THE ROLE OF ZIRCON INTERNAL STRUCTURES IN THE U-Pb AGES OF CUNHAPORANGA AND TRÊS CÓRREGOS BATHOLITHS, APIAÍ DOMAIN (RIBEIRA BELT)- SOUTHERN BRAZIL *

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Introduction

Zircons are accessory minerals in a vast variety of mafic to felsic rocks and are capable to incorporate trace elements like U, Th, ETR, Y, P, Hf. This characteristic, associated to the zircons refractory behavior and to the advances of micro-analyses techniques (electronics probes, ion probes-SIMS, Laser Ablation-ICPMS etc), make them essential minerals in petrological studies. They also show a great capability to retain information about the crystallization, metamorphism and physical/chemical-isotopic characteristics from their magmatic precursors, as well as to demonstrate subsequent geological processes imposed to their host rocks.

The cathodoluminescence (CL) is the most used techniques to observe the zircon internal structure, usually undetected by optical microscopes, such as inherited nuclei, reabsorption areas, melt-precipitaded overgrowths, magmatic zoning etc. The CL technique has been used widely in petrological studies and it precedes the isotopic-geochemical analyses in zircons (Poller et al. 1997; Willian, 1998; Hoskin and Black, 2000).

In the present work it is discussed the influence of the zircon internal structures in the ages obtained in zircon nuclei extracted from selected rocks of Cunhaporanga and Três Córregos Batholiths that have revealed the existence of different sources on its generation.

Geological Setting

The Ribeira Belt (RB) of Almeida *et al.* (1973) is located in the Mantiqueira Province (Almeida *et al.*, 2000) and can be understood as a geologic unit constituted by several domains (Fig. 1a), with distinct lithologic, geochemical and isotopic characteristics (Cordani & Sato, 1999; Campos Neto, 2000). Among the different tectonic domains of the RB central-southern portion, the Apiaí Domain (AD) stands out as a 500-km long and 100-km wide belt. The Apiaí Domain tectonic limits with the southern units are marked by the Lancinha-Cubatão-Itariri Suture (Basei *et al.* 1999) and has as paleogeography reference the Paranapanema Craton (Basei *et al.* 1992; Mantovani and Brito Neves, 2005). To the southwest it is covered by Phanerozoic rocks of the Paraná Basin and Neoproterozoic/Eopaleozoic molassic basins (Fig. 1).

The metasedimentary rocks of AD are constituted by plataformal to distal sequences with interbeded acid to basic metavolcanics rocks, of low to medium metamorphic grade. The chronology of the main sedimentation and associated volcanism of these geological sequences is a matter of debate. Therefore U-Pb (zircon) dating of mafic metavolcanic rocks has indicated Mesoproterozoic ages for the Água Clara and Votuverava-Perau sequences (Weber *et al.* 2004; Basei *et al.*, submitted), and Neoproterozoic ages for Iporanga-Itaiacoca-Lageado sequences (Hackspacher *et al.* 2000; Siga Jr *et al.*, 2003; Siga Jr *et al.* in this symposium).

Among the AD granitic rocks, large granitic batholiths stand out, such as the Cunhaporanga, Três Córregos and Agudos Grandes as well as many granitic stocks including A-type granitoids (Fig 1b). The Cunhaporanga (CPB) and Três Córregos (TCB) batholiths strike NE-SW covering an area ca. 7000 km^2. Both batholiths show intrusive contacts with Neoproterozoic Itaiacoca Belt (CPB) and Mesoproterozoic Água Clara Sequence (TCB).

The CPB and TCB petrologic data point out that the batholiths are composed of a variety of I type medium- to high-K calc-alkaline granitoids formed between 650-590 Ma (U-Pb ID-TIMS and SHRIMP) by a multi-sequential event that was related to a continental magmatic arc evolution (Gimenez Filho *et al.* 2000; Prazeres Filho *et al.* 2003; Prazeres Filho, 2005).

CL Images

Zircon CL images from six samples of representative CPB and TCB granitoids show that more than 80% of analyzed crystals are dominated by oscillatory zonings without discontinuities between core and border, indicative of a single magmatic event. The presence of refractory phases (inherited nuclei) is characterized by discontinuities between nucleus and border, usually identified by nuclei seemingly without zoning, anhedral (sub-rounded crystal), usually of high luminescence and mantled by resorption textures (Fig. 2). These nuclei are interpreted as the substrata for a new saturation phase (overgrowth) of a melt-precipitated from the new magma of the studied granitic rocks. These

* Uncorrected Preliminary Version

saturation phases usually precipitate in the crystals pyramidal faces is always preceded by resorption textures (Vavra et al., 1996; Corfu et al. 2003).

