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ANALES XXXIV

U/Pb CONSTRAINS ON PROTEROZOIC MAGMATIC ARCS IN SW AMAZONIA CRATON, BRAZIL

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INTRODUCTION

Amazonia craton has had an important role in many supercontinent reconstructions. Rodinia reconstruction, for example, was proposed Amazonia joined to Laurentia-Baltica in a result of 1.1 to 1.0 Ga fusion (Hoffman, 1989; Dalziel, 1992). Geological knowledge in SW Amazonia craton region has recently identified new units by geochronologic studies (Bettencourt *et al* 1994), allowing paleo-tectonic juxtaposition of Amazonia with Laurentia-Baltica *ca.* 1000 Ma. Amazonia was probably joined to Laurentia-Baltica at 1.6 Ga and separated from it during Mesoproterozoic rifting that began a Wilson cycle which ended with formation of Rodinia (Sadowski and Bettencourt, 1996). Our isotopic data from SW Mato Grosso state, Brazil, place important constraints on evolution of SW Amazonia and for potential correlations of Amazonia with Laurentia-Baltica during the Proterozoic. SW Amazonia consists of several 1.9 to 1.0 Ga NW-SE trending belts that become younger to the SW. New Nd data (Sato and Tassinari, 1997) suggest that there is a major accretionary belt, the 2.0 to 1.8 Ga Ventuari-Tapajós Province (VTP), that trends NW-SE, southwest of Manaus. The Rondonia-San Ignacio Province (RSIP) of SW Amazonia in Brazil and Bolivia is parallel to and outboard of the 1.7-1.8 Ga (Tassinari *et al.*, 1996) Rio Negro-Juruena Province (RNJP). Paleoproterozoic basement in SW Mato Grosso consists of igneous and metamorphic rocks that are SE extensions of RSIP and the RNJP. Basement to the west consists of the Paragua block, which was affected by the San Ignacio orogeny and, to a lesser degree, by the 1.0 Ga Sunsas orogeny (Litherland *et al.*, 1989). Basement to the east includes several domains of different rock types, including several volcano-sedimentary belts, felsic plutonic-gneiss belts, and intrusive granitoids (e.g. Sta. Helena suite). Several undeformed granites intrude the basement complex in the East, while the basement is locally overlain by Mesoproterozoic clastic sedimentary rocks of the Aguapei group.

We have carried out U/Pb analyses of zircons separated from units in the Santa Helena Terrain and from units in the Jauru Terrain. We also analysed whole-rock powders from other samples of the same units for their Sm and Nd concentrations and Nd isotopic composition in order to calculate crustal formation ages (T_{DM}).

JAURU TERRAIN SAMPLES

Volcanic rocks of Jauru region were described inicially by Saes *et al.*, (1984) as Quatro Meninas volcanic Complex and by Monteiro *et al.*, (1986) as Alto Jauru greenstone belt (AJGB). Three Paleoproterozoic belts comprising metavolcanics and sediments (from E to W: Cabaçal, Araputanga and Jauru) are separated by a granitic-gneiss terrain. These are intruded by Proterozoic dolerites and granitoids and are covered by Mesoproterozoic Aguapei Group continental clastics. Monteiro described the following sequence for these units: basic volcanics (lavas and volcanic breccias); metavolcanics (andesites lavas and tuffs, interdigited with felsic lavas and tuffs and metapelites); and acid metatuffs (dacite-rhyodacite lavas, tuffs and epiclastics rocks). Analysed sample was colected in Cabaçal Mine, and comprises a metatuff, which shows in thin section small bands of sericite interlayed by bands of quartz and feldspar. The zircons yielded 1767 ± 24 Ma. interpreted as crystalization age. The Sm/Nd crustal formation age (T_{DM}) is 1868 Ma and $\varepsilon_{Nd(t)}$ =2.4. U/Pb and Nd

results of this sample indicate that the protolith for this tuff was derived from a source containing significant older crust or was contamined by the supracrustal host rocks during volcanism.

Plutonic rocks of composition tonalitic to granitic were described in Jauru region as coeval to the volcanic rocks of AJGB. Ruiz (1992) mapped an area between Cabaçal and Araputanga volcanic belts and described ortoderived gneiss (São Domingos granite-gneiss) which is intruded by the Alvorada granite. Carneiro *et al.*, (1992) reported a Rb/Sr whole rock isochron which yielded 1734 ± 226 Ma. and RI=7019. U/Pb dating in three fractions of this rock yielded 1795±10 Ma., T_{DM} 1926 Ma and $\varepsilon_{Nd(t)}$ of 2.16. Other body mapped by Ruiz (1992) named Aliança Gneiss (97-149) was also collected, and has a granodioritic composition (gray to pink, fine- to coarse-grained rocks). The main minerals are quartz, feldspar and plagioclase. Sample 97-149 from this unit had zircons fractions analyzed and they yielded 1747 ± 13 Ma.

