

**Sr- and Nd ISOTOPES OF CONTRASTING CALC-ALKALIC GRANITES IN THE
EASTERNMOST ALTO PAJÉU TERRANE, NE BRAZIL,
AND IMPLICATIONS FOR THEIR ORIGIN**

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Introduction

The eastern Alto Pajeú terrane (APT), Borborema province, NE Brazil, is limited to the north by the Patos shear zone, which separates this from the Seridó terrane, and by the Alto Moxotó terrane to the south. The APT is characterized by four different magma types emplaced in three time intervals: (a) high-K calc-alkalic and shoshonitic magmas emplaced at 650-620 Ma, (b) high-K calc-alkalic series followed by ultrapotassic magmas emplaced at 580-570 Ma, and (c) peralkalic magmas at 520 Ma. Recent geological mapping of the region of Guarabira, State of Paraíba (Brito Neves, 2004) at the easternmost APT revealed two other magma types, leucocratic peraluminous and metaluminous calc-alkalic magmas.

In this work plutons of these two contrasting magma types besides a high-K metaluminous monzodiorite of the calc-alkalic series are described: the calc-alkalic Curral de Cima tonalite, the Mamanguape two mica syenogranite, and the Lourenço high-K calc-alkalic monzodiorite (Fig. 1).

Petrography

The Mamanguape pluton is a peraluminous, leucocratic equigranular to slightly inequigranular syenogranite containing microcline, quartz and plagioclase. Muscovite, biotite and garnet occur as major accessory phases. It is a medium- to fine-grained unfoliated to slightly foliated rock with variable proportion of muscovite and biotite. Garnet is present in most studied samples; locally it forms cm-sized clots of irregular shape. Enclaves of fine-grained igneous rocks, usually < 10 cm long, are locally observed.

The Lourenço pluton consists of a coarse-grained porphyritic to equigranular high-K monzodiorite that locally presents a well-developed magmatic foliation, defined by feldspar and amphibole crystals. Tonalite and quartz diorite enclaves are aligned, in a typical syn-plutonic feature. Hornblende, biotite and titanite, apatite, allanite, and zircon are the major accessory phases. The

pluton is unfoliated to weakly foliated (low angle, NE-SE trending).

The Curral de Cima pluton is a small elongate equigranular tonalite-granodiorite emplaced next to the northern boundary of the APT, strongly affected by shearing associated to the Patos shear zone. Two major facies are recognized: hornblende-biotite tonalite - granodiorite and biotite-hornblende-quartz diorite - tonalite. Locally amphibole-rich clots oriented according to the magmatic foliation are present. Two major foliations are observed: one is mainly E-W and the other one is NE-SW. Accessory phases are biotite, hornblende, titanite, which can present associated opaque minerals, zircon, epidote (both magmatic and secondary, in this case associated to plagioclase), and rare tourmaline.

Geochemistry

The Mamanguape syenogranite presents very high SiO₂ contents (> 70 wt %), and relatively low contents of MgO (0.18-3%), CaO (0.30 - 0.94%), TiO₂ (0.0 - 0.24%) and Fe₂O₃T (0.90 - 2.2%), Ba (80-400 ppm), Sr (2-140 ppm), Ni (≠ 26 ppm), Cr (30-190 ppm) and Zr (5-140 ppm). It presents, however, high contents of K₂O (4.2-6.9%), Rb (250-400 ppm) and Y (4 - 78 ppm), compared to the concentrations in the Lourenço and Curral de Cima plutons. The latter presents intermediate SiO₂ contents, partially overlapping the values of the Lourenço monzodiorite.

The Lourenço monzodiorite is characterized by high Na₂O, Fe₂O₃ (t), Ba, Sr (up to 1200 ppm), Zr (370 ppm) and Ni (60 ppm), and lower Rb and Y contents than the other types. The Curral de Cima tonalite presents intermediate concentrations between the two other types, for the elements considered, and a lower total variation. Rb/Sr ratios are high (up to 18) in the Mamanguape pluton, typical of composition of the residual system of crustal melting. The ratios in the Curral de Cima pluton on the contrary are low (<0.1) suggesting a mantle contribution in its origin. Rb/Sr ratios in the Lourenço pluton are low, between 0.5 to 0.11 that together with a compatible behavior of Sr and incompatible of Rb,

suggest that these ratios were not strongly influenced by mineral fractionation processes, and probably reflect an important mantle-derived component.

Isotopic data and discussion

The Mamanguape syenogranite shows strongly negative and variable $\epsilon\text{Nd}_{0.6\text{Ga}}$ values (-14.8 to -20), and very high initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios, which associated with low Rb/Sr ratios indicate crustal sources. Nd model ages are Archean to Paleoproterozoic (3.1 to 2.41 Ga), which are one of the oldest T_{DM} already found in the Borborema province.

Garnet, muscovite, and biotite, major accessory phases of the Mamanguape plutons, are phases typical of peraluminous leucogranites of medium to high grade orogenic metamorphic belts, formed by dehydration melting of felsic metapelites, that is, pure crustal melts (Patiño Douce, 1999). The major element compositions of the pluton are similar to that of peraluminous S-type granites, which are characterized by the presence of mafic aluminous minerals of low P and high T, such as cordierite.

The Lourenço monzodiorite presents variable initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios (0.707 to 0.710), and negative ϵNd (-13.4 to -11) values, and average t_{DM} of 1.9Ga, suggesting long residence time, and probably reflect mixture of Mesoproterozoic and juvenile Neoproterozoic material. These features are compatible with a differentiation from partial melt in the lower crust with an important mantle-derived component.

