Tectonophysics 666 (2016) 173–187

Contents lists available at ScienceDirect

Tectonophysics

journal homepage: www.elsevier.com/locate/tecto

Evidence of post-Gondwana breakup in Southern Brazilian Shield: Insights from apatite and zircon fission track thermochronology

Christie Helouise Engelmann de Oliveira [a,*], Andréa Ritter Jelinek [a], Farid Chemale Jr. [b], Matthias Bernet [c]

[a] Instituto de Geociências, Universidade Federal do Rio Grande do Sul, Brazil
[b] Instituto de Geociências, Universidade de Brasilia, Brazil
[c] Institut des Sciences de la Terre (ISTerre), Université Joseph Fourier, France

ARTICLE INFO

Article history:
Received 30 July 2015
Received in revised form 29 October 2015
Accepted 5 November 2015
Available online 14 November 2015

Keywords:
Gondwana
Apatite fission track
Zircon fission track
Sul-Rio-Grandense Shield
Camaquã Basin

ABSTRACT

Apatite and zircon fission track thermochronology studies are applied to basement and sedimentary rocks from the Sul-Rio-Grandense Shield to unravel the tectonic history of the onshore southernmost Brazilian margin. The Sul-Rio-Grandense Shield is a major geotectonic feature of southernmost Brazil that includes Paleoproterozoic basement areas and Neoproterozoic fold belts linked to the Brasiliano/Pan-African orogeny. Crustal reworking and juvenile accretion events related to this cycle were dated in the region between 900 and 500 Ma and were responsible for the assembly of southwestern Gondwana in southeastern South America. Apatite fission track (AFT) ages range from 340 ± 33 to 77 ± 6 Ma and zircon fission track (ZFT) ages range from ca. 386 to 210 Ma. Based on thermal history modeling, the most part of the samples record an early cooling event during the Carboniferous, which reflect the main tectonic activity of the final stages of the Gondwanides at the Pacific margin of West Gondwana. Subsequently, the Permo-Triassic cooling event is related to the last stages of the Gondwanides, with convergence along the southern border of Western Gondwana and consequent reactivation of N-S and NE-SW trending basement structures. The onset of initial breakup of southwestern Gondwana with opening of the South Atlantic Ocean is mostly recorded in the eastern terrain and ZFT ages show that the temperature during this period was high enough for total or at least partial resetting of fission tracks in zircon. The last cooling event of the Sul-Rio-Grandense Shield records the final breakup between South America and Africa, which began during the Late Cretaceous. However, the Cenozoic rapid cooling episode probably is a result of plate adjustment after breakup and neotectonic reactivation of faults associated with South Atlantic rift evolution.

1. Introduction

The South Atlantic Ocean Margin results from the breakup of Gondwana during Early Cretaceous times and exhibits much more variety of topography and geology than the conjugate margin of Africa. From the Chain Fracture Zone in the north to the Falkland Agulhas Fracture Zone in the south, the South American Margin is segmented in various ways (e.g., Cappelletti et al., 2013; Chaboureau et al., 2013; Nürnberg and Müller, 1991). In the north, the margin is underlain by Precambrian rocks of the Brazilian Shield, has a dominant structural lineament parallel to the margin and high topography. To the south, the topography gets progressively lower and in the south of the Rio de la Plata craton there is no Precambrian basement exposed (Fig. 1). The nature of the margin has influenced the development of offshore sedimentary basins and onshore intracontinental basins.

On the South American Margin most thermochronology studies have focused on southeastern Brazil (e.g., Cogné et al., 2011, 2012; Franco-Magalhaes et al., 2014; Gallagher et al., 1994, 1995; Hackspacher et al., 2007; Hiruma et al., 2010; Jelinek et al., 2003; Karl et al., 2013; Tello Saenz et al., 2003), where the rifted-margin escarpment is most clearly expressed, such as Serra do Mar and Serra da Mantiqueira. In contrast, the uplift and denudation history of the margin further to the south have not been studied in much detail until now. Borba et al. (2002, 2003) and Bicca et al. (2013) used AFT data focused on relatively restricted areas to constrain denudation in the NW cratonic interior of the Sul-Rio-Grandense Shield. In order to improve the understanding of the thermotectonic evolution of this last sector of south Brazilian continental margin 57 new thermochronological data were obtained: 37 new AFT ages from basement and detrital samples and 20 new ZFT ages from detrital samples. AFT and ZFT cooling ages are related to the continental breakup between South America and Africa and the quantitative thermal histories derived from the data provide the denudation rates, which have a significant effect on the evolution of continental topography and allow us to reconstruct the low-temperature cooling history of the Sul-Rio-Grandense Shield.

