PALEOPROTEROZOIC EVOLUTION OF NORTHWESTERN RORAIMA STATE – ABSENCE OF ARCHEAN CRUST, BASED ON U-Pb AND Sm-Nd ISOTOPIC EVIDENCE.

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Keywords: U-Pb geochronology, detrital zircon, Amazon Craton, Roraima State, Tracajá orogeny

INTRODUCTION

The northwestern Roraima region – the Parima Mountains – is one of the least known regions in the world. Reconnaissance studies identified two main units in the Parima region basement: The Urariqüera Complex (Pinheiro et al., 1981; CPRM, 2002) and the Parima Group (Arantes & Mandetta, 1970). Parima Group is an association of green schist facies volcano-sedimentary rocks and amphibolite facies paragneisses. The Urariqüera Complex is an amphibolite facies orthogneiss unit including amphibolites and granitoid. Based on reconnaissance field data, the Parima Group was interpreted as a greenstone belt of Archean (Pinheiro et al., 1981) or Paleoproterozoic (Reis et al., 1994; Gaudette et al., 1996) age. Some authors (Tassinari & Macambira, 1999; Tassinari et al., 2000) propose the existence of a large Archean block in northern Roraima and southeastern Venezuela (the Roraima block), while others include the Parima Group in the Trans-Amazonian Orogeny (Reis et al., 1994; Gaudette et al., 1996). To investigate the question of the basement age in northwestern Roraima region (Archean or Trans-Amazonian) we dated two zircon samples of the Parima Group by U-Pb SHRIMP and seven whole rock samples of the Urariqüera Complex and two samples of the Parima Group using Sm-Nd isotopes.

This abstract reports the results of the U-Pb and Sm-Nd dating and provides a new interpretation for the Parima Group as well as for the Amazon Craton evolution.

REGIONAL GEOLOGY

The Parima Group crops out in the basins of the following rivers: Parima, Auaris, and Mucajaí, Catrimâni and Urariqüera headwaters (Fig. 1). The unit is geographically associated to the Urariqüera Complex composed by orthogneiss, metabasalt and granitoid. Both units are cut by Mesoproterozoic rapakivi granites (Surucucus suite) and mafic-ultramafic bodies (Tapuruquara magmatism) and covered by Mesoproterozoic sedimentary outliers (Serra Surucucus Formation; Santos et al., 2003a). Field and remote sensing data indicate dominant NW-SE to E-W lineaments and sinistral transcurrent movements (Reis & Fraga, 2000). The rocks present at the type-area (lower course of Parima River) are green schist facies meta-andesite, meta-rhyodacite and meta-pyroclastic rocks (Arantes and Mandetta, 1970). Amphibolite facies rocks are present in Couto Magalhães, Parima, and Uatatás rivers headwaters (mostly sillimanite-cordierite paragneisses; Nunes, 1992). The stratigraphic relationship between Parima Group and Urariqüera Complex is unknown and both units show the same style of deformation. The orthogneisses are referred to the complex and the paragneisses are associated to the group.

Uatatás quartzite sample is from Uatatás River headwater (Fig. 1) and was collected in a green schist facies meta-sedimentary sequence compose by orthoclase quartzite, quartz-biotite phyllite, and carbonate quartzite, light to dark grey and fine grained. This sequence is well laminated and interpreted as turbiditic (Reis et al., 1994). Prainha meta-andesite comes from Prainha Creek, a Mucajaí River tributary (Fig. 1). It displays an E-W nematolitic foliation is has actinolite-andesine assemblage (green schist facies).

METHODS

We dated zircon from two samples and integrate the results will all available U-Pb data of the region (Table 1). The two selected samples for U-Pb study are a meta-andesite from Prainha Creek (JO2) and a low grade metamorphosed fine sandstone (LM6). Zircon analyses were carried out on the SHRIMP II at the Curtin University of Technology following standard procedures (Smith et al., 1998; Santos et al., 2000). Reference standard was CZ3 zircon (564 Ma; $^{206}Pb/^{238}U$=0.0914). All presented U-Pb ages are $^{207}Pb/^{206}Pb$ ages. Sm-Nd analyses (Table 2) were done on the Isotopic Geology Laboratory at the Federal University of Rio Grande do Sul. Decay constants used are those recommended by Steiger and Jägger (1977).

