SHRIMP AGES FOR GRANITOIDS FROM BACAJÁ DOMAIN, SOUTHEASTERN AMAZONIAN CRATON, BRAZIL; NEW EVIDENCE OF SIDERIAN ACCRETION

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Keywords: Amazonian Craton, Siderian, granitoids, SHRIMP

INTRODUCTION

The Bacajá Domain is located in the southeastern Amazonian Craton and represents the southern part of the Maroni-Itacaiúnas Province (Cordani et al., 1979; Tassinari and Macambira, 1999), or Transamazonian Province (Santos et al., 2000, 2003). Previous isotope data indicated that the rocks from this domain are related to the Transamazonian Cycle (1.9 – 2.2 Ga), which comprises Paleoproterozoic granitoids, supracrustal rocks, granulites, paragneisses and charnockitic rocks with associated Archean orthogneiss inliers. The limits of the domain were based on Rb-Sr and K-Ar data obtained during the 1980's. To the south and west, it borders the Central Amazonian Province, where the Archean Carajás Province is included. To the north it is covered by a Phanerozoic sedimentary basin. Based on Rb-Sr data, Santos et al. (1988) suggested a Paleoproterozoic reworking of the basement gneisses and the addition of a juvenile crust of mafic volcanic rocks. The first U-Pb SHRIMP and Pb-evaporation data indicated the dominance of Rhyacian granitoids and charnockitic rocks at 2.08 Ga and local occurrences of Neoarchean and Siderian orthogneisses, supracrustal rocks and granitoids of 2.44 to 2.67 Ga and 2.31 to 2.36 Ga (Macambira et al. 2003, 2004; Santos, 2003; Faraco et al., 2005; Vasquez et al., 2005). In addition, the Nd isotope data distinguished a juvenile crust of 2.67 Ga with $\varepsilon Nd = +2.7$ and two sources to Rhyacian granitoids (ca. 2.1 Ga) from the eastern part of the Bacajá Domain: a late Siderian juvenile source with T_{DM} ca. 2.3 Ga ($\varepsilon Nd = +0.83$ to -0.6), and a Neoarchean crustal source with T_{DM} around 2.6 Ga (εNd from -4.25 to -1.91) (Macambira et al., 2004).

GEOLOGICAL SETTING

The geological mapping carried out during 1980s and 1990s on the Bacajá Domain distinguished tonalitic to granodioritic gneiss, enderbitic and mafic granulites, pelitic and calcsilicatic paragneisses showing different degrees of migmatization, ductile deformed granodiorites and strongly sheared monzogranites in the igneous and metamorphic basement, as well as supracrustal sequences (João Jorge et al., 1987; Santos et al., 1988; Oliveira et al., 1994). In addition, recent geological mapping has identified charnockitic rocks intruded into enderbitic granulites and paragneisses (Faraco et al., 2005).

The main orthogneiss bodies are located in the western part of the Bacajá Domain. They are banded- and augen-metatonalites and metagranodiorites, and rare metaquartz diorites and metamonzogranites exhibiting polygonal microtexture with orthoamphibolite boudins and local migmatitic structures. Ages between 2500 and 2440 Ma were obtained for these orthogneisses by U-Pb SHRIMP and Pb-evaporation zircon methods (Santos, 2003; Vasquez et al., 2005).

The paragneisses are metapelitic, quartz-rich metapsammitic and rare calcsilicatic rocks with frequent migmatitic structures and associated boudins of mafic granulites. They are gneissose pelites, granofels psammites, mesosomatic augen gneisses with leucossomatic veins of muscovite- and garnet-bearing leucogranites. Previous Rb-Sr data yielded ages between 1820 and 1930 Ma for these paragneisses, whereas the zircon ages range from 2076 to 2362 Ma (Santos et al., 1988; Vasquez et al. 2005).

The granulites of igneous derivation are gneissose and granofels enderbites and charnoenderbites, usually hosting mafic granulite boudins. Retrograde metamorphic textures of pyroxenes, as replacements, inclusions and intergrowths are common, but locally pyroxenes, hornblende and biotite are in equilibrium. Pyroxene-free enderbitic granulites are common especially in the strong sheared bodies. The ages of the protoliths of these granulites are unknown.

