SINGLE ZIRCON Pb-EVAPORATION AGE OF SOME GRANITIC PLUTONS IN THE CENTRAL PART OF THE RIBEIRA BELT, SOUTHEASTERN BRAZIL

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RESUMO IDADE POR EVAPORAÇÃO DE Pb DE MONO CRISTAL DE ZIRCÃO DE ALGUNS PLUTONS GRANÍTICOS DA PORÇÃO CENTRAL DO CINTURÃO RIBEIRA, SUDESTE DO BRASIL Idades de cinco plutonitos graníticos da parte central da Faixa Ribeira foram obtidas por evaporação de Pb em monocristal de zircão. Quatro desses corpos, São José do Barreiro, Capivara, Mendanha e Funil, intrudiram entre 605 e 584 Ma no período correspondente ao da etapa sin-colisional 1 ou fase deformacional D1+2. A idade mais antiga, provavelmente, está relacionada a um evento metamórfico que precedeu o metamorfismo principal (MR1) da Faixa Ribeira. A idade mais jovem é relacionada ao pico desse evento metamórfico, representado pela colocação do granitóide Rio Turvo com idade de 579 ± 6 Ma. Neste trabalho sugere-se a ampliação do intervalo de tempo, de 605 a 565 Ma, para o episódio intrusivo granítico da fase sin-colisional 1 da Faixa Ribeira. O Granito Itanhandu, que ocorre na zona de interferência entre as faixas Ribeira e Brasília, tem idade de cristalização de 649 ± 6 Ma e foi relacionado ao metamorfismo da Faixa Brasília.

Palavras-chaves: idades $^{207}\text{Pb}/^{206}\text{Pb}$, granitos, Faixa Ribeira.

ABSTRACT The single zircon Pb-evaporation technique was used to determine the age of five granitic plutons in the central part of the Ribeira belt. Four of these granitic plutons, São José do Barreiro, Capivara, Mendanha and Funil, were intruded between 605 and 584 Ma and are synchronous with the syn-collisional 1 or D1+2 deformational phase. The older age probably represents a first metamorphic phase predating the principal metamorphic event (MR1) of the Ribeira belt. The younger age is equivalent to the metamorphic peak of this event, represented by the emplacement of the Rio Turvo granitoid, at 579 ± 6 Ma. In this paper a new interval between 605 to 565 Ma is suggested for the syn-collisional 1 Ribeira intrusive granitic episode. The tectonic setting, in the interference zone of the Brasília and Ribeira belts, as well as the crystallization age of the Itanhandu granite (649 ± 6 Ma) relates this body to the metamorphism of the Brasília belt.

Keywords: $^{207}\text{Pb}/^{206}\text{Pb}$ age, granite, Ribeira Belt.

INTRODUCTION The Ribeira belt (Hasui & Oliveira 1984), is the principal tectonic unit of the Mantiqueira Province and one of the several Neoproterozoic orogenic belts surrounding the São Francisco craton. This belt was generated between ~700 and 450 Ma during the Brasiliano Orogeny, that is regarded as the South American equivalent of the Pan-African Orogeny (Machado *et al.* 1996).

The central portion of the Ribeira belt covers part of the Rio de Janeiro, São Paulo and Minas Gerais states, located in southeastern region of Brazil. This paper presents new geochronological data, obtained by the single zircon Pb-evaporation technique, for five Brasiliano-related granitic plutons. All of the studied bodies are medium size plutons (30-50 km²) which crop out in the mid-valley of the Paraíba do Sul river (Funil, São José do Barreiro and Mendanha granites) and in the high Rio Grande river basin (Capivara and Itanhandu granites).

