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Extended Abstracts

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Sr and Nd isotope systematics of the Capituva and Pedra Branca syenitic massifs (SW Minas Gerais, Brazil): Petrogenesis and inferences on Neoproterozoic lithospheric mantle reservoirs[a]

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The youngest Brasiliano plutonic occurrences within the Guaxupé Domain, an allochtonous high-grade terrane located to the south of the São Francisco Craton (SFC) are two ellipsoidal syenitic massifs intrusive into gneissic migmatites and syn-orogenic (630-625 Ma[1-2]) high-K calc-alkaline granitoids and mangerite-granite suites[3]. Recent U-Pb dating of the Pedra Branca massif[3] yielded a nearly concordant age of 612 ± 2.5 Ma, confirming its stratigraphic position as an early manifestation of the late- to post-orogenic Itu granitoid belt (610-580 Ma[4]). Although built up of several intrusive phases, each one comprising different textural facies, both massifs show little compositional variation, being composed basically of K-rich syenites.

Medium to coarse grained, usually laminated syenites bearing small (<5 vol.%) amounts of quartz constitute most of the earliest intrusions in the Capituva massif; ring-like bodies of fine-grained quartz syenite and a central body of porphyritic biotite-rich mela-syenite occur within the youngest unit at the core of the massif[3].

Slightly supersaturated syenites also occur extensively within the Pedra Branca massif, as porphyritic and laminated facies in the eastern border and a predominantly fine-grained facies at the core. Saturated to locally insaturated (nepheline-bearing) laminated syenites occur as a large, ring-like intrusion and exhibit a peculiar mineralogical assemblage (K-feldspar + soda-augite to egirine-augite + phlogopite + ilmeno-hematite + magnetite + titanite + apatite), indicative of crystallization under strongly oxidizing (slightly below the HM buffer) conditions[5]. The mafic mineralogy of the supersaturated facies in both the Pedra Branca and Capituva massifs (diopside + Mg-biotite + hemo-ilmenite + apatite) point to their crystallization under slightly less oxidizing conditions (fO_2 above the NNO buffer)[3,5].

Geochemical data presented elsewhere[3,5] confirm the contrasts between the main petrographic groups (namely, mela-syenites (MS), quartz-bearing medium- to coarse-grained syenites (MCS), quartz-free (saturated) syenites (SS) and fine-grained quartz syenites (FQS)) and show that they cannot be related to each other through simple closed-system crystal-liquid fractionation. In spite of these contrasts, they all share a very particular chemical signature, being strongly rich in LILE such as K, Ba, Sr, LREE as well as P_2O_5 and relatively poor in HFS elements as Nb, Ta and Ti, and were interpreted as products of fractionation from mafic ultrapotassic magmas chemically akin to minettes, derived from LILE-enriched horizons within the subcontinental lithospheric mantle[3,6].

Sr and Nd isotope data were obtained for representative samples from the Capituva massif and for one sample from the Pedra Branca massif. They place further constraints on the petrogenesis of these syenites and have some interesting implications for the evolution of mantle reservoirs on a regional scale.

Samples from all main facies groups in the Capituva massif show a vary narrow range of $^{87}Sr/^{86}Sr_{612}$ (0.7072-0.7078; εSr = 46-54) with no simple pattern of variation (*e.g.*, the extreme values of $^{87}Sr/^{86}Sr_{612}$ are shown by two samples of FQS). The

average $^{87}Sr/^{86}Sr_{612}$ value (0.70756 ± 0.00025) is remarkably coincident with that obtained by Töpfner[2] for SS facies syenites from the Pedra Branca massif (0.70754 ± 0.00024), emphasing the cogenetic nature of both massifs.

Nd isotope data were obtained in two samples from the Capituva massif (FQS CA957 and MCS CA369b) and one from the Pedra Branca massif (SS PB8a). All samples have negative εNd_{612} values (-7 to -10) and are situated in the enriched field of the εNd x εSr diagram (Figure 1), close to the less radiogenic syn-orogenic regional granites (e.g, 7).