The supracrustal sequences generally are elongated bodies which are parallel to NW-SE regional trend. These metavolcano-sedimentary sequences are comprised of metandesites, metabasalts, metadacites, metatuffs, mafic schists, amphibolites, BIFs, quartzites, mica-, graphite- and quartz-bearing schists. The metamafic rocks of the Três Palmeiras sequence are transitional between island arc tholeiites and MORB showing a paragenesis of greenschist to amphibolite facies (Jorge João et al. 1987). The meta-andesites of this greenstone belt gave a Pb-evaporation zircon age of 2359 ± 3 Ma (Macambira et al., 2004).

The batholiths of granitoids are elongated and parallel to the NW-SE transcurrent shear zones. Two different groups of granitoids were distinguished. The first one is composed by porphyroclastic tonalites and granodiorites showing microtextures of deformation at high-temperature (> 550˚C), probably resulted from submagmatic flow. The second group comprises inequigranular monzogranites and granodiorites with preserved igneous textures and features of solid state deformation at lower temperature (≤ 550˚C) related to the NW-SE shear zones (Vasquez et al., 2005). High-temperature deformed granitoids show zircon ages between 2215 and 2154 Ma, whereas the low-temperature deformed granitoids yielded zircon ages from 2080 to 2070

Ma (Macambira et al., 2003; Santos, 2003; Vasquez et al., 2005).

The bodies of charnockitic rock are generally elongated following an E-W trend. Charnockites and enderbites are the dominant type and charnoenderbites, mangerites and jotunites are subordinate. There are charnockitic rocks with preserved igneous textures and others showing ductile deformation at low- and high-temperatures. Sometimes they are completely replaced (pyroxene-free) or just show pseudomorphos of pyroxene.

RESULTS

Three samples of granitoids from the central part of the Bacajá Domain were selected for dating at the Australian National University by the U-Pb SHRIMP method. These samples are related to a Siderian greenstone belt of 2.36 Ga age (Três Palmeiras sequence). The samples are a banded metatonalite (sample MVD134A) that just borders on the greenstone belt, a strongly sheared tonalite batholith (sample MVD103A), and an undeformed quartz monzodiorite pluton (MVD125A), which intrudes the greenstone belt.

Sample MVD134A is a banded porphyroclastic metatonalite with boudins of mafic dykes showing a submagmatic fabric. It is partially overprinted by low temperature mylonitic texture. The zircons from this sample show short pyramids and long prisms, are light yellow and colorless, have few inclusions and present euhedral oscillatory zoning, typical of magmatic zircons (Fig. 1A). The eight least discordant analyses gave a concordia age of 2338.2 ± 5.4 Ma (Fig. 2) interpreted as the crystallization age of the tonalite. The rims of some crystal gave ages between 2022 and 2268 Ma that probably reflect lead loss related to younger metamorphic events.

Sample MVD125A is an inequigranular quartz monzodiorite with well-preserved igneous textures and a strong hydrothermal alteration, possibly related to gold mineralization. Zircon morphology is homogenous with euhedral equant pyramids, brownish and grayish grains with few inclusions. In cathodoluminescence these zircons show weak oscillatory zoning and many crystals have U-rich rims and patches (Fig. 1B). The more concordant points gave a mean $^{207}Pb/^{206}Pb$ age of 2160.4 ± 3.2 Ma (Fig. 2). No traces of inherited crystals or cores were found.

Sample 103A is a granular metatonalite with banding, folded leucogranite veins and xenoliths of mafic metavolcanic rocks. This metatonalite shows feldspars and quartz in polygonal array and the biotite is strongly recrystallized. It looks like an orthogneiss or granitoid formed at high temperature and strongly affected by mylonitic deformation at low temperaturess related to transcurrent shear zones. Zircon morphology is varied in this metatonalite. The main population is comprised of light yellow, euhedral, equant pyramids and prisms with oscillatory zoning. A secondary population is made up of light brown to colorless, subhedral and rounded zircon

