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Extended Abstracts

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Comments on the Sm-Nd isotope systematics of calc-alkaline granitoids from the Pinhal-Ipuiúna batholith (São Paulo and Minas Gerais, Brazil)[a]

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The Pinhal-Ipuiúna Batholith (PIB) makes up a large volume of the southern portion of the Guaxupé Domain (GD), an allochtonous terrane thrust over the Alto Rio Grande Fold Belt, south of the São Francisco Craton, during the Brasiliano orogeny. Much of the Domain is composed of poorly known orthogneisses, now converted to granulites and migmatites.

The granites forming the PIB are similar to those found in other syn-orogenic batholiths in southeastern Brazil[1]. Modally and chemically they follow an expanded high-K calc-alkaline trend, with the preponderance of rocks with intermediate composition (porphyritic Hbl-Biot quartz monzonites and monzogranites grouped into the Ipuiúna, IPU, unit) over both less and more fractionated rocks (respectively, Biot-Hbl monzodiorites of the São José da Prata, SJP, unit and chemically contrasted monzogranites and syenogranites of the Serra do Pau-d'Alho, SPA, unit)[2]. Mafic enclaves are more abundant in the more mafic facies; some small gabbro bodies appear within the IPU unit. Recent U-Pb data suggest the regional high-K calc-alkaline plutonism to be confined to a narrow time span (630-625 Ma)[3].

Sm-Nd isotope data were obtained on four samples representative of the major units recognized in the PIB: SJP monzodiorite SC-333, IPU quartz monzonite IU-08b, SPA monzogranite SC-347 and SPA syenogranite PH-146. REE data for a large suite of samples from throughout the batholith[4] show the SJP and IPU granitoids to have very similar chondrite-normalized REE patterns, moderately fractionated (La_N/Yb_N = 15-20) and with small to negligible negative Eu anomalies. SPA monzogranites, as represented by sample SC-347, have more pronounced LREE fractionation but flat HREE patterns (Dy_N/Yb_N near 1) and well defined negative Eu anomalies, possibly reflecting Hbl + Pl removal, whereas SPA syenogranites as PH-146 have the more fractionated REE patterns (La_N/Yb_N over 30) and smaller Eu anomalies.

The εNd_{630} values of three of the samples are less negative ($\approx$ -7) than most of the syn-orogenic granites from nearby terranes for which similar data are available (e.g., 5). The fourth sample, IPU quartz monzonite IU-08a, in contrast, has a strongly negative εNd_{630}, and is less radiogenic than all other syn-orogenic granitoids. $^{87}Sr/^{86}Sr_{630}$ is quite uniform (0.709-0.710) in most granitoids from the PIB including those analysed for Nd; as a result, the samples studied here plot outside the fields encompassing the regional syn-orogenic granites in an εNd x εSr diagram (Figure 1).

The strong contrast between the three more radiogenic samples and the IPU quartz monzonite IU-08a is also apparent in an εNd x T diagram (Figure 2). Two of the first, showing $^{147}Sm/^{144}Nd$ ratios of ca. 0.10, have Sm-Nd TDM model ages near 1.55 Ma, significantly younger than values shown by syn-orogenic granites found in nearby domains. The other less radiogenic sample, SPA monzogranite SC-347, has lower $^{147}Sm/^{144}Nd$ (0.075), possibly reflecting intra-crustal fractionation, what must respond for its slightly younger TDM (ca. 1.3 Ga). The strongly negative εNd of the IPU sample

indicates that their parent melts had strong contributions from very old crust (possibly Archaean; T_{DM} value of ca. 2.3 Ga reflects the low $^{147}Sm/^{144}Nd = 0.089$).

The chemically expanded character of the batholith, coupled with the abundance of mafic granitoids, suggests an important input of mantle-derived ("juvenile") basic magmas[2,6]. In such "hybrid" granitoids, the isotope signatures of the rocks should reflect the mixing, and vary according to the proportions of the mantle and crust components. In the PIB, however, εSr_T has been shown to be quite uniform[2] and largely independent of the mafic content of the rocks; the same appears to happen to Nd, since the three samples with less negative εNd_T correspond to two contrasted felsic granites and one of the most mafic monzodiorites of the batholith.

Several other examples of compositionally varied cogenetic granitic suites showing uniform isotope signatures are known, and are thought to result from assimilation of crustal material and efficient homogenization (MASH-type processes)[7-9] of basalts underplated in large magma chambers at the lowermost crust. In such cases, the Nd isotope signature should reflect the combination of the two sources, with predominance of that richer in REE, normally the crust.

