# U-PB SHRIMP NEW DATA ON THE HIGH-GRADE SUPRACRUSTAL ROCKS OF THE CAUARANE-COEROENI BELT - INSIGHTS ON THE TECTONIC EO-OROSIRIAN EVOLUTION OF THE GUIANA SHIELD

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## ABSTRACT

New U-Pb SHRIMP data for three paragneisses of the Cauarane-Coeroeni Belt allowed the characterization of Archean, Siderian and Eo-Rhyacian sources for the metasediments, as well as a major provenance from Late-Rhyacian to Eo-Orosirian terranes. The latter terranes are related to 2.050-2.025 Ga magmatic arc edified along 2110-2060 Ga continental margins. Closing of the Cauarane-Coeroeni basins and syn-kinematic high-grade metamorphism is tentatively admitted at 2.020 Ga. Ages in the 1990-1960 Ga and 1940-1920 Ga intervals for zircon borders with low Th/U ratios (<0.1) are interpreted as reflecting thermal perturbation, fluid input and migmatization caused by the emplacement of huge igneous belts.

## INTRODUTION

SHRIMP isotopic analysis allied to textural studies of complex zircon crystals from terranes recording multiphase metamorphic/deformational history (Harley et al. 2007) are a powerful tool to understand the geological evolution of such areas.

The Cauarane-Coeroeni Belt (CCB) is the main tectonic feature of the central part of the Guiana Shield, northern Amazonian Craton. It is delineated by multiphase metamorphic supracrustal rocks, intruded to the north and to the south by huge igneous belts depicting a complex geological scenario.

This extended abstract presents new U-Pb SHRIMP data for three samples of aluminous paragneisses distributed along the CCB and discusses the analytical results in the context of the geology of the Guiana Shield. The new analyses have been obtained at the Laboratory of Geochronology of the Universidade de São Paulo (USP).

## GEOLOGICAL SETTING

The CCB combines the outcrops of the high-grade supracustal rocks of the Cauarane Group (Brazil), Kanuku Complex (Guyana) and Coeroeni Belt (Suriname) which are disposed in a sinuous structure (Fig. 1), well characterised in aeromagnetic maps (Fraga et al. 2009a). The high-grade rocks comprise migmatitic aluminous paragneisses with subordinate calcsilicate rocks, amphibolites, metacherts, quartzites, gondites and mafic schists, syn-kinematicaly metamorphosed at amphibolite to granulite facies with a superimposed static amphibolite facies metamorphism (Fraga et al. 2009a and references therein).

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In the vicinities of the high grade supracrustal rocks of the CCB, Eo-Orosirian 2.04-2.03 Ga crustal fragments (Fig.1), consisting of TTG complexes and calc-alkaline granitoids of the Anauá Complex and Trairão Suite, show important juvenile contribution and are interpreted as recording arc magmatism (Santos 2003; Almeida et al. 2007; Fraga et al. 2009 a).

A-type and high-K calc-alkaline high crustal level granitoids and volcanic rocks related to the 1.99-1.96 Ga Orocaima Magmatism (Reis et al 2003) extend for almost 1000 km along the northern border of the CCB (Fraga et al. 2009 a) forming the Pedra Pintada Igneous Belt (PPIB). Immediately to the south 1.95-1.93 Ga granitoids and gneisses with A-type and high-K calc-alkaline affinities predominate and charnockites and granulite lens also crop out, recording emplacement and crystallization/ recrystallization at deeper crustal levels (Fraga et al. 2009 b). This 1.95-1.93 Ga magmatism bordering to south the CCB is here named Rio Urubu Igneous Belt (RUIB). 1.99-1.96 Ga granitoids also occur further south of the CCB.