GEOLOGIC BACKGROUND The tectonic subdivision adopted for the region (Fig. 1), comprises five early to late

proterozoic tectonic units: the Embu Domain (ED) in the southern, the Socorro-Guaxupé Thrust Nappe (SGTN) in eastern, the Andrelandia Thrust System (ATS) in the northern, the Juiz de Fora Thrust System (JFTS) in the central and the Paraíba do Sul Klippe (PSK) in southeastern part of the area (Pereira 2001). This subdivision puts together the tectonic framework proposed by various authors e.g. Heilbron *et al.* (2000), Trouw *et al.* (2000) and Campos Neto & Figueiredo (1995). Some of these domains are bounded by dextral transcurrent faults (e.g. Cubatão, Alto da Fartura shear zones) of the São Paulo shear zone (Hasui & Oliveira 1984) or Atlantic Shear Belt of Machado & Endo (1993). Various granitic plutons crop out within this area and they are preferably linked with the Embu Domain (Funil and São José do Barreiro granites), the Socorro-Guaxupé Nappe (Mendanha granite) and the Andrelandia Thrust System (Capivara and Itanhandu granites).

Conventional U-Pb ages obtained from zircons, monazites and titanites have provided a temporal framework for the magmatic, deformational and metamorphic events of the central

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part of the Ribeira belt (Machado *et al.* 1996, Valladares 1996). Three periods or phases of deformation have been registered in the central segment of the Ribeira belt. The main deformation phase D1+2, is associated with the Ribeira metamorphic peak at c.a. 579 Ma (Heilbron *et al.* 1995); and the D3 and D4 episodes that post-date the main deformational event. A number of intrusive granitic bodies in the area has been previously related to five magmatic episodes: pre-collisional from 630 to 595 Ma; syn-collisional 1 from 595 to 565 Ma; syn-collisional

2 from 565 to 540 Ma; late-collisional from 540 to 520 Ma and slab detachment from 520 to 480 Ma (Heilbron *et al.* 1999, Valladares *et al.* 2000). Machado (1997) suggested the interval between 650 - 620/600 Ma for the pre-collisional (pre D1+2 / F2) and 600 - 590/570 Ma for the syn-collisional (syn D1+2 / F2) bodies.

The Embu Domain comprises the Embu Complex, a sequence of supracrustal rocks variably deformed and metamorphosed. In this complex, two lithological units have been recognised:

Figure 1 - Tectonic map of the middle Paraíba do Sul and high Rio Grande rivers areas. Tertiary Sedimentary Basins: Taubaté and Resende basins. Mesozoic alkaline massifs: Passa Quatro, Itatiaia and MR = Morro Redondo. Neoproterozoic Granites: Tq = Taquaral; RT = Rio Turvo; Fu = Funil; Me = Mendanha; Ma = Marins; SJB = São José Barreiro; IT = Itanhandu; Cp = Capivara; QC = Quebra-Cangalha; Mr = Maromba; Im = Itamonte; PS = Pedra Selada. Tectonic Domains: ATS = Andrelândia Thrust System; JFTS = Juiz de Fora Thrust System; SGTN = Socorro-Guaxupé Thrust Nappe; ED = Embu Domain; PSK = Paraíba do Sul Klippe. Shear Zones: AF-SZ = Alto da Fartura; C-SZ = Cubatão. SFC = São Francisco Craton; BB = Brasília Belt; RB = Ribeira Belt. Brazil states: MG = Minas Gerais; RJ = Rio de Janeiro; SP = São Paulo.

the Rio Una unit which is represented by quartz-mica schists, gneisses and quartzites, and the Redenção da Serra unit formed by gneiss and migmatites. The migmatites have folded, stromatitic (with amphibolitic, biotite-amphibolitic and biotite-gneissic paleosome and granitic pegmatitic neosome), and schlieren / nebulitic structures. Two granitic bodies occur in this domain: the Funil granite, a slightly peraluminous / metaluminous, non deformed, I-type granitic pluton that it is bounded by the Alto da Fartura shear zone. The main rock type is a light grey to pale pink coarse granitic to monzogranitic porphyritic (microcline phenocrysts with 1,0 to 7,0 cm) rock. The other body, the São José do Barreiro granite (Machado & Pellogia 1987), is a grey, peraluminous, foliated, S-type, coarse grained biotite granite rock with megacrysts of microcline and plagioclase.

The Socorro-Guaxupé Thrust Nappe, in the considered region, is represented by the Piracaia Complex (Morais *et al.* 1998). The Piracaia Complex has a volcano-sedimentary origin and is composed by a sequence of amphibole bearing gneisses and biotite paragneisses, with quartzite layers and lenses of calc-silicate rocks and gondites. The Mendanha granite crops out within this domain, between Piquete and Cruzeiro cities (São Paulo State). It is a pale pink deformed coarse grained monzogranite pluton. The geochemical characteristics of this granitic magma point to a calc-alkalic fractionated body with a peraluminous character (Pereira 2001).

