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SYN-COLLISIONAL PERALUMINOUS MAGMATISM IN THE RIO DOCE REGION: MINERALOGY, GEOCHEMISTRY AND ISOTOPIC DATA OF THE NEOPROTEROZOIC URUCUM SUITE (EASTERN MINAS GERAIS STATE, BRAZIL)

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ABSTRACT The Urucum Suite granitoids (Rio Doce region, southeastern Brazil) contains four main facies: megafeldspar granites, deformed medium- to coarse-grained granites, tourmaline, and pegmatitic facies. They intrude both the staurolite-garnet-muscovite-biotite schist of the São Tomé Formation (Rio Doce Group) and the Galiléia metaluminous suite (596 ±4 Ma). Detailed structural studies suggest that the Urucum Suite emplaced during an important dextral strike-slip movement (*D_l* phase) of the Brasiliano orogeny (650-450Ma). Modal and chemical mineralogical variations suggest an evolution from the megafeldspar facies to the pegmatitic facies. Whole-rock geochemistry indicates the peraluminous character of the Urucum Suite granitoids, the evolution from the megafeldspar facies granites to pegmatitic facies granites and suggests the syn-collisional character of this suite. U-Pb zircon (582 ± *2* Ma) and monazite (576-573 ± 4Ma) data indicate that the Urucum Suite emplaced during the Brasiliano orogeny. The peraluminous nature of the Suite and isotopic-rich character in the Rb-Sr ($^{87}Sr/^{86}Sr$ = 0.7114 to 0.7165) and Sm-Nd (eNd = -7.4 and -8.2) systems indicate that it formed by partial melting of older intermediate to felsic crustal sources. Based on early Proterozoic model-ages (2.3 to 1.8 Ga) and on 2.0 Ga U-Pb inherited signature, granitoids of the Suite are probably derived from a rocks with a long crustal residence (Transamazonian basement), without extensive mantle contribution.

Keywords: granitoids, peraluminous, geochemistry, isotopic data, Neoproterozoic

INTRODUCTION Peraluminous granitoid suites form small but genetically important components of granitic intrusions in most orogenic belts. Models for the origin of peraluminous granitoids emphasize the importance of the composition of the source rock and partial melting (Chappell and White 1974, 1977, 1992), and crystal fractionation as the main controls of the chemical variation in these suites (Bateman and Chappell 1979), and mixing of granitic melts derived from metasedimentary rocks and more mafic materials (Gray 1984). Peraluminous leucogranites are of great interest as they may help us understand the syn-collisional magmatism and the tectonic evolution of the continental crust during tectono-thermal events.

The Galile'ia-Conselheiro Pena region (Rio Doce region, eastern of the Minas Gerais State, Brazil) is an excellent area to study the constraints of leucogranite emplacement, petrogenesis and the relation between leucogranites and complex rare-element pegmatites. The aims of this paper are 1) to characterize the mineralogy, geochemistry and some crystallization conditions of the leucogranites of the Neoproterozoic Urucum Suite; 2) to constrain the timing (U-Pb geochronological data) and source rocks (Rb-Sr and Sm-Nd isotopic geochemical data) of the syn-collisional magmatism associated with the Brasiliano orogeny (650-450 Ma) in the Rio Doce region.

GEOLOGICAL SETTINGS The Rio Doce region is located within the northern Mantiqueira structural province (Almeida *et al.* 1981), east of the São Francisco cratonic block (Almeida 1977), southeastern Brazil (Fig. 1). The northern Mantiqueira province is interpreted as been connected to the West-African Congo fold belt (Porada 1989) before the South Atlantic rifting (Early Cretaceous). It comprises the Araçuaí (Almeida and Hasui 1984) and the Atlantic or Coastal (Leonardos and Fyfe 1974, Mascarenhas 1979) belts with poorly defined limits.

The first geological works in the Rio Doce region aimed to recognize different lithological units and identify rare elements and gem-bearing pegmatites (Barbosa *et al.* 1964, Fanton *et al.* 1978, Moura *et al* 1978, Silva *et al.* 1987).

The Galiléia-Conselheiro Pena region consists of an Archean to Early Proterozoic amphibolite- to granulite-facies gneiss (Pocrane complex), supracrustal rocks represented by garnet-staurolite-muscovite-biotite schists (São Tome Formation of the Rio Doce Group) and sericite quartzites (Crenaque Group) considered of Neoproterozoic age, and by two granitoid suites (Galiléia and Urucum suites) and intrusions of rare-element pegmatites associated with the Brasiliano orogeny (650-450 Ma). The Galiléia metaluminous suite (594 ± 6 Ma, Nalini Jr. 1997) is characterized by an expressive polydiapiric batholith. The suite consists of granodiorite, with subordinate tonalite and granite. The Galiléia Suite has been associated with the syn- to late-collisional phase of the Rio Doce Orogeny (Campos Neto and Figueiredo 1995) and, recently, with the pre-collisional magmatism of the Brasiliano orogeny (Nalini Jr. 1997). The Urucum Suite consists of different facies of two mica leucogranites that intruded the Galiléia Suite and the Rio Doce Group metasediments.