Tracking Down The Inheritances

In spite of the limited number of analyses (18 spots) it is possible to draw a pattern of different inheritances ages for CPB and TCB (Fig 3). In CPB the inheritances are concentrated exclusively on Paleoproterozoic among 1700 to 2200 Ma, while in BTC achieved the Arquean (Fig 3).

Paleoproterozoic ages between 2200-2000 Ma have been found in orthogneiss of Curitiba Domain-Atuba Complex (Siga Jr. et al. 1995; Basei et al. 1999; Passarelli et al. 2003) and in detrital zircons from Capiru, Votuverava and Itaiacoca Sequences (Basei, verbal communication). Ages between 1700-1800 Ma were also found in some protomylonitic A type-granite inliers in AD metavulcanosedimentar sequences (Cury et al. 2003, Prazeres Filho et al. 2005; Siga Jr. et al. 2005).

Arquean zircons nuclei are rare and are only registered in TCB between 2700-2950 Ma. Sato et al. (2003) determined ages of 3040 Ma in nucleus of zircon of orthogneiss of the Atuba Complex. On the other hand, Paleoproterozoic ages between 2200 to 1800 Ma were also obtained in Luis Alves Craton, (Basei et al. 1999; Harara, et al. 2003).

Conclusions

It is difficult to decide the provenience of the inherited nuclei observed in CPB and TCB. They can either be restitic zircons or captured crystals from the host rocks during the emplacement of the batholiths. However the inheritance ages are surely reflecting the heterogeneity of the Apiaí Domain basement and also demonstrating the presence of different sources in the generation of CPB and TCB.

It is suggested that these sources are situated in a continental crust (Paranapanema Craton?), reworked in Neoproterozoic time. Based on Nd and Pb data it is also suggested that these batholiths were generated at different crustal levels with TCB originated in deeper level in relation to CPB (Prazeres Filho, 2005).

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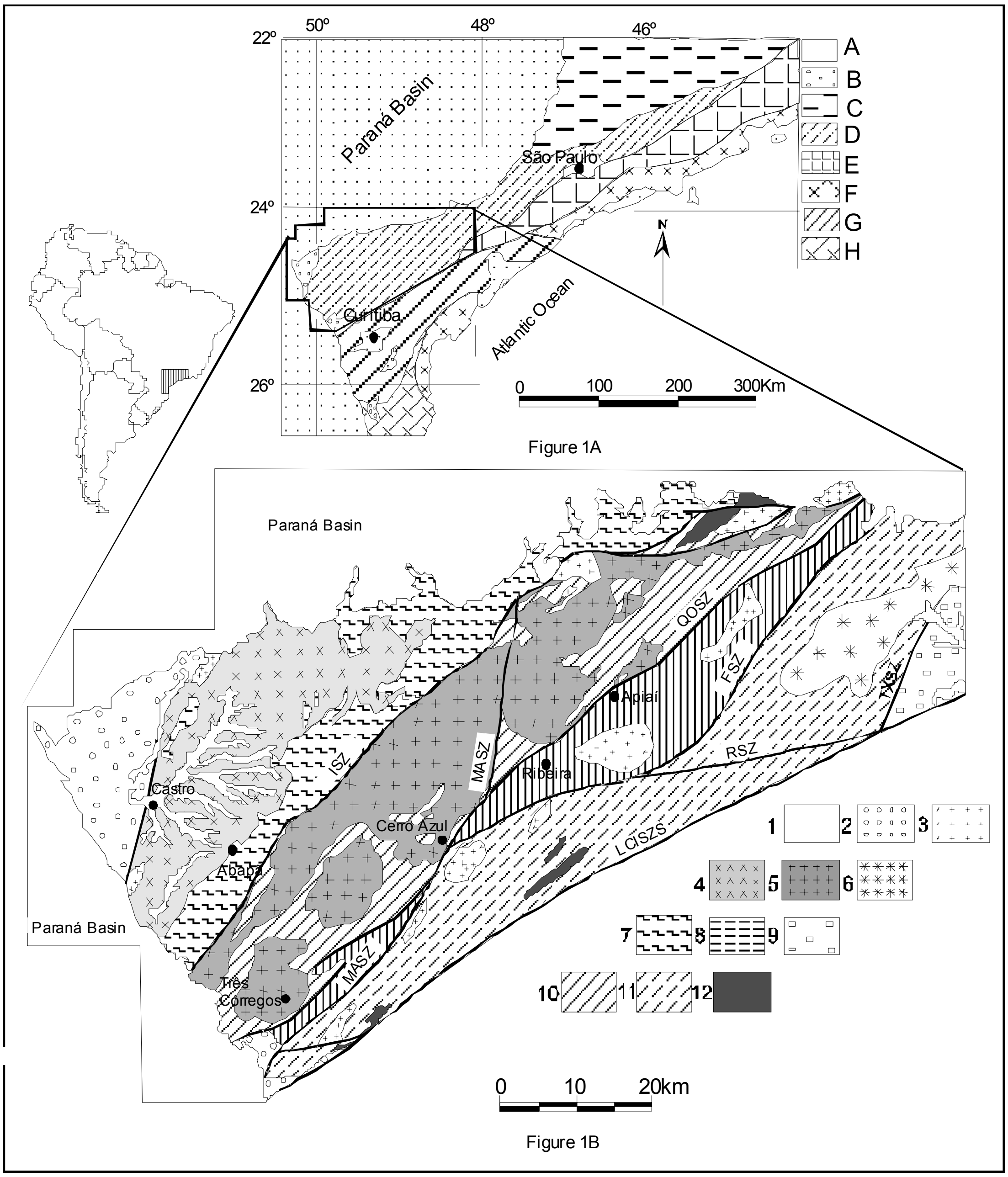
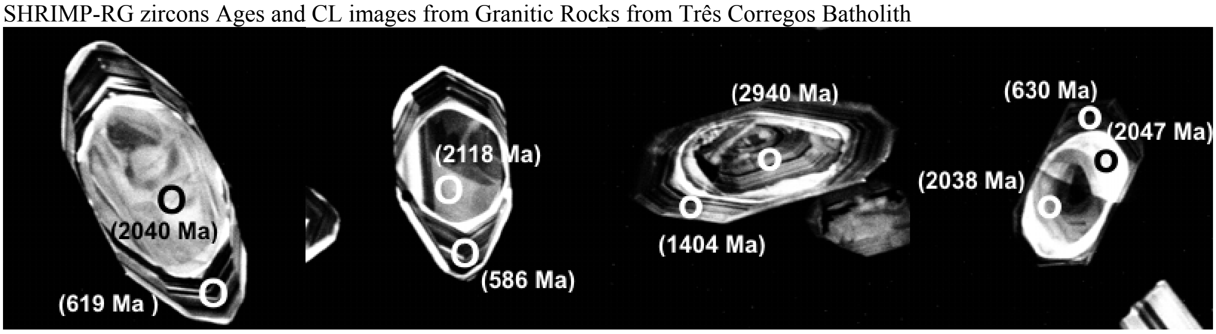