The Curral de Cima pluton presents initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios < 0.710 , positive (+2.0) to slightly negative (-2.72) $\epsilon\text{Nd}_{(0.6\text{ Ga})}$ values and T_{DM} varying from 1.31 to 0.99 Ga. Contrasting with the old Nd model age for the Mamanguape pluton, these are among the youngest Model ages already obtained for granitoids in the Borborema province.

Partial melting of amphibole compositions can give rise to calc-alkalic magma whose differentiation can produce quartz diorite to tonalite, compositionally similar to that of the Curral de Cima rocks. Presence of amphibole-rich clots, together with the available isotopic data is compatible with a juvenile magma derived from a protolith of amphibolite composition, as the source for the Curral de Cima tonalite that has suffered only minor crustal contamination.

The concentrations of Y, Nb, and Rb for the Mamanguape syenogranite are compatible with those for sin-collisional granitoids in tectonic setting discrimination diagram, while those for the Curral de Cima and Lourenço plutons are compatible to those of magmatic arc granitoids.

Absolute age determinations, underway, will help constraining time the emplacement at different tectonic setting of these contrasting magmas in terms of protolith (Meso-Neoproterozoic igneous source vs. Archean sedimentary source).

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RESUMO

Entre os diferentes tipos de plutons que ocorrem no extremo leste do terreno Alto Pajeú, província Borborema (BP), NE Brasil, estão três plutons de idade Neoproterozóica, distantes poucos km uns dos outros, originados de magmas e ambientes tectônicos contrastantes. O pluton Curral de Cima é um hornblenda biotita tonalito-granodiorito com assinatura geoquímica de granitóides de arco magmático. As rochas são calcio-alcálicas, metaluminosas, têm alto Rb/Sr ($< 0,1$) e $(^{87}\text{Sr}/^{86}\text{Sr})_i < 0,710$, positivo (+2,0) a ligeiramente negativo (-2,72) $\epsilon\text{Nd}_{(0.6\text{ Ga})}$, com T_{DM} variando de 1,31 a 0,99Ga, um dos mais jovens já obtido para um granitóide na BP. Esses dados são compatíveis com magma juvenil derivado de um protólito de composição anfibolítica que sofreu contaminação crustal pequena. O pluton Mamanguape é um sienogranito com duas micas e granada, com baixo Ba, Sr e Zr, e alto Rb e Y, e assinatura geoquímica de granitóides sin-colisionais. Apresenta ϵNd variável e fortemente negativo (-14,8 a -20), e muito altas $(^{87}\text{Sr}/^{86}\text{Sr})_i$ e Rb/Sr (até 18), típicas de magmas crustais, e idades modelo Nd das mais antigas (3,1 a 2,41Ga) já registradas na BP. O pluton Lourenço é um hornblenda monzodiorito com mais alto Sr (até 1200ppm), Zr (370ppm) e Ni (60ppm), e mais baixo Rb e Y que os outros plutons. Apresenta assinatura geoquímica de granitóides de arco magmático, baixo Rb/Sr (0,5 a 0,11), $(^{87}\text{Sr}/^{86}\text{Sr})_i$ de 0,707 a 0,710, e ϵNd negativo (-13,4 a -11), com $t_{\text{DM}} \sim 1,8\text{Ga}$, sugerindo um longo tempo de residência crustal. Esses dados provavelmente refletem mistura de material Mesoproterozóico com um importante componente Neoproterozóico juvenil derivado do manto.

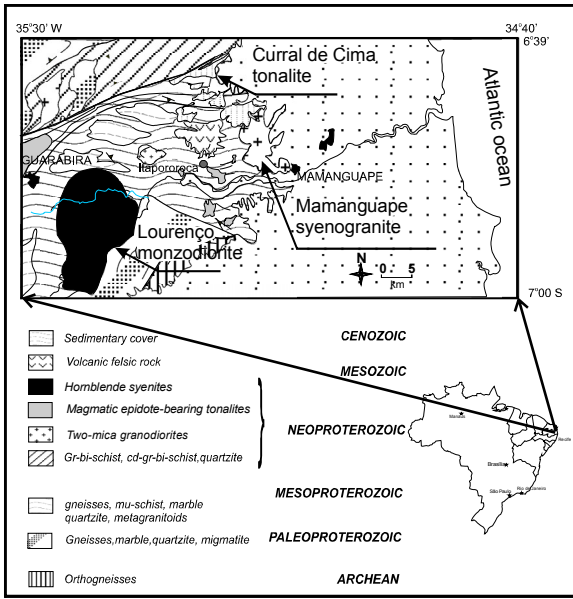


Fig. 1. Sketch of the geological map of the Guarabira region, State of Paraíba, northeast Brazil, showing the three studied plutons.

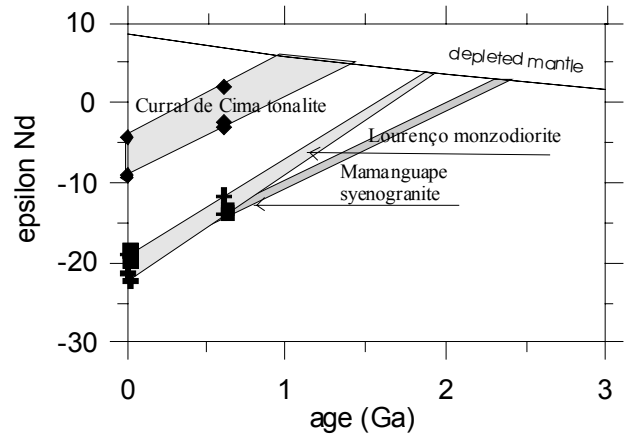


Fig. 2. Nd- model age vs. ϵ Nd diagram for the studied plutons.