Cunningham *et al.* (1996) proposed for the region located between Galiléia and Conceição de Tronqueiras towns (about 80 km toward the west) a structural style represented by west-trending (shallow east-dipping gneissic foliation) overthrust of rigid basement blocks over metasedimentary sequences.

Detailed structural studies in the Galiléia-Conselheiro Pena region (Nalini Jr. 1997) point to two deformation phases and a medium grade metamorphism as the main effects of the Brasiliano orogeny. Dj is the main deformational phase and is characterized by a N-NW high-angle foliation and by oblique to horizontal mineral stretching lineation. Such set of structures is related to an important dextral strike-slip movement. D_1 is also responsible for the ascension and emplacement of the Galiléia metaluminous and the Urucum peraluminous suites. The second phase (D_2) involves a crenulation cleavage, boudinage and normal faults related to a late extensional phase. Both phases fit in a regional transpressional regime (Nalini Jr. 1997).

PETROGRAPHY AND MINERALOGY Circular and elliptical (NW-SE) plutons of the Urucum Suite (Fig. 1) intrude both the metasediments of the São Tome Formation and the Galiléia metaluminous suite. Four granitoid facies with distinct lithological features were determined in the field: a feldspar megacryst (5 to 10 cm) facies (megafeldspar facies), a highly deformed medium- to coarse-grained facies, a tourmaline facies, and a highly fractionated pegmatitic facies (associated with gem-bearing rare-element pegmatites). Detailed petrographic analysis and geochemical evidence confirm these initial distinctions. The strike slip deformation and the syn-kinematic character of these granitoids are indicated by the parallel solid-state and magmatic flow foliation oriented according to the foliation of the São Tome schist. The intrusive contacts are often marked by decimetric to metric granitic veins. Xenoliths of the São Tome schist are common, mainly near the contacts.

Rocks of the Urucum Suite are composed by plagioclase (An_{24-10}), potassic feldspar (Or_{97-91}), biotite, muscovite, garnet, tourmaline, monazite, zircon and apatite.

Biotite contents decrease from the megafeldspar facies to the pegmatitic facies. The proportion of biotite controls the MgO content of the rock. Biotite *mg* (=MgO/(FeO+MgO)) lies between 40 (megafeldspar facies) and 27 (tourmaline and pegmatitic facies) and AL_2O_3-between 18 and 20%. It plots in the peraluminous alumino-pofassic field of the Nachit's *et al.* (1988) diagram (Fig. 2A). This composition is comparable to that of biotite of the Gueret type granites in the French Central Massif (Chevremont *et al.* 1988).

Muscovite is present in all facies. It is slightly iron-rich (0.53 <FeO <2.48%) and magnesian (0.34 <MgO <1.19%). The *mg* (71 to 34) and TiO. (1.89% to 0.09%) contents decrease from the megafeldspar facies to the pegmatitic facies. Muscovite Ti contents are related to the crystallization temperature (Guidotti *et al.* 1977), as its crystallization

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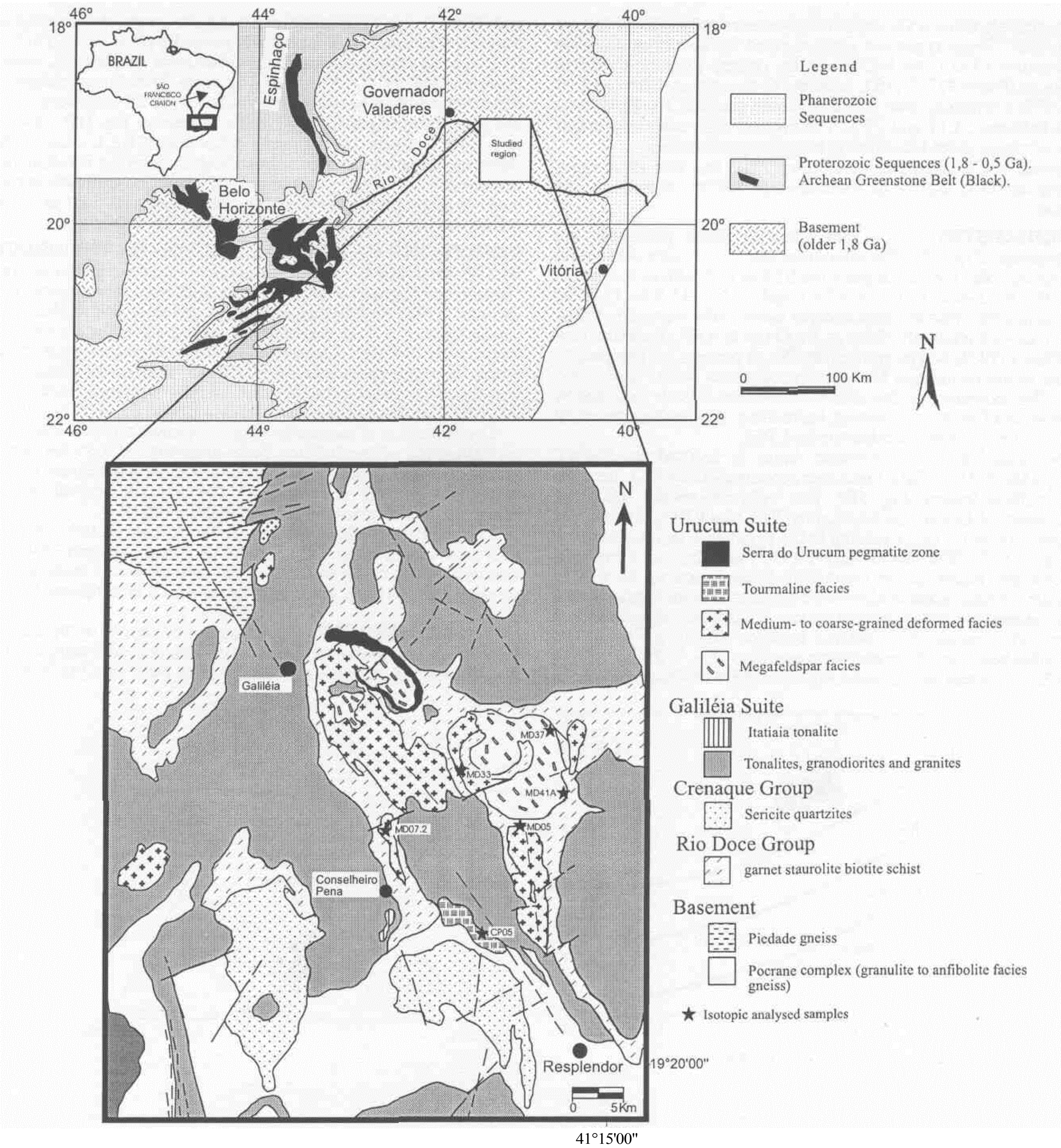