Figure 1 - Tectonic and geological sketch of the south-southeast Brazilian Pre-Cambrian portion. 1A) Tectonic sketch of center-south portion of the Ribeira Belt A) Fanerozoic Cover; B) Neoproterozoic/Eopaleozoic basins; C) Socorro-Guaxupé Domain; D) Apiaí Domain; E) Embu Domain; F) Serra do Mar Domain ; G) Curitiba Domain; H) Luís Alves Craton. 1B) Schematic map of the main geological units of Apiaí Domain. 1) Fanerozoic Cover, 2) Eo-Paleozoic Molassic Basins. Granitic Rocks Neoproterozoic III: 3) Post- to tardi orogenic massives. **Pre- to Late orogenic Calc-alcaline Granitic Batholiths: 4) Cunhaporanga**; **5) Três Córregos**; 6) Agudos Grande. Metavolcanic-sedimentar Sequences: Neoproterozoic Plataformal Sequences: 7) Itaiacoca 8) Lageado Subgroup; Mesoproterozoic Distal Sequences 10) Água Clara Formation; 11) Votuverava-Perau-Betara. 12) Paleoproterozoic Nuclei (1.7 Ma). Shear Zones (SZ): ISZ- Itapirapuã; TXSZ- Taxaquara; LCISZ- Lancinha-Cubatão-Itariri SZ System; MASZ, Morro Agudo; RSZ, Ribeira; FSZ, Figueira; QOSZ, Quarenta-Oitava; ISZ, Itapirapuã. 9) Embu Domain.

SHRIMP-RG zircons Ages and CL images from Granitic Rocks from Três Corregos Batholith



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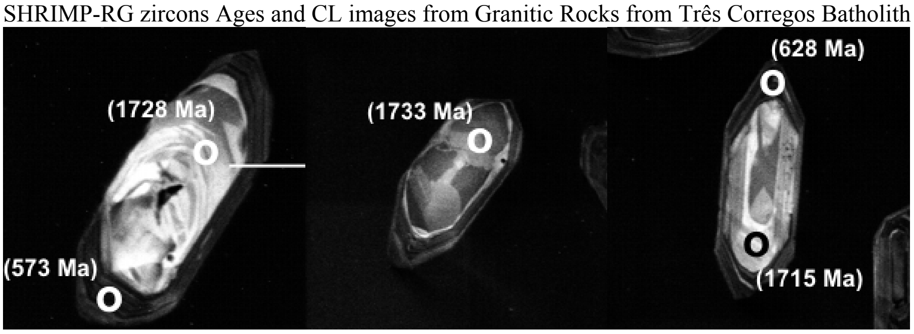

Figure 2- Morphologic characteristics, textures and SHRIMP-RG zircons ages from selected granitic rocks from Três Córregos and Cunhaporanga Batholiths (scale bar = -------------------- 200 µm).