The tectonic evolution of the CCB remains under debate. Fraga et al. (2009a, b) envisage the belt as the result of the closing of orogenic basins *ca*. 2,00 Ga, during the assembly of the 2.04-2.03 Trairão and Anauá magmatic arcs with Rhyacian blocks. Those authors admit a post-collisional setting for the PPIB and interpret the RUIB as recording the concentration of major post-collisional transpression zones and magmatism to the south of the CCB. In a different point of view Santos (2003) interprets the 1.99-1.96 Ga and the 1.95-1.93 Ga magmatisms as related to active subduction zones and proposes that the high-grade supracrustal rocks are related to the 1.99-1.96 Ga orogenic setting. Kroonenberg et al. (2016) suggest that the CCB and the Bakhuis Belt (Fig.1) evolved through rift-type basin formation, volcanism, sedimentation with high-grade metamorphism at 2.07-2.05 Ga and 1.99-1.95 Ga, during the third phase of the Transamazonian orogeny.

A very limited geochronological dataset is available for the CCB. Ages of 2223 ± 17 Ma (U-Pb zircon Gaudette et al. 1996), 2074 ± 15 Ma and 2038 (U-Pb-SHRIMP zircon, Santos 2003) have been cited for the source of the metasediments and values of 1969 ± 4 Ma (U-Pb-SHRIMP zircon, Taiano Gneiss, Santos 2003) and 1995 ± 4 Ma (U-Pb SHRIMP on monazite for a S-type granite, Fraga et al. 2009 a) have been interpreted as reflecting the high-grade syn-kinematic metamorphism on the supracrustal rocks. It is important to mention that xenoliths of folded paragnaisses of the CCB occurs inside granitoids dated at 1,97 Ga along the OIB, posing doubts over the assumption of the 1969 ± 4 Ma age for the high-grade metamorphism.

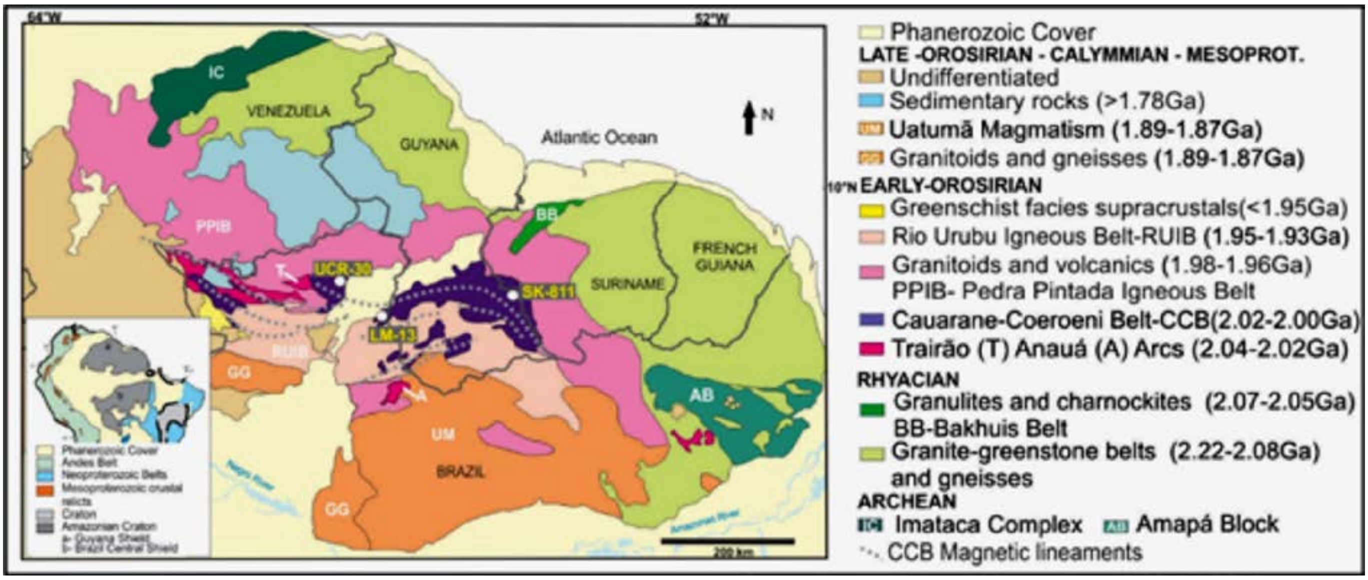


Figura 1- Simplified Geological Map of the Guiana Shield.

