



U-Pb zircon SHRIMP data constraints on the evolution of the São Caetano Complex, Cariris Velhos Belt, Borborema Province, NE Brazil

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INTRODUCTION

The Borborema Province has been interpreted as the result of the breakup of a Palaeoproterozoic supercontinent (Columbia, Rogers and Santosh, 2002; 2009) during the later Mesoproterozoic to early Neoproterozoic (Van Schmus et al., 2008). This event includes volcanism (mostly felsic) and granitic plutonism, deposition of extensional basins floored by Palaeoproterozoic crust, local basins approaching small oceans, and a larger ocean between the northern edge of extensional crust and the West African – São Luis craton (Van Schmus et al., 2008). However, at the present, there is no clear correlation between this later Mesoproterozoic - early Neoproterozoic event and the breakup of Rodinia.

The Brasiliano Orogeny (650 – 550 Ma) was characterized by intense granitic magmatism, resulting from intense remobilization and large scale shear zone. According to Van Schmus et al., (1995) two large scale, transcurrent shear zones (Pernambuco and Patos) divided the Borborema Province into 03 tectonic domains: North, Central and South. The São Caetano Complex is located in the Central Domain within the so-called Cariris Velhos Belt.

GEOLOGICAL SETTING

The Cariris Velhos Belt has been describe as a 50–100 km wide belt that extends for more than 700 km, from the coastline (northeastern) to the west – southwestward Riacho Pontal Fold Belt. It comprises 02 supracrustals sequences, the Riacho Gravatá and São Caetano complexes, and a large number of leucocratic granitic (now orthogneisses) plutons. The Cariris Velhos Belt is limited by the E-W Patos Shear zone in the north and two NNE direction shear zones: the Serra do Caboclo shear zone to the west and Afogados da Ingazeira shear zone to the east.

The São Caetano Complex comprises a sequence of metagraywackes, metapelites, metapsamites, marble and calc-silicate rocks associated with metavolcanic rock, deposited to the east side of the orthogneisses intrusions. According to Santos et al. (1995), the sources of the clastic sediments are mature magmatic arcs. The São Caetano Complex can not be part of the Riacho Gravatá Complex as proposed by Medeiros (2004) because they are two distinct lithologic sequences: ultramafic rocks, green schists and BIF are common in the Riacho Gravatá Complex and absent in the São Caetano Complex.

RESULTS

To define the depositional age of the São Caetano Complex, zircon populations were extracted from three samples:



Sample ES-246 - This sample was collected in a sequence of metagreywackes from the southern part of the São Caetano Complex, eastern of the Afogados da Ingazeira shear zone. It shows many euhedral to subhedral zircon crystals with most of them showing primary igneous zoning. Thin metamorphic overgrowths are observed in many zircon grains.

The SHRIMP data show a large number of discordant ages. The most concordant (% discordant = 0) youngest detrital zircon age was 862 ± 10 Ma. This analysis was carried out in a zoned core of the grain, which shows Th/U ratio of 0.32. Another concordant (% discordant = 0) analyzed spot shows age of 883 ± 10 Ma with a $^{232}\text{Th}/^{238}\text{U}$ ratio of 0.01. Igneous rock with such ages has not been identified within the Transversal Domain of the Borborema Province. However, U-Pb SHRIMP zircon age of 875 ± 9 Ma and 858 ± 7 Ma have been reported in orthogneisses from the Araçuáí Belt, eastern Brazil (Da Silva et al., 2008). There are 04 others distinct age clusters. These include populations with ages in the 900- 970 Ma; 1007-1130 Ma and 1940 – 2366 Ma intervals. The high $^{232}\text{Th}/^{238}\text{U}$ ratios (0.39 – 1.05) recorded in zircons from all 03 populations suggest that the source sedimentary rocks had inflow of sediments derived from igneous rocks with these ages. Three concordant ages, ca. 707 - 657 Ma, were recorded in the rims of three zircon grains, with low Th/U ratios (0.00-0.01) reflecting a deformation event around 700 Ma.

