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A paleoproterozoic intra-arc basin associated with a juvenile source in the Southern Brasilia Orogen: Application of U–Pb and Hf–Nd isotopic analyses to provenance studies of complex areas

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ABSTRACT

Early Proterozoic sedimentary basins are an important record of crust generation processes and consequently a fundamental key to unraveling Earth's evolution through geological time. Sediments within the basins are typically deformed and metamorphosed by subsequent tectonothermal events, which can obliterate their links to source terranes. Nd-whole-rock and detrital zircon U–Pb and Lu–Hf isotopic analyses are among the most reliable tools to be used in provenance investigations, since zircon is a resilient mineral and the Sm–Nd system is not extensively modified during metamorphism. These methods have been applied to a study of the provenance and tectonic setting of the São Vicente Complex, preserved in a Neoproterozoic passive margin related allochthon within the Southern Brasilia Orogen. The complex consists of siliciclastic and calc-silicate gneisses with mafic and minor ultramafic rocks, which were deformed and metamorphosed during late Neoproterozoic collision between the Paranapanema Block and the São Francisco-Congo plate. Detrital zircons indicate derivation from a juvenile Paleoproterozoic source terrane (peaks of crystallization ages of ca. 2130 Ma, 2140 Ma and 2170 Ma; εHf_t between +0.1 and +6.0; NdT_{DM} = 2.31–2.21 Ga; εNd_t = +1.6 to +2.8), with a minor contribution from older continental crust. Interlayered amphibolite rocks, with juvenile signatures (εHf_t = +5.8 to +8.2; NdT_{DM} = 2.14 and 2.30 Ga; εNd_t = +2.2 and +3.2), yielded similar ages of 2136 ± 17 and 2143 ± 14 Ma, suggesting syn-sedimentary magmatism. Thus, the maximum age of deposition at around 2130 Ma represents the best estimate of the depositional age of the complex. The dominance of detrital zircons ages close to the age of deposition, along with syn-sedimentary magmatism, imply a convergent margin basin tectonic environment for the São Vicente Complex, with similarities to fore arc basin and trench deposits. Amphibolite and meta-sedimentary rocks point to important juvenile magmatism around 2.14 Ga. Juvenile Rhyacian (ca. 2.1 Ga) granite-granodiorite-tonalite orthogneisses with arc-related geochemical signatures (Pouso Alegre Complex) that override the São Vicente Complex, are the probable main source of detritus within the complex. Both basin and source were part of the southern edge of the São Francisco plate during the assembly of West Gondwana, and served as sources for early Neoproterozoic passive margin related basins. The age of intrusive anorogenic A-type Taguar granite indicates that by 1.7 Ga the São Vicente Complex was in a stable tectonic environment.

1. Introduction

Provenance studies of sedimentary basins, even when metamorphosed, provide an important constraint on tectonic setting as well as the evolution of the continental crust (Bhatia and Crook, 1986; Cawood, 1991; Cawood et al., 2012; Dhuime et al., 2011; Dickinson and Suczek, 1979; Hawkesworth et al., 2010; Taylor and McLennan, 1985). However, the determination of the provenance and tectonic setting of basins in tectonically complex areas, subjected to subsequent deformation and metamorphic events, can be hindered by the masking or destruction of original mineral assemblages, sedimentary structures and primary stratigraphic relations, including separation of the basin from its original source. Zircon, due to its physicochemical resilience during deposition and metamorphic