Figure 1 - Geological map of the studied region at the southeastern Brazil (modify from Barbosa et al. 1964). Archean to Early Proterozoic basement: Piedade gneiss and Pocrane complex; Late Proterozoic supracrustals sequences: schists of the São Tomé Formation (Rio Doce group) and sericite quartzites of the Crenaque group; Galiléia Suite: tonalite, granodiorite and granite; Urucum Suite: megafeldspar granite, medium- to coarse-grained deformed granites, tourmaline granite and Serra do Urucum pegmatite zone.

temperature decreases from the megafeldspar to the pegmatitic facies. Urucum muscovite composition (Fig. 2B) is similar to the primary muscovite composition (Miller *et al.* 1981) and comparable to the St. Julien leucogranite muscovite of the Millevaches Massif in France *(Monieretal.* 1984).

The Urucum Suite garnet (Fig. 2C) is almandine-spessartite (up to *35%* of spessartite). The evolved facies (tourmaline and pegmatitic facies) contain more garnet than the other facies. The late crystallization of garnet results from the increase of the Mn/(Mn+Fe) ratio during the evolution of the Urucum Suite granitoids (Miller and Stoddard 1980). The importance of the role played by MnO in the genesis of granite garnets has been underlined by Green's (1977) applied studies. Manganese increases the field of garnet stability allowing its crystallization under very low pressures. According to Green, garnets with 20-25% of spessartite (thus comparable to garnet of the Urucum Suite) can crystallize in granitic liquids under pressures of 3 kbar or less (<12 km).

Tourmaline is Fe-rich (schorl-dravite). Its evolution is given by the increase of MnO (0.03<MnO<0.47) (Fig. 2D) and FeO (5.88<FeO<6.96%) and by decrease of mg (50 to 16) and TiO_2 (0.79% to 0.53%) contents in the tourmalines of the tourmaline-facies granite to the most evolved pegmatitic-facies granite. It is often zoned (with a blue Fe-rich core and a green Mg-rich border).

Modal proportions of monazite decrease from the megafeldspar and deformed medium- to coarse-grained facies to the tourmaline-facies granites. Monazite is absent in granitic pegmatoids and in complex pegmatites. It occurs in small oval inclusions in biotite and locally in muscovite suggesting the early character in this suite. The evolution of monazite composition is marked by increase of the light rare earth elements (La and Ce) and decrease of the Th, U, Y, Si and Ca from the megafeldspar to the medium- to coarse-grained facies.

The Urucum Suite zircon is represented by Pupin's (1976) L and S morphological types. The most prominent characteristic of these zircons is the pronounced development of prismatic faces (110). Some zircon crystals show a Gl-type inherited core with a L- or S-type overgrowth. These types are characterized by low crystallization temperatures (700°C to 600°C) under crustal physical-chemical conditions (Pupin 1976). HfO_2 contents of zircon vary between 1.04 and 3.95%, compatible with crustal anatectic granites. The Zr/Hf ratio varies between 53.11 and 27.8. The highest ratio often represents inherited zircon cores identified in morphological studies.

Apatite is a fluor-apatite (2.77<F<3.78%) and occurs as small acicular crystals, locally as inclusions in biotite, muscovite and feldspar.