RESULTS AND DISCUSSION

The Prainha meta-andesite (JO2) zircons are clear prisms without evidence of older cores. They compose a single population and 13 of 14 analyses are concordant and group at the $^{207}Pb/^{206}Pb$ age of 1946 ± 7 Ma (MSWD=1.6; Fig. 2). This age is about 20-10 m.y. younger than the ages of the rocks formed during the Creporizão orogeny (Santos et al., 2003b), such as the Surumu Group and the Pedra Pintada suite (Orocaima volcano-plutonism, Reis et al., 2000). It is comparable to the ages of several rocks from eastern Roraima State (Rio Urubu Complex, this paper), such as the Tracajá Granodiorite (1941 ± 4 Ma; recalculated from Gaudette et al., 1996) and two metamorphic rocks: the Mucajaí

Gneiss (1938 ± 8 Ma; J.O.S. Santos, unpublished data), the Barauana anatexite (1943 ± 7 Ma; J.O.S. Santos, unpublished data), and the Vilhena mylonite (1937 ± 7 Ma; J.O.S. Santos, unpublished data).

Nineteen zircon crystals from the Uatatás quartzite (LM6) yield concordant to sub-concordant results and two grains are Archean (2869 ± 7 Ma and 2795 ± 9 Ma). Disregarding the eventual removal of large areas of the Amazon Craton since the Archean, the only possible source for those two grains is the Imataca Belt of Venezuela, located about 650 km to the north-northeast. The remaining 17 analyses form four populations with ages from 2203 to 1968 Ma (Fig. 3). Three age groups of 2203 ± 6 Ma (n=5), 2141 ± 5 Ma (n=2), and 2097 ± 14 Ma (n=5) are probably derived from the Trans-Amazonian belt to the north-northeast. The younger group is clearly post-Trans-Amazonian in age (1968 ± 7 Ma) considering the duration of that orogen as 2.26-2.01 Ga (Santos et al., 2003b). This age constrains the maximum possible age for the Uatatás quartzite and the Parima Group. There are two possible main sources for this population. One possibility is the volcano-plutonic rocks cropping out to the east and northeast of the Parima Group Basin, such as the Pedra Pintada Suite and the Surumu Group (1966 Ma; Schobbenhaus et al., 1994). Another possibility is the metamorphic rocks from the Cauarane Group such as the Taiano gneiss molten at 1969 ± 4 Ma (J.O.S. Santos, unpublished data). The ages near 1968 Ma (Surumu, Pedra Pintada, Uatatás) are correlative to the rocks formed during the Creporizão orogeny of the Tapajós domain. Distinctly from the Tapajós domain, the Creporizão orogeny in Roraima is formed not only by volcano-plutonic rocks in a continental arc environment, but it encloses metassedimentary rocks produced in a collisional setting (Uatatás quartzite), Which may be correlative to the Muruwa (Guyana) and Los Caribes (Venezuela) Formations (Gibbs & Barron, 1993; Reis et al., 2000).

The Sm-Nd data for the Urariqüera Complex (Table 2) suggest a derivation from Trans-Amazonian rocks (T_{DM} model ages of 2178-2022 Ma) and a short crustal residence interval (ε_{Nd} greater than zero). The T_{DM} model ages of two Parima Group paragneisses correspond to one Late Neoarchean age (2502 Ma) and one Early Siderian age (2485 Ma), Table 2. These paragneisses may have several sedimentary sources, as shown in the Uatatás quartzite and the two model ages of 2502 and 2485 Ma probably have no geological meaning being the result of a mixture of Nd isotopes of several sources, Archean and Paleoproterozoic.