Among the few other Nd isotope data available for rocks from the GD are three determinations for late-orogenic potassic syenites whose parent melts derived from enriched horizons of the lithospheric mantle[10] and a single determination (K. Sato, unpublished result) on a mangerite derived from melting of depleted granulites in the lower crust[11]. As shown in Figure 2, both mantle- and crust-derived magmas have Mesoproterozoic (1.4-1.7) model ages broadly similar to those seen in the PIB.

A simple explanation for the few data now available, therefore, would be that the Mesoproterozoic was an important crust-forming event in the GD, possibly in a subduction environment in which calc-alkaline rocks would have been generated (parts of the granulites and migmatites of unknown age that make up most of the GD?) and the lithospheric mantle would have been metasomatized. Considered within the regional framework, such an explanation can not, however, be taken as more acceptable than several others also permitted by the present data, even though it should be noted that terranes where granitoids of contrasted origin and also metasediments show similar Nd_{TDM} patterns have been reported in other regions of south Brazil[12,13]. Additionally, although reports of Mesoproterozoic ages of rock formation are scarce and in some cases still doubtful in the region, nearby African counterparts include large extents of rocks formed in the 1.7-1.0 Ga range within the Namaqua belt[14].

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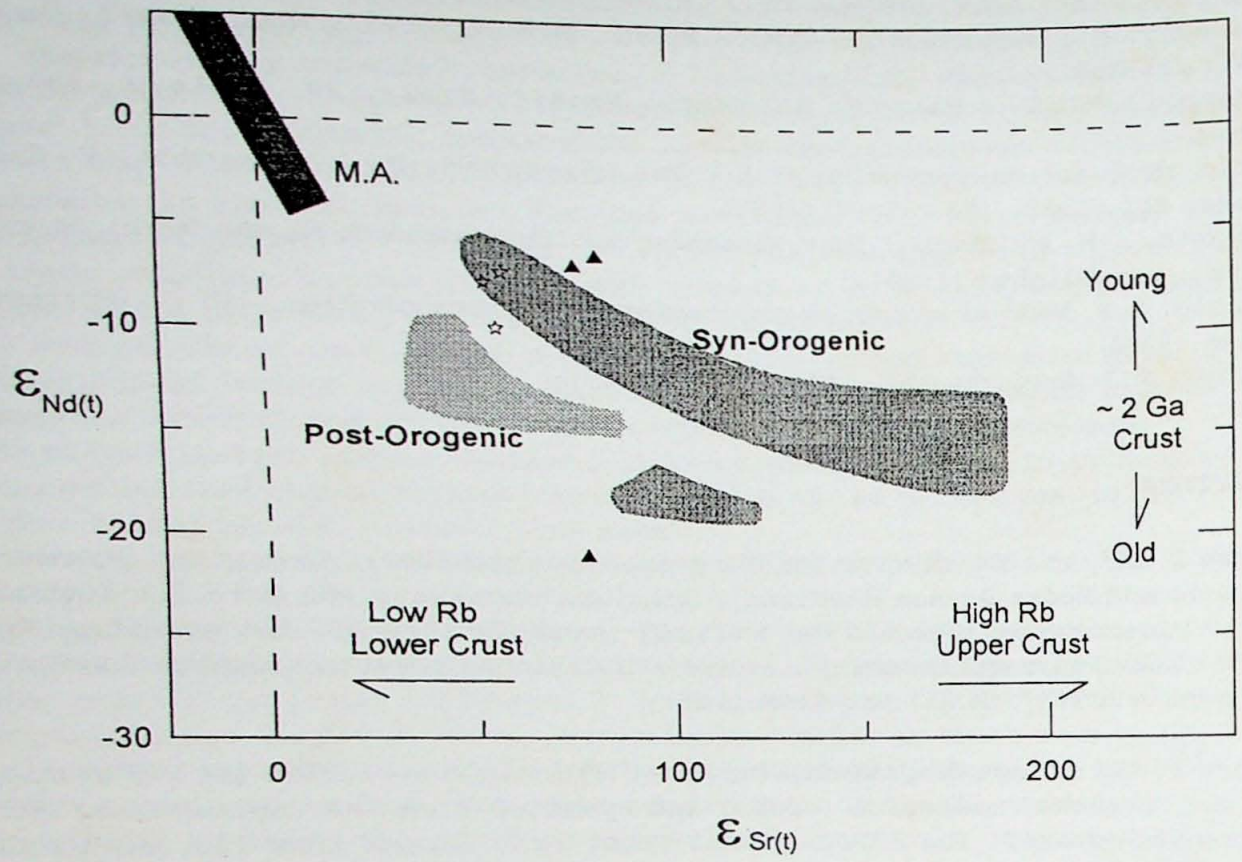
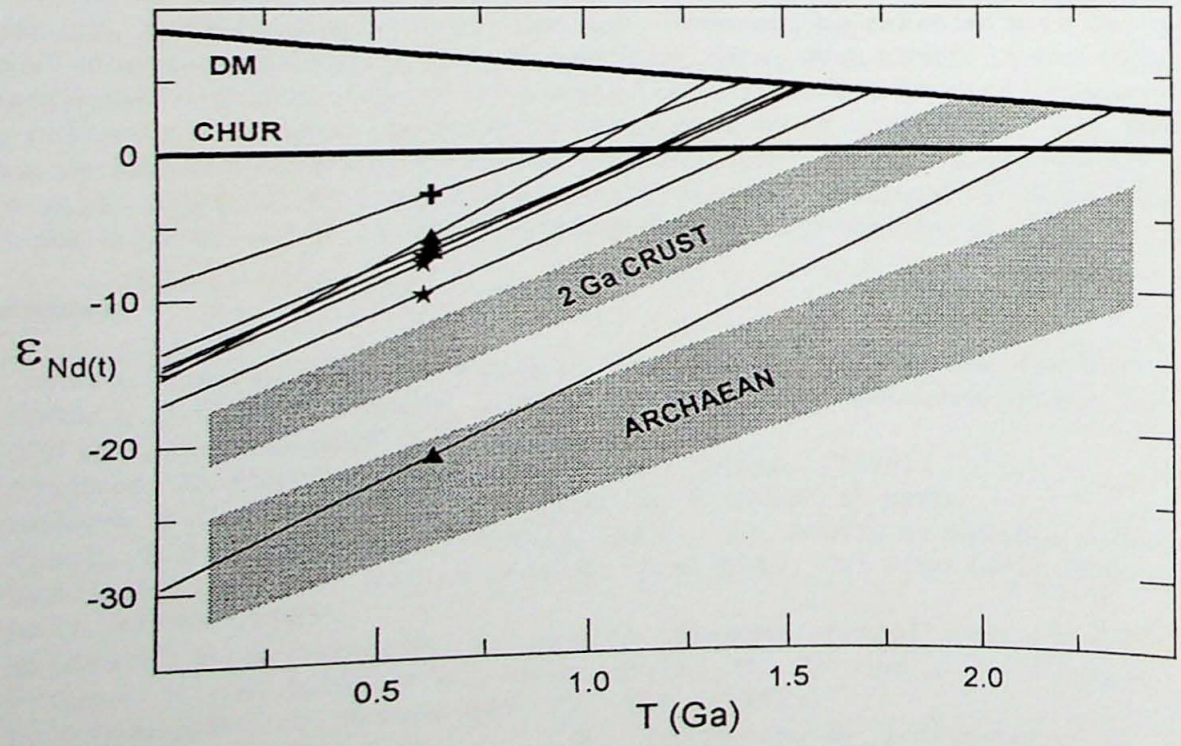
FIGURE CAPTIONS

Figure 1. εNd_T *vs.* εSr_T diagram for PIB granites (triangles). Open stars represents the Capituva and Pedra Branca Massifs[10]. Envelops encompass the data for regional brasiliano syn-orogenic (640-625 Ma) and post-orogenic (610-580 Ma) granites from the States of São Paulo and Parana[5,15]. Isotopic notations, reference mantle reservoirs and the "mantle array" (M.A.) are from (16).

Figure 2. εNd *vs.* age diagram showing model Nd isotope evolution for PIB granites (triangles), regional mangerite (cross) and syenites from the Capituva and Pedra Branca Massifs (stars). The 2 Ga regional crust is inferred from (5), mean model Archaean crust is from (17). Isotopic notations, model ages and reference mantle reservoirs are from (16).


0
-10
-20
-30
$\varepsilon_{Nd(t)}$
M.A.
Syn-Orogenic
Post-Orogenic
Young
~ 2 Ga
Crust
Old
Low Rb
Lower Crust
High Rb
Upper Crust
0
100
200
$\varepsilon_{Sr(t)}$


DM
CHUR
0
-10
-20
-30
$\varepsilon_{Nd(t)}$
2 Ga CRUST
ARCHAEAN
0.5
1.0
1.5
2.0
T (Ga)