In the southern part of Minas Gerais State, in the Andrelândia Thrust System, the Itanhandu and Capivara granites crop out near the alkaline Passa Quatro and Itatiaia intrusions, at the neighborhood of Itanhandu and Itamonte cities (Minas Gerais

State). They are two syn-collisional medium grained leucogranitic bodies, slightly foliated and intruded in the metatexite (migmatites and banded paragneiss) and diatexites (granitic leucogneiss) units of the Andrelândia Group. This area is interpreted as the interference zone of the Brasília and Ribeira belts (Trouw *et al.* 1994). The Capivara granite also shows two important facies: the Monte Belo muscovite granite and the Dois Irmãos biotite granite (Almeida 1996). The Itanhandu granite has a tourmaline-bearing and a pegmatoid facies. Its geological and geochemical data point to a parautochthonous, calc-alkalic, peraluminous S-type granitic magmatism, probably derived from the melting of feldspathic metasediments (Junho 1995).

SAMPLING AND ANALYTICAL TECHNIQUES Five granite plutons were selected based on the field and tectonic relationship and were sampled for geochronological investigation. The zircon crystals were extracted from the rocks and concentrated using bromoform and Frantz magnetic separation. All the samples used in this study yielded < 250 μm euhedral (bipyramidal square prisms) to subhedral, transparent / translucent, slight metamict, magmatic, non magnetic white and pale yellowish zircons and each grain analysed was described in Tables 1 – 5. The analyzed crystals varied from long (width x length = 1x4) to short (width x length = 1x2) prismatic without apparent opaque inclusions and fractures.

The ages of these plutons were investigated by the single zircon Pb- evaporation technique (Pb-Pb in zircon) developed by Kober (1986, 1987). The isotope analyses were carried out at the Laboratorio de Geologia Isotópica da Universidade Federal do Pará (Pará-Iso), on a Finnigan MAT 262 thermal ionization mass spectrometer. The data acquisition was dynamically made using the ion counting (IC) system of the instrument. Pb signal was collected by peak hopping in the order 206, 207, 208, 206, 207, 204 along 10 mass scans, defining one block of data with 18 $^{207}\text{Pb}/^{206}\text{Pb}$ ratios. Outliers were eliminated using Dixon's test. The average $^{207}\text{Pb}/^{206}\text{Pb}$ ratio of each step was determined based on five blocks, or until the intensity beam was sufficient for a reliable analysis. The $^{207}\text{Pb}/^{206}\text{Pb}$ ratio was measured in three steps of evaporation at temperatures of 1450, 1500, and 1550°C. Usually, the average $^{207}\text{Pb}/^{206}\text{Pb}$ ratio obtained in the highest evaporation temperature, in each zircon, was considered for age calculation. However, the ages of the lower temperature steps were also considered when they overlapped within the error with those ages obtained at the highest evaporation temperature. The ages were calculated with 2 σ error and common Pb correction was done for those blocks where the $^{204}\text{Pb}/^{206}\text{Pb}$ ratios were lower than 0.0004, using an appropriate age value derived from the model of Stacey & Kramers (1975).

RESULTS Five zircon of the Funil granite were selected and used for $^{207}\text{Pb}/^{206}\text{Pb}$ apparent age determination and yielded a weighted-mean age of 584 ± 5 Ma, calculated based on 524 $^{207}\text{Pb}/^{206}\text{Pb}$ ratios (Table 1, Fig. 2).

The São José do Barreiro granite provided fourteen zircon crystals for $^{207}\text{Pb}/^{206}\text{Pb}$ apparent age determination. Three zircon crystals (1, 3 and 9) gave much older ages than those obtained for the other zircons and are considered inherited crystals (Table 2). Zircons 1 and 9 gave ages of 1834 ± 9 Ma and 1685 ± 11 Ma in the evaporation step of 1550°C, respectively, while the zircon

3 gave an age of 1796 ± 8 Ma (1500°C). The other eleven crystals gave an average age of 603 ± 3 Ma, calculated based on 1156 $^{207}\text{Pb}/^{206}\text{Pb}$ ratios (Fig. 3).