GEOCHEMISTRY The Urucum Suite granitoids are peraluminous (Fig. 3A). The aluminum saturation index ASI = mol Al_2O_3 /($CaO+Na_2O+K_2O$) ranges from 0.98 to 1.38 with an average of 1.F3. The K_2O+Na_2Q (6.8 to 9.2%) and $A1_2O$ (13.5 to 15.09%) contents increase from the megafeldspar facies to the pegmatitic facies. These rocks are relatively richer in Na_2O (up to 4.4%) than Chappell and White's (1974) S-type granites, butTMa$_2$O contents are comparable to those of the Himalayan Manaslu leucogranites (Vidal *et al.* 1982, 1984). The peraluminous character of the Urucum Suite is indicated by the presence of muscovite, garnet, tourmaline, and by the permanent presence of normative corindon (up to 4.7%).

The evolution of the Urucum Suite is marked by FMMT ($Fe_2O_3^T+MgO+MnO+TiO_2$) decrease accompanied by SiO_2 increase during differentiation (Fig. 3B). This behavior results Trom the fractionation of biotite and tourmaline. The MgO/TiO_2 ratio ranges between 2.14 and 5.33, increasing in the pegmatitic facies granitoids (average = 5.17). The $MnO/(MnO+Fe_2O_3^T)$ ratio increases from the megafeldspar facies to the pegmatitic facies resulting in a more important crystallization of almandine-spessartite in the most evolved facies (tourmaline and pegmatitic facies). Rb contents range between 262 to 121 ppm and Ba contents between 464 to 63 ppm. The compatible behavior of the transition elements (Co, V, Zn and Ga) is controlled by biotite fractionation, whereas Zr (143 to 26 ppm), Hf, Th and REE (113 to 17 ppm) have a compatible behavior controlled by the early fractionation of zircon and monazite (Figs. 3C and 3D). The REE spectra reflect the compatible behavior of the REE, which is characterized by $(La/Yb)_N$ ranging from 31.6 (megafeldspar and deformed medium- to coarse-grained facies) to 2.8 (pegmatitic facies), and presence of important negative Eu anomalies. The Th/U ratio (0.30 to 4.33) is controlled by monazite extraction. P, Be, Cs, Li, Ta and B show incompatible evolution resulting in a fertile residual liquid responsible for the crystallization of complex gem-bearing rare-element pegmatites. The Urucum Suite granitoids plot in the syn-collisional field in tectonic diagrams (Figs. 3E and 3F).

CONDITIONS OF CRYSTALLIZATION OF THE URUCUM SUITE MAGMAS From the application of the zircon saturation (Watson and Harrison 1984), monazite light rare earth element content (Montel 1993) and biotite-muscovite (Monier and Robert 1986) geothermometers, it is reasonable to consider that the crystallization temperature of megafeldspar- and medium- to coarse- grained facies granitoids ranges between 750-700°C. Crystallization of such facies was followed by the crystallization of the tourmaline facies around 700-650°C and of the pegmatitic facies around 650-600°C.

Crystallization of muscovite suggests a lower pressure limit for the crystallization of the Urucum Suite granitoids at 3.75 Kb (Kerrick 1972). The water contents in excess of 8-9 wt.% and pressure in excess of about 4 Kb are necessary for the primary crystallization of muscovite from a granitoid melt (Burnham 1967).

The presence of Mn-rich garnet in the Urucum Suite is compatible with pressures of about 4 kbar (depth of 12 km). Garnets (20-25% of spessartine) can be crystallized in equilibrium with a relatively low-pressure granitic melt, sometimes lower than 3 kbar (Green 1977).

ISOTOPIC RESULTS Four fractions of zircons of the deformed medium- to coarse-grained facies have been analyzed using the U-Pb isotopic method/Analytical results of three fractions (1 to 3; Table 1)