Sm-Nd TDM model ages (Figure 2) vary form ca. 1.5 Ga (the MCS and SS samples) to ca. 1.7 Ga (the FQS sample). If we consider that, as inferred from elemental geochemistry, their parent magmas are derived essentially form LILE-enriched mica-clinopyroxenite veins that were emplaced within the subcontinental lithosperic mantle during a previous subduction event[3,6], it might be admitted as a simple working hypothesis that the εNd x T evolution lines passing through the K-syenitic samples in Figure 2 roughly represent the evolution of this enriched-mantle component in the region. Support for these conjectures comes from the behavior of the Mesozoic low-Ti ultrapotassic rocks of south Brazil and Paraguai, which have similar Sm/Nd ratios, follow exactly the same εNd x T trend (Figure 2) and are likewise inferred to be derived from enriched sources in the lithospheric mantle8. The inference that both Neoproterozoic and Mesozoic potassic melts derive from a similar mantle reservoir is further reinforced by similar $^{87}Sr/^{86}Sri$ (averaging 0.7068 in the latter[8]) and element ratios not strongly affected by fractionation (the MgO contents of the studied syenites are tipically lower than 5 wt.%), as Ti/Y and La/Nb.

Somewhat surprisingly, in spite of all evidence that both groups of potassic rocks come from the same mantle reservoir, the studied syenites are situated clearly to the north of the boundaries of the lithosphere yielding low-Ti melts during the Mesozoic, as inferred from both ultrapotassic and CFB basalts. Two alternative explanations are envisaged: (1) as shown from several lines of evidence, the Guaxupé Domain is allochtonous over the SFC and if the syenites post-date this allochtony (what is not immediately obvious from field data) they might have derived from a lithospheric mantle similar for instance to that situated below the Dom Feliciano belt, a Neoproterozoic terrane in Santa Catarina and Rio Grande do Sul over which most of the best studied low-Ti basalt sections[9] are situated and that seems to have Nd isotope signatures[10] similar to those of the Guaxupé Domain[11]; (2) the "low-Ti" and "high-Ti" mantle reservoirs in southern Brazil may reflect a vertical rather than lateral zoning of the lithosphere[9,12], and as such the generation ultrapotassic magmas having one or another chemical and isotopic signature would reflect basically the depth of melting.