Fourteen zircons of the Mendanha granite were used to determine the $^{207}\text{Pb}/^{206}\text{Pb}$ apparent age of the body. Three grains (crystals 5, 8 and 14) were considered inherited zircons (Table 3). Zircons 5, 8 and 14 gave ages of 733 ± 22 Ma, 787 ± 6 Ma and 655 ± 11 Ma in the evaporation steps of 1500°C, 1450°C and 1550°C respectively. Four grains (crystals 3, 7, 17 and 21) were eliminated from age calculation since their $^{204}\text{Pb}/^{206}\text{Pb}$ ratios were higher than 0.0004. Crystal 20 was subjectively eliminated since its age was obtained in the lowest temperature evaporation step. Six crystals gave an average age of 592 ± 5 Ma, calculated based on 466 $^{207}\text{Pb}/^{206}\text{Pb}$ ratios (Fig. 4).

Seven zircon crystals of the Capivara granite were selected for age determination. Four crystals gave much older ages than those obtained for the other three zircons (Table 4). Zircons 4, 22, 23 and 32 gave ages of 2091 ± 2 Ma, 2087 ± 5 Ma, 2101 ± 11 Ma and 1871 ± 6 Ma respectively in the evaporation step of 1500°C. The other three crystals gave an average age of 605 ± 11 Ma, based on the results of 266 $^{207}\text{Pb}/^{206}\text{Pb}$ ratios (Fig. 5).

The Itanhandu granite supplied nine zircon crystals for $^{207}\text{Pb}/^{206}\text{Pb}$ apparent age determination (Table 5). Two crystals (1 and 13) gave much older ages than those obtained for the other zircons (Table 5) and were considered inherited zircons with ages of 2156 ± 3 Ma (evaporation step of 1500°C) and 1058 ± 6 Ma (evaporation step of 1450°C) respectively. Zircon 5 was eliminated because their $^{204}\text{Pb}/^{206}\text{Pb}$ ratio was higher than 0.0004. The other six crystals (3, 6, 9, 10, 11 and 14) gave an average age of 649 ± 6 Ma, based on the results of 702 $^{207}\text{Pb}/^{206}\text{Pb}$ ratios (Fig. 6).

REGIONAL IMPLICATIONS The non-foliated I-type Funil granite was considered to be a post-F2 pluton (Machado *et al.* 2000) but in fact, the 584 ± 5 Ma Funil granite $^{207}\text{Pb}/^{206}\text{Pb}$ age is more compatible with the syn-collisional 1 tectonic setting proposed for the central region of the Ribeira belt. A typical syn-collisional (D1+2) granite in this region is represented by the strong foliated S-type Rio Turvo granitoid, whose conventional U-Pb age of 579 ± 6 Ma marks the peak of the MR1 metamorphic event of the Ribeira belt in their central region (Heilbron *et al.* 1995). Both granites (the I-type Funil granite and the S-type Rio Turvo granitoid) are in close proximity in space and time in this region. Similar situation has been described to the close and penecontemporaneous I- and S-type suites of the New England and Lachlan belts in the Tasmania orogenic provinces, eastern Australia, which have a controversial geodynamic formation regime (Föster *et al.* 1997). Three crystals (1, 3 and 9) of the São José do Barreiro granite were considered inherited zircons which ages range between 1843 to 1674 Ma. The older age probably is an indicative of a Paleoproterozoic crustal source for this rock and the younger ages the partial Pb loss of the zircon during the anatexis process. In the central segment of the Ribeira belt Machado *et al.* (1996) determined U-Pb ages near 604–611 Ma and according to these authors these ages suggest the presence of a metamorphic event predating the MR1 metamorphism of the Ribeira belt. Here, the 603 ± 3 Ma age of the São José do Barreiro pluton is considered to be related to the syn-collisional phase of the Ribeira belt and correlated to an early metamorphic stage predating the MR1 metamorphic event.