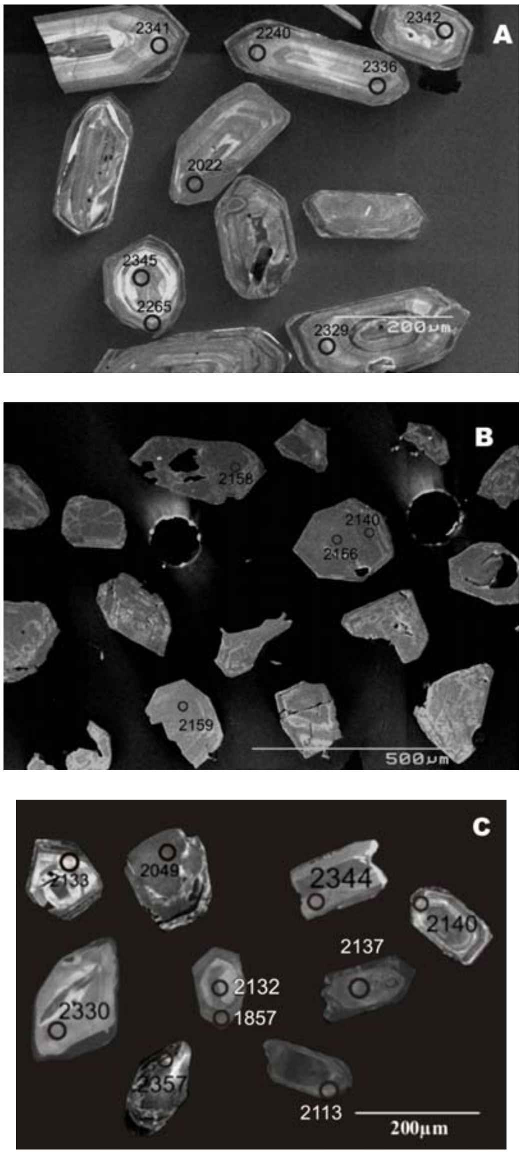

Figure 1. Cathodoluminescence images of zircon crystals from samples (A) MVD134A, (B) MVD125A, and (C) MVD103A.

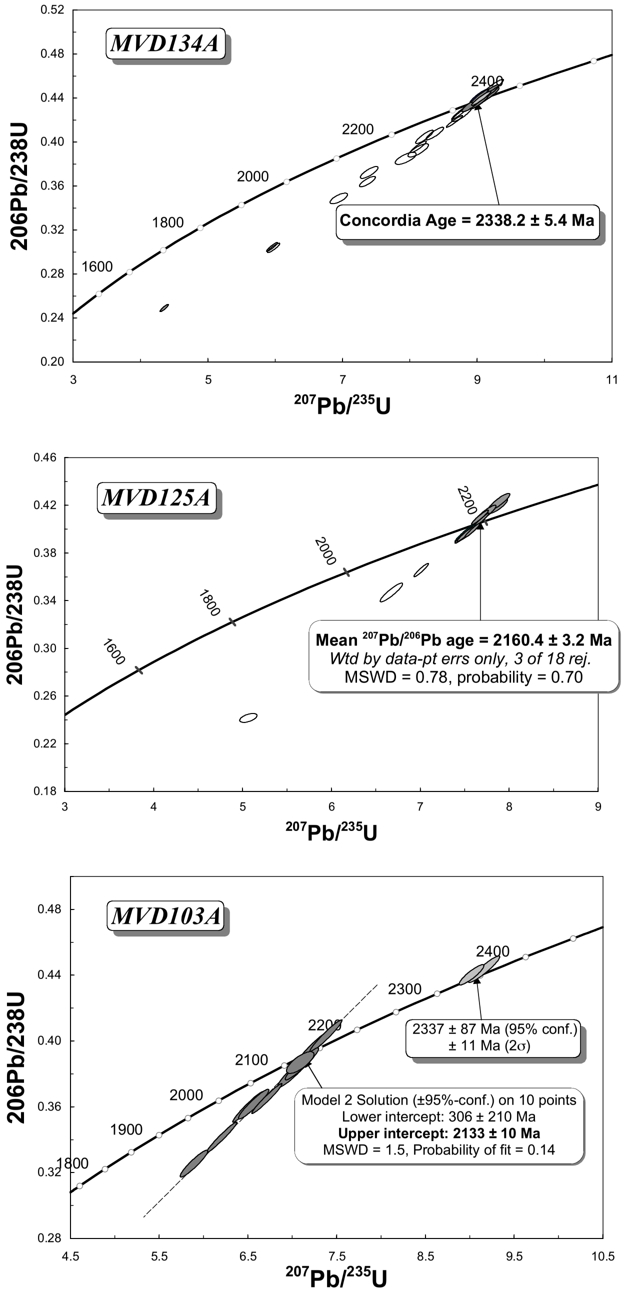

Figure 2. Concordia plots of the samples MVD134A, MVD125A and MVD103A. Individual data point error ellipses are plotted at 1σ levels.

crystals without clear rim-and-core structures, long prisms showing a weak oscillatory zoning (Fig. 1C) Ten data points of the main population yielded an upper intercept age of 2133 ± 10 Ma (Fig. 2C), interpreted as the crystallization age of the tonalite. Two concordant zircon crystals with a mean $^{207}Pb/^{206}Pb$ age around 2340 Ma are interpreted as inherited zircon crystals.

