THE SANTA TEREZINHA SEQUENCE, GOIÁS MAGMATIC ARC, CENTRAL BRAZIL: CONSTRAINTS FROM U-Pb AND Sm-Nd DATA

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INTRODUCTION

The Goiás Magmatic Arc in the Neoproterozoic Brasília Belt, Tocantins Province, central Brazil, was formed by accretion of island arc systems to the western margin of the São Francisco Craton during approximately 290 Ma, since ca. 890 Ma until ca. 600 Ma (Pimentel and Fuck, 1992; Pimentel et al., 2000, 2004; Laux et al., 2005). In the Mara Rosa area, in the northern sector of the arc, the earlier magmatic activity was dated at ca. 860 Ma, and is represented by juvenile rocks with island arc geochemical and isotopic signature (Viana et al., 1995; Pimentel et al., 1997). Syntectonic peraluminous granites and one diorite intrusion are in the age interval between 615 and 640 Ma. Sm-Nd garnet ages and titanite U-Pb ages of 610, 600, 630, and 760 Ma are indicative of the main metamorphic events (Junges et al., 2002a,b). A younger episode of juvenile magmatism, dated at ca. 600-640 Ma, is recorded by tonalites and amphibolites at the western part of the Mara Rosa arc (Junges et al., 2002a, 2003). The youngest ages, of ca. 570 Ma, refer to post-orogenic granites. In this study we report new Sm-Nd isotopic data and U-Pb zircon ages of metavolcanic and metaplutonic rocks from Santa Terezinha de Goiás, ca. 100 km to the southwest of Mara Rosa, which indicate island arc-related volcanism and sedimentation at ca. 670 Ma and calc-alkaline intrusions of ca. 610-650 Ma.

GEOLOGICAL SETTING

The Goiás Magmatic Arc constitutes the western part of the Neoproterozoic Brasília Belt. It is limited to the west by the Araguaia fold belt, and it is thrusted eastwards over the Goiás Massif. Main continuous exposures are in northern (Mara Rosa arc) and southern Goiás (Arenópolis arc, see Pimentel et al., 2000, 2004).The study area is at the southwestern end of the Mara Rosa arc, where the Neoproterozoic arc rocks are thrusted over Archean granite-greenstone terrains. Airborne geophysical survey, 1:100,000 scale geological mapping of the Santa Terezinha de Goiás and Campinorte quadrangles (49°-50°W, 14°-14°30'S) (Fuck et al., 2006; Oliveira et al., 2006) and of the Itapaci sheet (Blum et al., 2001; Jost et al., 2001), combined with isotopic data, led to separate the Santa Terezinha volcanic-sedimentary sequence from the Mara Rosa Sequence, in which it was previously included (Arantes et al., 1991; Lacerda Filho et al., 1999).

The Mara Rosa sequence is characterized by three NE-SW trending belts of amphibolite facies mafic volcanic rocks, clastic and chemical sedimentary rocks separated from each other by ca. 800-860 Ma tonalite gneiss terrains. All rock units have geochemical and isotopic features indicating the juvenile nature of the igneous protoliths (Pimentel et al., 1997; Junges et al., 2002b). The very primitive nature of amphibolites suggests that the protoliths were calc-alkaline basalt and andesite. Subalkaline tholeiitic basalt has also been identified (Kuyumjian, 1994; Palermo, 1996). Tonalite orthogneisses display volcanic arc chemical characteristics and positive ε_{Nd} values, pointing to a depleted mantle component.

