

THERMAL HISTORY AT THE MANTIQUEIRA PROVINCE, SOUTHEASTERN BRASIL: MODELING WITH FISSION TRACK ON ZIRCON

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GEOLOGIC SETTING

The reconstruction of the South American Platform has to consider different tectonic and stabilization stages at the end of the Proterozoic and during the Phanerozoic. Modeling of the thermal history of the Precambrian basement, at the Serra da Mantiqueira, north of the city of São Paulo, state of São Paulo, Brazil, was done using U/Pb monazite, $^{40}\text{Ar}/^{39}\text{Ar}$ on biotite, K/Ar whole rock and apatite fission track methodologies (Hackspacher et al., 2004).

Our intention is to details the thermal history with new zircon fission track absolute age (Tello, 2005).

The NE-SW trending Mantiqueira Mountain Range (Fig. 1) is a key region to understand the tectono-thermal history along the southeastern Brazilian margin. It basement rocks register all geological and tectonic events since the Precambrian.

The geological setting of the eastern part of the South American Platform comprises the São Francisco craton surrounded by mobile belts (Fig. 1): the Brasília and Ribeira belts (Cordani et al., 2000). Both belts resulted from the closure of the Goianides and the Adamastor Ocean. Paleo- and Mesoproterozoic basement rocks and intracratonic successions; Neoproterozoic passive margin successions; magmatic arcs of intraoceanic and active continental margin settings; pre- and syn-collisional granitoids; late-orogenic sedimentary succession where involved in the collisional process at 620 Ma (Hackspacher et al., 2005)

Figure 1 show the studied area, with subdivision of the regional geology into tectonic units: a) the São Francisco Craton, composed of Archean to Paleoproterozoic orthogneisses and migmatitic complexes; b) the Reworked Cratonic Border, composed mainly of Archean to Paleoproterozoic tonalitic and granodioritic orthogneisses, strongly reworked during the Neoproterozoic; c) the Brasília belt and the associated Metasedimentary Succession Domain (Araxá and Andrelândia Groups), the Guaxupé and the Socorro Domains; and d) the Central Ribeira belt (Heilbron et al., 2004).

In addition, the tectonic history of the Ribeira belt includes an important escape tectonic event, with transpressional character, juxtaposing different crustal levels (amphibolite and greenschist facies), along NE-trending shear zones. This event took place between 600 and 580 Ma ago, as supported by U-Pb age of post-kinematic syenitic rocks (Töpfung, 1996).

THE TEMPERATURE-TIME DIAGRAM

A temperature-time diagram using preexisting data (Hackspacher et al. 2004) where completed with fission track on zircon (Tello, 2005) (Fig. 2 and table 1)

U/Pb monazite (blocking temperature of ca. 650 °C) data from a series of igneous bodies with tangential and transpressional tectonic regime are related to the main collisional stage, occurred between 625 and 610 Ma. During the following escape tectonics, between 600 and 580 Ma the exhumation process of the Brasília and Ribeira belts, indicates cooling rates of ca. 12°C/Ma.

$^{40}\text{Ar}/^{39}\text{Ar}$ biotite ages between 570 and 490 Ma (ca. 300 °C) are related to transpressional tectonics (brittle plastic transition), with alternation of vertical displacement and stabilization along shear zones of the Ribeira belt overprinting. The cooling path permitted the interpretation of tectonic and stabilization epochs until the final consolidation. Since the Neoproterozoic, a sequence of fast and slow cooling processes could be modeled (path 1 and path 2 at figure 2).

Corrected fission-track age on zircons (240° C) between 450 and 350 Ma indicate an exhumation event related to block tectonics, correlated to the Paraná Basin evolution. A stabilization phase, with low exhumation, and cooling rate around 0.25°C/Ma was recorded from the Ordovician to at the middle to Devonian

A transpressional fault system is described along the Jacutinga Shear Zone with fission track ages on apatite (100 °C) around 220 Ma (Ribeiro et al., 2005).

Corrected fission-track ages on apatite at 120 Ma indicates the South Atlantic rifting event with exhumation related to block tectonics. At 65 Ma the Mesozoic Paleoplatform start a Cenozoic extensional process with block tectonics, related with acceleration of exhumation and denudation of the Southeastern coastline.

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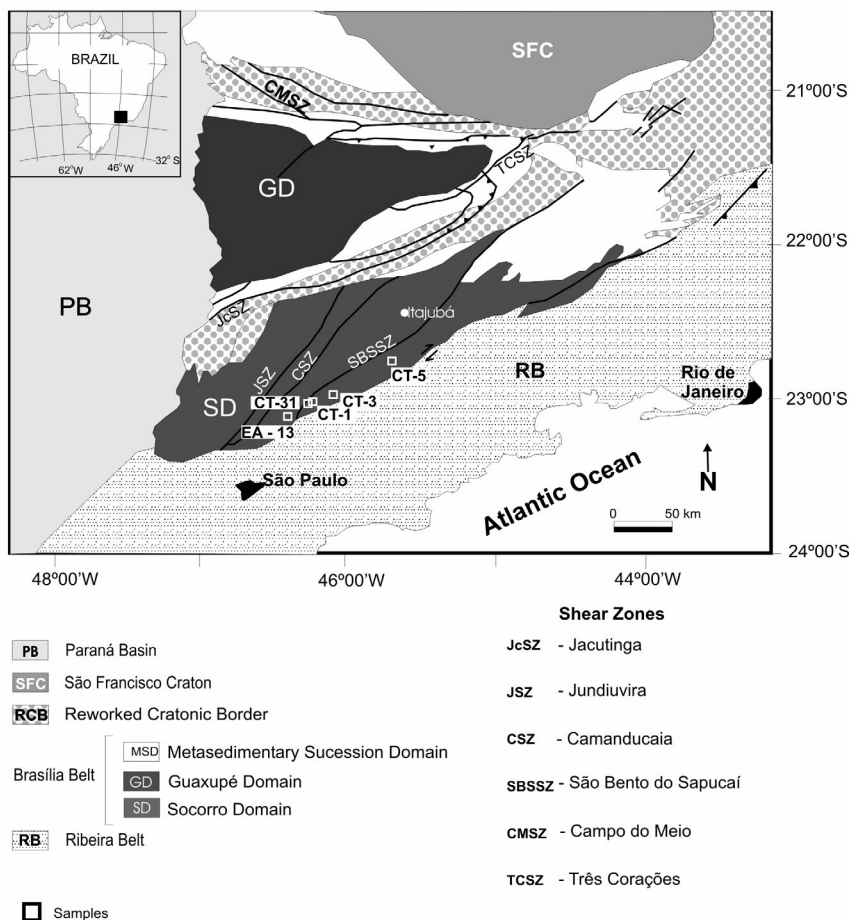