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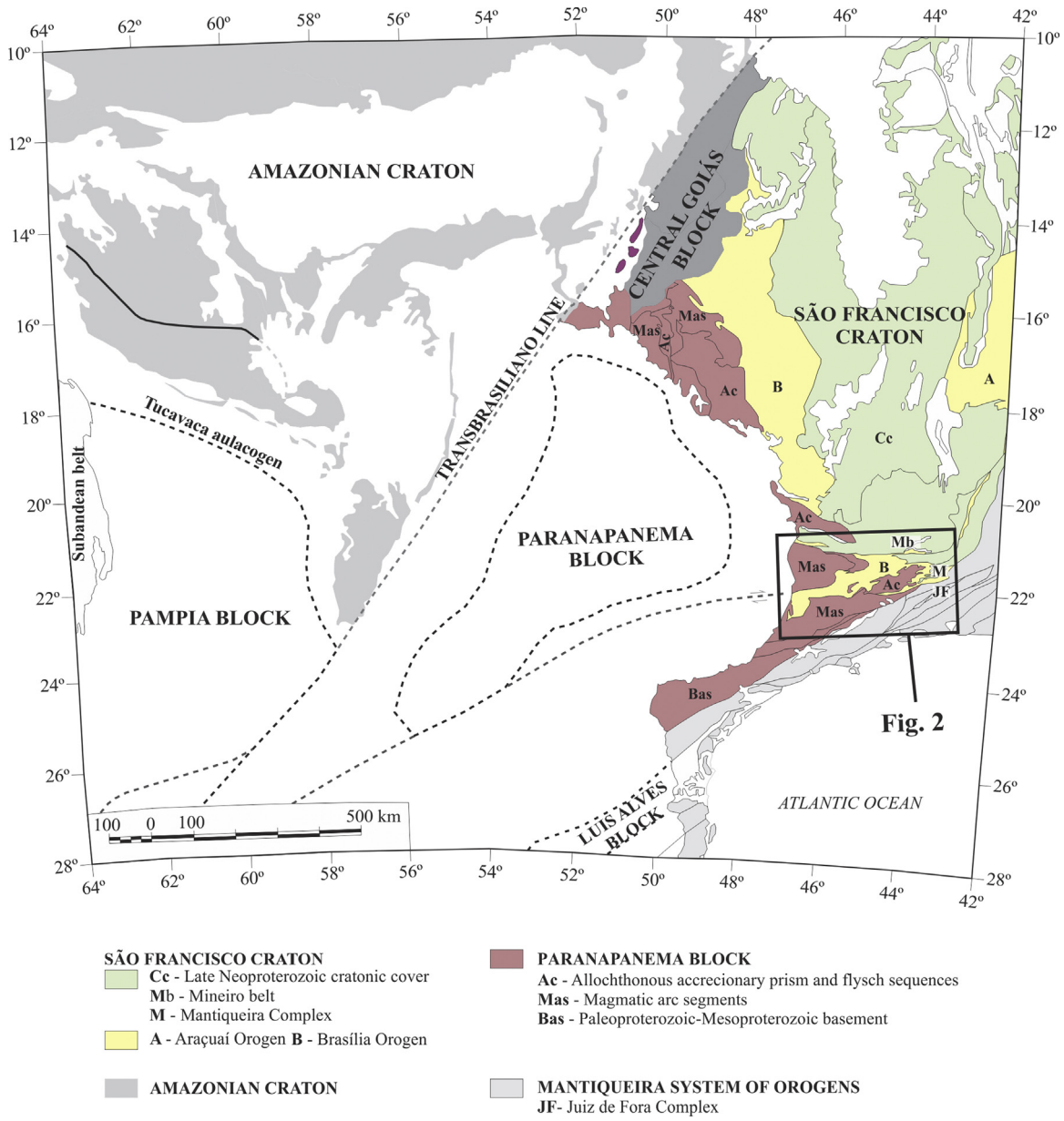

Fig. 1. Tectonic map showing the configuration of the São Francisco Craton and Paranapanema Block. The Amazonian and Luis Alves cratons and Central Goiás and Pampia blocks have been inserted to contextualize the studied area. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)

Source: Modified from the Geological Map of South America (Commission for the Geologial Map of the World, 2001) and Westin and Campos Neto (2013).

events, enables the determination of crystallization age and isotopic signature of source rocks through U–Pb and Lu–Hf analyses (Cawood and Nemchin, 2001; Cawood et al., 2012, 2007; Condie et al., 2005; Dhuime et al., 2011; Dickinson and Gehrels, 2009; Hanchar and Hoskin, 2003; Hawkesworth and Kemp, 2006). Thus, study of detrital zircons has proven to be an important technique in provenance studies and in linking basins to probable source regions. Allied to detrital zircon analysis, the use of whole-rock Nd isotope compositions of the basin strata can help reveal the role of crustal and juvenile sources during sediment accumulation (McCulloch and Wasserburg, 1978; McLennan et al., 1990). Furthermore, petrographic, isotopic and geochemical signatures of igneous rocks within the basin succession can provide better information on the time of deposition, deformation and the tectonic setting of the basin (Barbarin, 1999; Pearce and Stern, 2006; Pupin, 2000, 1980; Sun and McDonough, 1989).

The southern segment of the Brasilia Orogen provides an example of how U–Pb detrital ages and Nd–Hf isotopic compositions can be applied to discriminate different sedimentary basins and their probable sources and tectonic environments. The orogen runs along the southern margin of São Francisco Craton (Fig. 1) and it comprises three distinct paleogeographic domains: passive margin, fore-arc/accretionary prism and magmatic arc (Campos Neto, 2000; Campos Neto et al., 2011). Therefore, the combination of field mapping with isotopic signatures of rocks, and detrital and magmatic zircons are among the most reliable tools to investigate the provenance and tectonic setting of this complex area. Additionally, the presence of diverse potential sources with similar ages around the area (e.g. ~2.1 Ga orthogneisses and granitoids in allochthons related to passive and active margins) ensures that the association between different isotopic analyses remains a key approach.