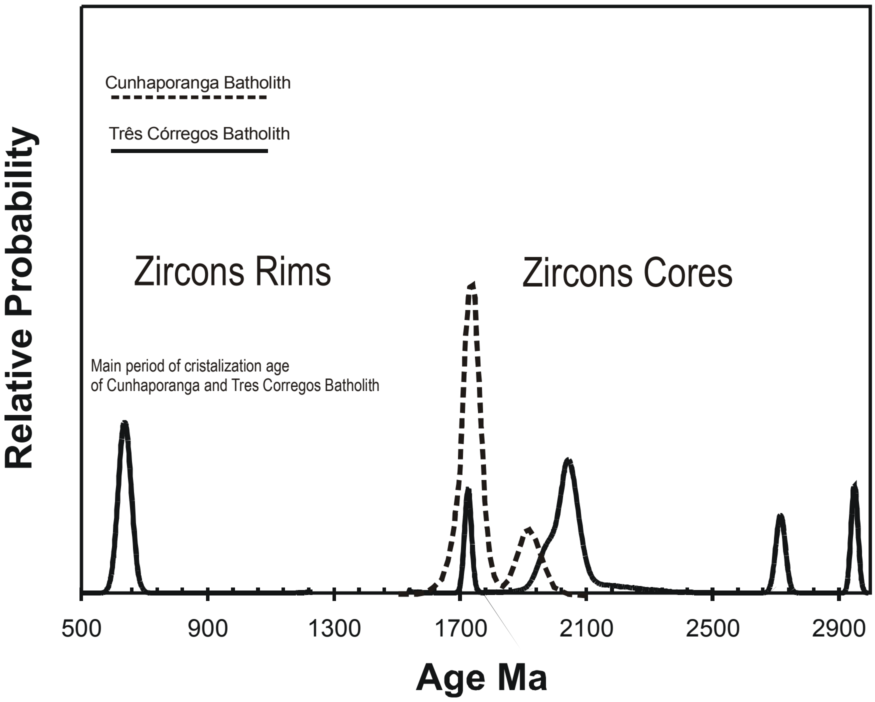

Figure 3 – Relative Probability plot of U-Pb SHRIMP-RG ages (<1700 Ma $^{206}Pb/^{238}U$ and >1700 Ma $^{207}Pb/^{206}Pb$ of zircons cores and rims from Cunhaporanga and Três Córregos Batholiths.

RESUMO

Neste trabalho é discutido a influência das estruturas internas do zircão nas idades SHRIMP obtidas em núcleos de zircão de rochas dos Batólitos Cunhaporanga (BCP) e Três Córregos (BTC). Ambos os batólitos são compostos por uma variedade de granitóides cálcio-alcalinos do tipo I, de médio a alto-K, formados entre 650-590 Ma por um evento multi-sequencial relacionado a um arco de magmático continental durante a evolução do Cinturão Ribeira Brasiliano-Pan Africano (sul do Brasil).

A catodoluminescência (CL) é a técnica mais utilizada para se observar estruturas internas do zircão como núcleos herdados, áreas de reabsorção, sobrecrescimentos, zoneamento magmático, etc. Imagens de CL de seis amostras representativas do BCP e BTC, mostram que a maioria dos cristais analisados é dominada por zoneamentos oscilatórios formados por um único evento magmático. A presença de núcleos herdados é caracterizada por descontinuidades entre o núcleo e borda, normalmente identificadas por núcleos aparentemente sem zoneamento, anedral (cristal sub-arredondado), normalmente com alta luminescência e manteado por texturas de reabsorção.

Os dados SHRIMP mostram um claro padrão de diferentes épocas de heranças para o BCP e BTC. No BCP as heranças estão exclusivamente concentradas no Paleoproterozóico entre 1700-1900 Ma, enquanto no BTC alcançou o Arqueano. Este padrão está refletindo uma heterogeneidade e demonstra a presença de fontes diferentes na geração dos batólitos. Baseado nos dados de Nd e Pb é sugerido também que este batólitos foram gerados em níveis crustais diferentes com o BTC originado em nível mais profundo em relação ao BCP.