Sample GN-P93 - This sample is a metagreywacke collected in the northern part of the São Caetano Complex, west of the Afogados da Ingazeira shear zone. Thirty spots were analyzed for this sample. Two main age cluster were identified, which include populations with ages 1050 – 1113 Ma and 939- 996 Ma. One analyzed spot shows concordant $^{206}\text{Pb}/^{238}\text{U}$ age of 1999 Ma. One important feature is the presence of zoned zircon grains with ages 806 ± 11 Ma ($^{232}\text{Th}/^{238}\text{U}$ ratio = 0.50) and 898 ± 12 Ma (Th/U ratio = 1.53). All the analyzed spots from this sample show high $^{232}\text{Th}/^{238}\text{U}$ ratios (>0.4) suggesting that the source rocks were sediments derived from igneous rocks. $^{232}\text{Th}/^{238}\text{U}$ ratios recorded in most of the analyzed zircon grains, showing $^{206}\text{Pb}/^{238}\text{U}$ age in the interval 1100 Ma – 939 Ma are similar to those recorded in metavolcanic rocks from the Riacho Gravatá Complex (Kozuch, 2003). It suggests that the main source of the metasediments were the metavolcanic rocks, with minor contribution of the Paleoproterozoic basement.

Sample SCBMGV - This sample was collected in the eastern part of a sequence of metagreywackes, which according to the literature, represents the eastern part of the São Caetano Complex. This sample (Brito Neves et al. 2001) have a Nd TDM model age of 1.41Ga ($^{147}\text{Sm}/^{144}\text{Nd} = 0.1283$)

53 spots were analyzed from this sample, encompassing 38 grains. This sample has a large population of zircon with $^{232}\text{Th}/^{238}\text{U}$ ratios >0.4 and ages in the interval 612 – 670 Ma. An age of 612 ± 8 Ma was recorded in the core of a zoned subhedral grain showing overgrowth age of 570 ± 6 Ma. The core has high $^{232}\text{Th}/^{238}\text{U}$ ratio (0.43) which associated to zoning suggests that this age can be interpreted as the maximum deposition age of the sequence. Ages of ~ 570 Ma have been recorded in extension - related granitoids within the Central and North Domain of the Borborema Province (Guimarães et al., 2004). Another age clusters associated to high $^{232}\text{Th}/^{238}\text{U}$ ratios, include zircon with ages of 700 – 720 Ma, 814 Ma, 994 – 1094 Ma and 1941 - 1952 Ma. Ages in the interval 610 - 640 Ma have been recorded in granitoids, volcanic rocks and leucosome of paragneisses from the Central Domain of the Borborema Province (Guimarães et al. 2004; Neves et al., 2006; Kozuch, 2003). It suggests that the mainly provenance of the zircon grains from the sample SCBMGV were Brasiliano igneous rocks, with small inflow of sediments from Paleoproterozoic and later Mesoproterozoic to early Neoproterozoic igneous rock.



CONCLUSIONS

The deposition age of sedimentary rocks must be younger than the youngest component contained within them. The SHRIMP analyses from the São Caetano Complex included one grain with an age of 862 ± 10 Ma (sample ES-246) and another grain with age 806 ± 11 Ma (sample GN-P93). Taken these two grain ages under consideration, the São Caetano Complex have original ages younger than those within the 862 – 806 Ma interval.

The large number of components showing ages within the interval 612 – 670 Ma recorded in the sample SCBMGV, which has been described in the literature as the east part of the São Caetano Complex, indicates a later Neoproterozoic deposition age for this rock. Its deposition appears to be associated with the Brasiliano/Pan-african event ie., younger than those recorded in the west side.

The ages recorded in the analyzed zircons from the São Caetano Complex, point to a major contribution from igneous source as either: volcanic rocks from the Riacho Gravatá complex and Cariris Velhos orthogneisses.

Ages within the interval 657 - 707 Ma recorded in the overgrowth of some analyzed zircon grains from all the analyzed samples, associated with low values of the Th-U ratios (< 0.02) are suggestive of an early Brasiliano tectonic/metamorphic event.