The Santa Terezinha sequence, originally proposed by Souza and Leão Neto (1984, see also Costa, 1986), is exposed in a large arcuate structure with concavity facing N-NE. Its western sector, striking NW-SE to N-S, is mainly composed of metasedimentary rocks, including feldspathic micaschist, quartzite, muscovite schist; northwards, banded iron formation is associated with amphibolite and biotite-muscovite gneiss of volcanic origin. The southern and eastern parts of the arcuate structure, striking NW-SE to E-W to NE-SW, comprise a volcanic unit of amphibolite and meta-andesite, and a unit of muscovite-chlorite schist with intercalation of volcanic material (amphibole schist, amphibolite, biotite-muscovite gneiss); a sample of felsic metavolcanic rock was dated at 661±8 Ma (Dantas et al., 2001). The central part of the structure comprises muscovite quartzite overlying banded biotite gneiss, the latter of probably Archean age (D'el-Rey Silva and Barros Neto, 2002), feldspar-bearing biotite schist, and chlorite-muscovite schist, which includes a variety of rock types, like muscovite-quartz schist, chlorite schist, iron formation, gondite, magnetite quartzite, and garnet-bearing micaschist; this unit includes also magnetite-muscovite schist of probably volcanic origin and several 1-10m thick layers of emerald-bearing talc schist, chlorite-amphibole-talc schist, dolomite-talc schist, and biotitite.

Orthogneiss terrain constitutes the core of the arc-like structure, comprising two main bodies separated by supracrustals. The southeastern part is mainly made of biotite-hornblende gneiss of tonalite composition, including small oval bodies of deformed and

metamorphosed gabbro/diorite and pyroxenite, and a narrow belt of biotite gneiss, ranging in composition from quartz monzonite to granite. The northern part of the core includes a central body of biotite-hornblende gneiss of tonalite-granodiorite composition, surrounded by biotite-muscovite gneiss, garnet-muscovite gneiss, and augen gneiss. The latter units are of granodiorite to granite composition, and they may be separated by supracrustal septa of the Santa Terezinha sequence.

RESULTS AND DISCUSSION

Two samples of metavolcanic rocks of the Santa Terezinha sequence were dated. Sample VIII-208 is a porphyritic meta-andesite from the volcanic unit, exposed to the east of Santa Terezinha de Goiás. Sample Santa 1 is a felsic metavolcanic rock intercalated with muscovite-chlorite schist to the south of Santa Terezinha de Goiás. Zircon grains from VIII-208 are clear, medium-sized, colourless to yellowish prisms, which yielded a concordia age of 670±4 Ma. The felsic metavolcanic sample Santa 1 yelded clear, short, pink zircon prisms, which indicate a upper intercept age of 666±8 Ma. Within error, both results are identical to the age of 661±8 Ma obtained in a volcanic rock further south (Dantas et al., 2001).

Sample Santa 2 is from a small deformed granodiorite emplaced at the contact of muscovite schist and muscovite-chlorite schist, to the west of Santa Terezinha de Goiás. Clear, pink, broken zircon grains of this sample yielded an upper intercept age of 648±5 Ma.

Sample TF03V235 is a biotite-hornblende gneiss from the tonalite body to the east of Santa Terezinha de Goiás. Zircon grains are clear, pink, long prisms and give a lower intercept age of 633±7 Ma. Sample TF03V178 is from a small granite body emplaced at the thrust shear zone separating the tonalite orthogneiss unit from the Santa Terezinha supracrustals, a few kilometers northeast of Santa Terezinha de Goiás. The granite displays a strong mylonitic foliation, suggesting its sytectonic nature. Zircon grains from this sample are long, pink prisms and their upper intercept age is 611±11 Ma, taken also as the maximum age of deformation in the shear zone.

Sm-Nd T_{DM} model ages of the Santa Terezinha volcanic rocks range between 0.8 and 1.19 Ga, and $\varepsilon_{Nd(T)}$ values are positive, between 0 and +5. T_{DM} model ages of metasedimentary rocks have a wider range, between 0.95 and 2.42 Ga. Older model ages and more negative $\varepsilon_{Nd(T)}$ values, between -5.3 and -15.1, are more common in muscovite schist and feldspathic micaschist in the western part of the sequence, indicating that older, Paleoproterozoic or Archean sources contributed to sediment accumulation in the precursor basin, together with material from Neoproterozoic magmatic arc sources. Less negative $\varepsilon_{Nd(T)}$ results (-2.4) and positive values (+1.7 to +3.5) were obtained in rocks of tectonic slices containing frequent intercalations of volcanic rocks, showing that sediment sources were within the magmatic arc.

