400 km along the Atlantic coast of SE-Brazil (Almeida et al., 1981; Campos Neto, 2000; Trouw et al., 2000; Heilbron et al., 2000, 2004a,b, 2008). Its African counterpart, in Angola and Namibia, is represented from north to south by the West Congo belt, the Angola craton and the Kaoko belt (Goscombe et al., 2003, 2005a,b; Gray et al., 2006; Goscombe and Gray, 2007, 2008).

Rio Negro Complex is the plutonic portion of a 790–600 Ma magmatic arc (foliated tonalites, granodiorites, granites and gabbros) that presently crops out in the central segment of the Ribeira Belt (Tupinambá et al., 2000a; Heilbron and Machado 2003).

The Rio Negro Arc is located in the central portion of western Gondwana between large cratonic blocks (Fig. 1). Despite the internal location within the agglutinating supercontinent, subduction of a large oceanic lithospheric plate is suggested by great longitudinal extension and protracted history (Heilbron and Machado, 2003; Heilbron et al., 2008).

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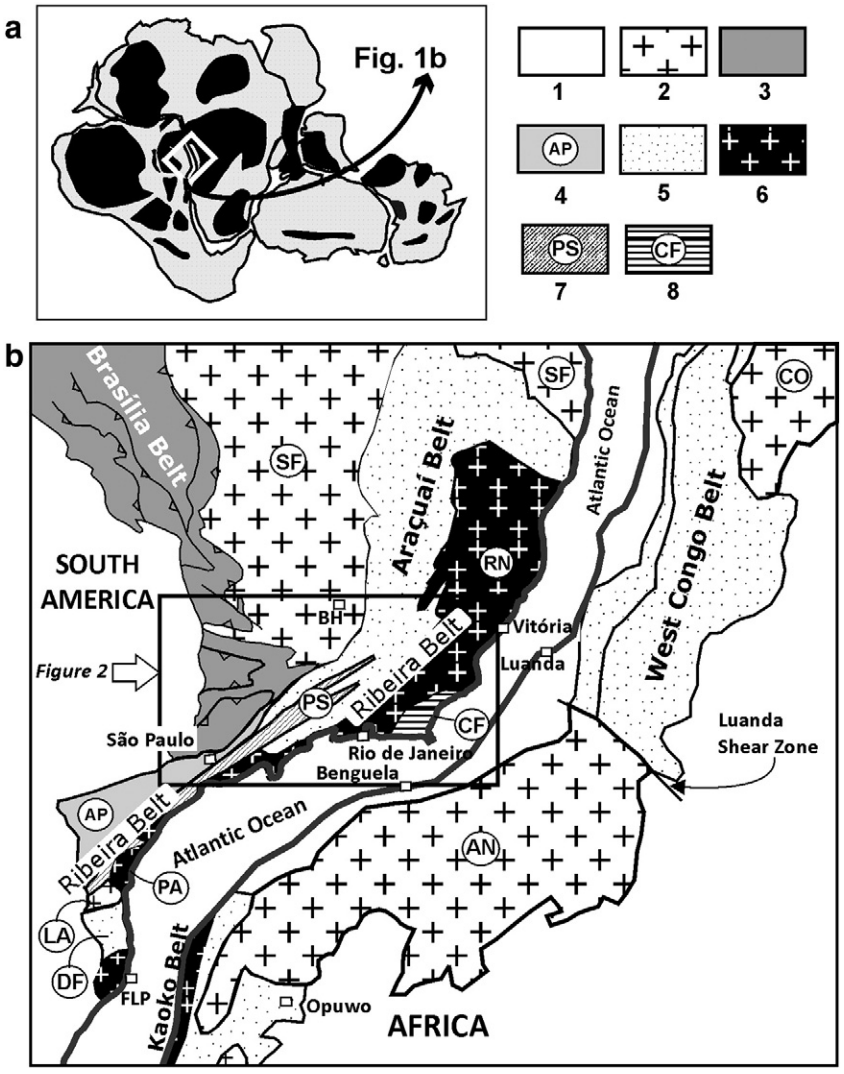

Fig. 1. a) Western Gondwana map, cratonic blocks in black; b) tectonic map of SE Brazil and SW Africa in the pre-South Atlantic (Cretaceous) reconstruction of the Gondwana supercontinent (simplified from Heilbron et al. 2008). 1, Post-Cambrian sedimentary basins; 2, cratons (SF, São Francisco; Co, Congo; LA, Luis Alves; RP, Rio de la Plata; AN, Angola; KA, Kalahari); 3, Mesoproterozoic units; 4, cratonic cover; 5, reworked cratonic margins, including basement and Neoproterozoic passive margins; 6, intra-continental West Congo Belt; 7, Brasília (Bb) and São Gabriel (Sgb) belts; 8, Apiaí terrane; 9, Paraíba do Sul, Embú and Curitiba terranes; 10, magmatic arcs (RN, Rio Negro; PA, Paranaguá; PE, Pelotas; WT, Western terrane); 11, Cabo Frio terrane.

In order to investigate the tectonic setting of the Rio Negro Arc in the Rio de Janeiro State, new U–Pb zircon ages and geochemical/isotopic (Nd, Sr) data from the Rio Negro Complex are presented. Discussions on the role of the arc in the context of Western Gondwana amalgamation and comparisons with modern arc associations are also addressed.

2. Tectonic subdivision of Ribeira belt

The major tectonic framework of the Ribeira belt (Fig. 2) comprises several tectono-stratigraphic terranes (Howell, 1989): the Occidental, Paraíba do Sul-Embú, Oriental (Serra do Mar Micro plate) and Cabo Frio terranes in Rio the Janeiro and southern Espírito Santo states (Northern and Central Ribeira belt, Heilbron et al., 2004a); and Socorro, Apiaí, Embú, Curitiba and Luiz Alves terranes in São Paulo and Paraná states (Southern Ribeira belt, Campos Neto, 2000). These terranes are limited either by thrust faults or dextral transpressive shear zones.

The accretionary history of the belt is characterised by complex diachronous docking of Neoproterozoic magmatic arcs and older cratonic fragments, throughout the southern and south-eastern sectors of the São Francisco paleocontinent. Terranes and microplates were progressively accreted during four major tectonic episodes:

a) The oldest episode (ca. 650–630 Ma) is recorded only in the southern segment of the Ribeira belt (Fig. 2). This event resulted from the accretion of the Socorro terrane as NE–E verging nappes (Campos Neto, 2000; Trouw et al. 2000) in the context of the development of the southern Brasília belt (Valeriano et al., 2008).

b) The second tectonic episode occurred between ca. 605 and 580 Ma and resulted in the docking of the Paraíba do Sul and Embú terranes. This event overprints the southern segment of the Brasília belt.

c) The third collisional event (580 Ma) is related to the docking of the Oriental terrane, which contains the Neoproterozoic Rio Negro Arc – against the São Francisco paleocontinent. The collisional suture zone, referred as the Central Tectonic Boundary (CTB), separates the Oriental terrane from the lower Occidental terrane (Figs. 2 and 3). The CTB (Almeida et al., 1998, Almeida, 2000) is a folded shear zone (Fig. 3) which shows a complex long-term structural evolution developed under high temperature conditions. Mylonitic fabrics and