Figure 1. Geologic map of Southeastern Brazil (modified after Hackspacher et al., 2005) with sample locations and numbers.

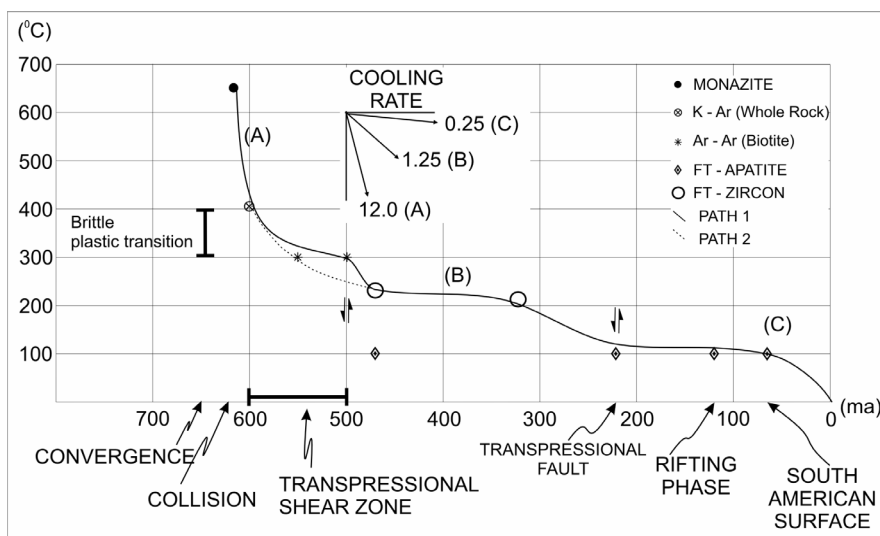


Figure 2. Temperature-time diagram for the Serra da Mantiqueira, Southeastern Brasil (modified after Hackspacher et al., 2004)

Sample	Zircon age, MV (MA) $\pm 1\sigma$	Zircon age, WMV (MA) $\pm 1\sigma$
CT-5 1306 m	474 \pm 50 N= 8	398 \pm 36 $P(\chi^2_v) = 0.05$
CT-1 1324 m	388 \pm 17 N = 24	350 \pm 21 $P(\chi^2_v) = 0.90$
EA-13 1391 m	285 \pm 19 N= 25	244 \pm 14 $P(\chi^2_v) = 0.05$
CT-3 1077 m	342 \pm 25 N= 26	280 \pm 14 $P(\chi^2_v) = 0.01$
CT-31 723 m	426 \pm 23 N = 26	384 \pm 20 $P(\chi^2_v) = 0.80$

Table 1. Fission track ages on zircon of Precambrian rocks of the Serra da Mantiqueira. Location Fig. 1. Column 2; MV- Middle Values (without error of each age). Column 3; WMV- Weighted Middle Values (with error of each age) (modified after Tello, 2005).

RESUMO

A reconstrução tectônica da Plataforma Sulamericana foi feita através de diferentes geotermômetros permitindo a modelagem de histórias térmicas através da crosta. Desde o Neoproterozóico uma seqüência de processos de resfriamento rápida e lenta pode ser modelada. O caminho de resfriamento permitiu a interpretação de diferentes épocas de tectonismo e estabilização, até a consolidação final.

Como geotermômetros foram usados U/Pb monazita, $^{40}\text{Ar}/^{39}\text{Ar}$ mineral, K/Ar rocha total e traços de fissão em zircão e apatita, de rochas precambrianas do Sudeste brasileiro.

O diagrama temperatura-tempo reflete período de exumação acelerada ao final da Orogênese Brasileira, seguido de um complexo cenário durante o Fanerozóico.

U/Pb em monazita (temperatura de bloqueio por volta de 650 °C) são relacionados a principal fase colisional entre 625 e 610 Ma.

Idades $^{40}\text{Ar}/^{39}\text{Ar}$ em biotita (temperatura de bloqueio por volta de 300 °C) entre 570 e 490 Ma são relacionadas a alternância de deslocamentos verticais e estabilização ao longo de zonas de cisalhamento da Faixa Ribeira. A metodologia Ar/Ar permitiu a definição de diferentes caminhos de resfriamento nos diferentes blocos. Idades traços de fissão em zircão (240 °C) entre 450 e 350 Ma indica um evento de exumação relacionado a tectônica de blocos e a evolução da Bacia do Paraná.

Idades de traços de fissão em apatita (100 °C) em 120 Ma estão relacionados ao processo de abertura do Atlântico Sul. Em 65 Ma a Plataforma Mesozóica inicia um processo de fragmentação relacionado a extensão. Exumação e denudação são aceleradas a partir daí.