Figure 2 - Age (Y) x Evaporation step (X) of zircon crystals of the Funil granite. (●) Block of isotopic ratio considered for age calculation; (□) eliminated block; (x) Eliminated block: isotopic ratio $^{204}\text{Pb}/^{206}\text{Pb}$ 0,0004; 2σ error

Figure 5 - Age (Y) x Evaporation step (X) of zircon crystals of the Capivara granite. (●) Block of isotopic ratio considered for age calculation; 2σ error.

Figure 3 - Age (Y) x Evaporation step (X) of zircon crystals of the São José do Barreiro granite; (●) Block of isotopic ratio considered for age calculation; 2σ error.

Figure 6 - Age (Y) x Evaporation step (X) of zircon crystals of the Itanhandu granite. (●) Block of isotopic ratio considered for age calculation; (□) eliminated block; (x) Eliminated block: isotopic ratio $^{204}\text{Pb}/^{206}\text{Pb}$ 0,0004; 2σ error.

Figure 4 - Age (Y) x Evaporation step (X) of zircon crystals of the Mendanha granite. (●) Block of isotopic ratio considered for age calculation; (□) eliminated block; (x) Eliminated block: isotopic ratio $^{204}\text{Pb}/^{206}\text{Pb}$ 0,0004; 2σ error.

The 592 ± 5 Ma age of the Mendanha granite may be related to the syn-collisional 1 Ribeira belt phase. Ages like this (587 ± 5 Ma and 591 ± 8 Ma) were found in the Socorro-Guaxupé Nappe on a late-tectonic granite and charnockite near São Francisco Xavier village (Negri & Oliveira 1999). Inherited zircons, with ages between 787 and 655 Ma, suggest neoproterozoic rocks as the protolith of the Mendanha granite.

Although located in the Alto Rio Grande belt, considered as an interference zone of the Ribeira and Brasília belts (Trouw *et al.* 1994), the 605 ± 11 Ma age of the Capivara granite is here related to the syn-collisional phase of the Ribeira belt. Three zircon grains found in this granite are inherited zircons and have ages between 2101 and 2087 Ma. These ages suggest the contribution of rocks formed during the proterozoic Transamazonian cycle (2200-1900 Ma). The other inherited zircon of 1871 ± 6 Ma is similar to the U-Pb age of 1872 ± 11 Ma obtained in zircons of a quartz-schist of the Andrelândia Group (Sölner & Trouw 1997) which was interpreted as the

age of the source of the metasedimentary rocks (Ribeiro *et al* 1995).

On the basis of the ages determined for the São José do Barreiro, Capivara, Mendanha and Funil bodies, we considered that these four plutons represent a major period of syntectonic (D1+2) intrusive activity, and suggest a new interval between 605 to 565 Ma for the syn-collisional I Ribeira intrusive granitic episode.

The crystallization age of the Itanhandu granite was 649 ± 6 Ma and probably linked to the Brasília metamorphism (MB).

Two crystals (1 and 13) of the Itanhandu granite have ages of 2156 ± 3 Ma and 1058 ± 6 Ma. The older age (Transamazonian Cycle) may represent the age of the source of the metasedimentary rocks and the younger, probably, the partial Pb loss of the zircon during the anatexis process. The tectonic setting of the Itanhandu granite is in the interference zone of the Brasília and Ribeira belts, and this body crop out near the Socorro-Guaxupé Nappe and the Andrelândia Thrust System boundary. U-Pb ages of 625 Ma were found on the Socorro-Guaxupé Nappe (Janasi 1999) and were considered as

Table 1 - $^{207}\text{Pb}/^{206}\text{Pb}$ apparent ages for zircon crystals of the Funil granite. Uncertainties are given at 2σ

Zircon	description	T evaporation (°C)	n° of ratios	$^{204}\text{Pb}/^{206}\text{Pb}$	$^{208}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$ (**)	age (Ma)
3	Euh,lgpr,tl	1450	86	0.000236	0.16728	0.06304	0.05952	586 ± 4
		1500	86	0.00049	0.16034	0.06000	0.05926	577 ± 4
5	Euh,lgpr,tl	#1450	18	0.000554	0.18205	0.06671	0.05867	555 ± 27
		1500	90	0.000205	0.19790	0.06671	0.05932	579 ± 6
7	Euh,lgpr,tl	1500	84	0.000115	0.48667	0.06106	0.05936	580 ± 4
		*1550	18	0.000019	0.58504	0.06082	0.05963	623 ± 8
8	Euh,stpr,tl	1500	88	0.000073	0.16888	0.06075	0.05963	590 ± 4
10	Euh,lgpr,tl	*1450	18	0.000168	0.12685	0.06175	0.05931	579 ± 9
		1500	90	0.000061	0.17563	0.06055	0.05963	590 ± 4
							mean	584 ± 5