A second group of tonalitic rocks were sampled in Araputanga area, between Cabaçal and Araputanga Paleoproterozoic volcanic belts. Ruiz (1992) described Cachoeirinha tonalite (97-134) as coeval with Cabaçal tonalite (97-130), and the three samples intruded gray and pink gneiss and tuffs mencioned above (samples 97-133 and 97-131). They are gray, mediun to coarse grained rocks, with plagioclase, amphibole, quartz and biotite. U/Pb results for Cachoeirinha granite (97-134) yielded 1536± 11 Ma, T_{DM} 1883 Ma and $\varepsilon_{Nd(t)}$ of 2.45. Sample 97-150 yielded 1540± 16 Ma. The third sample (97-149) didn't yielded zircons and Sm/Nd results are: T_{DM} = 1773 Ma and $\varepsilon_{Nd(t)}$ is 2.01 (T=1556 Ma). These results indicate that the original magmas were derived from a source containing significant older crust.

Four granodiorites samples were analysed in the same region where the tonalitic samples were collected (samples 97-145, 97-148 and 97-150). Their mineralogical composition is quartz, k-feldspar, plagioclase, hornblende and biotite. The rocks show foliation due to biotite and hormblende orientation. Sample 97-145 (Santa Cruz gneiss) had three zircons fractions analysed and yielded 1556 ± 02 Ma. Sample 98-148 U/Pb analyses yielded 1567 ± 06 Ma (four zircons fractions). Água Clara granodiorite was mapped as a large batolith by Saes *et al.*, (1984) and Monteiro *et al.*, (1986). U/Pb results in 3 fractions yielded 1485 ± 4 Ma and T_{DM} = 1675 Ma and $\varepsilon_{Nd(t)}$ is 1.73. U/Pb results and Nd result indicated that the original magma was derived from a source containing significant older crust.

Four granites were collected in the same region of the tonalites and granodiorites. The main minerals are quartz, k-feldspar, plagioclase and biotite. Alvorada Granite sample was collected in the Alvorada farm, where the units was originally described (sample 97-132). U/Pb analyses yielded 1522 ± 12 Ma., T_{DM}=1777 Ma and $E_{Nd(t)}$ is 0.55. A second sample of Alvorada granite collected near Araputanga town had three zircons fractions analyses for U/Pb and yielded 1522 ± 12 Ma and T_{DM}=1777 Ma and $\varepsilon_{Nd(t)}$ is 0.55. U/Pb analyses of Cachoeirinha granite (sample 97-138) yielded 1537 ± 06 Ma and T_{DM}=1754 Ma and $E_{Nd(t)}$ is 0.73. The last granite collected (sample 97-139) was described by Ruiz (1992) as belonging to Alvorada unit had three zircons fractions analysed for U/Pb and yielded 1522 ± 12 Ma and T_{DM}=1743 Ma and $\varepsilon_{Nd(t)}$ is -0.21. These results indicate the original magma was derived from source containing important older crust.

SANTA HELENA TERRAIN (SH)

Tonalitic rocks of SH may be found in gold prospects at Lavrinha area (sample 97-113) and at Pau-a-Pique area (97-140). Rocks are gray to green, coarse grained, and foliation is rarelly observed. Main mineralogy includes plagioclase, amphibole, biotite and quartz. Analyses of zircon fractions of Lavrinha tonalite plotted on a U-Pb concordia diagram yield an upper intercept (crystallization age) at 1463 ± 4 Ma. T_{DM} age for this unit is 1532 Ga ($\varepsilon_{Nd(t)}$ =3.8). Three zircons fraction of sample 97-140 (Pau-a-Pique tonalite) yield 1488 ± 11 Ma and T_{DM}=1500 Ma ($\varepsilon_{Nd(t)}$ =4.4). These results indicate that the original magma was derived from a source containing a very little, if any, older crust.

Three granodioritic samples from SH were also collected in the Pontes e Lacerda area. Rocks are gray and coarse-grained (Guapé Farm granodiorite, sample 97-105 and 97-106) or banded (Triângulo Farm granodiorite, sample 97-102 and 97-108). They contain K-feldspar, quartz, amphibole, plagioclase and biotite. Sample 97-108 had three zircon fractions analysed and results plotted on a U-Pb concordia diagram yield an upper intercept at 1450 ± 13 Ma.

