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The ancestry and magmatic evolution of Archaean TTG rocks of the Quadrilátero Ferrífero province, southeast Brazil

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ABSTRACT

Combined LA-ICP-MS and SHRIMP U–Pb ages from Quadrilátero Ferrífero (QF) province reveals for the first time three main periods of TTG magmatism in the southern part of the São Francisco Craton (Brazil). These periods – described here as the Santa Barbara (SB), Rio das Velhas I (RVI) and Rio das Velhas II (RVII) events – embody a significant part of a protracted tectonomagmatic history of the Craton, spanning from 3220 to 2770 Ma. The initial stages of TTG magmatism (the SB event) led to formation of a core of Palaeoarchaean TTG crust via magmatic additions of juvenile felsic rocks into mafic–ultramafic rocks, at ca. 3212–3210 Ma. The following event (RVI event) saw the growth of this Palaeoarchaean core into a more composite, polydefomed continental segment through magmatic additions of juvenile TTG rocks and tectonic accretion of mafic–ultramafic greenstone belt terrains. Our U–Pb data and regional constraints suggest that much of the TTG crust exposed in the QF region today was produced during the RVI event, between 2930 and 2900 Ma. The final stages of TTG crust production (RV II event) were marked by convergence-related magmatism, affecting an extensive Palaeo- to Mesoarchaean continental block (The RVI block). The timing and duration of the latest TTG event coincides with the felsic volcanism and deposition of turbiditic wackes of the main greenstone belt sequence.

1. Introduction

The Quadrilátero Ferrífero (QF) province, in the Southern São Francisco Craton, exposes a large segment of Palaeo- to Neoarchaean continental crust that served for many years as type locality for understanding early crustal evolution in South America (Figs. 1 and 2) (e.g., Teixeira and Figueiredo, 1991; Machado and Carneiro, 1992; Machado et al., 1992, 1996; Teixeira et al., 1996; Carneiro et al., 1997; Noce et al., 1998, 2005; Hartmann et al., 2006; Romano et al., 2013). The Archaean history of this segment spans about 600 My, and can be subdivided into two fundamentally distinct stages. The first stage, lasting more than 400 My, involved the emplacement of voluminous Tonalite–Trondjhemite–Granodiorite (TTG) magmas and extrusion of mafic and ultramafic rocks between 3200 and 2770 Ma (e.g., Teixeira et al., 1996). The TTG magmatism led to the construction of a regionally extensive sialic crust containing several greenstone belt occurrences (e.g., Teixeira et al., 1996). The second stage was marked by high-grade ductile deformation, partial melting of the TTG-greenstone crust, and concomitant emplacement of voluminous potassic granitoids between 2750 and 2600 Ma (Machado et al., 1992; Teixeira et al., 1996; Campos et al., 2003; Romano et al., 2013). This period of intra-crustal melting saw the emergence of a stable continental platform that was rigid enough to sustain the deposition of thick Palaeoproterozoic sequences, including extensive banded iron formation units of the QF mining district (Romano et al., 2013).

Specifically for the TTG rocks, limited zircon U–Pb TIMS data suggest that the main TTG magmatism was coeval with extrusion of several felsic volcanic units of the main greenstone belt (the Rio das Velhas Greenstone Belt) between 2770 and 2780 Ma (Machado et al., 1992; Noce et al., 1998). The age dataset, together with previous Sm–Nd TDM model ages, also indicate that this magmatic event involved partial melting of sialic crust older than 3000 Ma (Carneiro et al., 1997; Teixeira et al., 1996). However, U–Pb zircon age data from the earliest TTG rocks, which could provide clues to the first emergence of continental crust, have not been fully explored. The >3000 Ma ancestry of the TTG crust is mainly indicated by Rb–Sr and Pb–Pb model ages (Teixeira et al., 1996) and indirectly via detrital zircon ages from the greenstone belt rocks and overlying supracrustal sequences (Machado et al., 1992, 1996; Noce et al., 2005; Hartmann et al., 2006). The detrital age dataset is characterized by main peaks at 2700–2730 Ma, 2770–2800 Ma and 2900 Ma,