Table 2 - $^{207}\text{Pb}/^{206}\text{Pb}$ apparent ages for zircon crystals of the São José do Barreiro granite. Uncertainties are given at 2σ . Description of the zircon crystals: Euh= euhedral; stpr= short prismatic ($l/w=3$); lgpr= long prismatic ($l/w=4$); tl= translucent. ♦ inherited zircon; # $^{204}\text{Pb}/^{206}\text{Pb} > 0.0004$; * step not considered for age calculation; (**) $^{207}\text{Pb}/^{206}\text{Pb}$ ratio correct for common Pb contamination.

Zircon	description	T evaporation (°C)	n° of ratios	$^{204}\text{Pb}/^{206}\text{Pb}$	$^{208}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$ (**)	age (Ma)
♦1	Euh,stpr,tl	*1450	64	0.000157	0.04897	0.06971	0.06739	850 ± 20
		*1550	86	0.000049	0.07880	0.09818	0.09746	1576 ± 19
		*1560	18	0.000057	0.11644	0.11289	0.11212	1834 ± 9
♦3	Euh,lgpr,tl	*1450	80	0.000020	0.05329	0.06177	0.06148	656 ± 5
		*1500	82	0.000026	0.06253	0.11014	0.10977	1796 ± 8
♦9	Euh,lgpr,tl	*1450	86	0.000062	0.04932	0.07117	0.07036	939 ± 42
		*1500	88	0.000050	0.04057	0.09372	0.09301	1488 ± 10
		*1550	82	0.000045	0.04033	0.10395	0.10334	1685 ± 11
2	Euh,lgpr,tl	1450	88	0.000046	0.05734	0.06051	0.05987	599 ± 4
		1550	84	0.000045	0.08314	0.06068	0.06002	605 ± 5
4	Euh,lgpr,tl	1450	84	0.000032	0.05579	0.06033	0.05989	600 ± 6
		1500	88	0.000026	0.10031	0.06018	0.05981	597 ± 4
5	Euh,lgpr,tl	*1450	18	0.000157	0.06722	0.06240	0.06012	608 ± 57
		*1500	84	0.000366	0.10802	0.06490	0.05959	589 ± 17
6	Euh,lgpr,tl	1450	16	0.000080	0.06402	0.06124	0.06008	607 ± 14
7	Euh,stpr,tl	1500	50	0.000020	0.04688	0.06040	0.06021	611 ± 8
		1550	16	0.000111	0.08222	0.06134	0.05973	594 ± 13
8	Euh,lgpr,tl	1450	18	0.000085	0.05150	0.06113	0.05989	600 ± 11
		1500	86	0.000115	0.06450	0.06111	0.05946	584 ± 10
10	Euh,stpr,tl	1450	84	0.000050	0.05544	0.06088	0.06021	611 ± 4
		1500	84	0.000026	0.11810	0.06017	0.05981	597 ± 4
11	Euh,stpr,tl	1450	84	0.000021	0.03556	0.06031	0.06000	604 ± 3
12	Euh,lgpr,tl	1450	86	0.000068	0.05016	0.06101	0.06001	604 ± 4
		1500	88	0.000082	0.07356	0.06107	0.05990	600 ± 12
13	Euh,lgpr,tl	1450	82	0.000033	0.05411	0.06021	0.05973	594 ± 10
		1500	84	0.000094	0.10684	0.06140	0.06005	606 ± 4
14	Euh,lgpr,tl	1450	68	0.000037	0.07731	0.06073	0.06014	609 ± 4
		1500	50	0.000073	0.17652	0.06103	0.06001	604 ± 7
							mean	603 ± 3

Table 3 - $^{207}\text{Pb}/^{206}\text{Pb}$ apparent ages for zircon crystals of the Mendanha granite. Uncertainties are given at 2σ . Description of the zircon crystals: Euh= euhedral; stpr= short prismatic ($l/w=3$); lgpr= long prismatic ($l/w=4$); tl= translucent. ♦ inherited zircon; # $^{204}\text{Pb}/^{206}\text{Pb} > 0,0004$; * step not considered for age calculation; (**) $^{207}\text{Pb}/^{206}\text{Pb}$ ratio correct for common Pb contamination.