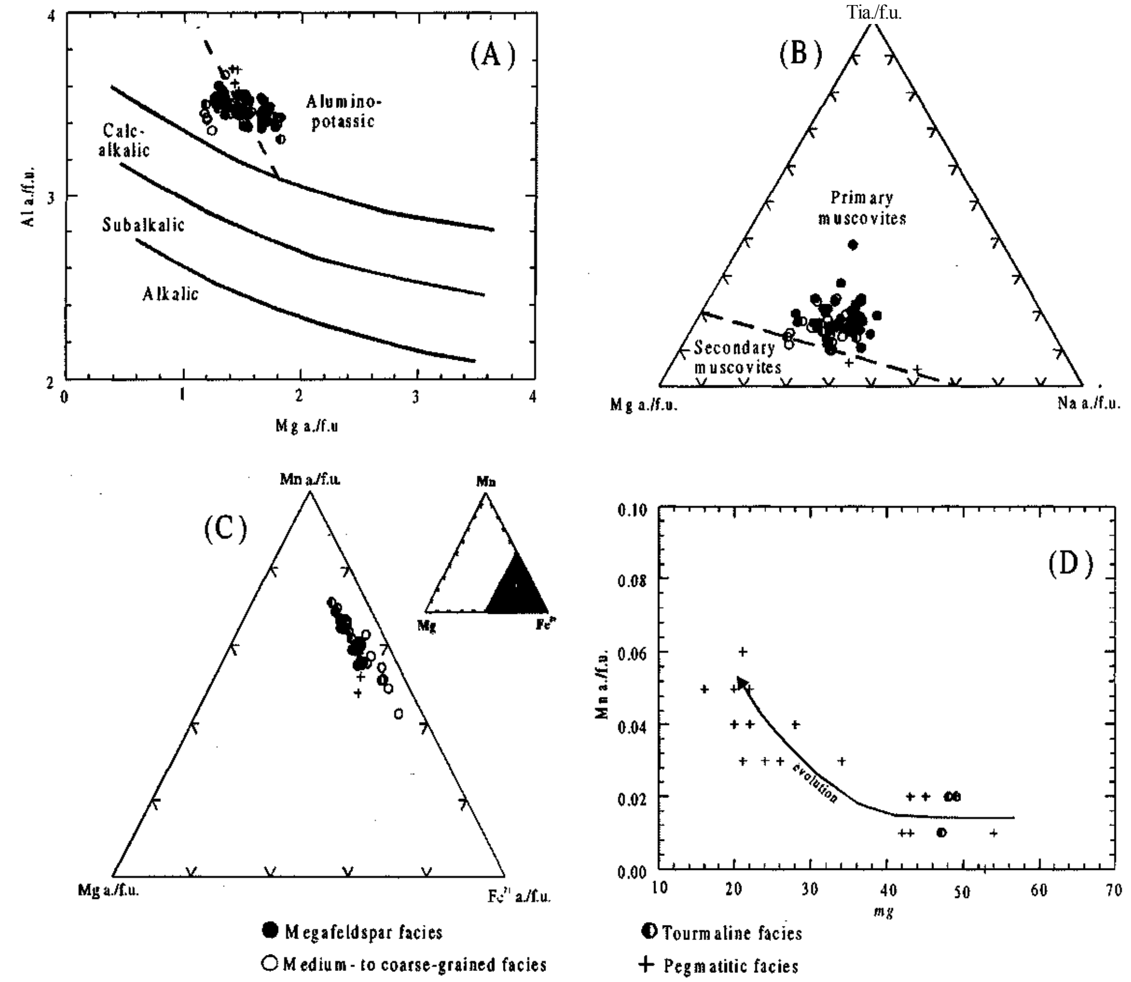


Figure 2 - (A) Classification Mg versus Al diagram for Urucum Suite biotite (Nachit et al. 1985); (B) Urucum Suite muscovite plotted in Na-Mg-Ti diagram (Miller et al. 1981); (C) Almandine-spessartite composition of Urucum Suite garnets in Fe^{2+}-Mg-Mn diagram; (D) Evolution of Urucum Suite tourmaline in mg (Mg/(Mg+Fe)) versus Mn diagram. a./f.u.= atoms/formula unit

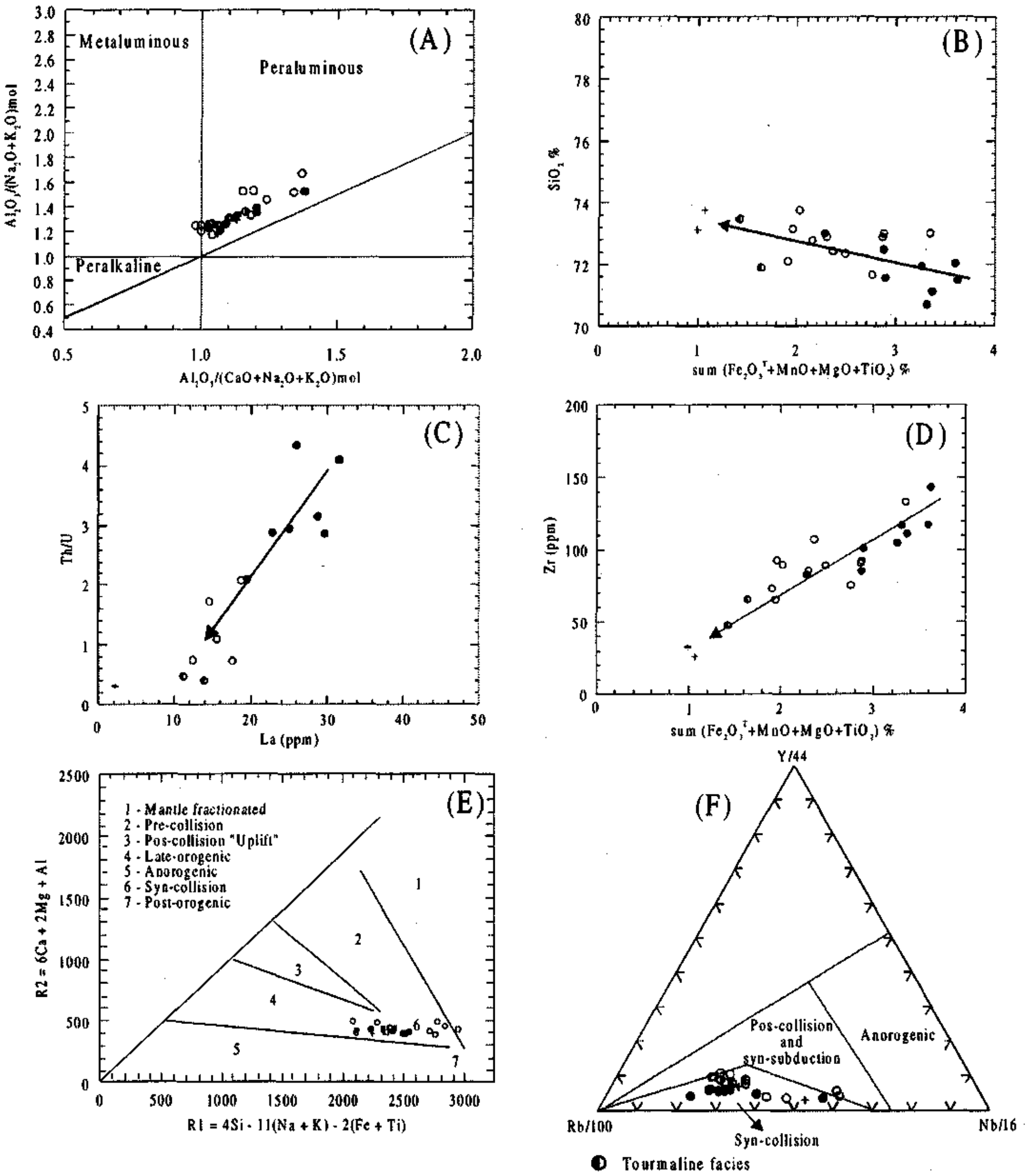
yield an U-Pb age of 582 ±*2 Ma* (Fig. 4A). The fourth fraction (4) is very discordant and seems to indicate the presence of an isotopic inherited memory with an age about 2.2 Ga. In complement, two monazite fractions (5 and 6; Table 1) have been analyzed. These fractions indicate an age of 576 ± 4 Ma (Fig. 4A). This age is slightly younger than the one obtained from the zircon fractions, but it plots within the analytical error interval.