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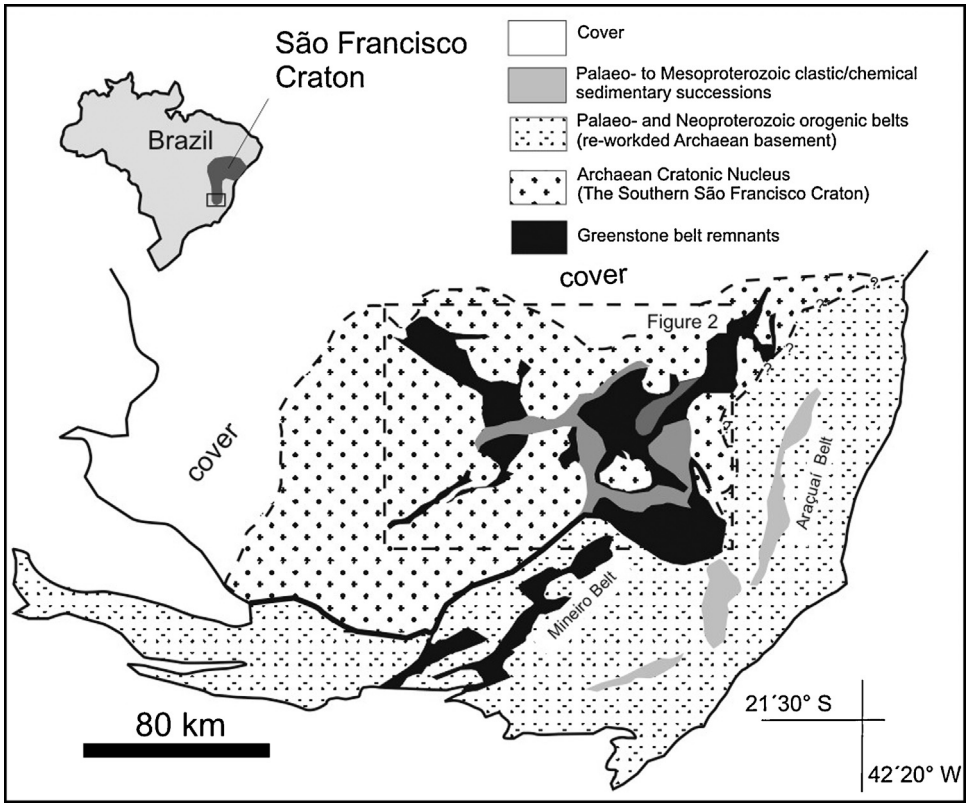

Fig. 1. Simplified map of the Southern São Francisco Craton showing the main Palaeo- to Neoarchaean terrain and adjacent Proterozoic belts.

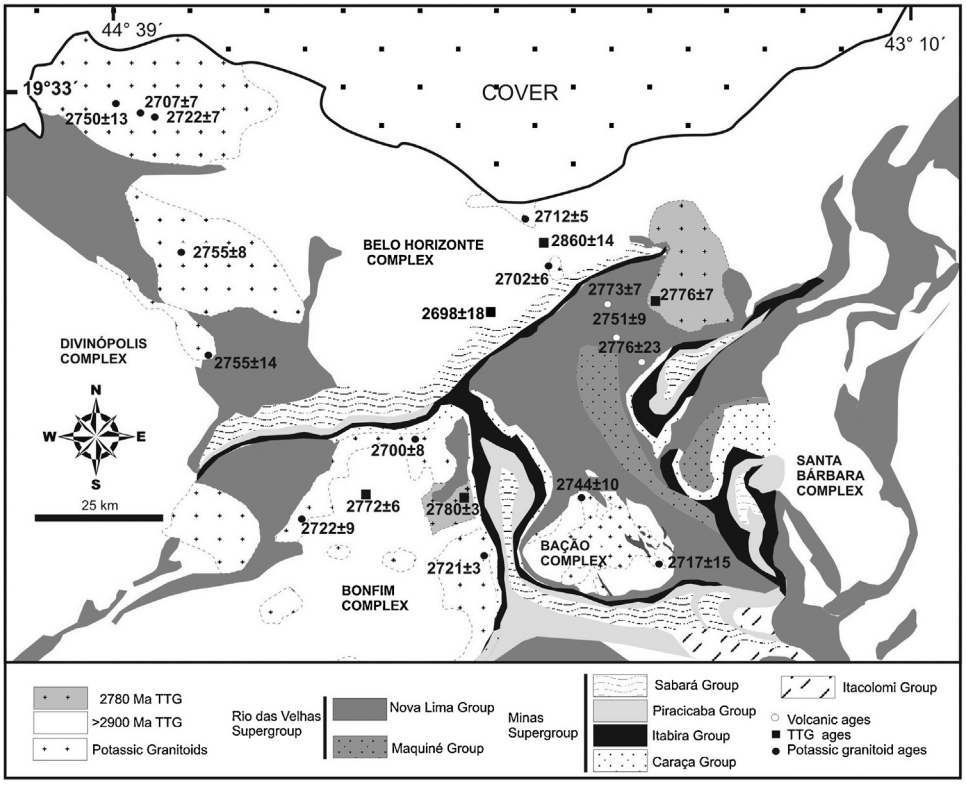

Fig. 2. Geological map of the Quadrilátero Ferrífero province. Previously published U–Pb ages of some relevant granitoid rocks are indicated (ages are compiled from Machado et al., 1992; Machado and Carneiro, 1992; Romano, 1989; Noce et al., 1998; Romano et al., 2013).