Zircon	description	T evaporation (°C)	n° of ratios	$^{204}\text{Pb}/^{206}\text{Pb}$	$^{208}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$ (**)	age (Ma)
5	Euh, prlg, tr	*1500	78	0,000115	0,08818	0,06618	0,06372	733 ± 22
8	Euh, prlg, tl	*1450	90	0,000257	0,09541	0,06907	0,06538	787 ± 6
		#1500	82	0,000745	0,20581	0,07522	0,06441	755 ± 12
		#1550	88	0,000642	0,20518	0,07461	0,06545	789 ± 7
14	Euh, prlg, tl	*1550	88	0,000229	0,10203	0,06477	0,06145	655 ± 11
3	Euh, prlg, tl	#1500	90	0,000871	0,05211	0,07622	0,06396	740 ± 7
		#1550	18	0,000871	0,21477	0,09615	0,08054	1211 ± 174
7	Euh, prlg, tl	*1450	82	0,001172	0,12807	0,07566	0,05866	555 ± 44
11	Euh, prlg, tr	*1450	52	0,000172	0,16068	0,06136	0,05889	563 ± 7
		1500	90	0,000078	0,19111	0,06068	0,05951	586 ± 7
12	Euh, prlg, tl	*1450	32	0,000339	0,18119	0,06616	0,06125	648 ± 40
		1500	88	0,000094	0,17709	0,06086	0,05946	584 ± 6
16	Euh, prst, tl	#1450	36	0,001047	0,12381	0,07523	0,0987	599 ± 20
		#1500	36	0,000516	0,15183	0,06702	0,05955	588 ± 13
17	Euh, prst, tl	#1450	16	0,000542	0,12619	0,06696	0,05910	571 ± 47
		1500	86	0,000084	0,16876	0,06094	0,05970	593 ± 4
18	Euh, prst, tl	*1450	88	0,000342	0,13487	0,06415	0,05919	574 ± 5
		1500	78	0,000085	0,16720	0,06083	0,05957	588 ± 10
		1550	18	0,000169	0,08340	0,06204	0,05958	589 ± 28
19	Euh, prlg, tl	1500	18	0,000006	0,15386	0,05991	0,05982	597 ± 13
20	Euh, prlg, tl	*1450	18	0,000346	0,21572	0,06417	0,05914	573 ± 16
21	Euh, prlg, tl	#1450	50	0,000619	0,19899	0,06876	0,05940	582 ± 13
22	Euh, prlg, tl	1500	88	0,000114	0,19277	0,06160	0,05992	601 ± 6
							mean	592 ± 5

Table 4 - $^{207}\text{Pb}/^{206}\text{Pb}$ apparent ages for zircon crystals of the Capivara granite. Uncertainties are given at 2σ . Description of the zircon crystals: Euh= euhedral; lgpr= long prismatic ($l/w=4$); tl= translucent. ♦ inherited zircon; # $^{204}\text{Pb}/^{206}\text{Pb} > 0,0004$; (**) $^{207}\text{Pb}/^{206}\text{Pb}$ ratio correct for common Pb contamination.