T_{DM} age for this sample is 1550 Ma. Three zircon fractions from sample 97-102 yielded 1442 ± 15 Ma and T_{DM}=1563 Ma and $E_{Nd(t)}$ is 2.9. Sample 97-105 yielded T_{DM}=1567 Ma., $\varepsilon_{Nd(T)}$ of 4.4; Sample 97-106 yielded T_{DM}=1491 Ma and $\varepsilon_{Nd(T)}$ of 4.6. Results of four granodioritic samples indicate that the gneiss protolith for this gneiss contained very little older crustal component.

Granitic rocks have a scattered distribution in the SH batolith. Four samples were collected: Pontes e Lacerda granite (sample 97-115), Cardoso granite (sample 97-120W), Maraboa granite (97-141) and Ellus Farm granite (97-168). Rocks are redishing to gray, medium to coarse grained. Comprises granite-gneisses, augen-gneisses, biotite gneisses and magnetite-gneisses (Menezes *et al.*, 1993). The following minerals were observed in thin sections: k-felspar, quartz, plagioclase and biotite; hormblende occurs as the mineral acessory. Zircon fractions from Pontes e Lacerda granite (sample 97-115) yielded an upper intercept (crystallization age) of 1434 ± 07 Ma on the U-Pb concordia. T_{DM} for this unit is 1618 Ma ($\varepsilon_{Nd(t)}$=3.8), indicating that the original granitic magma was derived from a source containing significant older crust. The U-Pb results of Maraboa Granite, when plotted on a U-Pb concordia diagram yield an upper intercept (crystallization age) at 1476 ± 35 Ma. T_{DM} age for this unit is 1698 Ma ($\varepsilon_{Nd(t)}$=2.6), indicating that the original granitic magma was derived from a source containing a significant older crustal component. The three zircon fractions analyses from Ellus farm granite plotted on a U-Pb concordia diagram yield an upper intercept (crystallization age) at 1424 ± 61 Ma. The three analyses fall far concordia, resulting in a low-precision age. T_{DM} age for this unit is 1518 Ma ($\varepsilon_{Nd(t)}$=3.6), indicating that the original magma was derived from a source containing a very little, if any, older crust. Zircon fractions from Cardoso granite (sample 97-120) yielded an upper intercept (crystallization age) of 1423 ± 06 Ma on the U-Pb concordia. T_{DM} age for this unit is 1516 Ma ($E_{Nd(t)}$=3.8), indicating that the original granitic magma was derived from a source containing significant older crust.

DISCUSSION

Our results clearly show that much of the previous inferred chronology for the region, which was based on recongnaissence Rb/Sr and K/Ar work, needs to be revised as new U/Pb ages using zircons and Sm/Nd crustal formation ages are obtained. As a preliminary working model, we present the following interpretations:

1. Metavolcanic and metaplutonic rocks of Jauru terrain were acreted during a juvenile event about 1.75 Ga ago. Coeval volcanic and plutonic association suggest an island arc for the generation of these units. The magma source for these units was derived from a source containing significant older crust or was contamined by the supracrustal host rocks during intrusion.

2. A second important event in Jauru area took place at 1.55 Ga ago during which a calc-alkaline suit was formed including magmas derived from a source containing a significant older crustal component. Anorogenic plutons were formed about 1.44 to 1.39 Ga and have U/Pb and Nd data suggesting reworking.

3. Igneous and metaigneous rocks in the Pontes e Lacerda region represent magmatic activity that occurred about 1440 to 1470 Ma. This includes not only the Santa Helena granite and related units, but also includes the proximal host terrain for these plutons. We tentatively propose that the granites, orthogneisses, and tonalite are all components of a ca. 1450 Ma Santa Helena volcano-plutonic arc.

4. The relatively low Sm/Nd crustal formation ages for SH complex suggest that parts of it represent juvenile crust, while other parts may include a significant contribution from older crust. We suggest that the SH was developed along the (now) western margin of a continent which 1.7 to 1.8 Ga units are represented by volcanic and gneissic complexes to the east of Jauru (Jauru, Araputanga, and Cabaçal volcano-sedimentary belts; Quatro Marcos, and Cachoeirinha felsic gneiss belts).

REGIONAL AND GLOBAL IMPLICATIONS

The eastern volcano-sedimentary and gneiss belts of Jauru terrain represent SE extensions of the Rio Negro-Juruena Province, and the Santa Helena Arc probably represents the eastern part of SE extensions of the Rondonia-San Ignacio Province. The age pattern of 1450 Ma rocks intruded into or adjacent to 1.7 to 1.8 Ga continental crust is similar to relationships along the eastern and southern margin of Laurentia prior to 1400 Ma and would be compatible with tectonic models which propose proximity

between Laurentia and Amazonia about 1,8 to 1,4 Ga.

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