CONCLUSIONS

The isotopic results indicate that the Parima and Urariqüera units are not Archean nor Rhyacian (Trans-Amazonian) in age, but much younger, Orosirian (ages between 1.97-1.94 Ga). This fact has important implications for the interpretation of the Amazon Craton evolution and for the absence of a large Archean block named the Roraima Block (extension of the Central Amazon Province) in northern Roraima-southeastern Venezuela region (Tassinari et al., 2000). There are two main possibilities for the Archean Roraima Block: a) the rocks older than 2.3 Ga form very small bodies undetected by the regional mappings or b) Archean rocks are totally absent and the Roraima Block crust was formed after ca. 2.1 Ga.

The interpreted sources to the Uatatás quartzite deposition were Trans-Amazonian and Archean rocks located far to the north-northeast (about 650 km) and Orosirian rocks located relatively close (300-150 km) from the Creporizão orogeny to the east and northeast. The maximum age of 1968 Ma precludes any correlation of the Parima Group to Archean or Trans-Amazonian rocks as stated in the past. The absence of detrital zircon crystals having similar ages to the neighboring Prainha meta-andesite (JO2) may suggest that the Uatatás quartzite was deposited before 1940 Ma during the 1968-1940 Ma period. The age of the youngest population (1968 ± 7 Ma) of detrital zircon and the ages of the Orocaima volcano-plutonism (Reis et al., 2000) are typical ages of the Creporizão orogeny of the Tapajós domain, which is dominated by a continental arc environment. The data here presented suggest an extension of that orogeny to the Parima domain.

The Prainha andesitic volcanism at 1946 ± 7 Ma is synchronous with both magmatic (Tracajá and Rio Urubu) and metamorphic (Taiano, Barauana, and Vilhena) events to the east of Roraima State. These events are post-Creporizão in age and no equivalents have been found in the Tapajós Domain. They represent another orogeny in the Tapajós-Parima Orogeny between the Crepozizão (1970-1960 Ma) and Tropas (1900-1890 Ma) orogenies. This orogeny has an important collisional component and is here named the Tracajá orogeny.

REFERENCES

Almeida, M.E., Fraga, L.M.B., and Macambira, M.J.B., 1997a. New geochronological data of calc-alkaline granitoids of Roraima State, Brazil. In: South-American Symposium on Isotope Geology, Campos do Jordão, 1997. Resumo, p. 34-37.

Almeida M.E., Ferreira A.L., Pinheiro S.S., 2001. Principais Associações Graníticas do Oeste do Estado de Roraima. In: Sociedade Brasileira de Geologia-Núcleo Norte, Simpósio de Geologia da Amazônia, 7, Belém, Pará. Sessão Workshop II, 4 p.

Arantes J.L. & Mandetta P., 1970. Reconhecimento geológico dos rios Urariqüera, Aracaçá, Parima e Uauaris, Território federal de Roraima. Departamento Nacional da Produção Mineral, Relatório Inédito 6012, Manaus, 10 p.

Companhia de Pesquisa de Recursos Minerais, 2002. Geologia e Recursos Minerais da Amazônia Brasileira: Sistema de Informações Geográficas - SIG e Mapa na escala 1:1.750.000. In: Luiz Augusto Bizzi, Carlos Schobbenhaus, João Henrique Gonçalves, Franciscus Jacobus Baars, Inácio de Medeiros Delgado, Maísa Bastos Abram, Reginaldo Leão Neto, Gerson Manoel Muniz de Matos, João Orestes Schneider Santos (ed.), Brasília: 1 CD-Rom

Fraga L.M., & Reis N.J., 2002. The Calc-Alkaline Volcano-Plutonism in the Northern Roraima State, Guiana Shield: Implications for the Uatumã Event Concept and Geotectonic Significance. In: Simpósio sobre Vulcanismo e Ambientes Associados, 2, Belém, PA, Anais: 15.

Gaudette, H.E., Olszewski Jr., W.J., and Santos, J.O.S., 1996. Geochronology of Precambrian rocks from the northem part of Guiana Shield, State of Roraima, Brazil. Journal of South American Earth Sciences, 9 (3/4): 183-195.

Gibbs, A.K. & Barron, C.N., 1993. The Guiana Shield reviewed. Episodes, 1983 2:7-14.