The four zircon fractions analyzed (7 to 10; Table 1) for the megafeldspar facies yield a lower intercept age of 570 Ma and an upper intercept age of 2.2 ± 0.3 Ga (Fig. 4B). The last age is in accordance with fraction 4 from the medium- to coarse-grained facies, and confirms the presence of inherited zircon cores reported in the zircon morphological study (Nalini *et al.* 1997). Three monazite fractions analyzed (11 to 13; Table 1) for the megafeldspar facies indicate a crystallization age of 573 ± 4 Ma (Fig. 4B) that is comparable to the one obtained from the medium- to coarse-grained facies monazites (576 ± 4 Ma).

Initial $^{87}Sr/^{86}Sr$ isotopic ratio (Table 2) for Urucum Suite granitoids varies between 0.7114 to 0.7165. The ratio increases according to the evolved character of the rocks, from the megafeldspar to the pegmatitic facies. The $eNd_{(T)}$ values vary between -7.4 and -8.2 (Table 2). The most negative value is observed in the tourmaline facies (CP05; £Nd = -8.2) and in one of the medium- to coarse-grained facies samples (MD33; eNd = -8.1). The pegmatitic facies shows an eNd value (-7.4) close to the others analyzed samples, which suggests a genetic link between the different facies of the Urucum Suite. T_{DM} model ages obtained for two samples of the megafeldspar facies are about 1.8 Ga (Table 2). Other facies yield older model ages (2.3 to 2.1 Ga). Such ages are in accordance with the presence of an isotopic-inherited memory in zircons of the megafeldspar (2.0 ± 0.3 Ga) and medium- to coarse-grained (2.0 Ga) facies.

In summary, the U-Pb data show that the emplacement of the Urucum Suite occurred during the Neoproterozoic (Brasiliano orogeny) and the Rb-Sr and Sm-Nd isotopic results point to a strong crustal affinity for the Urucum Suite, whose origin is probably from reworking of an older Early Proterozoic (2.3 to 1.8 Ga T_{DM} ages) basement.

CONCLUSION Urucum Suite leucogranite intrusions occurred by the end of the Brasiliano orogeny (582 ± 2 Ma, U-Pb in zircon). These granitoids comprise four main facies: megafeldspar granites, deformed medium- to coarse-grained granites, tourmaline and pegmatitic facies. Modal mineralogical variations and chemical composition of biotite, muscovite, monazite, garnet and tourmaline suggest an evolution from the megafeldspar facies to the pegmatitic facies.



● Megafeldspar facies

O Medium-to coarse-grained facies + Pegmatitic facies

Figure 3- Whole rock geochemical diagrams of the Urucum Suite. (A) A/NK versus A/CNK diagram (Maniar & Piccoli 1989); (B) $(Fe_2O_3^T+MnO+MgO+TiO_2)$ versus SiO_2 diagram. The arrow indicates the evolution trend of the suite rocks; (C) and (D) La versus Th/U and $(Fe_2O_3^T+MnO+MgO+TiO_2)$ versus Zr diagrams showing the monazite and zircon fractionation respectively; (E) Rl versus R2 diagram (La Roche etal. 1980) with the tectonic domains of Batchelor & Bowden (1985); (F) Nb/16 - Rb/100 - Y/44 tectonic diagram proposed by Thieblemont & Cabanis (1990).

Structural studies (Nalini 1997) suggest the syn-kinematically emplacement of the Urucum collisional suite within a water-rich environment (primary muscovite). The emplacement is favored by magma canalization within a N to NW-trending, dextral strike-slip shear zone related to the end of the Brasiliano orogeny. Temperature and pressure estimations for the Urucum Suite crystallization occurred at 750-600°C and 4 kbar (depth of 12 km), respectively.