Zircon	description	T evaporation (°C)	n° of ratio	$^{204}\text{Pb}/^{206}\text{Pb}$	$^{208}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$ (**)	age (Ma)
♦ 4	Euh,lgpr,tl	1500	96	0,000317	0,02411	0,12960	0,12949	2091 ± 2
♦ 22	Euh,lgpr,tl	#1450	18	0,000671	0,10726	0,10383	0,9454	1519 ± 15
		1500	86	0,000142	0,12534	0,13091	0,12914	2087 ± 5
♦ 23	Euh,lgpr,tl	1500	18	0,00000	0,15995	0,13018	0,13018	2101 ± 11
♦ 32	Euh,lgpr,tl	1450	16	0,000135	0,02861	0,07881	0,07689	1119 ± 35
		1500	88	0,000090	0,04903	0,11569	0,11443	1871 ± 6
7	Euh,lgpr,tl	1500	88	0,000047	0,04151	0,06083	0,06009	607 ± 4
		1550		0,000071	0,05216	0,06138	0,06045	620 ± 8
18	Euh,lgpr,tl	1450	88	0,000177	0,14115	0,06206	0,05934	580 ± 12
		1500		0,000073	0,14871	0,06076	0,05975	595 ± 11
21	Euh,lgpr,tl	1500	90	0,000284	0,06842	0,06337	0,05923	576 ± 18
							mean	605 ± 11

Table 5 - $^{207}\text{Pb}/^{206}\text{Pb}$ apparent ages for zircon crystals of the Itanhandu granite. Uncertainties are given at 2σ . Description of the zircon crystals: Euh= euhedral; stpr= short prismatic ($l/w=3$); lgpr= long prismatic ($l/w=4$); cl= translucent. ♦ inherited zircon; # $^{204}\text{Pb}/^{206}\text{Pb} > 0.0004$; (**) $^{207}\text{Pb}/^{206}\text{Pb}$ ratio correct for common Pb contamination.

Zircon	Description	T evaporation (°C)	n° of ratio	²⁰⁴ Pb/ ²⁰⁶ Pb	²⁰⁸ Pb/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²⁰⁶ Pb (**)	age (Ma)
1	sub,spr,tl	1450	84	0,000080	0,17955	0.12954	0.12836	2076±8
		1500	80	0,000013	0,18349	0.13458	0.13440	2156±3
13	Euh,lgpr,tl	1450	72	0,000184	0,03187	0.07729	0.07461	1058±6
3	sub,lgpr,tl	1500	88	0,000109	0,19080	0.06325	0.06165	662±5
		1550	82	0,000005	0,15681	0.06169	0.06159	660± 9
5		#1450	16	0,001878	0,23794	0,08887	0,06170	664 38
6	Euh,lgpr,tl	1550	16	0,000135	0,11265	0.06270	0.06074	630±26
9	sub,lgpr,tl	#1450	88	0,001077	0,12291	0,07732	0,06172	665±11
		1500	78	0,000217	0,09180	0.06436	0.06117	646±5
10	sub,spr,tl	1450	18	0,000383	0,13259	0.06640	0.06086	635±18
		1500	88	0,000047	0,11064	0.06159	0.06092	637±9
11	Euh,lgpr,tl	1450	82	0,000185	0,19866	0.06401	0.06129	650±4
14	Euh,lgpr,tl	1450	86	0,000133	0,11413	0.06287	0.06093	637±7
		1500	80	0,000109	0,10824	0.06289	0.06128	649±6
		1550	84	0,000083	0,10681	0.06232	0.06108	642±8
							mean	649±6

representative of the peak of metamorphism of the Brasília belt (MB). This interpretation is also supported by the U/Th-Pb 630 ± 20 Ma age determined in monazites from biotite garnet gneiss of the Socorro-Guaxupé Nappe (Vlach *et al.* 1999).

CONCLUDING REMARKS The granite magmatism in the study area (central segment of the Ribeira belt) is represented by alkalic-calcic peraluminous S-type granites (Capivara, São José do Barreiro and Mendanha) and slightly peraluminous/metaluminous I-type granite (Funil). $^{207}\text{Pb}/^{206}\text{Pb}$ ages from singles zircons indicate that most of the granitic plutons were intruded between 605 Ma and 584 Ma and were related to the

syn-collisional 1 phase of the Ribeira belt. The ages of these plutons probably constraints the timing of the metamorphism of the Ribeira belt. The emplacement of the São José do Barreiro and Capivara granites (605/603 Ma) is here related an early stage predating the MR1 metamorphism and the Funil granite (584 Ma) to the metamorphic peak of the MR1 Ribeira belt metamorphism in the region. The Itanhandu granite, with a crystallization age of 649 ± 6 Ma, is related to the metamorphism of the Brasília belt.

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