## RESULTS AND DISCUSSION

The analyzed samples, UCR-30, LM-13 and SK-811, consist of poli-folded (biotite)-cordierite-(garnet)-sillimanite migmatitic gneisses distributed along the CCB (Fig.1).

The analytical results are presented in relative age probability diagram integrating reliable 207Pb/206Pb ages (<10% discordance) (Fig.2b). Analyzed spots with Th/U < 0.1 (common in metamorphic and hydrothermal environments) are shown separately from those with Th/U > 1. Th/U ratios reflect elements availability and partitioning between zircon and co-existing minerals, fluids and melts and, although not diagnostic, if used in a combination to other observations can be a criterion for distinguishing zircon formation environment (Harley et al.2007). CL images of selected zircons are also shown (Fig.2b).

The results on the analyzed samples indicate that the Cauarane-Coeroeni basin (or basins) received the contribution of Archean sources, with ages at 2980-2920 Ga (3 crystals), 2720-2610 (8 crystals) Ga and 2551-2540 Ga (2 crystals); Siderian sources with ages at 2500-2420 Ga (5 crystals) and 2300 Ga (1 crystal); Rhyacian sources with ages at 2220-2110 Ga (7 crystals) and major contributions from Late-Rhyacian 2100-2060 Ga (17 crystals) and Eo-Orosirian 2050-2025 Ga (8 crystals) sources (Fig.2a, b). These ages were obtained from the detrital nucleus of the zircon crystals. Some of these nucleus preserve original igneous oscillatory zoning (Fig 2.b, crystals i and j) other exhibit a complex internal structure (Fig. 2b). One crystal, dated at 2540 Ga, shows very low Th/U ratio, suggesting a possible metamorphic source (Fig 2.b, crystal c).

The provenance area for the 2980-2920 Ga and 2720-2610 Ga zircon populations could be represented by the Archaen Amapa Block, formed by 3.26-2.83 Ga crustal material, reworked at 2.65-2.60 Ga (Rosa-Costa et al. 2006 and references therein). However crustal formation or reworking at 2550-2540 Ga during Neoarchean, has not yet been documented in the Guiana Shield. Siderian 2490-2430 Ga rocks has also not been document along the shield, but Siderian Sm-Nd $T_{DM}$ model ages have been reported (Rosa-Costa et al. 2006; Santos 2003; Almeida et al. 2007) pointing out to the possibility that sources now situated deep in the crust were at the surface during the Eo-orosirian evolution of the Cauarane-Coeroeni Basin.

The 2.26-2.13 Ga granite-greenstone-belt terranes, 2.11-2.08 Ga granitoids and gneisses and 2.07-2.05 Ga ultra-high temperature metamorphic rocks (Bakhui Belt), charnockites and granitoids of the north and western borders of the shield (Delor et al. 2003, Rosa-Costa et al. 2006) fit to the 2200-2110 Ga and 2100-2060 Ga detrital zircon populations and are possible source areas for the CCB. The 2050-2025 Ga population may reflect the contribution of Eo-Orosirian Trairão and Anauá magmatic arcs. This scenario suggests that the main source components for the Cauarane-Coeroeni Basin were shed from magmatic arc systems (2.050-2.025 Ga) edified at 2100-2060 Ga margins of Rhyacian newly built continents.

The abrupt cessation of zircon input into the Cauarane-Coeroeni basin at around 2.020 Ga (Fig. 2a) may reflects a change in the tectonic regime and the onset of the collisional phase along the Anauá-Trairão orogens. Two zircon borders with very low Th/U ratios (Fig 2.b, crystals e, l) dated at the same age (2,020 Ga) could be related to the initial phase of the syn-kinematic high grade metamorphism during the closing of the basins.