Chemical compositions indicate the peraluminous character of the Urucum Suite granitoids. The suite evolves from the megafeldspar facies granites to pegmatitic facies granites. Whole-rock chemical evolution is in accordance with the mineral-chemical evolution. The compatible behavior of certain elements (Fe, Mg, REE, Zr, etc) clearly shows the role played by fractional crystallization of biotite, monazite and zircon in the evolution of these granitoids. However, other elements such as Mn, P, Ta, Li and B show an incompatible behavior that is responsible for the fertile residual granitic melt from which the rare-element pegmatites originated. Geochemical signatures suggest the syn-collisional character of this suite.

The peraluminous composition and the enriched character of the isotopic Rb-Sr ($^{87}Sr/^{86}Sr$ = 0.7114 to 0.7165) and Sm-Nd ($eNd_{(T)}$ = -7.4 and -8.2) data indicate that the Urucum Suite rocks are formed by partial melting of older intermediate to felsic crustal sources (lower-crustal metasediments and/or metaigneous basement rocks). Based on early Proterozoic model ages (2.3 to 1.8 Ga) and on 2.0 Ga U-Pb inherited isotopic memory, the leucogranites are probably derived from a crust with a long crustal residence time (Paleoproterozoic). Isotopic results agree with regional studies (Cordani *et al.* 1988, Ebert *et al.* 1996) that suggest an origin for the Brasiliano granitoids by reworking of the older Transamazonian basement (2.2-1.8 Ga), without extensive mantle-derived contribution.

U-Pb ages for the Urucum Suite are comparable to those of the peraluminous Rio Turvo massif (579 ±2 Ma, Valladares 1996), located in Rio de Janeiro State, south of the studied region. These granitoids appear to be relatively older (-10-20 Ma) than the collisional granitoids in Espfrito Santo State, as proposed by Figueiredo and Campos Neto (1993) and Campos Neto and Figueiredo (1995). On other hand, these ages plot in the 600-570 Ma range as proposed by Machado (1997) for the collisional-phase magmatism in Rio de Janeiro State. Finally, considering the analytical errors, it seems that the collisional phase-magmatism associated with the Brasiliano orogeny in the Rio Doce region must be constrained between 585 and 570 Ma. The Urucum peraluminous magmatism postdates the pre-collisional calc-alkaline magmatism of the Galiléia Suite in the Rio Doce region (596 ±4 Ma, Nalini 1997).

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Table 1 - U-Pb analytical results of the Urucum suite; individual analyses were performed on the least magnetic (3° forward and side tilt at 2.2A using a Frantz magnetic barrier separator), euhedral and crack-and inclusion-free grains. The isotopic ratios are corrected for mass discrimination (0.1 ± 0.015 % per uma for Pb and U), isotopic tracer contribution and analytical blank: 5-10 pgfor Pb and 1 pg for U. Initial common Pb is determined using the Stacey and Kramers (1975) two-steps model. The errors on the isotopic ratios are given at the 2s level. Abbreviations: Zr.= zircons; Mz.= monazites; na.= unabraded; ab.= air-abraded; in.= colourless; ja.= yellow. Number in brackets is the number of grains infraction.

Fraction (µm)	Poids (mg)	U (ppm)	Pb rad (ppm)	$^{206}Pb/^{204}Pb$	$^{208}Pb/^{206}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$
		concentrations			atomic ratio					apparent ages (Ma)	
				Medium- to coarse-grained facies (sample MD07.2)							
1 : Zr >100 ab. [9]	0.056	159	16.3	1692	0.1843	0.09436	0.7728	0.05940	581	581	582
2 : Zr >100 ab. [10]	0.076	151	14.3	4599	0.1005	0.09416	0.7714	0.05942	580	581	582
3 : Zr >100 ab. [9]	0.074	157	14.9	4261	0.1104	0.09394	0.7695	0.04941	579	579	582
4 : Zr >100 ab. [12]	0.096	287	51.8	19199	0.0996	0.1733	2.602	0.1089	1030	1301	1781
5 : Mz na.	0.082	1188	1157	246	10.005	0.09436	0.7655	0.05926	577	577	577
6 : Mz na.	0.111	1081	1122	322	11.007	0.09342	0.7632	0.05925	576	576	576
				Megafeldspar facies (sample MD41)							
7 : Zr <75 ab.in. [29]	0.030	551	80.1	764	0.1672	0.1295	1.616	0.09051	785	976	1436
8 : Zr <75 ab.in. [22]	0.029	435	63.4	9718	0.0989	0.1420	1.800	0.09198	856	1046	1467
9 : Zr <75 na. ja. [19]	0.024	730	72.7	1523	0.0970	0.09774	0.8585	0.06371	601	629	732
10:Zr <75 na. ja. [25]	0.026	1190	128	7132	0.0838	0.1081	1.037	0.06955	662	722	915
11 : Mz na. >75	0.092	5871	1615	2120	2.324	0.09301	0.7592	0.05920	573	574	574
12 : Mz na. >75	0.048	6131	1785	1366	2.500	0.09305	0.7595	0.05920	574	574	574
13 : Mz na. <75	0.047	5559	1763	2592	2.858	0.09277	0.7564	0.05914	572	572	572

Table 2 - Rb-Sr and Sm-Nd analytical results for the Urucum suite granitoids.