DISCUSSION AND CONCLUSIONS

The U-Pb SHRIMP ages obtained for the granitoids from central-northern part of the Bacajá Domain confirm a new occurrence of Siderian rocks in this domain and their contributions to formation of Rhyacian granitoids. Up to now, two other occurrences of Siderian rocks are known in the Bacajá Domain: a metavolcanic rock of a greenstone belt of 2.36 Ga (Macambira et al., 2004) and a granitoid of 2.31 Ga (Faraco et al., 2005).

The dated granitoid bodies are related to the Siderian greenstone belt, allowing some interpretations. The little difference of ages between the metatonalite of 2.34 Ga (sample 134A) and the greenstone belt of 2.36 Ga and the absence of a clear relationship of intrusion suggest they are coeval and juxtaposed by shear zones. On the other hand, field evidence shows that the quartz monzodiorite pluton of 2.16 Ga (sample MVD125A) and the metatonalite batolith of 2.13 Ga (MVD103A) clearly intrude the greenstone belt. However, they are distinguished because the younger metatonalite have inherited zircon grains of ca. 2.34Ga, whereas traces of inheritance were not found in the quartz monzodiorite sample.

The evidence of Siderian crust in the Bacajá Domain presented here, combined with data obtained for the Três Palmeiras sequence and some granitoids of 2.1 Ga by Macambira et al. (2004), suggests that the formation of this Siderian crust may be related to a accretion of island arcs to an Archean craton. In the Rhyacian (2.07 – 2.21 Ga) these Archean and Siderian crusts were affected by orogenies related the Transamazonian Cycle.

Accretion terranes have been described in the Guiana Shield, some with Archean contributions but Siderian ages have only been found as Nd isotope signatures (Vanderhaeghe et al., 1998; Delor et al., 2003; Rosa-Costa et al., in press). Therefore, evidence of Siderian crust distinguishes the Bacajá Domain from other Transamazonian domains of the Amazonian Craton.

ACKNOWLEDGEMENTS

We would like to acknowledge the support for this study from the following sources:
- Scholarship for Marcelo Vasquez: CAPES,
- Financial support: CPRM-Brazilian Geological Survey and Project MCT/PRONEX 138/98 (CG/UFPA).

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RESUMEN

O Domínio Bacajá está localizado no sudeste do Cráton Amazônico e representa a porção sul da Província Maroni-Itacaiúnas. Esse domínio compreende granitóides, rochas supracrustais, granulitos, migmatitos e rochas charnockíticas paleoproterozóicas com remanescentes de gnaisses arqueanos associados. Idades prévias indicam que essas rochas paleoproterozóicas estão relacionadas ao Ciclo Transamazônico (1,9 – 2,20 Ga). As idades em zircão indicam uma predominância de granitóides riacianos (2,08 Ga) com ocorrências locais de rochas neoarqueanas e siderianas (2,44 – 2,67 Ga e 2,31 – 2,36 Ga) e os dados de isótopos de Nd distinguiram fontes siderianas juvenis (2,30 Ga) e neoarqueanas crustais (ca. 2,6 Ga) para os granitóides riacianos.

Novos dados U-Pb SHRIMP foram obtidos para granitóides da porção central do Domínio Bacajá indicando idades siderianas e riacianas. Nesta área, o greenstone belt sideriano (2,36 Ga) está em contato com um metatonalito bandado que forneceu uma idade concordia em zircão de 2338,2 ± 5,4 Ma. O greenstone belt foi intrudido por um pluton de quartzo monzodiorito, com textura ígnea preservada e idade em zircão de 2160.4 ± 3.2 Ma, e um batólito de tonalito fortemente cisalhado com idade em zircão de 2133 ± 10 Ma e uma população de cristais de zircão herdados com cerca de 2340 Ma. Esses novos dados ampliaram a ocorrência de rochas siderianas e ratificaram que elas participaram na formação dos granitóides riacianos do Domínio Bacajá. Essas rochas podem estar relacionadas a uma crosta sideriana acrescida a um cráton arqueano, ambos afetados pelo Ciclo Transamazônico.