Most ages obtained for borders zones or patches crossing through the crystals (Fig. 2b) show Th/U ratios < 0.1 and fall into two main intervals, 1990-1960 Ga (13 crystals) and 1945-1915 Ga (5 crystals), suggesting the superposition of metamorphic / fluid or melt interaction events. The 1990-1960 Ga and 1940-1920 Ga zircon populations fit well to the time of emplacement respectively of the Pedra Pintada and Rio Urubu igneous belts. We envisage that allied to the thermal perturbation, the emplacement of such continental scale igneous belts (Fig.1) provided important fluid input inside the previously metamorphosed supracustals of the CCB, resulting in local migmatization and static metamorphism. In this context the 1969 ± 4 Ma (Santos 2003) and 1995 ± 4 Ma (Fraga et al. 2009 a) ages reported for the metamorphism in the CCB can reflect respectively the OIB perturbation on the supracrustal rocks and the final crystallization of S-type granites possibly related to the *ca*. 2.02 Ga event.

## CONCLUSIONS

The interpretation of the SHRIMP U-Pb analyses for three paragneisses of the CCB interpreted in the context of the geology of the area indicate that:

*Archean (2980-2920 Ga; 2720-2610 Ga; 2551-2540 Ga), Siderian (2500-2420 Ga; 2300 Ga) and Eo-Rhyacian (2220-2110 Ga) sources contributed to the Caurane-Coeroeni basin; however, the main populations were probably shed from Eo-Orosirian and (2.050-2.025 Ga) magmatic arcs edified at Late-Rhyacian (2110-2060 Ga) margins of newly formed continents;

*The abrupt cessation of zircons input at around 2.02 Ga is probably related to the onset of the collisional tectonics and high grade syn-kinematic metamorphism along the CCB;

*Ages in the 1990-1960 Ga and 1940-1920 Ga intervals for zircon borders with low Th/U ratios (<0.1) reflect important thermal perturbation, fluid input and migmatization caused by the emplacement of huge igneous belts (OIB and RUIB).

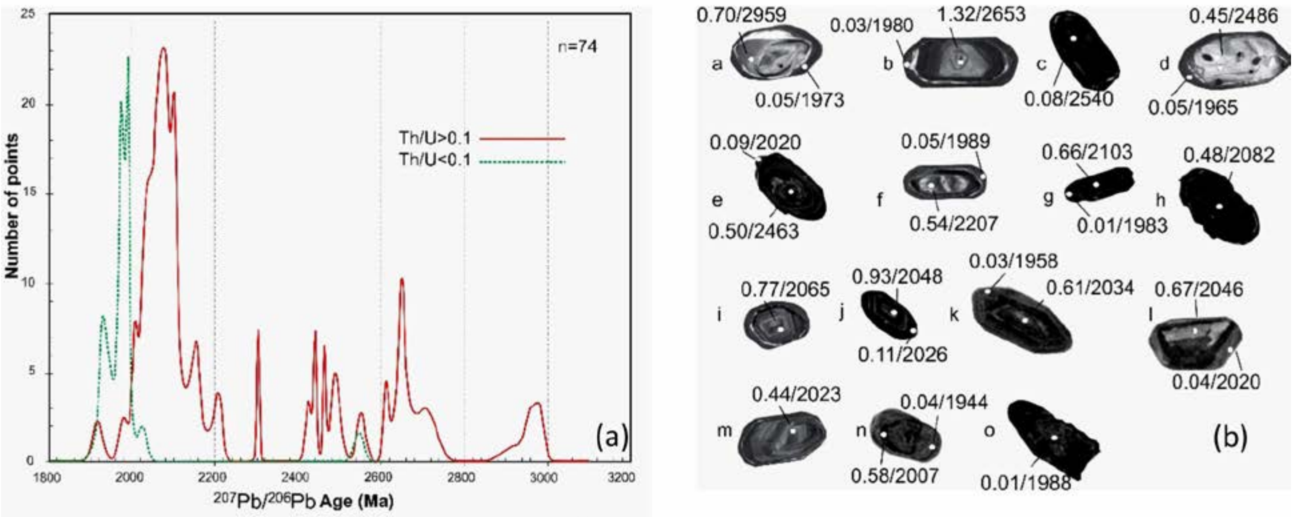


**Figure 2 - (a) Relative age probability diagram (ages<10% discordance); (b) CL images of zircon crystals of samples UCR-30 (a, b, d, f, i, m), LM-13 (k, l, n) and SK-811 (c, e, g, h, j, o).**

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(a) (b)

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