Sample	Facies	Sm (ppm)	Nd (ppm)	$^{147}Sm/^{144}Nd$	$^{143}Nd/^{144}Nd \pm 2\sigma_{(M)}$	$\varepsilon Nd_{(T)}$	T_{CHUR} Ma	$T_{D.M.}$ Ma	Rb (ppm)	Sr (ppm)	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr \pm 2\sigma_{(M)}$	$^{87}Sr/^{86}Sr_{(i)}$
MD41A	Megafeldspar	6.21	30.3	0.1238	0.511958 ± 6	-7.9	1425	1840	214	75	8.32	0.78189 ± 2	0.7130
MD37	Megafeldspar	5.53	26.2	0.1276	0.511996 ± 7	-7.5	1420	1860	248	55	13.2	0.82057 ± 2	0.7114
MD07-2	Med. - to coarse	4.61	19.5	0.1426	0.512038 ± 7	-7.8	1695	2165	159	104	4.44	0.74965 ± 2	0.7129
MD33	Med. - to coarse	3.99	16.5	0.1461	0.512034 ± 10	-8.1	1820	2290	237	53	13.1	0.82377 ± 2	0.7154
CP05	Tourmaline	2.18	9.49	0.1388	0.512003 ± 9	-8.2	1680	2125	165	59	8.15	0.78328 ± 2	0.7159
MD05C	Pegmatitic	0.51	1.58	0.1947	0.512256 ± 13	-7.4	-	-	132	45	8.55	0.78721 ± 2	0.7165

T= 580 Ma; T_{CHUR} is calculated with Jacobsen and Wasserburg (1980) parameters; TD.M. is calculated after De Paolo (1981) model; Mean of the La Jolla standards $^{143}Nd/^{144}Nd$ = 0.511850± 6 (2a)

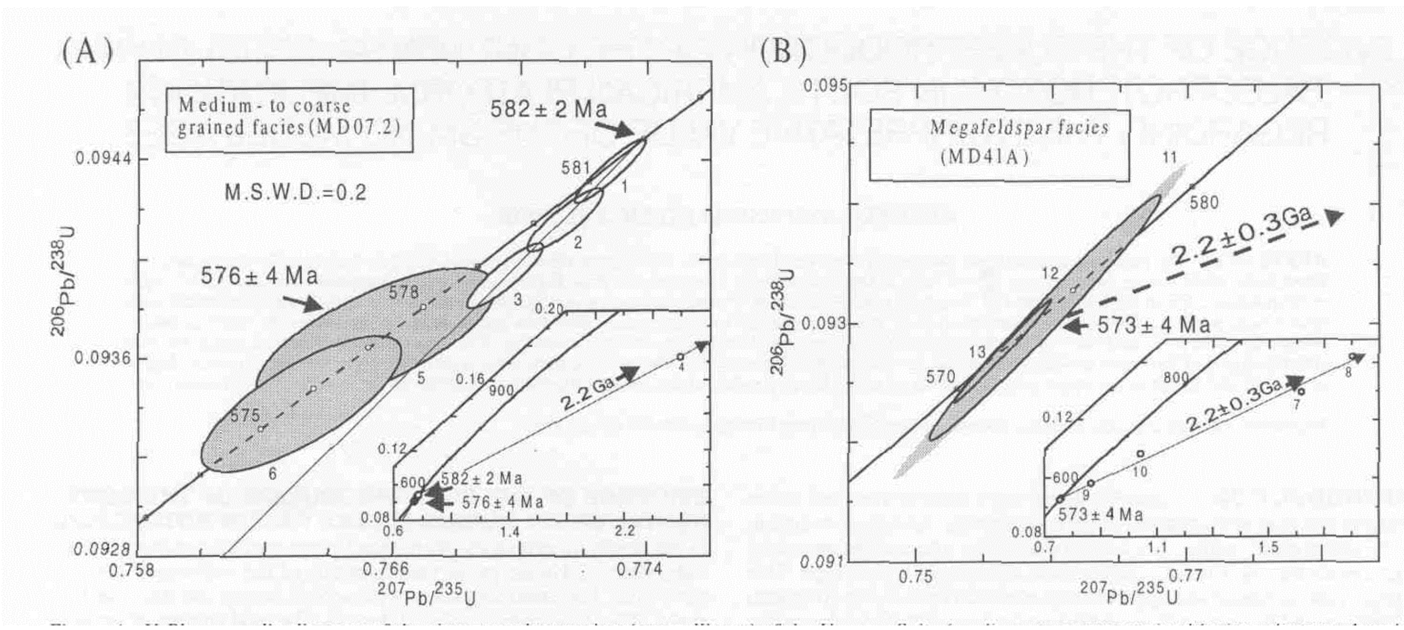

Figure 4 - U-Pb concordia diagram of the zircons and monazites (gray ellipses) of the Urucum Suite (medium- to coarse grained fades - diagram A and megafeldspar fades - diagram B).

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