The maximum deposition age recorded in the SCBMGV sample (612 ± 8 Ma) is similar to the deposition age of others metasedimentary Complexes from the Central (Surubim; Neves et al, 2006) and from the North Tectonic Domain (Seridó Formation; Van Schmus et al, 2003). The similarity between the detritus from the SCBMGV sample and those from the Jucurutu Formation of the Seridó Group (Van Schmus et al., 2003) suggest that they are correlated.

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REFERENCES

- Bittar, S.B., 1999, Faixa Piancó Alto Brígida: Terrenos tectonoestratigráficos sob regimes metamórficos e deformacionais contrastantes. Tese de Doutorado, Universidade de São Paulo. 126p.
- Brito Neves, B.B.; Campos Neto, M.C.; Van Schmus, W.R.; Santos, E.J., 2001. O Sistema Pajeú - Paraíba e o Maciço São José de Campestre no leste da Borborema. *Revista Brasileira de Geociências*, 31, 173-184.
- da Silva L.C.; Pedrosa-Soares, A.C.; Teixeira, L.R., Armstrong, R., 2007. Tonian rift-related, A-type continental plutonism in the Araçuaí Orogen, eastern Brazil: New evidence for the breakup stage of the São Francisco–Congo Palecontinent. *Gondwana Research*, 13: 527-537.
- Guimarães, I.P., Da Silva Filho, A.F., Almeida, C.N., Van Schmus, W.R., Araújo, J.M.M., Melo, S.C., Melo, E.B., 2004. Brasiliano (Pan-African) granite magmatism in the Pajeú-Paraíba belt, Northeast Brazil: An isotopic and geochronological approach. *Precamb. Res.* 135, 23–53.
- Kozuch, M., 2003. Isotopic and trace element geochemistry of early Neoproterozoic gneissic and metavolcanic rocks in the Cariris Velhos orogen of the Borborema Province, Brazil and their bearing tectonic setting. PhD thesis, Kansas University, USA, 199p.



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Medeiros, V.C., 2004. Evolução Geodinâmica dos Terrenos Piancó-Alto Brígida e Alto Pajeú, Domínio da zona Transversal, NE do Brasil. Doctoral Thesis, Universidade Federal do Rio Grande do Norte, Brazil. 198p.

Neves, S.P.; Bruguier, O.; Vauchez, A.; Bosch, D.; Da Silva, J.M.R.; Mariano, G., 2006. Timing of crust formation, deposition of supracrustal sequences, and Transamazonian and Brasiliano metamorphism in the East Pernambuco belt (Borborema Province, NE Brazil): Implications for western Gondwana assembly. *Precambrian Research*, 149: 197–216.

Rogers, J.J.W., and Santosh, M., 2009. Tectonics and surface effects of the supercontinent Columbia. *Gondwana Research* 15: 373–380.

Rogers, J.J.W. and Santosh, M. 2002. Configuration of Columbia, a Mesoproterozoic Supercontinent. *Gondwana Research*, 5: 5-22.

Santos, E.J. 1995. O complexo granítico Lagoa das Pedras: Acresção e colisão na região de Floresta (Pernambuco) Província da Borborema. Doctor Thesis, Universidade de São Paulo, 220p.

Van Schmus, W.R., Brito Neves, B.B., Harckspacher, P. & Babinsky, M., 1995. U/BP and Sm/Nd geochronologic studies of the eastern Borborema Province, Northeastern Brazil: Initial conclusions. *Journal of South American Earth Sciences* 8, 267-288.

Van Schmus, W.R.; Brito Neves, B.B.; Williams, I.S., Hackspacher, P.; Fetter, A.; Dantas, E.L. and Babinski, M. (2003) The Seridó group of NE Brazil, a late Neoproterozoic pre- to syn-collisional basin in western Gondwana: insights from SHRIMP U-Pb detrital zircon ages and Sm-Nd crustal residence (T_{DM}) ages. *Precambrian Research*, v. 127, pp. 287-327.

Van Schmus, W.R., Oliveira, E.P., Silva Filho, A.F., Toteu, S.F., Penaye, J., Guimarães, I.P., 2008. Proterozoic links between the Borborema province, NE Brazil, and the Central African Fold Belt. *Geological Society of London, Special Publication*, 294, 69-99.