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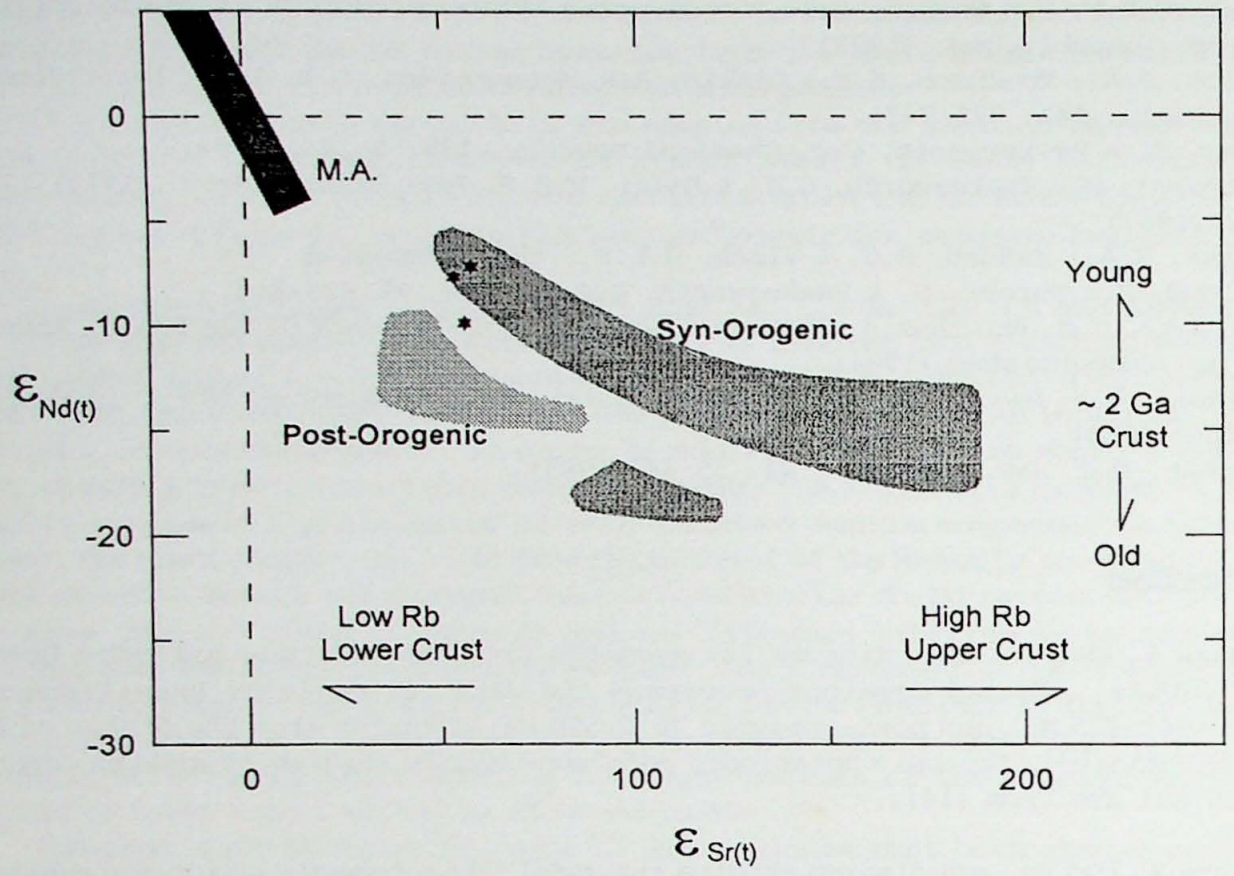
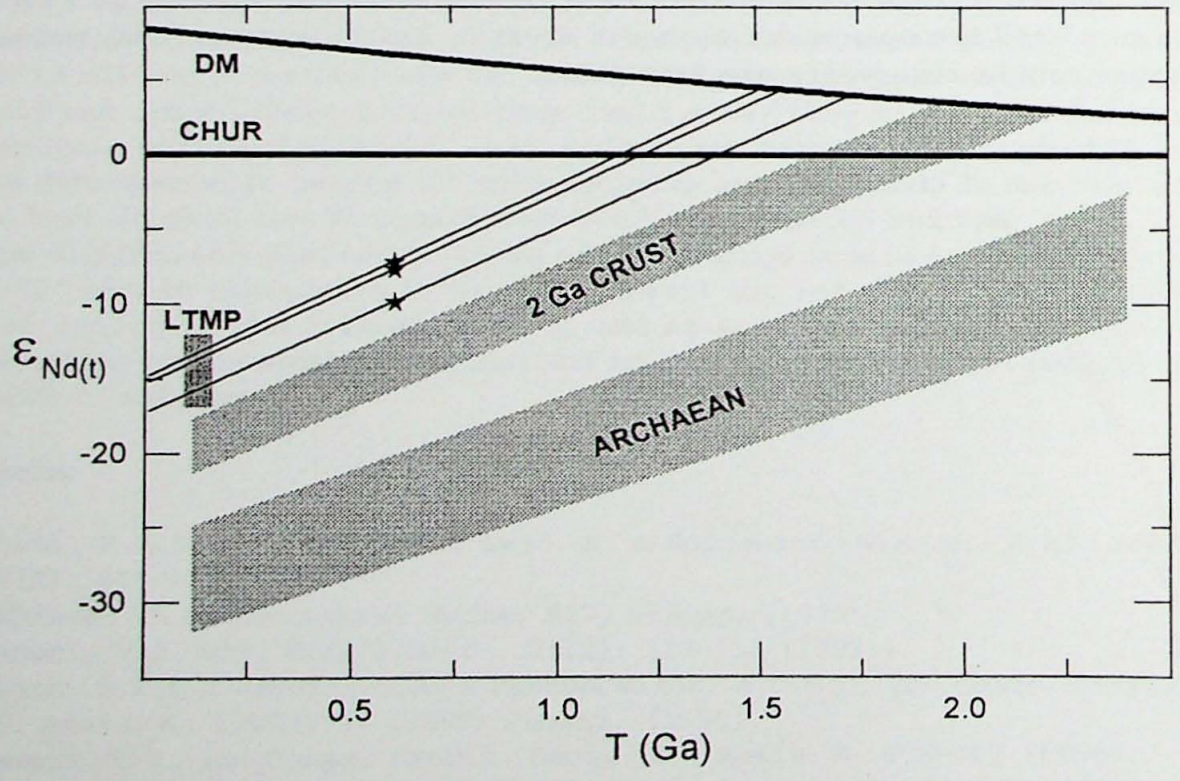
FIGURE CAPTIONS

Figure 1. εNd_T *vs.* εSr_T diagram for syenites from the Capituva and Pedra Branca Massifs (stars). Shaded 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[7,13]. Isotopic notations, reference mantle reservoirs and the "mantle array" (M.A.) are from (14).

Figure 2. εNd *vs.* age diagram showing the model Nd isotope evolution for syenites from the Capituva and Pedra Branca Massifs (stars). Also shown are the field of the low Ti mafic potassic rocks from southern Brazil and Paraguay, LTMP[8], the 2 Ga model regional crust[7] and the mean model Archaean crust[15]. Isotopic notations, model ages and reference mantle reservoirs are from (14).


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


DM
CHUR
0
-10
-20
-30
LTMP
2 Ga CRUST
ARCHAEAN
ε Nd(t)
0.5
1.0
1.5
2.0
T (Ga)