Nunes, N.S.V., 1992. Reavaliação petrográfica das amostras coletadas por Arantes & Mandetta (1970) ao longo dos rios Parima, Auaris, Urariqüera e Aracaçá. Porção Oeste do Estado de Roraima. Companhia de Pesquisa de Recursos Minerais, Superintendência Regional de Manaus. Relatório Interno R-111a, 11 p.

Pinheiro, S.S., Nunes, A.C.B., Costi, H.T., Yamaguti, H.S., Faraco, M.T.L., Reis, N.J., Menezes, R.G., Riker, S.R.L., Wildner, W., 1981. Projeto Catrimâni-Urariqüera: Relatório de Progresso. Manaus, Departamento Nacional da Produção Mineral/Companhia de Pesquisa de Recursos Minerais, v.II-B: p.399-401.

Reis, N.J., Fraga, L.M.B., Pinheiro, S.S., 1994. Reconhecimento Geológico da Região do rio Uatatás - setor oeste do Estado de Roraima. In: Sociedade Brasileira de Geologia-Núcleo Norte, Simpósio de Geologia da Amazônia, 4, Belém, Pará. Anais: 33-36

Reis N.J., Faria M.S.G., Fraga L.M.B., Haddad R.C. 2000. Orosirian Calc-Alkaline volcanism and the Orocaima Event in the northern Amazonian Craton, Eastern Roraima State, Brazil. Revista Brasileira de Geociências, 30 (3): 380-383.

Santos, J.O.S, Hartmann, L.A., Gaudette, H.E., Groves, D.I., McNaughton, N.J., Fletcher, I.R., 2000. A new understanding of the provinces of the Amazon Craton based on integration of field mapping and U-Pb and Sm-Nd geochronology. Gondwana Research, 3(4): 453-488.

Santos, J.O.S., Rizzotto, G., Easton, M.R., Potter, P.E., Hartmann, L.A., McNaughton, N.J., 2002. The Sunsás Orogen in Western Amazon Craton, South America and correlation with the Grenville Orogen of Laurentia, based on U-Pb isotopic study of detrital and igneous zircons. In: Geological Society of America, 2002 Denver Annual Meeting (October 27-30, 2002), Precambrian Geology, paper 122-8.

Santos, J.O.S., Potter, P.E., Reis, N.J., Hartmann, L.A., Fletcher, I.R., McNaughton, N.J., 2003a. Age, source and regional stratigraphy of the Roraima Supergroup and Roraima-like outliers in northern South America based on U-Pb geochronology. Geological Society of America Bulletin 115 (3): 331–348.

Santos, J.O.S, Hartmann, L.A., Bossi, J., McNaughton, N.J. Fletcher, I.R., 2003b. Duration of the Trans-Amazon Cycle in South America based on U-Pb SHRIMP geochronology of La Plata Craton, Uruguay. International Geology Review 45 (1): (in press).

Tassinari, C.C.G. and Macambira, M.J.B., 1999. Geochronological Provinces of the Amazonian Craton. Episodes, 22 (3): 174-182.

Tassinari, C.C.G., Bettencourt, J.S., Geraldes, M.J.B., Macambira, M.J.B., Lafon, J.M., 2000. The Amazonian Craton. In: U.G.Cordani, E.J.Milani, A.Thomaz Filho, D.A Campos (eds) Tectonic Evolution of South America. In: International Geological Congress, 31, Rio de Janeiro, p. 41-95.

Table 1. Ages and data of rocks discussed along text.

Sample	Rock	Unit	U-Pb age	MSWD	zircon type	Event	Reference
JO2	Meta-andesite	Parima group	1946 ± 7	1.60	igneous	Tracajá	This work
JO1	Granodiorite	Tracajá	1941 ± 4*	0.25	igneous	Tracajá	Gaudette et al. (1996)
SR6	Anatexite	Barauana	1943 ± 7	1.90	igneous	Tracajá	J.O.S. Santos, unpublished
CA47	Mylonite	Vilhena	1937 ± 7	2.60	igneous	Tracajá	J.O.S. Santos, unpublished
MF6	Gneiss	Mucajaí	1941 ± 5	1.40	igneous	Tracajá	J.O.S. Santos, unpublished
LM6	Quartzite	Parima	1968 ± 7	1.50	detrital	Orocaima	This work
SUR1	Rhyodacite	Surumu	1965 ± 4*	2.40	igneous	Orocaima	Schobbenhaus et al. (1994)
JOSP1b	Paragneiss	Taiano	1969 ± 4	0.13	metamorphic	Orocaima	J.O.S. Santos, unpublished
SR109	Gneiss	Rio Urubu	1966 ± 37	-	igneous	Orocaima	Fraga et al. (1997)**
NR17	Monzogranite	Igarapé Azul	1960 ± 21	-	igneous	Orocaima	Almeida et al. (1997)**
JO180	Monzogranite	Creporizão	1957 ± 6	1.46	igneous	Creporizão	Santos et al. (2001)