Samples of orthogneiss from the southern plutonic body, close to Santa Terezinha de Goiás, have T_{DM} ages between 0.78 and 1.19 Ga, with $\varepsilon_{Nd(T)}$ values between +0.6 and +3. However, orthogneiss samples from outcrops to the north of Campos Verdes range between 1,48 and 1,96 Ga, with negative $\varepsilon_{Nd(T)}$ values between -4.3 and -9, indicating significant contamination from crustal material.

The 660-670 Ma U-Pb zircon ages of volcanic rocks indicate that the Santa Terezinha sequence is ca. 200 Ma younger than the Mara Rosa sequence. Similarly, plutonic rocks from the Santa Terezinha de Goiás area, with ages between ca. 650 and 610 Ma, are much younger than the oldest orthogneisses from Mara Rosa (Pimentel et al. 1997), and have ages similar to igneous rocks from Amaralina (Junges et al., 2002a,b, 2003). The new data pose important implications for the evolution of the Goiás Magmatic Arc in northern Goiás:

1. The two sets of ages confirm that island arc rocks formed in at least two distinct episodes, one at ca. 800-860 Ma generated the Mara Rosa sequence and related plutonic rocks, and the other at ca. 600-670 Ma formed the Santa Terezinha sequence and related plutonic rocks, apparently extending northeastward to Amaralina (Junges et al., 2003).
2. Rocks with ages between ca. 600 and 670 Ma constitute large portions of the western part of the magmatic arc in the study area and have an important role in the arc evolution.
3. The Goiás Magmatic Arc is a very important tectonic unit in central Brazil. In the Mara Rosa-Santa Terezinha de Goiás region, magmatic activity started at ca. 860 Ma and ended at ca. 570 Ma, with an important peak between ca. 630 and 670 Ma. Age distribution in northern Goiás suggests westward younging of arc rocks, a finding that appears to be supported by even younger ages (<600 Ma) recorded west of the Transbrasiliano lineament, west of Porangatu.

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RESUMO

Geocronologia U-Pb em zircão em dados isotópicos Sm-Nd, combinados com levantamento aerogeofísico e mapeamento geológico em escala 1:100.000, permitiram descriminar a Seqüência Santa Terezinha, datada em ca. 670Ma, da Seqüência Mara Rosa, com ca. 860 Ma no setor norte do Arco Magmático de Goiás, Faixa Brasília, Província Tocantins, Brasil central. Ambas as seqüências compreendem rochas metavulcânicas e metassedimentares, com assinatura geoquímica e isotópica característica de arcos de ilha, e são associadas a ortognaisses resultantes de deformação e metamorfismo de rochas plutônicas calci-alcalinas. Além da diferença de idade, a Seqüência Mara Rosa inclui volume mais expressivo de rochas vulcânicas máficas, associadas a rochas sedimentares de origem química e detrítica, enquanto a Seqüência Santa Terezinha é dominantemente composta por rochas metassedimentares de origem detrítica, com intercalações comuns de rochas vulcânicas félsicas a intermediárias e depósitos de origem química. Rochas vulcânicas são menos freqüentes que em Mara Rosa e ocasionais camadas de rochas ultramáficas estão presentes, como as hospedeiras de esmeralda em Campos Verdes.

As idades U-Pb em zircão e os dados isotópicos Sm-Nd confirmam que as rochas com afinidade de arco de ilhas no arco de Mara Rosa foram formadas em pelo menos dois episódios distintos, um entre 800 e 860 Ma deu origem à Seqüência Mara Rosa e rochas plutônicas associadas, e outro mais jovem, entre 600 e 670 Ma, gerou a Seqüência Santa Terezinha e rochas plutônicas relacionadas.