* Corresponding author.
E-mail address: christie.oliveira10@gmail.com (C.H.E. Oliveira).

http://dx.doi.org/10.1016/j.tecto.2015.11.005
0040-1951/

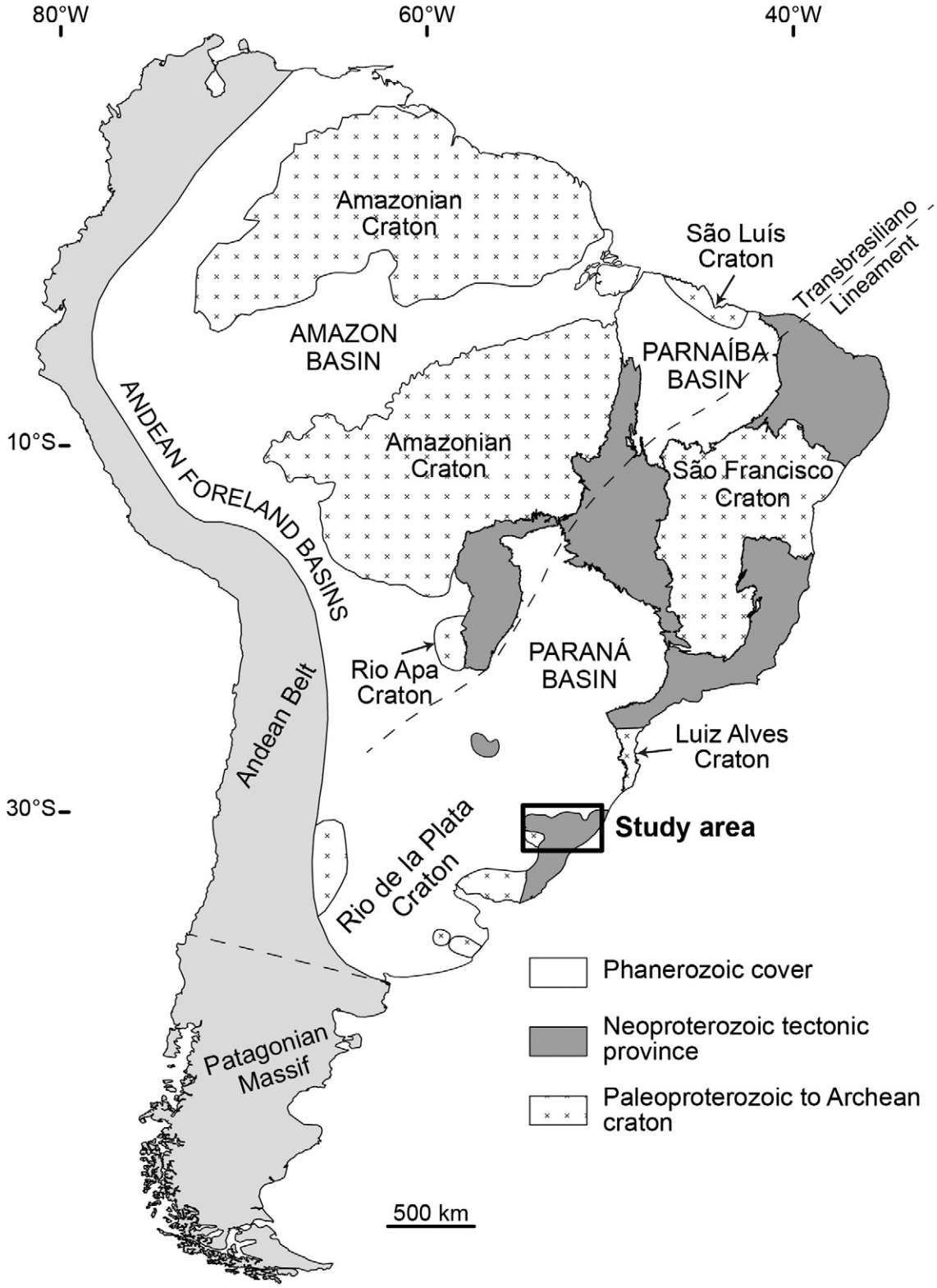

Fig. 1. Geotectonic map of South America with location of the study area (modified from Basei et al., 2010).

2. Geologic setting

The Sul-Rio-Grandense Shield, situated in the southwest Gondwana, comprises rock assemblages generated between Archean and Cambrian-Ordovician (Chemale Jr., 2000; Fernandes et al., 1992; Hartmann et al., 2007) including Dom Feliciano Belt. The Dom Feliciano Belt is an orogenic belt formed as result of the tectonic accretion of the Rio de la Plata, Kalahari and Congo cratons during formation of West Gondwana (e.g., Chemale et al., 1995; Fernandes et al., 1992) in the Brasiliano/Pan-African orogeny.

The Sul-Rio-Grandense Shield is composed of the following four units (Fig. 2) bounded by NE-SW and NW-SE oriented regional Brasiliano shear zones: (1) the Taquarembó Terrane, bounded in the north by the NW-SE trending Ibaré shear zone and in the east by the