Location of most samples shown in Figure 1. MSWD=Mean Standard Weighted Deviation; (*) recalculated age; (**) Pb-Pb data

Table 2. Sm-Nd data of Urariqüera Complex and Parima Group

Sample	Rock	Unit	Latitude	Longitude	T_{DM} model ages	ε_{Nd}
EC-130B	meta-tonalite	Urariqüera	2.76275	-62.07874	2022	+ 2.04
GM-116	Gneiss	Urariqüera	4.07650	-64.35228	2116	+ 0.73
EC-118	meta-tonalite	Urariqüera	2.77987	-61.99956	2090	+ 1.47
WW-111	Gneiss	Urariqüera	3.98505	-64.41337	2096	+ 0.63
SP-34A	meta-diorite	Urariqüera	3.56576	-63.17108	2136	+ 0.79
NR-49B	meta-tonalite	Urariqüera	3.06571	-62.57815	2172	+ 0.01
EC-26	Gneiss	Urariqüera	2.79648	-63.11364	2178	+ 0.82
WW-125	two mica gneiss	Parima	3.98075	-64.27467	2485	- 4.37
AB-47	cord-sill gneiss	Parima	3.85390	-63.74418	2502	- 4.86

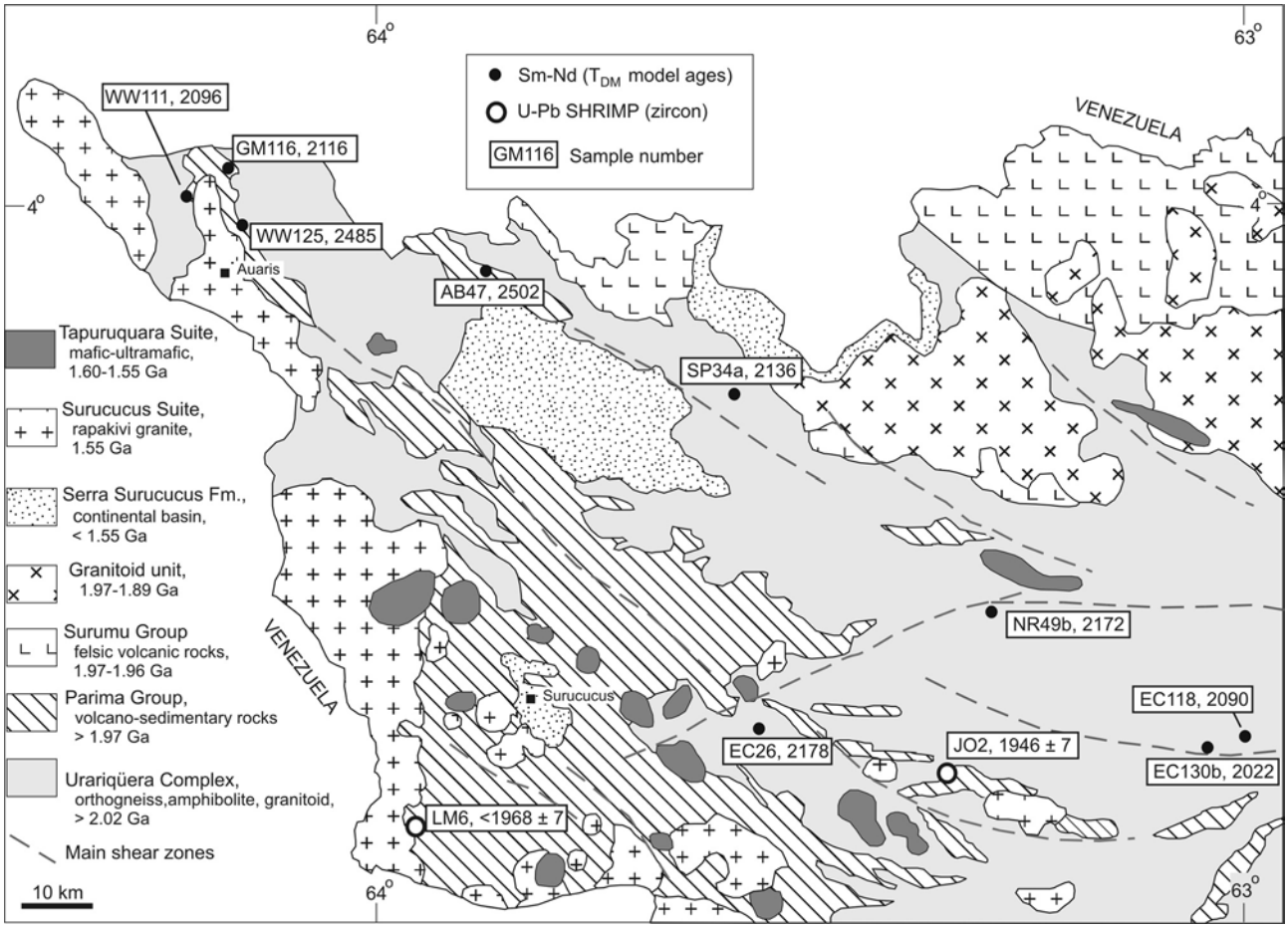

Figure 1. Geological map of northwestern Roraima State showing location of dated samples (ages in Ma).

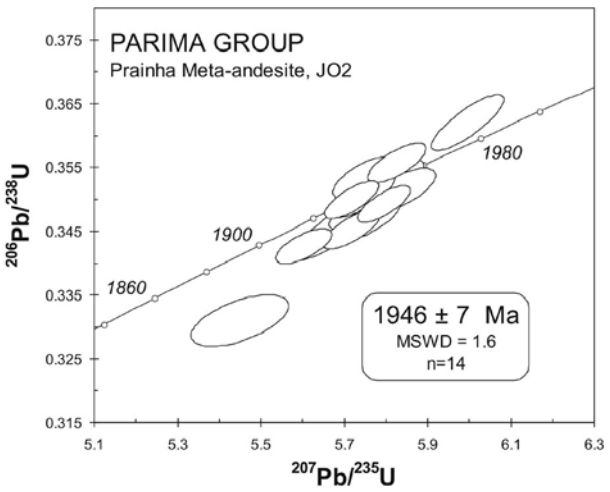

Figure 2. U-Pb concordia diagram for zircon from the Prainha Meta-andesite (JO2), Parima Group.

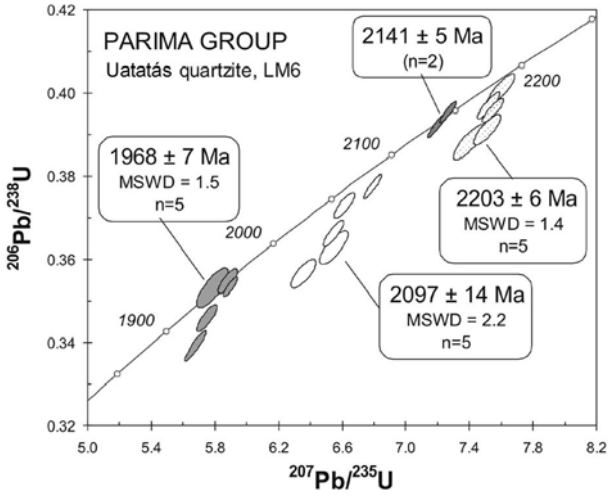

Figure 3. U-Pb concordia diagram for detrital zircon from the Uatatás quartzite (LM6), Parima Group. Two Archean ages are not shown here.